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Photovoltaics Program
Technology Development and Applications
Lead Center

Photovoltaic System Criteria Documents

Volume III: Environmental Issues and Evaluation Criteria for Photovoltaic Applications

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SECTION I

INTRODUCTION

This section identifies the environmental issues and evaluation criteria relating to the suitability of sites proposed for photovoltaic (PV) system deployment. The important issues are defined, briefly discussed and then developed into evaluation criteria.

A. OBJECTIVES

The objectives of this document are to provide system designers with information on the environmental sensitivity of PV systems in realistic applications, to provide background material which indicates the applicability of the siting issues identified, and to define evaluation criteria to facilitate the selection of sites that maximize PV system operation.

B. SCOPE

Initially, the siting issues associated with the intermediate load and grid-connected residential applications are addressed. Previous research concerning potential environmental impacts associated with PV technology indicates that the issues important to central station and remote applications are generally of a different level of significance than those important to intermediate load and residential applications.

To date, DOE's PV Program has emphasized intermediate load and residential applications by targeting the series of Initial System Evaluation Experiments (ISEE's) to intermediate load applications and by emphasizing residential applications in the Multi-Year Program Plan (MYPP). However, many of the issues identified for intermediate and residential applications are applicable to central station and remote applications. Therefore, subsequent iterations of this document will include issues and evaluation criteria generic to each application category. In addition, because both of the applications considered are grid-connected the issues associated with storage systems are not addressed.

The near-term focus of the PV Tests and Applications projects is on silicon technology. Consequently, the issues and criteria presented here are limited to considerations of silicon solar cell systems.

C. APPROACH

The format of this Environmental Evaluation Criteria volume differs from that of the other volumes to include background information in support of the evaluation criteria. The description of siting issues and evaluation criteria is divided into two main sections. The first section describes characteristics of potential site environments and identifies the impacts these characteristics may have on PV system performance. The second section describes PV system operation procedures and identifies the impact these procedures may have on the site environment.

In both sections the discussion of each issue is composed of two parts. First the relevance of the issue to PV system implementation is described; secondly, evaluation criteria which indicate optimal conditions for PV system implementation are given. Sites for PV system implementation can be measured against the optimal conditions described in the evaluation criteria to determine their suitability.

SECTION II

SITE IMPACTS OF THE ENVIRONMENT UPON PHOTOVOLTAIC SYSTEM PERFORMANCE

A. PHYSICAL ENVIRONMENTAL ISSUES AND DATA REQUIREMENTS

Potential impacts of the physical environment on photovoltaic system performance must be identified and their magnitudes assessed, or evaluated, in order to ensure maximum efficient operation of any Test and Application of a residential or intermediate load photovoltaic system.

A broad variety of physical factors enters into the determination of impact of the physical environment upon system performance. Each factor, or impact, can be analyzed independently, but in the final evaluation the synergistic effect of all factors must be assessed. Primary factors that enter into the impact analysis are weather elements (insolation, temperature, atmospheric moisture, humidity and precipitation, and atmospheric pressure or winds), geomorphic factors, geologic factors, soil properties, and biologic elements. For any given site or region one or more of these factors can dominate all others. For example, in some desert environments wind and blowing dust on a regular basis would greatly reduce the operating efficiency of the solar system, while in another area persistent cloud cover would adversely affect receipt of insolation and thus system performance.

Especially critical in the evaluation of physical impacts is the determination of the magnitude of catastrophic events that could significantly impact system performance. These events include thunderstorms, windstorms, tornadoes, and earthquakes.

A brief justification for including the factors listed is given on the following pages. The major criteria for assessing impacts of the environment upon system performance are essentially data requirements so that sites can be selected that have the least adverse physical characteristics. Each factor will be evaluated and the relative importance of each established. As noted, depending upon particular regional characteristics, one factor may dominate in one area but be a minor factor in another.

The proposer must provide the necessary physical data so that a comprehensive evaluation of the impact of the physical site upon the system can be made. It is not expected that all the data will be available for each criteria area, but an effort should be made to provide as much of the information requested as possible. In addition, specifics of a particular project will likely reduce the number of criteria; that is, the scale of the project determines the degree and kind of environmental information required to evaluate potential environmental impacts. The criteria are listed in terms of data; obviously optimal conditions for each factor are preferred (e.g., minimum cloud cover development diurnally or seasonally; no extreme wind gusts; probability of tornadoes near zero).

1. Solar Energy Availability

Availability of insolation and insolation variations are primary considerations in the determination of system performance. Insolation components have definite spatial and temporal variations that are often omitted from the normal insolation data bases. These variations can significantly affect the receipt of solar energy at the earth's surface and in turn, affect system performance. The diurnal and seasonal variations of insolation and the processes by which insolation is attenuated must be considered in the overall evaluation. In order to assess the magnitude of these variations the criteria include a variety of data requirements.

Sunshine data can be used to complement insolation data, especially where the latter are not comprehensive. Hours of sunshine give an indication of the seasonal state of the atmosphere, especially in terms of cloud cover (development and persistence). Variations associated with latitude can be gleaned from monthly sunshine hour data.

Criteria-optimal conditions desired

a) total horizontal insolation, by month
b) direct normal insolation, by month
c) diffuse insolation, by month
d) measuring instruments, maintenance and calibration routines used
e) models used to extrapolate insolation at the intended site
f) distance to nearest insolation monitoring station
g) average annual hours of sunshine
h) seasonal variation in sunshine availability
i) instruments used to measure sunshine availability

2. Visibility

Visibility data, where available, will be used to estimate the level of atmospheric pollution. Various pollutants can hinder system performance by both reducing the total amount of insolation and by partitioning insolation into its major components. Visibility data, along with other meteorological data, can be used to evaluate the intensity of dust storms in an area.

Criteria

a) average monthly visibility
b) distance to nearest recording station

3. Cloud Cover

Cloud cover can adversely affect the performance of a PV system by substantially reducing the amount of insolation available at a site. Because the development and persistence of cloud cover has definite spatial and temporal characteristics, an assessment of these characteristics are important inputs into the overall evaluation of site suitability for an experiment. The assessment requires data on the diurnal and seasonal variations in cloud cover. Identification of the cloud type, or family, assist in determining the significance of the cloud cover. Cloud cover data and sunshine data can also be used to estimate the availability of insolation at a site if reliable insolation data are not available.

Criteria

a) average annual cloud cover in percent of total sky cover
b) monthly mean cloud cover in percent of total sky cover
c) diurnal variation of cloud over period of peak electric demand
d) predominant cloud type or family, by month

4. Wind

Wind can significantly affect the operation and maintenance of a system. Wind is very site specific and influenced by a variety of factors, including topography. Wind can have either negative or positive effects depending upon its direction and velocity. For example, a light wind precludes the formation of dew on solar arrays during periods of high humidity and/or shallow temperature inversion development. Wind can also hinder the operation of a system by airborne transportation of surface materials which can settle on the arrays, thereby reducing the efficiency of the arrays and potentially scratching array surfaces.

Criteria

a) mean monthly data on wind speed and direction
b) monthly extreme wind speeds and direction
c) average annual wind speed
d) data sources and distance to nearest recording station

5. Atmospheric Moisture

Atmospheric moisture, humidity, and precipitation can significantly affect the operation and maintenance of a photovoltaic system. Accordingly, data on humidity and precipitation are used to evaluate the appropriateness of a photovoltaic operation.

Precipitation data will be used to assess the likelihood of severe erosion potential at a site (data on soil type and slope percentage are also necessary). Humidity data can be used to evaluate potential environmental degradation of the solar arrays and the likelihood of condensation formation on the arrays, diurnally and seasonally. An indication of the degree of sensible heat convection from the array can be determined from data on humidity and temperature.

Criteria

a) average monthly diurnal range of humidity
b) mean monthly values of relative and absolute humidity
c) mean monthly precipitation
d) mean monthly snowfall
e) monthly values of extreme precipitation
f) 24-hour maximum precipitation amount and probability of occurrence

6. Temperature

Temperature data are used to determine the optimal operating temperature. These data are used with other meteorological data to make the assessments.

Criteria

a) average monthly diurnal ranges of temperatures
b) mean monthly temperatures
c) monthly temperature extremes

7. Severe Events

Of greater significance than the average conditions, which allow for broad siting assessment, are severe events that can affect or damage photovoltaic systems. Severe events that require evaluation are primarily meteorological and represent different types of storms.

Criteria

a) thunderstorms, number of days per month
b) hailstorms, number of days per month
c) tornadoes, number of days per month
d) ice storms, number of days per month
e) flash floods, number of days per month

8. Geomorphology

The geomorphological setting can have a significant impact upon the operation and maintenance of the photovoltaic system. Because of their collective effects on other physical variables, geomorphic factors can either make an impact less or more severe than it would otherwise have been.

Criteria

a) slope in percent
b) aspect (compass orientation)
c) elevation
d) relief of site environs (range of elevation)
e) landform type

9. Soils

Soil type has a direct bearing upon the potential for erosion during periods of intense precipitation and can be used to evaluate the potential for deflation of fine-grained materials.

Criteria

a) soil type (taxonomy)
b) texture profile of soil at intended site
c) occurrence of desert pavement or vesicular layers

10. Geology

Geological factors enter into evaluation of impacts of physical environments upon photovoltaic systems in various ways. Primary among these are slope stability, depth to bedrock and earthquake potential. Each can significantly affect the construction, operation and maintenance of the system.

Criteria

a) bedrock, type and depth of overburden
b) slope stability
c) faults, location and history of recent seismic activity, seismic zone classification

11. Biology

Biological impacts are, for the most part, of less significance than the potential impacts from weather or geomorphic-related impacts. Of greatest concern is the type of vegetation that surrounds the proposed site. Identification of the vegetation type allows determination of the degree of potential shading and of bird populations (residents or migratory); several experiments have shown that the accumulation of bird guano on obstructions placed in an open environment (e.g., desert) can be exceptionally rapid. Any obstruction tends to become a nesting or roosting area for many bird species.

Criteria

a) vegetation type in and near proposed site
b) resident and migratory bird species common to area (estimate numbers)

B. SOCIAL AND INSTITUTIONAL ISSUES

The major institutional issues pertaining to PV system applications arise from consideration of codes and ordinances, public and private financial policies, insurance liability, and utility interface. Insurance companies, financial institutions, and legal institutions depend upon codes, ordinances and standards for guidelines in assessing risk, safety, compatability, reliability and compliance. While model codes and standards already exist for solar thermal systems, their applicability to PV systems is limited because of the distinct electrical aspects and physical composition. Thus, until model codes for photovoltaics are drafted and adopted, the institutions involved with PV systems will vary widely in terms of their regulatory complexity, impediments, and flexibility. This section identifies and decribes these institutional issues and sets forth evaluation criteria pertinent to phases of PV application experiments.

1. Solar Access

A solar energy facility can operate only if it receives sunlight. Therefore, site proposers should demonstrate that some form of guaranteed solar access will be available at the site for the duration of the system operation. In many jurisdictions where a legal right may be unobtainable, guaranteed access may not arise as a constraining factor because of the physical character of the site (e.g. photovoltaic arrays in a location where it is physically impossible to block insolation). If, however, solar access is guaranteed by a legal right, it is important that granting such a right does not limit the pre-proposal land uses of surrounding property owners unless they are compensated.

Criteria

a) guaranteed solar access is available at the site for the duration of the system operation
b) guaranteed solar access does not result in an uncompensated loss to surrounding property owners in the use of their land

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2. Environmental Regulatory Requirements

Environment-related permits and licenses (e.g., water, air) required for PV systems will vary depending upon the site. Before any of these permits or licenses are granted, the lead agencies for the project (namely DOE and, in most cases, the local planning authority) will have to assess the potential environmental impacts of the proposed project to comply with the National Environmental Policy Act (NEPA) and any existing state environmental statutes. Therefore, to expedite environmental review and permit acquisition processes, it is important that site proposers include information in proposals indicating their awareness of the types of permits, licenses and procedures required for PV system siting and operation.

Criteria

a) site proposers have a clear understanding of the permits, licenses and procedures required for PV system siting and operation
b) time for permit acquisition is not lengthy, and procedures are not too complex with respect to the time and monetary resources available for the project

3. Zoning

City and county ordinances reserving sections of a city, borough, township or county for different purposes (e.g. residential, commercial or industrial) may have to be changed to permit deployment of a PV system. A change in the existing set of zoning ordinances could adversely impact a community by promoting incompatible adjacent land uses, destabilizing the efficient distribution of public services (e.g., fire, police), or altering existing development patterns. While the potential magnitude of any of these impacts would depend upon the type and size of the system deployed, any type of zoning change would require additional regulatory procedures and permits. Therefore, it is important that proposers for sites which require zoning change demonstrate the compatability of the PV system with surrounding land uses.

Criteria

a) no change or minimal change from existing zoning
b) compatibility with surrounding land uses

4. Building Codes, Standards and Controls

Some construction and design standards are commonly included within zoning ordinances; for example, building height limitations, architectural design guidelines (commonly referred to as aesthetic controls), and building set-back requirements. In addition, all structures must satisfy the standards of basic construction codes (e.g., fire, electrical, plumbing, etc.) (These codes may require that licensed electricians install photovoltaic arrays. This requirement would lead to the involvement of labor unions in insuring that the systems they install are approved for safety.) Satisfying these zoning and "basic" standards should not pose major obstacles to small-scale PV system applications, but larger-scale systems could encounter considerable regulatory impediments and conflicts. Therefore, it is important that site proposers demonstrate an understanding of regulatory requirements and procedures that must be met and followed to assure avoidance of delays in the approval and certification of PV systems.

Criteria

a) site proposers demonstrate a clear understanding of the building codes and standards necessary for system certification
b) time for permit acquisition is not lengthy, and procedures are not complex with respect to the time and monetary resources available for the project

5. Utility Interface

It is important that proposed sites for grid-connected systems be conveniently located for transmission line tie-in. Additionally, the utility serving the site should be capable of providing a reliable source of back-up power for system users. While these two requirements are the major factors in terms of utility interface for small-scale grid-connected experiments, the issues of PV system ownership and utility rate structures become predominant with larger-scale application experiments. For example, with large-scale residential applications in which photovoltaic systems are user-owned, public utility commission hearings, which are commonly lengthy, expensive and controversial, will likely be required as utilities attempt to seek approval to recover the capital cost of the back-up systems.

Criteria

a) the proposed site is conveniently located for transmission line tie-in
b) the utility serving the site is capable of providing a reliable source of back-up power
c) site proposers have a clear understanding of any required regulatory proceedings and such procedures are not lengthy and complex with respect to the time and monetary resources available for the tests and applications

6. Insurance and Liability

Most insurance companies have had little, if any, experience with solar energy systems - especially photovoltaics. This may result in relatively high insurance premiums for PV systems. To minimize unknown risk (and therefore the cost of premiums), it is important that site proposers demonstrate compliance with any additional codes and standards deemed appropriate by insurance companies but not specifically required by some state or local officials (e.g., lightning protection codes).

Criteria

a) local insurance carriers have had experience with solar energy device (e.g., solar cooling and heating systems)
b) site proposers have a clear understanding of insurance carriers' requirements for code and standard compliance

7. Community/Regional Support

It may take a period of time before photovoltaic tests and applications achieve an acceptable level of efficiency. In the interim, experimental performance is open to public scrutiny, which could lead to adverse publicity. This may injure development programs, preventing the required research to achieve maximum efficiency. Therefore, a site within an area positively inclined toward photovoltaic development can provide a more beneficial site than one in an area without this inclination. A locality with experience with innovative technologies (e.g. solar heating and cooling, passive solar architecture, etc.) may indicate such a positive inclination.

Criteria

a) the locality has a variety of media types (e.g. newspapers, newsletters and television stations) which will publicize the locality's involvement in the photovoltaic system experiment
b) the locality has a demonstrated interest in innovative technologies

SECTION III

PHOTOVOLTAIC SYSTEM IMPACT ON THE SITE ENVIRONMENT

A. PHYSICAL ENVIRONMENTAL ISSUES

In this section, the impact PV system processes may have on the site environment are discussed. A significant impact created by PV system activities which cannot be mitigated will make the site inadequate. Although PV systems may impact the environment less than any of the conventional electricity generating technologies, as a new technology there may be aspects which have not yet been identified. As PV technology is developed, it will be important to identify these environmental impacts and determine their significance. The issues addressed in this section are: ecosystems, air quality, water quality and supply, waste disposal, noise, health and safety and short-term socioeconomic impacts.

1. Ecosystems

The impact PV systems may have on ecosystems in grid-connected residential and intermediate load applications is most significant during construction and operation/maintenance activities. The ecological issues identified in this section are particularly relevant to intermediate load applications. The ecological issues discussed include effects of the photovoltaic system on soils, vegetation, wildlife and climate.

Soil disruption negatively impacts vegetation, which subsequently may impact local wildlife populations. In deserts, disruption of the surface would be particularly damaging because desert surfaces often have a layer of crust or pavement. Crust consists of desert lichens, mosses and sediments which stabilize subsurface soil horizons. The crust is vulnerable not only to movement of light construction equipment but also to pedestrian traffic. Desert pavement also provides a stabilizing environmental influence. It consists of a surface cover of rocks and pebbles. Desert pavement may be capable of supporting light-duty vehicular activity. Disruption of either results in increased wind and water erosion which leads to degradation of both vegetation and wildlife. Furthermore, in areas of sparse vegetation and minimal rainfall, vegetative recovery is slow.

Vegetative disruption could alter faunal community structures by elimination or reduction of food sources, thereby increasing mortality rates among non-mobile species and dispersing highly mobile species. The significance of the impact is intensified in areas supporting wildlife included on the rare and endangered species list.

Finally, climatic impacts may potentially impact ecology on both mesoclimatic and microclimatic scales. Potential mesoclimatic impacts include the creation of atmospheric heat islands, reduced wind speeds and increased cloudiness. The extent of mesoclimatic effects is a matter of scale in both residential and intermediate load applications, and is site-specific. For example, it has been hypothesized that large-scale or widesdpread use of PV systems could create heat islands. In an urban or industrial environment where there is a high level of waste heat emitted into the atmosphere, implementation of photovoltaic arrays on a large scale would contribute to the heat already being generated. In contrast to mesoclimatic effects, microclimatic effects probably have greater significance to intermediate load applications than to residential applications. Microclimatic effects result from increased shading from arrays. Studies have indicated that such shading has significant impacts, altering both soil moisture content and ambient temperatures. Subsequent changes include growth of new vegetation types and attraction of new faunal species into the area. Significance of all ecologic effects depends upon the extent to which the site has been previously disturbed.

Criteria

a) soil types existing at the proposed site should be capable of supporting PV system activities without significantly impacting off-site soil and vegetation.
b) PV system implementation should not significantly impact critical wildlife habitats or endangered species on the site.
c) Climatic conditions on the proposed site should not be prone to alteration which could significantly impact the ecology of the region due to PV system activities.
d) To assess ecological impacts on the site, proposals should characterize the site's soil type and stability, evaluate species distribution in terms of occurrence and type, identify species type, distribution, degree of mobility and indicate species on the rare and endangered species list present on the site.

2. Air Quality

Operation of PV systems may impact the air quality of proposed sites by several means. During construction, dust may be released into the atmosphere and fossil fuel combustion products emitted from construction equipment. These impacts are anticipated to be most significant in the intermediate load application where the PV system is installed on the ground and construction necessitates site clearing, grading and excavation. Similarly, these impacts may occur during system decommissioning.

During operation the primary detrimental impacts on air quality are thermal releases. While part of the sun's rays are converted to electricity within the PV system, some thermal energy is absorbed by the array itself and re-radiated to the atmosphere. In addition, if an array malfunctions off-gassing may occur. Gases that may escape from PV systems arise from thermal or photolytic degradation of adhesives and plastics comprising the arrays, and polychlorinated biphenyls (PCB'S) from power conditioning equipment. System malfunction can also ignite fires that may release combustion products of many different substances within the system and on the site, to the atmosphere.

Operation of PV systems reduces the need to combust fossil fuels in conventional electricity generating plants, thus reducing air quality impacts. However, the electricity user may be located in a different air basin from the plant generating its electricity and therefore the use of PV systems may not increase the air quality at the user's site.

Criteria

a) normal PV system implementation activities in all phases must not exceed the air quality standards enforced at their sites
b) proposals must contain information indicating air quality in the region of the site and must indicate air basin classification, if so designated; (i.e., nonattainment area, attainment area, PSD (Prevention Significant Deterioration area)

3. Water Quality and Supply

Water quality and supply issues become significant to photovoltaic systems during construction, operation and maintenance. The first two phases involve water quality, while all impact water supply. During construction, depending upon the dust level and proximity of the PV system to surface waters, fugitive dust falling in the water could increase its biological oxygen demand. While PV system operation does not require any water, daily water requirements may become an issue in the event that photovoltaic systems are installed in remote areas low in construction manpower. Should there be a significant influx of workers to the community, daily water supplies could be taxed. Cleaning the arrays during maintenance does not require significant amounts of water but detergents used in cleaning may threaten water quality.

Criteria

a) the water supply and waste disposal systems at the proposed site must be capable of supporting PV system activities without significantly impacting existing water users or hydrologic cycles
b) the proposed water supply and disposal systems for PV systems at the site must have the concurrence of local water quality protection agencies
c) to assess water quality and supply, proposals must contain

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information on how PV system implementation on the site will alter water quality and quantity of supply by indicating the availability of water treatment facilities and the existing demand on the local water supply

4. Waste Disposal

Wastes associated with PV system implementation are primarily conventional materials, with the exception of photovoltaic cells. Silicon cells are chemically stable, non-toxic, and may be crushed and disposed of in landfills. However, repurification of the silicon in malfunctioning cells and its refabrication into new cells may become a viable option for waste material in the future.

The quantity of conventional waste products from PV system implementation is not anticipated to be excessive in grid-connected residential and intermediate load applications. Wastes are generated primarily from construction and decommissioning phases of PV system utilization and consist of extra, damaged, and obsolete array foundation, support and system components. While most components are recyclable some are not and must be disposed of.

<u>Criteria</u>

a) waste disposal facilities capable of receiving crushed silicon cells and balance of system (BOS) waste materials must be convenient to the site and the site proposal must describe the proposed waste disposal plan
b) any on-site disposal of material must have the approval of local water quality agencies, health and safety agencies, and other agencies with legal jurisdiction

5. Noise

Impacts of noise associated with PV system implementation occur during construction, repair, and decommissioning. There is essentially no noise generated by PV systems during normal operation. The noise emitted during construction, repair, and decommissioning procedures is comparable to conventional construction activities. In the grid-connected residential application, noise levels are highest from electric power tool utilization. This is also the case in the intermediate load center application if the system is not roof-mounted. However, if ground located, high noise levels would result from heavy earth moving equipment, grading and digging foundation implacements.

<u>Criteria</u>

a) installation and decommissioning activities must be planned for daylight hours, especially in the grid-connected residential application. Intermediate load center applications in populated areas should also install and decommission PV systems between 8:00 a.m. and 5:00 p.m. Repair activities should be planned for early evening hours in grid-connected residential applications and in evening hours in intermediate load applications to take advantage of the system's natural down-time. In residential areas where repair activities can disturb neighbors the earlier in the evening repair activities are performed the better. In intermediate load applications, where the distance between the facility and the people who would be disturbed by repair noise is greater, it is less important to schedule repair activities as early in the evening as possible

b) the proposal must include repair and maintenance schedule

6. Health and Safety

While lifecycle phases (construction, operation and decommissioning) of a photovoltaic system are not expected to pose any novel health and safety concerns, this category of issues needs to be addressed. Safety concerns during construction of residential applications involve hazards associated with electric power tool utilization and for the most part should be similar to any other activity requiring construction workers to work on a roof. Concerns raised in the past over construction of intermediate load facilities include increased shock hazards from electric power tool utilization and exposure to infectious fungus diseases, e.g., valley fever. While potential for shock hazards applies to any photovoltaic construction activity, the concern over valley fever applies primarily to construction activities in some desert environments. The issue has been successfully mitigated due to advances in the medical field and implementation of standard dust abatement measures during construction. General health considerations arising from fugitive dust can likewise be mitigated.

Health and safety issues associated with the operation phase of either residential or intermediate load facilities involve glare potential from the arrays and atmospheric releases of polychlorinated biphenyls (PCB'S) from power conditioning equipment; the former is not likely to be a concern. Finally, health and safety concerns from accidents or catastrophic events such as fire, seismic activity or lightning should not be significant because silicon is chemically inert.

Criteria

a) proposals may be evaluated from the health and safety standpoint based on the extent to which the following issues have been addressed: dust abatement measures during construction and operation, safety procedures during roof activity, eye protection devices during operation and maintenance, delineation of health and safety precautions around power conditioning equipment, and general health and safety procedures during construction activity.

B. SOCIAL/INSTITUTIONAL ISSUES

1. Short-term Socioeconomic Impacts

The degree to which photovoltaic system construction, operation and maintenance activities may impact localities will depend upon: (1) the scale of the photovoltaic system and (2) the existing level of resources in the locality (i.e. manpower, equipment, and material). A locality which possesses the appropiate skills, adequate quantities and qualities of materials and equipment for photovoltaic system development will be least impacted by system activities. A photovoltaic system in a locality without these resources will require the importation of people, materials, and equipment which would create a strain on public services (e.g. water supply, sewage treatment, housing, etc.).

<u>Criteria</u>

a) the locality possesses the appropriate skills, adequate quantities and qualities of materials and equipment for a photovoltaic system.