AN EVALUATION OF THE LAND AND MATERIAL REQUIREMENTS FOR THE SATELLITE POWER SYSTEM

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Current research and evaluation of the physical resources requirements for SPS concentrated on three topics: land requirements and the siting of rectenna; the environmental impacts of a rectenna siting, and the materials requirements for SPS. The first two of these topics focus exclusively on the earth-based element of the SPS while the materials assessment considered requirements for both the space and earth systems. The identification, classification, and selection of adequate areas deemed eligible for rectenna siting is critical to further consideration of the SPS reference system. Although each specific rectenna site will generate unique environmental, social, and economic impacts, the prototype environmental assessment illustrates the range of problems which may be encountered. The sheer size and scope of total SPS operations begs questions relating to detailed materials requirements and the availability which are addressed in the materials assessment work.

The methodology employed in the rectenna siting work has been one of systematically eliminating areas in the contiguous forty-eight states which could not be used for rectenna siting. Areas were eliminated through the analysis of categories of variables (Exhibit 1) ranging from those variables which would absolutely exclude rectenna siting, to those which potentially might exclude rectenna siting, to those affected by SPS design and/or cost constraints. Among the absolute exclusion variables are topography, specifically designated lands such as national recreation areas and military reservations, specific land use areas such as populated areas and interstate highways, and areas which pose problems of electromagnetic compatibility. Potential exclusion areas include specifically designated lands such as Indian reservations and national parks and grasslands, specific land-use areas such as croplands, areas which pose problems of electromagnetic compatibility, and flyways of waterfowl and and other birds. Design/cost variables included natural occurrences such as tornadoes, freezing rain, and seismic risk.

These "eligible" areas are plotted on 7.5 minute quad maps roughly 13 kilometers on a side for maximum definition and the analytic results have been automated to to enhance further studies as well as the performance of sensitivity analyses. Sensitivity analyses and validation studies have been performed as part of the work. In short, the methodology for determining "eligible" areas for SPS rectenna sites is highly automated, elegant, and widely applicable. What the methodology shows is that there probably are adequate suitably-located areas for rectenna sites in the U. S. It shows that topography is the most important physical variable in determining eligible areas; sites can be placed in different terrain but only at substantial cost penalties incurred in site preparation. Important questions the methodology does not completely address are those concerning electromagnetic compatibility and the effect of microwave energy on migratory birds.

Considerations for the selection of a specific rectenna site has been addressed in a prototype environmental impact statement (EIS) performed for a site in the California desert about 250 kilometers north of Los Angeles. This SPS study benefitted from data assembled and analyses performed for an EIS for a geothermal project in the same area and required only the hypothetical placement of a rectenna in the area and alteration in the analyses. The specific objectives of the study were: (1) to develop a comprehensive prototype assessment of the non-microwave-related impacts on the natural and human environments of the SPS reference systems ground receiving station (GRS); (2) to assess the impacts of GRS construction and operations in the context of actual baseline data for the specific site; and (3) identify the critical GRS characteristics or parameters that are most significant in terms of both the natural and human environment. The prototype EIS concluded that the critical project parameters include: the sheer size and intensivity of use of the contiguous land area required by an SPS GRS; the lack of flexibility in siting individual rectenna structures once the rectenna boundaries are established; the difficulties in finding suitable sites that do not conflict with other societal needs and values; uncertainties relating to reestablishing nature ecosystems following total ecosystem modifications during construction, and the related need for further research into microclimatic effects near the ground-surface beneath the rectenna panels; the proposed two-year GRS construction schedule which has significant implications for project socioeconomic impacts, air quality, water supply and biological resources and possible logistical problems for GRS construction - all of which could be reduced by extending the construction schedule; and the public versus private GRS ownership which has significant implications for GRS impacts on the local tax base.

Since the earth and space components of the SPS will require enormous amounts of materials, a materials assessment was conducted to detail the material requirements for SPS and to identify potential availability problems and constraints so that responsive action could be defined and incorporated into overall SPS planning. The materials assessment analysis identified 22 materials used in the SPS, and tracing the production processes for these 22 materials, identified a total demand for over 20 different bulk materials and revealed a requirement for nearly 50 raw materials. The analysis evaluates each material in terms of world and domestic supply, manufacturing capacity and adequacy of the data base. The refined methodology uses computerized screening of the materials with the flags raised at various threshold levels as a function of several parameters, such as current domestic and world production rates and domestic and world reserves. Thresholds can be changed and the analysis rapidly run to determine sensitivities.

Assessment of these SPS material requirements produced a number of potential material supply problems (Exhibit 2), the more serious associated with the solar cell materials (gallium, gallium arsenide, sapphire, and solar grade silicon), and the graphite fiber required for the satellite structure and space construction facilities. In general, the gallium arsenide SPS option exhibits more serious problems than the silicon option, possibly because gallium arsenide technology is not as well developed as that for silicon.

EXHIBIT 1. CATEGORIES OF THE VARIABLES

ABSOLUTE EXCLUSION

- Inland Water
- Military Reservations
- Atomic Energy Commission Lands
- National Recreation Areas
- SMSA's
- Adjusted Population Density
- Marshland Vegetation
- Perenially Flooded Areas
- Endangered Species
- Interstate Highways
- Topography Unacceptable
- EMC-A150
- EMG-A100
- EMC-A50

POTENTIAL EXCLUSION - HIGH IMPACT PROBABILITY

- Indian Reservations
- National Forests and Grasslands
- Wild and Scenic Rivers
- Agricultural Lands - Mostly Cropland
- Agricultural Lands - Irrigated
- EMC-P150
- EMC-P100
- EMC-P60
- EMC-P50

POTENTIAL EXCLUSIONS - IMPACT UNKNOWN

- Flyways of Migratory Waterfowl - Ducks
- Flyways of Migratory Waterfowl - Geese

DESIGN/COST VARIABLES

- Tornado Occurrence
- Acid Rainfall
- Snowfall
- Freezing Rain
- Sheet Rainfall
- Wind
- Lightning Density
- Hail
- Seismic Risk
- Timbered Areas
- Water Availability

MATERIALS

MATERIAL	PERCENT SUPPLIED AS BY-PRODUCT	WORLD PRODUCTION GROWTH RATE	SPS PERCENT OF DEMAND	NET PERCENT IMPORTED	PERCENT WORLD RESOURCE CONSUMPTION	COST $/kW
Threshold Value	50%	10%	10%	50%	200%	$50/kW
Gallium	A	A	A	A		
Graphite Fiber		A	A			A
Sapphire		A	A			A
Silicon SEG		A	A			A
Gallium Arsenide		A	A			A
Electricity						A

EXHIBIT 2