SATELLITE POWER SYSTEMS PROGRAM

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The Department of Energy and the National Aeronautics and Space Administration are engaged in an intensive three-year analysis to determine what course of action the Federal government should pursue relative to this nonconventional energy system.

Opinions concerning the potential viability of the concept now cover a wide emotional spectrum which ranges from very negative to highly enthusiastic. In reality, this diversity of opinion merely reflects the uncertainty which surrounds the technical feasibility and operational practicability of the idea. Accordingly, we are now in the process of developing an information base which will be sufficient by 1980 to support a decision on whether or not to proceed with the next phase of the program.

The current program plan which was approved by the Administration in February of this year is, with the exception of microwave effects, entirely analytical. We must, therefore, realize that this effort is very unlikely to achieve a firm recommendation to implement the concept. Rather, if no insurmountable barriers are found, recommendations directed to laboratory experimentation and field and space testing are likely to result.

The program is now organized as shown on Figure 1. DOE has overall program coordination responsibility which is assigned to an SPS project office under the Director of Energy Research. NASA is responsible for the definition of the overall systems concept and all technology which is involved. The Office of Energy Programs, NASA Headquarters, manages the effort and is supported by Marshall Space Flight Center and Johnson Space Center. The remainder of the program is managed by the DOE with the SPS project office and the Assistant Secretary for Environment sharing programmatic responsibility. Participating DOE laboratories include Battelle Pacific Northwest, Los Alamos Scientific Laboratories and the Argonne National Laboratory.

The SPS Working Group assists the DOE coordinator and is composed of senior project personnel from both Agencies. The objective is to insure that the results of work performed by the various participating organizations are integrated to achieve scheduled program milestones.

The major milestones are shown by Figure 2 and relevant activities for each fiscal year are listed in Figure 3. It should be noted that, along with the baseline concept selection milestone in Oct. 1978, initial recommendations for an experimental research plan will also be completed. We anticipate that the initial plan will be directed mainly to definition of experiments which should start in 1980 and which address highly critical program issues. In addition, an outline of other experimental research projects which can begin in subsequent years and which will be needed to achieve full technology readiness for SPS will be prepared.

Our System Definition Centers, JSC and MSFC, are now working to evolve a consolidated recommendation for a baseline SPS concept. Preliminary recommendations based upon independent assessment by each Center of various candidate SPS concepts were presented in January of this year. As was expected there were some significant differences as well as many areas of agreement. The differences are now in process of resolution by way of a MSFC/JSC working group. The essential elements of the initial recommendations made by the Center are shown by Figures 4 and 5.

It is important to note that the baseline system approach is expected to continue to change with time as we become more knowledgable of the specific problems to be resolved and as our technological capability evolves. However, it is important to establish and maintain a baseline to guide the combined efforts of the DOE and NASA as the program progresses.

Program funding by Agency management responsibility is shown by Figure 6. It is anticipated that if no absolute barriers to the concept are identified by 1980, that additional funding for further field test work could be made available by the Administration.

The technological challenge presented by the SPS is well recognized by all who are familiar with the size and complexity of the system. However, the overall system problem is only partially technical - in fact, the most difficult issues to resolve will probably lie in the environmental effects and international areas. Accordingly, it will be mandatory that NASA continue to work closely with the DOE as we join forces to assess all aspects of the problem to gain the understanding which is so vitally needed to guide our future programmatic effort.

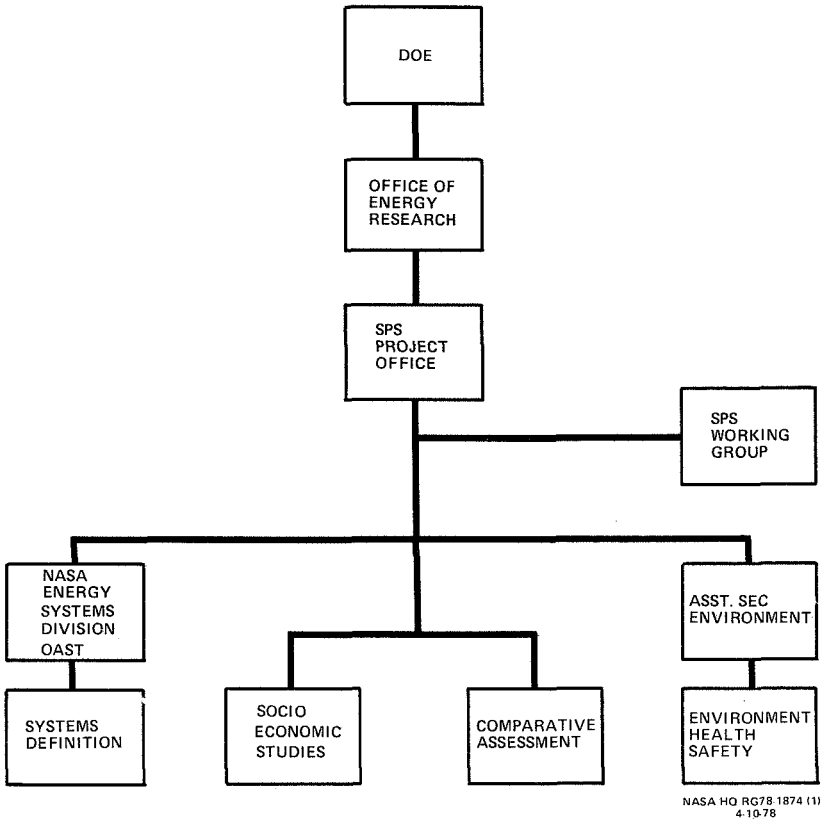

Figure 1.

MAJOR PROGRAM MILESTONES

MILESTONE	1977 J F M A M J J A S O N D	1978 J F M A M J J A S O N D	1979 J F M A M J J A S O N D	1980 J F M A M J J A S O N D
PROGRAM START	▼ JULY			
BASELINE CONCEPT(S) SELECTION		▽ OCT.		
PRELIMINARY PROGRAM RECOMMENDATIONS			▽ MAY	
UPDATED PROGRAM RECOMMENDATIONS				▽ JAN.
FINAL PROGRAM RECOMMENDATIONS				▽ JUNE

Figure 2.

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ACTIVITY SCHEDULE FOR SPS PROGRAM

YEAR	NASA MANAGED	DOE MANAGED
1977	CONCEPTUAL SYSTEM (S) DEFINED TECHNICAL REQUIREMENTS IDENTIFIED SUBSYSTEM TRADEOFFS COMPLETED	INITIAL GUIDELINES DEFINED INITIAL METHODOLOGY DETERMINATION
1978	BASELINE CONCEPT(S) RECOMMENDATION PRELIMINARY SYSTEMS INTEGRATION BASELINE CONCEPT(S) SELECTION * EXPERIMENTAL RESEARCH PLAN	INITIAL ENVIRON. IMPACT ASSESSMENTS INTERIM METHODOLOGY DETERMINATION PRELIMINARY ENV. IMPACT ASSESSMENT BASELINE CONCEPT(S) SELECTION * INTERIM METHODOLOGY UPDATE
1979	BASELINE SYSTEMS INTEGRATION PRELIMINARY PROGRAM RECOMMENDATIONS * FINAL SYSTEMS INTEGRATION TECH. STATUS ASSESSMENT	BASELINE ENVIRON. IMPACT ASSESSMENT PRELIMINARY PROGRAM RECOMMENDATIONS * FINAL ENVIRON. IMPACT ASSESSMENT FINAL COMPARATIVE ASSESSMENT FINAL METHODOLOGY
1980	UPDATED PROGRAM RECOMMENDATIONS * STUDY INTEGRATION TECHNOLOGY ADVANCEMENT PLAN	UPDATED PROGRAM RECOMMENDATIONS * STUDY INTEGRATION FINAL PROGRAM RECOMMENDATIONS *

(* MAJOR MILESTONES)

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Figure 3.

SPS PRELIMINARY BASELINE COMPARISON

	MSFC	JSC
POWER GENERATION CAPABILITY	5GW	10 GW
OVERALL DIMENSIONS (Km)	3.8x21	5.3x24
POWER CONVERSION-PHOTOVOLTAIC	GaAs (CR=2) (0.2 MILLS)	SILICON (CR =1) (2. MILLS)
STRUCTURE MATERIAL	ALUMINUM	GRAPHITE COMPOSITE
CONSTRUCTION LOCATION	GEO	LEO
TRANSPORTATION		
● EARTH-TO-LEO -CARGO (PAYLOAD) -PERSONNEL (NO)	HTO WINGED 1or2-STAGE (91,000 K g) MODIFIED SHUTTLE (75)	VTO WINGED 2-STAGE (424,000 K g) MODIFIED SHUTTLE (75)
● LEO-TO-GEO -CARGO	DEDICATED ELECT. OTV	SELF-POWERED $^1/_8$ SPS MODULES
-PERSONNEL (NO)	2-STAGE LOX/LH_2 (75)	2-STAGE LOX/LH_2 (75)
MICROWAVE POWER TRANSMISSION		
● NO. OF ANTENNAS	1	2
● ANTENNA POINTING/CONTROL	MOTOR DRIVE	CMGs
● DC-RF CONVERTER	KLYSTRON	KLYSTRON
● FREQUENCY (GHZ)	2.45	2.45
● RECTENNA DIMENSIONS (Km)	10x13	9.4x13
● RECTENNA POWER DENSITY (mw/cm^2)		
CENTER	23	23
EDGE	1	1

Figure 4.

SPS PRELIMINARY BASELINE COMPARISON

MASS STATEMENT (10^6 KG)	5 GW	10 GW
COLLECTOR ARRAY (DRY)	13.9	51.8
ANTENNA SYSTEM	14.2	25.2
TOTAL SPS DRY WEIGHT	28.1	77.0
TOTAL SPS DRY WEIGHT WITH 30% GROWTH	36.5	100.1
COST (10^9 1977 $'s)		
COST TO PLACE FIRST SPS (INCLUDES DDT & E)	66	87
AVERAGE UNIT SYSTEM COST	14	23

Figure 5.

SATELLITE POWER SYSTEM

PROGRAM DEFINITION PLAN
(FUNDING BY AGENCY MANAGEMENT RESPONSIBILITY)

	FY 77	FY 78	FY 79	FY 80	TOTAL
DOE					
ENVIRONMENTAL FACTORS	220	1,940	2,050	1,740	5,950
COMPARATIVE ASSESSMENT	95	376	754	565	1,790
SOCIO-ECONOMIC ASSESSMENT	164	537	537	322	1,560
TOTAL DOE	479	2,853	3,341	2,627	9,300
NASA					
SYSTEMS DEFINITION	1,800	1,700	1,300	800	5,600
SPACE RELATED TECHNOLOGY	700	0	0	0	700
TOTAL NASA	2,500	1,700	1,300	800	6,300
TOTAL DOE/NASA	2,979	4,553	4,641	3,427	15,600

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Figure 6.