

# Deep Space Network Energy Program

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*If the Deep Space Network is to exist in a cost-effective and reliable manner in the next decade, the problems presented by international energy cost increases and energy availability must be addressed. The Deep Space Network Energy Program has been established to implement solutions compatible with the ongoing development of the total network.*

## I. Introduction

The question of energy availability and burden of increased energy cost is affecting the Deep Space Network (DSN) just as it is every segment of our nation's activities. Each of the three DSN complexes has an average base power requirement of between 1.5 and 2.0 megawatts. During 1979, the cost of fuel to supply this power more than doubled in one day at Madrid, escalated approximately 80 percent in eight months in Australia, and increased 25 percent in one month at Goldstone, California. While each of these conditions may not be repeated in the near future, there is little question that costs will continue to escalate and the finite available resources will be placed under significant additional strain.

While these recent developments have heightened concern within the DSN, they have also added significant impetus to expanding and accelerating the already existent DSN Energy Program. This program, officially begun in 1976, actually had its roots in studies and energy conservation activities begun in early 1974.

## II. Goals and Objectives

It is the goal of this program to support national energy policies, such as the President's recent conservation directive. In addition, the DSN must manage NASA energy resources so that implementation of energy reduction procedures and

solar power augmentation equipment minimizes life cycle costs and keeps them in balance with other costs. The goals are being achieved by tasks supporting long term objectives. These objectives are:

- (1) To save money by cost-effective and operationally acceptable energy conservation implementation.
- (2) To carry out renewable energy augmentation demonstration projects to provide data on existing low risk technology and its applicability to the DSN environment.
- (3) To implement solar energy augmentation when new technology meets the DSN Energy Program requirements for reliability and cost effectiveness.
- (4) To implement an energy data management system.

The objectives of the program are being put into effect under a phased schedule, with the Goldstone Deep Space Communications Complex (GDSCC) in California generally preceding the overseas stations.

## III. DSN Energy Characteristics

The DSN is, in fact, a network of decentralized communities (Fig. 1). Each complex represents a significantly different set of political, socioeconomic, and environmental conditions. In the application of solar power generation solu-

tions, these communities present three uniquely different distribution problems.

The GDSCC creates the question of centralized vs decentralized power as a result of having an existing power grid. However, decentralized power generation capability also exists by virtue of backup power generators located at each site. The question requires careful examination both from operational reliability and maintenance requirements standpoints.

In Australia, the conjoint Deep Space Stations 42 and 43 will be similar to GDSCC if a proposed power grid is built to replace existing separate diesel generators. However, Deep Space Station 44 resides in a national preserve area, and present information indicates no electric power lines will be permitted into that facility. Distributed power capability is a necessity.

In Spain, the complex is also considering the introduction of a power grid. At this complex, the question of extending it beyond the conjoint Deep Space Stations 61 and 63 to Deep Space Station 62 is posed for a different reason. The results of energy conservation, including the introduction of waste heat utilization at DSS 62, have been so successful (a 50 percent reduction of power requirements) that the introduction of the electric power may have questionable merit. If the waste heat locally available is not used, additional energy must be provided to replace this source. Several interesting solutions are apparent.

The DSN is a fascinating distributed environment well oriented to verifying concepts of both centralized and distributed methodology in an effort to supply power from renewable sources. However, as a result of its primary commitment of communicating with deep space vehicles, constraints limit the DSN Energy Program to investigative studies, conservation procedures and modifications, and low risk exploratory demonstrations of new technology utilizing only proven equipment. Within these constraints the program still has many innovative aspects, some of which are discussed below.

#### **IV. Program Activities**

The program has completed studies or has under investigation a full range of alternative energy conservation and power augmentation projects. The projects developed to support energy conservation activities are generally near term; that is, they are planned for implementation within the next five years since this technology is furthest in its commercial development. The projects planned for power augmentation, such as photovoltaic and solar thermal electric generators, are generally long term and planned to begin in a phased implementa-

tion about 1984-1985. The exception to these long-range plans would be the implementation of earlier solar power generation capability with funding provided by other government agencies from presently authorized programs, such as the Federal Photovoltaic Utilization Program and the Solar in Federal Building Demonstration Program. Proposals are submitted as part of a NASA package, with the proposal data derived from DSN studies and energy planning. An implementation of this type at Goldstone could involve the augmentation of existing power from the Southern California Edison Company grid. This would be followed by a major solar power generation project patterned after the earlier prototype.

Hybrid systems using a variety of solar power generating techniques are also under investigation. Among these, a hybrid biogeneration and conversion process holds promise as a long-term solution to the alternate fuel problem created by the use of transportation vehicles and backup power generators. Biodegradable garbage and sewage would supply the base material for aquatic biomass ponds, and anaerobic digesters would provide the methane to be stored as a major source of fuel. This method of energy generation could provide up to 18 percent of anticipated energy requirements at Goldstone in 1985. One of the more exciting features of the methane generation capabilities would be its anticipated utilization in fuel cells and the inherent increase in conversion efficiency derived from this use. The study of fuel cell status and the applicability of fuel cells to the DSN environment is to be completed by the end of September 1980.

An engineering study to evaluate the potential of a photovoltaic array for direct electric power at Goldstone was completed in 1979. In addition, a proposal to study the Canberra, Australia, site and its photovoltaic array potential was submitted to the Department of Energy's Photovoltaic Utilization Program.

A proposal for a solar still at GDSCC to produce distilled water has been accepted by the Department of Energy under the Solar in Federal Buildings Program (SFBP). The system will provide cooling water for the klystrons at DSS 13 and DSS 14.

Wind data from the Goldstone site indicates that the potential exists for constructing low-speed windmills. These could be used to pump water or to generate electric power for feeding the existing power grid at Goldstone.

Each area of study has a potential for decreasing DSN dependence on fossil fuels. It is highly improbable that any one method of power augmentation will be adequate alone. But, a balanced system, utilizing multiple renewable sources of energy, may be capable of meeting the majority of DSN energy needs.

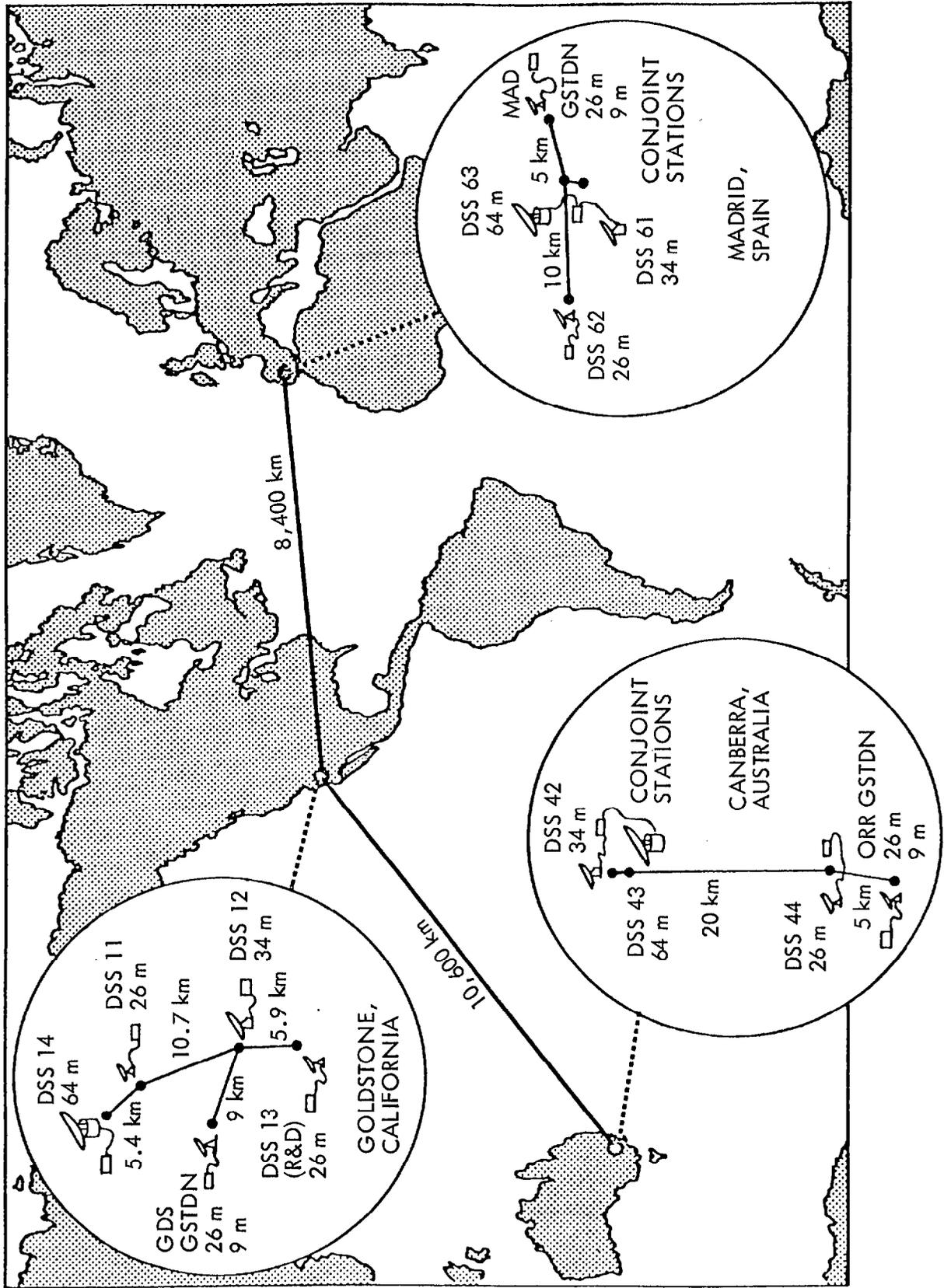


Fig. 1. Deep Space Network Complexes