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LINE-FOCUS CONCENTRATING COLLECTOR PROGRAM

Abstract

The Line-Focus Concentrating Collector Program has been in effect since about 1973. This program has emphasized the development and dissemination of concentrating solar technology in which the reflected sunlight is focused onto a linear or line receiver. Although a number of different types of line-focus concentrators have been developed, the parabolic trough seems to have gained the widest acceptance and utilization within the industrial and applications sectors. The trough is best applied for application scenarios which require temperatures between 140° and 600°F. Another concept, the bowl, is being investigated for applications which may require temperatures in the range between 600° and 1200°F. Current technology emphases are upon the reduction of system installation cost and the implementation of production oriented engineering.

Introduction

During the time of a national resource shortage, there are a number of responsibilities which the government of the United States must exercise. These responsibilities are outlined in Figure 1. The first of these responsibilities is to develop and disseminate alternative energy technologies. The expediting of this responsibility involves assisting industry in defining viable alternative resource options and assisting in establishing and disseminating a technological understanding sufficient to allow public decisions with high confidence. A second major responsibility is the application of economic incentives. In general, it is very important for these incentives to be simple, that is, that they be established at a high level of economic leverage. This tends to move energy utilization sectors away from the resource in short supply and toward other more abundant resources. A third responsibility of government is the coordination of the resource transition. This coordination is required to ensure that technological understanding is in place prior to the application of economic leverage or incentives. The Line-Focus Concentrator Program is primarily oriented toward the technical responsibilities of government relative to this particular classification of solar collectors.

Program Definition and Justification

The direct thermal conversion of solar energy using concentrating collectors may be considered under two classifications of receiver geometries: distributed receivers and central receivers.

GOVERNMENTAL RESPONSIBILITIES IN TIMES OF A NATIONAL RESOURCE SHORTAGE

- DEVELOP AND DISSEMINATE ALTERNATIVE TECHNOLOGIES
- APPLY SIMPLE ECONOMIC INCENTIVES -- AVOID DETAILED REGULATION
- COORDINATE THE RESOURCE TRANSITION

FIGURE 1

Central receivers may be considered to be either concentrating or nonconcentrating systems. In this particular document we will be considering only concentrating types of collectors and the distributed receiver category will be decomposed into line-focus concentrators and point-focus concentrators.

As is outlined in Figure 2 line-focus concentrators may be separated into a number of categories or classifications. These classifications can be described based upon whether or not the reflector is fixed or tracking the sun and whether or not the receiver is fixed or in motion. The Line-Focus Concentrator Program has considered each of the concepts outlined in Figure 2. There are advantages and disadvantages to each one of the alternatives. In general, systems which have fixed nontracking reflectors will collect less energy over a year than a system which has tracking reflector. Also, systems which have higher concentration ratios of sunlight on the receiver are more capable of generating higher temperatures at higher efficiencies. In general, the cost of the various systems depends upon materials used for construction and the construction technique that is used. Some of these systems require more site specific construction activity as compared to other systems which can be more completely assembled within a factor environment. In general, the systems which can be more completely assembled within a factory are less expensive when considered throughout the installation phase.

Figure 3 outlines the possibilities for the application of solar thermal energy from line-focus concentrating collectors. The first and most obvious application is to utilize the heat directly. Currently, approximately 13 quads of energy are used each year in industrial process heat applications at temperatures below 550°C. In fact, almost 11 quads per year are applied at temperatures below 300°C. In addition to industrial process heat, there is the potential for using process heat from line-focus collector systems for enhanced oil recovery operations and for commercial cooling. If desired, the heat from these systems may be used to operate heat engines which supply shaft power or shaft power plus thermal energy in cogeneration applications.

Program Activities

The Solar Thermal Line-Focus Concentrating Collector Program has been broken up into six major activities. An outline of these activities is demonstrated in Figure 4. Also shown in this figure is a description of these various activities as a function of time. As can be seen, most of the activities at the various levels of integration have preceded in parallel since the early to middle 1970s. As the development and commercialization process moves into the 1980s, the emphasis tends to shift from component and subsystem development to systems development, commercialization assessment, and system utility and reliability demonstration.

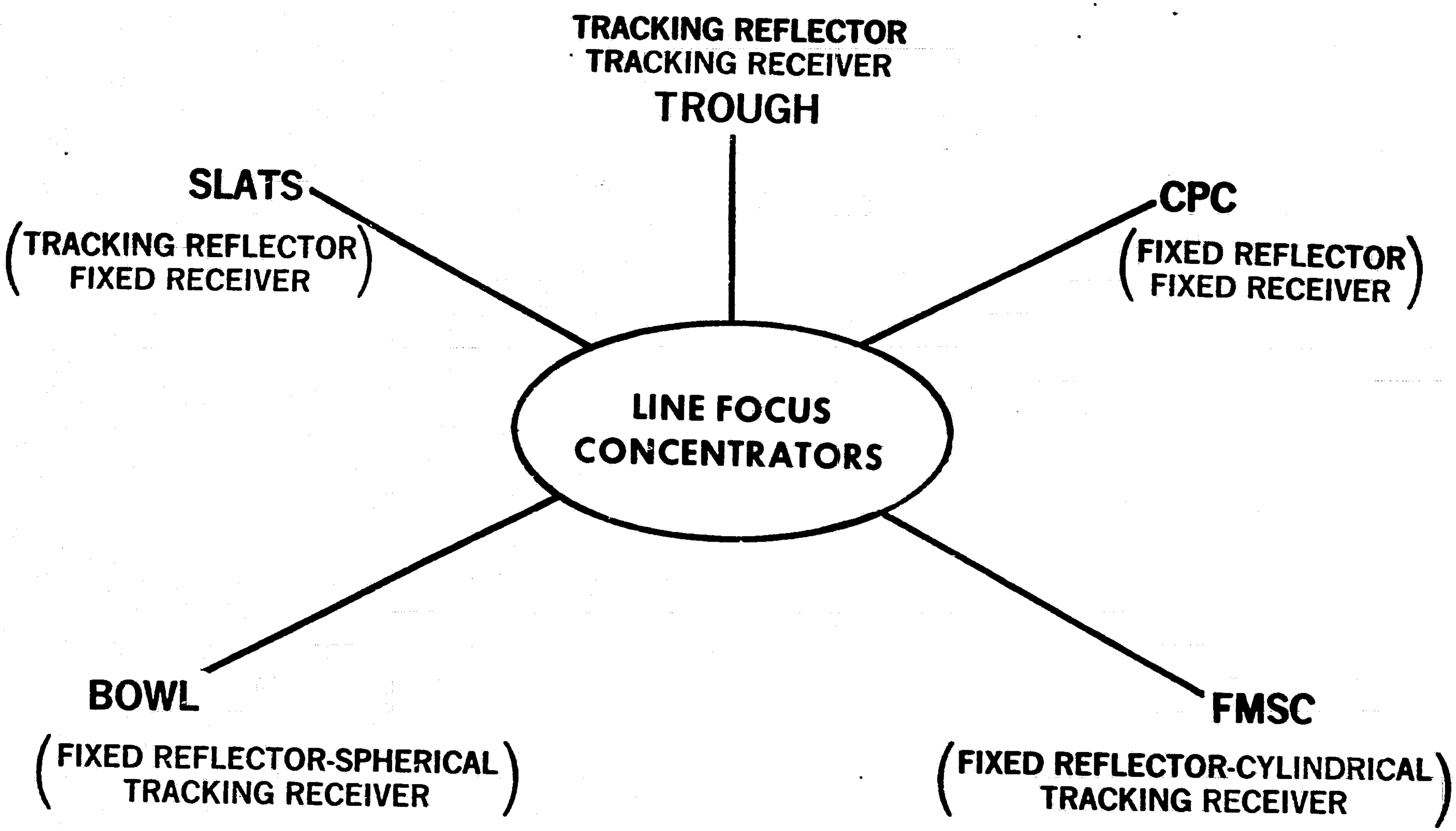
TRACKING REFLECTOR
TRACKING RECEIVER
TROUGH
SLATS
(TRACKING REFLECTOR
FIXED RECEIVER)
CPC
(FIXED REFLECTOR
FIXED RECEIVER)
LINE FOCUS
CONCENTRATORS
BOWL
(FIXED REFLECTOR-SPHERICAL
TRACKING RECEIVER)
FMSC
(FIXED REFLECTOR-CYLINDRICAL
TRACKING RECEIVER)

FIGURE 2

LINE-FOCUS CONCENTRATING COLLECTOR PROGRAM JUSTIFICATION

SOLAR THERMAL LINE-FOCUS CONCENTRATING COLLECTOR TECHNOLOGY → SOURCE OF HEAT (<550°C) + HEAT ENGINE + HEAT RECOVERY

SOURCE OF HEAT (<550°C)
- INDUSTRICAL PROCESS HEAT (13 Q/YR)
- ENHANCED OIL RECOVERY (0.2Q/YR)
- COMMERCIAL HEATING & COOLING (7 Q/YR)

HEAT ENGINE
- MECHANICAL DRIVE: IRRIGATION
- ELECTRICITY: INDUSTRIAL

HEAT RECOVERY
- COGENERATION
- TOTAL ENERGY

FIGURE 3

SOLAR THERMAL
LINE-FOCUS CONCENTRATING COLLECTOR PROGRAM

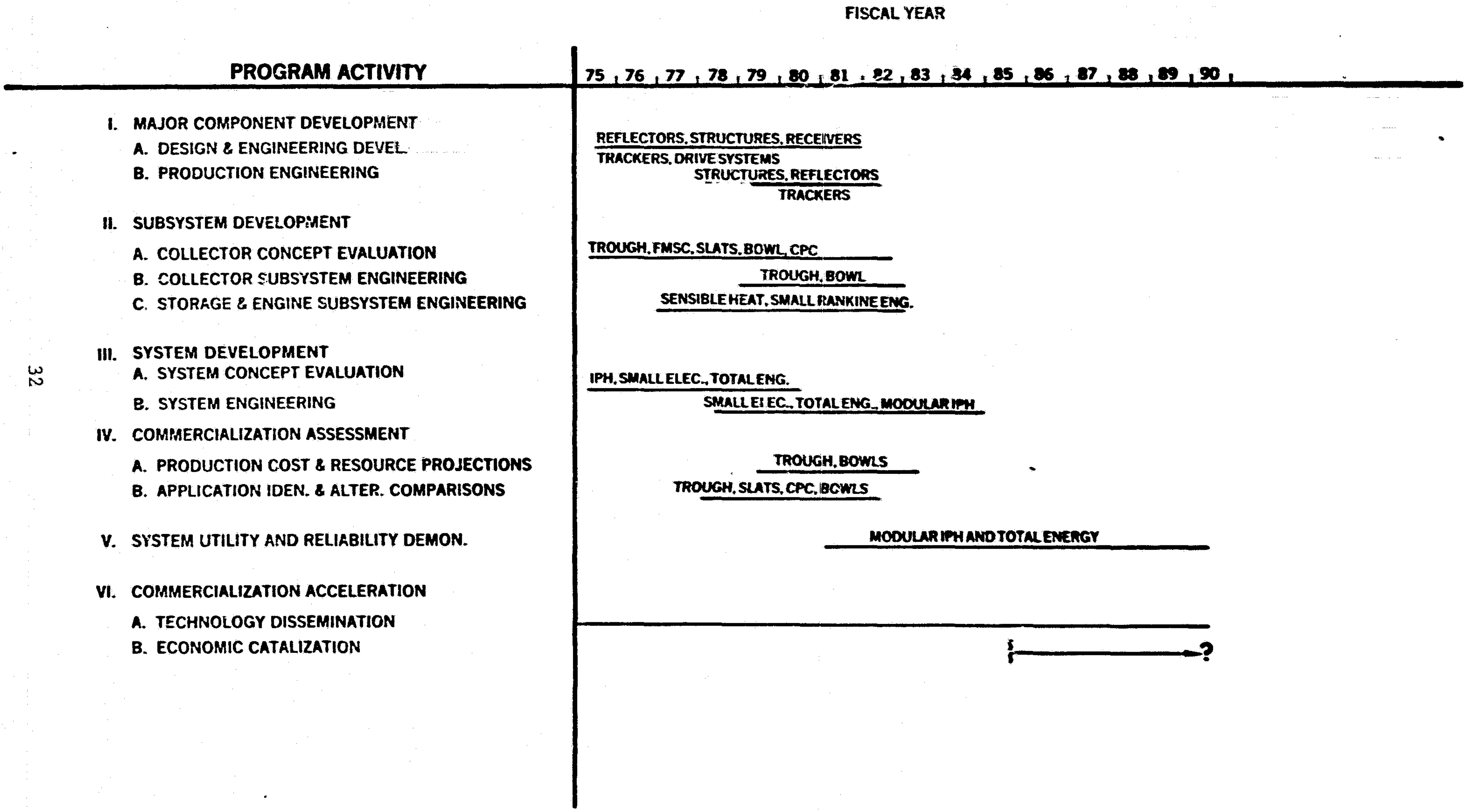

FIGURE 4

Major emphases in the 1980, 81, and 82 time frame will be (1) the demonstration of production prototype parabolic trough hardware, and (2) the implementation of a Modular IPH Program. The Modular IPH Program is oriented in its first cycle towards reducing the installation cost and improving the overall system reliability of current hardware. The production prototype demonstration effort will provide the initial technology which will allow parabolic trough hardware to move into mass production levels of effort as soon as markets have been established for this alternative energy system.