



REQUEST FOR PROPOSALS

FINANCING SERVICES FOR CONSTRUCTION OF

**SOLAR-THERMAL TRIGENERATION
FACILITIES**

THE CONSORTIUM OF ALTERNATE ENERGIES
SAN DIEGO, CALIFORNIA

REQUEST FOR FINANCING PROPOSALS

Including Project Overview

SOLAR-THERMAL TRIGENERATION FACILITY

(Proj. Code: SCR-RCA-560-81)

The Consortium of Alternate Energies

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Contents

Part A

Request for Proposals	A-1
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Part B

I. Project Executive Summary	B-1
II. Site Description	B-9
III. Licensing & Permitting	B-10
IV. Technical & Commercial Feasibility	B-10
V. Loan Guaranty Program	B-15

Appendix

PART A

CENTRAL TOWER RECEIVER
PARABOLIC DISH
CONCENTRATOR
FLAT PLATE COLLECTOR
WIND TURBINE

THE CONSORTIUM OF
ALTERNATE ENERGIES

P O BOX 84450
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ELECTRICAL GENERATION
WATER DESALINATION
INDUSTRIAL PROCESS STEAM
ENHANCED OIL RECOVERY
AGRICULTURAL PROCESSING

February, 1984

To: Interested Lenders, Lenders' Agents, Investment Bankers, Underwriters, Leasing Companies, Brokers, Syndicators and Municipal Finance Officers

Re: REQUEST FOR PROPOSALS—FINANCING SERVICES FOR CONSTRUCTION OF SOLAR-THERMAL TRIGENERATION PLANT (Electrical-Food-Water)

Project Title: Ridgecrest Solar Plant (description enclosed)

Capital Cost: (Funding Required): \$850 Million

Duration of Final Development & Construction: 48 to 60 months

Proposal Submittal Deadline: Continuous filing

I. GENERAL INFORMATION

The Consortium of Alternate Energies (CAE), a California corporation, has elected to release this RFP to announce the imminent construction of the above project, located in the California high desert near the City of Ridgecrest, and to solicit funding proposals from qualified organizations and agents. The time and effort expended in analyzing this opportunity is appreciated, as will be your Proposal for financing services.

Your written response will illustrate the capacity of your organization to successfully participate in this program. Accordingly, it should be specific, complete in detail and must closely approach the needs of the present project. Company brochures are not sufficient, although they may accompany formal Proposals. To assist you in preparation of a response, the ensuing material will provide basic data about Proposal structure, project overview and economics. For additional information, refer to Paragraph IX.

All types of financing approaches are eligible for consideration. Examples of methodologies we expect to hear about include, but are not limited to:

- Equipment leasing plans, tax-advantaged and otherwise
- Low-interest loans, reinvested at higher rates during construction
- Equipment sale & installment repurchase plans (e.g., individual heliostats)
- Trust fund placement and arbitrage arrangements
- Limited partnership syndications or equity participation
- R&D partnership with sale to owner groups

RFP-Ridgecrest Solar Plant

- Institutional fund placement
- Foreign fund placement
- Eurobond issues
- Joint-ventures with large, tax-liable corporations
- Syndication of municipalities to purchase plant through revenue bonding
- Project incorporation and public stock offering
- Wealthy investor placement
- Project rollover (R&B group to developer group to ultimate owners)

Within ten (10) days after receipt of written submittals, CAE will advise respondents as to whether their proposals will be considered under this RFP.

II. OBJECTIVES

Solar Central Receiver (SCR) systems, sometimes referred to as "power towers," have been proven technically feasible, practical to construct and, most important, economically competitive with other power sources in large applications, such as the Ridgecrest Facility.

Accordingly, the CAE group has established the objective of installing SCR plants (500 MWe class) at preselected sites in the southwest U.S. Sites have been carefully selected according to their solar characteristics and other factors. These objectives support our philosophy of developing major alternate energy sources with the ability to lessen or eliminate national dependence on imported oil and gas. Our systems have this ability.

A corollary or spin-off of this effort is the creation of attractive investment opportunities for financial groups in the arranging of third party or conventional financing, leasing services or equity partnership arrangements. In packaging responses, respondents should be especially cognizant of (a) the heavy positive cash flows arising from the sale of electricity alone, (b) the relatively small O&M expenses and absence of fuel costs, (c) the potential for greatly increasing operating profits from, food processing, (d) the wide range of ownership arrangements possible, (e) the superior tax benefits applicable to energy property, and (f) the minimization of risk due to simplicity of design and the existence of a guaranteed product market (mandated by federal law).

III. RFP EVALUATION CRITERIA

Prior to making a comprehensive evaluation, all proposals will be reviewed to determine that the following qualification criteria are met. Offerors will be evaluated according to:

RFP-Ridgecrest Solar Plant

- (1) Previous experience and success in arranging large project financing.
- (2) Adequate resources (facilities, manpower, administrative support, contracts).
- (3) Understanding of energy project needs, especially private, non-utility facilities.
- (4) Practicality and cost (must be practical to implement and not demand of great amounts of capital up front, for fees, expenses, etc.).
- (5) Flexibility, creativity and willingness to design special programs, if needed.
- (6) Willingness to work constructively with small, rapidly growing business organizations in such a way that critical entrepreneurial spirit is enhanced and nurtured, not challenged.
- (7) Ability to maximize use of available investment and energy tax credits and writeoffs.
- (8) Ability to devise and manage plans that will withstand the scrutiny of public utilities doing business with CAE, as well as reviewers from the Federal Energy Regulatory Commission, California Energy Commission and possibly the Public Utilities Commission. These groups will probably examine financial plans for feasibility and stability over the long term.

IV. PRE-PROPOSAL CONFERENCE

At the request of interested respondents, a fact-finding conference will be scheduled in San Diego or southern California.

V. PROPOSAL INSTRUCTIONS

Offerors should plan to provide the following information:

- (1) Project title.
- (2) Name, address and telephone number of person responding.
- (3) Name of company Chief Executive Officer (this individual should be aware of any proposals submitted).
- (4) Previous experience of individual or company in performing related financial services. References should be provided.

RFP-Ridgecrest Solar Plant

(5) Listing of all financing methodologies available through Offeror that are applicable to this project.

(6) Offerer's recommendation as to the most suitable approach. This recommendation becomes your Proposal, which should be elaborated to include:

- a) Cost to CAE, initially and over the project term.
- b) Time required to implement.
- c) Cash flow estimate (state shortest time capital can be raised; if spread out, provide monthly estimates» up to 48 months),
- d) Summary of SEC and other registration, filing and legal requirements.
- e) Guarantees required (assets, insurance, bonding, etc.).

(7) Submit Proposal in letter form, bearing initial or signature of upper-level management representative, preferably VP or higher.

VI. PROPOSAL COSTS

In the absence of written authorization, CAE assumes no liability for costs associated with Proposal development or submission.

VII. ACCEPTANCE

CAE expresses appreciation in advance for all Proposals submitted. All responses will be acknowledged in writing. We reserve the right to accept or decline any offer of services.

The Consortium will consider signing Non-Circumvention or Exclusive Agency agreements with selected Offerers, in order to protect their rights and interests,

VIII. PERIOD OF NOTICE

Response deadline is September 30, 1983; however, 30-day extensions will be provided if necessary to ensure adequate response.

IX. ADDITIONAL PROJECT DATA

This document may or may not have been inserted in a larger project package,

RFP-Ridgecrest Solar
Plant

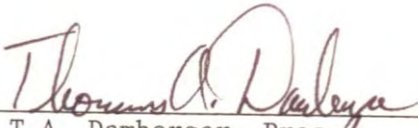
depending upon the nature of the initial request for information. In the event this is only the short Executive Summary version, the reader should be advised that a larger (265-page) manual is available for review. Due to their limited number and cost, however, circulation is restricted and it is asked that all copies be returned after examination. In most cases, a refundable deposit will be required.

Should the 265-page manual prove inadequate for engineering assessment purposes, please ask for our 1,500-page technical summary. We are willing to assist you in your information needs.

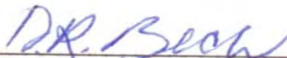
ALL REPOSSES SHOULD BE FORWARDED TO:

The Consortium of Alternate Energies
P.O. Box 84450
San Diego, California 92138

APPROVED FOR DISTRIBUTION:



T.A. Damberger, Pres.



D.R. Beck, V.P.

PART B

I. PROJECT EXECUTIVE SUMMARY

The Consortium of Alternate Energies, a California corporation, is pleased to announce development of the momentous and historic Ridgecrest Solar Trigeration Project. Cooperating with other major partners, the Consortium plans completion of this facility within five years, offering to the world an example of one of the best possible solutions to our energy problems; for this is truly an economic, efficient, flexible and ecologically benign power source, driven by an inexhaustible natural resource—the sun itself.

The proposed facility is designed to produce 560 megawatts of electric power, 6,000 tons per day of processed food and 8 million gallons daily of desalinated water. Capital cost will be about \$850 million (1980 dollars) with very limited possibilities for cost overruns, thus rendering it less expensive to construct than comparable fossil-fueled or nuclear stations. It will provide sufficient electric power for 500,000 homes, serve the water needs of the Ridgecrest area and feed more than 3 million people. It will provide jobs for 10,000 workers directly, and if successfully duplicated, create the basis for a new industry employing hundreds of thousands.

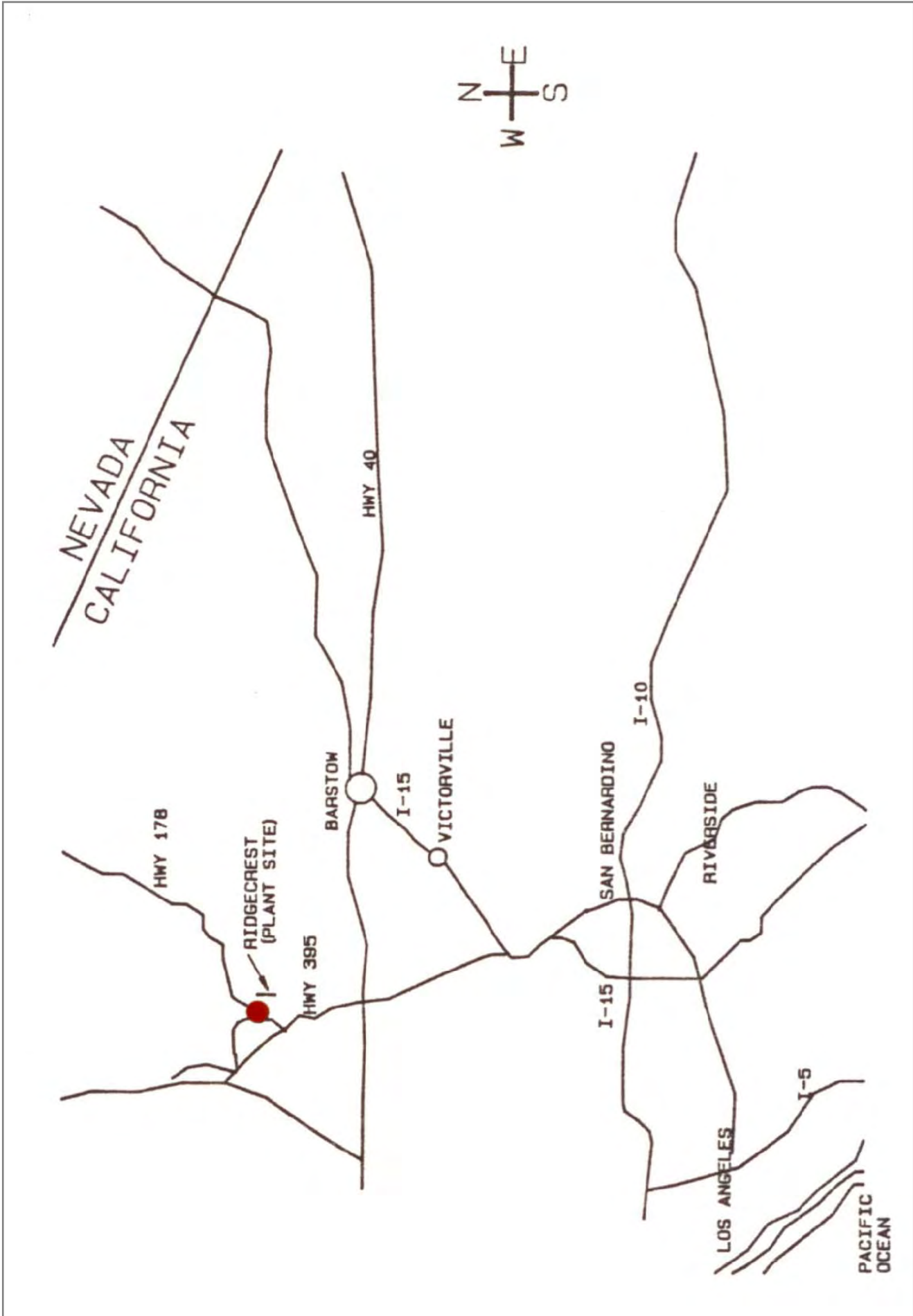
The plant will displace the equivalent of 5 million barrels of oil annually, resulting in a savings to the U.S. economy of at least \$200 million per year. Inasmuch as the facility uses no fuel, millions of tons of pollutants will be prevented from entering our atmosphere each year over its 30-year life cycle. Clearly, this is the best solution to the serious problems of acid rain, fallout, the "greenhouse effect," etc., all of which have been linked to fossil-fueled plants. Other benefits include substantial tax revenues to government, stabilization of energy costs and creation of highly attractive investment opportunities for the financial community. Briefly stated, the Ridgecrest Solar Project is what the nation needs, wants and will have.

We have endeavored to develop the project with all our resources and energy since its inception in August, 1981. We have developed a conceptual design and completed necessary work in the areas of economic and risk analysis, engineering feasibility and constructability, political, social and community impacts, environmental factors, legal and regulatory interfaces, and have now entered the capital funding stage.

This RFP is delivered to the reader as the product of tens of thousands of hours of intense work by dedicated senior scientists and technicians, legal, tax and accounting specialists and highly credentialed organizational and



Illustration of a Central Tower Receiver with 10,000 heliostats (tracking mirrors) powering a copper smelter. Ridgecrest plant will feature 7 towers and 70,000 heliostats arrayed as depicted.



management personnel who have provided the entrepreneurial drive to bring the project together and move it forward. Having progressed far beyond the idea stage, this is a site-specific, articulated and substantive project that has been made ready and delivered to the financial community for required capital funding. Project personnel now look to that community for the ability, serious commitment, and if necessary, the boldness to complete this significant effort.

PROJECT PARTICIPANTS

The Ridgecrest Solar Trigeneration Project (hereinafter referred to as the Project) is sponsored by the Consortium of Alternate Energies (CAE) which acts as lead agency through the developmental process. It shall be the initial entity holding title to the facility in joint partnership with other corporations or interests who elect to provide equity investment in the Project. These others may include the plant constructor, suppliers of hardware or venture capitalists, including wealthy individuals and corporations.

It is anticipated that the plant operations and maintenance (O&M) function be provided by Pacific Gas & Electric Company, under contract, or equally qualified entity.

The Project will ultimately require two basic feedstocks: raw, unprocessed foodstuffs from farms in the San Joaquin and Imperial Valleys, and brackish water from underground salt aquifers and recycled sewage water from the City of Ridgecrest and the Indian Wells Valley.

Product purchasers include the following:

(1) For electricity: Pacific Gas & Electric Company (PG&E) and possibly Southern California Edison Company (SCE).

(2) For fresh water: the Indian Wells Valley Water District (IWVWD) and China Lake Naval Weapons Center (CLNWC).

(3) For processed food: wholesale distributors and large retail food chains.

PLANT LOCATION

The prime site for the Project is a 3,000 acre block of land currently owned by the U.S. Bureau of Land Management (BLM), Department of the Interior. Its location is illustrated in the following pages. The site is in San Bernardino County, California, about two miles due east of the city limits of

Ridgecrest. The land is zoned by the Federal government for power production and is available for purchase from BLM if (1) environmental analyses affirm that the Project meets Federal and State environmental guidelines and (2) the California Energy Commission (CEC) grants approval after filing of a Notification of Intent (NOI).

Preliminary and ongoing discussions with CEC have confirmed their enthusiastic support of the Project as well as a commitment to shorten as much as possible the NOI and Application for Certification (AFC) processes.

Access to the site is possible by two roads, one belonging to the Naval base and another public road interconnecting Ridgecrest and Trona. A commercial airport exists 15 miles to the west while a major railhead is located 15 miles northeast in Trona. Highways 178 and 395 will support heavy vehicular traffic into the area from the south and west.

The site is bounded on its northern and eastern perimeters by CLNWC, on its southern perimeter by BLM property and private land owned by the Spangler family and on its western side by private property owned by various individuals.

Estimated acquisition cost from BLM is less than \$1,000 per acre, including environmental analysis expense and purchase of three mining claims (Spangler) on the property. In 1981, average BLM land costs in California were \$300 per acre.

It should be noted that the site is located in the area of highest daily average solar insolation in the continental U.S., perhaps the highest in the Western Hemisphere (8.0 KWH/m²/day). It is situated in the eastern section of Indian Wells Valley where the winds are least intense and centrally located in the valley area wherein brackish water quality is unacceptable for potable purposes.

The property is free of underlying fault lines and has between 5 and 20 feet of sediment lying over solid bedrock. There is no underlying water table or stream. It is currently covered with scrub brush (about 3 to 8 feet tall) and is used by trail bikes and recreational vehicles. Due to vehicular traffic, native wildlife has largely departed the area, except perhaps for birds, snakes and insects. Squirrels and turtles no longer reside in this section and according to BLM data there are no endangered flora or fauna on the site.

The general siting near Ridgecrest also yields other benefits. The relatively large indigenous population of about 30,000 can tolerate the expected labor force of 2,000 during plant

construction. The city infrastructure includes utilities, permanent and temporary housing, schools, roads, rail, airport, community shops, businesses and entertainment. Ridgecrest is roughly equidistant from the Imperial and San Joaquin Valleys, Los Angeles and Bakersfield which comprise major markets and materials/feedstock sources for the Project. Clearly, it is an ideal site for this type of endeavor.

Community meetings held by CAE, as well as public surveys conducted by local newspapers, have revealed a strong, almost overwhelming attitude of support by the local citizenry. Prevailing also is a high level of anticipation about the arrival of this clean, high-technology industry, its employment opportunities and myriad other benefits.

TECHNOLOGY AND PERFORMANCE

The facility embodies Central Receiver Solar-Thermal technology, a relatively new approach to solar energy based upon well understood and accepted thermal, mechanical, electronic and materials engineering principles. There are no fundamental elements of science, physical or chemical, that must be developed in order to design and construct the facility. The Central Receiver concept has been proven at several facilities in this country and elsewhere: e.g., the Central Receiver Test Facility in Albuquerque, New Mexico, the "Solar One" 10 MWe Pilot Plant near Barstow, California, the ARCO enhanced oil recovery facility near Bakersfield, California, plus others in Spain, Italy and Japan.

A German consortium plans the construction of an air-cooled Central Receiver (20 MWe) in Spain for 1987 delivery. Five other Central Receiver projects, ranging in size from 30 to 100 MW, are planned for the U.S. The CAE facility is by far the largest; and, by virtue of its inherent economies of scale, is the only one that can possibly achieve commercial viability in the near terra. A heliostat production study completed by General Motors corroborates this statement, as does the SEIA Central Receiver Council.

Electrical production performance is projected at 560MWe peak, averaging 1800 GWhe (net) per year. Water production is based on 2.9 billion gallons of brackish water per year feedstock, averaging 5,000 ppm TDS, yielding 2.0 billion gallons of drinking water (less than 500 ppm TDS), 0.65 billion gallons of water evaporated in the plant cooling system, and 0.25 billion gallons evaporated in salt evaporation ponds. Food production is estimated at 1.0 to 1.5 million tons of processed foodstuffs annually.

The plant onstream factor should be close to 100 percent, with a capacity factor of 0.367 for electricity, 0.742 for food processing and 0.685 for water production.

Throughput should be at or near peak capability for up to 30-years.

Much of the equipment for the facility is commercially available without modification, i.e., steam turbines, condensers, cooling towers, demineralizers, pumps, piping, heat exchangers, ducting, valving, rebar, concrete, steel forms, etc. Three major components—heliostats, receivers and remote-heated gas turbines are now available as prototypal hardware. Gas turbines utilizing either a GE or Westinghouse industrial, split-shaft model, can easily be modified to accommodate the system. Receivers must be custom designed for the application and will likely utilize Inconel 617 tubing and alumina casting reflector/insulation walls. Babcock & Wilcox, a McDermott company, is the likely supplier of the fabricated receiver and alumina castings. Huntington alloys can supply the Inconel. The heliostats will be produced in a mass production facility and will probably be based on designs developed under Department of Energy (DOE) contracts by ARCO, McDonnell Douglas, Martin Marietta and others. Foreign production is also under consideration.

The Consortium's innovative design would include photovoltaic (solar cell) powered azimuth-elevation drive motors to avoid field wiring. Each unit will feature its own independent microprocessor for tracking control, with manual override via radio telemetry vis-a-vis the master control system. Plans call for 70,000 heliostats (tracking mirrors), each with a reflecting area of 528 square feet and 10 square feet of solar area (100 watt peak). The solar cell purchase (7,000KWe) would be the largest in history.

Life expectancy for the great majority of components is greater than 30-years. The operational life of a few items, such as microprocessors, transponders, heliostat motors and electromechanical controllers, is projected at 7 to 10 years minimum. Periodic inspection and maintenance, combined with an adequate spare parts inventory, should be sufficient to eliminate unexpected failure of these parts. Reverse osmosis cartridges, developed by duPont and Dow Chemical, have life expectancies of more than 7 years. Gas turbines, using pure air, should last over 200,000 hours (50 years) without major overhaul, as should the steam turbines. The towers should stand for hundreds of years, barring earthquakes of greater magnitude than 7.2 epicentered within a 10-mile radius; they are designed to withstand that degree of tremor coincident with a

90-mile-per-hour wind. The receiver tubing may require replacement at 20 to 30-year intervals. Heliostat glass mirror modules may require replacement due to rippling effects every 30-years, although recent test results seem to indicate that an even longer life can be expected.

Estimated O&M costs are in the range of 50 to 100 million dollars per year in the 1988 time frame, with about half for personnel, 20 percent for spare parts, and the balance for property taxes and insurance. About 10 to 12 weeks worth of working capital will be required to operate the facility, or about 100 million dollars. This amount will allow for a 60-day billing and receipt periods for feedstocks vs. products and timely payments of interest, taxes, insurance, etc. The detailed project construction schedule is available upon request. Briefly, actual construction may require up to three years to complete, including site preparation (4 to 6 months), erection, field assembly and installation (20 to 24 months) and plant testing and startup (3 to 4 months). Much of the site preparation will be accomplished in parallel with construction; for example, trenching for air ducts and foundations may coincide with piping work. Backfill over the foundations, thermal storage unit and piping will utilize displaced earth from excavation. Roads may be laid over the underground ducts for access to the central food and water processing facilities.

Final construction schedules will be developed during the licensing phase.

INTERCONNECTION

We intend to route a 500KV line across CLNWC through the Sierras along Highway 178 into the Kern County oil fields 15 miles east-northeast of Bakersfield, or into Bakersfield itself. An alternate route would send the line southwest from the site down to Highway 58, along the SCE transmission corridor paralleling Highway 395 to the south of Bakersfield, interconnecting at the first PG&E trunk line about 20 miles southwest of the city.

The overall environmental impact will be negligible, perhaps even benign when one considers the fact that the Project will eliminate destructive recreational vehicle traffic on the site lands (the perimeter will be fenced and guarded). The only "hazardous" wastes from the facility may be the highly brackish salt water effluent which is to be evaporated in lined ponds, and airborne dust and food particles from the food processing plant. However, given proper security around the ponds and a baghouse on the food plant, local personnel and community residents will not be affected.

PRODUCT SALES

In conformance with Federal law governing such matters, a commitment to purchase plant power has been obtained from Pacific Gas & Electric Company. Modifications to their standard contract will include a 30-year levelized rate with a small portion thereof escalating to cover normal O&M cost increases.

Water will be sold to the local water district in barter trade for the city's sewage and water rights to the brackish underground aquifers. It is significant to note that the plant (through the reverse osmosis desalination process) will halt and possibly reverse a serious threat to the local water supply—brackish water encroachment into the fresh water aquifers and severe over draught of the fresh water aquifers (30,000 acre-feet discharge vs. 8,000 acre-feet recharge).

Our research indicates that firm contracts can be offered to farm cooperatives located in Imperial and San Joaquin Valleys to purchase feedstock, based on take-or-pay contracts secured with wholesalers and distributors for processed food products in southern California.

FEEDSTOCK

Water feedstock is readily available from the city sewage system and brackish aquifers. Estimated uptake of brackish water (2.4 billion gallons per year) is equivalent to a 68 year supply without recharge. It is believed that recharge of fresh and brackish water combined is about 11,000 acre-feet per year, or more than 3,000 acre-feet for brackish water alone. If this is true, then no shortfall of brackish water supply should occur for nearly 120 years. The balance of brackish feedstock (sewage) should be about 0.5 billion gallons per year. If this is not available (the Navy currently has rights for its golf course), brackish water supply should be sufficient for at least 100 years.

Foodstuff feedstocks are available from the triple-cropping farming communities to the southeast and north west. These areas grow about five times the amount of food that could be processed by the facility. Long-term contracts with co-ops in the region could be acquired if the price is attractive. Current farm gate prices are in the range of 4 to 8 cents per pound. Processed food prices range from 30 to 300 cents per pound. There is plenty of room for bargaining.

No exotic chemicals, catalysts or other feedstocks are required, and those needed are readily available.

PLANT ECONOMICS

After startup in the 1987/88 time frame, annual plant net operating income ranges are projected as follows (in Millions of Dollars):

	Minimum ¹	Nominal ²	Highest Probable ³
Electrical Sales ⁴	\$270M	\$360M	\$360M
Food Processing	75M	300M	450M
Water Desalination ⁵	-0-	-0-	-0-
Gross Income Minus	\$345M	\$660M	\$810M
O&M (Avg.) ⁶	<u>75M</u>	<u>75M</u>	<u>75M</u>
NET OPERATING INCOME	<u>\$270M</u>	<u>\$585M</u>	<u>\$735M</u>

¹\$0.15/KWh Electrical; \$0.025/Lb. Food, value added

²\$0.20/KWh Electrical; \$0.10/Lb. Food, value added

³\$0.20/KWh Electrical; \$0.15/Lb. Food, value added

⁴Based on annual production of 1800 GWHe

⁵Breakeven

⁶Average Operations and Maintenance costs, total of electrical, food and water plants

II. SITE DESCRIPTION

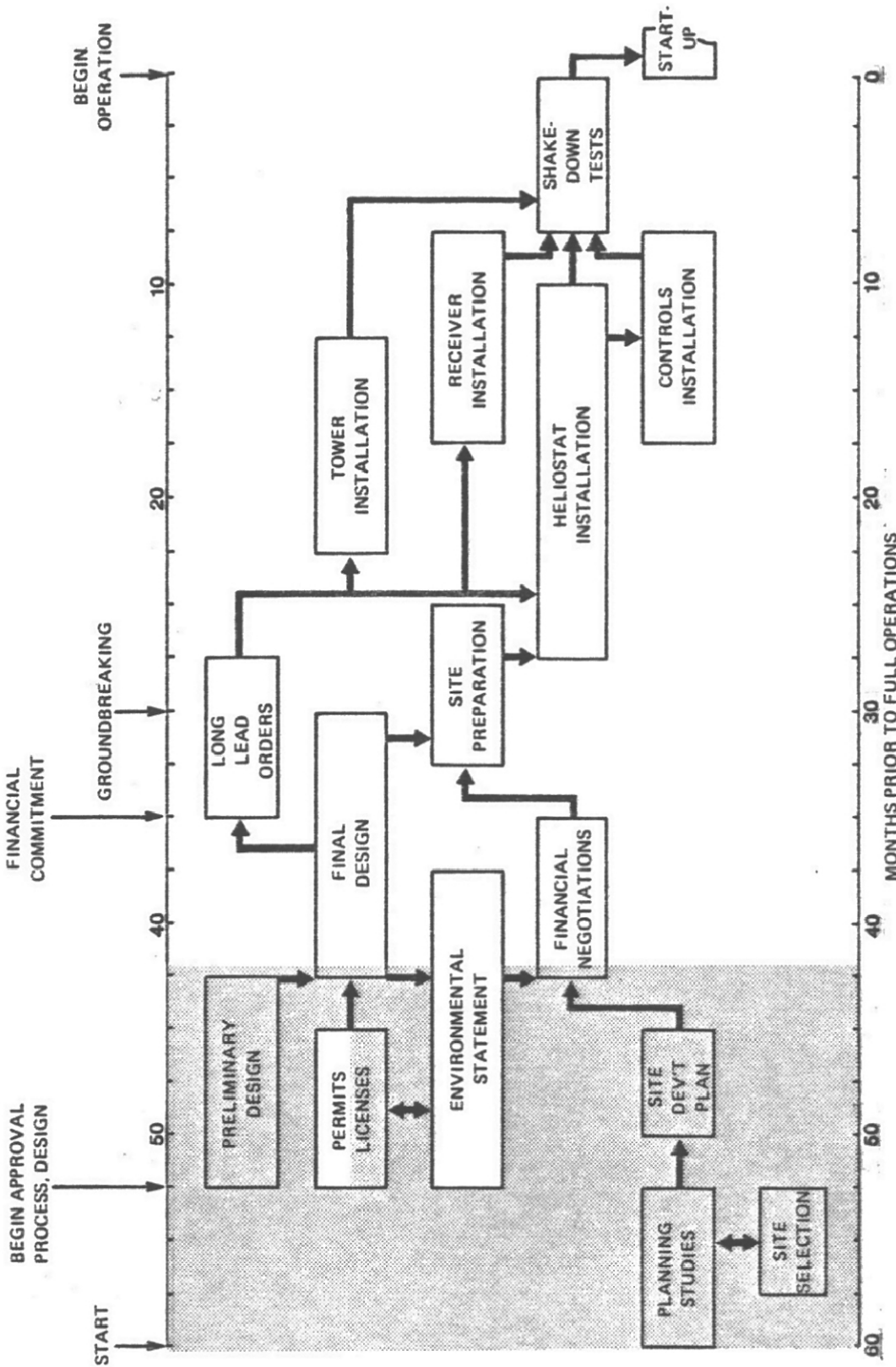
The plant site for primary consideration is centered on coordinates 35° 37' N by 117° 33' W. The property is owned by the Bureau of Land Management and is boundaried on two sides by China Lake Naval Weapons Center property. It is roughly triangular, as shown on the following map. The western boundary of the site is less than two miles from the eastern edge of the City of Ridgecrest. The site is in San Bernardo County. A gas pipeline and 50 MVA power line currently traverse the site. It is boundaried by three roads, as illustrated by the map. It is not in the approach path for the CLNWC Armitage Field, which is more than six (6) miles away, but is close to the Valley View Airport. The nearest railheads are in Trona and on the base, 6 to 10 miles away by road. The site is gently sloping and is covered by 10 feet of alluvial soil over solid bedrock. There are no fault lines under the site; it is about 10 to 12 miles north of the Garlock Fault. This fault is partially active, but has not had a major quake in over 1,000 years.

Water will be piped in from the sewage ponds on the base and from Ridgecrest, the Salt Wells Valley, and will tap aquifers around China Lake. Average total dissolved solids in these waters is expected to range from 3,000 to 5,000 ppm, and annual usage should average 2.9 billion gallons (8,900 acre-feet). About 2.0 billion gallons (6,140 acre-feet) will be delivered to the local residents as city drinking water (300 to 500 ppm TDS), 675 to 765 million gallons (2,070 to 2,350 acre-feet) will be evaporated in the plant cooling system, and 135 to 225 million gallons (414 to 690 acre-feet) will be evaporated in salt evaporation ponds.

Contracts will be sought to acquire rights to use this brackish water from the Navy and the City of Ridgecrest. A reverse osmosis desalination plant will be constructed on the western section of the site to process the brackish feedwater. Evaporation ponds will be structured to fill in gaps around the plant boundary. About 300 acres will be utilized for evaporation and cooling ponds.

Alternate sites have been identified just southwest of the prime site, as well as others in the Spangler Hills, Salt Wells Valley, Searles Valley, and near Inyokern. Some of this property (in the Salt Wells Valley) is owned by the Navy and may not be viable for acquisition. The Garlock Valley, south of Laurel Mountain, was originally considered a prime site; however, it is located on or between three potentially active faults.

RIDGECREST POWER PROJECT



GENERIC DEVELOPMENT PLAN TIMELINE

Completed

III. LICENSING AND PERMITTING

The first "license" has been obtained (FERC Notification of Qualification). The next step will comprise negotiation for acquisition or lease of BLM property, which shall occur subsequent to final site analysis and evaluation activities. Once BLM has a formal request from CAE to purchase or lease the site, BLM must sponsor an environmental study, leading to an Environmental Impact Report (EIR), Environmental Impact Study (EIS) or Finding of No Significant Impact (FONSI). This will be conducted by the California and National EPAs as a joint action. Initial analysis leads us to believe that we will receive an environmental report stating a finding of no significant impact (FONSI).

During this period, applications to the California Energy Commission (CEC) for construction permits will be filed. A positive ruling is expected shortly after filing. The FAA and California Department of Transportation (CALTRANS) will be requested to grant allowances for the construction of the towers (exceeding 200 feet in elevation) after the site has been approved for acquisition or lease. The final permit for operation will be filed about a year before expected start-up. Other licenses, permits and certifications will be applied for and obtained as required.

IV. TECHNICAL/COMMERCIAL FEASIBILITY

At this stage of development, it is the judgment of Gibbs & Hill and CAE that the technical and commercial aspects of the Ridgecrest Solar Plant are feasible. The conceptual design efforts conducted by Gibbs & Hill's engineering support groups have confirmed the technical feasibility of the plant concept.

Depending upon the geological suitability of the selected site, a prime alternate concept may be favored over the baseline. This concept utilizes a buried Thermal Energy Storage system (TES) with a closed-loop, compressor-driven circuit to collect and store solar-heated air. As such, solar heat collection is totally independent of power generation. A separate loop would be utilized to gate the heated air to a supercritical steam generator. Steam at 3,000 psi and 1,000° F would be used in a dual-reheat supercritical steam system with a single deaerating feedwater heater. Such a system could generate 300 MWe at a 0.67 capacity factor, or up to 700 MWe at a 0.28 capacity factor with seven power towers, each rated at 270 MWt (peak). The air loop would run at 400 to 500 psia, assuming the ability to bury the TES to a minimum depth of 150 feet below grade in bedrock.

Steam turbine inlet conditions are 3,000 psia at 1,000° F (HPT), 1,000° F at 1,900 psia (IPT1), 1,000° F at 1,000 psia (IPT2) and 16.9 psia at 219° F (LPT). Discharge of the LPT at 100° F and 0.95 psia is expected to be viable, using 70° F cooling water. Deaerator discharge at 208° F at 13.6 psia would be pumped to the supercritical heat exchanger at 3,400 psia.

Air conditions at critical points include: reheater inlet: 1,206° F at 400 psia; superheater inlet: 1,089° F at 394 psia; feedwater heater inlet: 730° F at 387 psia; compressor inlet: 225 F at 380 psia. Log mean temperature difference (LMTD) for each heat exchanger block is : RH1: 207° F; RH2: 230° F; SH: 50° F; and FWH: 20.5° F.

This alternate concept would utilize the TES over a 950 F temperature differential (between 1,210° F and 260° F) and limit maximum receiver air temperature to less than 1,250° F. Such a system could utilize Inconel 617 or 625 tubing, or Incolloy 800H tubing in the receiver.

The baseline concept utilizes gas turbines with an open loop. At peak conditions, with inlet air at 110° F and 13.6 psia, peak receiver air discharge conditions are 1,500° F at 106 psia with 270 MWt delivered to the air in each receiver. All other ambient conditions (at lower ambient temperature, higher ambient pressure, and/or lower receiver power) result in lower receiver pressure, temperature and tubing stress levels. Only Inconel 617 or 625 tubing would be suitable for this design. The baseline system could utilize 5 Westinghouse Canada 352 turbines at each tower, suitably modified for remote heating and speed control.

The tower would utilize a slip-formed, reinforced concrete design with a backfilled, submerged pedestal foundation. Base diameter is roughly 60 feet, with a minimum diameter of 30 feet at the receiver base. The receiver will rise about 200 feet from the neck of the tower. An additional 25 feet of height is required for aircraft warning lights, lightning rods and the maintenance crane. Overall height is 825 feet. Four apertures facing NE, NW, SE and SW would be used, 8 by 10 meters on the south (vertical/horizontal axis diameters) and 10 by 12 meters on the north. The receiver cross section is likely to be fluted, increasing from a 30 foot diameter at the base to 150 feet across at the top. The internal surfaces are to be insulated with alumina, which doubles as a reflector to distribute and redirect the field flux to the ceiling of the receiver. The tubing will span the ceiling of the receiver with a gentle arch, much the same as a concrete bridge, between the inlet and exhaust manifolds. Inlet manifold and riser ducting would be 7 feet in diameter. Exhaust manifold and ducting would

be 9 feet in diameter, internally insulated and lined with Inconel sheet. The tubing and manifolds will be allowed to freely expand without constraint in the vertical direction (upwards) upon heating. A gap of 6 feet will be left with the ceiling to accommodate the expansion. The inlet (riser) would enter at one end of the inlet manifold, while the exhaust (downcomer) would exit at the opposite end of the tubing array. This manifolding design will provide for even flow distribution in all tubes, and the multiple reflection deep cavity design will provide a nearly uniform flux level on the tubing banks. The tubing will be laid out with two banks of tubes spanning the ceiling, with the lower set of smaller diameter tubes to act as shields for the larger-diameter set above.

This receiver design takes into consideration the simplicity of function, in that the entire air heater loop is a single weldment with no moving parts. The non-uniform flux field from the heliostat array is made uniform within the receiver via multiple reflection from diffuse reflectors. The reflector material doubles as an insulator. Its shape and texture naturally distributes the flux randomly. The heated surfaces are well above the cavity openings, which will set up a natural circulation to provide convective heating of the tubes above, while facing away from the apertures to minimize reflection and re-radiation losses. The closed, downward-facing cavity arrangement should result in low overall convection losses, while the large cavity ratio (about 35:1) will result in an effective emissivity of about 0.025 with absorptivity of 0.975. Overall annual average receiver efficiency (based on flux admitted) should exceed 85 percent. It should also be pointed out that the thermal inertia of the receiver, as designed, will provide up to 15 minutes of smooth operation during rapid transients of field flux. Coupled with the innovative design of the gas turbine flow control system, operation during cloud transients should be possible without severe transients in the gas power system.

The gas turbine modifications include manifolding on the compressor discharge and compressor turbine inlet, the use of an induction motor for startup and speed control of the compressor turbine shaft, and use of a thyristor chopping circuit for overall control of each unit's rotational speed through variance of the induction motor torque. The power turbines will each be coupled to synchronous generators, and will use variable inlet guide vanes for synchronization and fine-tuning of exhaust pressure and temperature. Discussion of this concept can be found in the Gibbs & Hill, Inc. Department of Energy report on solar cogeneration.

Similarly, the G&H report presents a thorough discussion of the TES concept. In this case, the waste heat from all 35 gas turbines will be gated into a single TES plenum, and there routed to either the steam generator or the TES, or both. The TES would contain one million tons of iron orthosilicate (copper slag) in a conical frustum, occupying 420,000 cubic yards. With a mean particle size of one to two inches, its effective heat exchange surface area is between 75 and 600 million square feet (about 200 million SF is expected). Its effective heat capacity would be sufficient to provide 10,000 MWe of generation by the steam system. Overall TES pressure drop at full flow is estimated at less than 0-5 psig. Overall heat loss through the 12 feet of earth berm cover is about 0.2 percent per day of containment. Considering an average daily heat input to storage of 14,000 MWht, effective TES losses amount to 0.5 percent of generation.

The air-heated steam generators are expected to be cross-flow, spiral-tube type with finned tubes on the air side. The firm of Green Economizers is willing to supply the units, through Foster Wheeler (FW); Combustion Engineering (CE), Babcock & Wilcox (B&W) and Garrett are also contenders.

The plant's four steam turbines will likely each be rated at 25 to 30 MWe. They will operate with a turbine inlet condition of 700°F at 420 psia, and exhaust at 104°F at 1 psia. Bleed steam at 219° F and 16.9 psia will be used in the deaerator. Suppliers include Brown Boveri, GE or Westinghouse.

Gas turbine suppliers can be Westinghouse Canada, GE, Brown Boveri or GEC. Receiver suppliers can be B&W, FW, Boeing E&C, or CE. Materials (tubing and sheet) can be acquired through Huntington Alloys. B&W makes alumina castings for the insulator/reflector.

Copper slag can be acquired from smelters throughout the Southwest; e.g., from Anaconda, Phelps Dodge, Kennecott, etc.

Heliostat suppliers include McDonnell Douglas, Martin Marietta, Boeing E&C, Arco Solar Industries, Cethel, MBB or General Motors.

The reverse osmosis (RO) plant will likely utilize the latest DuPont Permasep (TM) membranes. There are several potential suppliers for the hardware.

The cooling system will likely use brackish water rejected from the R0 plant. It will first be spray-cooled in ponds before use in the cooling towers or condensers. Cooling tower blowdown (at or near 60,000 ppm TDS) will be rejected to the salt evaporation ponds.

Current plans call for heating of the RO plant feedwater to 92.5°F in the solar steam plant cooling system. Annual average heat rejection to the RO feedwater is greater than 7 percent of total cogeneration plant output (greater than 136 GWht per year), or about 19° F rise in temperature for the 2.9 billion gallon feedwater requirement.

All potential suppliers and vendors of hardware are enthusiastic and willing to work an accelerated schedule to develop the commercial hardware. The pacing or longest lead items are the heliostats (12-18 months), receiver (12-18 months), gas turbines (12-15 months) and steam turbines (12-15 months). Other items are either available immediately or within 12 months of the order date.

The final development program and construction steps are outlined in the engineering section (D). Insurance specifications for the project have been formulated in cooperation with Johnson & Higgins, Inc. These will include accident insurance, plant performance bonding, workers compensation and liability coverage.

V. LOAN COLLATERAL PROGRAM

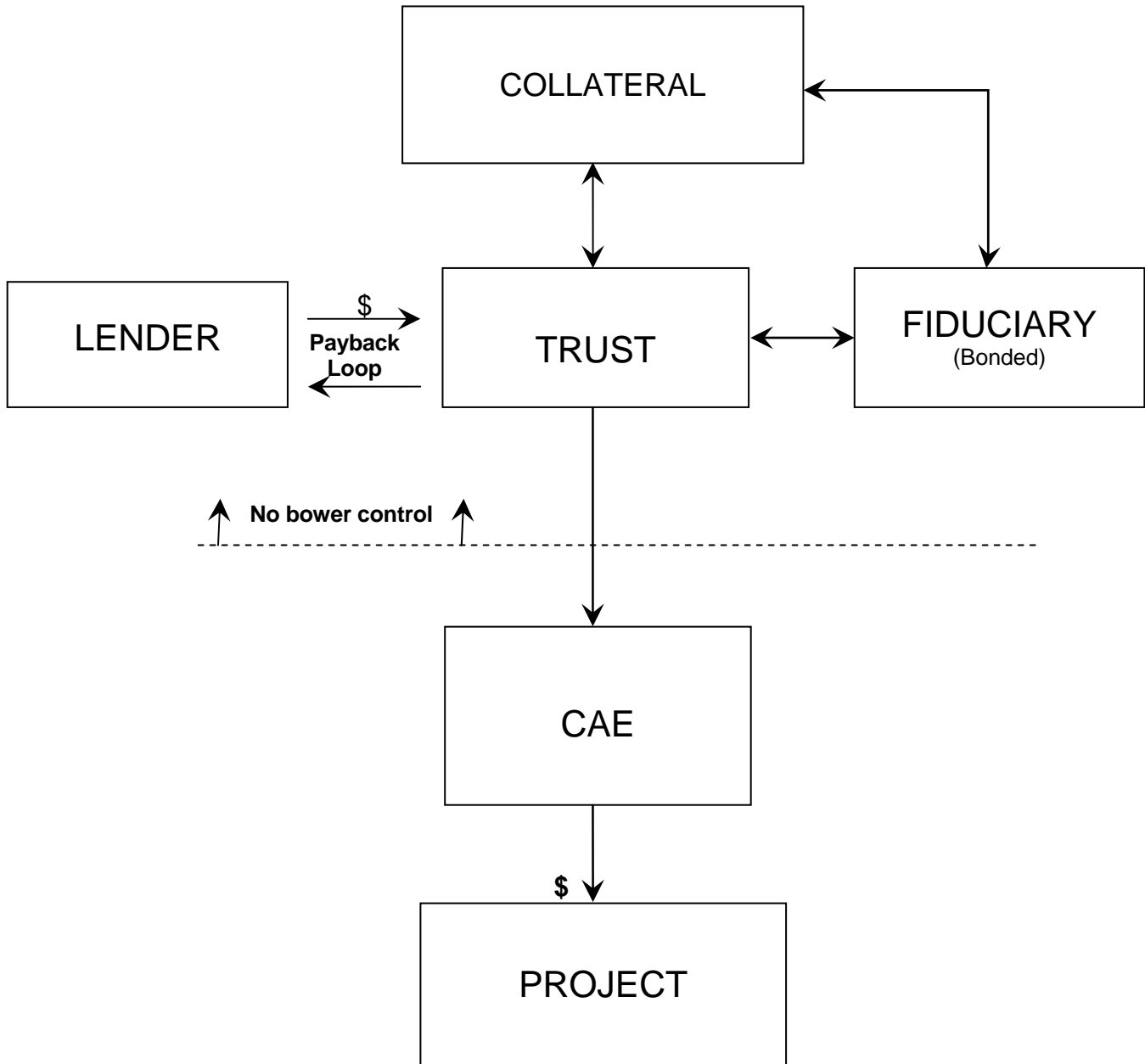
Should project lenders or underwriters require the provision of collateral, in any amount up to and including the full amount borrowed or invested, CAE would be pleased to arrange what may be considered one of the world's strongest loan security programs for energy development. It is a trustee-administered, fully collateralized and bonded program that utilizes highly liquid U.S. Government securities as instruments of guarantee. The type of security selected is the Government National Mortgage Association (GNMA) mortgage-backed certificate, in pool form, at or substantially near full par. These, of course, are backed by the full faith and credit of the United States and are thus inherently safe.

This collateral, along with monthly income derived from it, is held in trust by a fiduciary agent (bank) appointed by or with approval of the lender or investor-partner. Guaranty bonding is also provided, creating what is essentially a no-risk venture in the financial sense.

While details of the plan are not provided in this document, the block diagram found on the next page illustrates the general relationship between lender, borrower, fiduciary and collateral. A written summary of the trust plan is available upon request.

Trustee-Administered
BONDED, FEDERALLY-BACKED LOAN PROGRAM

Secured by certificates backed by the full faith and credit of the U.S. Government



An energy funding innovation of The Consortium of Alternate Energies, San Diego, CA

APPENDIX

The new 'generation' of solar power

by Timothy A. Fausch

Many announcements have been made recently concerning the development of large-scale solar power generating facilities. These projects utilize the technologies of central receiver power towers (CRPT), photovoltaics (PV), and solar thermal. Because of the large number of participants involved and the proximity of the projects, SE&C has contacted key personnel for updates on project developments. The table below is the result of this research.

The importance of these projects to the solar industry should not be underestimated. Successful completion of the facilities would improve immensely the image of solar as a major power source for the immediate future. Failure of the projects certainly would blemish the industry and provide ammunition for those who say that solar doesn't work.

After years of research and development, as well as the successful completion of "Solar One" (see table), these large-scale facilities no longer

can be viewed as demonstration projects. Also, enormous cost overruns and multi-year delays in many nuclear generating projects have opened the door for solar to enter into large-scale electrical power generation.

DOE awards nearly \$6 million

Because of the enormity of many of these projects, large companies, utilities, and government agencies are pooling their resources. Especially important are contracts for design and engineering of these facilities recently awarded by the Department of Energy (DOE), and also the financial involvement of utility companies, such as Southern California Edison Co. (SCE) and Sacramento Municipal Utility District (SMUD)

DOE contracts totaling \$5.95 million were awarded for preliminary design studies of four solar CRPT facilities. Construction of the generating plants will be based on economic feasibility as concluded by the studies.

Design-package terms require the financial involvement of the sponsoring company and its subcontractors. Design packages and their awards from DOE include the following four companies:

Amfac Energy, Inc.'s design will cost \$815,000, with DOE contributing \$675,000. **Arizona Public Service Co.'s** (APS's) design will cost \$2,367,000, with DOE's share being \$2,103,000. The **El Paso Electric Co.** (EPE) design will cost \$2,325,000, with DOE providing \$1,831,000. **Rockwell International's** design will cost \$2,068,000, with DOE contributing \$1,341,000.

Other abbreviation used in the table are: B&R - Brown and Root, Inc.; B&V - Black and Veatch Consulting Engineers; B&W - Babcock and Wilcox; CAE - Consortium of Alternate Energies; CEC - California Energy Commission; F-W - Foster Wheeler; G&H - Gibbs and Hill, Inc.; Hels. - heliostats; M-D - McDonnell Douglas Co.; MM - Martin Marietta Corp.; MWP - peak megawatt; N.A. - not available; PG&E - Pacific Gas and Electric Co.; S-R - Steams-Roger; and S&W - Stone and Webster. ■

SOLAR POWER PLANT UPDATE

MWp	site	project known as	est. cost (mill. \$)	major parties	technology	current stage	est. date "on-line"
560	Ridgecrest, CA	Ridgecrest Solar Power Plant	1,700*	CAE, B&R, G&H, SCE	CRPT - 70,000 hels., 7 fields	prelim, design complete, pursuing contracts	1987-1990
100	Daggett, CA	Solar 100	400-600	SCE, M-D, M-M, S-R, Rockwell, ARCO, B&V	CRPT - 15,000 hels., 2 fields	prelim, design complete, obtaining bids	1986-1988
1-100	Sacramento County, CA	SMUD Solar Power Plant	270	SMUD, DOE, CEC, Acurex	PV - flatplate tracking panels	completing final detail design (by Dec. 1982)	1984-1994**
66†	Red Rock (Tucson), AZ	Saguaro Solar Repowering	215*	APS, DOE, M-M	CRPT - 5,740 hels., 1 field	concept design complete, enter prelim, design	1987
41†	El Paso, TX	Newman Station Solar Repowering	136*	EPE, DOE, B&W, S&W, Westinghouse	CRPT-1,800 hels., 1 field	feasibility study done, enter prelim, engineering	1987
31.8†	Lahaina, Maui, HI	Amfac Solar Power Project	65.7*	Amfac, DOE, Bechtel, F-W	Cogeneration - CRPT & oil	concept design complete, enter prelim, engineering	1987
30†	Carrizzo Plain, CA	Carrizzo Plain Solar Power	152*	Rockwell, PG&E, DOE, ARCO	CRPT - 1,900 hels., 1 field	concept design complete, enter prelim, engineering	1985
15	Daggett, CA	Solar Trough Power Project	100+	Luz, SCE, Israel govt.	Solar thermal, linear troughs	prelim, design begun, construction begins 1983	1983-1985††
12	Daggett, CA	Acurex Solar Power Plant	75	Acurex, SCE	Solar thermal, 5,300 troughs	engineering complete, halted at construction	halted indef.
10	Barstow, CA	Solar One	141	SCE, DOE, M-D	CRPT-1,800 hels, 1 field	constructed, producing electricity in tests	1987‡
1	Hesperia, CA	ARCO PV Power Project	N.A.	ARCO, SCE	PV - 100 tracking panels	engineering complete, under construction	Dec. 1982

*Estimated cost projected in 1986 dollar equivalents.

**SMUD design calls for 1 MW in 1984; 1 MW - 1985; 2 MW - 1986; 5 MW - 1987; 6 MW - 1988; 7 MW - 1989; 10 MW - 1990; 13 MW - 1991; 20 MW - 1992; 35 MW - 1993-94. Total; 100 MWp.

†Projects received DOE grants on Sept. 30, 1982.

††Luz project calls for 3 MW in 1983; 6 MW - 1984; 6 MW - 1985. Total: 15 MWp.

‡Solar One project will be used as a demonstration plant until 1987.

Central Solar Receivers — Applications for Utilities and Industry

Molten salt and forced air central receiver systems have been developed to the point of commercial demonstration. The projected costs are competitive, even for first generation plants

Paul Allen Curto

Gibbs & Hill Inc.
Washington, D.C.

George Stern

Consultant
Mamaroneck, N Y

Gibbs & Hill, Inc., a subsidiary of Dravo Corp., has recently completed two conceptual design studies relating to central receiver applications. The first deals with a "power tower" for repowering of the Saguaro Station of Arizona Public Service. The second deals with a solar cogeneration facility integrated with an industrial process in New Mexico to generate power and provide process heat. The two systems utilize the central receiver concept but effect solutions in fundamentally different ways; one uses a molten salt receiver with a heat exchanger for a steam cycle to efficiently generate electricity. The second utilizes a Brayton air cycle which produces electricity and provides total recovery of waste heat in the form of air at 980°F (526.6°C) for direct use in the industrial process.

For the past several years, G&H has performed numerous studies of the potential, design, and feasibility of central receivers for use in utility and industrial applications. These studies have been conducted with industrial teams, including Martin Marietta Aerospace, Boeing Engineering and Construction, Foster Wheeler, Arizona Public Service and Phelps Dodge Corporation. The latest study, entitled "Solar Central Receiver System Integrated with a Cogeneration Facility," was completed in August 1981. The findings of the work indicated good potential for central receiver applications in the primary metals industries, i.e., copper, lead, zinc, and nickel smelting, with further potential applications to steelmaking.

Concepts

In the molten salt system, molten salt is pumped from the cold storage tank to the receiver, where it is heated to about 600°C (1112°F). The salt is returned to the hot storage tank after heating. In a secondary loop, the hot salt passes through a steam generator, where water is heated, vaporized to steam which is then superheated and finally reheated in four heat exchanger blocks. The superheated primary steam is fed to steam turbines for power generation, returned to the salt-heated reheater, then recycled back to the low-pressure turbines to extract more energy for power generation. Bleed steam from the turbines is utilized for deaeration and feedwater heating prior to introduction to the salt/steam generator. Heat is rejected in water or air-cooled condensers from the steam to ambient. After the hot salt is cooled in the steam generator, it is returned to the cold storage tank. Recent studies conclude that the thermal storage capacity should be sufficient for four to 12 hours of steam generation at capacity (full rating) of the steam turbines. The overall peak efficiency, from sunlight to electricity, is approximately 23.2 percent using the molten salt concept. The level compares with 8- to 12-percent system efficiencies with photovoltaics, and 14 percent for the first generation water-to-steam central receiver plant at Barstow, Calif.

In the forced-air system, ambient air is inducted into

Combined cycle system performance

Gas turbine exhaust temperature (°F)

	700	750	800	850	900	950	1000
Optimum steam boiling pressure (psia)	350	380	420	465	520	580	640
Steam turbine inlet temperature (°F)	600	650	700	750	800	850	900
Air exhaust temperature from HX (°F)	400	400	400	400	400	400	400
Pinch point ΔT (°F)	29	33	35	37	40	44	52
Steam cycle heat rate (Btu/kWhe)	11,950	11,710	11,460	11,220	10,970	10,730	10,580
Peak net steam turbine power (MWe)	79	89	100	111	123	136	150
Peak gas turbine power (MWe)	526	493	460	427	397	371	350
Annual heat cycle efficiency (percent)	37.4	37.0	36.6	36.2	35.9	35.7	35.6
Plant factor (percent)	32.1	33.0	34.0	34.9	35.8	36.6	37.0

speed-controlled gas turbines and forced through an Inconel 617 metal tube receiver, where it is heated to between 600 and 816°C (1112 to 1500°F). The receiver discharge air is expanded in the compressor-turbine (which drives the compressor) and further expanded in the power turbine (which drives the synchronous generator). Depending on the downstream application (for further steam raising for power generation in steam turbines and/or for direct use in some industrial process), the exhaust temperature and pressure are tightly controlled by variation of compressor rotational speed and power turbine guide vane positioning. The exhaust air from the gas turbines is ducted to the thermal energy storage (TES) plenum, where it is further gated to either the TES or to the downstream process (depending on generation and load demand). The TES is discharged using compressors to force air up through the packed bed, until the air reaches required temperature and flow rate to accommodate the downstream process conditions.

In the table, the use of this exhaust air in steam generation systems is explored. As the turbine exhaust temperature is lowered, the steam power generation is reduced while the gas turbine generation is increased. The overall cycle efficiencies range from 35.6 to 37.4 percent (from heat to electricity) with these combined cycle configurations. Coupled with annual average (sunlight-to-heat) collection efficiency of 54 percent in the air receiver (peaking at 62 percent), overall annual system efficiency ranges from 19.2 to 20.2 percent, with peak efficiency as high as 23.2 percent. Of course, the turbine/exhaust air might also be used in an industrial process, such as copper smelting. The findings in the industrial cogeneration study

(with Phelps Dodge and Boeing) predicted 90-percent smelting throughput improvement utilizing process air solar-preheated to 527°C (980°F). The greater oxidation potential and sensible heat content of the air more effectively burns the sulfur and iron in the smelting concentrates. In this system, 650 GWh of heat is collected annually by the solar system, while 231 GWh of fuel energy is used to produce 384 GWh mech/elec recovered by the cogeneration systems in the plant. The premodified plant burns 886 GWh of oil and recovers only 200 GWh mech/elec in its cogeneration system.

The plant capacity is nearly doubled, increasing from 106,000 metric tons of anode copper per year to 200,000, while sulfuric acid production increases from 630,000 metric tons to 1,200,000. The integrated solar facility virtually halves the required total primary fuel needed to produce a unit of anode copper, while greatly improving plant profitability and productivity. Three primary innovations make possible the use of gas turbine/combined cycle-cogeneration systems. These include:

- (1) Thermal storage using copper slag;
- (2) Multi-power port gas turbines;
- (3) Integrated, intrinsically redundant master control and communications systems.

The slag storage concept is a breakthrough which enables heat storage at elevated temperature (up to 816°C) for several days rather than merely hours. Its cost (about \$30 to \$40 per cubic meter) results in thermal storage capacity costs on the order of pennies per thermal kilowatt-hour, or about 10 cents per electrical kilowatt-hour, once the heat is converted in heat engines. Multi-power

port gas turbines provide speed control through electrical means, which tightly control receiver power extraction, air temperatures, pressures and flow rates without the use of auxiliary fuel or combustors, turbine valving, or complex interconnecting bypass ducting. The new Gibbs & Hill master control system concept makes possible continuous, distributed, fully automated power generation without resorting to complex, yet-to-be-developed computer hardware. Its projected reliability in the smelter application exceeds 0.9999.

Other Potential Applications

It is clear that the primary emphasis on central receiver development has recently switched to molten salt for utility power generation. However, the air systems can match or exceed the salt system potential economics for power, while adding the greater flexibility for far greater storage capacity and direct uses of high-quality exhaust air in industrial processes. For example, nickel smelting em-

bodies technology that is virtually identical to that for copper. Zinc and lead are also produced from exothermic reactions of ore concentrates which could use pure, heated air more effectively. Steelmaking process efficiencies could be enhanced using preheated pure air, along with coke-produced CO and air blasting to improve furnace productivity rates. Use of pure gases other than air, such as helium, CO₂, O₂, synthesis gas (CO and H₂), and hydrocarbons (such as CH₄, C₂H₅, etc.) could be utilized in Brayton-type systems for chemicals and petroleum industry applications. Processes would be made cleaner, more productive, more economic, and manufacture chemical products of exceptional stability and purity.

Economics

Central receiver economics have historically been driven by the cost of heliostats, receivers, and thermal storage. In the case of utility applications, only the heliostat price, which is governed by production quantities

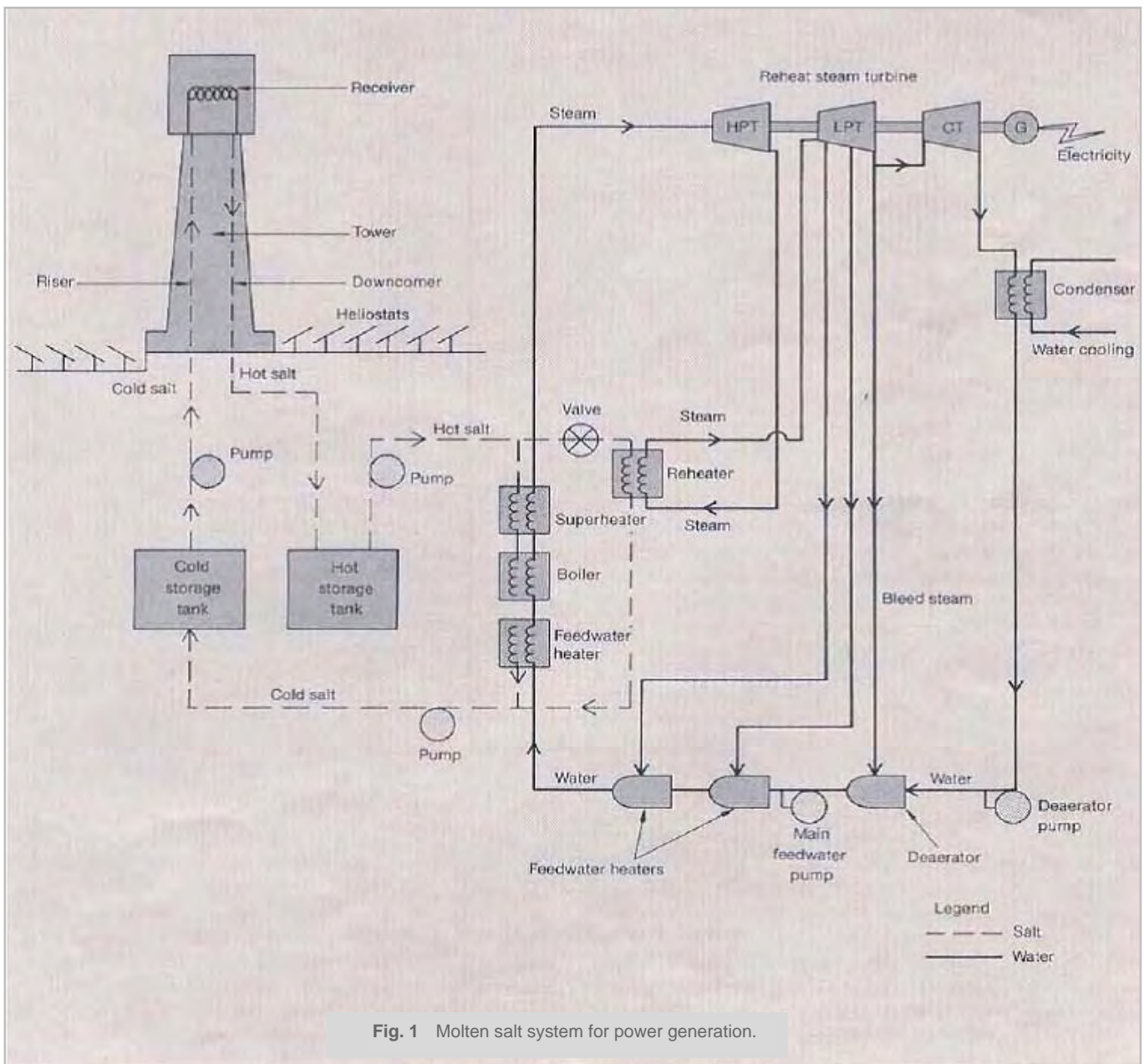


Fig. 1 Molten salt system for power generation.

and delivery schedules, becomes critical. The last Barstow heliostat cost over \$250 per square meter. The 100,000th unit of a production line for commercial heliostats will likely be in the \$90 to \$130 price range, installed at a site within 1500 km of the heliostat plant.

We contend that the economy of scale for central receivers requires that production rates must exceed 50,000 heliostat units per year for the cost of thermal energy produced in a sunny region (insolation greater than 2000 kWh_T/m²/yr) to be competitive for power generation. Some integrated processes in the industrial sector could tolerate high heliostat prices, perhaps as high as \$200 per square meter installed. In the smelter application, a 50-percent discounted cash flow rate-of-return to equity is exhibited with a heliostat price in this range, but this is primarily due to the marked improvement in overall plant productivity.

A recent in-house Gibbs & Hill study concludes that a 500 MWe combined cycle plant (based on our concept)

could be designed and built for about \$750 million (1980 dollars) or \$1.5 billion (1987 dollars) that would produce an average of 1600 GWh per year. Power cost would be 16¢/kWh in 1987 (8¢ in 1980), not rising in current dollars for about 10 years. This would compete favorably with small coal-fired systems, integrated coal gasifier/combined cycle systems, windmills, nuclear power, and most certainly with oil- or gas-fired combined cycle units. Such units could be installed throughout the Southwest, but also in areas as far north as eastern Oregon and Washington, Idaho, Montana, Wyoming, Nevada, and Utah. Power costs would vary about 20 percent over this entire area from those projected for the southern desert sites. Molten salt and forced air central receiver systems have been developed to the point of commercial demonstration. The new generation of these plants have broad applications in new and retrofit utility and industrial facilities. The projected costs are competitive, even for first generation plants.

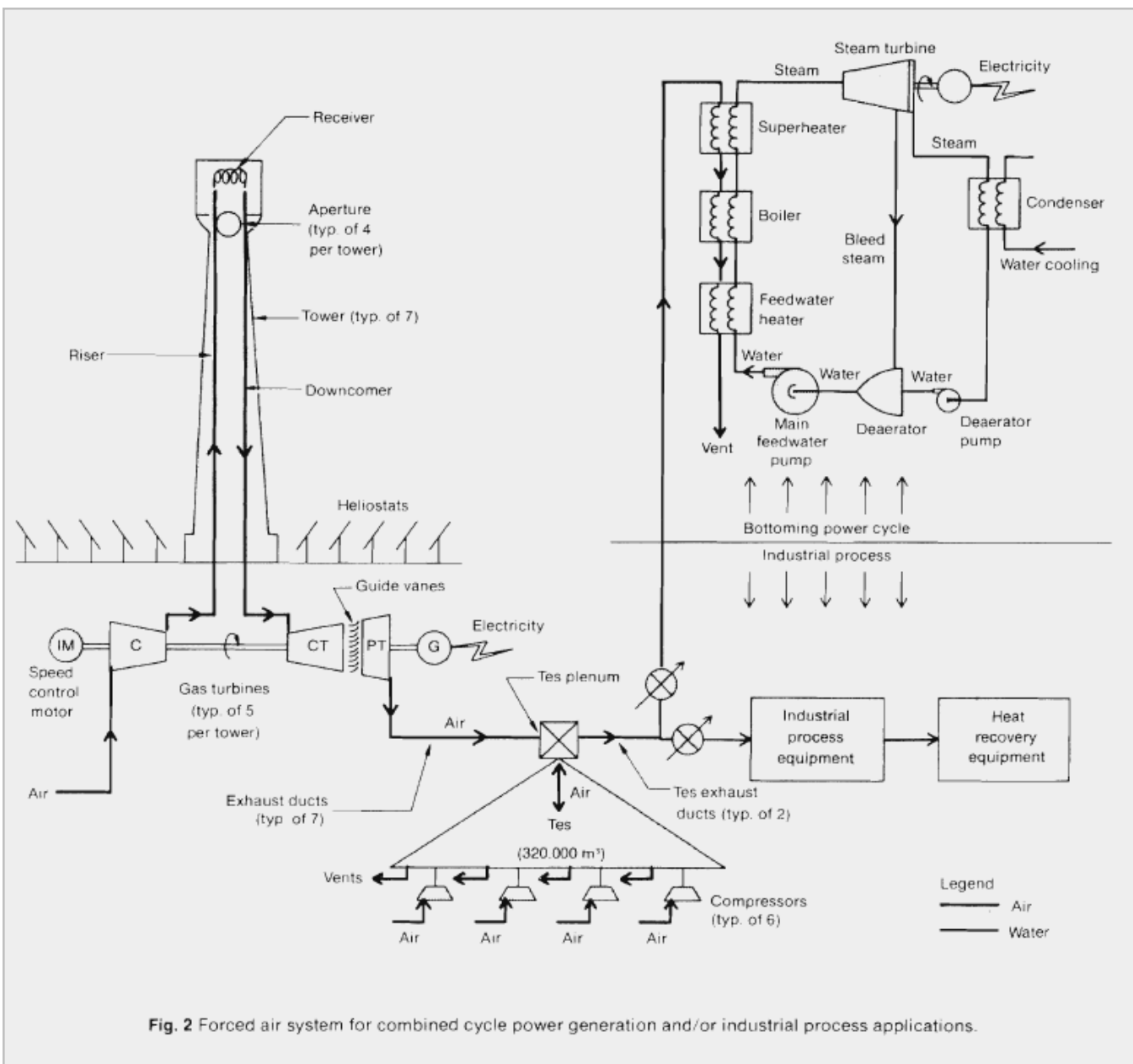


Fig. 2 Forced air system for combined cycle power generation and/or industrial process applications.