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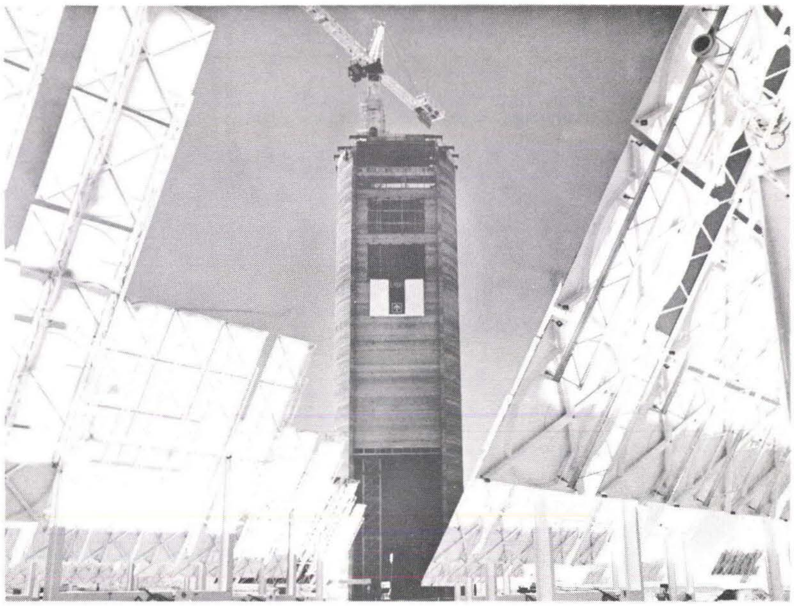
Solar Repowering Workshop

A Summary Report



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August 2-3, 1978

Denver, Colorado

Summarized by:
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A Division of Midwest Research Institute

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SOLAR REPOWERING WORKSHOP

A SUMMARY REPORT

AUGUST 2-3, 1978

DEAN NORDMAN

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1536 Cole Boulevard
Golden, Colorado 80401

A Division of Midwest Research Institute

Prepared for the
U.S. Department of Energy
Division of Solar Technology
Under Contract EG-77-C-01-4042

PREFACE

This report summarizes the Solar Repowering Workshop held on August 2 and 3, 1978, in Denver, Colorado. That Workshop was developed and conducted in compliance with Contract Number EG-77-C-01-4042 for the Division of Solar Technology of the U.S. Department of Energy, as a part of SERI Task 3508, "Systems Analysis Support to DOE."

Approved for:

SOLAR ENERGY RESEARCH INSTITUTE

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Section 1.0

SUMMARY OF WORKING GROUP RESPONSES

Two separate worksheets labeled Group A and Group B were prepared prior to the Workshop. These worksheets contained the following questions:

Group A: Key issues in the demand for solar thermal technologies

1. Is repowering the best emphasis for a federal solar thermal program aimed at penetrating U.S. grid electricity markets? Explain.
2. What should be the relationship between utilities, manufacturers, and the federal government in such a program?
3. What is the best strategy for reducing the cost of solar thermal technologies?
4. What is the best strategy for demonstrating the reliability of solar thermal systems? How long do reliability tests have to last?

Group B: Key issues in the supply of solar thermal technologies

1. What is the range of heliostat prices that have to be achieved for solar thermal technologies to be economically competitive?
2. What assumptions are made with respect to the cost of the balance of the system in deriving these heliostat prices?
3. What improvements have to be made to reduce present prices of heliostats to those competitive levels?
4. What design or process improvements are most likely to provide these cost reductions?
5. What capital investments are required to implement these cost reductions?
6. What market and competitive conditions would have to exist before a profit-motivated firm would make these investments?

Each workshop participant was asked to specify in advance whether he wished to join a Group A or Group B working group. That selection process yielded five "A" and two "B" working groups.

A leader was appointed to each working group. Each group met separately and deliberated for two to three hours. The leader then prepared a report reflecting the consensus of his working group.

Each of the seven group leaders presented his report orally to all workshop participants. These oral reports were recorded and subsequently transcribed to form the basis for the Working Group Results contained herein.

In preparation of this document, the working groups' responses to each question were collated and edited. Thus, the answers to Group A questions reflect the consensus of all five "A" working groups; those to Group B questions, the consensus of both "B" working groups.

In summary, the working groups provided the following responses to the questions:

Group A: Response to Demand Questions

1. Repowering exhibits lower technical risk, more favorable economics, and better availability than new stand-alone or hybrid plants. It appears to offer the best vehicle for obtaining utility acceptance and early commercialization of solar thermal power for U.S. grid electricity markets.
2. The federal government, the utilities, and the manufacturers should equitably share the financial risks of the program. The federal government should coordinate technology development but allow the traditional relationship between utilities and manufacturers to prevail in implementing programs.
3. The best way to assure reduced cost is to establish a high volume, long life, competitive market.
4. Ideally, reliability is best demonstrated by long-term actual operation. However, the "window" for commercial repowering applications is narrow, possibly 1985 to 1995. Therefore repowering demonstrations must commence quickly, nearly in parallel with Barstow. In addition, life testing of critical components and subsystems should be pursued.

Group B: Responses to Supply Questions

1. The competitive price for heliostats is highly variable, depending on utility-specific and site-specific factors. In general, the DOE goal of $65 to $75 per square meter is a value that should yield a large market.
2. The cost of the balance of the system is about equal to the cost of the heliostats.

3. & 4. Heliostat cost reductions should result from relaxation of presently stringent requirements such as wind speed survival, pointing accuracy, and emergency stow. Cost reductions from research and improved production methods should also occur.

5. A capital investment of $20 million will be required to produce heliostats for repowering projects. Approximately ten times that will be required for an advanced commercial heliostat industry.

6. A credible near-term (5 to 7 years) future market must exist before suppliers will commit the investment for heliostat production. That credible market cannot exist without a National Energy Policy and a viable repowering program which the utilities and industry can see as long-term and dependable.

In addition to the above responses to questions, the working groups also expressed some other major points, as follows:

- Demonstrated operation of repowering must occur before any significant utility commitments will be made.
- Economic viability of repowering must be determined before any significant utility commitments will be made.
- Repowering projects cannot be standardized because of the need to integrate with an existing plant in each case.

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Section 2.0

WORKING GROUP RESULTS - GROUP A - DEMAND

2.1 EMPHASIS ON REPOWERING

The question posed was:

> "Is repowering the best emphasis for a federal solar thermal program aimed at penetrating the U.S. grid electricity markets? Explain."

Responses to this question are summarized in the following paragraphs.

2.1.1 Repowering: Advantages and Problems

The consensus of the working groups considering the basic options of the federal solar thermal program (stand-alone plants, hybrid plants, and repowering of existing plants) was that repowering is a very good initial step leading to the penetration of the utility market. Some of the reasons cited are that repowering appears to have

- the relatively lowest technical risk;
- the most favorable economics; and
- highest availability due to highest system redundancy.

Repowering, because of its hybrid nature, appears to offer the best vehicle for obtaining the electric utilities' acceptance of, and participation in, solar thermal programs; thus, to offer the earliest potential for commercialization. Since retention of fossil-fuel capability provides discretionary control by the utility system operators, acceptability of repowering should be greatly enhanced compared to solar stand-alone systems. Moreover, because of the expressed utility interests, repowering offers a near-term opportunity for joint utility/DOE involvement in solar electric programs.

Some favorable aspects of a solar thermal repowering program include the following:

- The repowering program has both momentum and inertia, and has acceptability in the Administration.
- It can be used as a learning program for development of solar thermal systems and subsystems.
- It provides a "clean" fuel for plants that must have their fuel source replaced or eventually close down.

Some disadvantages of a solar thermal repowering program were considered to be:

- Repowering would cause a financial problem to the host utility (in nonrevenue-producing capital requirements).
- It would temporarily take existing capacity out of service and, in addition, may decrease reliability of mature capacity in the power system.
- Repowering is a small market relative to a new solar hybrid plant market.
- The retrofit to existing units could add a magnitude of problems to actual development of the resource.
- Repowering cannot be standardized because of the requirement to interface with existing units; each interface will have its own specific problems.

However, it was recognized that repowering offers incentives that could easily offset site-specific disadvantages. These incentives include:

- Demonstration of more cost-effective technology to utilities;
- Reduction of the time frame for solar market penetration;
- Creation of a large manufacturing base; and
- Establishment of the base for future solar hybrid and stand-alone plants.

To turn these incentives into objectives, careful selection of candidate plants for repowering, and of alternative receivers, could minimize site-specific problems. In addition, alternative receivers such as molten salt or liquid metal were viewed as a means of decoupling the solar subsystem from the electric power generating subsystem, thereby minimizing the feedback control problems associated with system transients.

2.1.2 Time Frame for Repowering Demonstrations

The working groups strongly recommended that both Barstow and solar repowering demonstration programs be pursued with vigor. Each would provide valuable information needed in the near term for long-term viability for the solar thermal program. Barstow is expected to establish the technical viability and economic base for solar stand-alone plants and to provide an additional base for any other solar thermal endeavor including repowering.

Furthermore, the consensus was that a repowering program should be carried on in parallel with Barstow, even if slightly behind the Barstow schedule. Thus repowering could serve as the springboard to new solar hybrid and stand-alone plants. This parallel pursuit of the two programs would lead to the quickest penetration:

- Barstow will demonstrate an integrated operating system. While it will be demonstrating an admittedly outdated technology, Barstow nevertheless will provide utilities with operating characteristics vital to their continuous in-house evaluation processes. (That is, utilities must continually evaluate all potential resources to meet increasing demands.)
- Barstow offers the opportunity to create a manufacturing base so vital to the establishment of a new industry. However, the repowering market appears to be quite limited, and a decision on commercialization should wait until later into the demonstration.

An implementation of demonstration programs following (rather than in parallel with) Barstow might very well make commercial repowering impracticable. The window for potential commercialization appears small--about 1985-1995--requiring utmost haste in repowering demonstrations. Beyond this time frame a large number of the candidate plants will be retired, and a limited number likely subjected to some other form of repowering.

2.1.3 Some Legal Aspects of Repowering

An interesting observation was made in relation to the Clean Air Act; namely, that new plants built to use fossil fuel must satisfy the Act's environmental emission requirement. But an old (i.e., existing) plant being repowered does not come under the Act, and does not have to satisfy the emission requirement. Therefore repowering is the first federal way for utilities to extend the lifetime of their old fossil-fuel plants. Otherwise these plants would be scheduled for early retirement.

A question was raised for DOE about the Coal Conversion Act, which requires both oil- and gas-fueled plants to convert to coal: While the intent of this Act is to cut back on the consumption of oil and gas, the requirement is that the utility convert specifically to coal. Therefore, will solar repowering satisfy the Coal Conversion Act? The answer to this question should have an impact on the solar repowering program.

2.2 RELATIONSHIP OF GOVERNMENT, UTILITIES, AND MANUFACTURERS

The second question considered was:

> "What should be the relationship between utilities, manufacturers, and the federal government in such a program?"

The responses were as follows.

2.2.1 Objectives

Delineation of the relationship between utilities, manufacturers, and the federal government in a repowering program requires a definition of discrete objectives.

The objective of the utilities is to minimize cost to the consumer and still provide an equitable return to investors. The manufacturers want profit and incentives, such as long-range markets that justify long-term investments. Government objectives are to eliminate the economic and technical barriers to commercialization, to reduce front-end risk for utilities and manufacturers, and to get out of involvement as quickly as possible.

Having identified these objectives, the working groups sought a consensus on the question itself.

2.2.2 Relationships

The basic relationship between the government, manufacturers, and utilities should be one of risk-sharing. The government should not carry the entire program on its shoulders to the point of absorbing all the risk before the private sector enters. Specifically, the utility-government relationship hinges very strongly on an equitable assessment of the amount of risk, a reasonable level of risk, that the utility industry is willing to assume.

Utilities must be provided with a means of impacting the formulation of federal programs, so that their economic and financial commitments can track a common objective. Since utility planning commitments are made for five to ten years into the future, utility response to near-term federal programs would result in major financial impact on their own plans. (For this reason alone, solar repowering appears to provide the basis to turn around those commitments within the time frame to effect grid penetration.)

The federal government's role should be to coordinate technology development, but to allow the traditional relationship between utilities and manufacturers to prevail in implementing programs. In particular, the federal government should sponsor demonstrations of the technical and economic viability of solar repowering, and should also provide economic incentives for the introductory phase of solar technology with minimum government control.

The role of utilities and manufacturers should be to educate and sell utility commissions, the public, and Congress on desirable energy alternatives, including solar programs. (DOE must participate in selling the programs to the rest of the federal government, particularly to Congress.) In addition, both utilities and manufacturers should participate in, even sponsor, development programs; and should make financial as well as technical contributions.

The relationship between utilities and manufacturers is not normally a problem, since both can rely on past experience. Where such experience is not available, manufacturers can respond to utility requirements provided that component performance guarantees are insured by the governmment. As market and performance risks are reduced, utilities and manufacturers will be willing to invest more dollars into ongoing programs.

However, potential repowering sites encompass a broad range of utility sizes. The larger utilities clearly have a few more dollars (if not really venture capital, at least exploration R&D kinds of monies) to participate in programs that are within the allowable constraints; whereas, some of the smaller utilities would certainly be limited. Perhaps a starting point would be to develop an understanding of just what is the latitude for investment by the utilities, just what is acceptable to the public and allowed by the state regulatory agencies. Then a meaningful projection could be made of how much the market must be stimulated artificially before private industry is able and willing to take over.

2.2.3 Other Considerations

If the federal government wants to accelerate the solar thermal repowering program and circumvent normal market development, it must fund the first several plants to prove concept, availability, and reliability; or, fund one or two plants and then plan the timing for construction of subsequent plants so that their design can utilize the knowledge gained on the first few.

Again, if the federal government wants to accelerate the program and circumvent normal market development, it will have to fund or underwrite manufacturing facilities, particularly for heliostats. The MITRE Corporation projects the construction of almost $1 billion of manufacturing facilities in about a two-year period. An expansion of this magnitude would be very difficult without government participation, especially since most of the present suppliers in the solar field are not really manufacturers in the volume-production sense.

2.3 COST REDUCTION STRATEGY

The third question was:

> "What is the best strategy for reducing the cost of solar thermal technologies?"

Responses are summarized as follows.

2.3.1 Subsystems and Component Development

The overall strategy is an increase in overall solar subsystems efficiency coupled to an increased cycle efficiency. Stronger subsystems development must be accelerated within the program of total system development. Moreover, for acceptance of the development, the government must place more reliance on industry and seek more input from industry. This in turn leads to an interesting question: What kind of protection does the government really provide to manufacturers for proprietary designs?

There was a concern expressed that, when several programs or several competing projects within a program are carried on in parallel, a decision point is reached, a selection made, and the rest of the options dropped. If that selection is made from an untimely decision, the result could be elimination of some good options too soon.

2.3.2 Heliostats

The emphasis for cost reduction should be placed on heliostats, since they represent the dominant cost fraction of the solar subsystem. Suggestions for reducing the cost of heliostats include the following:

- The government should consider making mass purchases of heliostats in much the same manner as the photovoltaic program; or
- The government should subsidize the heliostat market; or
- The government should guarantee both a market and a price for heliostats.
- The government should continue to support the development of alternative advanced design concepts for heliostats and receivers.
- A pilot production facility should be established with capabilities for being automated to increase production rate.

2.3.3 Market Establishment

The consensus was that the best way to assure reduced cost was to assure a reasonable promise of market life. Establishing a commercial potential through a viable repowering program will set the stage for standard enterprise methods, mainly in the arena of competition. As this market is stimulated and sustained, the manufacturers' attitude will be that the mass production market, if it is justified, will lead to reduced cost under the normal free enterprise system.

Another point: multiple applications for the components of solar technology should be explored. Take the heliostat, for example. It is generally associated with the central receiver electric power plant application. Could it be used for process heat applications, thus expanding its market potential?

A suggestion was also made that the government should explore the foreign market in parallel with establishing the domestic market, thus widening the market potential for solar technologies.

2.3.4 Cost Reduction Studies

Component and system cost reduction studies can be, and to a certain extent are being, undertaken right now. The government should campaign to get companies who are in the business of mass production, like the automobile industry, interested and involved in component manufacturing.

It was noted that the bottom-line acceptable cost for one utility system would probably not be the same for another system because of site-specific factors.

2.4 RELIABILITY OF SOLAR THERMAL SYSTEMS

The final question considered by the A working groups was:

> "What is the best strategy for demonstrating the reliability of solar thermal systems? How long do reliablity tests have to last?"

The consensus of their responses follows.

2.4.1 System Reliablity

The normal strategy to demonstrate reliablity is to design, build, and test--and then to redesign, build, and test. In other words, solar thermal systems have to evolve just like any other new technology.

Nevertheless, successful total systems in the particular context of plant operation are the crux of the reliability question. Utilities traditionally take the attitude that a 30-year demonstration is desirable. But we cannot afford to wait for the first solar thermal plant, then stand and watch for 30 years. While there is no discrete cutoff point, at least two years of successful operation of the total system would appear to be a minimum requirement.

We cannot afford to wait until Barstow is entirely proven before we launch into other solar thermal programs. We must start the repowering as early as possible. Of particular concern is the vacillation of government programs and the lack of direction. And more specifically, will a venture analysis further delay demonstration?

2.4.2 Component Reliability

Accelerated life testing of critical components by manufacturers should be pursued as a basis for reliability evaluations, but not to the detriment of program schedules. Rather, the urgent need for reliability information should be an additional incentive for two demonstration programs to double the real exposure time of a unit.

The track record that will necessarily be developed in the process of reducing component costs to a point where the market will be self-sustaining should prove adequate for reliability demonstrations.

Failure modes of components should be identified so that utilities can carry on their normal procedure of inspection maintenance. Thus the utilities can make a valuable contribution to increased reliability in that their input can be applied to the evolution of succeeding units and to the attainment of technology for solar stand-alone plants.

And finally, a general comment: The solar thermal program may die or it may play a major role in the Nation's energy picture. If it dies, far better that it do so because it was proven impracticable and uneconomic than because too little data was obtained too late.

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Section 3.0

WORKING GROUP RESULTS - GROUP B - DEMAND

3.1 HELIOSTAT PRICE RANGE

The first question considered by the B working groups was:

> "What is the range of heliostat prices that have to be achieved for solar thermal technologies to be economically competitive?"

The responses were as follows.

3.1.1 Competitive Heliostat Prices

In today's market, heliostat prices are determined by various site-specific factors. The competitive price, therefore, is cost-dependent upon the following elements:

- site-specific costs
- amount of sunlight or insolation available in various geographical areas

When the effects of these factors are considered, the current range of heliostat prices is somewhat divergent. For example, in some markets, setting a heliostat price goal of zero dollars per square meter may be considered too high; whereas, in other markets, a price of $150 per square meter <u>is</u> considered competitive. To establish a realistic goal, however, a substantial number of solar thermal applications can be expected if a goal of $65 to $70 per square meter can be reached.

3.1.2 Rule-of-thumb Calculation

A quick calculation indicates that a heliostat price of $20 per square meter is comparable to a fossil-fuel cost of $1.00 per million Btu. Some utilities are currently paying $2.50 per million Btu; therefore, a competitive heliostat cost would be 2.5 times $20, or $50 per square meter.

3.2 COST OF BALANCE OF SYSTEM

The second question posed was:

> "What assumptions are made with respect to the cost of the balance of the system in deriving these heliostat prices?"

One general assumption was made: The cost of the balance of the system is equivalent to the cost of the heliostats.

3.3 REDUCING HELIOSTAT COSTS

Questions 3 and 4 both addressed the topic of reducing heliostat costs.

> 3. "What improvements have to be made to reduce present prices of heliostats to those competitive levels?"

and

> 4. "What design or process improvements are most likely to provide these cost reductions?"

During the process of determining how to reduce heliostat costs, two ideas evolved: (1) a redefinition of heliostat costs and goals and (2) evaluation of a new series of questions posed by the group members. These ideas are outlined in the following discussion. It is hoped that further evaluation of these suggestions will provide directives from which to work in determining viable solutions for reducing heliostat costs.

3.3.1 Redefinition of Heliostat Costs and Goals

Suggestions were made to redefine heliostat costs and goals. Heliostat installation costs should not be included in the cost of the pure manufactured items. Included in the installation costs are the following items:

- field wiring costs
- foundation costs
- field work and associated costs
- cost of the land

Because field installation costs are site-specific and vary from site to site, the cost goal should be determined only on the basis of the costs of the manufactured heliostat; installation costs should not be included in the overall cost goal for the heliostat and the collector subsystem. To include the installation costs only obscures the cost of the pure manufactured item.

3.3.2 Evaluation of New Questions

The following issues were posed as questions during the process of determining how to reduce heliostat costs and goals:

(1) Can the present codes and specifications for heliostat designs be further evaluated, and less stringent requirements be set in order to reduce production costs?

- Wind Survival Requirement

  Do we really need a 90-mile-an-hour wind survival requirement on heliostats? If not, then total costs per heliostat could be reduced by reducing the weight of the heliostat.

- Pointing Accuracy Requirement

  Can we lower the current standards and requirements for pointing accuracy? In other words, do we have too much money invested in achieving a high degree of pointing accuracy for individual heliostats, when we could just as easily add an additional 10 or 12 more heliostats? Reducing the requirements for pointing accuracy per individual heliostat would reduce the price per heliostat. Net results would be lowered heliostat field costs.

- Emergency Stow Condition Requirement

  Is the emergency stow condition a requirement? Can it be eliminated?

- Closed-Loop vs. Open-Loop Tracking

  Have the trade-offs between closed-loop tracking versus open-loop tracking been sufficiently evaluated? With the realization that manufacturers are again looking at drive trains and pointing accuracies, perhaps this issue should be re-evaluated.

(2) Can the technical assistance required in the field by the heliostat manufacturers be reduced?

(3) Can certain check-out costs be eliminated? In other words, can we eliminate the following needs?

- The need to go in and target;
- The need to go in and bore the site;
- The need for annual checks on items which have not been sufficiently defined; and
- The need for checking the loss of pointing accuracy.

(4) Can new research be initiated which would help reduce operating costs?

- Research on a first surface silvered mirror

- Research on a dirt repellent surface to reduce cleaning costs

(5) Improved production methods and advanced manufacturing developments should reduce heliostat costs.

3.4 CAPITAL INVESTMENT REQUIRED

Another question considered was:

> "What capital investments are required to implement these cost reductions?"

The topic of how to implement heliostat cost reductions led to the consensus that the best way to assure reduced cost is to assure a reasonably sound market life. As the market is stimulated and sustained, then the mass production market should lead to reduced manufacturing costs.

To date, heliostat production in the United States has been based on a relatively small scale. Heliostat production, in its present state of the art, is symbolically associated with "carriage house" types of operations--a term which signifies the early stages of the American automobile industry.

The first substantial heliostat order will be from Barstow. As stated in previous discussions stemming from Group A (Question 1: "Time Frame for Repowering Demonstrations"), Barstow offers the opportunity to create a manufacturing base so vital to the establishment of a new industry.

However, in terms of specific dollar amounts required to establish a credible market for repowering project orders, the minimum capital investment is estimated to be about $20,000,000. In today's market, this figure is comparable to the initial capital investment of Ford's first automobile production line. A capital investment of approximately $200,000,000 or more will probably be required to assure market stability of an advanced commercial heliostat industry.

3.5 NECESSARY MARKET CONDITIONS

The final question considered was:

> "What market and competitive conditions would have to exist before a profit-motivated firm would make these investments?"

The response was that a credible market must exist before manufacturers will risk financial investments. The market must be a relatively near-term market or a market which provides a return on investments within five to seven years.

A credible market cannot exist without a National Energy Policy or at least a defined Solar Energy Plan. A viable repowering program is also needed which would set the stage for standard enterprise methods and stimulate a competitive market situation. To date, only one demonstration repowering plant is forecast for development. Suppliers are not motivated to make the required financial investments to stimulate the market environment if they do not have profit incentives on which to base their decisions.

The leading question asked by manufacturers is: "What is the Government's long-range commitment in promoting a credible market situation?" Manufacturers want profit and incentives which substantiate long-range markets in order to justify long-term financial investments.

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APPENDIX A

SOLAR REPOWERING WORKSHOP AGENDA

Tuesday, August 1, 1978

7:00 - 9:00 pm	Registration	Silver Glade Foyer

Wednesday, August 2, 1978

8:00 - 8:30 am	Registration	Silver Glade Foyer
SESSION I (MORNING) - 8:30 am		Silver Glade Ballroom
Welcome		Neil H. Woodley Solar Energy Research Institute (SERI)
Repowering Perspectives		Charles Grosskreutz SERI
Keynote Address		Bennett Miller Department of Energy (DOE)
Workshop Overview		Neil H. Woodley SERI
Market Analysis of Solar Repowering		Jack D. Maddox Public Service Co. of New Mexico Gerald Parker Westinghouse Electric Corp. John T. Day Westinghouse Electric Corp.
EPRI-Related Programs		John E. Bigger Electric Power Research Institute (EPRI)
10:15 - 10:30 am	Break	
Requirements Analysis of Repowering		Martin Scholl MITRE Corp.
Results of Repowering Studies		Prem N. Mathur Aerospace Corp. Neal Kochman PRC Energy Analysis Co.

Central Receiver Program		Robert W. Hughey DOE/San Francisco Operations Office (SAN)
Technology Transfer from Barstow to Initial Repowering Projects		Robert W. Hughey DOE/SAN
12:30 - 1:45 pm	Lunch	Century Room
SESSION II (AFTERNOON) - 1:45 pm		Silver Glade Ballroom
Central Receiver/Heliostat Technology Development		Alan C. Skinrood Sandia-Livermore
Design Considerations in Repowering		Bill von KleinSmid Southern California Edison Co. William Lang Stearns-Roger
Formation of Working Groups		Dean A. Nordman SERI
Separate Working Group Sessions		Group Leaders
5:30 - 6:30 pm	Cocktail Hour (Cash bar)	Century Room

<u>Thursday, August 3, 1978</u>

SESSION III (MORNING) - 8:30 am		Silver Glade Ballroom
Working Group Reports		Group Leaders
10:00 - 10:15 am	Break	
Response-Panel Discussion		Gerald Braun, Chairman DOE Charles Grosskreutz SERI Melvin K. Simmons SERI Robert W. Hughey DOE/SAN
12:00 (Noon)	Adjourn	

APPENDIX B

SOLAR REPOWERING WORKSHOP - LIST OF ATTENDEES

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