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## **SOLAR THERMAL PARABOLIC TROUGH POWER PLANTS: AN OVERVIEW OF EXISTING POWER PLANTS & FUTURE TECHNOLOGICAL DEVELOPMENT**

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*NEW ADVANCES IN CONCENTRATING SOLAR POWER*



# **SOLAR THERMAL PARABOLIC TROUGH POWER PLANTS AN OVERVIEW OF EXISTING POWER PLANTS & FUTURE TECHNOLOGICAL DEVELOPMENT**

1. History of the SEGS Plants
2. SEGS Plants Brief Description
3. SEGS Experience
4. Future Development of SEGS
5. Concluding Remarks



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## THE SEGS HISTORY IN CALIFORNIA

SEGS I	1984	Daggett	14 MW
SEGS II	1985	Daggett	30 MW
SEGS III	1986	Kramer Junction	30 MW
SEGS IV	1986	Kramer Junction	30 MW
SEGS V	1987	Kramer Junction	30 MW
SEGS VI	1988	Kramer Junction	30 MW
SEGS VII	1988	Kramer Junction	30 MW
SEGS VIII	1989	Harper Lake	80 MW
SEGS IX	1990	Harper Lake	80 MW

**TOTAL CAPACITY INSTALLED = 354 MW**



**Kramer Junction - California**  
**Satellite view**

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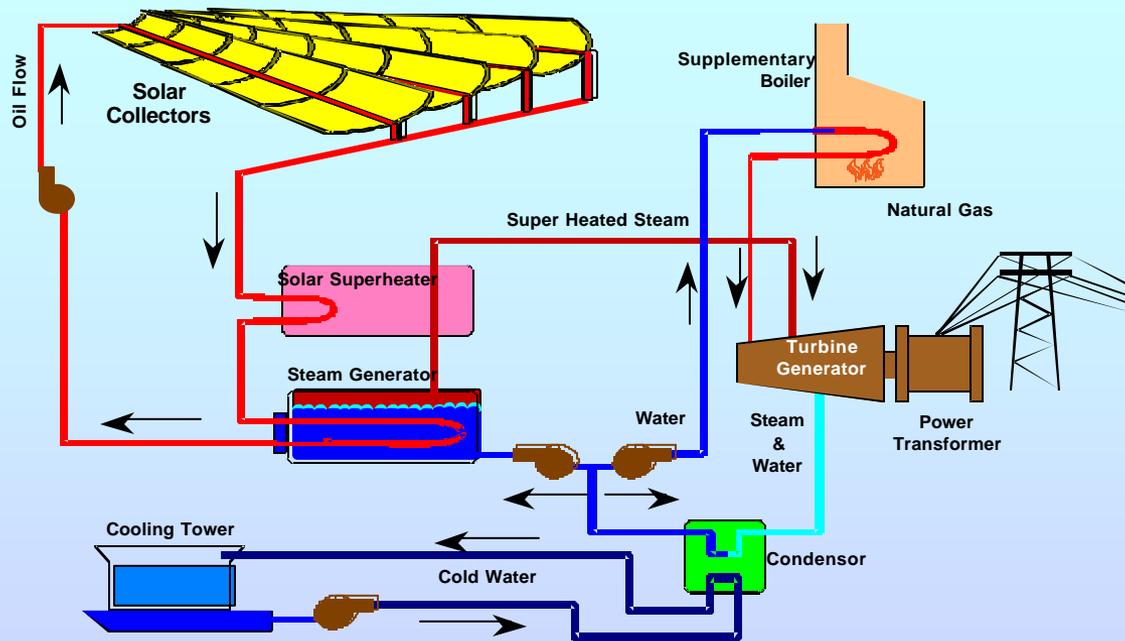




***AERIAL VIEW OF KRAMER JUNCTION***

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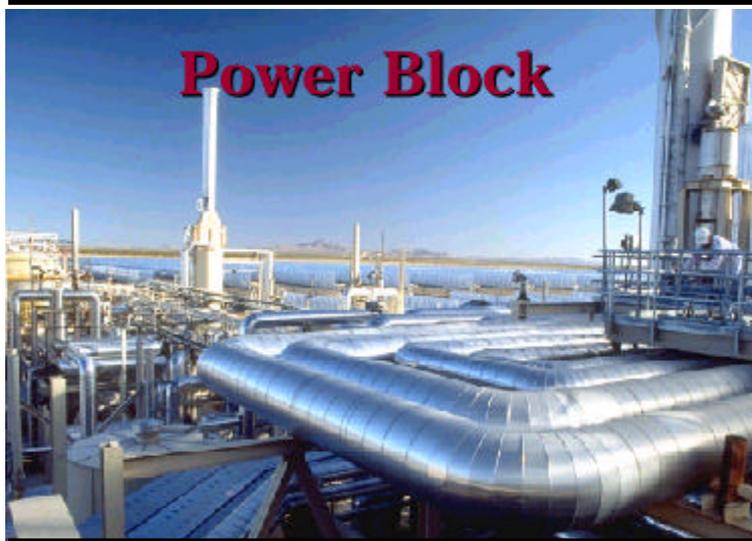


*SEGS - Schematic  
Hybrid Operation (Solar/Nat.Gas)*

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## SEGS: BRIEF DESCRIPTION



### **Electrical Conversion Efficiency**

**Solar Mode = 37.5 %**

**Gas Mode = 39.5 %**

**Turbine Generator Gross Output**

**33 MWe**

**Net Output to Utility**

**30 Mwe**

**Solar Steam Conditions**

**Inlet Pressure = 1450 psia**

**Inlet Temperature = 700 Deg.F**

**Gas Mode Steam Conditions**

**Inlet Pressure = 1450 bars**

**Inlet Temperature = 950 Deg.F**

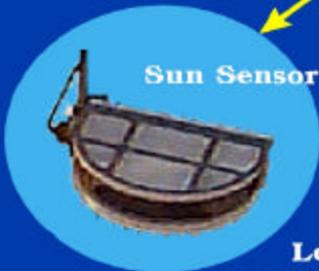
**NEW ADVANCES IN CONCENTRATING SOLAR POWER**



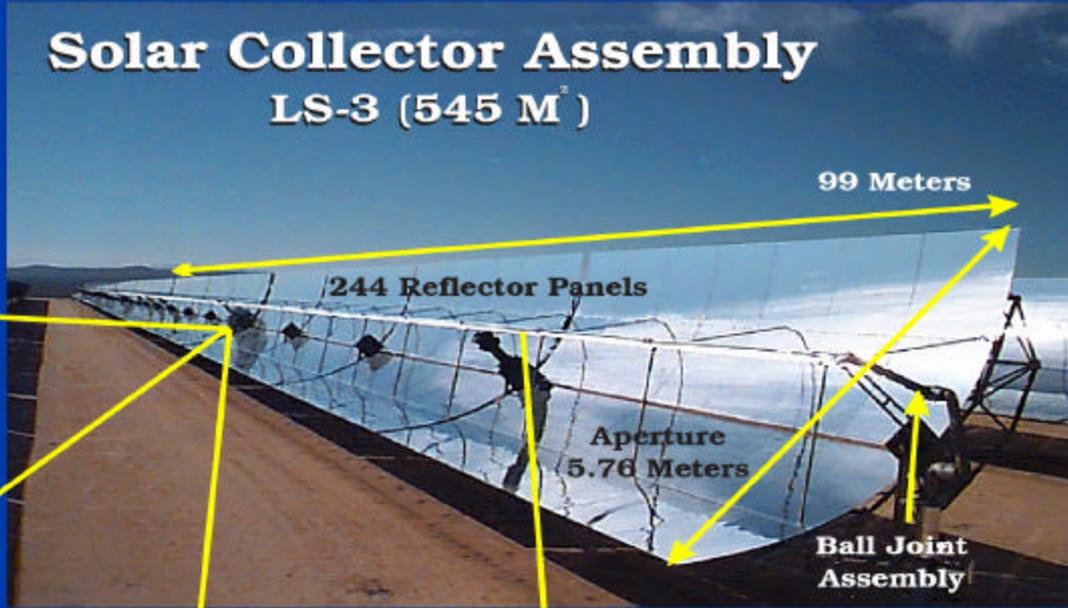
# Solar Collector Assembly LS-3 (545 M<sup>2</sup>)



Drive System



Sun Sensor



99 Meters

244 Reflector Panels

Aperture  
5.76 Meters

Ball Joint  
Assembly

Local  
Controller



24 Heat Collection Elements



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# SEGS: BRIEF DESCRIPTION



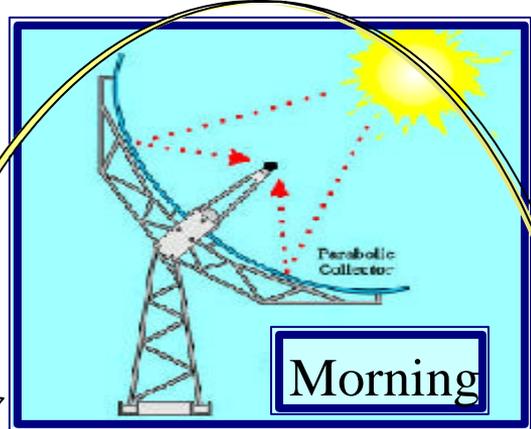
**Annual Efficiencies**  
Thermal = 43 %  
Peak Optical = 73 %

<b>SEGS V - Kramer Junction</b>	
<b>Solar Collector Assemblies</b>	
<b>LS2 (235 m<sup>2</sup>)</b>	<b>980</b>
<b>Aperture Area (m<sup>2</sup>)</b>	<b>5.0</b>
<b>Length (m)</b>	<b>47.1</b>
<b>Concentration Ratio</b>	<b>71</b>
<b>Optical Efficiency</b>	<b>0.737</b>
<b># of Mirror Segments</b>	<b>117.600</b>
<b>Field Aperture (m<sup>2</sup>)</b>	<b>230.300</b>
<b>Field Inlet Temp.(°C)</b>	<b>350</b>
<b>Field Outlet Temp.(°C)</b>	<b>395</b>

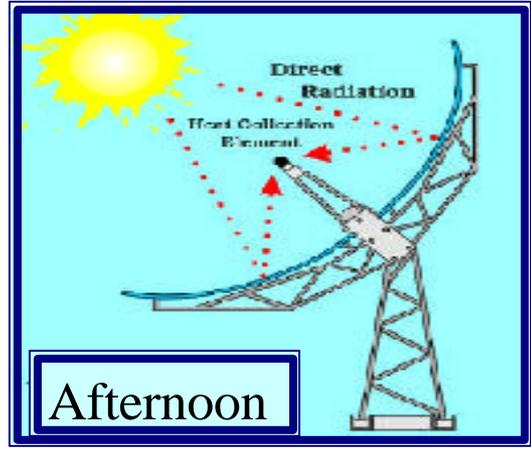


WEST

EAST



Morning



Afternoon

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# Operation and Maintenance



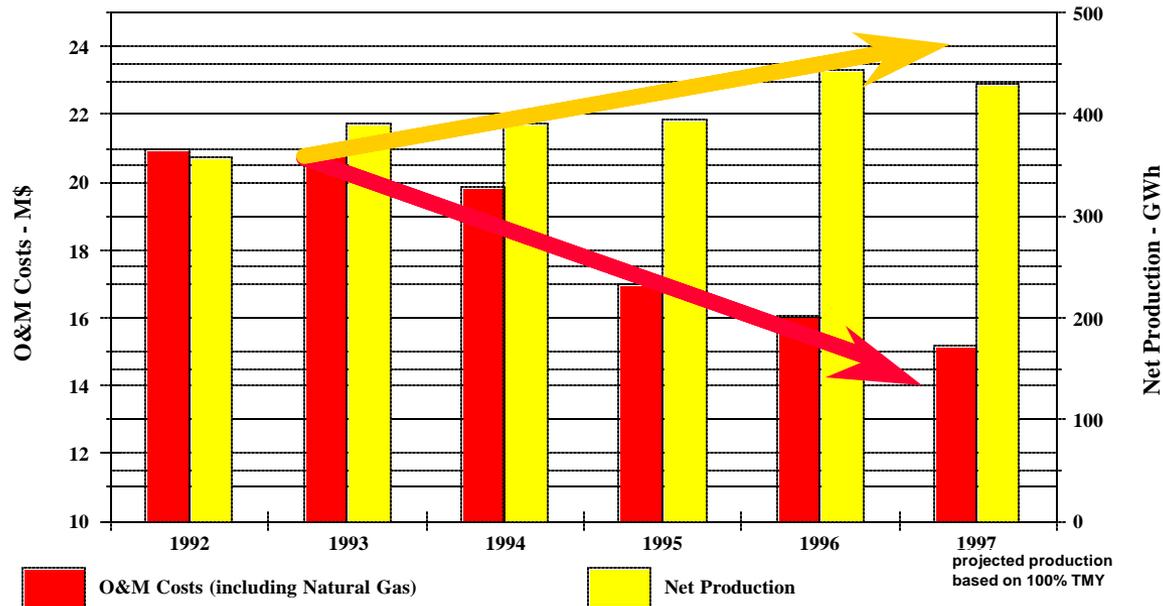
- Years of Data Available
- More than 100 years of Operating Experience
- High Reliability
- Mature Technology

*Experience With Parabolic Trough Systems*

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# O&M COST DECREASE WHILE NET PRODUCTION INCREASE



## *Experience With Parabolic Trough Systems*

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# Solar-to-Electric Efficiency



	<u>1997</u>	<u>2000</u>
• Peak	21%	23%
• Daily	18%	20%
• Annual	12%	15%

*Experience With Parabolic Trough Systems*

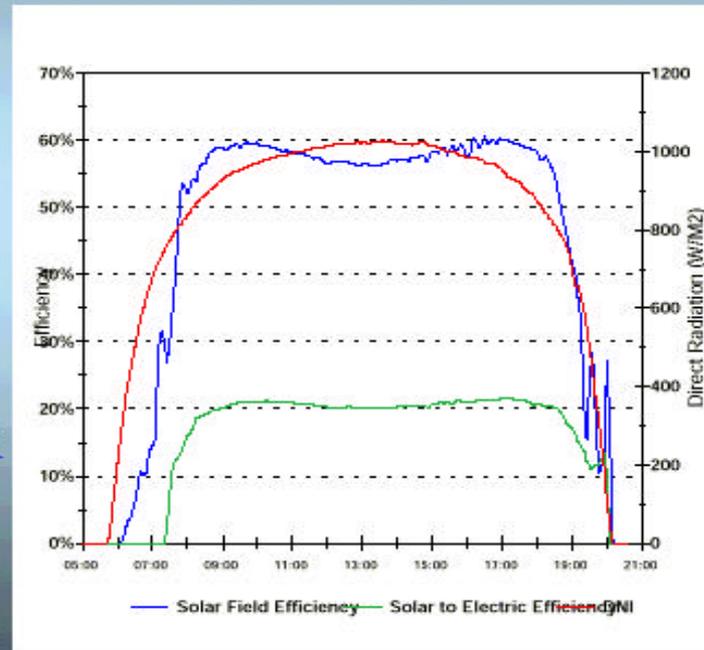
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# Kramer Junction Operational Experience

EXCELLENT EFFICIENCY

- Plants operating well
- Performance records set in 1998 and 1999
- Improvements due to:
  - ▶ Better O&M practices
  - ▶ Technical innovations
- Achieved in parallel with reduced O&M costs
- Typical clear summer day shown here



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## **SEGS: BRIEF DESCRIPTION**

### **SOLAR ELECTRIC GENERATING SYSTEMS SEGS I - IX - FACT SHEET**

- **354 Mwe Installed and in Operation**
- **More than 7000 GWh produced**
- **\$ 1.25 Billion invested**
- **Matured O&M Procedures**
- **On-going Technical Innovations reducing costs**
- **Selected Technology for GEF Projects**

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# FUTURE DEVELOPMENT OF TROUGH AND Concentrator Solar Power (CSP) TECHNOLOGIES

## 1 *Potential Improvements in Trough Technology*

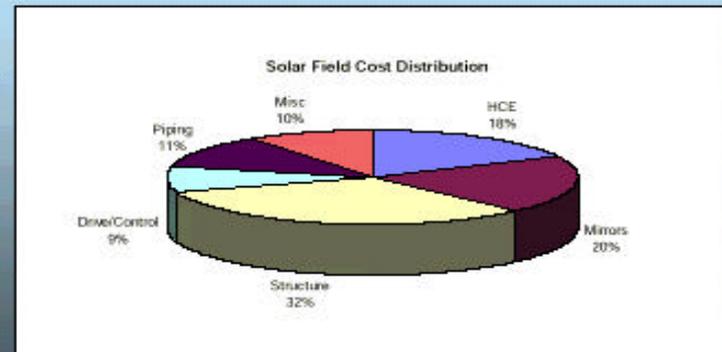
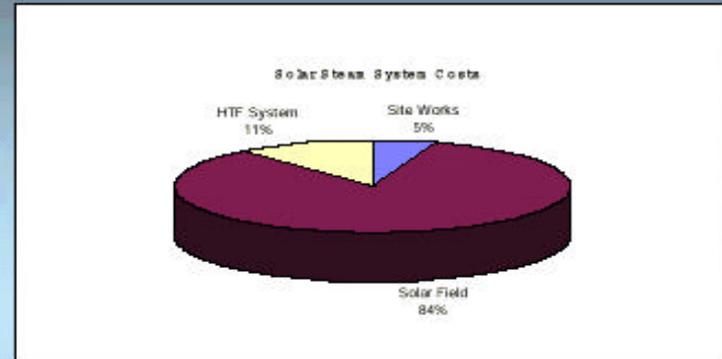
- Reduction in Trough Structure Cost
- Improved Receiver Performance, Reliability, & Maintainability
- Standardized Designs
- Lower Cost Reflectors

## 2 *Global Environment Facility*

- Has identified CSP as a favored technology to help achieve objectives on reduction of global greenhouse gas production
- Recent assessment of CSP concluded that trough and power tower technologies promise long-term competitiveness
- Has tentatively approved approximately \$200M of grants for four projects
- Additional projects beyond these four are possible

# Nominal Trough Solar System Cost Distribution

- Total Direct Cost for Solar Field
  - 250 \$/m<sup>2</sup> +/- 20% depending on vendor, design, location, etc.
- 70% of cost made up of structure, reflectors, and receivers (HCE)





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# CONCLUDING REMARKS

*It is The Right Time To Look For a Better Environment For Us And For Future Generations  
All Key elements At Hand*

- Abundant sources of Renewable Energy
- Strong Public Consciousness
- Technology readily available
- Global Energy companies involved

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