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LAS VEGAS NEVADA – MAY 16 ,2006

An overview of the Concentrating Solar Power Industry

NEVADA FIRST SOLAR ELECTRIC GENERATING SYSTEM

Gilbert E Cohen

Solargenix Energy

Senior Vice President

Renewable Energy – IEEE

May 16, 2006 – Las Vegas NV

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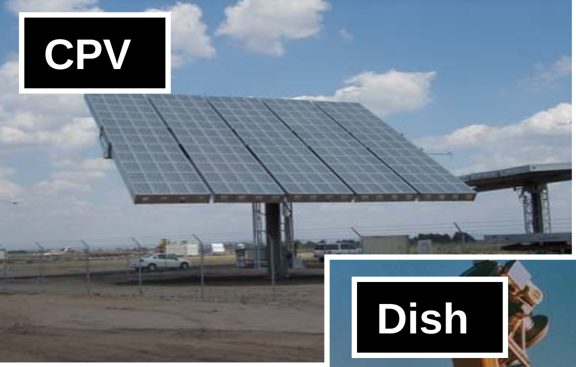
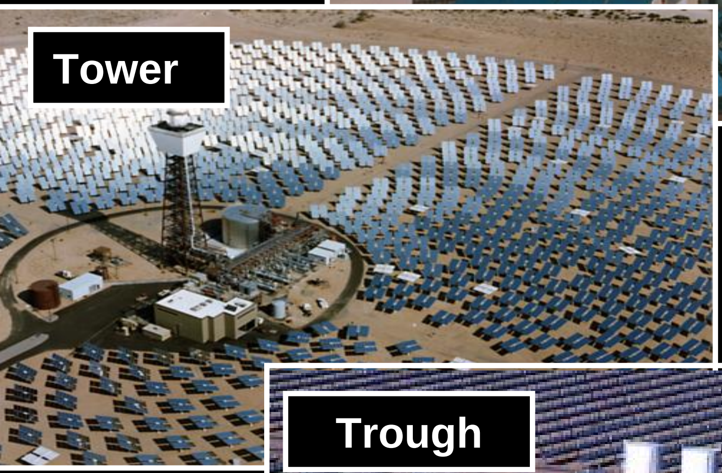
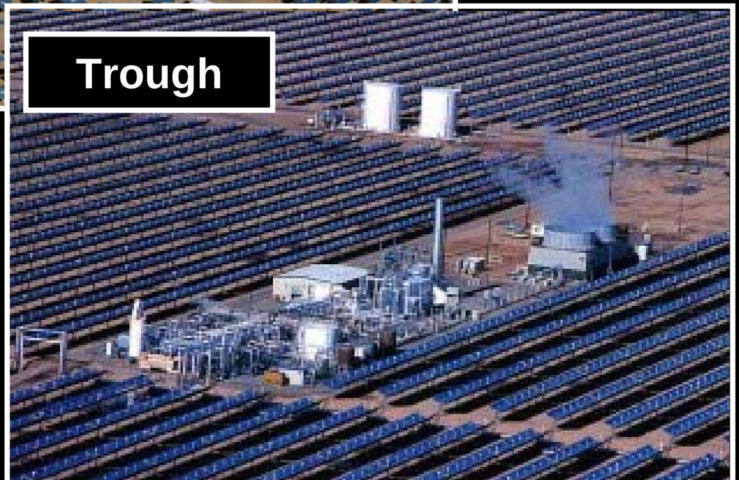
Introduction

- Status of the CSP industry and the technology
- Growth and Recognition of CSP
- Nevada Solar One – 64 MW solar power plant
- Future opportunities for CSP
- Concluding remarks







What is CSP?

Concentrating Solar Power

CSP is ……………………….

- ideal for multi-megawatt central power stations
- dispatchable power for peaking and intermediate loads through hybridization and/or thermal storage
- distributed power for grid support and remote applications
- rapidly deployed because it uses conventional items such as glass, steel, gears, turbines, etc.
- Water requirements similar to coal-fired plant.

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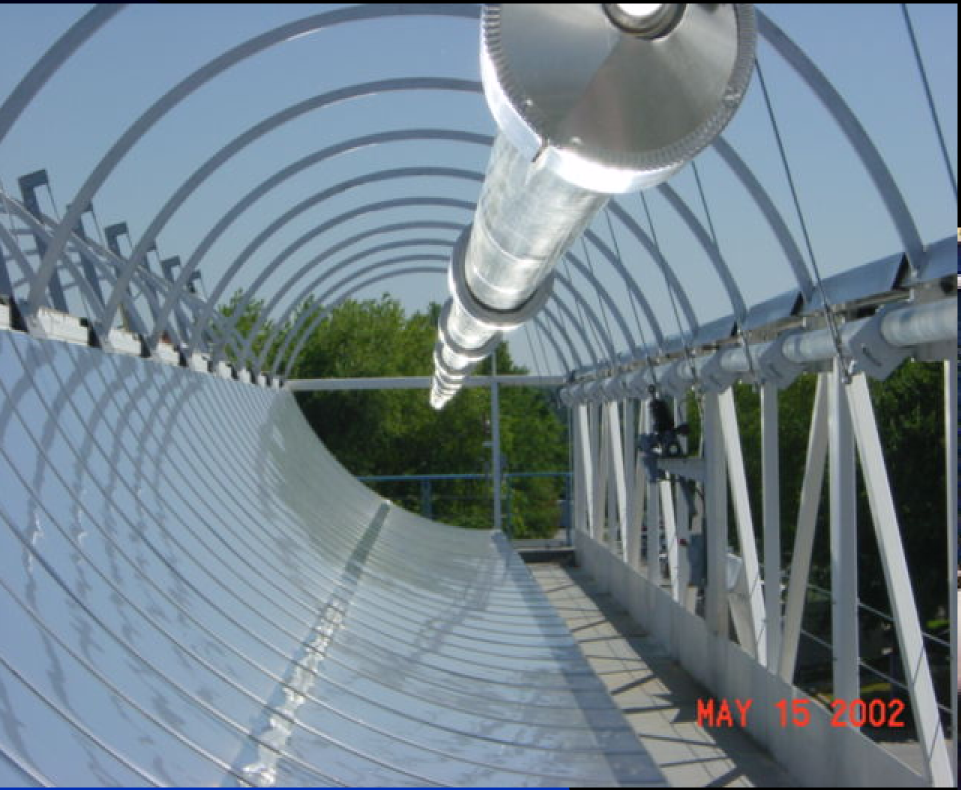
Concentrating Solar Power Technologies

Concentrating Solar Power Technologies (continued)

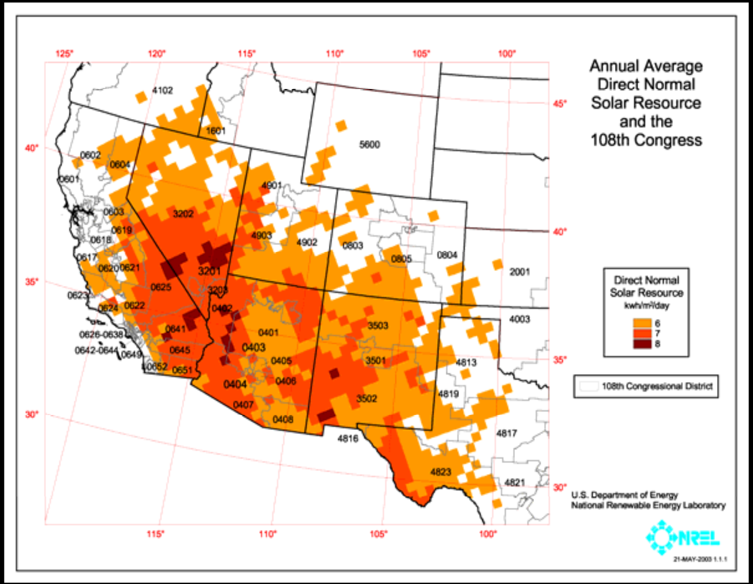


Roof Integrated Systems

SW CSP Solar Potential

State	Solar Capacity (MW)	Land Area (Sq Mi)
AZ	1,652,000	12,790
CA	742,305	5,750
NV	619,410	4,790
NM	1,119,000	9,157
Total	4,132,715	32,487

The table and map represent land that has no primary use today, exclude land with slope > 1%, and do not count sensitive lands.



Solar Energy Resource ≥ 7.0 kWhr/m^2/day (includes only excellent and premium resource)

Current total generation in the four states is 83,500 MW.

Planned additions in four states over the next 3 – 5. years are 37,099 MW of which 87.6% is natural gas.

1000 MW of CSP requires 7.7 mi^2.

Ref: SunLab

A solar vision for the future of America

★ **CSP Solar technologies have the potential to be major contributors to the global energy supply. The ability to dispatch power allows large-scale central solar technologies to *provide 50% or more of the energy needs in sunny regions around the world.***

- **In addition, because CSP technologies are built from commodity materials such as glass,steel,concrete and standard utility power generation equipment, it is possible *to scale up and rapidly deploy new solar power plants*.**

- **Large-scale solar technologies can *provide energy price stability* as well as quality jobs to the local community.Solar energy has the potential to become *the major new domestic energy resource in the 21st century".***

★ ***Reference: U.S Department of Energy***

Energy Efficiency and Renewable Energy

Parabolic Trough – A example of CSP Power Technology

- **"Although many solar technologies have been demonstrated,parabolic solar thermal electric power plant technology represents one of the *major renewable energy success stories of the last two decades"*.**

- ***<u>Parabolic troughs are one of the lowest cost electric power options available today"</u>***

- ***<u>Reference:</u> U.S Department of Energy Energy Efficiency and Renewable Energy***

HISTORICAL BACKGROUND

THE SOLAR ELECTRIC GENERATING SYSTEMS (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 NOMINAL CAPACITY = 354 MW

Kramer Junction - California
Satellite view

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Parabolic Trough Solar Power Plant

CSP offers significant local Opportunities

- The industry has built a very strong relationship and strategic alliances with key components vendors and contractors.
- Creating a variety of new jobs – During and after construction.
- Generating essential State tax revenues.
  Producing local economic and social advantages.

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Cost and Financing

- Numerous past studies and reports from diverse sources on CSP costs are available, with installed costs ranging ***from $1200 to $3500 per KW and cost of produced electricity ranging from 7 to 16 cents per KWhr produced***. These figures are to be used only for information since the *selection of plants layout and financial parameters* used are assumptions that may significantly be different for a specific location and project size.

- Costs of the power island are competitive with other conventional steam driven power plants.

- Costs of the solar field are known and highly dependent on economy of scale.

- Costs of operation and maintenance are reasonable in comparison with the rest of the generating industry. Extra costs for solar are often offset by the free cost of the energy source.

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Cost and Financing (Continued)

Key elements for a successful and low cost CSP project

- **Long term Power Purchase Agreement (20 years or more).**
- **Good credit rate of the power buyer.**
- **Correct site selection and infrastructure.**
- **Acceptance of the project by the local community, county and State.**
- **Federal and State programs (RPS, Tax credits, sales states credits, reduced property tax, etc..).**
- **Cooperation and assistance from local utilities in order to ease the interconnection and transmission issues.**

Nevada Solar One

- Location
- Technology
- Construction Status

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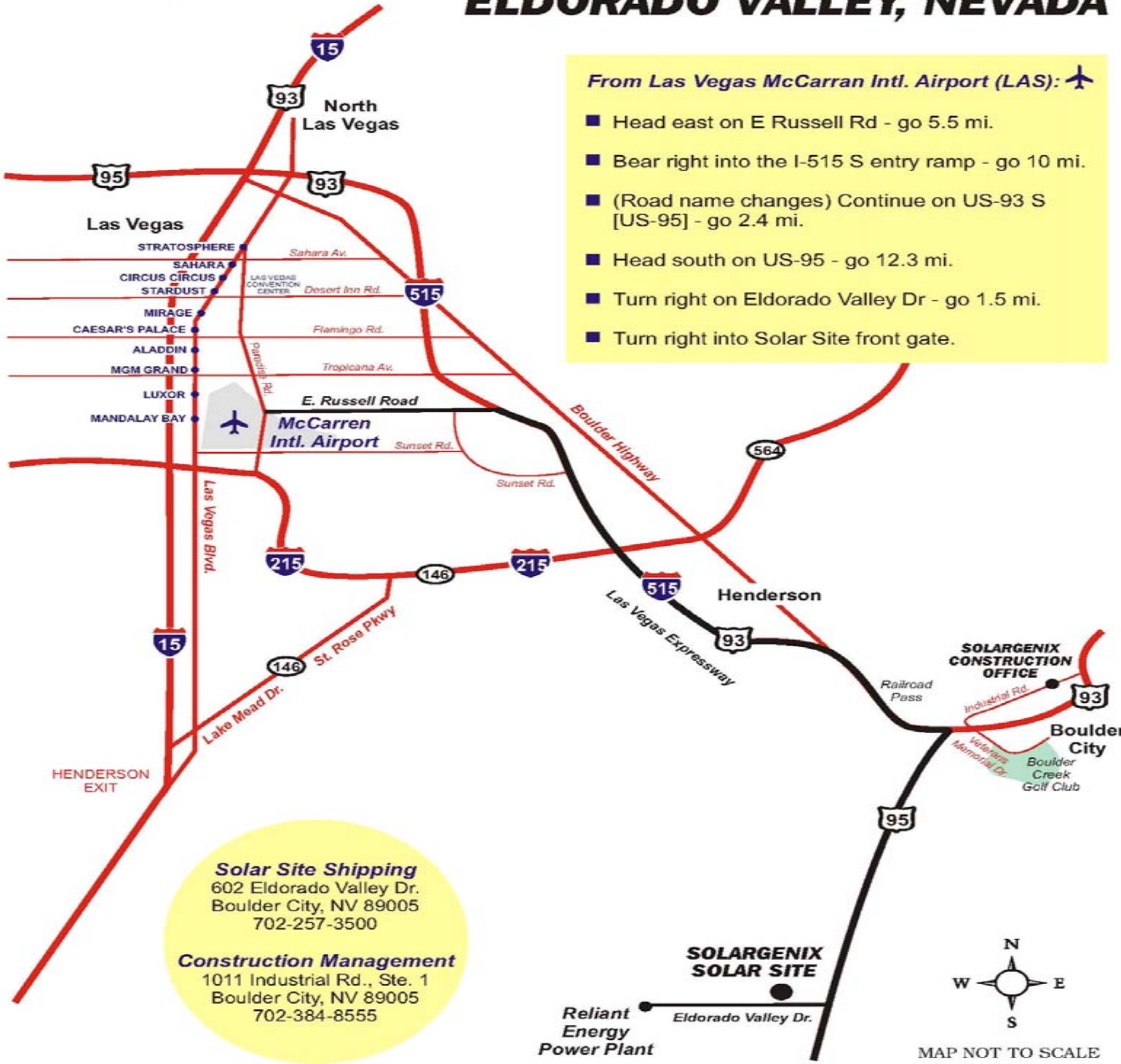
ELDORADO VALLEY SOLAR SITE ELDORADO VALLEY, NEVADA

From Las Vegas McCarran Intl. Airport (LAS):

- Head east on E Russell Rd - go 5.5 mi.
- Bear right into the I-515 S entry ramp - go 10 mi.
- (Road name changes) Continue on US-93 S [US-95] - go 2.4 mi.
- Head south on US-95 - go 12.3 mi.
- Turn right on Eldorado Valley Dr - go 1.5 mi.
- Turn right into Solar Site front gate.



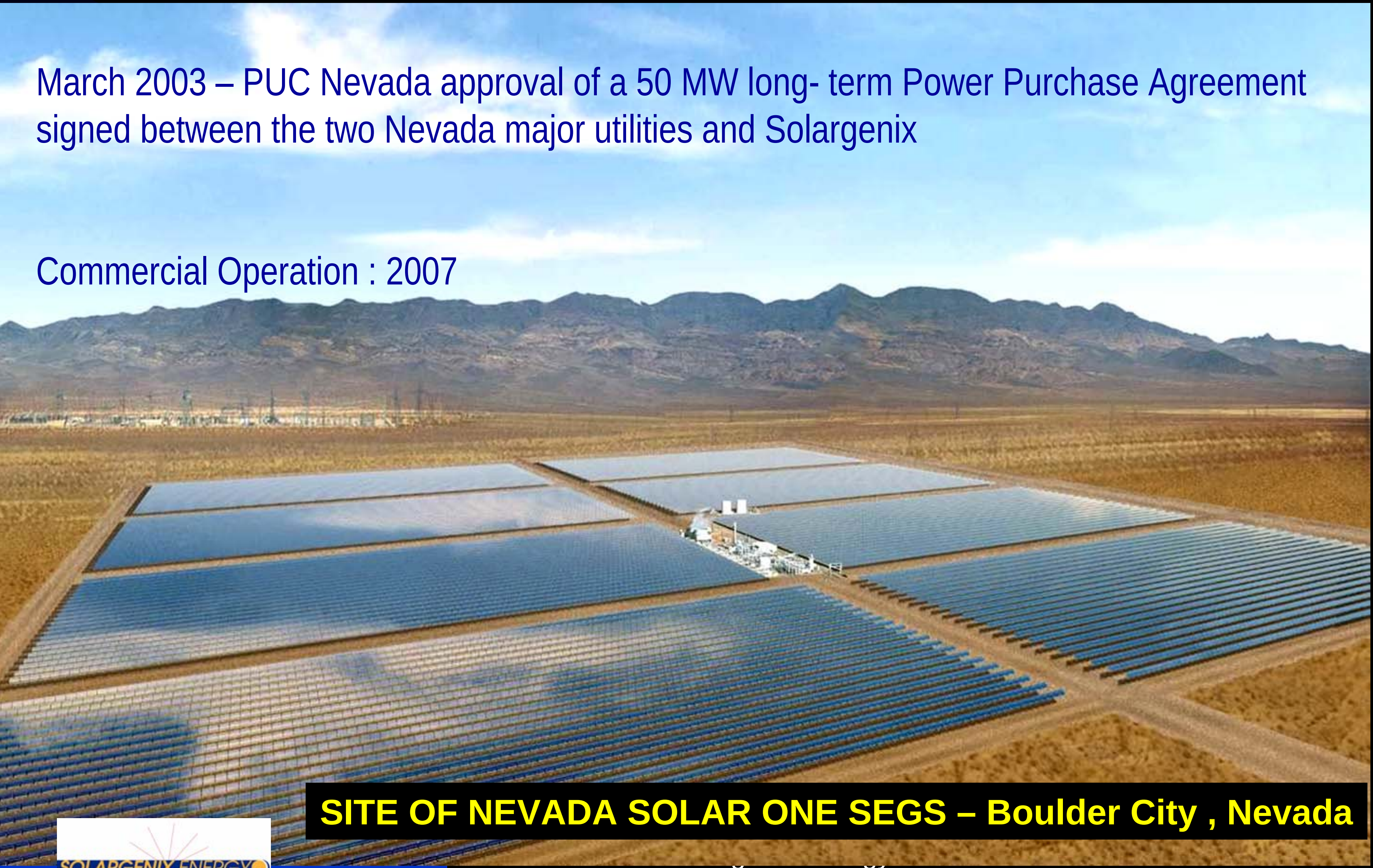
Solar Site Shipping
602 Eldorado Valley Dr.
Boulder City, NV 89005
702-257-3500

Construction Management
1011 Industrial Rd., Ste. 1
Boulder City, NV 89005
702-384-8555

Nevada First Solar Electric Generating Station

March 2003 – PUC Nevada approval of a 50 MW long- term Power Purchase Agreement signed between the two Nevada major utilities and Solargenix

Commercial Operation : 2007



SITE OF NEVADA SOLAR ONE SEGS – Boulder City , Nevada

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September 1, 1907

PATENT-URKUNDE

№ 237294

GESETZ v. 7. APRIL 1891

AUF GRUND DER ANGEHEFTETEN PATENTSCHRIFT IST DURCH BESCHLUSZ DES KAISERLICHEN PATENTAMTES

an Dr. Wilhelm Maier in Aalen und Adolf Remshardt in Stuttgart

EIN PATENT ERTEILT WORDEN.

GEGENSTAND DES PATENTES IST:

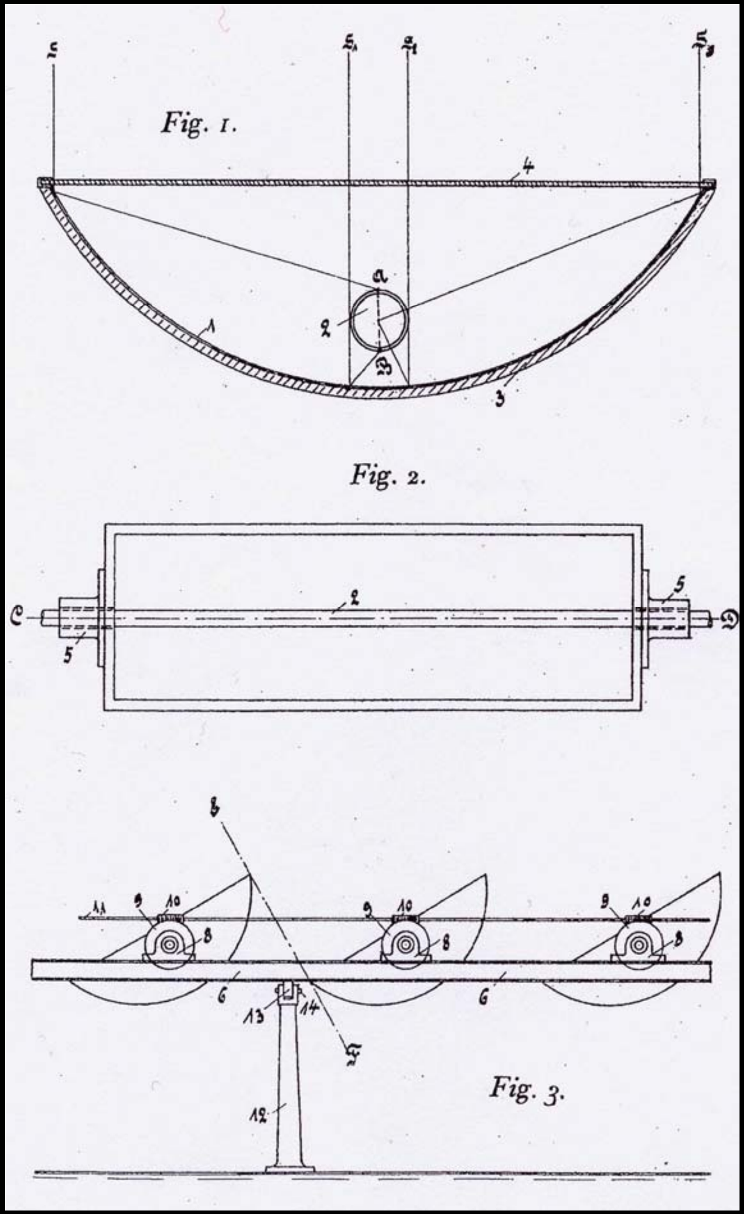
Vorrichtung zur unmittelbaren Verwendung der Sonnenwärme zur Dampferzeugung.

ANFANG DES PATENTES: 1. September 1907

DIE RECHTE UND PFLICHTEN DES PATENTINHABERS SIND DURCH DAS PATENT-GESETZ VOM 7. APRIL 1891 (REICHS-GESETZBLATT FÜR 1891 SEITE 79) BESTIMMT.

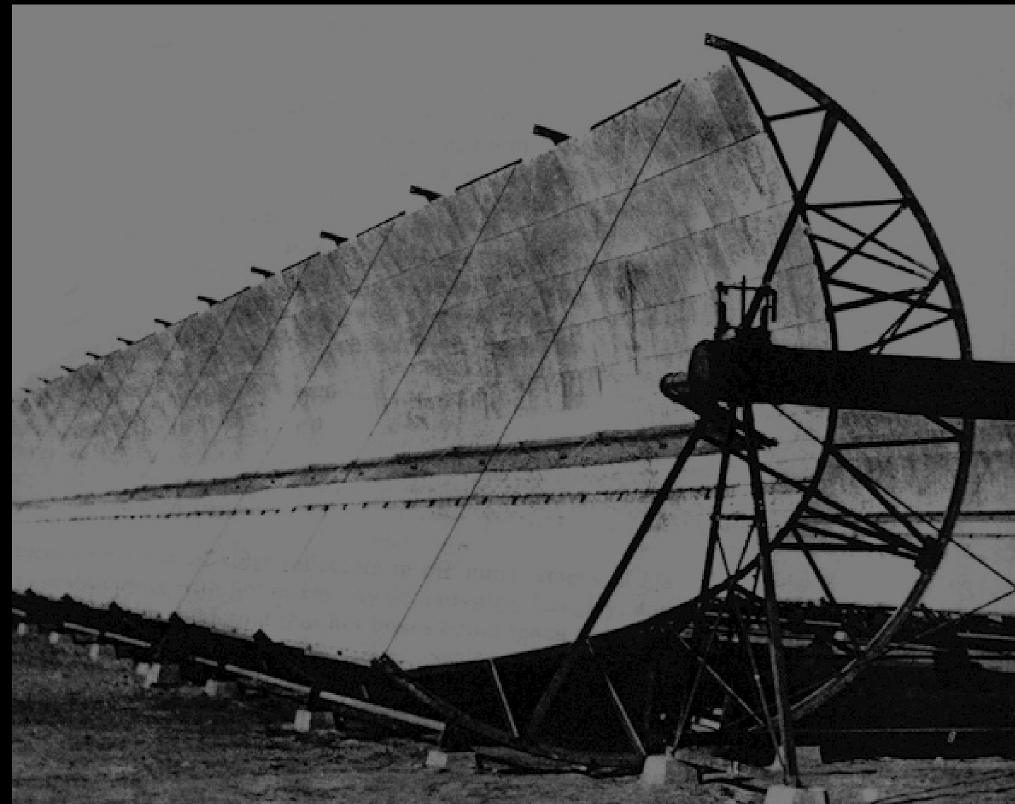
ZU URKUND DER ERTEILUNG DES PATENTES IST DIESE AUSFERTIGUNG ERFOLGT.

KAISERLICHES PATENTAMT.



Parabolic Trough Collector

1912: 55 kW
by Shuman in Egypt



September 1, 1907

KAISERLICHES PATENTAMT.

AUSGEGEBEN DEN 18. FEBRUAR 1911.

PATENTSCHRIFT

— № 231294 —

KLASSE **42*i*.** GRUPPE 18.

DR. WILHELM MAIER IN AALEN
UND ADOLF REMSHARDT IN STUTTGART.

Vorrichtung zur unmittelbaren Verwendung der Sonnenwärme zur Dampferzeugung.

Patentiert im Deutschen Reiche vom 1. September 1907 ab.

LS3

US006668820B2

(12) **United States Patent**
Cohen et al.

(10) **Patent No.:** **US 6,668,820 B2**
(45) **Date of Patent:** **Dec. 30, 2003**

(54) **MULTIPLE REFLECTOR SOLAR CONCENTRATORS AND SYSTEMS**

(76) Inventors: **Gilbert E. Cohen**, 115 White Bloom La., Morrisville, NC (US) 27560; **Roland Winston**, 5217C S. University Ave., Chicago, IL (US) 60615

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/939,261**

(22) Filed: **Aug. 24, 2001**

(65) **Prior Publication Data**

US 2003/0037814 A1 Feb. 27, 2003

(51) **Int. Cl.**[7] **F24J 2/18**; H01L 31/052

(52) **U.S. Cl.** **126/685**; 126/246; 126/259

5,062,899 A * 11/1991 Kruer 136/259
5,578,140 A * 11/1996 Yogev et al. 136/246
5,979,438 A * 11/1999 Nakamura 126/680

* cited by examiner

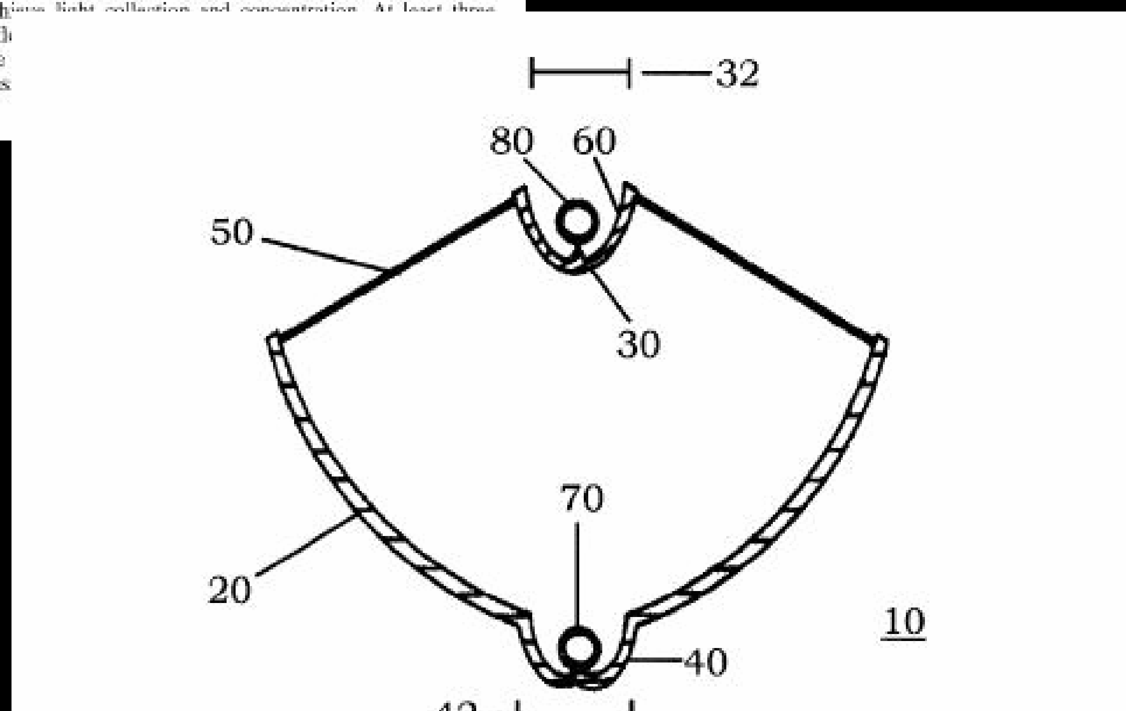
Primary Examiner—Nam Nguyen
Assistant Examiner—Brian L. Mutschler
(74) *Attorney, Agent, or Firm*—Brian D. Voyce

(57) **ABSTRACT**

The present invention relates to multiple reflector light or solar energy concentrators and systems using such concentrators. More particularly, the invention is concerned with an arrangement of optical elements for the efficient collection of light while minimizing complexities of optics needed to achi... refl... the... pos...

December 30, 2003

SGE NEW CONCEPT



Solargenix 2006

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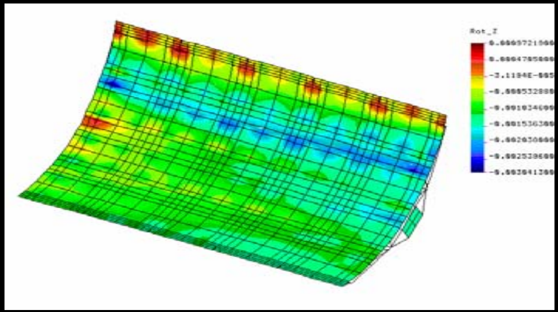
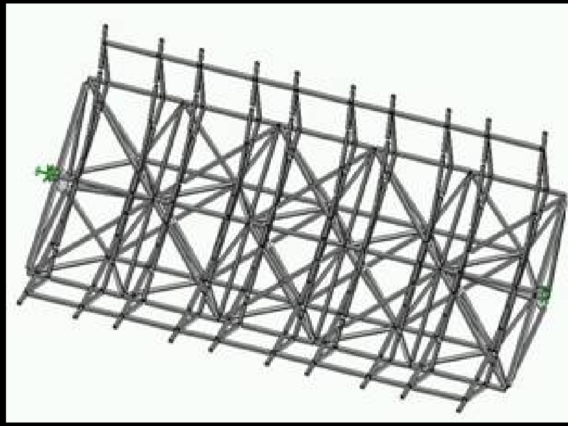
PARABOLIC TROUGH



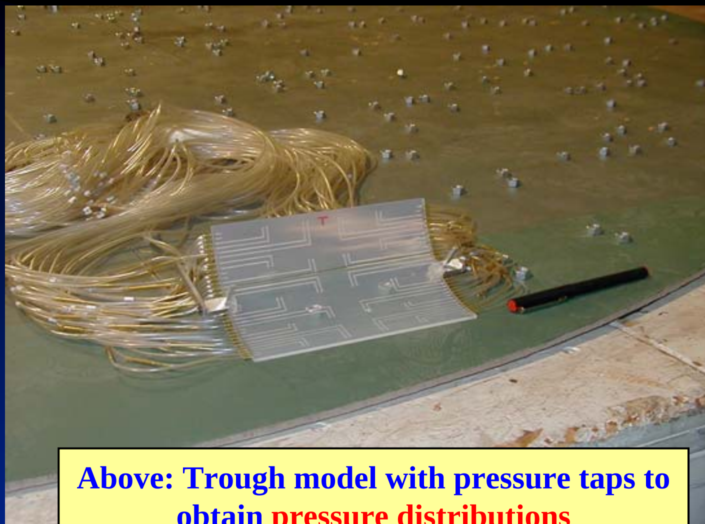
- Successful multiyear program with U.S DOE / National Laboratories for technology improvements
  - USA trough program
  - Advanced solar collector structure
  - Drive systems
  - Smart controllers



Solargenix parabolic trough

While the Solargenix collector appears to be no more than the natural evolution of the successful parabolic trough operating in the Mojave desert (CA) for many years, its design is the result of an intensive R&D task jointly conducted by NREL and Solargenix R&D division.

Comprehensive Trough Wind Tunnel Tests



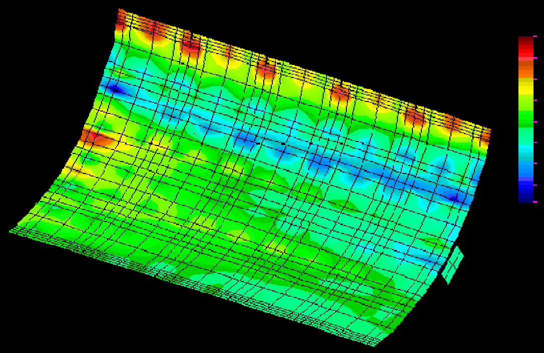
Above: Trough model with pressure taps to obtain pressure distributions

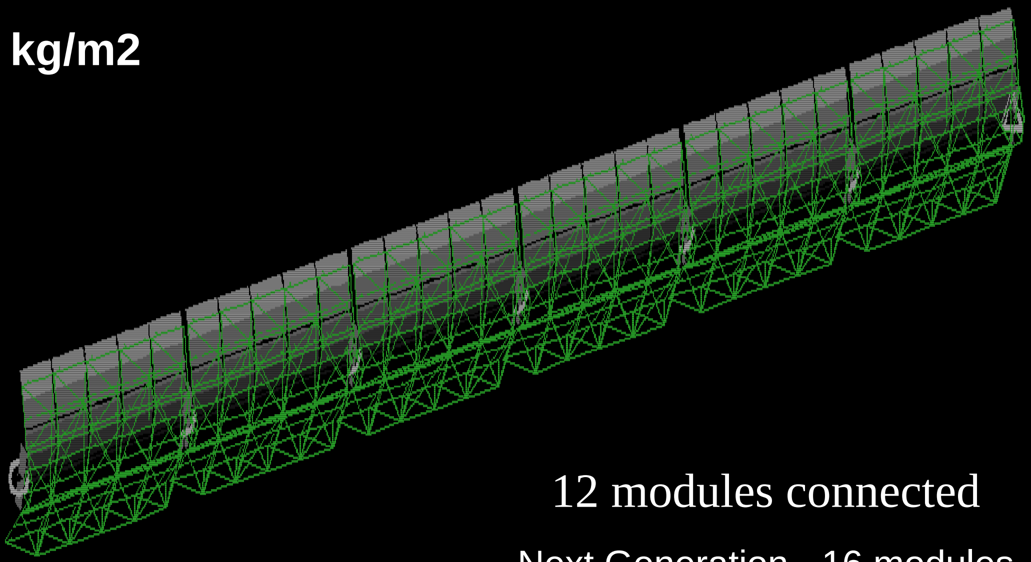
Below: Pitch moment tests in deep collector field

Field array without and with fence

Solargenix Advanced Parabolic Trough Design challenges

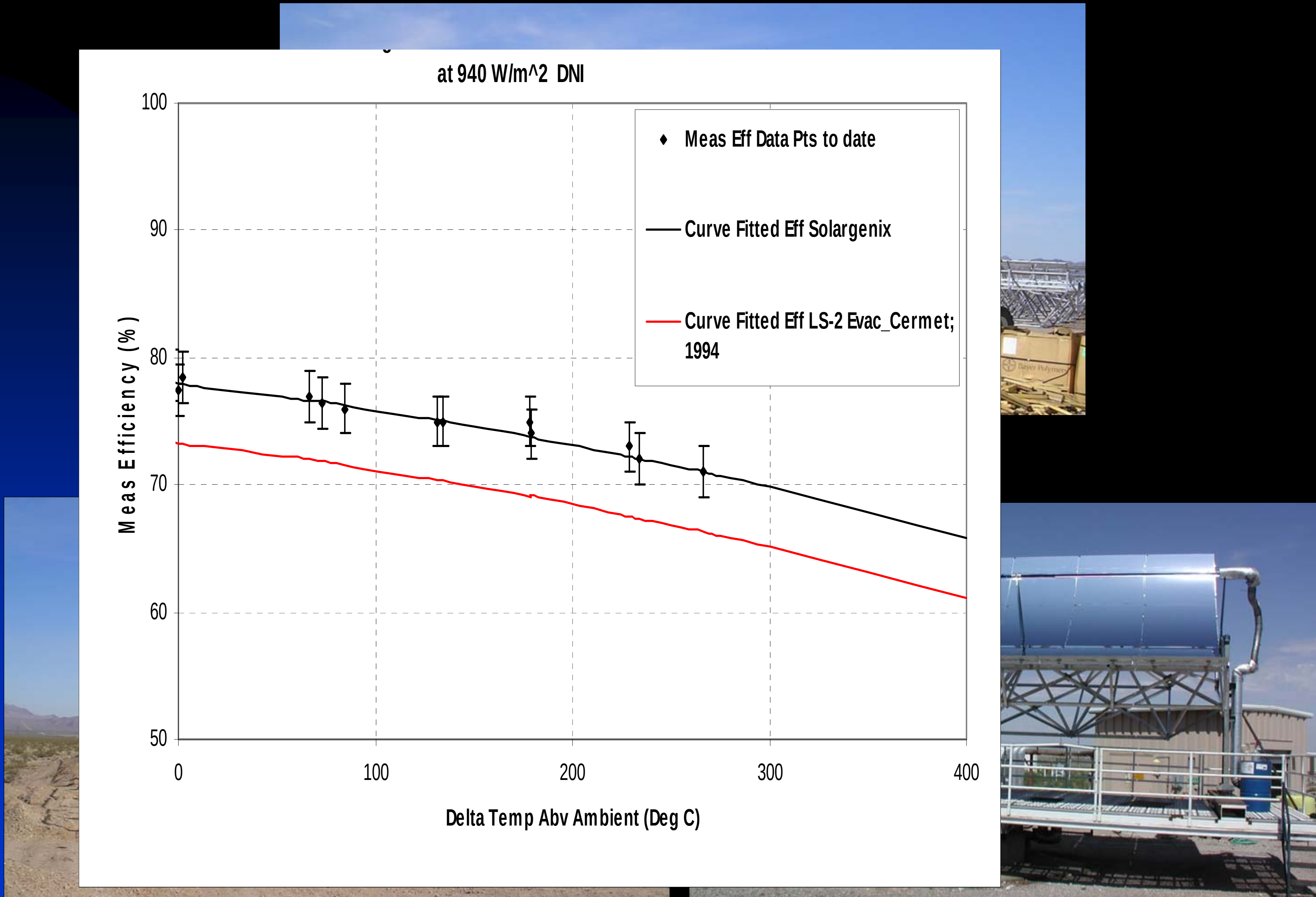
- Increased Rigidity via Interlinking
- No Site Cutting or Welding
- No Jig Necessary for Assembly
- Components Easier to Handle and Ship
- Weight Incl. Mirrors ~ 22 kg/m2
- Length : 100 meters





12 modules connected

Next Generation - 16 modules connected



at 940 W/m^2 DNI
Meas Efficiency (%)
Delta Temp Abv Ambient (Deg C)
100
90
80
70
60
50
0
100
200
300
400
Meas Eff Data Pts to date
Curve Fitted Eff Solargenix
Curve Fitted Eff LS-2 Evac_Cermet; 1994

Current SEGS Technology

- Parabolic trough mirrors focus sunlight into specially coated Heat Collector Element (HCE).
- Heat Transfer Fluid (HTF) is heated at 395 deg.C in the HCEs.
- HCEs are designed to maximize absorption of heat from the sun while minimizing heat losses as the HTF flows to the power block
- The solar field is computer-controlled to a very high degree of precision.
- HTF then produces superheated steam in a series of conventional heat exchangers.
- The steam drives a conventional reheat turbine/Generator.
- Natural gas / fossil fuel can be used as backup to provide additional steam during peak demand periods or when sunlight is not sufficient.
- Storage of thermal energy or/and Biofuels can be used as well in lieu of fossil fuel.

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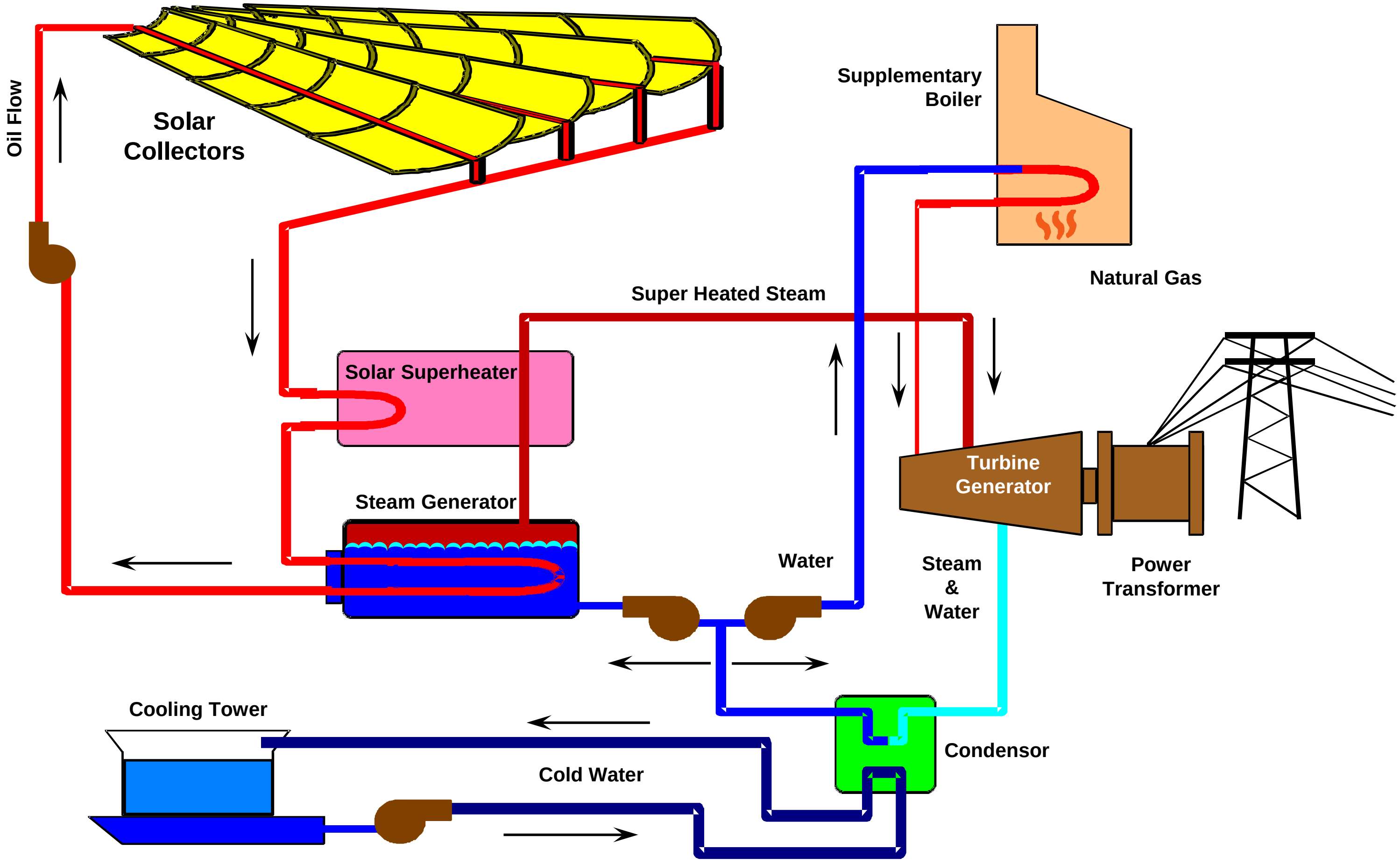
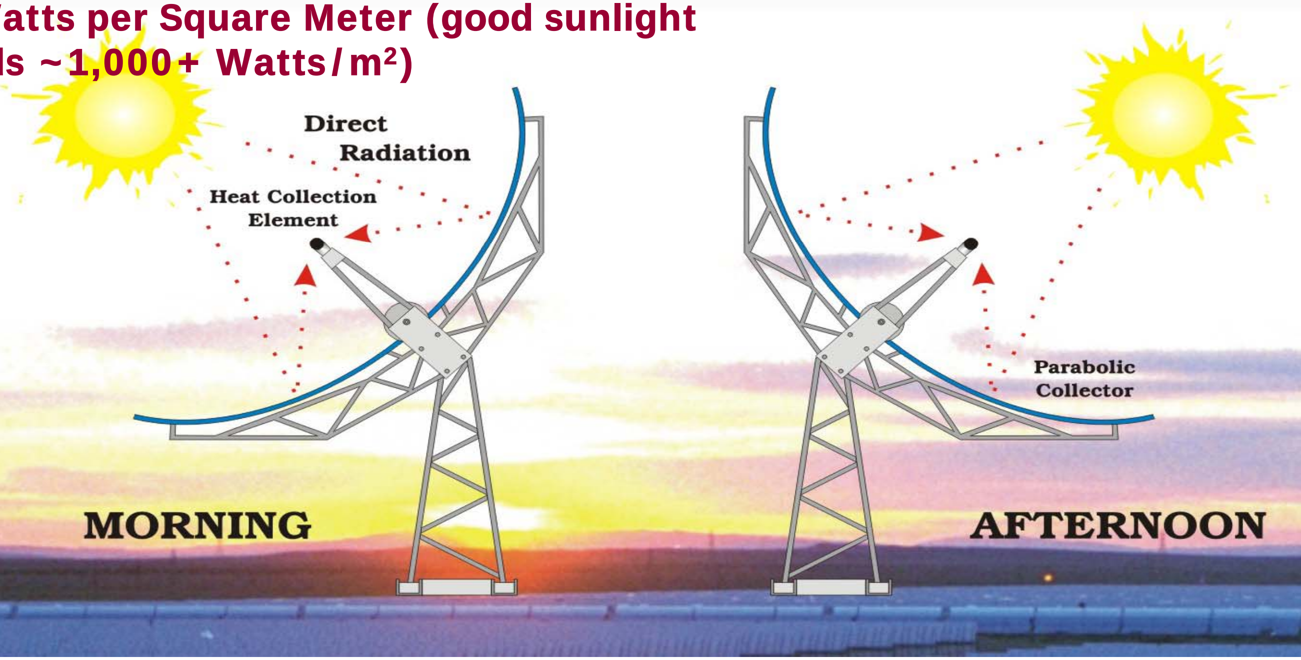


SEGS - Schematic
Hybrid Operation (Solar/Nat.Gas)

SIMPLE SCHEMATIC OF PARABOLIC TROUGH OPERATION (North-South Axis)

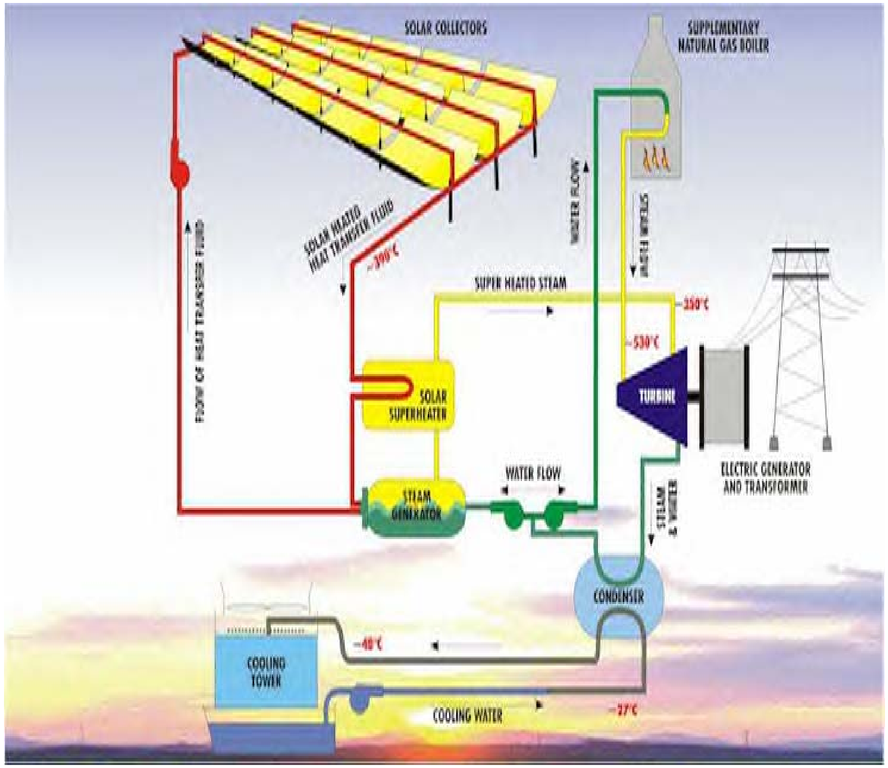
- The SEGS utilize Parabolic Trough Collectors which is a Concentrating Solar Power (CSP) Technology
- CSP Technologies utilize Direct Normal Radiation (DNR) which is measured in terms of Watts per Square Meter (good sunlight yields ~1,000+ Watts/m^2)

Concentration Ratio		
Solargenix	71:1	(71 Suns)



SOLAR FIELD

Simple schematic of a typical SEGS power plant



SOLAR FIELD

64 MW solar field – 30 Minutes Storage –No fossil fuel added

Solar Collector Assemblies:	**760**
Aperture Area (m²/Sq.ft):	**5.0 / 59**
Length (m/ft):	**100/328**
Concentration Ratio:	**71**
Optical Efficiency:	**0.77**
# of Mirror Segments:	**182400**
# of receiver tubes	**18240**
Field Aperture (m²):	**300,320**
Site area (Km²/acres):	**1.42/360**
Field Inlet Temp.(°C/°F):	**350/662**
Field Outlet Temp. (°C/F°):	**395/743**

The solar thermal industry and especially the Concentrating Solar Power industry are being developed worldwide in a rapid pace, this should attract more large manufacturers to consider the production of solar field components at attractive costs.

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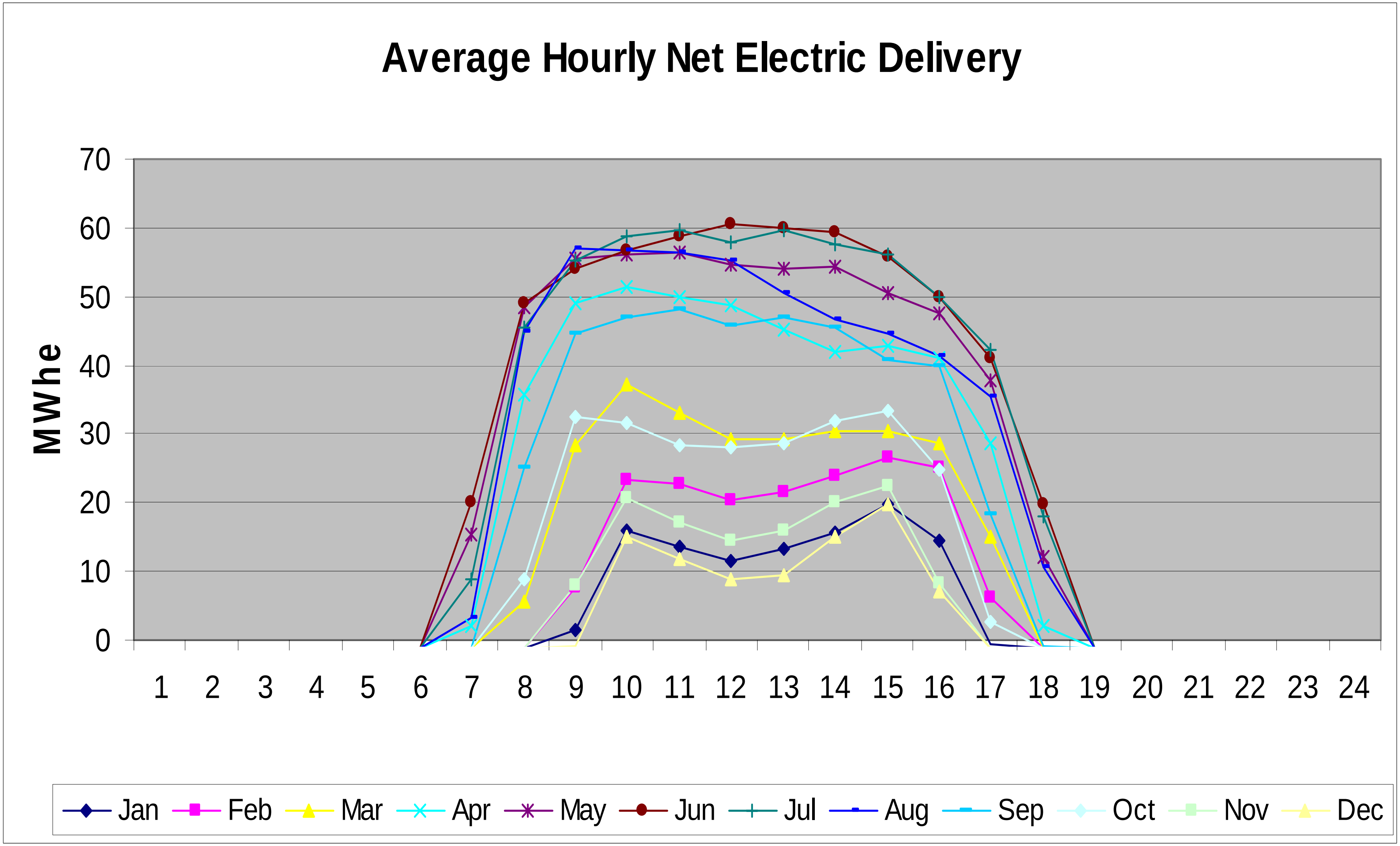
POWER BLOCK

POWER BLOCK

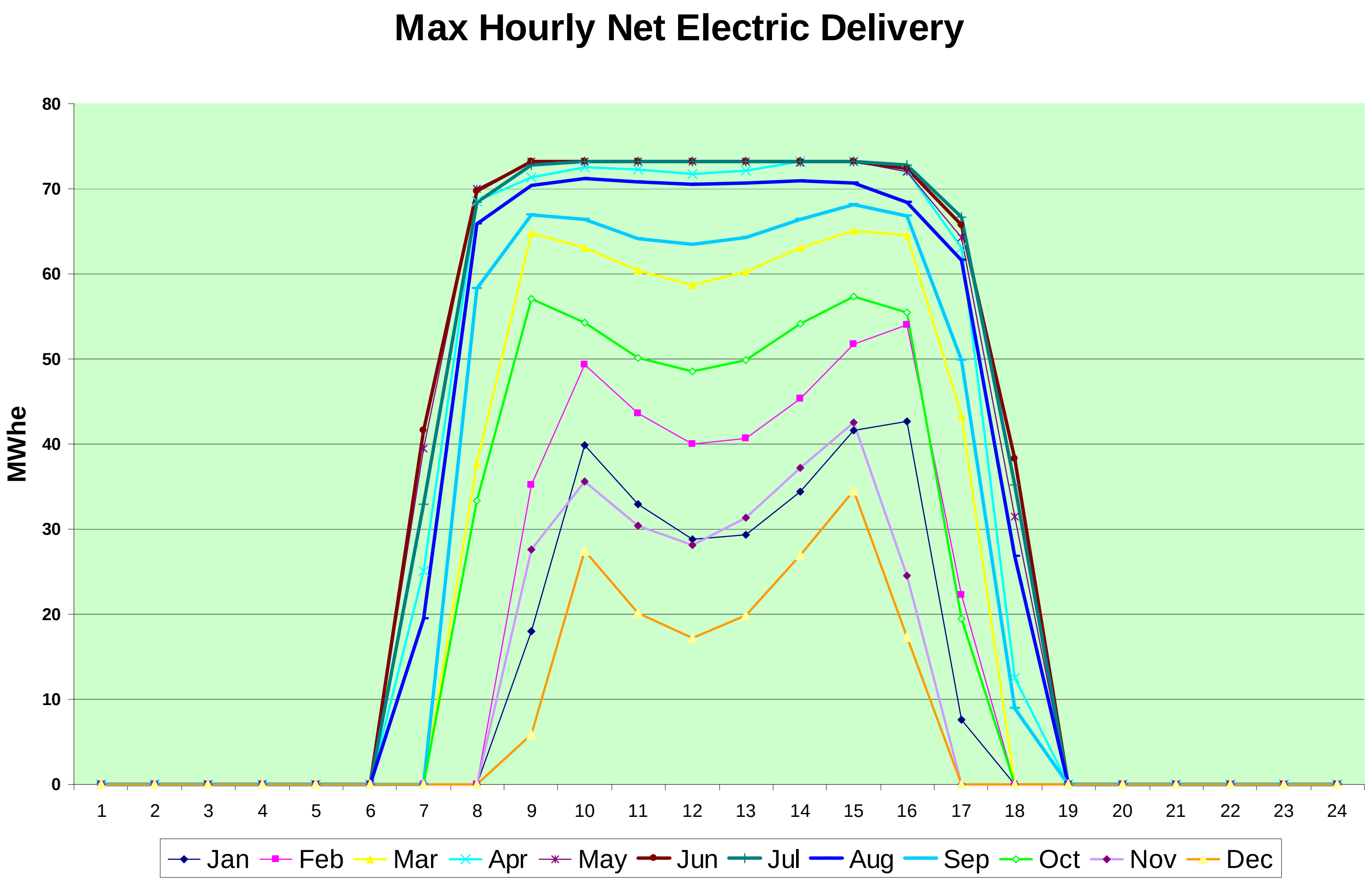
Turbine Generator Gross Output	75 MWe
Net Output to Utility	70 MWe
Solar Steam Conditions	
Inlet Pressure	102 bars/1480 psi
Reheat Pressure	17.5 bars/254 psi
Inlet Temperature	371 Deg.C / 700 Deg.F

Nevada Solar One

- Performance



NEVADA SOLAR ONE



NEVADA SOLAR ONE

PROJECT STATUS

Long term Power Purchase Agreement signed with Nevada Power and Sierra Pacific

Amendment for expansion to 64 MW - approved in June 5, 2005

Long term lease agreement signed with the City of Boulder City, at the Eldorado Valley - Nevada

Long term Water service contract signed with the City of Boulder City

Development agreement signed with the City of Boulder City

PROJECT STATUS (Continued)

Interconnection study – completed

Transmission Eng. & Construction contract – In place

Project design and Engineering in final stages

Financial team selected

EPC Notice to Proceed – January 2006

Purchase of major components – In progress

Site survey – Completed

Geological – completed August 18, 2005

Test loop – Installed

Permitting process in progress

1st STARTUP SCHEDULED FOR DEC 2006

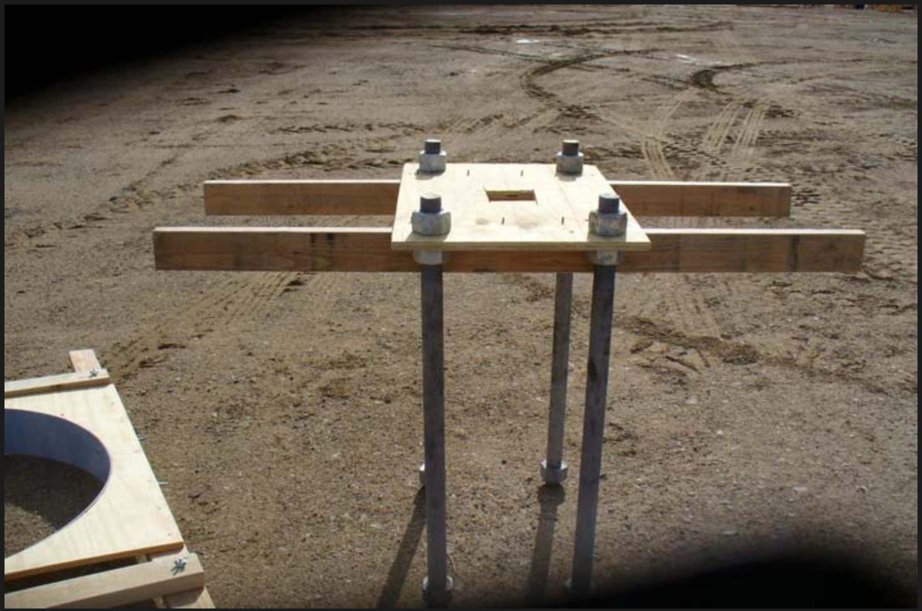

170
170

nix


CAP.
4960
TOYOTA



nix

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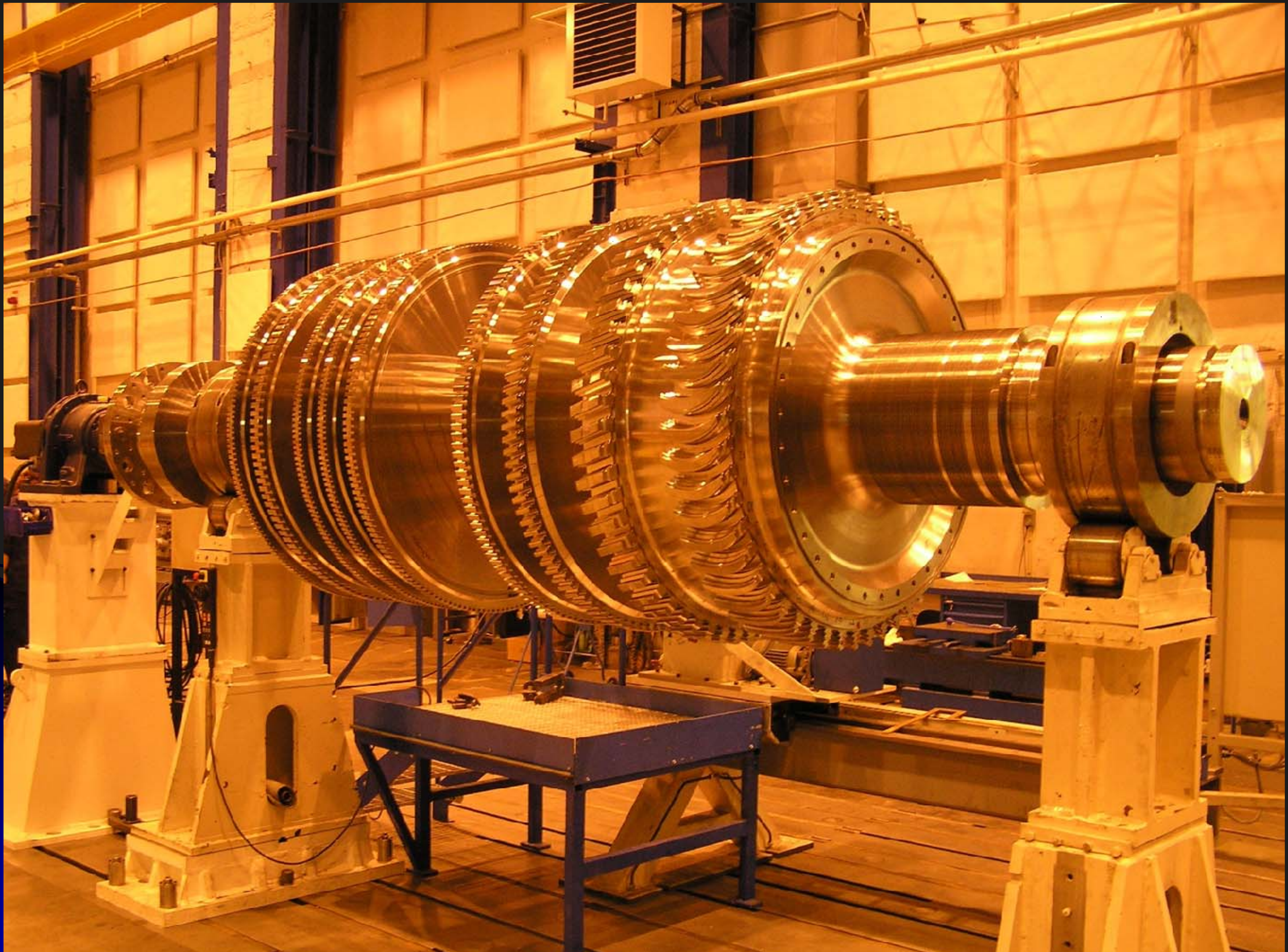

1000 MW - Background

- In 2001 Congress asked DOE to determine what would be required to deploy 1000 MW of CS Power in the Southwest U. S.
  - A number of Southwestern States have high solar potential and renewable energy portfolio standards (particularly, AZ, CA, NM, and NV) and the potential to gain from development of their solar energy resources.
  - DOE & CSP industry approached the Western Governors' Association to explore implementation.

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1000 MW CSP Project for the Southwest of U.S.

- In June 04'Western Governor Association passed resolution for 30 GW of new clean energy in the West by 2015 with a minimum of 1GW to be by CSP.
- WGA motivation for this initiative was driven by the following.
  - The solar energy resource in the Southwest U. S. is enormous and largely untapped.
  - The Southwest can add another engine for economic development by exploiting its CSP resource.
  - The economic benefits far exceed the cost to develop this clean, renewable energy resource.
  - In November 04' U.S DOE announced a five year cost share agreement with WGA to support the 1000 MW CSP program.
  - Under Secretary of Energy David Garman announces that: *"The federal long-term goal is to lower the cost of CSP to 7 cents per Kwhr from the current cost of 12 to 14 cents per Kwhr."*

Ref: SunLab

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