NREL CSP WORKSHOP

Central Receiver Panel

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Bright Source Energy Inc. – Oakland, CA

LUZ II Ltd. - Israel

A wholly owned subsidiary of Bright Source Energy

March 7, 2007

Bright Source Energy Presentation

- Background
  - DPT Technology
  - Solar Receiver & Steam Cycle
  - Implementation Schedule – Next Steps

Background

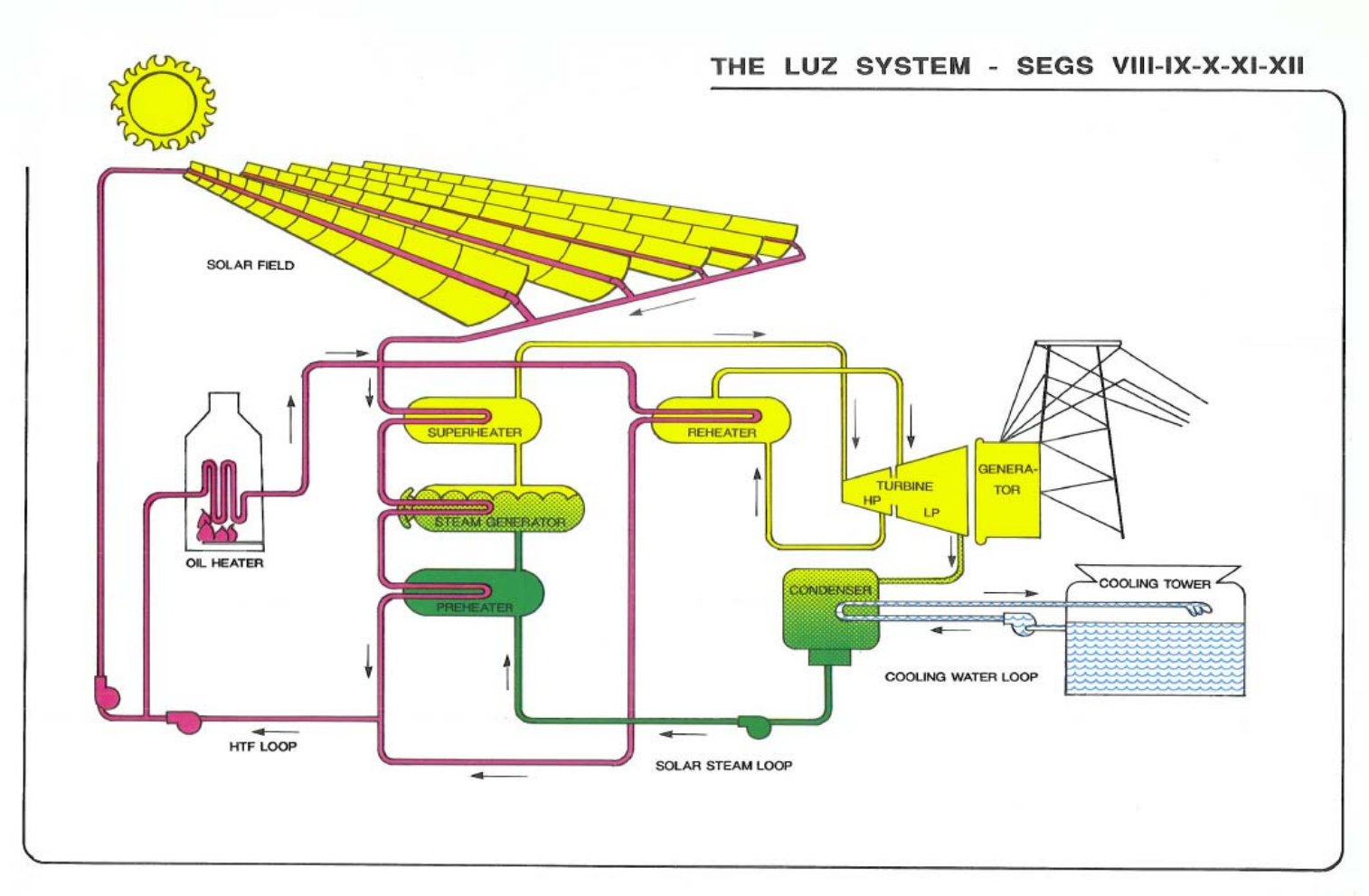
- **Twenty years ago Luz International Ltd. revolutionized the power world; solar with** utility standard power plants features (*but not for 21st century standards*)

- **The Luz plants works; 11,000 GWh** and produced more than $1.7 billion of revenue over the past 22 years, still profitably operating, current plan to operate 50 years.

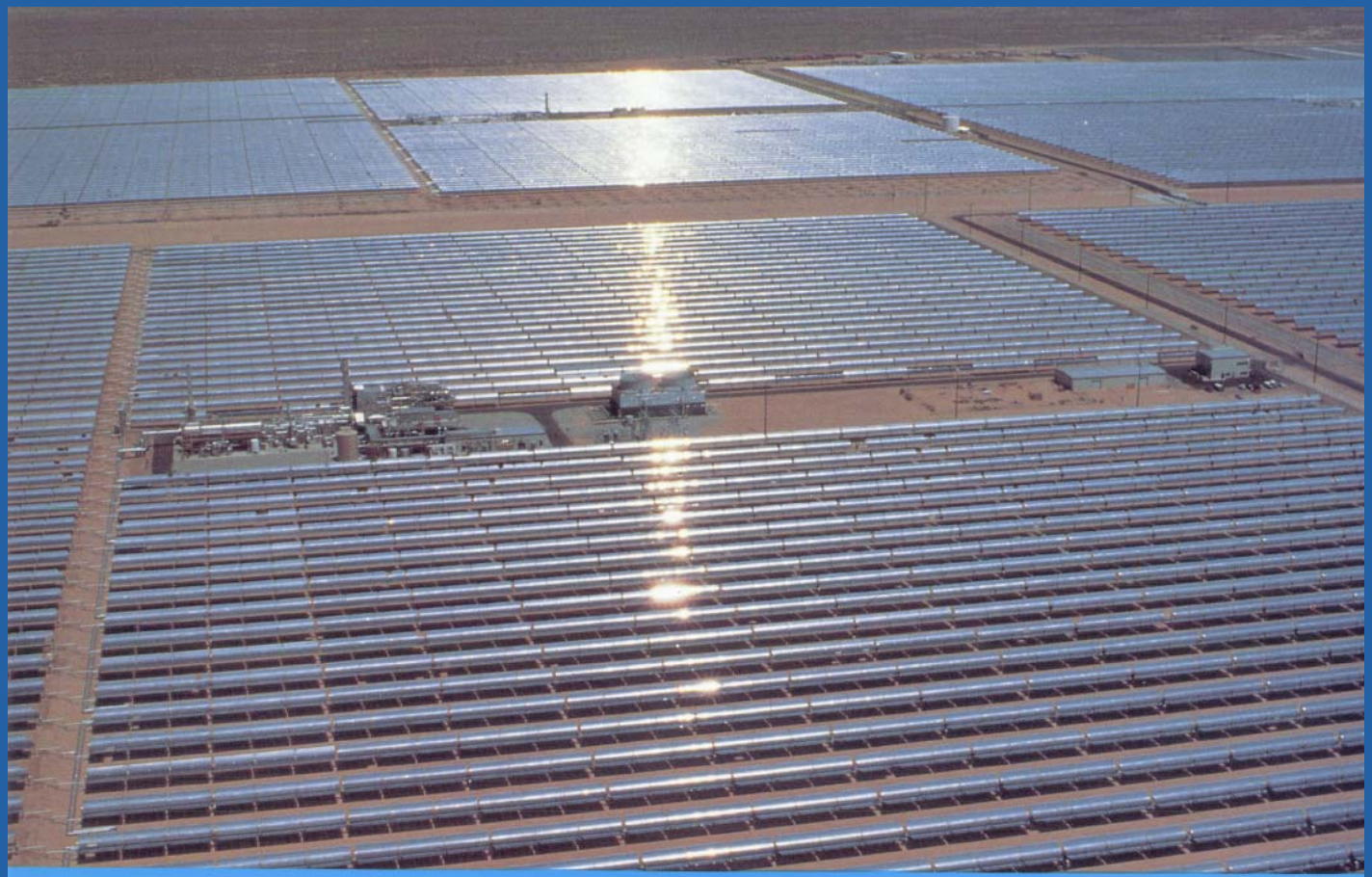
- **The Luz solar power revolution;** last century 80's return; Luz Bros. technical, management, finance, reassemble as Luz II.

LUZ II

Background – The LUZ system then…



Largest Solar Power Stations still in operation



Aerial view of SEGS III - VII, five Luz Solar Electric Generating Systems, which produce 150 net Megawatts of electricity for Southern California Edison utility company. Kramer Junction, U.S.A.

LUZ

LUZ II

Installed Base : 350 MW

Plant	SEGS I	SEGS II	SEGS III	SEGS IV	SEGS V	SEGS VI	SEGS VII	SEGS VIII	SEGS IX
Capa. (MWe)	13.8	30	30	30	30	30	30	80	80
Solar Field Size (m2)	82,960	189,000	230,000	230,000	233,000	188,000	194,280	464,340	484,000

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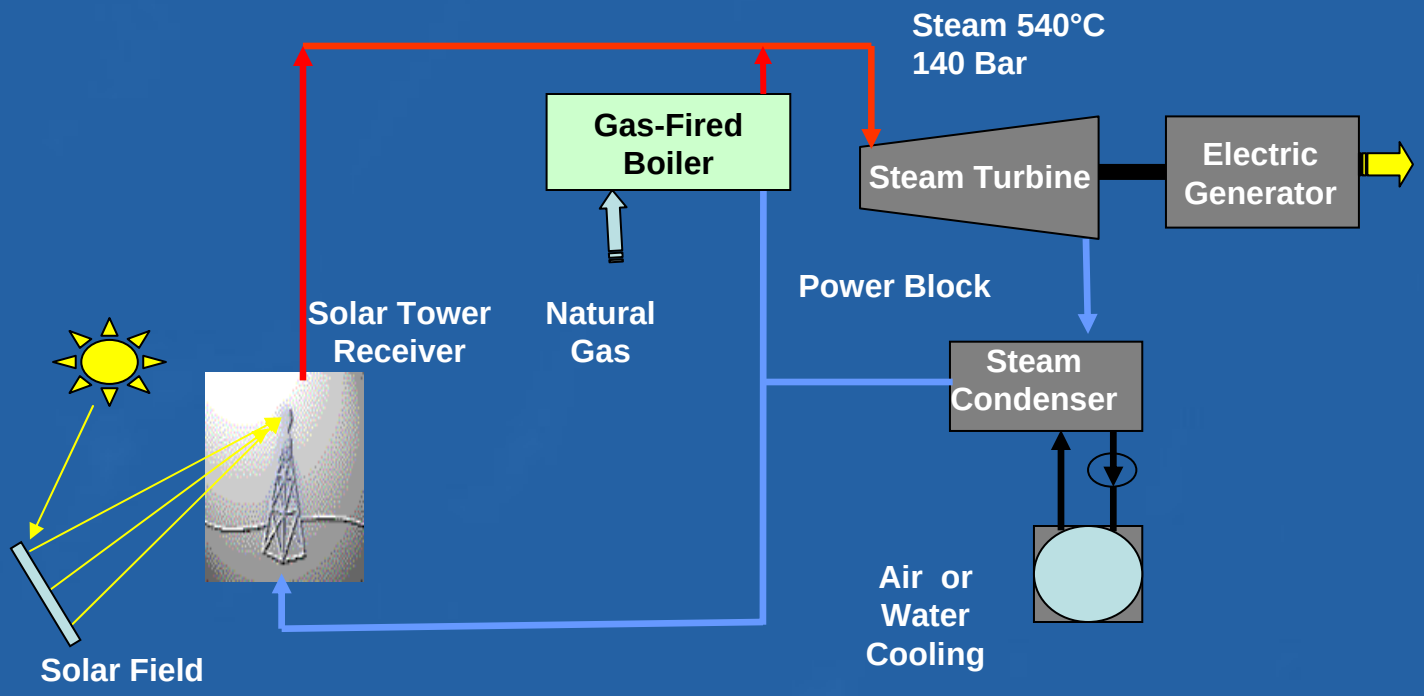
LUZ II Proprietary Technology

- **Luz II's proprietary, hybrid solar-gas power generating technology** - **D**istributed **P**ower **T**owers (DPT) – more cost effective than any other solar thermal technology.

- Luz II's Generation One technology (DPT 550) will unite DPT solar fields with steam turbines to produce reliable peak power.

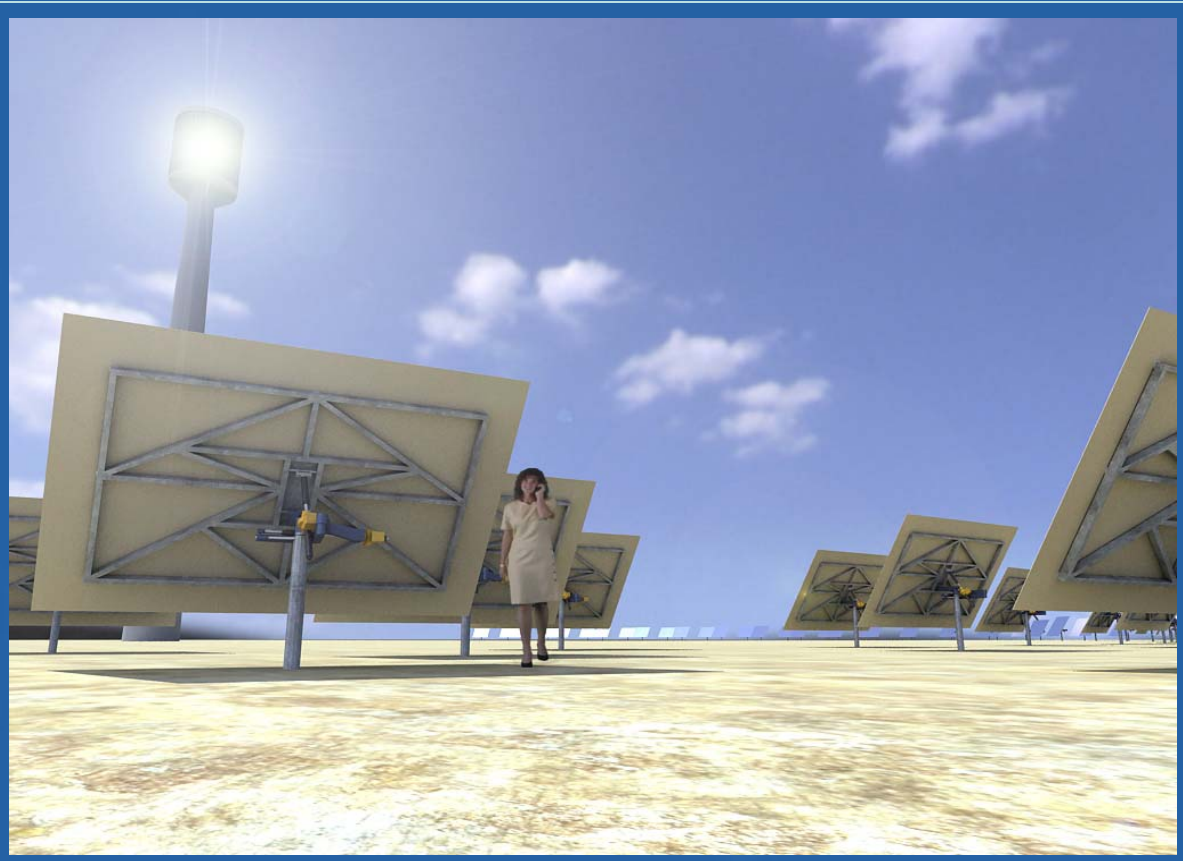
- The Generation Two technology (DPT 1200) will combine ultra-high temperature solar fields with high-efficiency combined-cycle gas turbines to produce reliable electricity at costs competitive with that of conventional combined-cycle gas turbines.

LUZ II Proprietary Technology



DPT 550 Power Generation Schematic

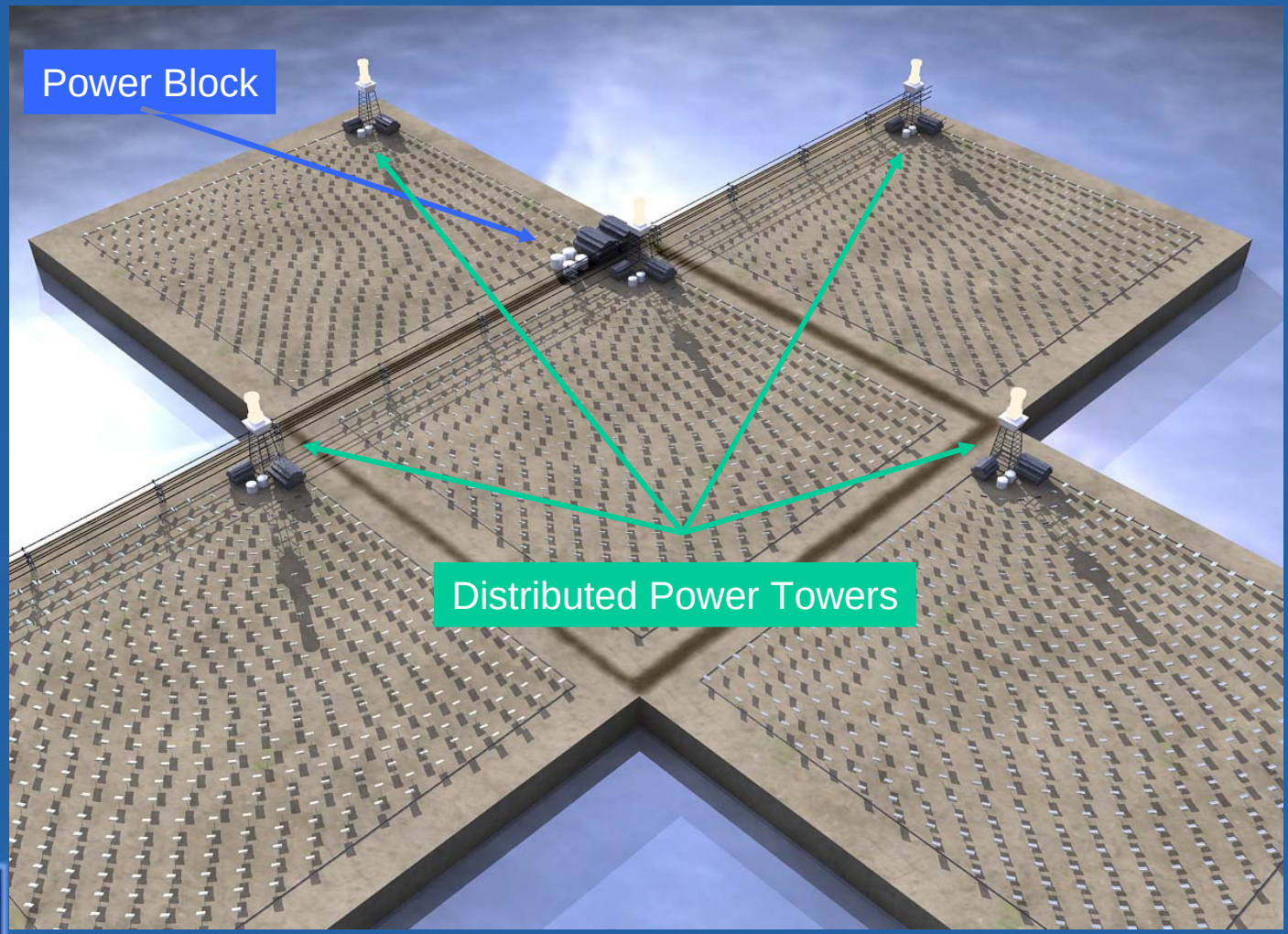
LUZ II Proprietary Technology



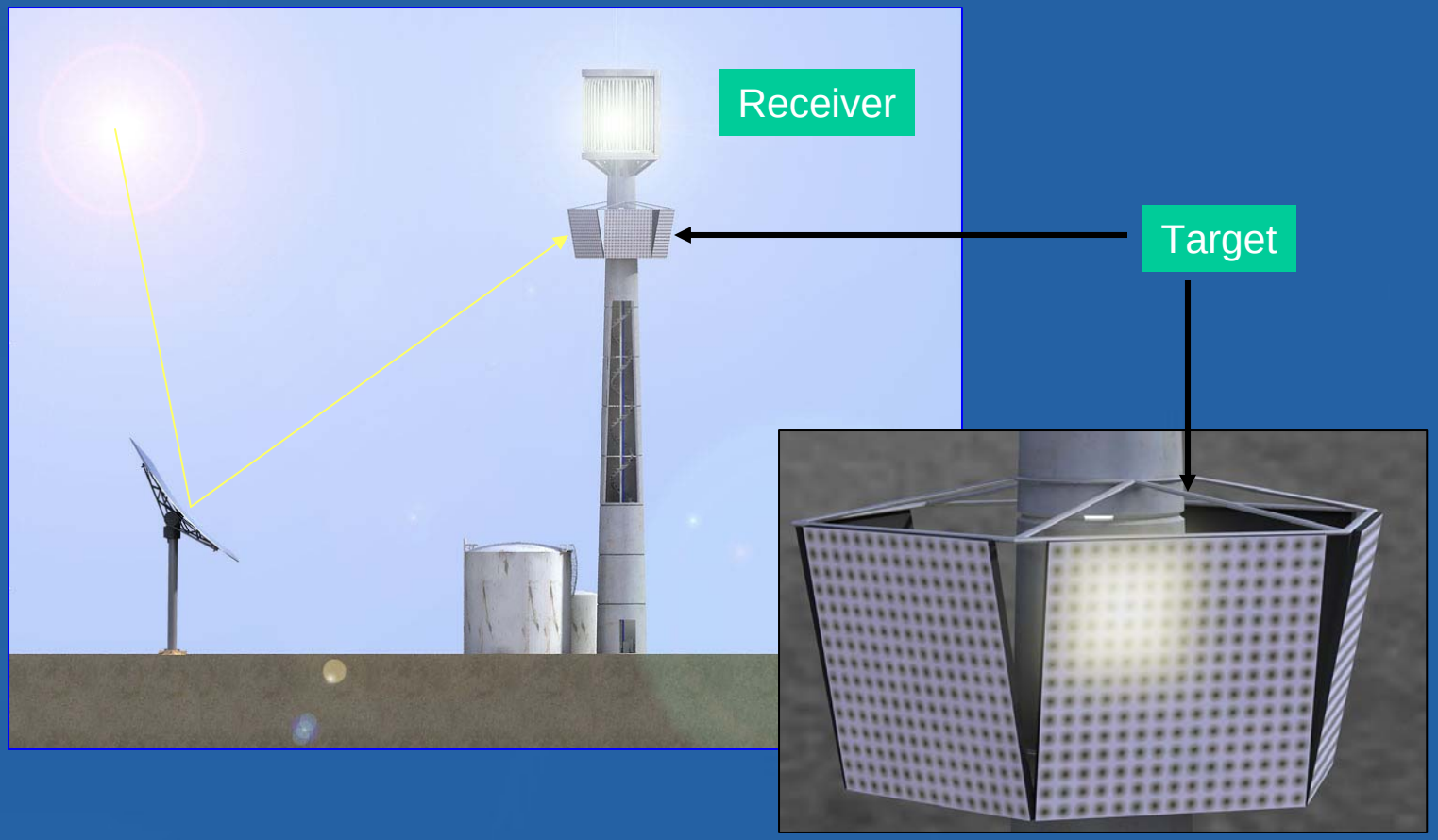
Artist rendering showing a LUZ II DPT solar heliostat array, around its receiver tower

Technology Elements

Technology Elements



Technology Elements



Technology Elements - Storage

- SEGS I storage type; proven technology of low temperature (300C)
- Cement and PCM (Phase Change Material); requiring development implementation
- Other storages development

- Thermal storage can be incorporated; pending incentive's price

Solar Field Layout for a100MW System

	Preferred concept	
Collector area	480,000m²	= 4 x 120,000
Land area	2,400,000m²	
Solar field configuration	360°	
Heliostat collector	7 m² flat mirrors (2.2m x 3.2m)	
Number of Heliostat	70,000	= 4 x 17,000
Tower	60-80 m height	
Receiver	10 m (height) x 8 m (diam.) cylinder	
First Generation		
Heat transfer media	Direct steam	
Power conversion	Steam turbine	
Second Generation		
Heat transfer media	Air	
Power conversion	Gas turbine	

DPT 550/Trough Comparison

- Steam Cycle Efficiency
- Collection Efficiency
- Collection Distribution
- Trough-Heliostat Economics
- Parasitic Losses
- HTF Elimination – hazardous waste
- Freeze protection Losses

Technology Cost Comparison

	SEGS 6	Optimum Trough	DPT 550	DPT 1200
Temperature (^{0}C)	370	400	550	1200
Solar to Thermal Efficiency	35%	40%	50%	48%
Gross Thermal to Elect Efficiency	37%	39%	43%	**51%**
Parasitic Power	14%	12%	5%	3%
Solar to Electrical Efficiency	11%	14%	20%	24%
Solar Field Cost $/m2	$280	$250	$150	$150
Relative Cost Per kWhr	**100%**	**90%**	**70%**	**55%**

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Power Block Configuration

- 4 steam generators (drum type) - receivers of central solar towers
- Condensing steam turbine generator with extractions of low and medium pressure steam
- Air cooled condenser (zero water discharge)
- Condensate and feed water pumps
- Five regenerative steam-to-feed water closed heaters, de-aerator and one regenerative HP condensate-to-feed water heater
- Steam re-heater
- Main Auxiliary Systems:

  Partial load gas-fired boiler (for transients; start-up and passing cloud)

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Projected Implementation Schedule

2010 – 2013 – 13 x 100 MW projects

- March 2008 – Pilot facility ready for evaluation
- 2007 – 2008 – 100 MW Project development
- 2009 – 2010 – 1st 100 MW project construction
- 2010 – 1st 100 MW project put in operation
- 2011 – 2 x 100MW Plant in operation
- 2012 – 4 x 100 MW Plants in operation
- 2013 – 6 x 100 MW Plants in operation

LUZ II

Next Step: PILOT Plant

PILOT Objectives

- Demonstrate, on a reduced scale, DPT-550 technology performances
- Provide a facility to run a complete test program for system evaluation and improvements.
- Main Objective is to produce superheated steam at same temperature and pressure as for the full scale 100 MW Power Plant (540 deg.C ; 140 Bar).
- No electricity production
- Pilot Plant to be ready for testing and evaluation by 31st March 2008.

PILOT Plant Main Data

- Heliostats Reflecting Area: ~ 12,000 m2 (~ 10% of one cluster)
- Number of Heliostats: 1700
- Heliostat Dimensions: 2.2m x 3.2m
- Reflecting area per Heliostat: 7 m2
- Distance between rows of Heliostats: 4.2 m
- Tower Height: 60 m (+ ~10m Receiver)
- Thermal Energy on receiver: 6 MWth

Questions – Comments

Thank you !