

*Exceptional service in the national interest*



# Overview of Concentrating Solar Power Program and the National Solar Thermal Test Facility

**James E. Pacheco**

**For the ECIS External Advisory Board**

**July 18, 2012**



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

# Agenda

- 12:35-1:15 PM: Lunch
- During lunch, briefing on:
  - Overview Concentrating Solar Power (CSP) Program
    - CSP Technology and Commercial Status
    - DOE SunShot Goals
    - SNL Research
    - National Solar Thermal Test Facility
- Tour (1:15-1:50 PM)
  - Drive by dish & heliostat test area, ARRA-funded remirroring of NSTTF heliostat field
  - Solar tower and molten salt test loop
- Depart NSTTF (2:00 PM)

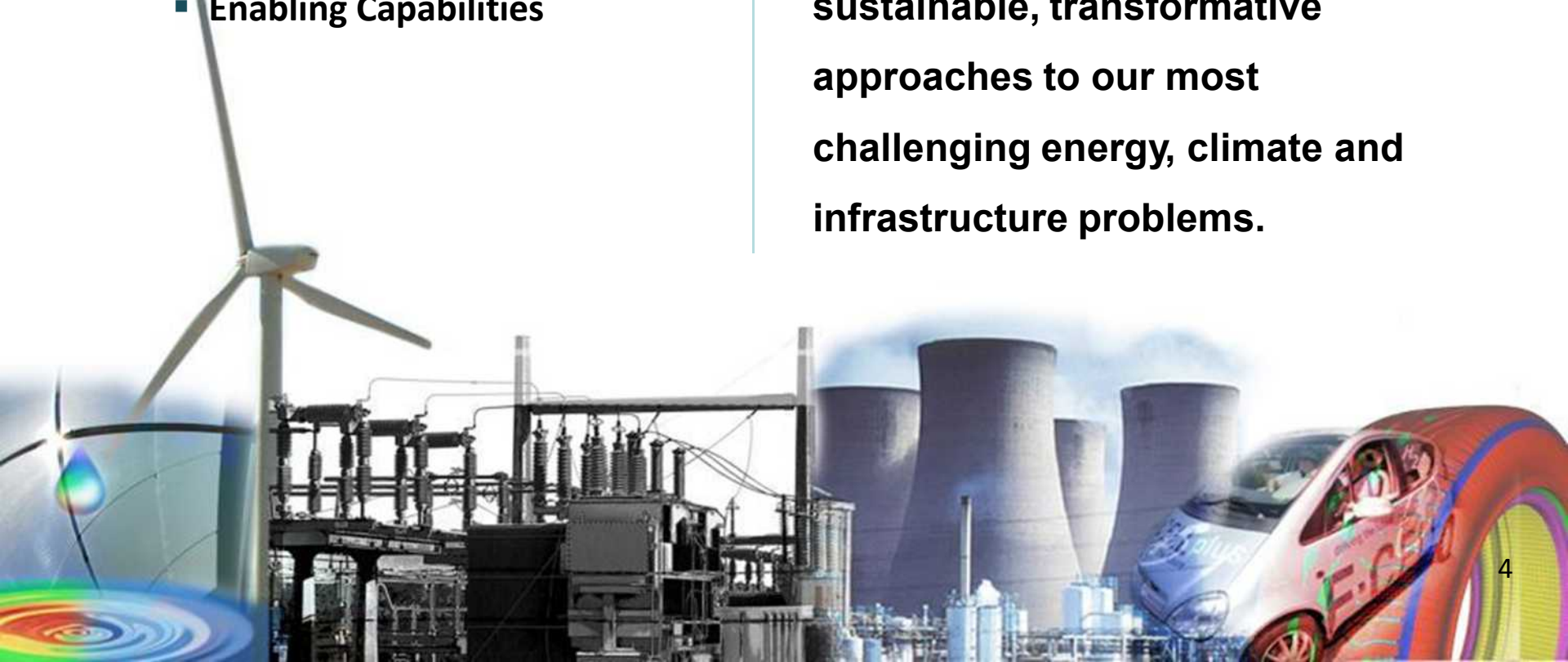
# Energy, Climate, and Infrastructure Security

## Program Areas

- Infrastructure Security
- Energy Security
- Climate Security
- Enabling Capabilities

## Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate and infrastructure problems.



# Renewable Energy R&D

- Solar
  - Photovoltaics
  - Concentrating Solar Power
  - Solar Fuels
- Wind
- Water
- Geothermal
- Biomass





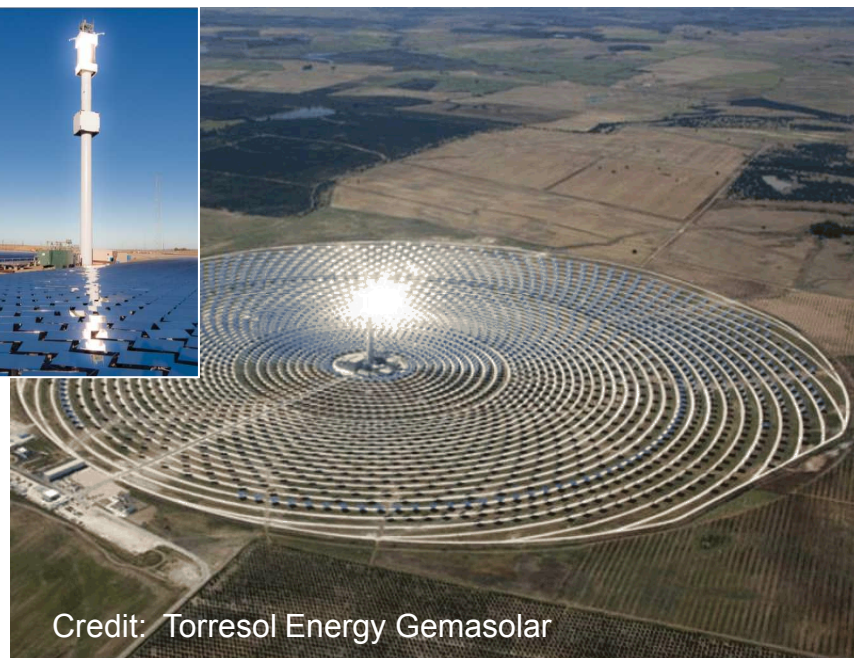
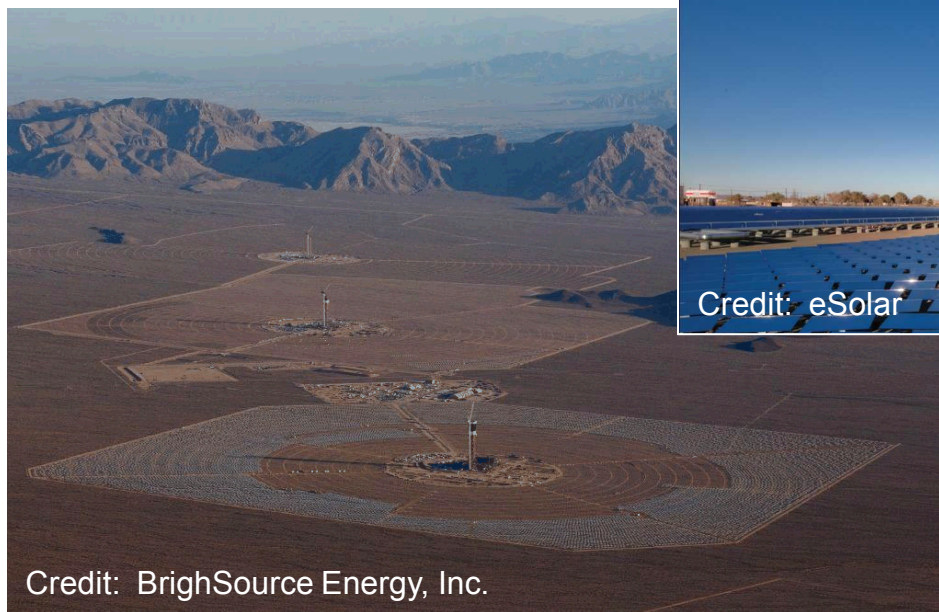
# Overview of CSP

- Several CSP plants are in operation around the world
  - 539 MW in the US
  - 1182 MW in Spain
  - 655 MW the rest of the world
  - Gigawatts under construction and planned
- Parabolic trough is the most mature and prevalent.
- Power towers are emerging and the first commercial plants are coming on-line.
- Dish engine systems have higher efficiency and the potential for significant cost reductions.



# Commercial Power Tower Plants

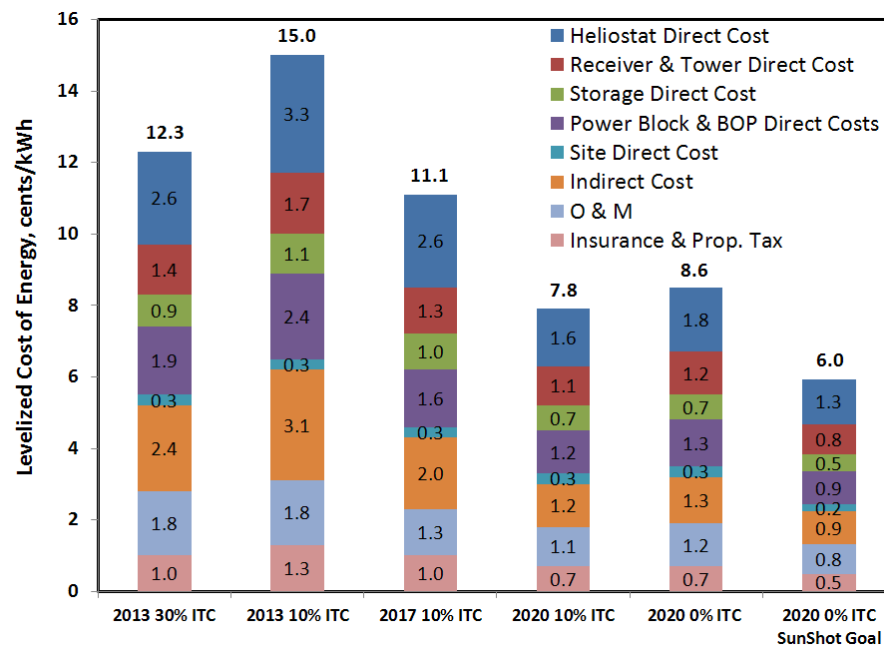
- Gemasolar Thermosolar Plant
  - **20 MWe** molten salt power tower
  - Operational in Andalucía, Spain
- BrightSource Ivanpah
  - **390 MWe** direct steam generation
  - Three plants under construction in CA
- Solar Reserve Crescent Dunes
  - **110 MWe** molten salt
  - Under construction in Tonopah, NV
- eSolar Sierra SunTower
  - **5 MWe** direct steam
  - Operational in Lancaster, CA





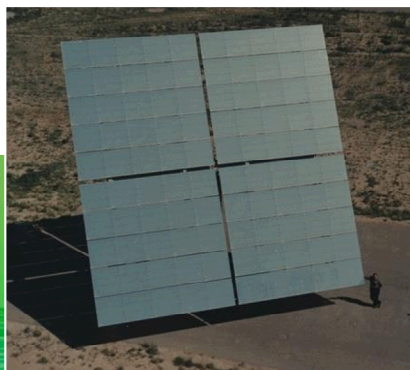
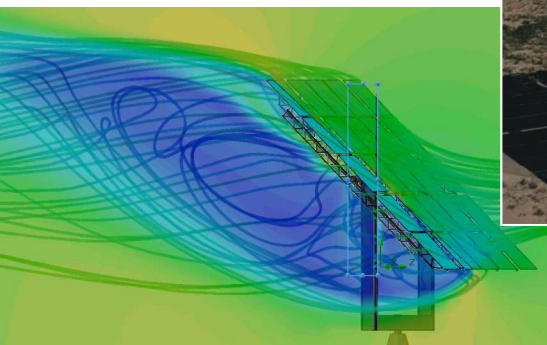
# DOE SunShot Goals

- Reduce the cost of solar-generated electricity to be competitive with fossil fuels (6 cents/kWh) by 2020 without subsidies.
- All major systems in a CSP plant must have improved performance and reduced costs
  - Collector Systems:  $\$75/\text{m}^2$
  - Receivers:  $>650^\circ\text{C}$  operating temperatures,  $>90\%$  efficiency,  $<\$150/\text{kW}_t$
  - Thermal Storage:  $<\$15/\text{kWh}$ ,  $>95\%$  exergy efficiency
  - Power Cycles:  $>50\%$  gross-cycle efficiency with dry cooling,  $>650^\circ\text{C}$  operating temperatures,  $<\$1200/\text{kW}_e$



# Sandia CSP Program R&D

- Power Tower R&D
- Dish R&D
- Trough R&D
- Thermal Storage R&D
- Systems Analysis
- Optical Materials and Tools
- \$7.3M in FY12





# National Solar Thermal Test Facility

Parabolic Trough R&D



PV System Reliability



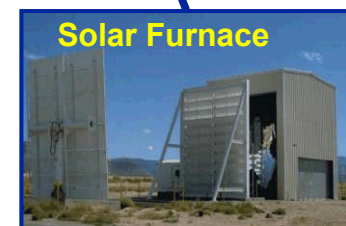
Dish Stirling R&D



Thermal Energy  
Storage R&D



Receivers and Heliostats



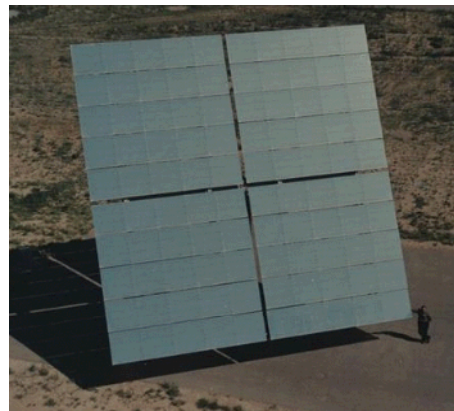
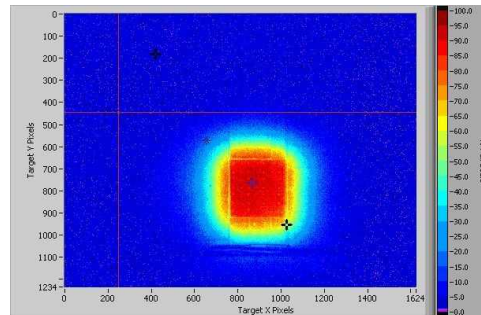
Solar Fuels and Selective Absorbers

# Power Tower & Heliostat Field

- Ability to test large receivers at incident power up to 6.2 MWt
- Heliostat Field
  - 214 heliostats.
  - 37 m<sup>2</sup>
  - Completely re-mirrored
  - Low-iron, >95% solar-weighted reflectivity
- Tower
  - 200 ft tall tower
  - 100-ton capacity elevating module
  - Three test bays
  - Beam Characterization Target
- Heliostat Test Bed
  - Full-scale heliostats
  - Novel designs
  - High performance reflective film evaluation

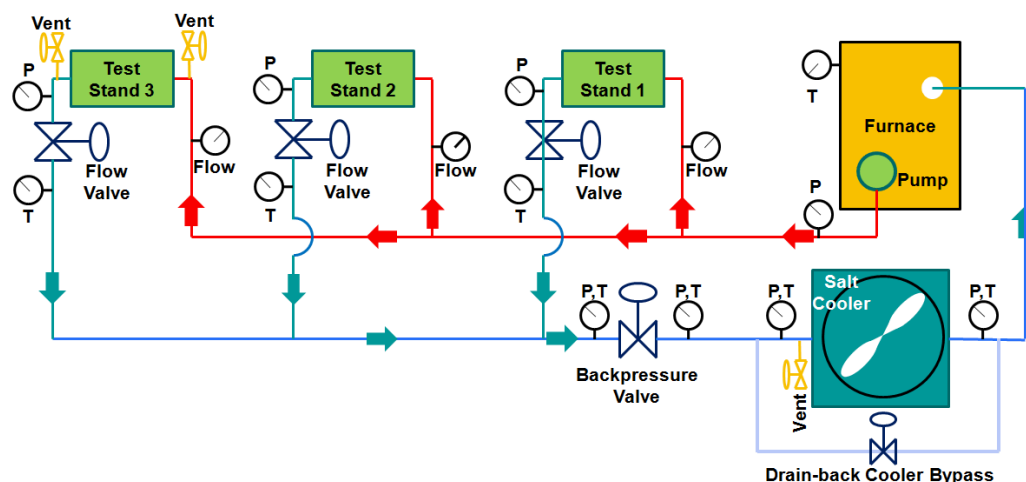


*Shuttle Tile  
Testing on  
top of Solar  
Tower*



# Molten Salt Test Loop

- Purpose:
  - Enables testing of molten salt hardware at high-flow and high-pressure, over a range of temperatures
- Features & Capabilities
  - 3 Test Stands
  - 60%  $\text{NaNO}_3$  / 40%  $\text{KNO}_3$
  - Flow rate: 1.5  $\text{m}^3/\text{min}$  (400 gal/min)
  - Salt temperature range: 300-585°C (572-1085°F)
  - Maximum salt pressure: 40 bar (580 psi)
  - Remove up to 1.4MW solar thermal input





# Dish Test Area

- Allows industry partners to install full-scale solar dishes for long-term reliability testing and evaluation.
- Currently site has ten 30-kW dishes and six 3-kW Infinia dishes at this location.
- The site also includes two SNL-developed solar dishes that are available for research.
- Fully characterize short- and long-term performance



# Solar Furnace

- The 16 kW solar furnace comprises:
  - Primary heliostat
  - A secondary concentrator
  - Test table where experiments or calibrations are performed.
- The peak flux provided is greater than  $600\text{W}/\text{cm}^2$ .
- Recently, the furnace has been used to demonstrate the feasibility of the Sunshine-to-Petrol initiative.
- The furnace is also used for selective absorber testing and material screening.
- The solar furnace is the only place in the US that can provide a solar calibration for flux gages.



# Regional Test Center

- Purpose: Support US industry in actual field test and validation of US-based PV modules and systems designs to accelerate bankability assessments.
- 1 MWe connectivity to the utility system on eight acres of the NSTTF.
- The second phase, an additional ten acres when complete, will provide an additional 1 MWe.
- One of four RTCs in the country to validate US manufacturers' products at the commercial scale and utility scale in a hot, dry climate.





# Concentrating PV

- First demonstration of a utility-size CPV test at SNL.
  - 110 kWe of SunPower's new C7 low-concentration PV systems.
  - SNL is using the systems data to evaluate the reliability of this low-concentration system.
  - SunPower is using the site to test new components in side-by-side comparisons.
- The groups are working together to improve performance models specific to this technology.



# TOUR

1. Conference room 103
2. Take shuttle to tower.
3. Elevator to top of tower. View NSTTF site and Molten Salt Test Loop.

