SunShot Concentrating Solar Power Program

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Thermochemical Energy Storage Workshop • January 8, 2013

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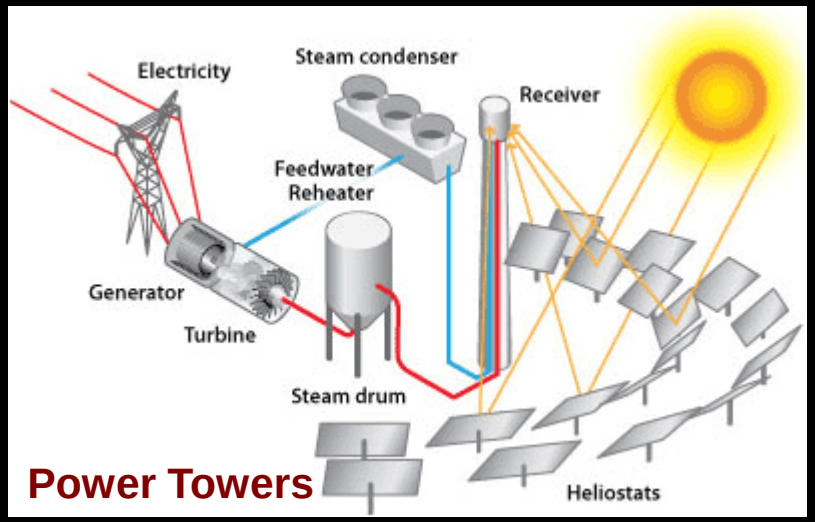
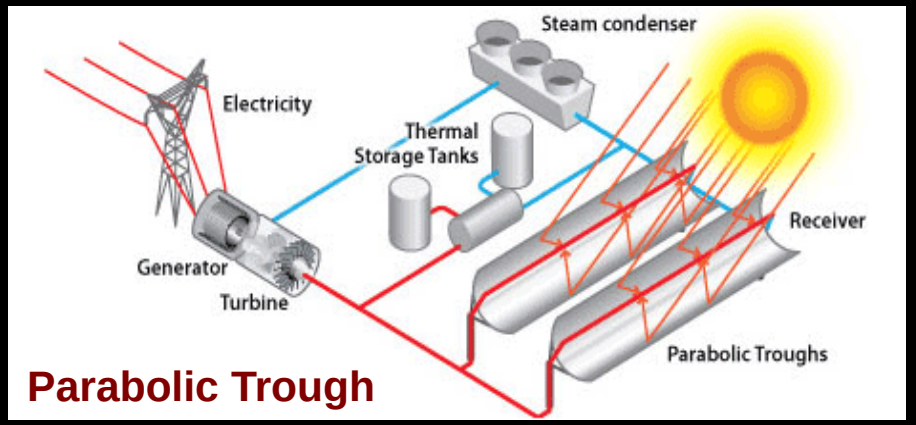
CSP Introduction

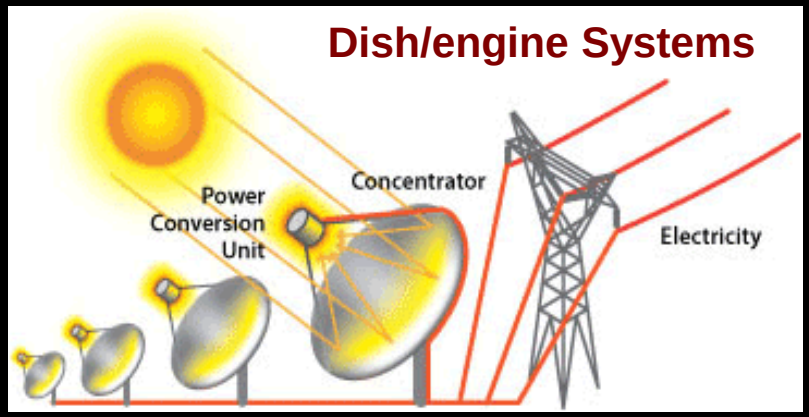
To view the video presented at the workshop, please follow the link below.

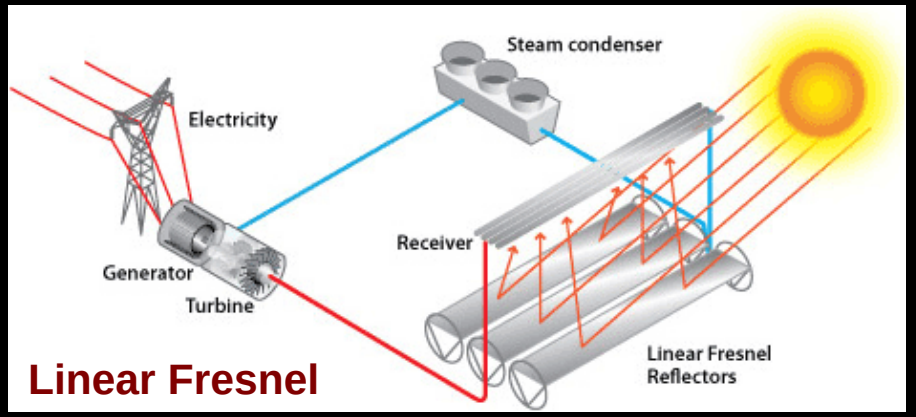
https://www.eeremultimedia.energy.gov/solar/videos/concentrating_solar_power_power_towers

CSP Systems









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CSP Plants Currently Operating in the U. S.

Project *(Developer)*	Size	Tech
SEGS 3-9 *(FPL-NextEra)*	310 MW	Trough
Martin *(FPL-NextEra)*	75 MW	Trough
Nevada Solar One *(Acciona)*	64 MW	Trough
SEGS 1-2 *(Cogentrix)*	44 MW	Trough
Coalinga *(BrightSource)*	10 MW	Tower
Sierra *(eSolar)*	5 MW	Tower
Kimberlina *(AREVA)*	5 MW	Fresnel
Holaniku *(Sopogy)*	2 MW	Trough
Maricopa *(SES)*	1 MW	Dish
Saguaro *(APS)*	1 MW	Trough
Cameo *(Abengoa)*	1 MW	Trough
Total	518 MW	

Nevada Solar One, Las Vegas, NV

Sierra Project, Lancaster, CA

Maricopa
Phoenix, AZ

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CSP Plants Under Construction in the U.S.

Project *(Developer)*	Size	Tech	Loan	Start
▪ Ivanpah *(BrightSource)*	392 MW	Tower	$1.6 B	2013

Broke ground in 2010. After delays associated with relocation of desert tortoises, construction has resumed for a mid-2013 COD for Unit 1 and late-2013 COD for units 2 and 3. As of February 2012, largest CSP project under construction in the world.

▪ Crescent Dunes *(SolarReserve)*	110 MW	Tower/Storage	$0.7 B	2013

Completed financing in September 2011 by SolarReserve & Santander. Completed 540 ft. power tower concrete shell in February 2012. Next phase will be to complete molten salt storage tanks.

▪ Genesis *(FPL-NextEra)*	250 MW	Trough	$0.8 B	2013/14

Approximately 13% of the site is undergoing further archeological surveying in accordance with approved plans. Construction continues on the remainder of site and is expected to be completed on time for the PPA start date for Unit 1 of November 2013.

▪ Solana *(Abengoa)*	280 MW	Trough/Storage	$1.4 B	2014

Construction began in December 2010 and solar field installation is underway.

▪ Mojave *(Abengoa)*	250 MW	Trough	$1.2 B	2014

CPUC approved PPA with PG&E in November 2011 and construction ramped up.

Total	1,282 MW		$5.7 B	

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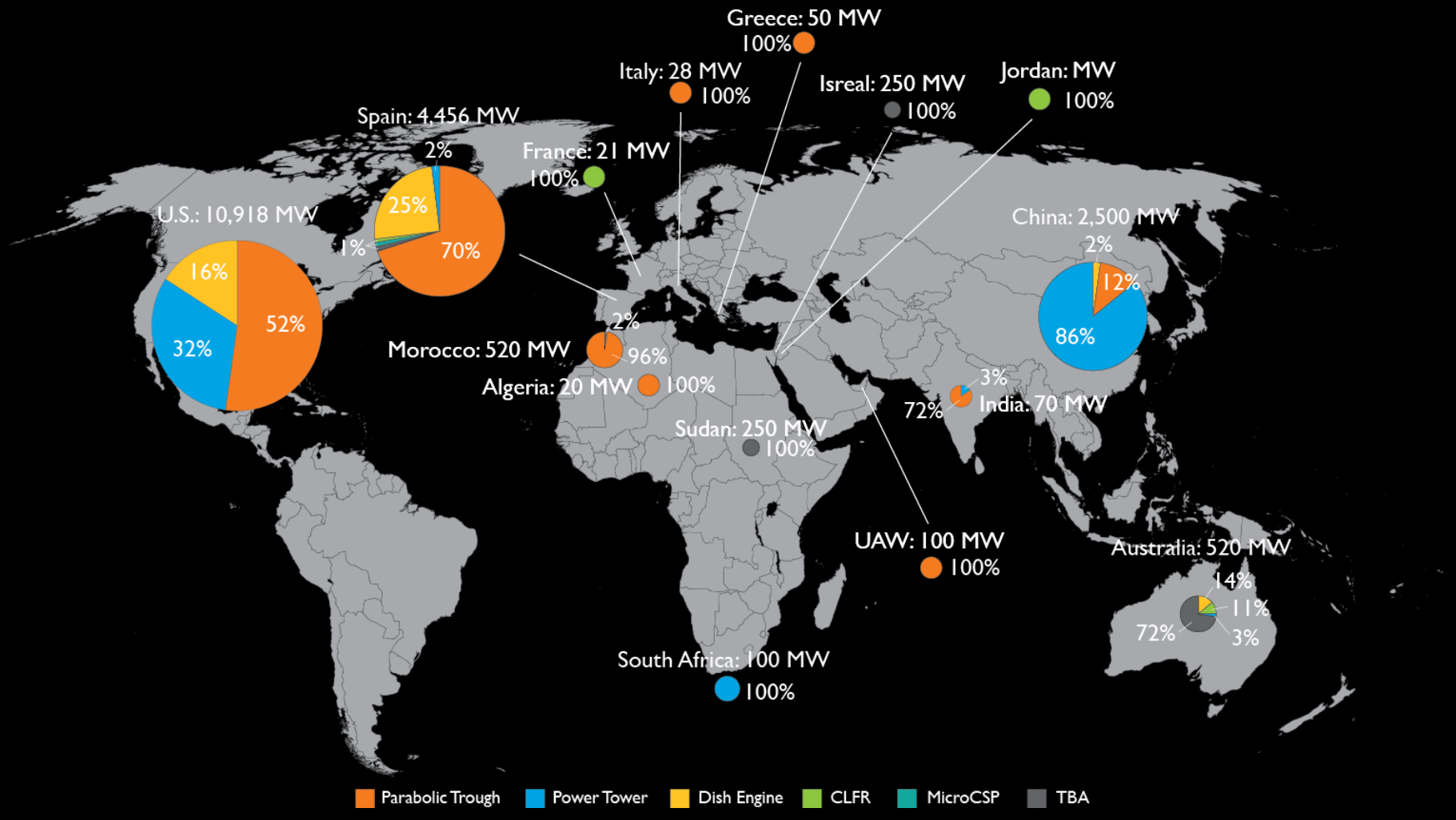
Global CSP Development Pipeline

CSP Plants Under Construction/Development (19.8 GW Total)



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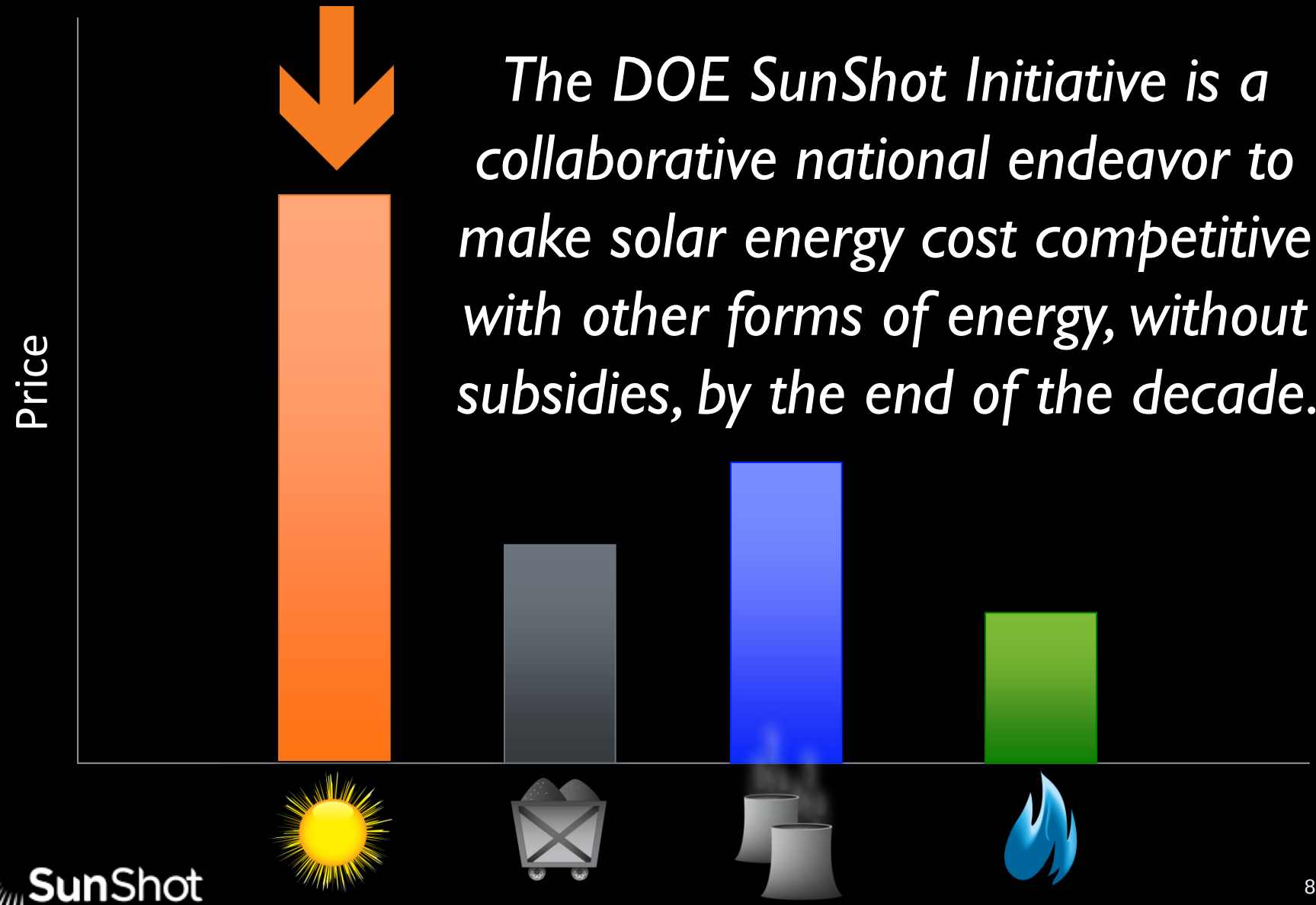
Source: "Concentrating Solar Power 2011: Technology, Costs and Markets," GTM Research • greentech.com

SunShot Initiative



The DOE SunShot Initiative is a collaborative national endeavor to make solar energy cost competitive with other forms of energy, without subsidies, by the end of the decade.

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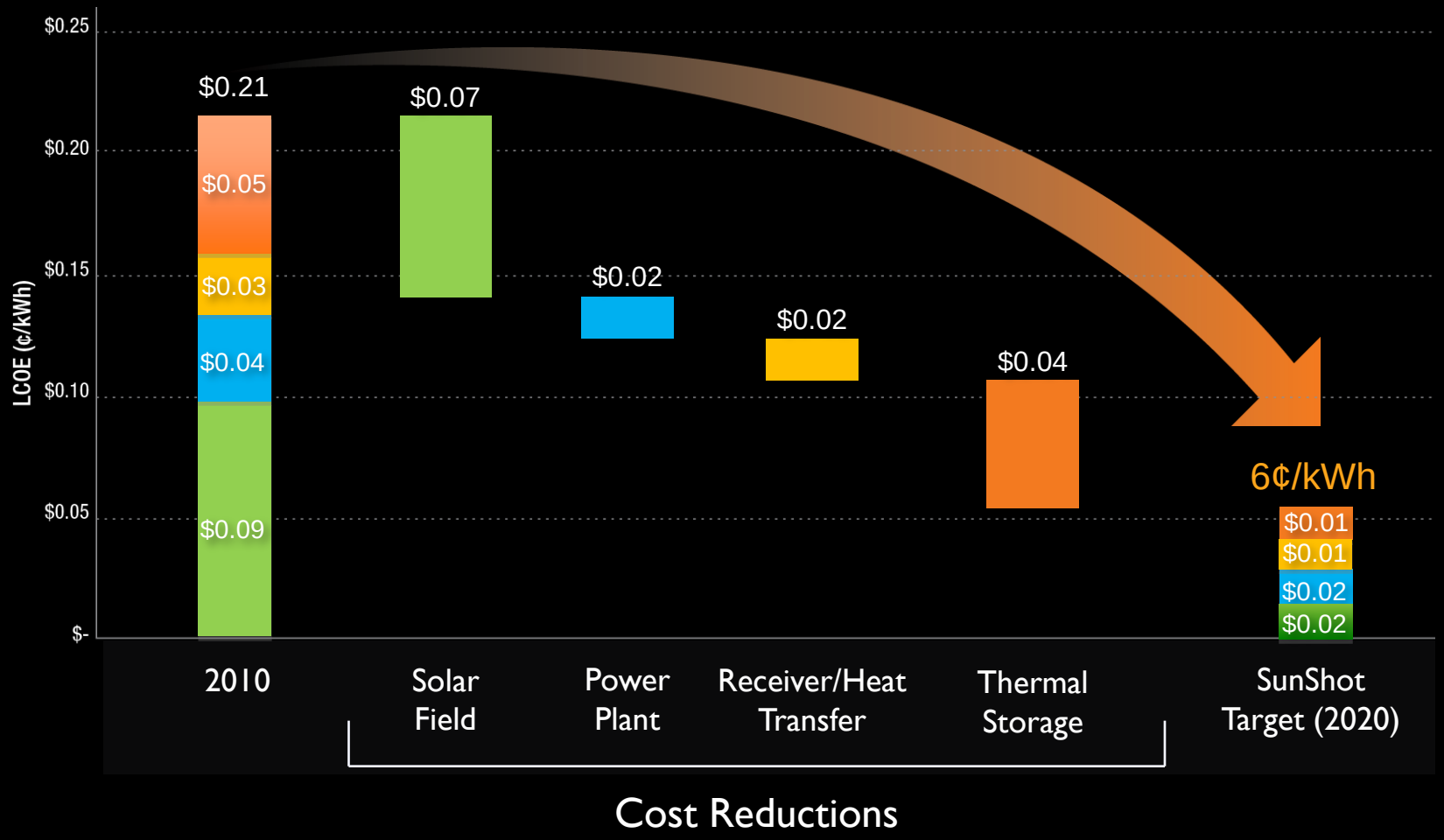
SunShot CSP Goal



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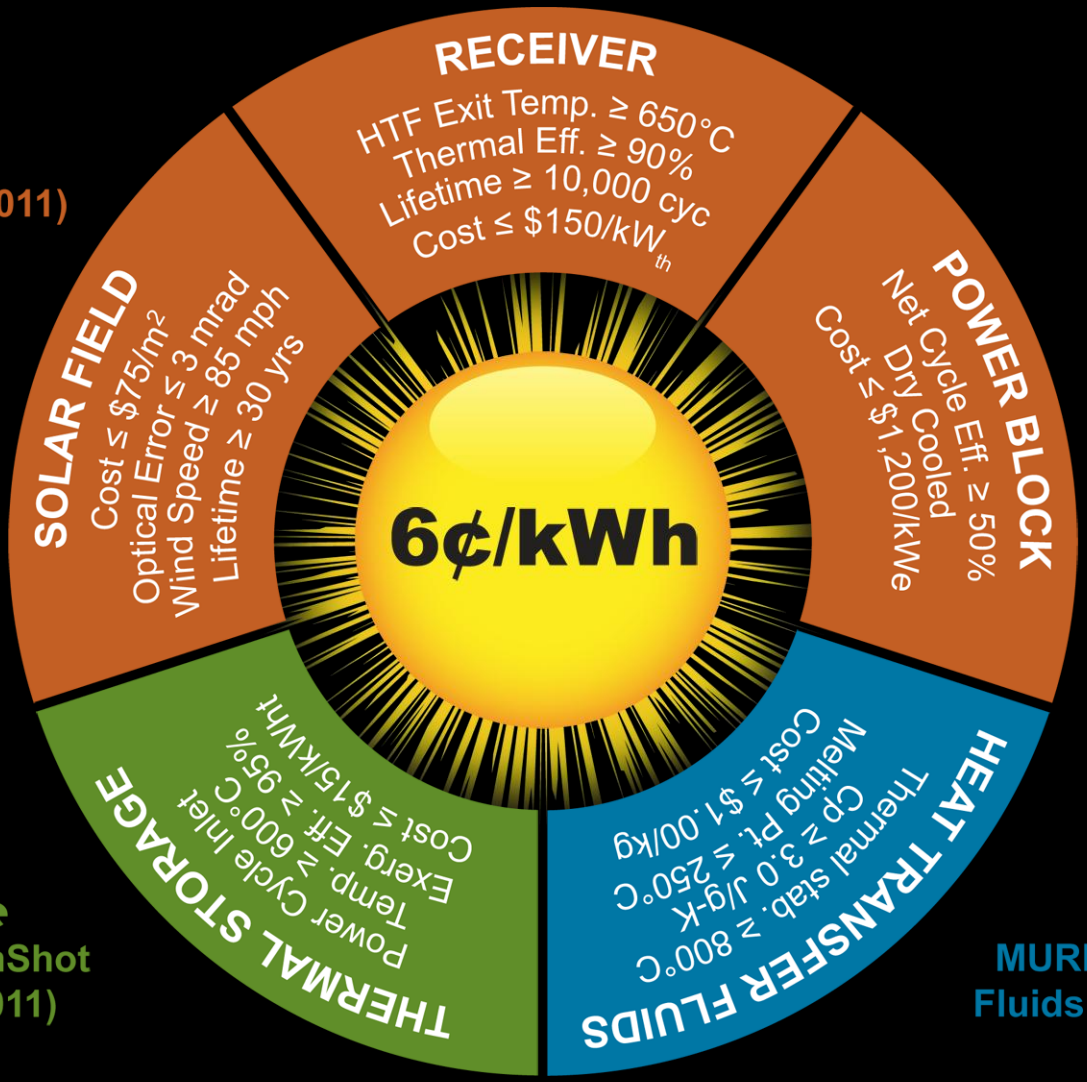
Strategy for Recent and Future CSP FOAs



CSP SunShot (2011)

arpa • e HEATS & SunShot Awards (2011)

MURI HOT Fluids (2012)

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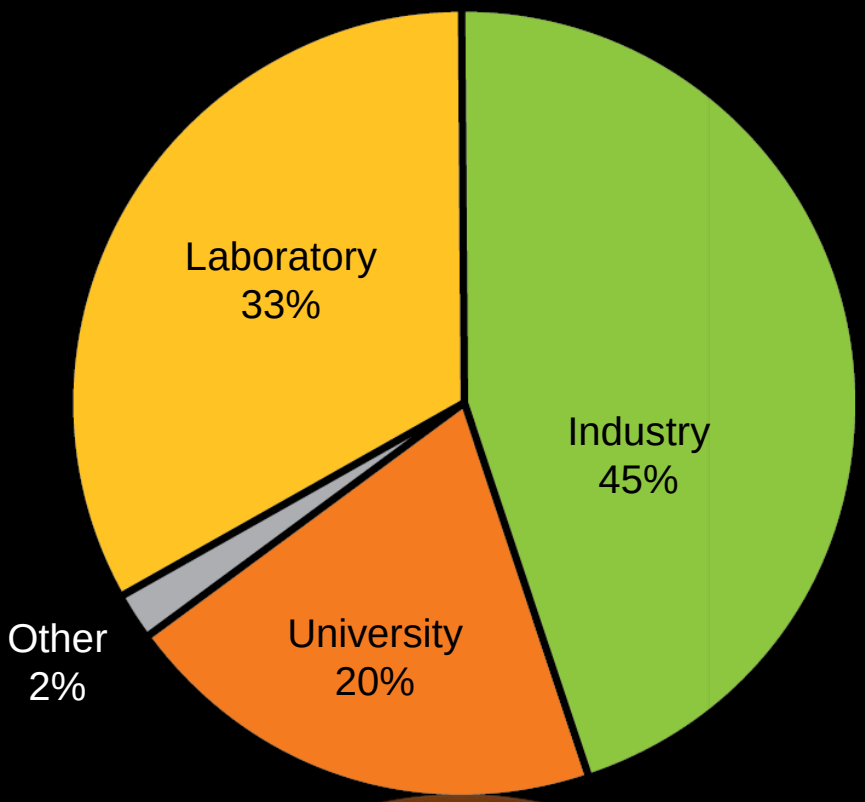
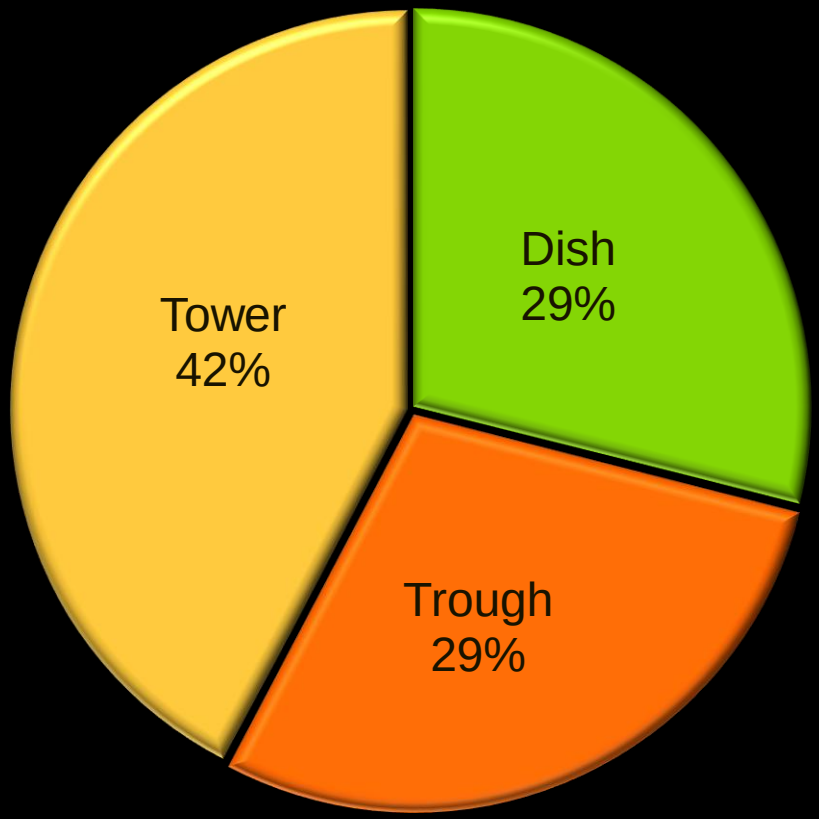
FY12 CSP Funding Distribution





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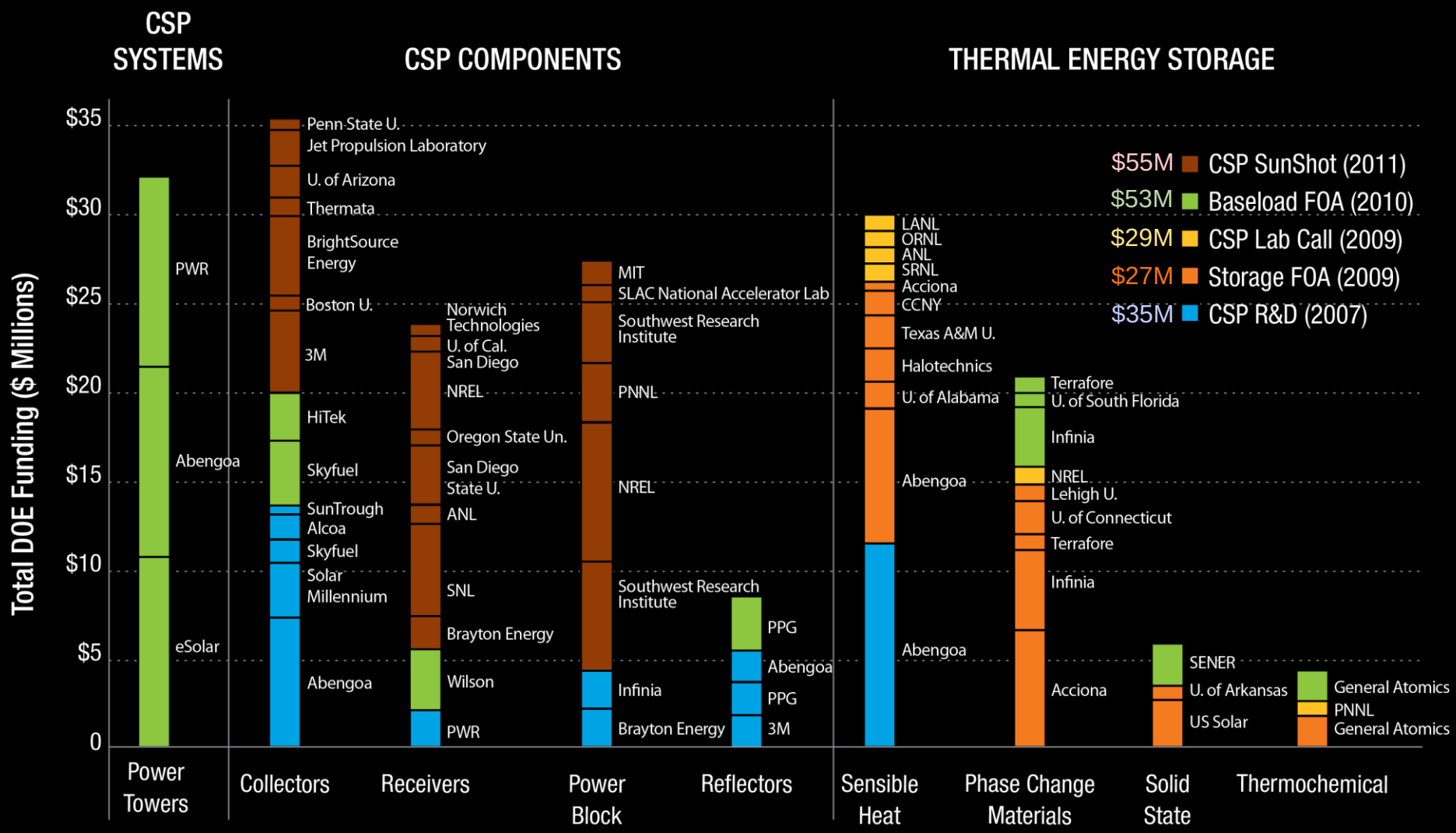
DOE CSP Portfolio



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Storing Sun's Energy in Chemical Bonds:

Thermochemical Energy Storage for Concentrating Solar Power

Thermal energy storage is a distinguishing feature of Concentrating Solar Power

Storage Options

- Sensible Energy ~150 kJ/kg
- Latent Energy ~230 kJ/kg
- **Chemical Energy > 12,000 kJ/kg**

1. Can we engineer CSP integrated energy storage based on chemical reactions to capture and release energy on demand?
2. Can we do so in a cost-effective manner with high efficiency to meet the SunShot goals?

Workshop Objectives

- To convene experts from industry, academia, national labs to have an open discussion on the viability of TCES for CSP as a solution to achieving the SunShot Initiative goals.
- To identify the significant technical challenges to be addressed based on CSP-integrated system considerations (system-driving-science and science-enabling-systems)
- Workshop Format:
  - Two keynote presentations on the international efforts related to thermochemical energy storage for CSP
  - A perspective on lessons learned in developing thermochemical cycles for solar energy storage
  - Breakout sessions for guided in-depth discussions

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