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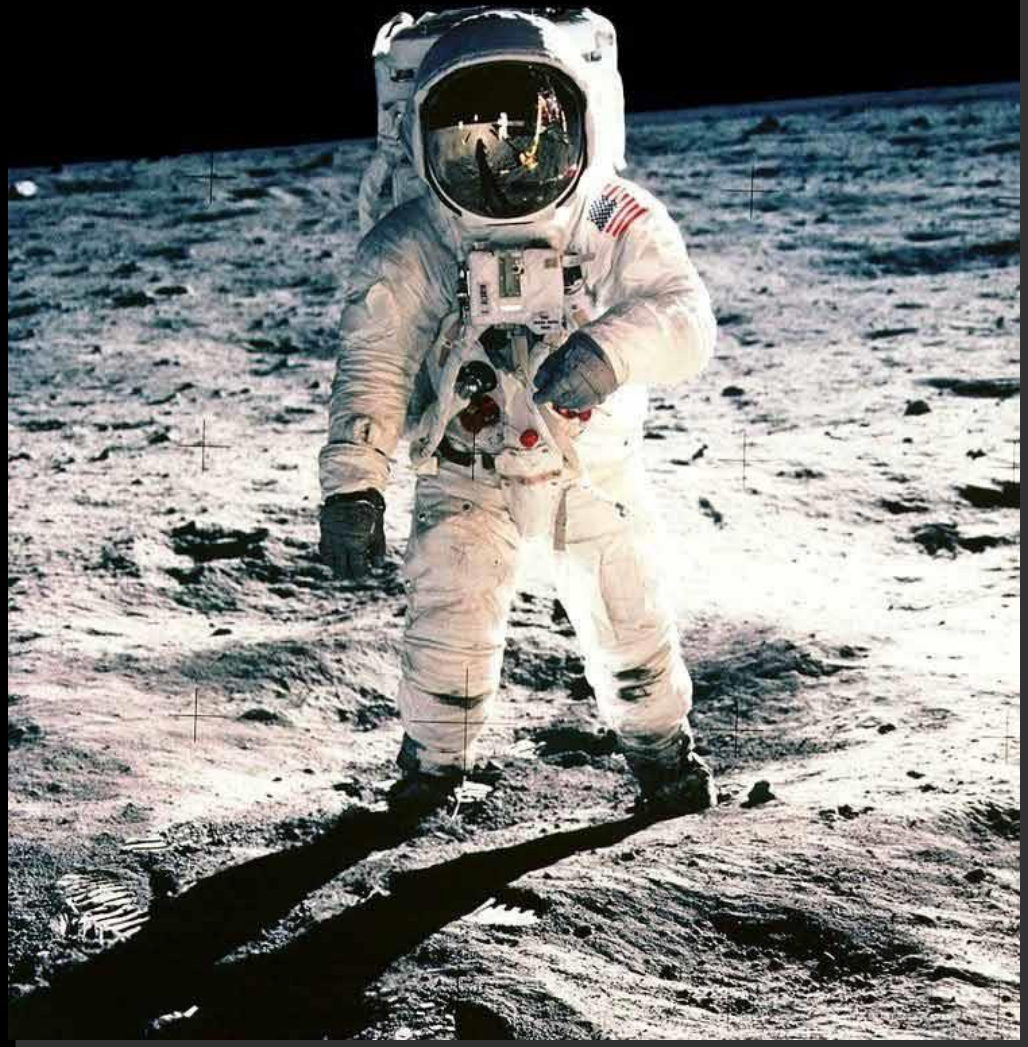
# Revitalizing American Competitiveness in Solar Technologies

**R. Ramesh, Former Director, SunShot**
**Deputy Director for Science and Technology**
**Oak Ridge National Laboratory**

# Lunar Landing: 1969

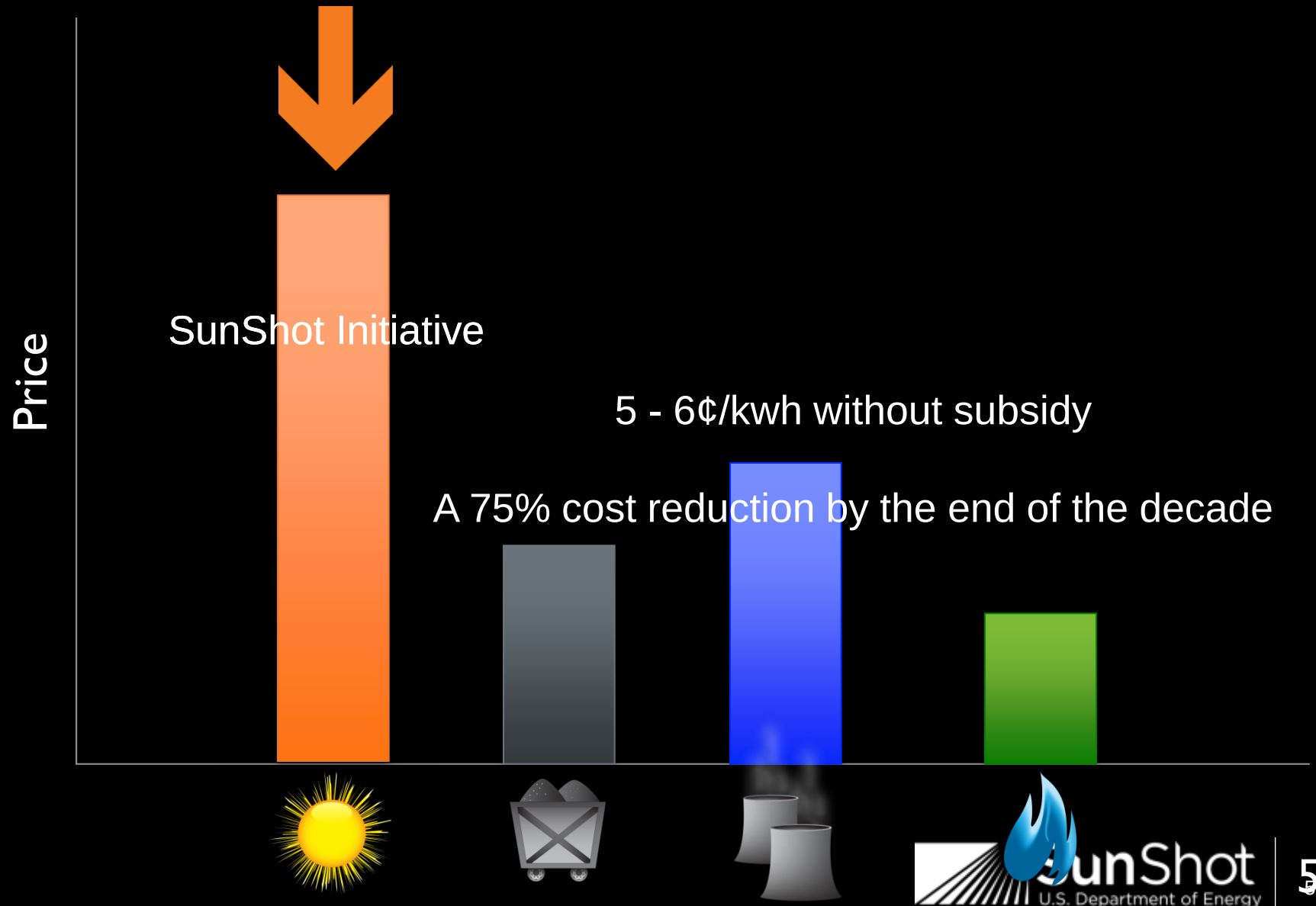


"We're telling America's scientists and engineers that if they assemble teams of the best minds in their fields, and focus on the hardest problems in clean energy, we'll fund the Apollo projects of our time."

- President Obama

2011 State of the Union

# So what is the SunShot Initiative?



# SunShot Program Structure

Photovoltaics (PV)

DOE SunShot

Concentrating Solar Power (CSP)

Soft BOS
Systems Integration

Distributed Generation
- on-site or near point of use -

Centralized Generation
- large users or utilities -

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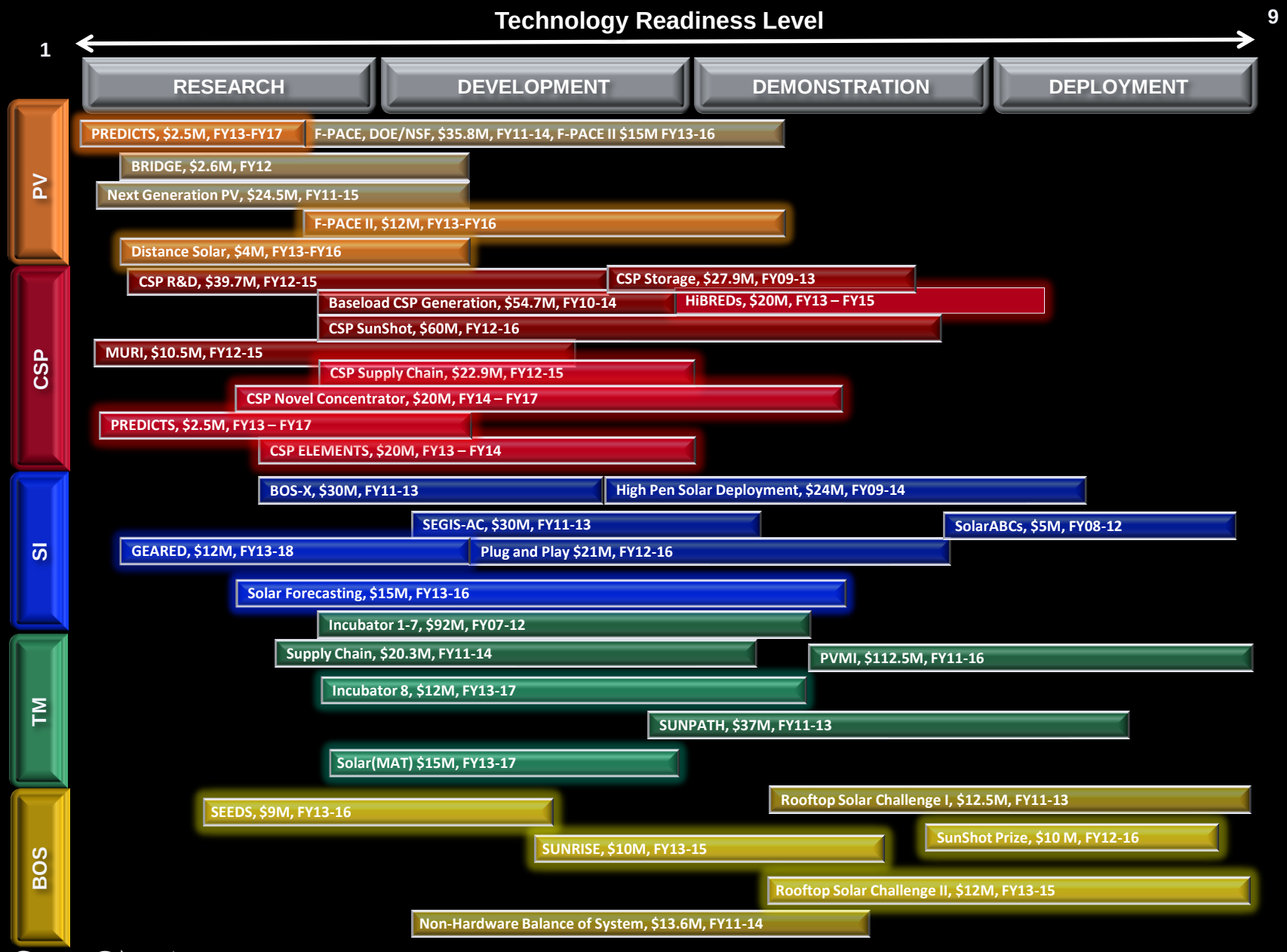
# SunShot Projects FY08–16

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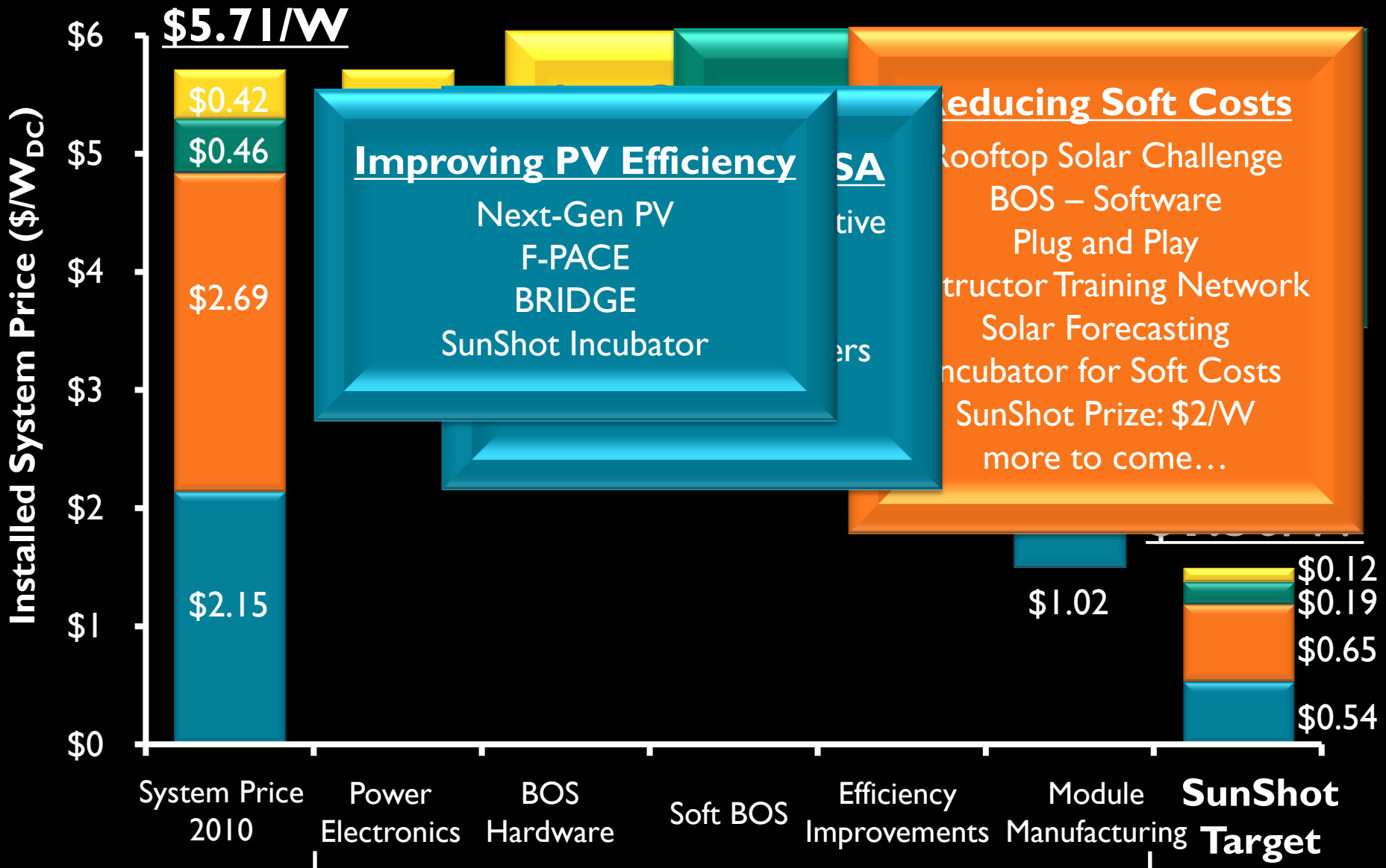
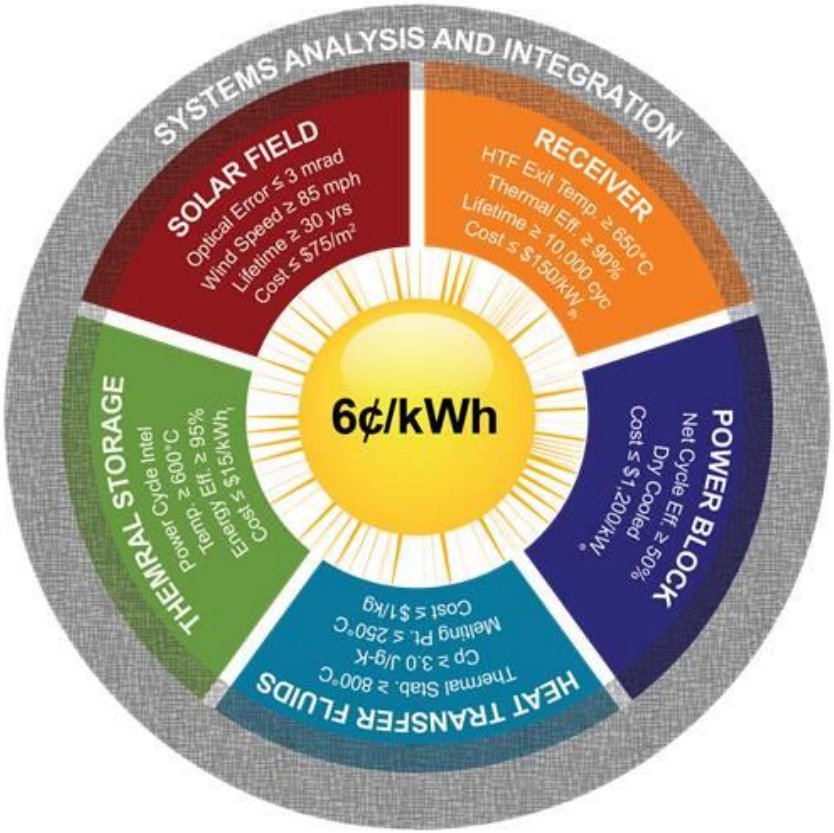
# SunShot Funding Philosophy : PV



# SunShot CSP Focus Areas & Targets

## Deconstructing 6¢/kWh




### Competitive Programs

- CSP: ELEMENTS (2014)
- CSP-HIBRED (2013)
- PREDICTS (2013)
- SolarMat (2013)
- SunShot MURI (2012)
- National Lab R&D (2012)
- BRIDGE (2012)
- SunShot CSP R&D (2011)
- Incubator (Recurring)
- CSP Baseload (2010)
- ARRA (2009)
- Thermal Storage (2008)

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# SunShot Initiative – Solar Grid Parity by 2020

2010 2013 2020

## MAJOR PROGRESS

- 60% progress towards 2020 objectives
- More than 13 GW of Solar on the nation's grid, 4.75 GW added in 2013: 11x growth rate from 2009
- Unprecedented job growth (143k jobs, 20% growth year-over-year)
- SunShot Incubator spurring small business growth, private sector investment: $18 in private follow-on funding for every $1 of DOE investment

## PRIORITY AREAS

- Soft costs reduction: 64% of cost of a residential system
- Grid integration with higher penetration of solar and other renewables
- CSP as an enabling technology for other renewables, thanks to thermal storage: Supercritical $CO_2$ to advance CSP performance
- As part of CEMI, capture a greater portion of the global value add

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# Its all about people…


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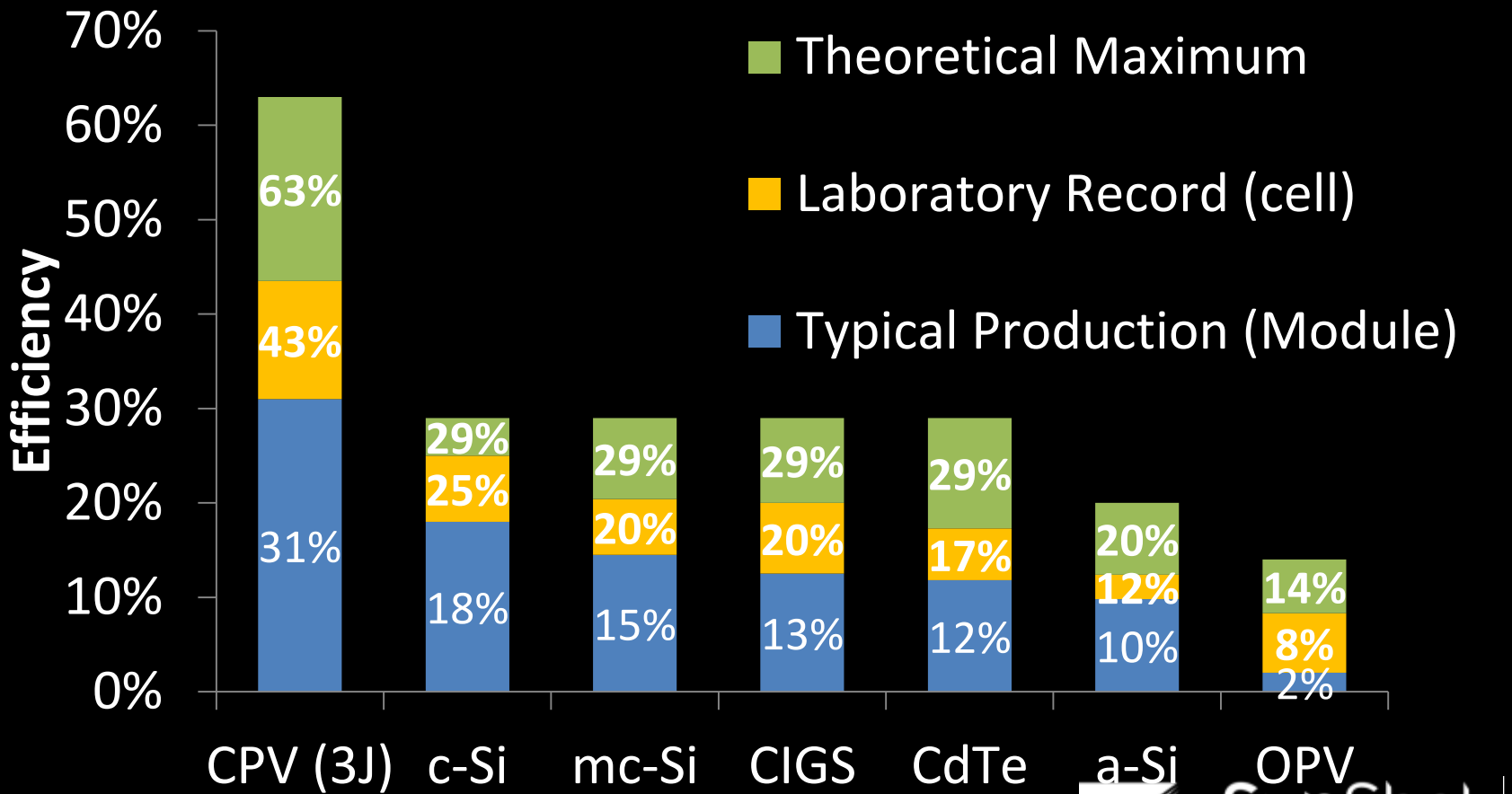
# Active Program Management

- Concept Paper
- Full Applications
- Independent Merit Review
- Rebuttal
- Review Panel Meeting
- In-Person Interviews
- Selection and Award Negotiation
- Project Monitoring

- KEY : Reduce process time by ~50% !!

# Barriers-based investments: Cell and module efficiency

$$\frac{\$}{Watt} \mu \frac{Manufacturing\ Cost}{Efficiency} \rightarrow h \mu J_{SC} \times V_{OC} \times FF$$

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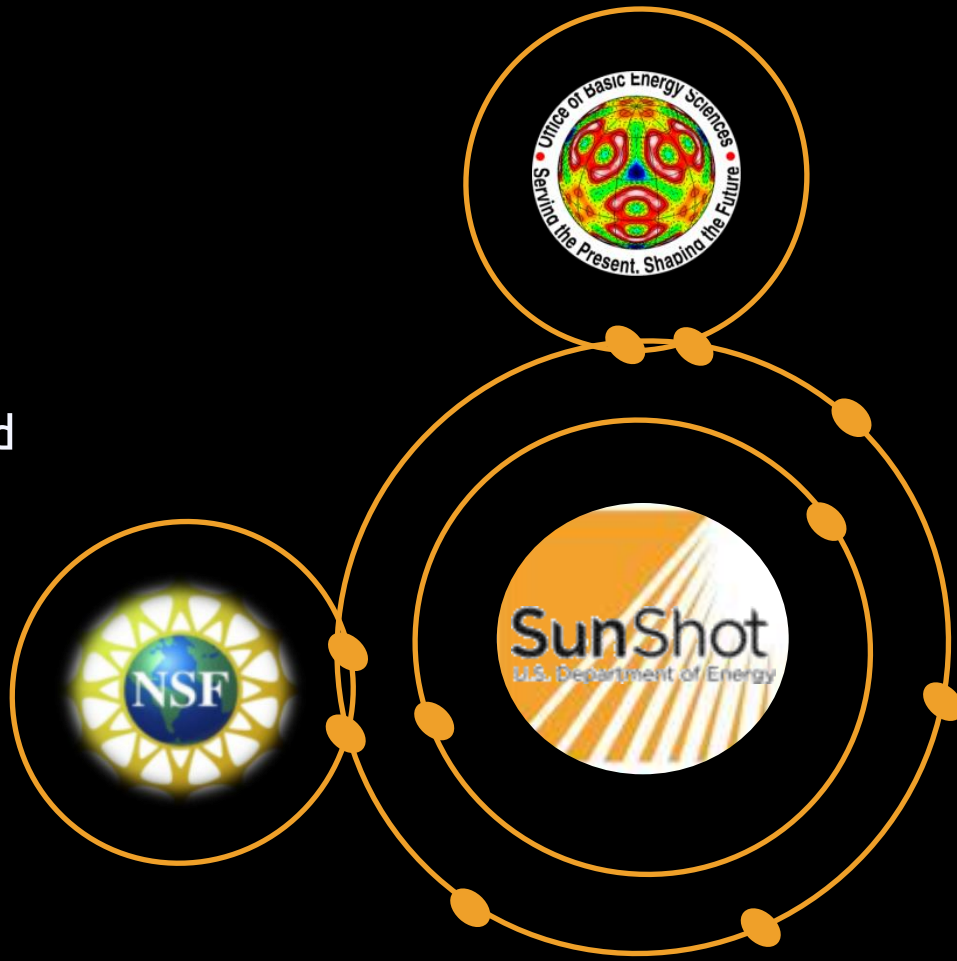
# BRIDGE – Bridging Research Interactions through Collaborative Development Grants in Energy

**Goal:**

- Establish process to usher basic science developed within BES/NSF into applied technologies programs.

**Sources of Basic Energy Research:**

- Chemical Sciences, Geosciences, and Biosciences (CSGB - BES)
- Materials Science and Engineering (MSE - BES)
- Scientific User Facilities (SUF - BES)
- Materials Research (DMR - NSF)
- Chemistry (CHE - NSF)

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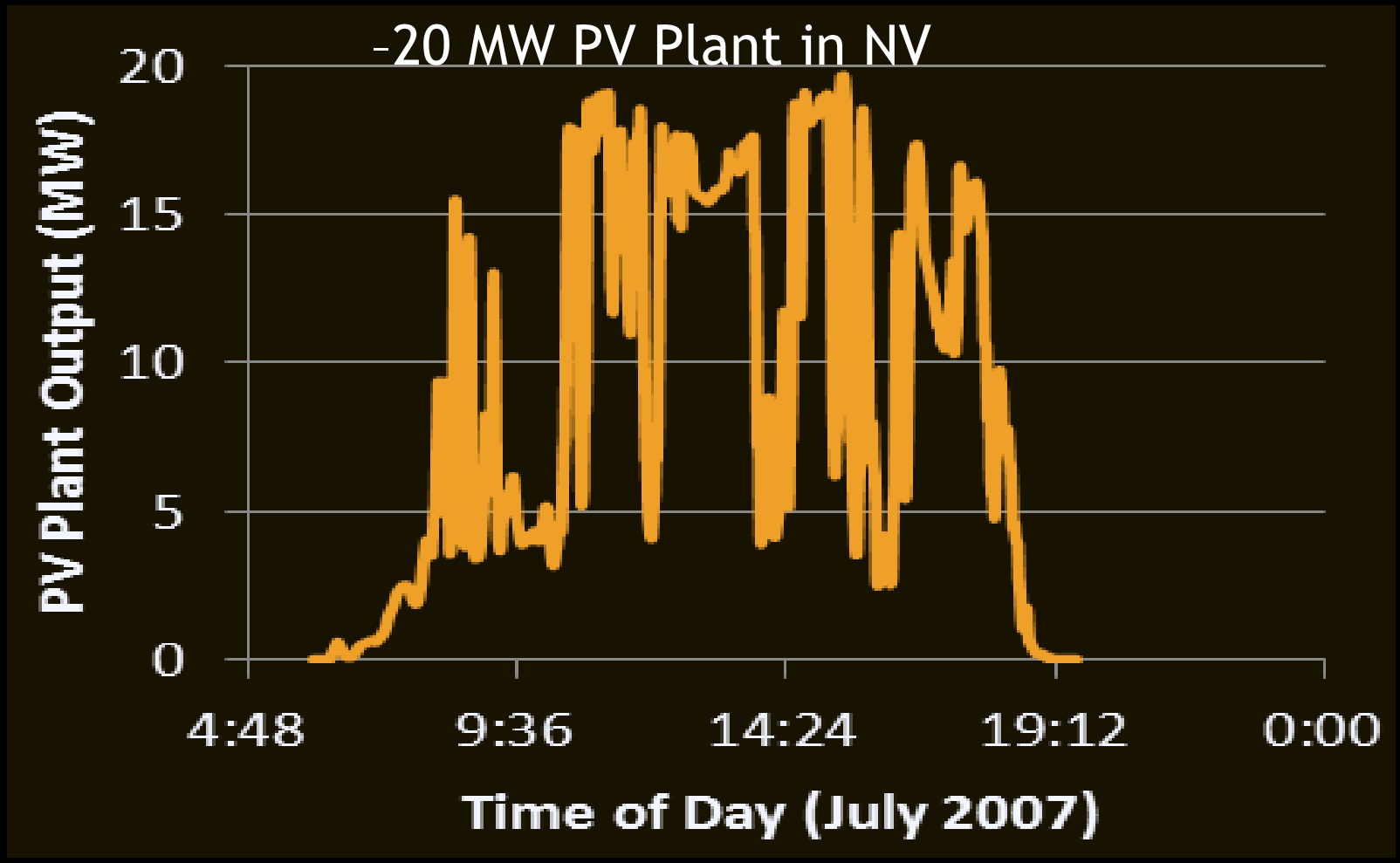
# PV Variability : A Fundamental Problem

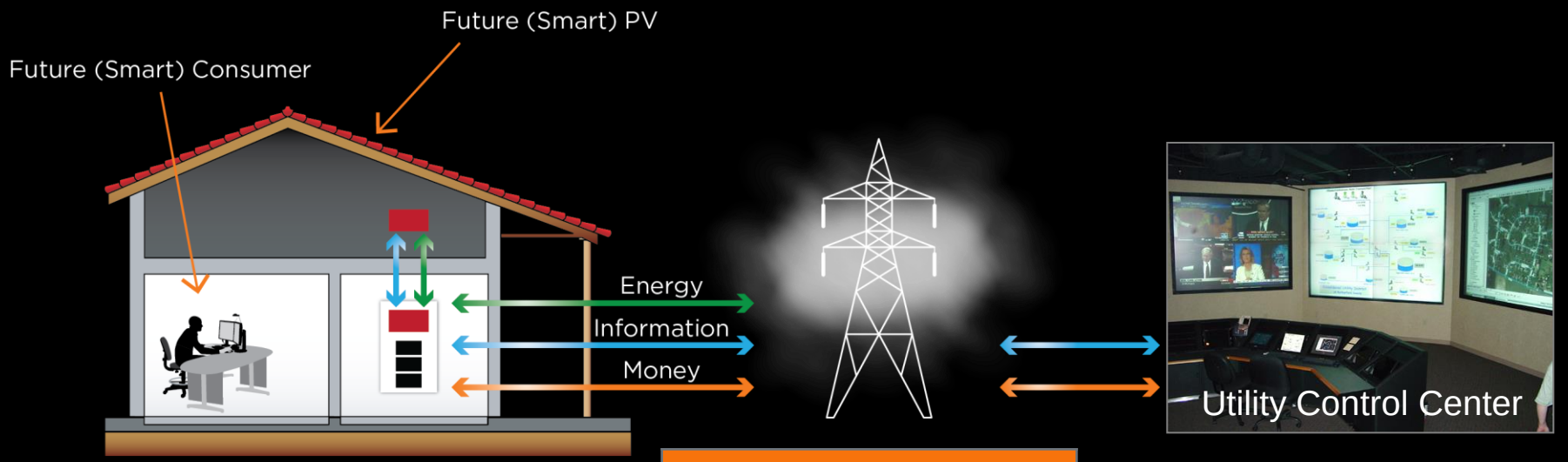



**Forecasting**
**Storage**

# Grid Integration : Plug-and-Play Solar

## Vision : PV as an Appliance

No permitting  Easy installation  Seamless grid integration




### Future (Smart) Home

- Smart outlet
- Smart circuit
- Smart breaker panel
- Smart appliances
- Home area network (HAN)

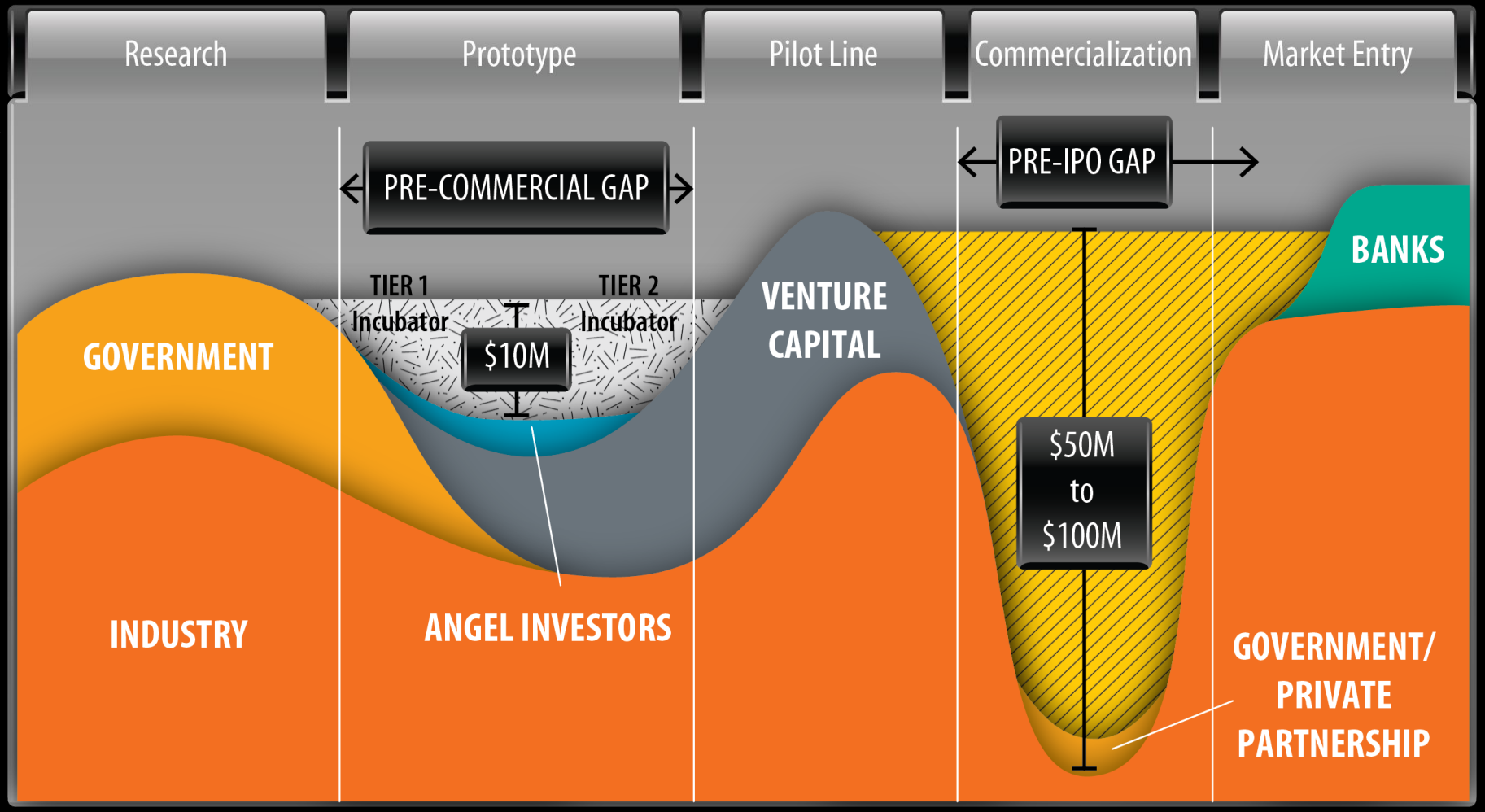
### Future (Smart) Grid

- Distributed generation
- Two-way power flow
- Communication and control
- Rich energy information and transactions
- Microgrid

### Future (Smart) City

- Integrated grid and city planning

# From Science to Technology to Productization

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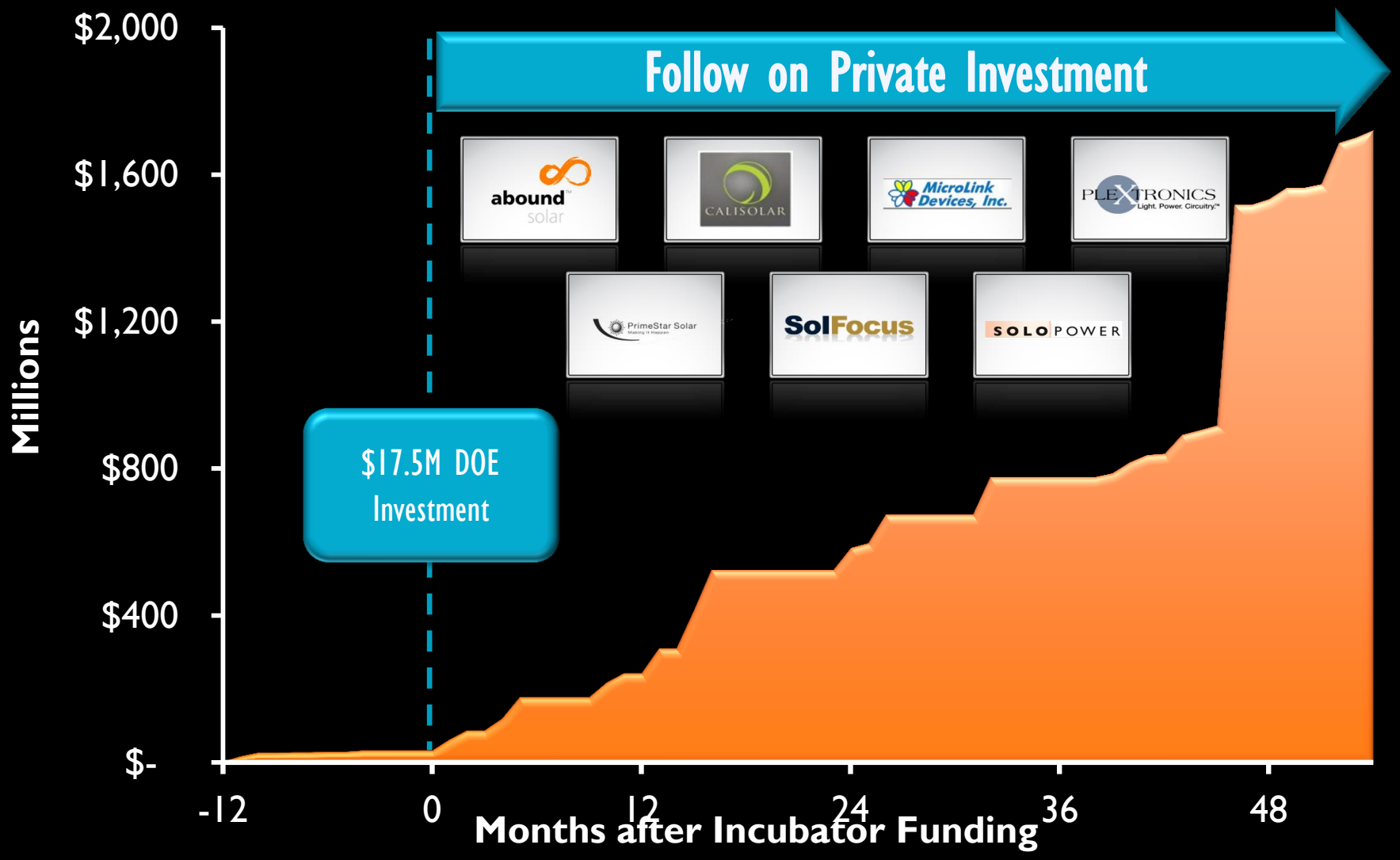
# SunShot Incubator

## DOE funding as Catalyst for Private Investment

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Source: U.S. Securities and Exchange Commission (2012)

# Cheaper Solar Trackers


- One robot replaces 400 tracking motors
- 50% reduction in tracker cost
- Robot manufactured exclusively in the USA
- $1M in DOE funding

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# Manufacturing

"Abandoning today's 'commodity' manufacturing can lock you out of tomorrow's emerging industry."

- Andy Grove, co-founder, former CEO, Intel

# PV Manufacturing Initiative (PVMI)

## Part I

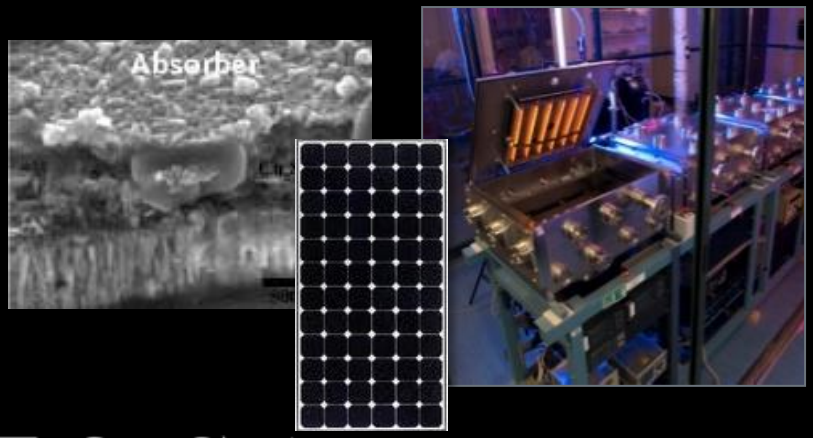
Solving pre-competitive problems common across industry (at pilot line manufacturing R&D)

- University and Industry Consortia
- Cost sharing
- Tools, materials, processes integration

## Part II

Innovative domestic manufacturing processes at scale Regional Test Centers

- Up to $50M over 2 years
- Minimum 3 to 1 cost leveraging

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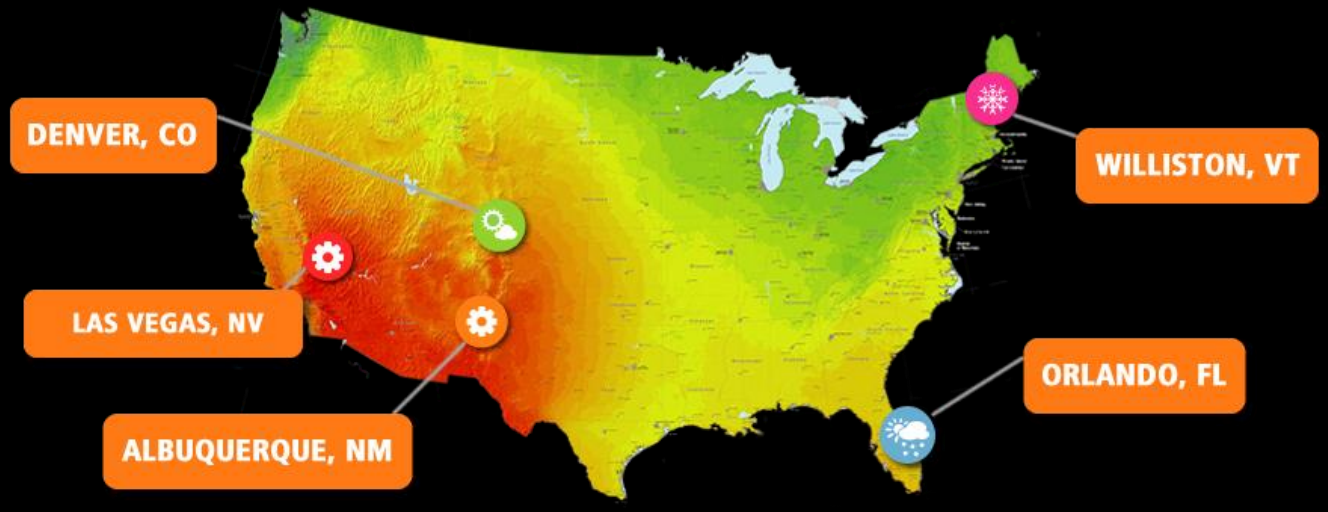
# PV Regional Test Centers

Regional Test Centers
*Differentiating PV Quality*

- **Background / Vision:**
  - Accelerate adoption of renewable energy generation sources by helping U.S. PV manufacturers overcome the commercialization "Valley of Death"
  - Provide technical basis for bankability of PV systems
    - Installation size:
      - Module-level testing: 10-50kW per site
      - System-level testing: 50–300 kW per site
    - Test in multiple climates, using a comprehensive validation approach to compare performance and initial reliability against prediction

- **Locations:**



# Soft Cost :The Critical Issue

"Even if you paid nothing for the hardware, you'd still pay thousands of dollars to install a residential solar power system."

- Former Secretary Chu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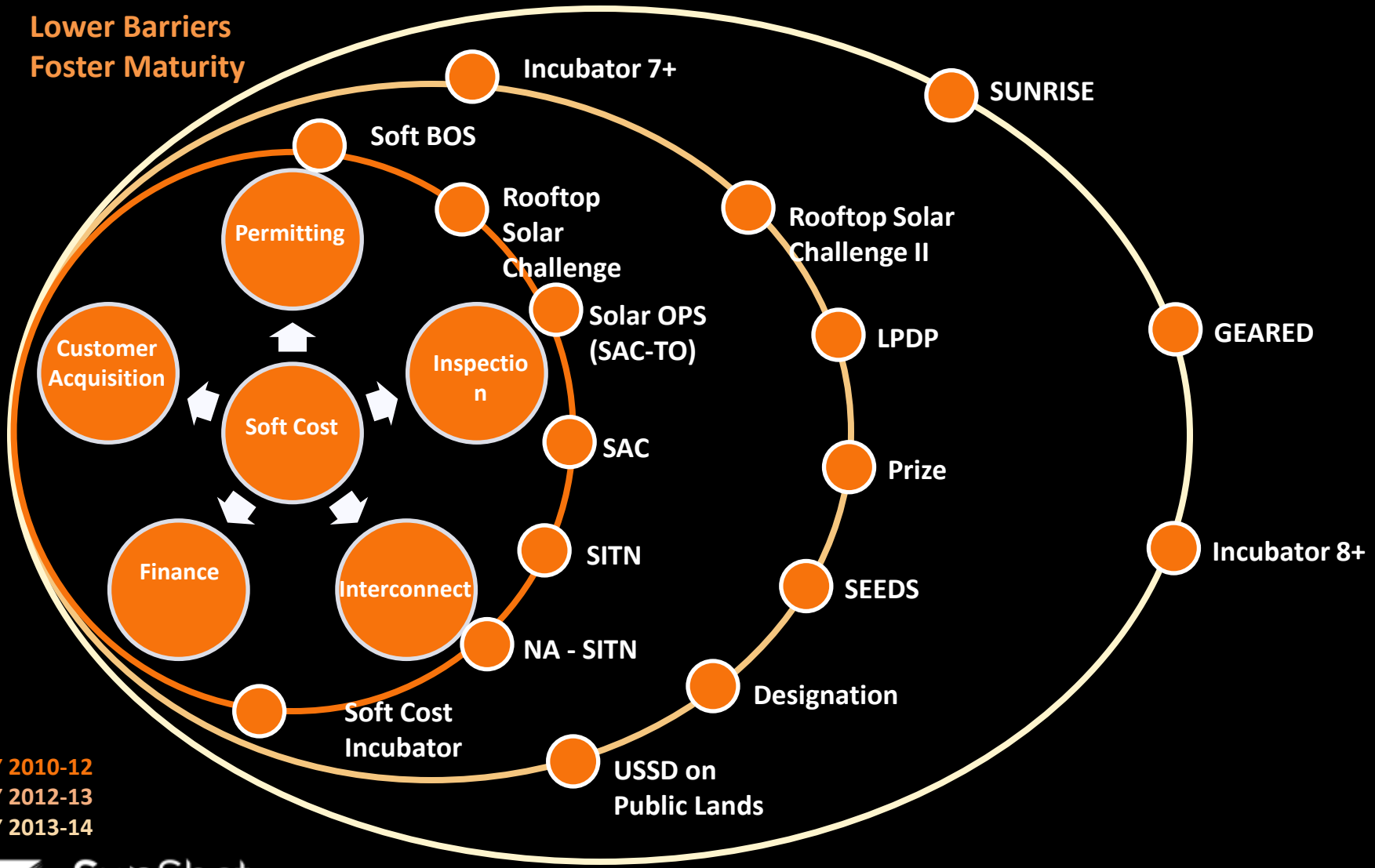
# BOS Multi-Year Approach

- Reduce Soft Cost
- Lower Barriers
- Foster Maturity




FY 2010-12
FY 2012-13
FY 2013-14

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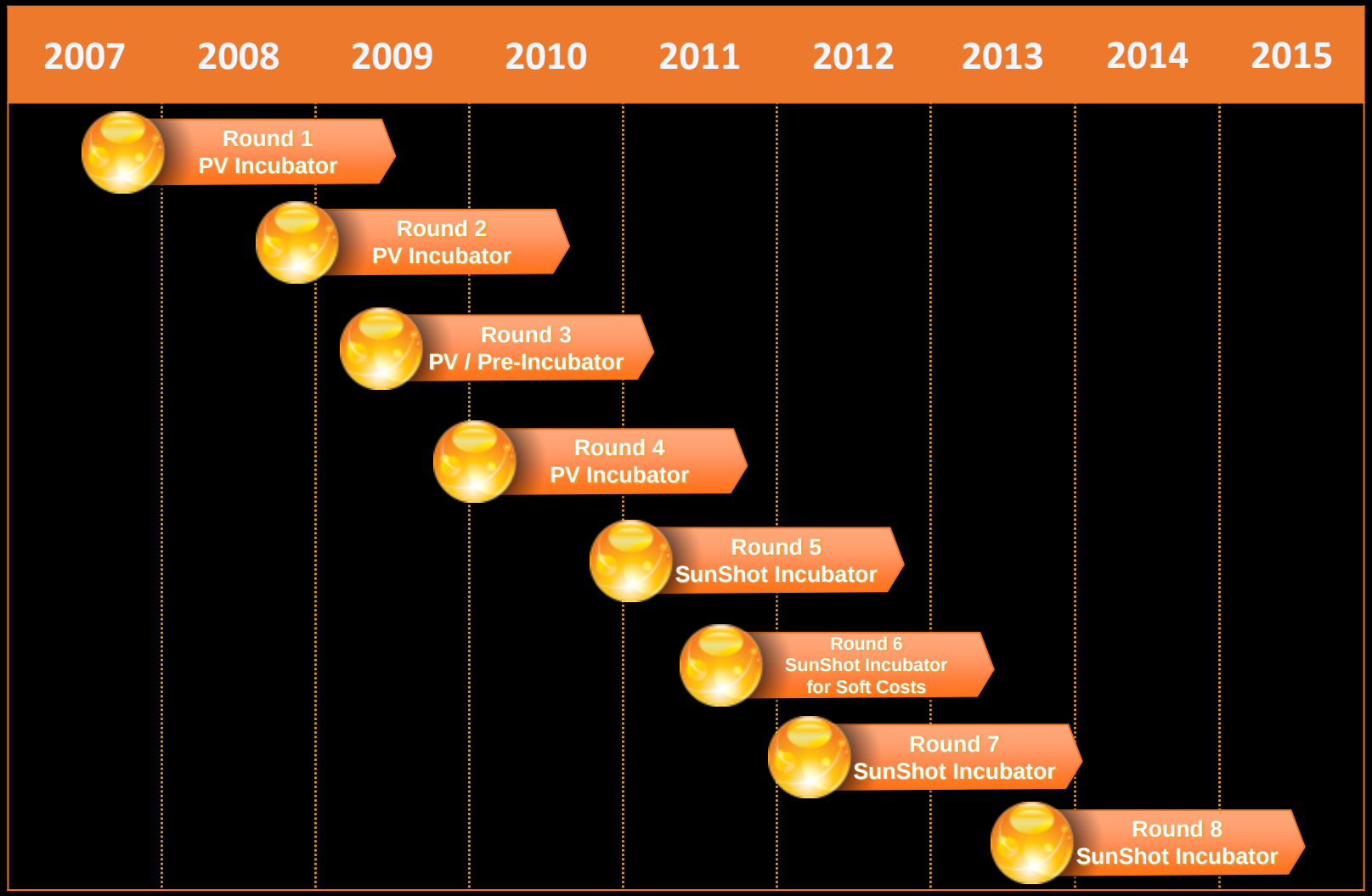
# Sunshot Incubator : Changing the Game

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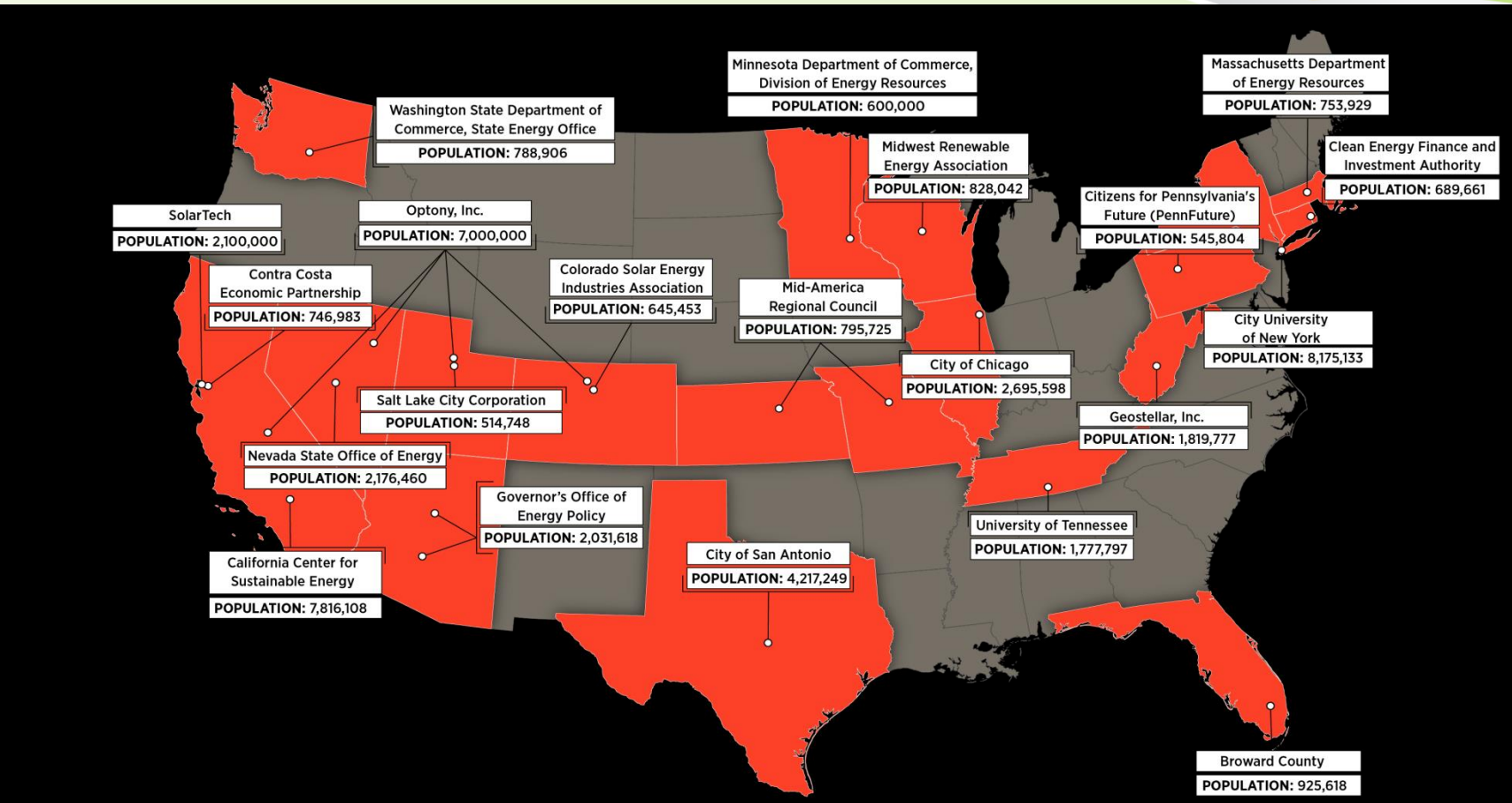
# ROOFTOP SOLAR CHALLENGE

**A national effort to make clean solar electricity cost–effective for your community.**

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America has the opportunity to lead the world in clean energy technologies and provide a foundation for our future prosperity.

We remain the most innovative country in the world … but "Invented in America" is not good enough to guarantee our prosperity.

"Invented in America, Made in America, Sold World-wide"

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