



A Utility Scale PV Perspective on SunShot Progress and Opportunities

Raffi Garabedian

New Bell Solar Battery Converts Sun's Rays Into Electricity

Bell Telephone Laboratories demonstrate new device for using power from the sun

Scientists have long reached for the secret the sun. For they have nearly as

Happy 60th!

the dream of the ages is closer to realitories has come the *Bell Solar Battery*—a device to convert energy from the sun directly and efficiently into usable amounts of electricity. Though much development remains to be done, this new battery gives a glimpse of future frogress in many fields. Its use with transistors (also invented at Bell Laboratories) offers many opportunities for improvements and economies in telephone service.

A small *Bell Solar Battery* has shown that it can send voices over telephone wires and operate low-power radio transmitters. Made to cover a square yard, it can deliver enough power from the sun to light an ordinary reading lamp.

Great benefits for telephone users and for all mankind will come from this forward step in harnessing the limitless power of the sun.

BELL TELEPHONE SYSTEM



SIMPLE AND EFFICIENT—The **Bell Solar Battery** is made of thin, specially treated strips of silicon, an ingredient of common sand. It needs no fuel other than the light from the sun itself. Since it has no moving parts and nothing is consumed or destroyed, the **Bell Solar Battery** should theoretically last indefinitely.



Yuma County, Arizona

Customer: NRG Energy & MidAmerican

Size: 290MW (AC)

Construction Time: 2010-2014

Acres: ~2,400

Modules: ~5 million

"Solar Project of the Year"

— Renewable Energy World



San Luis Obispo County, California

Customer: MidAmerican

Size: 550MW (AC)

Construction Time: 2011—2015

Acres: ~7,800 site

Modules: ~9 million



Cars Removed:

73,000



Tons CO₂ Displaced Annually:

377,000

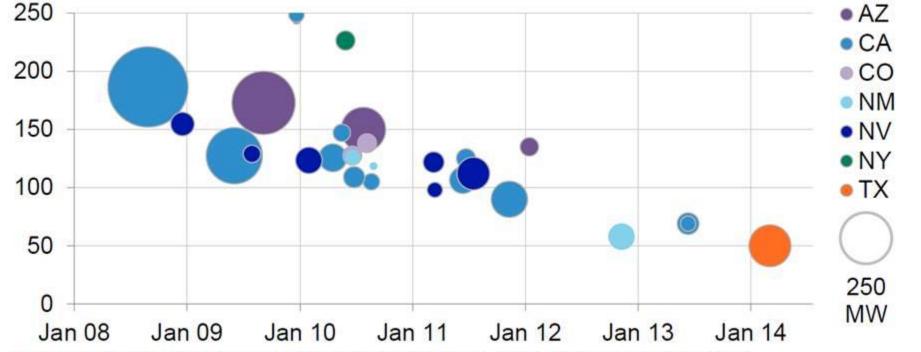
TOPAZ SOLAR FARM

U.S. Utility Scale Installations (MW)



US SOLAR PPA PRICES BY SIGNING DATE

H1 2008 - H2 2013 (\$/MWH)



Note: Does not include PPAs under 5MW. 'PPA price' is calculated as the average offtake price over the period of project operation. For projects reporting to FERC, the PPA price is calculated as the average selling price over the operating history of the project. For projects not reporting to FERC, the PPA price represents the 'year1' selling price.

Bloombera / / /

Michael Liebreich

BNEFSummit 2014

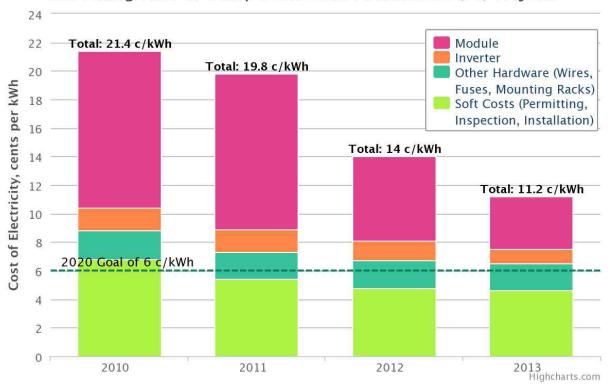
Twitter: @Mliebreich #BNEF2014

Source: Bloomberg New Energy Finance, FERCE SNEF2014 31

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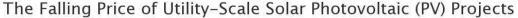
The Audacious Goal of 6c/kWh by 2020

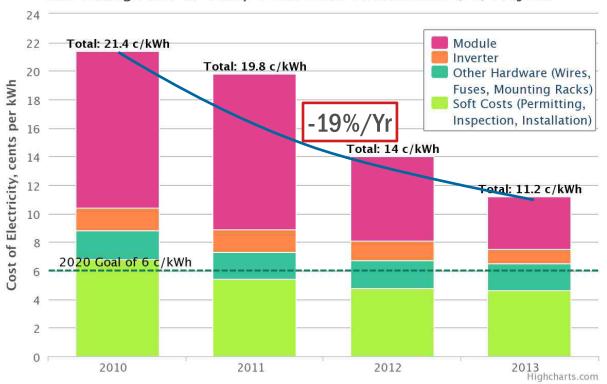




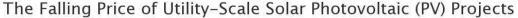
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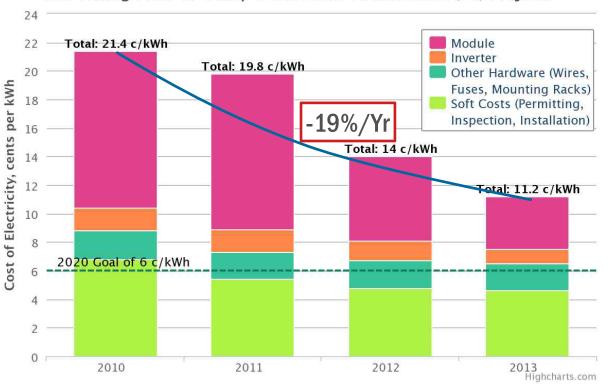
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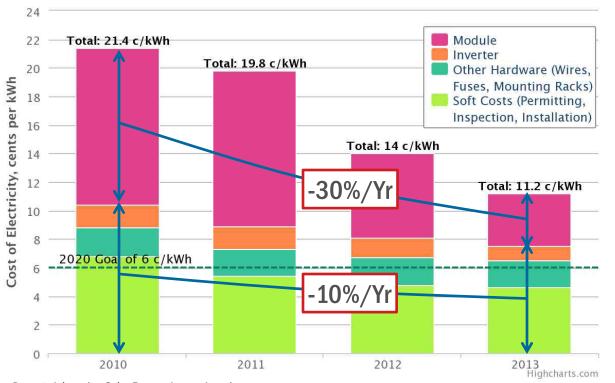




Total: 6 c/kWh

Where are the Gains Coming From?



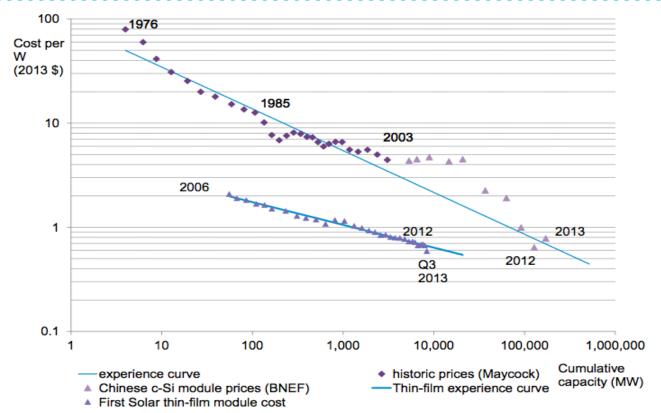


Total: 6 c/kWh

2016

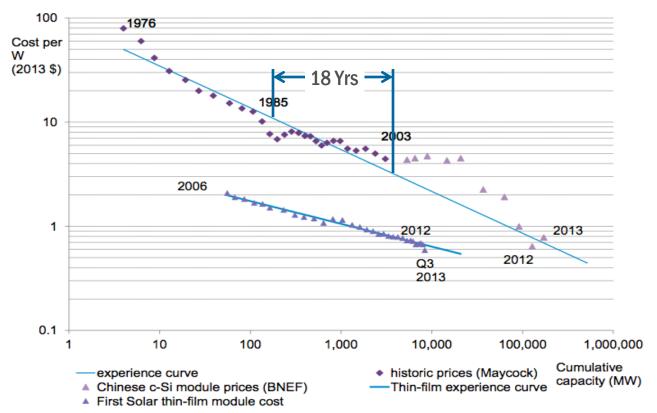
From: Feb. 2014 DOE Progress Report: Advancing Solar Energy Across America Data courtesy of National Renewable Energy Lab. Chart by Daniel Wood.

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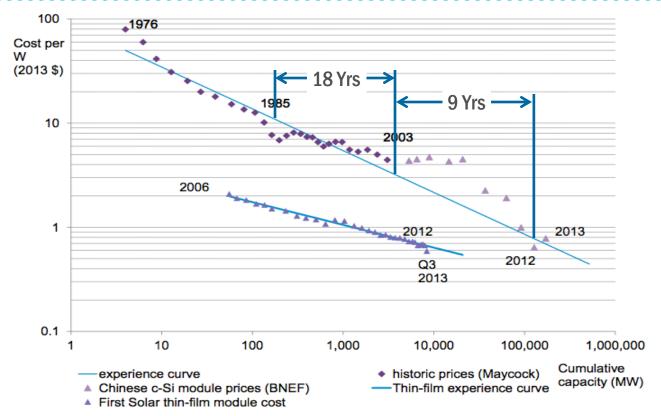
Note: Prices inflation indexed to US PPI.

Source: Paul Maycock, First Solar, Bloomberg New Energy



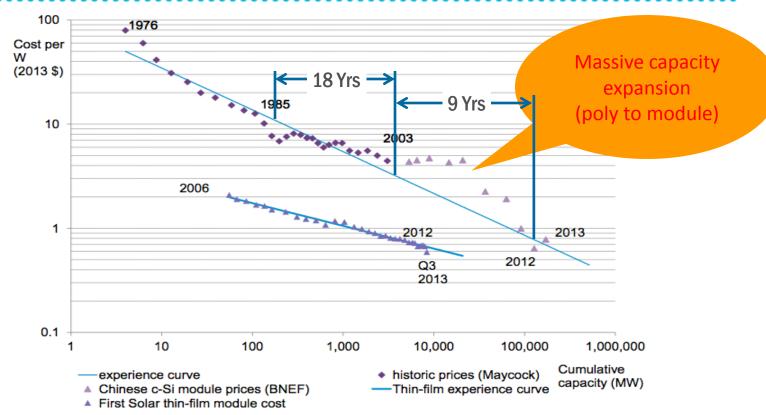
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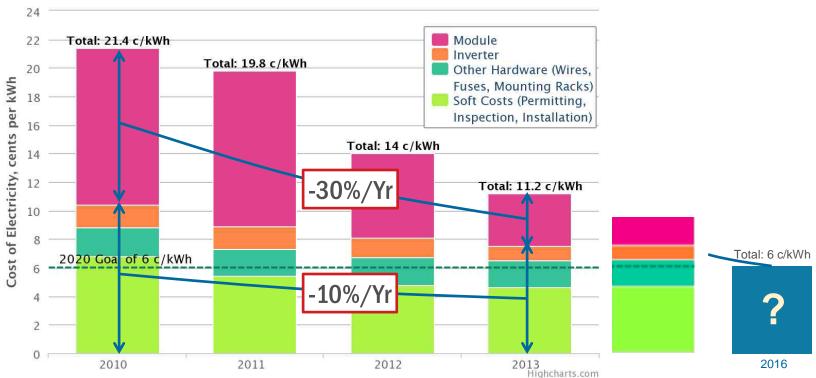


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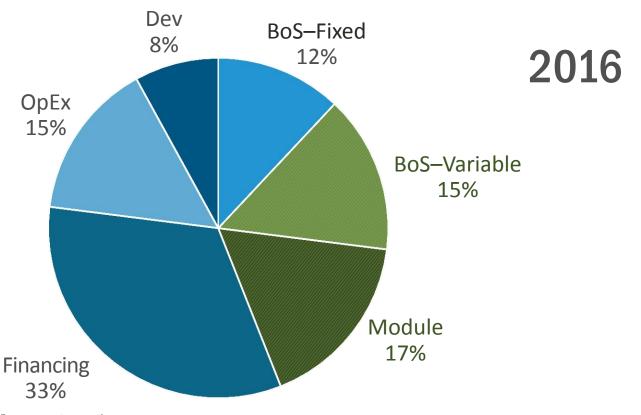
Where are the Gains Coming From?

The Falling Price of Utility-Scale Solar Photovoltaic (PV) Projects

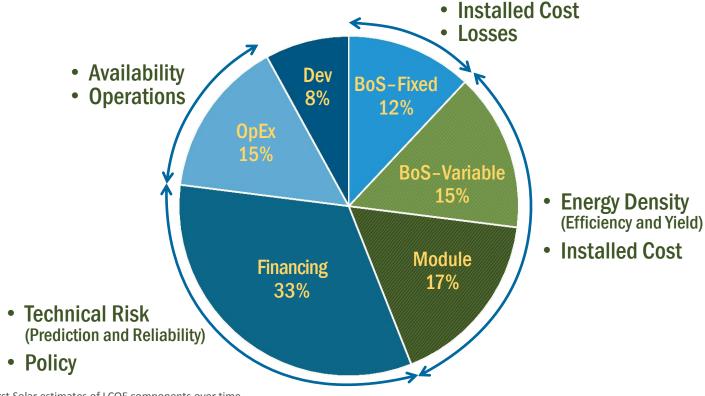


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Variable Components of LCOE

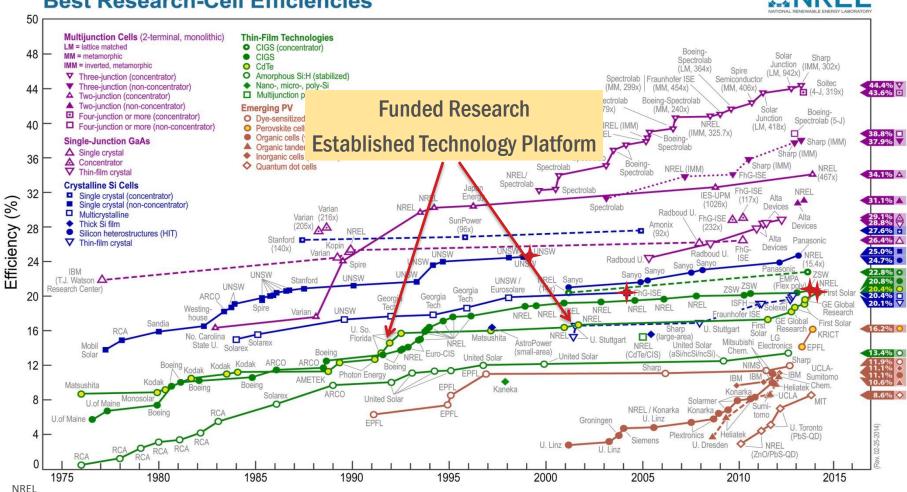


Which Opportunities Should we get EXCITED About?



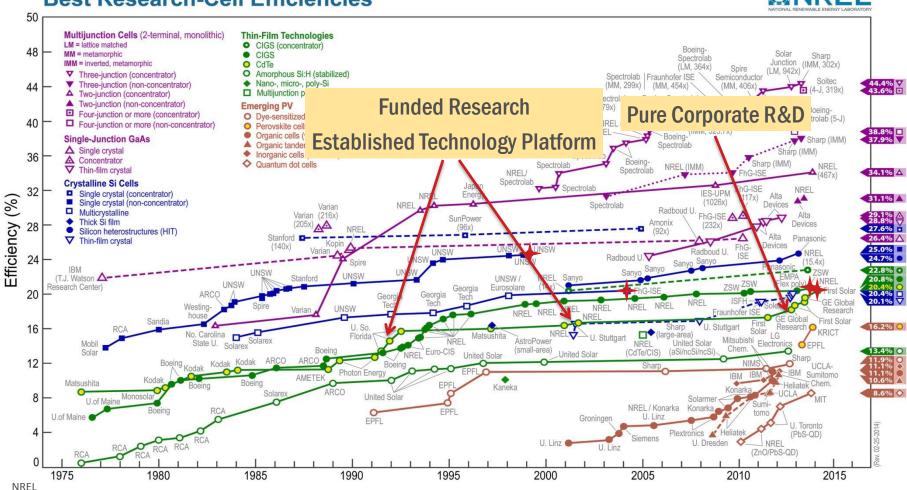
Best Research-Cell Efficiencies



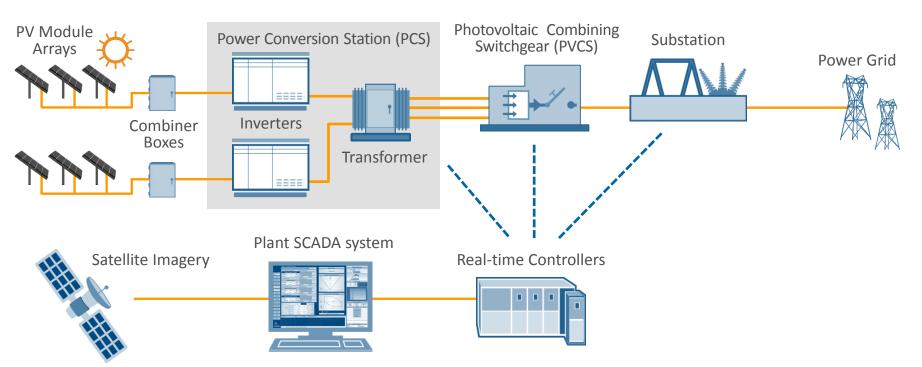


Best Research-Cell Efficiencies





Opportunities for Innovation Abound



What Works - from an Industry perspective?

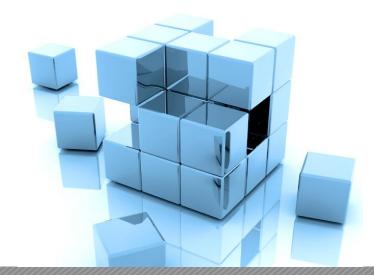
- Basic science at Universities and National Labs
 - The seeds of technology innovation take patience to nurture (not what we're good at)
- Support for radical and disruptive concepts (high risk, high reward)
 - Cost share and infrastructure support to entrepreneurs and innovators
 - Goals must be fundamentally disruptive, not incremental
- Independent validation to reduce perceived risk (and resulting FINANCE COSTS)
 - Testing and evaluations
 - Well designed technical standards
- Demonstrations addressing constraints to adoption
 - Projects showing that perceived integration risks can be addressed





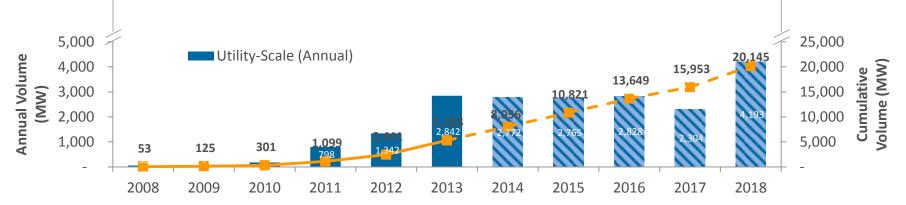
What Doesn't Work - from an Industry perspective?

- Incremental goals and innovation should be left to the private sector
 - Let the market work
- Localization of manufacturing is driven by state and national industrial policy, not technology
 - Competition for jobs is global
 - Technology can kick-start, but not sustainable
- The "Red Light, Green Light" game
 - Business and science both need predictability



10% of Total Generation Capacity

OPPORTUNITY!



Source: IHS Global, Projects 5MW and higher are considered Utility Scale

THANK YOU



Creating enduring value by enabling a world powered by clean, affordable solar electricity.





