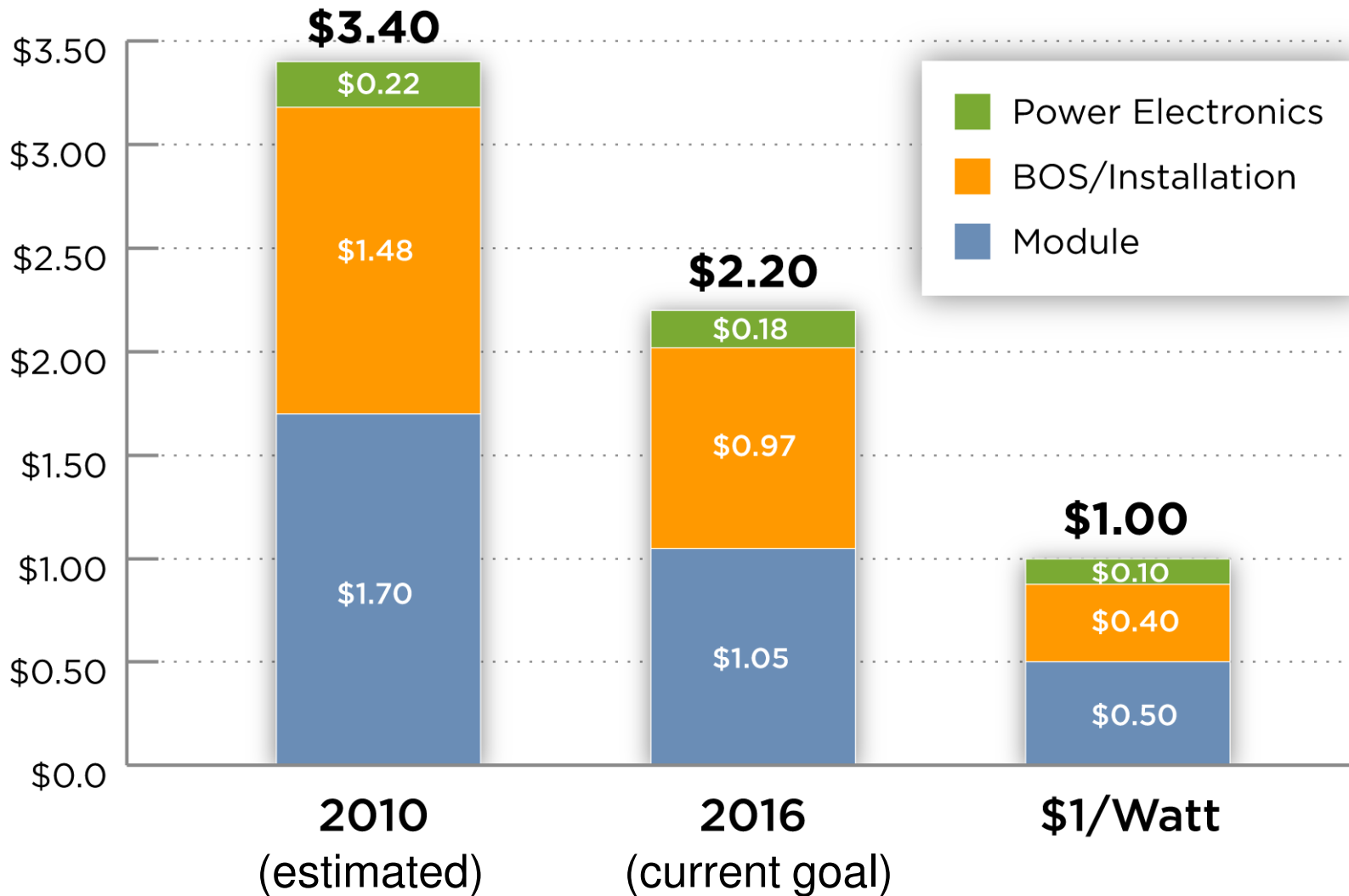
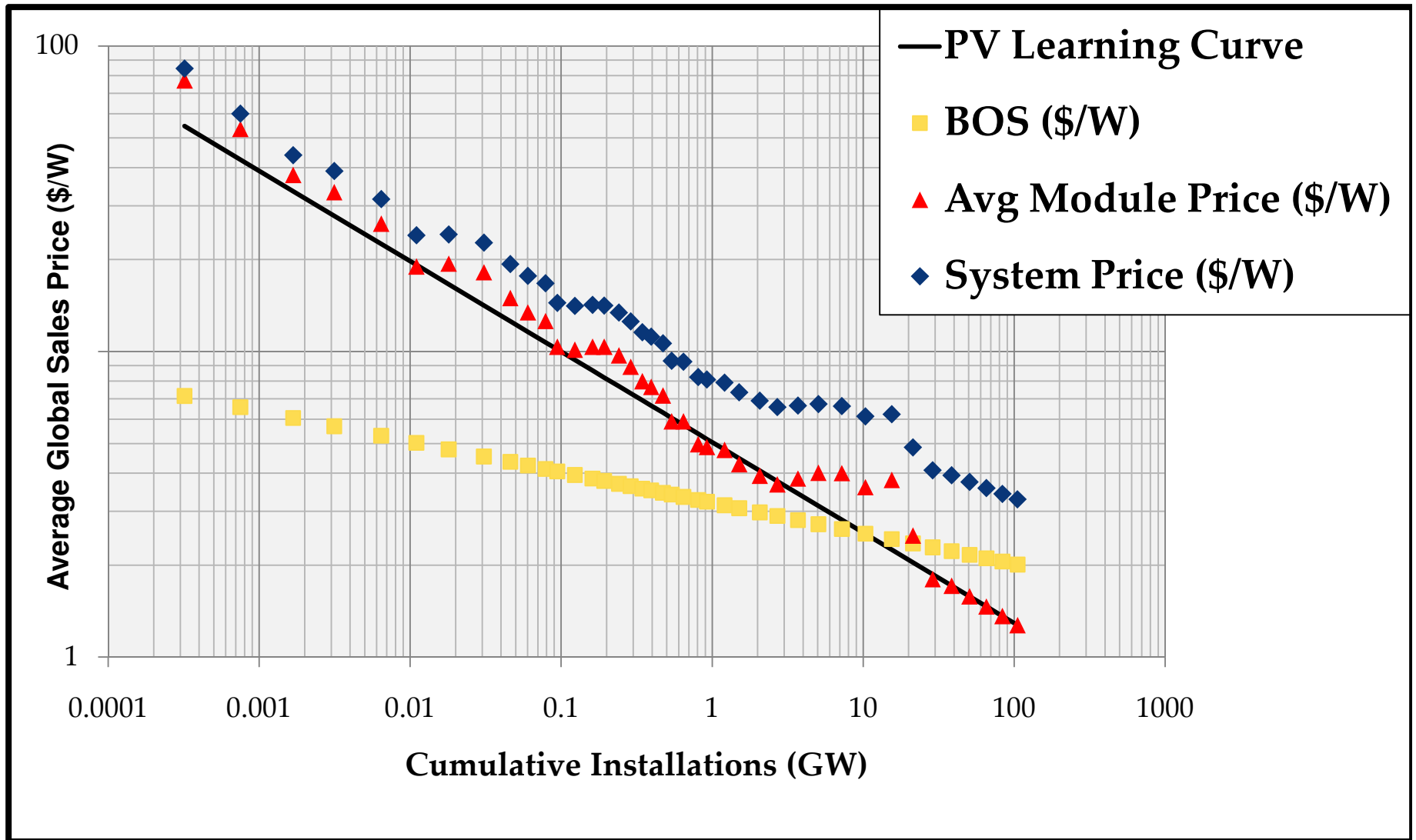


Reaching cost reduction targets will require advances in all PV system components

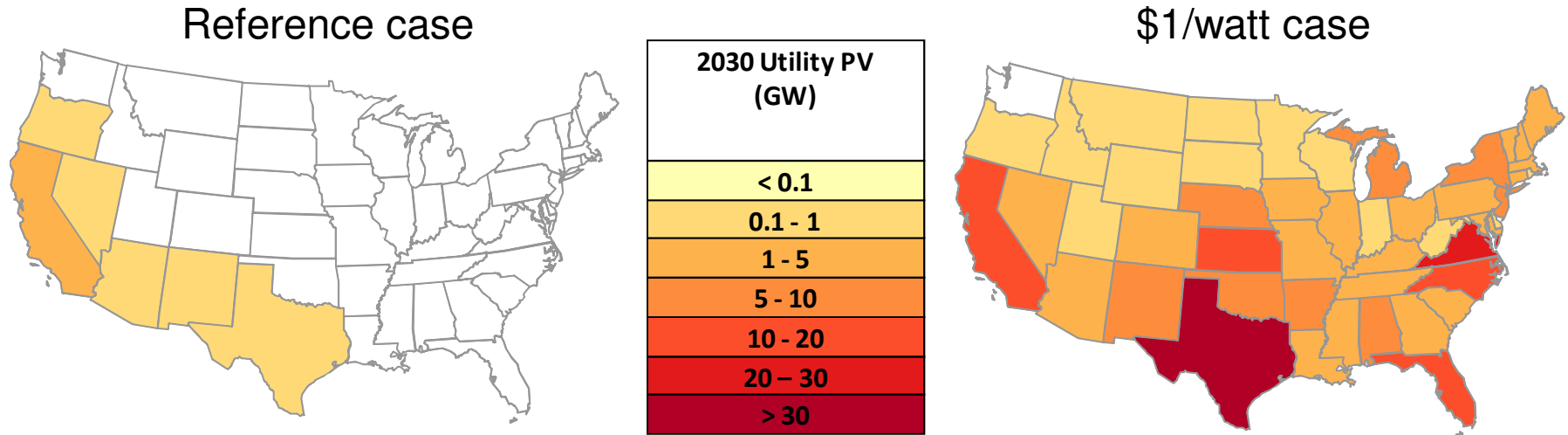


Utility System (Non Tracking) Cost Example

Learning rates for PV systems will decrease as Balance of Systems costs begin to dominate total installation price.



A \$1/watt fully installed photovoltaic solar energy system – equivalent to 5-6 cents/kWh – would be a game-changer



NREL: At \$1/watt, PV would be 14% of U.S. electricity by 2030, with minimal need for storage or additional transmission

Utility PV: LCOE Targets

Financing Conditions

- Low: 8.2% after-tax WACC
- High: 9.9% after-tax WACC

Geographic Locations

- Phoenix, AZ
- Kansas City, MO
- New York, NY

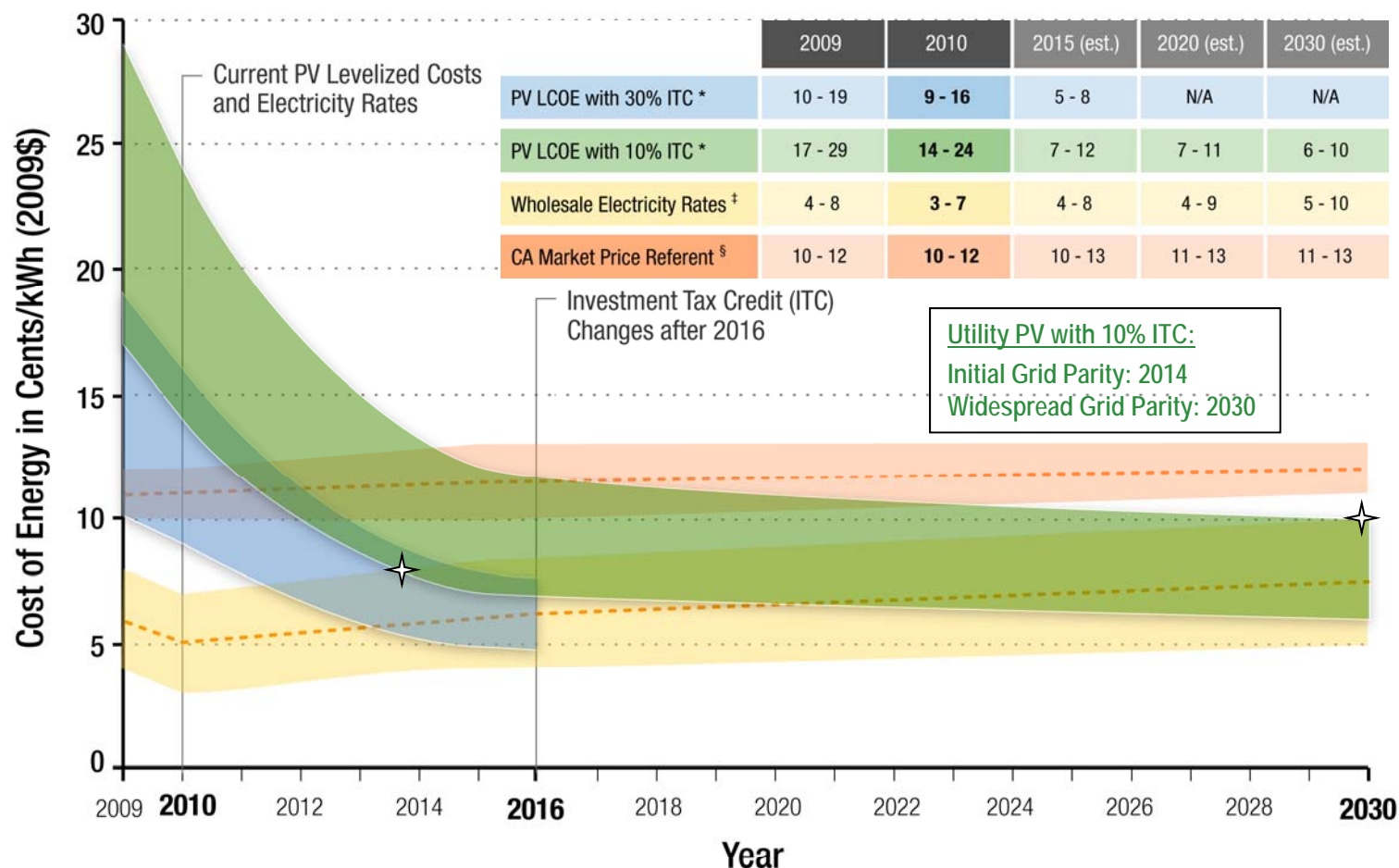
2015

- With the 30% ITC, PV is broadly competitive with wholesale electricity rates under all conditions
- With the 10% ITC, PV is equal to or below the CA MPR under most conditions and competitive with high wholesale electricity rates under the best insolation and financing conditions

2030

- With the 10% ITC, PV is broadly competitive with wholesale electricity rates under all financing and insolation conditions

Utility PV



* Assumes IOU or IPP ownership of PV, and thus the LCOE includes the taxes paid on electricity generated. Includes 5-year MACRS but not state or local incentives. The range in utility PV LCOE is due to different insolation and financing conditions. For a complete list of assumptions, see DOE Solar Cost Targets (2009 – 2030), in process.

† The electricity rate range represents one standard deviation below and above the mean U.S. wholesale electricity prices.

§ The 2009 CA MPR includes adjustments by utility for the time of delivery profile of solar (low case: SDG&E, mid case: PG&E, high case: SCE).

Residential PV: LCOE Targets

Financing Mechanisms

- Home Mortgage (80% financing, 6.0% interest, 30-year term)
- Home Equity Loan (100% financing, 7.75% interest, 15-year term)

Geographic Locations

- Phoenix, AZ
- Kansas City, MO
- New York, NY

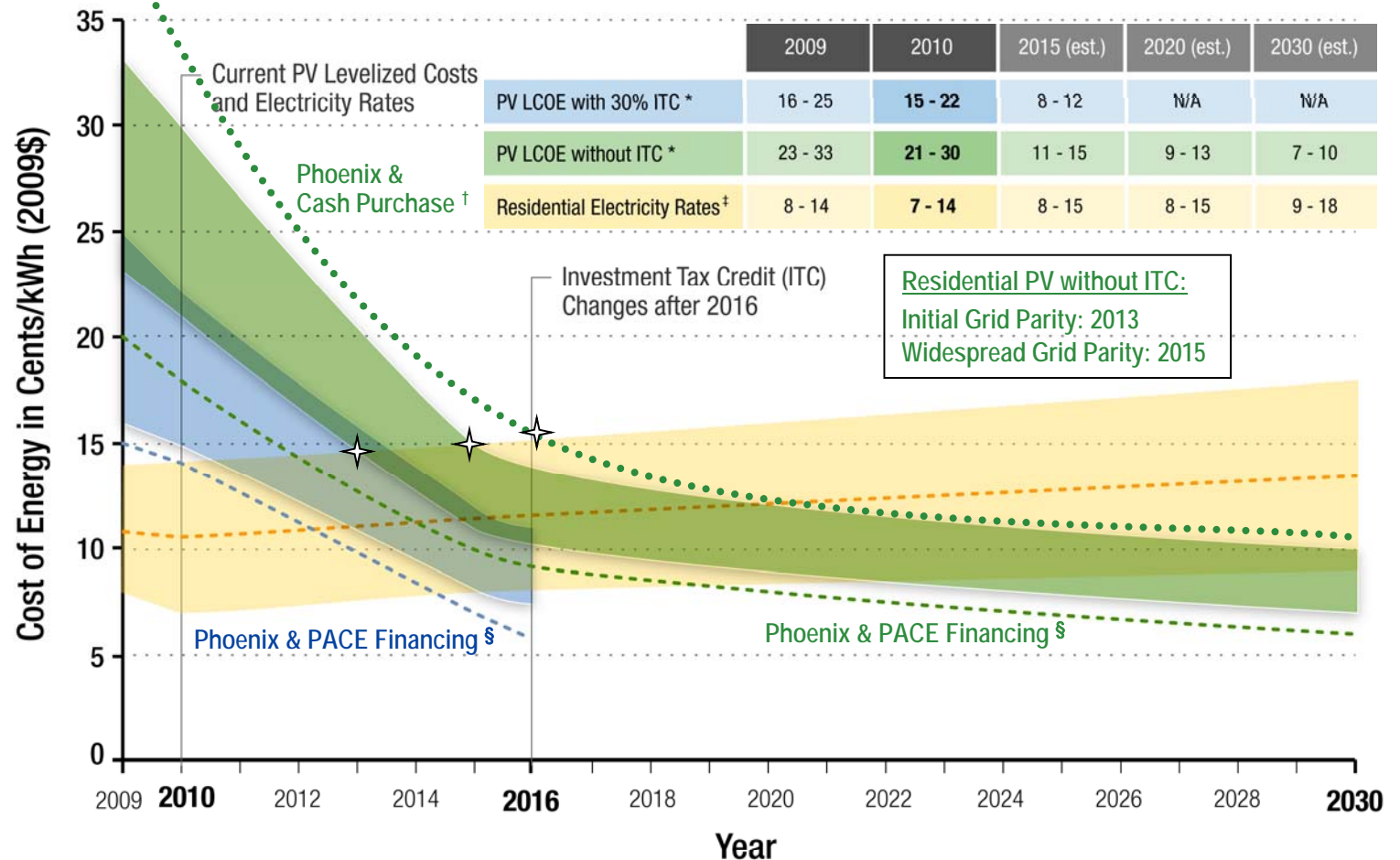
2015

- Without the ITC, PV is broadly competitive with residential electricity rates under all financing and insolation conditions

2030

- Without the ITC, PV has levelized costs that are lower than most residential electricity rates

Residential PV



* No state, local or utility incentives are included. The range in residential PV LCOE is due to different insolation and financing conditions. For a complete list of assumptions, see DOE Solar Cost Targets (2009 – 2030), in process.

† The electricity rate range represents one standard deviation below and above the mean U.S. residential electricity prices.

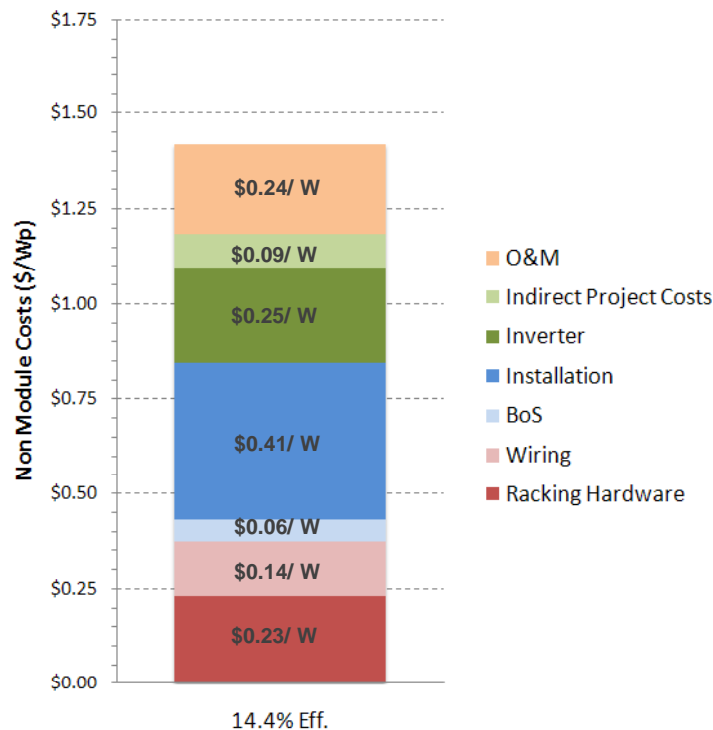
§ Property Assessed Clean Energy (PACE) Financing assumes 100% financing at 5.0% interest with a 20-year payback schedule

† Cash purchase assumes a discount rate of 9.2% (nominal), equal to the long term return on the S&P 500

Non-Module Solar PV Installation (BoS) Costs

Non Module Utility Scale Solar PV System Costs

20 MW Fixed axis Ground Mount System, Includes: O&M, Inverter



- Glass module installation costs burdened by disaggregate systems (number of components)
 - Integrate components at factory?

'Installation' labor:

- Nearly 75% of labor hours skilled
 - Electrician wage premium
 - Grid connect, wiring, power, other electronics

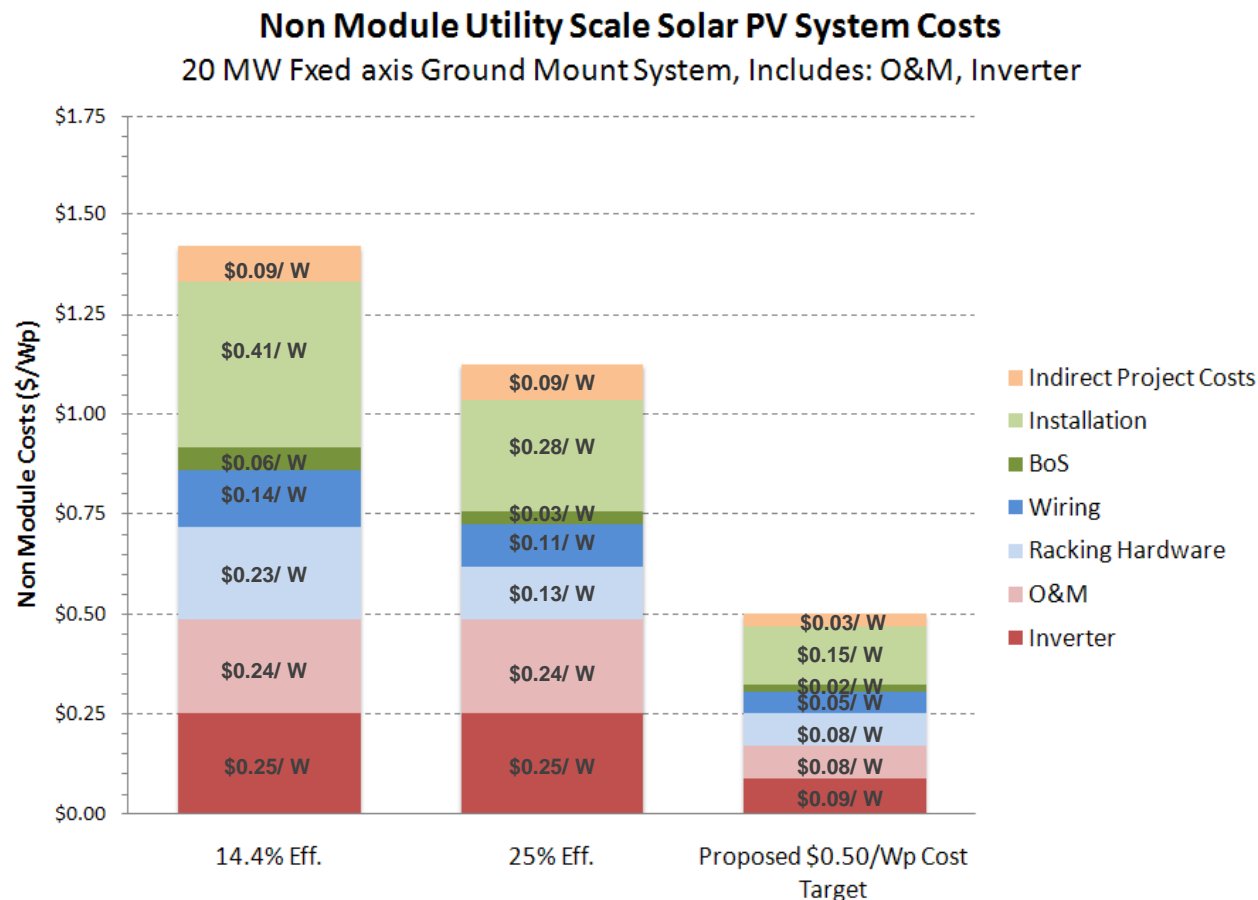
'O&M' costs: reliability

- Inverter reliability, repair costs
- System monitoring and preventative maintenance

'Indirect Project Costs' vary:

- Environmental review: \$100K, up to \$1 MM and 2 years
- Land prep.: <\$0.10/Wp, depending on site selection
- Transmission interconnect: \$1.0-\$1.5 MM, up to \$80 MM (prohibitive)

Utility Scale Solar PV: Non Module Costs

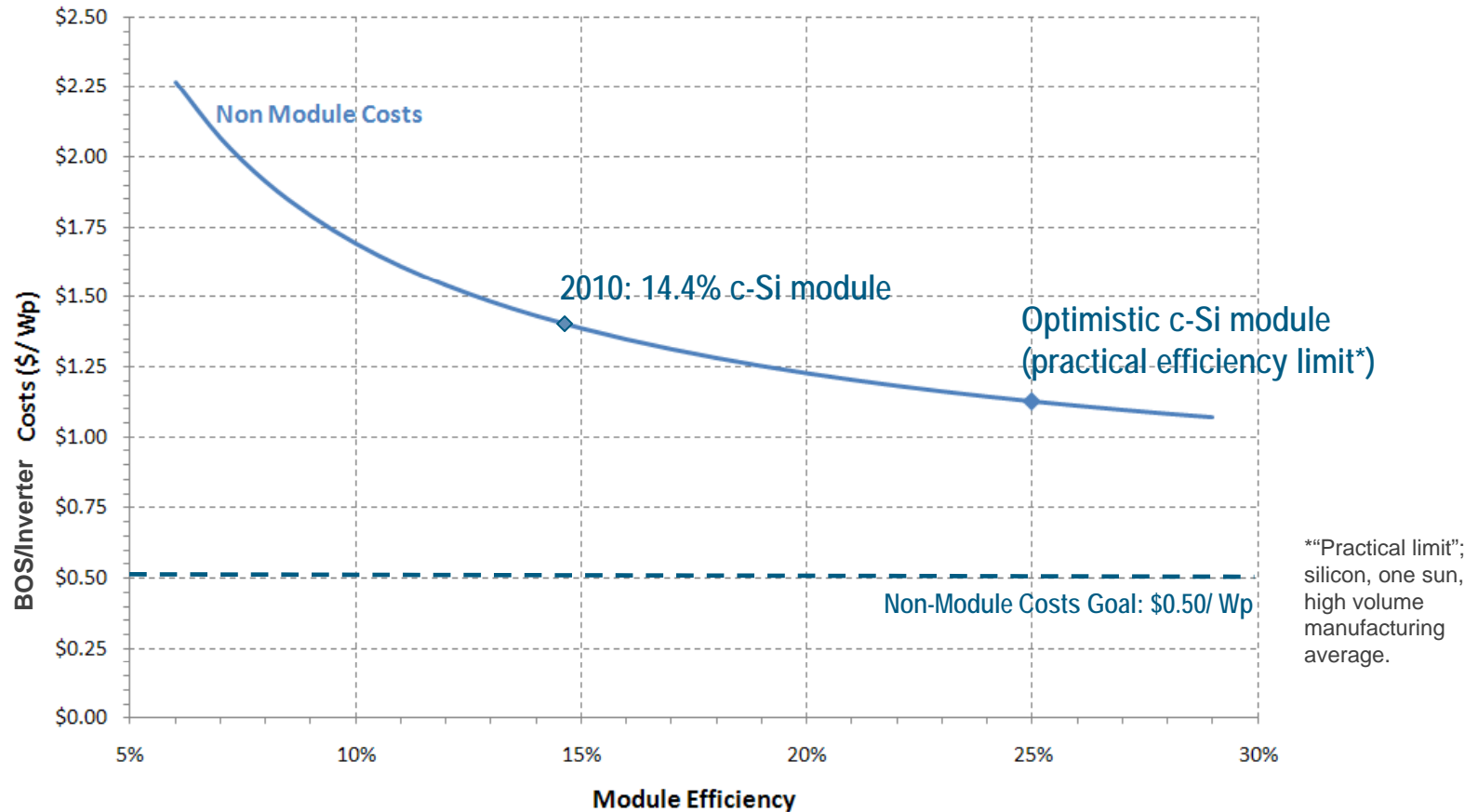


Relative to the 25% module efficiency scenario, the \$0.50/Wp system must:

- Reduce fixed power costs (Inverter, O&M) by 66%
- Trim (short, long) wiring costs (content) and installation by 50%
- Decrease racking hardware, BoS components by 33%

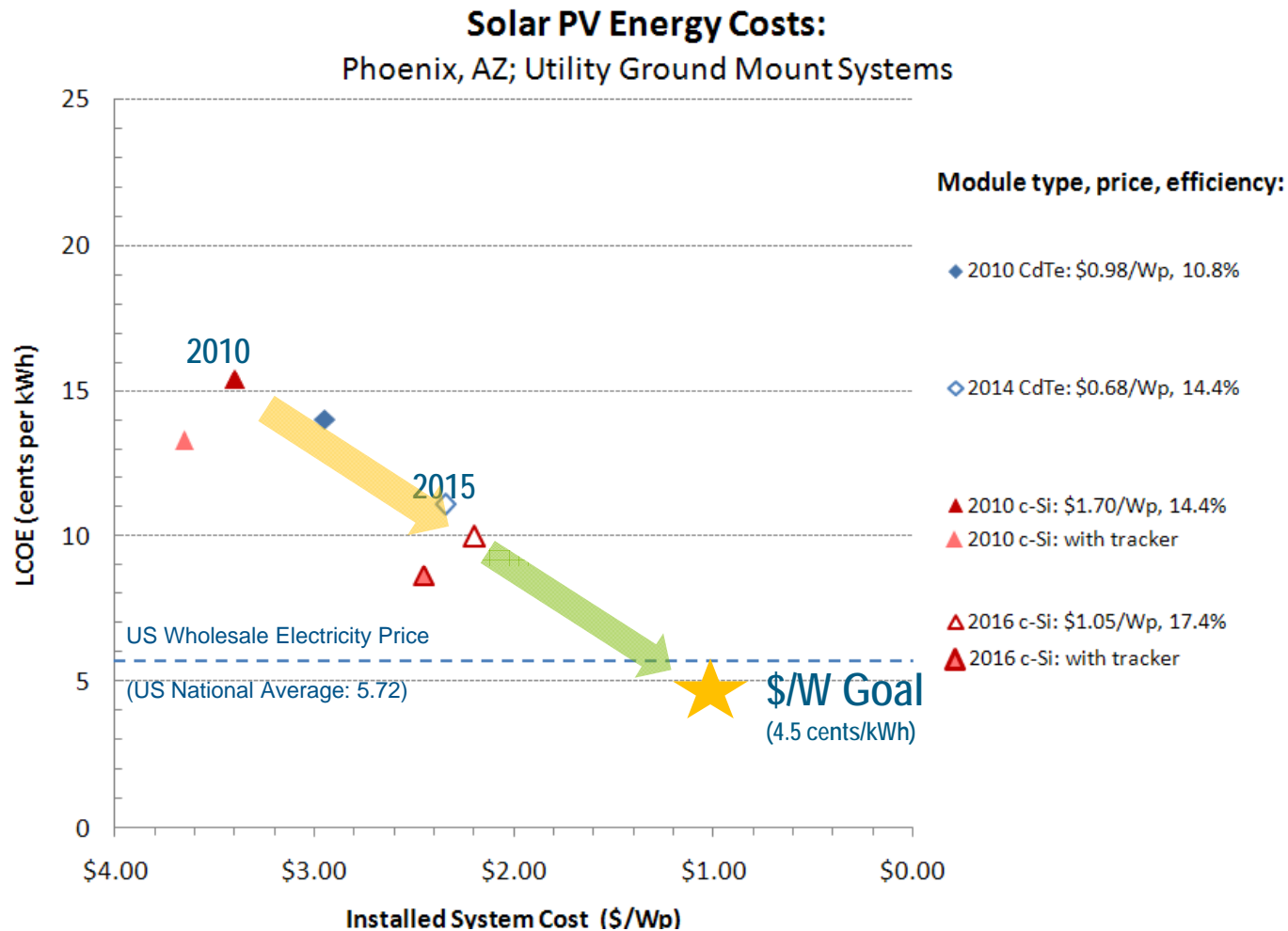
Non Module Cost-Sensitivity to Efficiency

Non Module Utility Scale Solar PV System Costs
20 MW Fixed axis Ground Mount System, Includes: O&M, Inverter



- Module efficiency alone is not adequate to achieve grid parity (non-module costs exceed \$/W at practical limit; 25%)

Solar PV Energy Costs: Current and Projected, Leading Technologies



- Unsubsidized Solar PV energy costs will remain >50% higher than US wholesale average (optimal solar resources)

- History of module cost reduction may not continue to be extrapolated
- Cost target for broad (unsubsidized) US adoption likely requires revolutionary technical innovations
 - Module cost and performance
 - Power electronics efficiency and reliability
 - BoS, installation costs
- Focus on high cost electricity markets may reduce the incentive for such industrial investments
- Success in the US market at \$1/W will enable US companies to lead in other regions of the world

Thank You



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