America's Smartland Series: Integrating Solar Energy

MGA

America's Smartland

Midwestern Governors Association

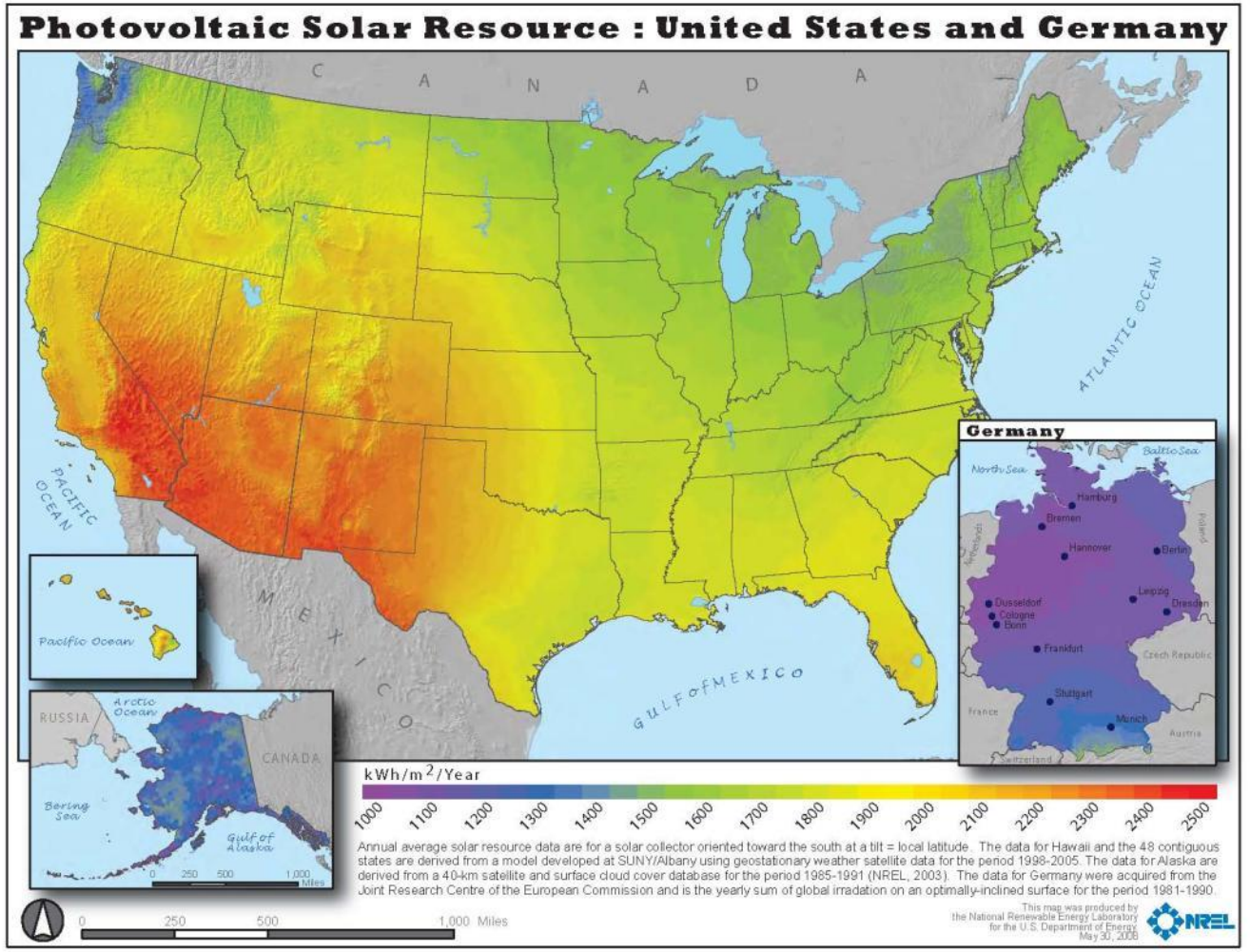
Solar 101: Foundational Information

- **Understanding solar resources**
- **Solar markets and value propositions**
- **Evolution of solar energy, current trends, market forecasts**
- **Considerations for policy decision-making**
- **Grid modernization**

Solar Resources . . .

Solar resources, as measured by solar insolation, vary considerably across the U.S.

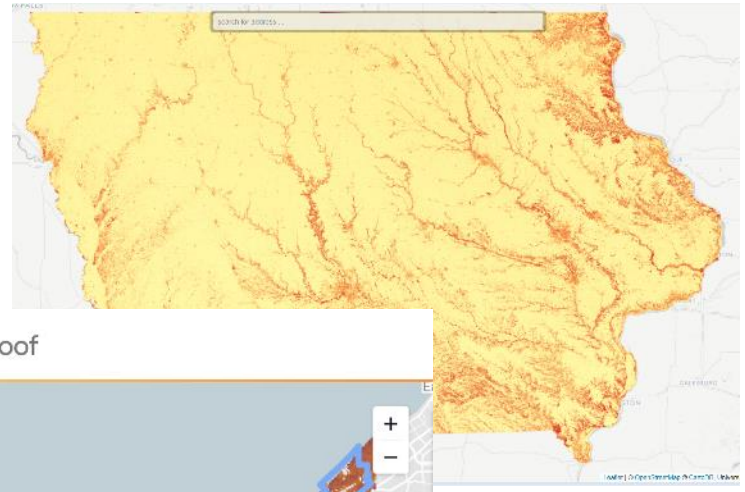
- ✓ Variation affects economic viability of some technologies more than others
- ✓ Midwestern solar resources are much better than in Germany, the worldwide leader in solar energy generation.

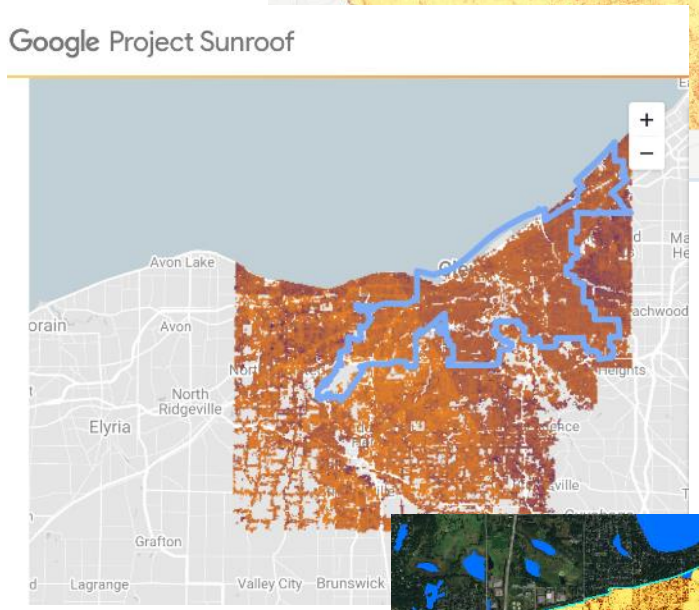


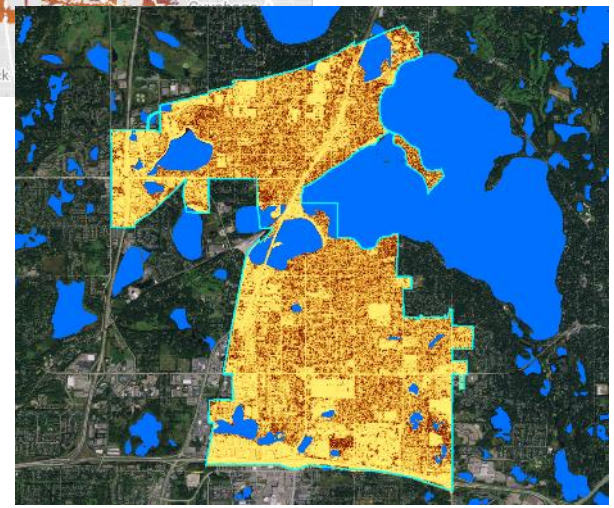
Solar Resources . . .

Solar energy resources in the Midwest can easily support a large and economically self-sustaining solar industry.

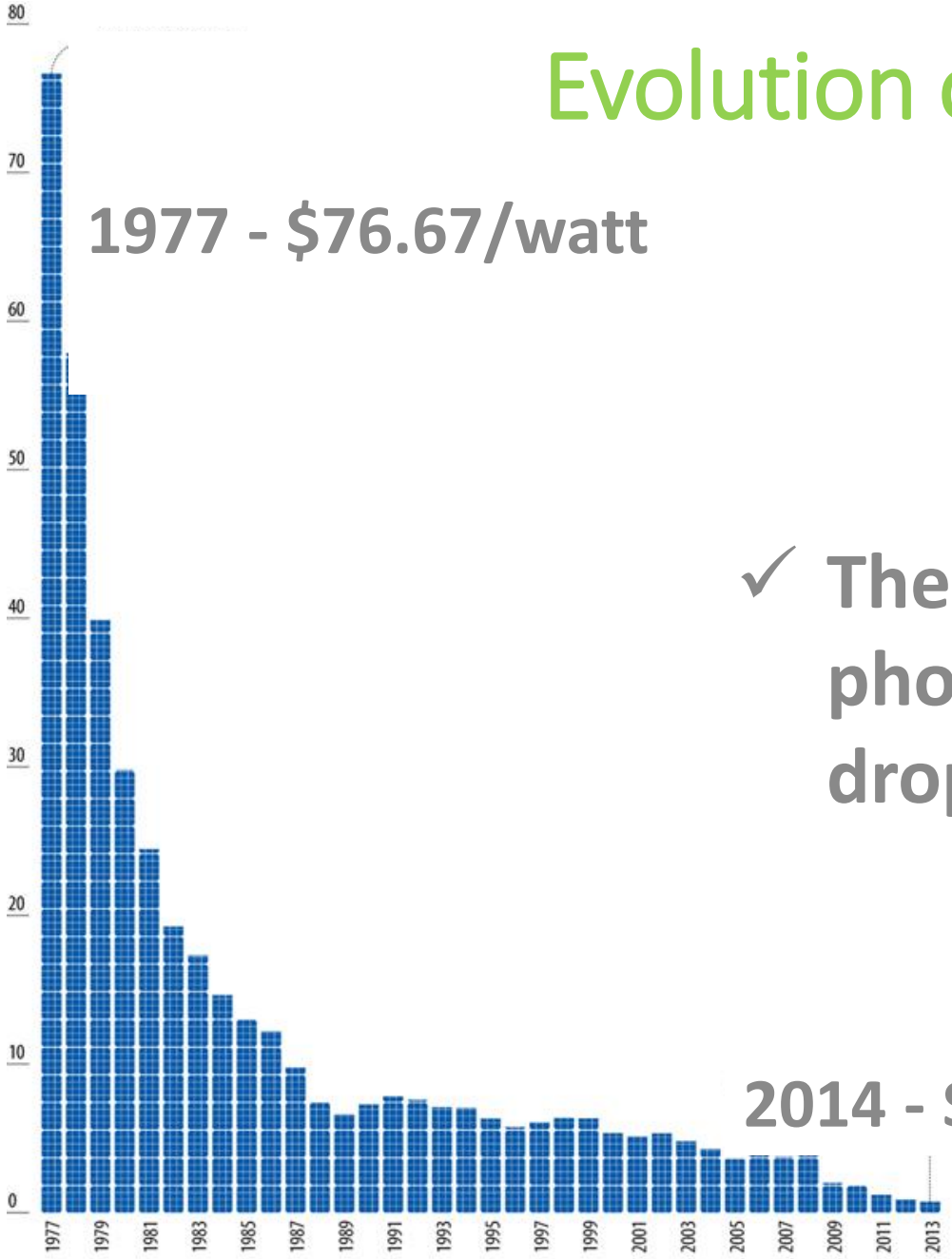
- ✓ **Just the rooftop solar resource in Cleveland is estimated to approximate 1,600 MW of electric capacity (Google Sunroof Project)**
- ✓ **Minnesota cities could generate an equivalent of between 20 and 60% of their total annual electric needs with just rooftop solar installations.**







Evolution of Solar Energy . . .



1977 - $76.67/watt

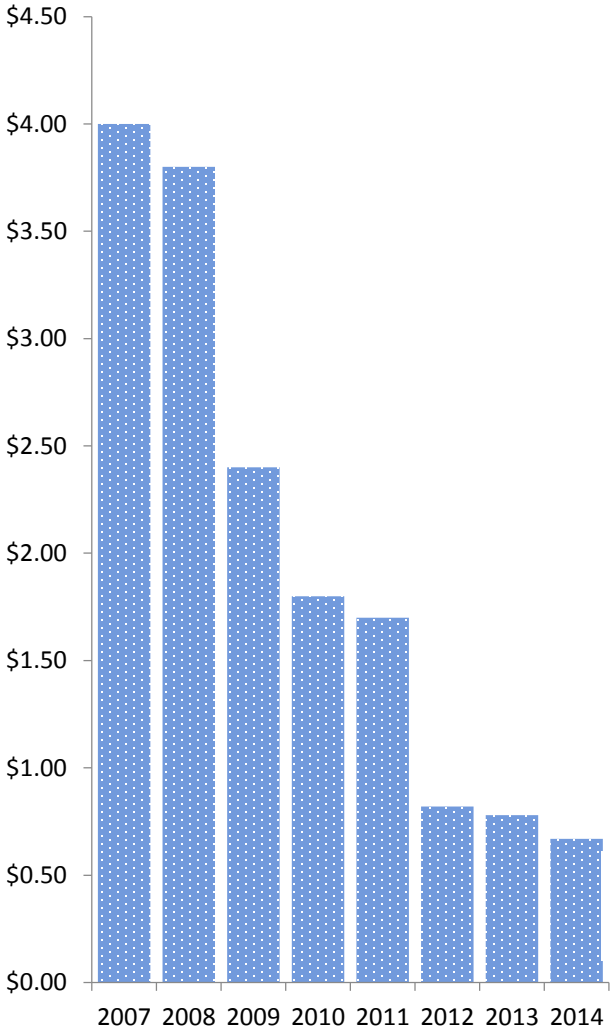
- ✓ **The wholesale price of solar photovoltaic (PV) panels ($/watt) has dropped by 99% since 1977.**

2014 - $0.67/watt

Source: Bloomberg New Energy Finance

Evolution of Solar Energy . . .

2007 - $4.00/watt



2014 - $0.67/watt

- ✓ **The wholesale price of solar photovoltaic (PV) panels ($/watt) has dropped by 99% since 1977.**
- ✓ **More significantly, since 2007, the price has declined by 83% . . .**

Solar Energy Markets

- ✓Retail Market (Distributed Solar)
- ✓Wholesale Market (Utility-Scale Solar)
- ✓Community Solar Market (solar array at the utility-scale, subscribers in the retail market)

Distributed Solar (Retail Market)

- ✓Behind the meter (net metering rules vary by state).
- ✓Value proposition based in retail market rates.
- ✓Excess power generally is generated and consumed in the distribution system.
- ✓Not counted as wholesale generation by ISO, but as demand reduction (but evolving).

Utility Scale Solar (Wholesale Market)

Solar Farms

- ✓PV, CSP, Tracking and Fixed mount
- ✓Interconnected directly to utility system, integrated into MISO dispatch.
- ✓Value proposition defined by wholesale market (PPAs)


Photo credit: NREL Phot Xchange


Photo credit: KARE 11 News


Photo credit: Prairie Restorations

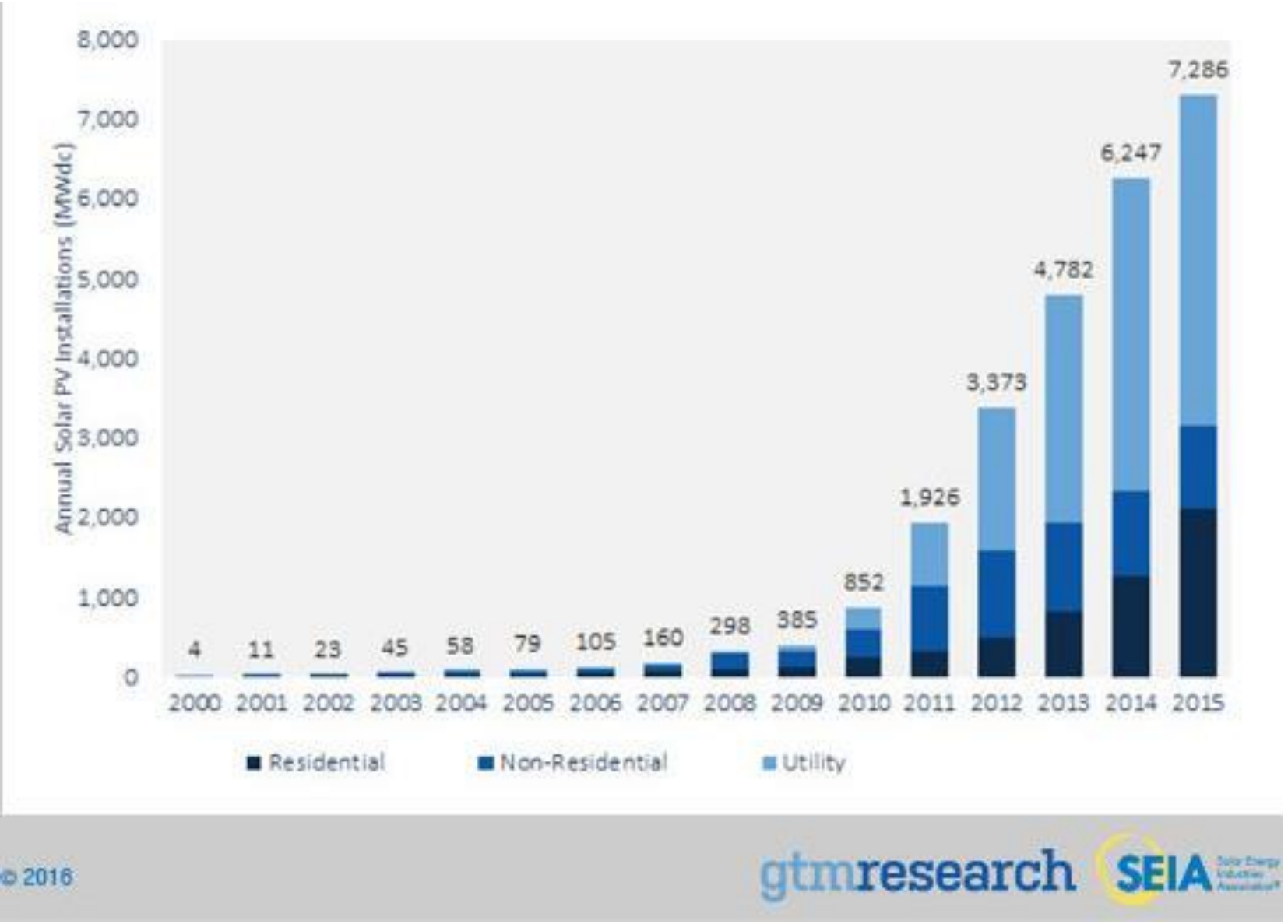

Photo credit: VTD/Eric Blokland, http://vtdigger.org/2011/07/28/vermont-solar-farm/

Community Shared Solar

- ✓Value proposition defined by utility or by state law, generally more than wholesale value, can be greater than retail value
- ✓Can be rooftop system similar to a behind the meter installation
- ✓Current market is developing small solar farms (1 – 5 MW, 5 – 30 acres)

Photo credit: Prairie Restorations

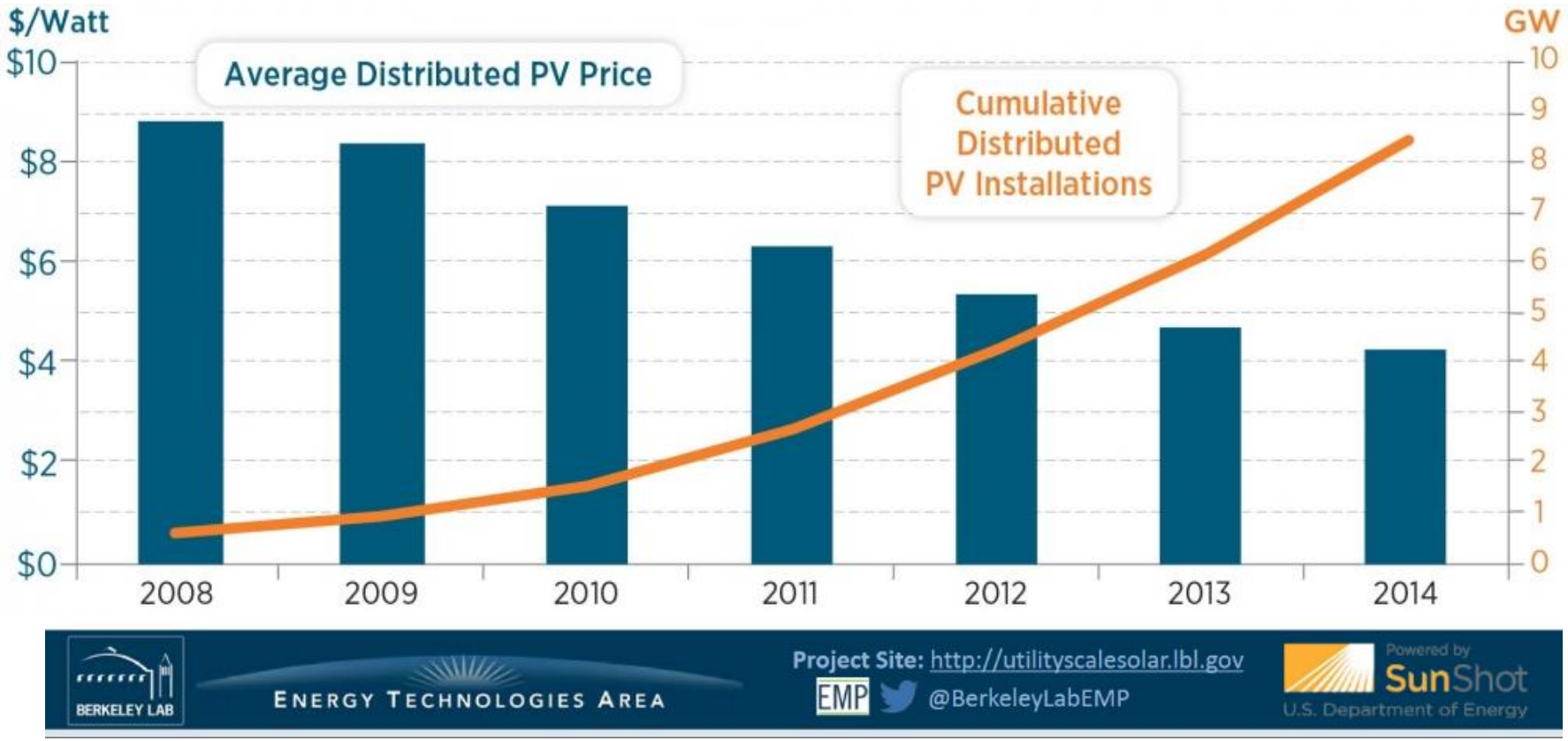
Annual Solar PV Capacity Additions



- ✓Annual additions for both wholesale and retail markets continue to grow each year.
- ✓Approximately 30% of the cumulative U.S. solar capacity was installed in 2015.
- ✓More solar capacity added in 2015 than natural gas capacity (29.5% of all capacity added)

gtmresearch SEIA

Retail Market Conditions
Distributed Solar Development



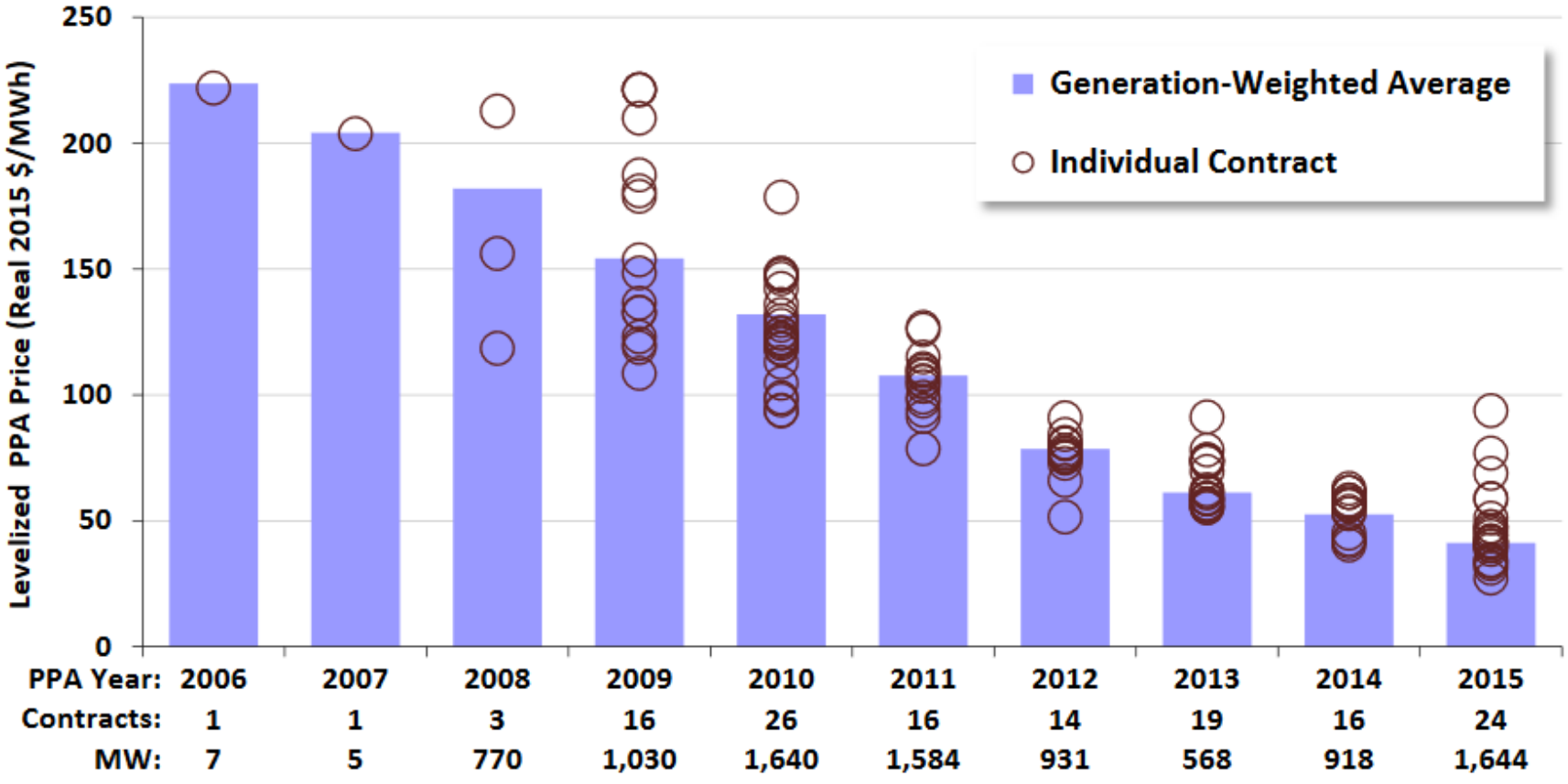
Since 2008 . . .

- ✓ 54% reduction in the installed cost of rooftop solar
- ✓ 800% increase in rooftop installed capacity

Wholesale Market Conditions

Utility-Scale Solar Development

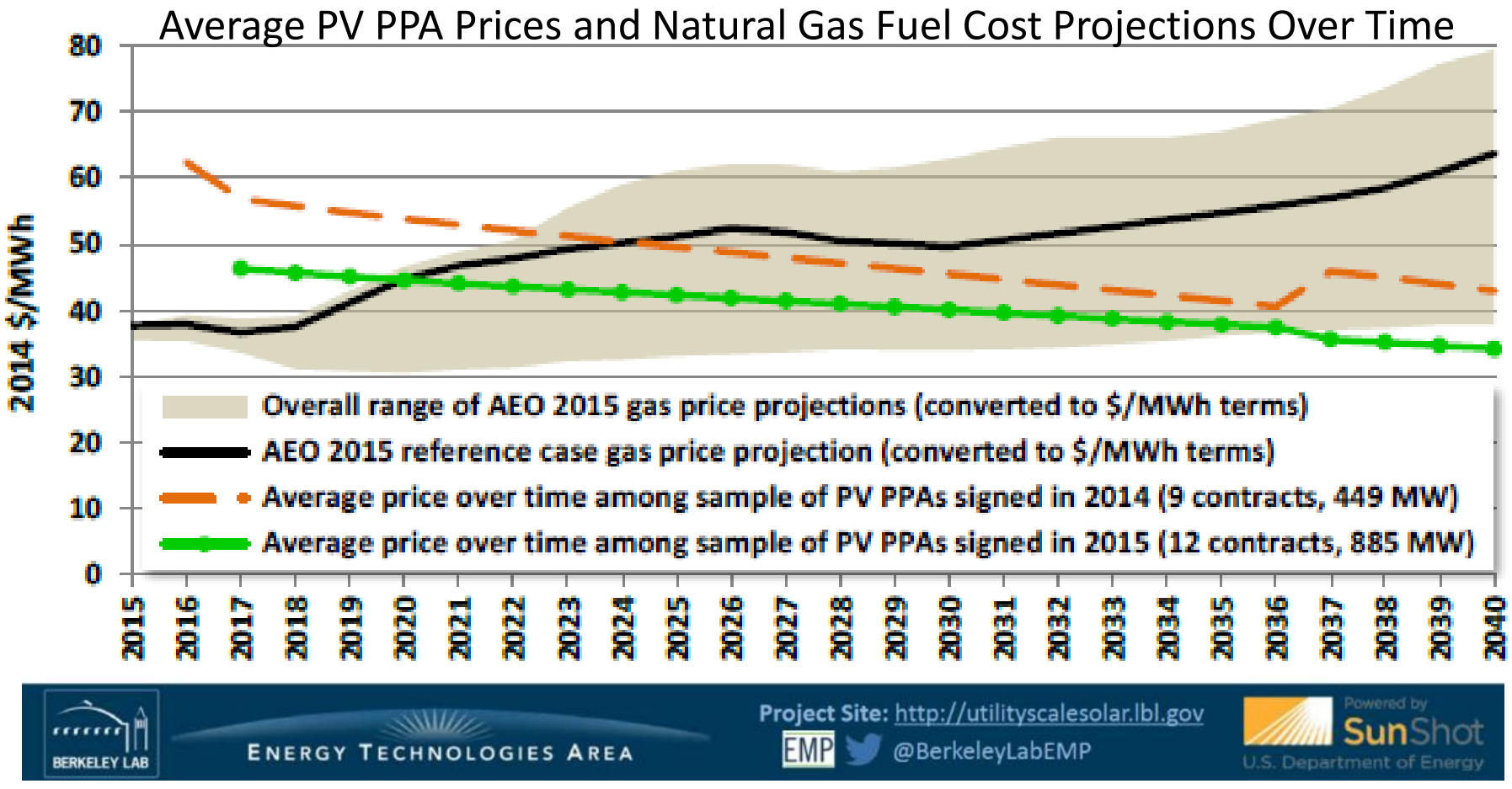
On average, Purchased Power Agreement (PPA) prices have fallen by nearly 75% since 2009



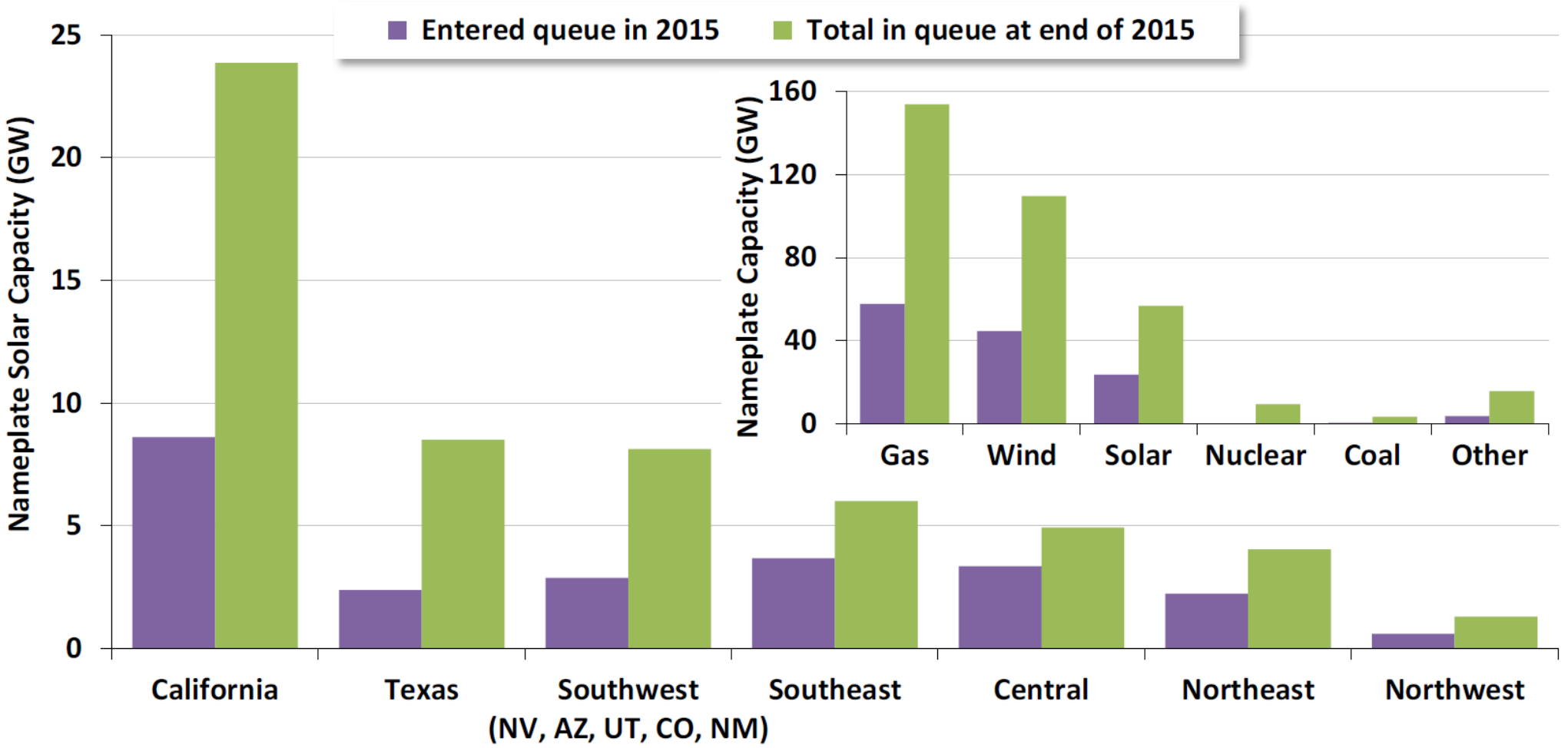
Wholesale Market Conditions

Utility-scale Solar Development

This downward price trend will continue, and . . .



Regional Wholesale Solar Trends

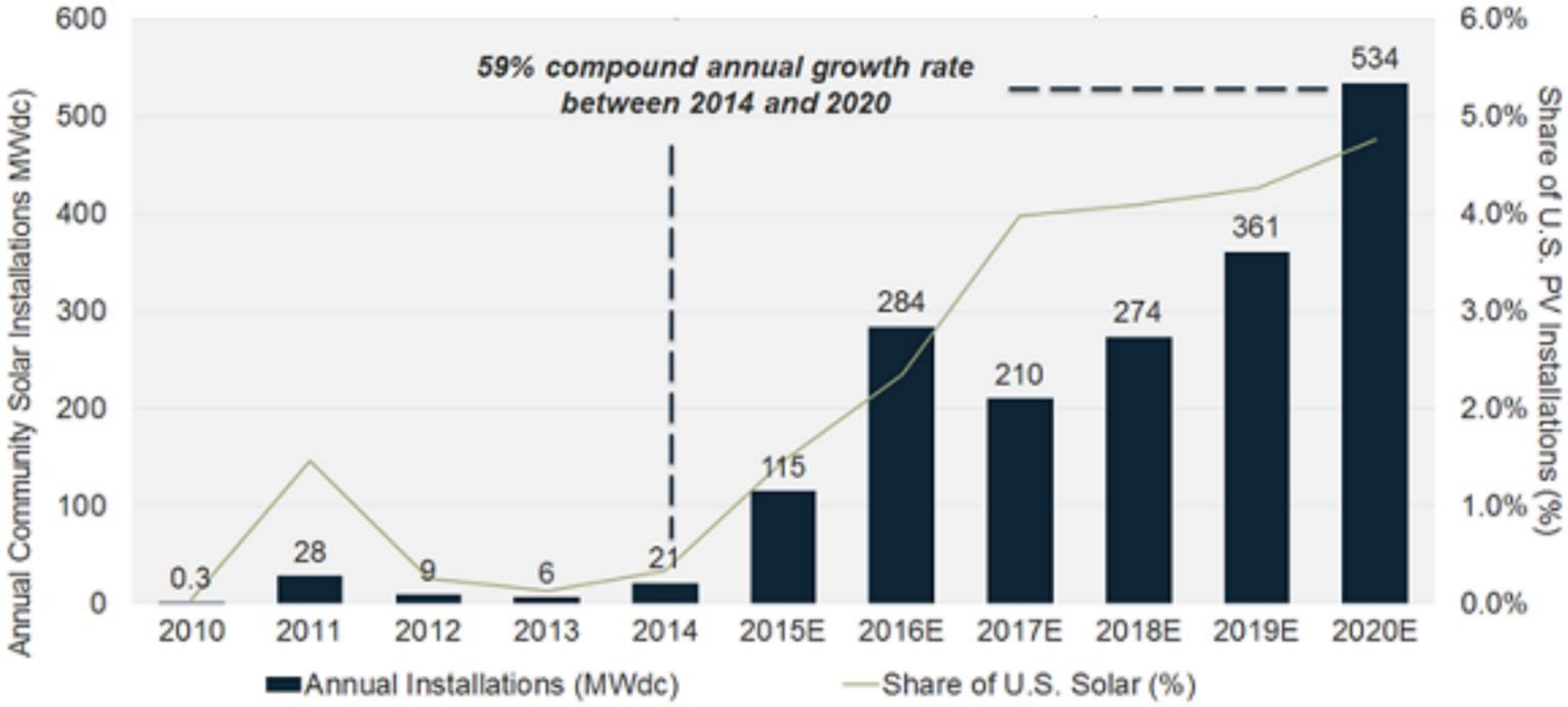


Source: Exeter Associates review of interconnection queue data

Utility Scale Solar 2015, LBNL, Figure 28

Community Solar Market Forecast

FIGURE: Annual U.S. Community Solar Installations, 2010-2020E



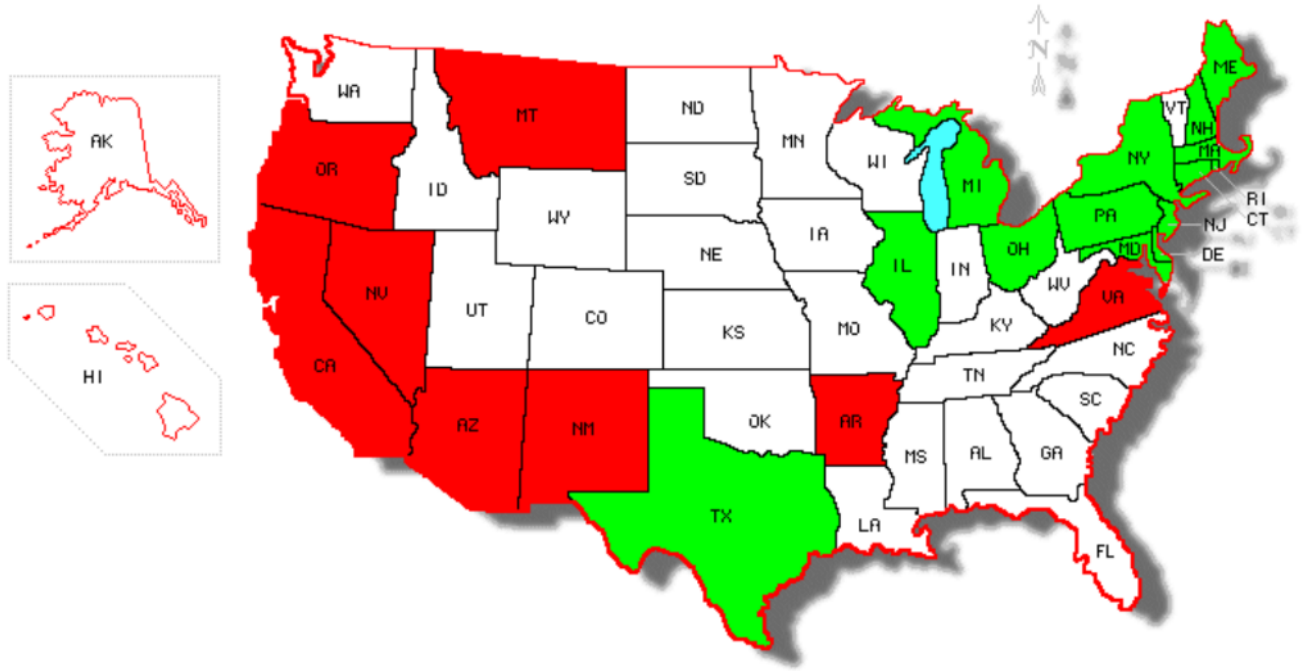
Source: GTM Community Solar Outlook, 2015 - 2020

Policy/Regulatory Environments Across Midwest

Three general forms of statewide electric utility regulation found in the Midwest:

- ✓**Traditional cost-based regulation** (North and South Dakota, Minnesota, Wisconsin, Iowa, Missouri, Kansas, Indiana)
- ✓**Retail choice enabled** or partially enabled (Michigan, Illinois, Ohio)
- ✓**Public power** (Nebraska)

Status of Retail Choice[3,4]



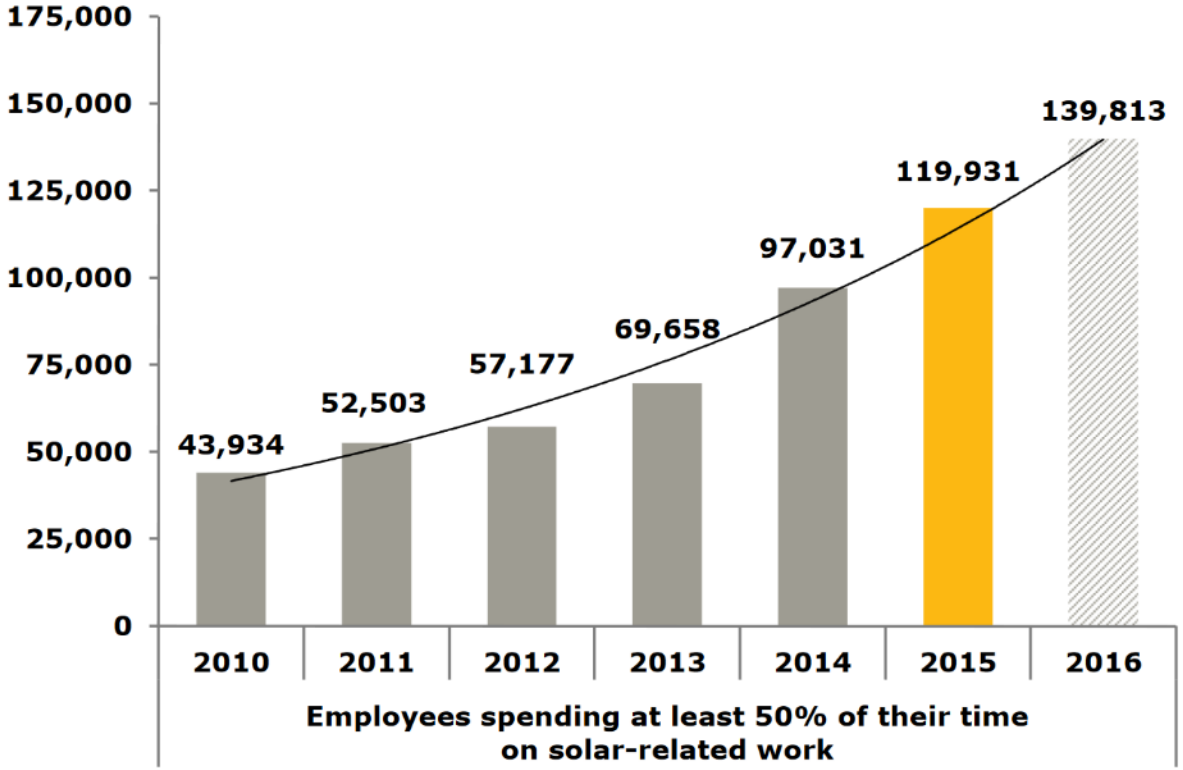
Green – Retail Choice State, Red – Suspended State, White – Traditional State

Source: Retail Choice in Electricity: What have we learned in 20 years? Christiansen Associates

Economic Impacts of Solar Development

- ✓National employment in the solar industry was over 200,000 in 2015
- ✓63% of the jobs are associated with the residential installation market
- ✓Employment growth rate from 2014 – 2015 was over 20%
- ✓Solar energy sector rivals other energy sector employment
- ✓Midwest employment lags due to less mature installation markets

Figure 5. Solar Installation Employment Growth, 2010-2016 (Projected)



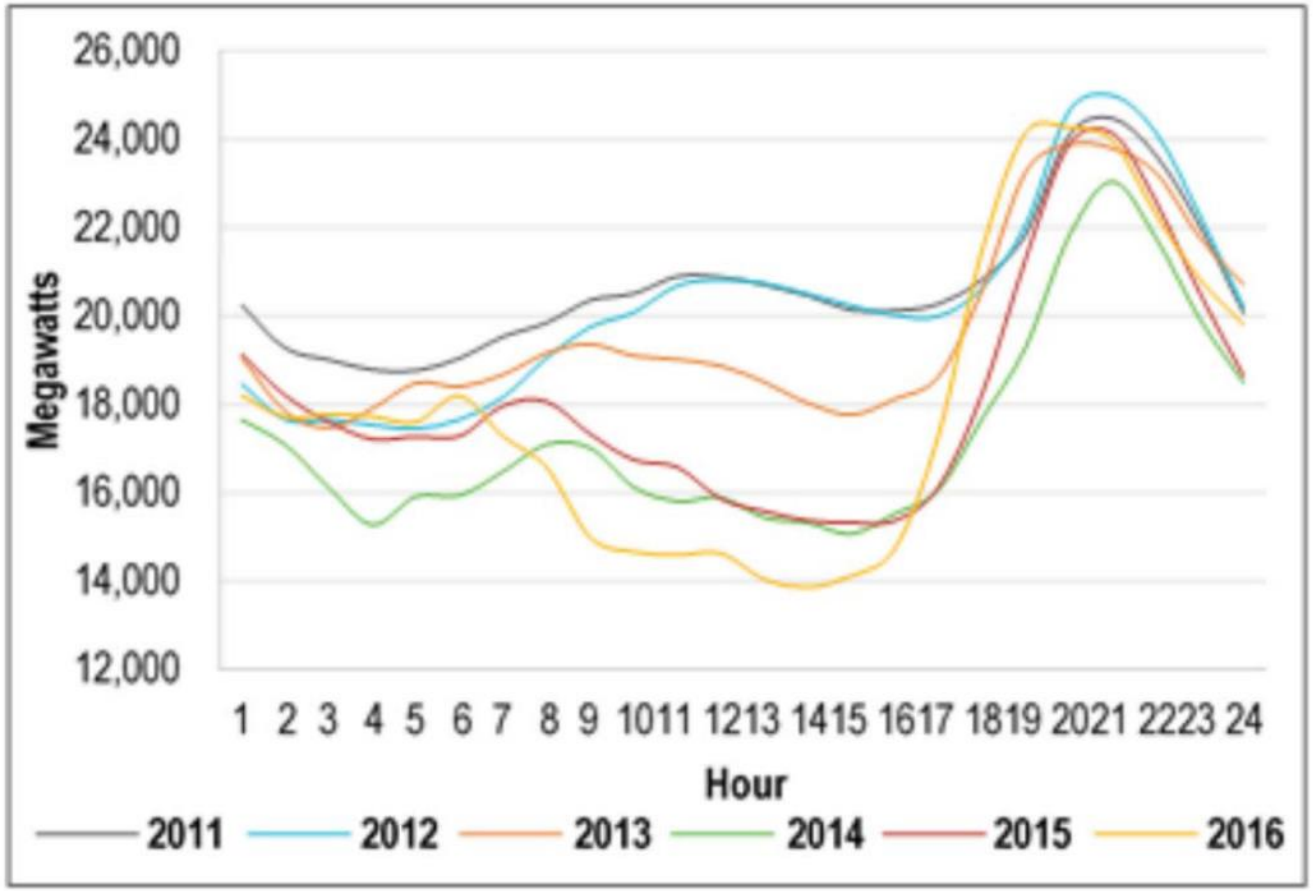
Source: National Solar Jobs Census 2015

Grid and Grid Management Implications for different solar deployment options

The anticipated development of the “duck curve” happening faster than anticipated in CAISO

- ✓Major contribution by wholesale solar (utility-scale) rather than distributed generation
- ✓Grid modernization needs for both wholesale and retail scale of solar deployment.

Figure 2: Lowest March Daytime Net Load, 2011–2016



ScottMadden Management Consultants