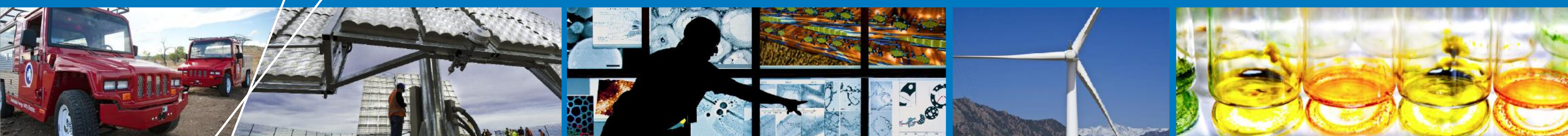
NATIONAL RENEWABLE ENERGY LABORATORY

Distributed Solar Policy and Business Model Issues



Lori Bird, NREL

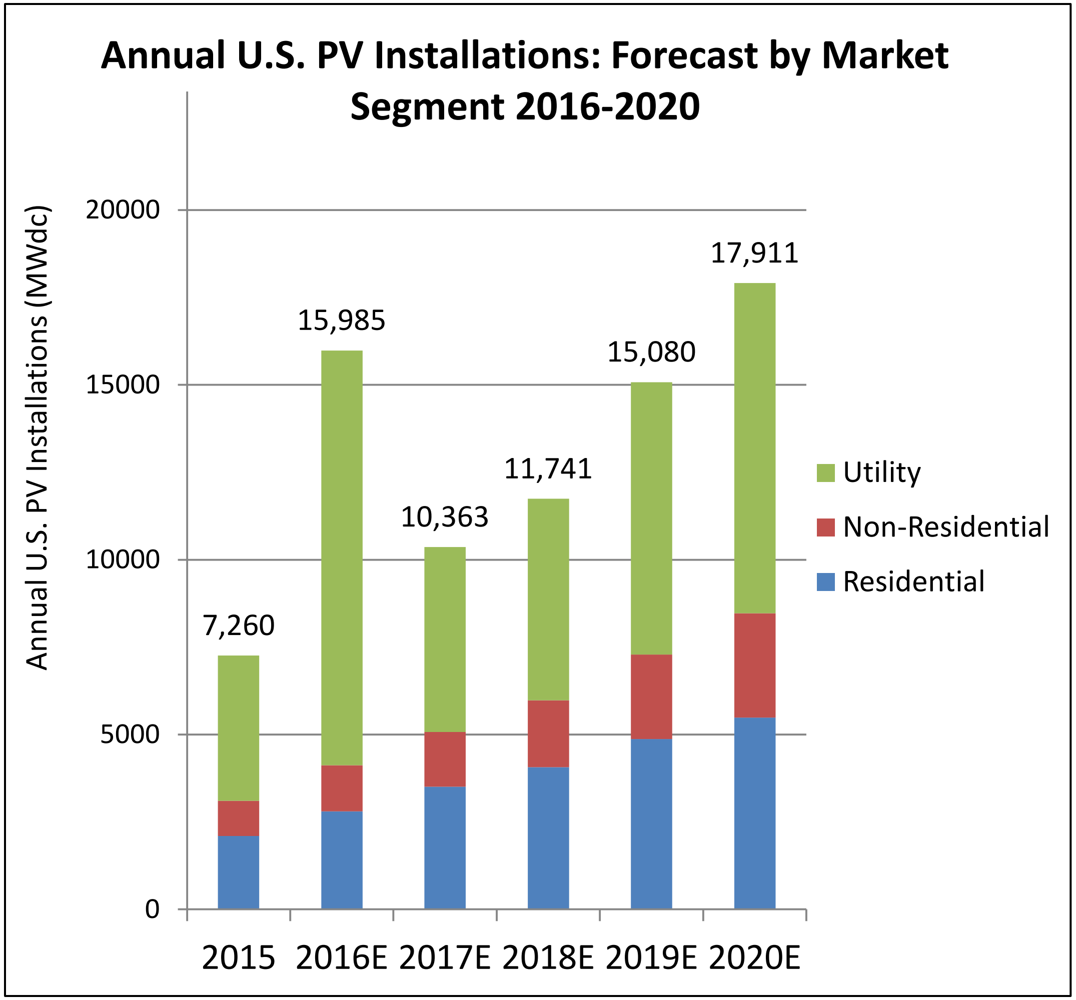
October 17, 2017

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Overview

- **Status and Growth of distributed PV in the U.S.**
- **Tariff Revisions to Address PV Growth**
  - Net Metering, Value of Solar, TOU Rates, Locational Value
- **Community Solar**
- **Emerging Interconnection Practices**
  - Processes to streamline interconnection
  - Hosting capacity
- **Aggregation of Distributed Resources**

Distributed PV Continues to Grow in the U.S.

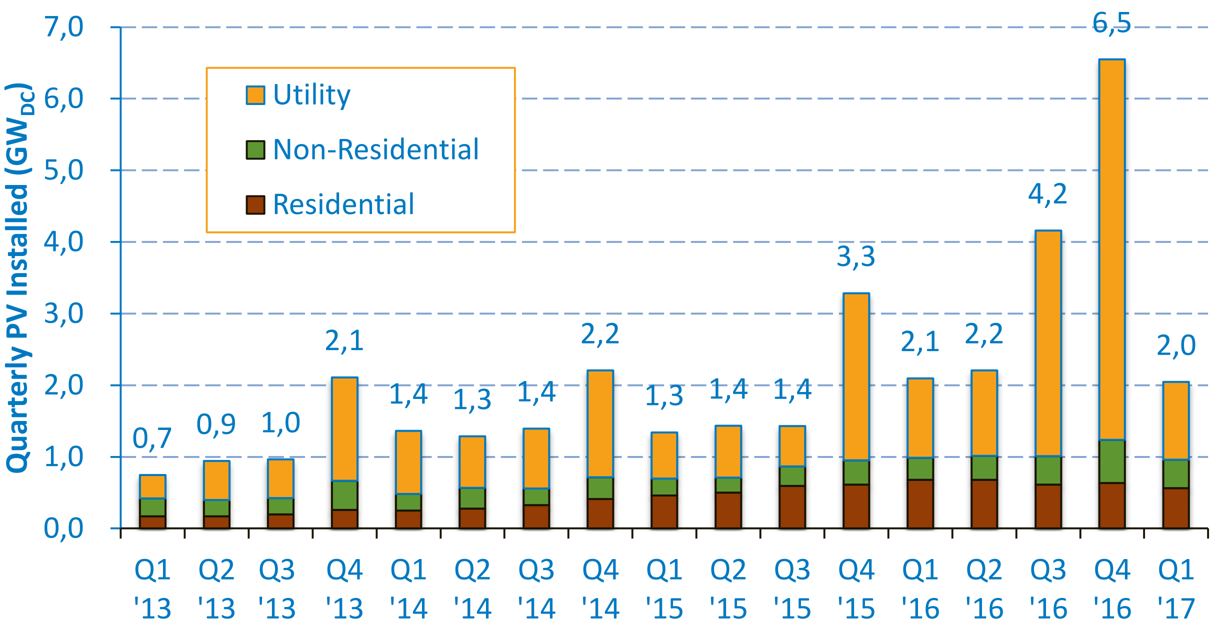


- Continued annual DG PV growth expected in 2018 and beyond
  - ~4GW in 2016
  - ~8GW in 2020
- As PV continues to decline in cost solar paired with storage is becoming cost effective

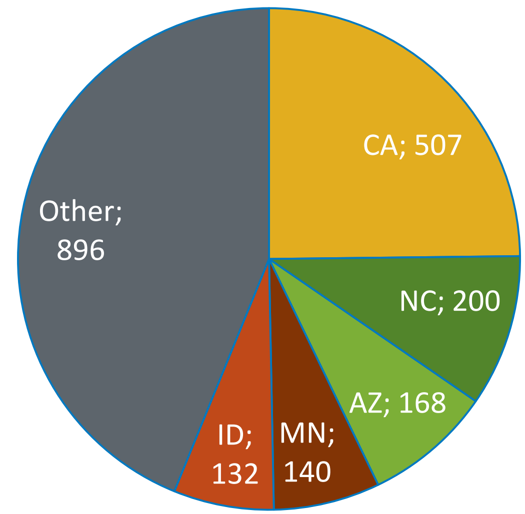
Source: GTM Research Q1 Solar Executive Briefing

U.S. Installation Breakdown

U.S. PV Installations by Market Segment



U.S. PV Installations by State (MW$_{DC}$), Q1 2017



- The United States installed 2.0 GW$_{DC}$ **of PV in Q1 2017—42.9 GW$_{DC}$ total.**
- The distributed PV growth has slowed this year as large integrators pursue profitability at the expense of growth, customer acquisition challenges remain, the potential for increased tariffs on modules and cells.
- However, some growth driven by community solar programs and virtual net metering, as well as greater number of states developing active markets.

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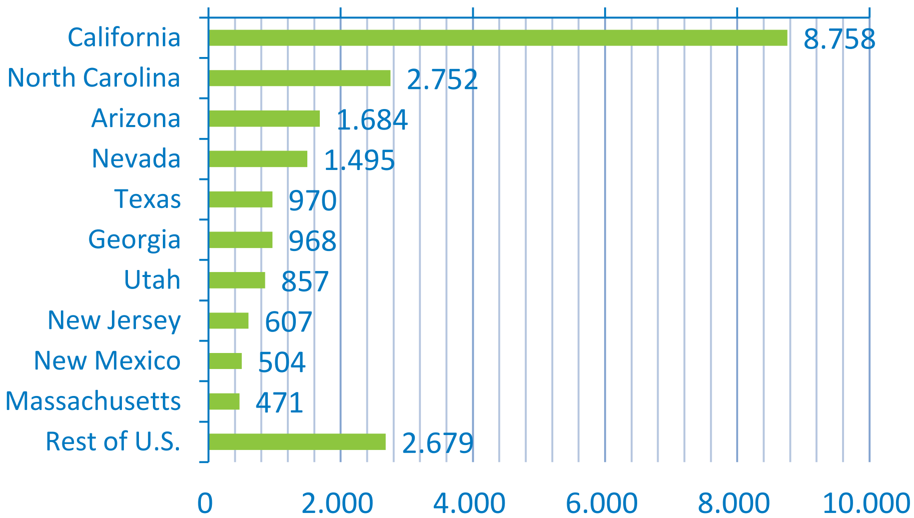
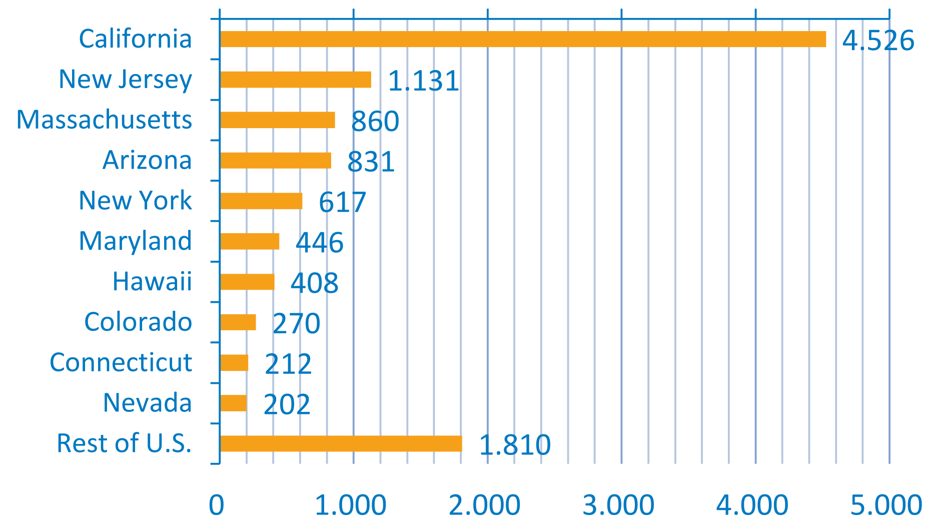
Source: GTM Research/SEIA: U.S. Solar Market Insight Q2 2017.

State Installations: Distributed vs. Utility Scale

Utility-Scale PV Installed Capacity, Top 10 States, as of May 2017
Megawatts (MW_{AC})



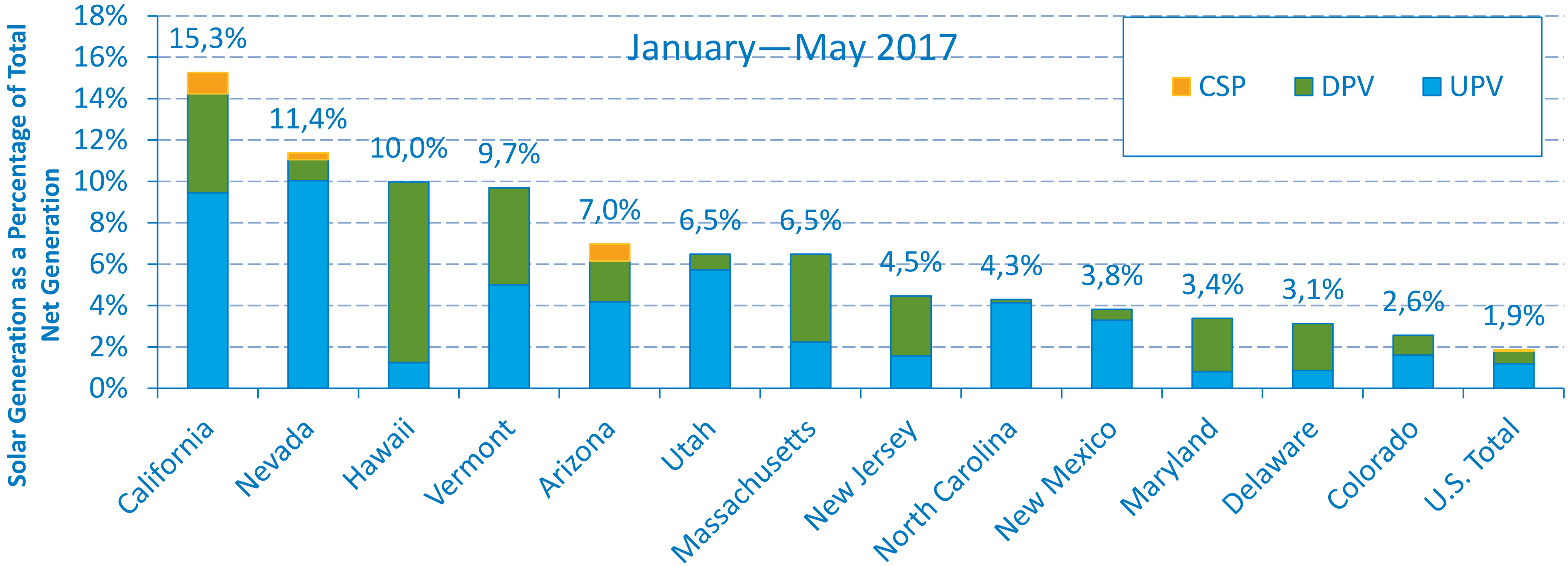
Distributed PV Installed Capacity, Top 10 States, as of May 2017
Megawatts (MW_{AC})



- **As of May 2017, 36.2 GW_{AC} of solar was installed in the United States.**
- **Of the 36.2 GW, 14.5 GW is distributed PV**
- **Half of the top 10 states led in both the utility-scale and distributed sectors, while the other states on the list had less diverse deployment**
  - Six of the top 10 states with utility-scale PV were in the Southwest while 5 of the top 10 states with distributed PV were in Northeast.

Source: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (July 2017).
Note: EIA monthly data for 2017 are not final. Additionally, smaller utilities report information to EIA on a yearly basis, and therefore, a certain amount of solar data has not yet been reported.

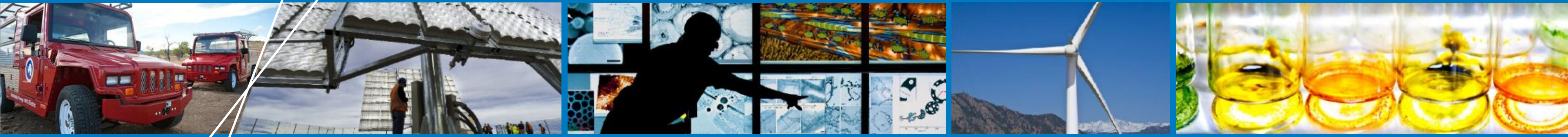
Solar as a Percentage of Total Generation



- Seven states produced more than 6.5% of total net generation from solar in in the first five months of 2017
- Another six states produced more than 2.5% of total net generation from solar.
- Hawaii generates most of its energy from distributed PV, while North Carolina generated the vast majority of its energy from utility-scale PV.

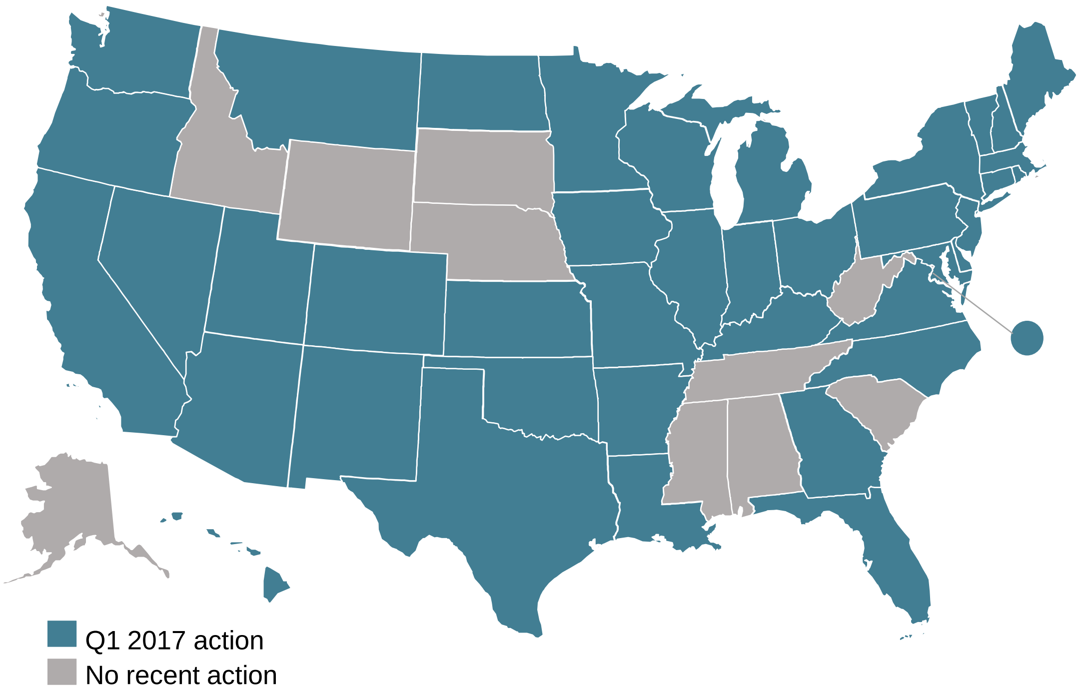
Source: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (February 2017).

Note: EIA monthly data for 2017 are not final. Additionally, smaller utilities report information to EIA on a yearly basis, and therefore, a certain amount of solar data has not yet been reported. "Net Generation" includes DPV generation.



Tariff and Net Metering Policy Revisions

Recent Activity on Net Metering and Solar Policy



40 States + DC took action on distributed solar policy and rate design during Q1 2017

Summary of Policy Actions

Policy Type	# of Actions	% by Type	# of States
Residential fixed charge or minimum bill increase	71	33%	35 + DC
Net metering	73	34%	28
Solar valuation or net metering study	20	9%	16 + DC
Community solar	18	8%	13
Residential demand or solar charge	16	8%	10
Third-party ownership of solar	9	4%	8
Utility-led rooftop PV programs	5	2%	5
Total	**212**	**100%**	**47 States + DC**

Source: "The 50 States of Solar: Q4 2016 & Annual Review Executive Summary ." NC Clean Energy Technology Center. http://www.dsireusa.org/resources/presentations-and-publications/

Options and Considerations for Regulators

Options for DG Tariffs

- Net metering
- Two-way rates
  - Value of solar
  - Other export compensation
- Time-of-use rates
- Locational value
- Fixed charges
- Demand charges
- Minimum bill

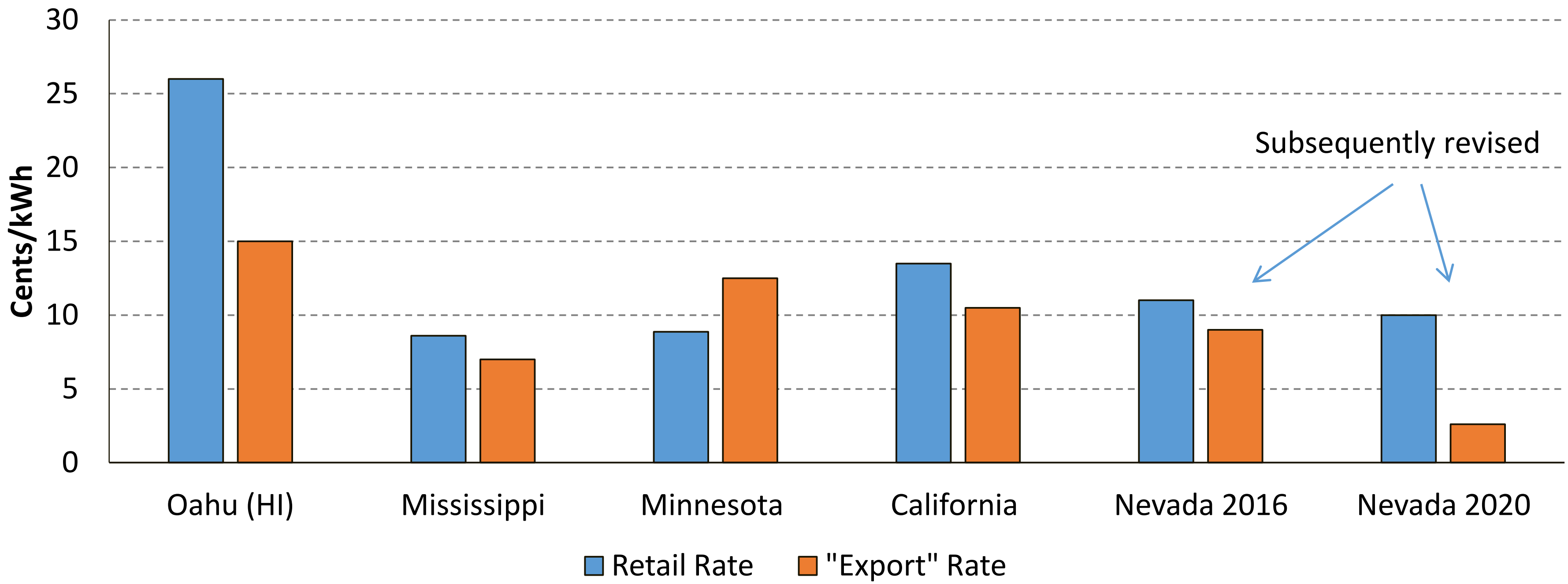
Regulatory Considerations

- Ensuring sufficient revenues collected to maintain the grid
- Fair and equitable rates
- Customer choice
- Ensuring policy goals are achieved
- Level playing field for new technologies
- Competition and provision of customer services

Compensation Methods for Distributed PV

- **Net energy metering retained in many jurisdictions**
  - Customer credited at retail rate for all generation from the PV system
- **Valuation methodologies**
  - Ex., New York value stack methodology
  - Ex., Minnesota value of solar methodology
- **Exports compensated at a specified rate less than retail rate**
  - E.g., Nevada law adopted in June 2017, compensates customers at 95% of retail rates initially and decreasing to 75% of the retail rate over time
- **Time of use (TOU) rates for PV customers**
  - E.g., Required for all net metered PV customers in California; Colorado initiated pilot program
- **Self supply only, no grid exports**
  - Hawaii also had a grid supply option but it is fully subscribed

Comparison of Residential Solar Bill Credit Mechanisms

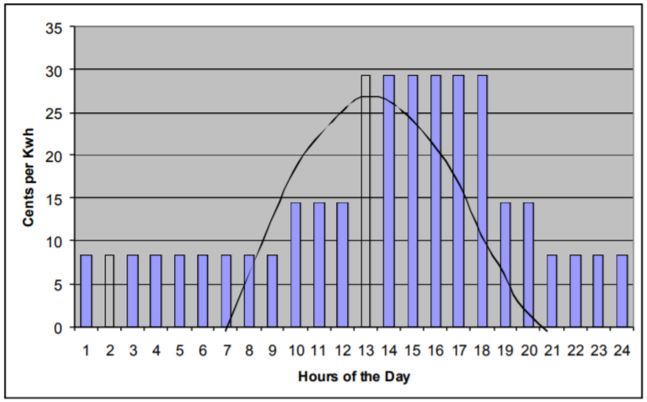


- States have developed systems other than net metering to compensate solar exported onto the grid
- States with a large deficit between retail and “exported” rates may provide incentive for storage/self-consumption

Sources: Hawaii Public Utility Commission Docket 2014-0192; Hawaiian Electric Effective Rate Summary April 2015; Form EIA-861. EIA Statewide Avg. Electricity Prices (2013), MS PUC Docket No. 2011-AD-2. NREL (10/3/15), GTM (12/15/15), NV Energy.

California's Net Metering 2.0 and TOU Rates

- NEM 2.0 successor tariff introduced in January 2016
- NEM 2.0 requires customer-generators to cover the costs for the services they obtain from the utility.
- The interconnection fee is levied on new NEM customer-generators and equal to the cost incurred by the utility to interconnect them
- Customer-generators to incur the non-bypassable charges on kWh from utility (2-3cents/kWh)
- Customers required to participate in TOU program
- NEM 2.0 to run until 2019 and then PUC will evaluate revisions to consider benefits of solar in different locations and times
    - Locational Net Benefit Analysis methods underway

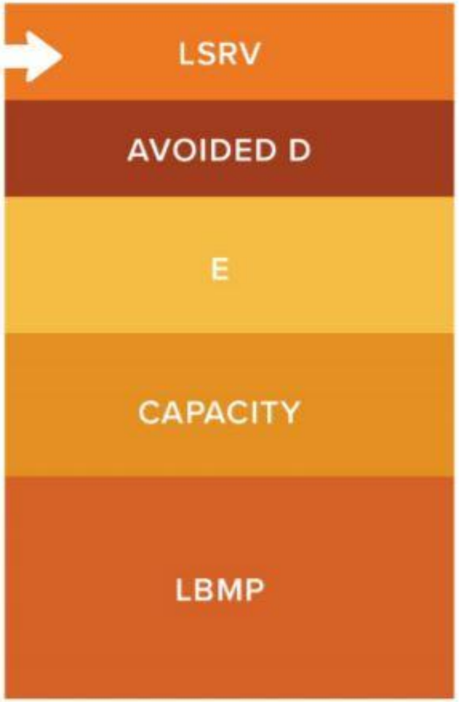


Summer pattern (May – October)

Source: "51st State Perspecitves: Distributed Energy Resources Integration." Scott Madden Management Consultants and Smart Electric Power Alliance (SEPA). December 2016. http://www.scottmadden.com/wp-content/uploads/2016/12/SEPA-ScottMadden-51st-State-Report_DER-Integration-CA-NY.pdf

NY - Value Stack for DER Compensation

- "Value Stack" pricing mechanism designed to provide more accurate compensation levels for larger DER projects
- Initial 2-year tariff; phase 2 tariff development under way.
- Behind-the-meter solar would be credited at the full retail rate until 2020
- Value components (applied to hourly net exported generation
  - Energy value
  - Installed capacity value
  - Environmental value
  - Locational System Relief Value (to be determined)
  - Market Transition Credit (for value that cannot be quantified)



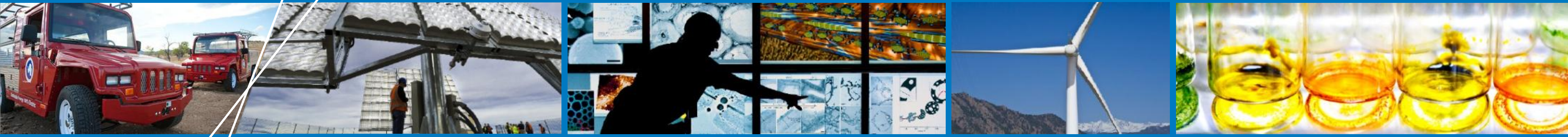
Determining Locational Value Adder

Source: ConEd

NY utilities determined "locational
system relief value areas"

DER systems in these areas receive adder to value stack

CA has Locational Net Benefit Analysis underway to determine locational value



Community Solar

Community Solar (Shared-Solar)

- **Customers participate in solar project not located on their property**
- **Customers receive some of the project's power or financial benefits**
- **Varied ownership, management models**
  - Utility, business, school, nonprofit
- **Benefits:**
  - Increase access to solar (for customers without on-site access)
  - Deliver solar at a competitive price; economies of scale with larger projects
  - Utility can play role in offering program

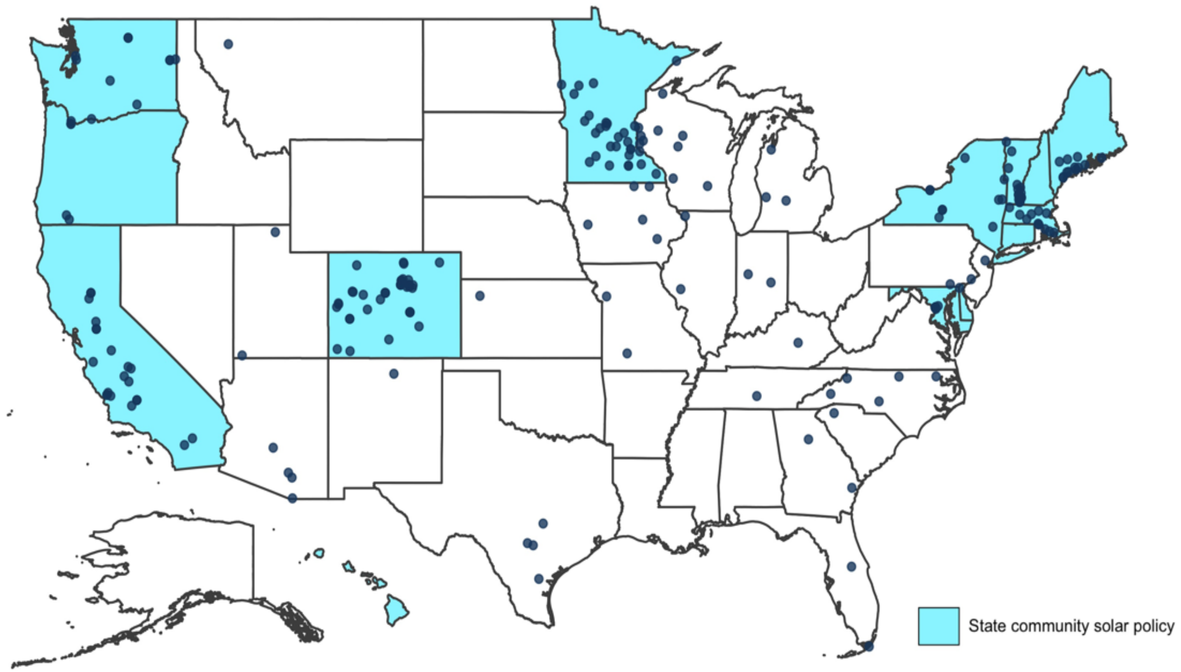
Why Community Solar?

There are many potential consumers of solar who are unable or don't want to install a PV system on their roof.

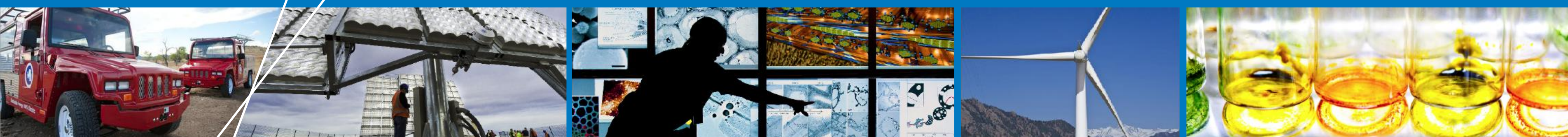
- 49% of households are currently unable to host a PV system
- 48% of businesses are unable to host a PV system

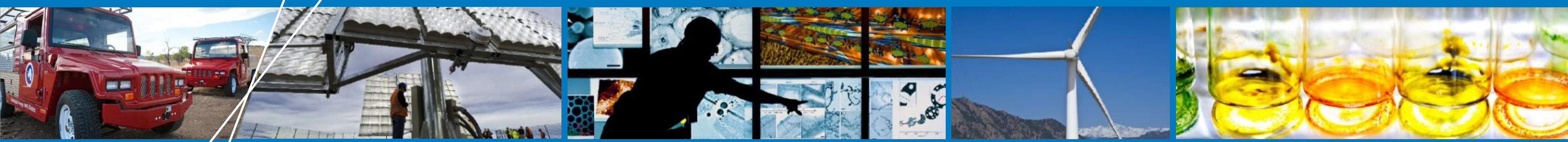
Why?

- Renters/lessees
- Condo owners
- Shaded or old roofs
- An entire system may be too costly
- Not allowed (HOA restrictions)
- Less than ideal roof orientation
- Low income customers



Community Solar Projects and States with Supporting Policies



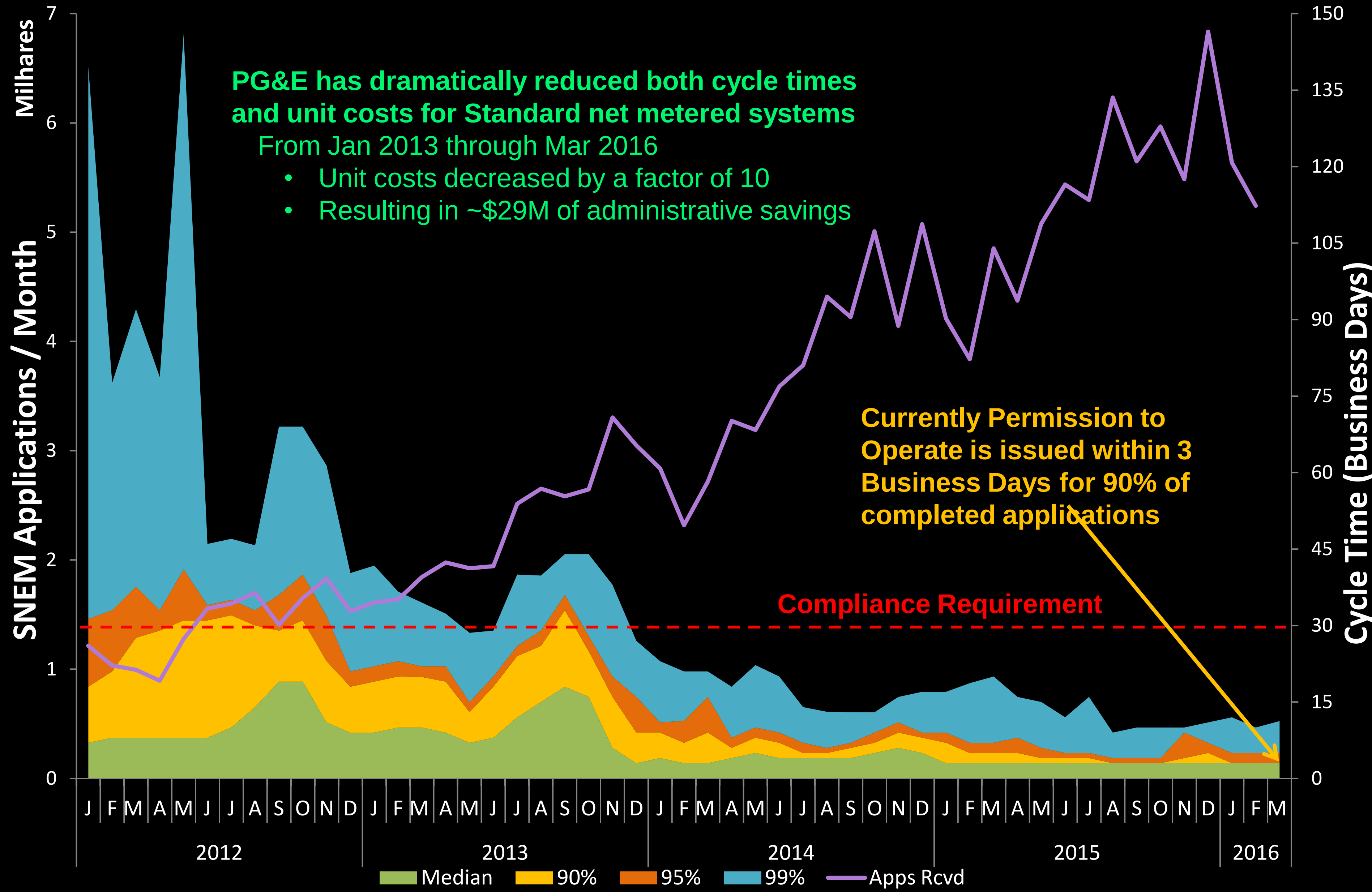


Interconnection Practices

Emerging Interconnection Practices

- **Expedited processing of interconnection applications**
  - Fast track procedures for small systems or those that meet certain screens
- **Automation of application processes**
  - Utilities updating software to manage higher volume of applications
  - Online applications and more visibility to customer
- **PV plus storage interconnection requirements**
  - Utilities just starting to see more PV plus storage systems.
  - Need for standard processes and approaches for interconnection
- **Hosting capacity mapping**
  - Maps provide visibility of where systems are installed and where the feeders can accommodate new capacity
  - Eventually can be used for expediting interconnection

Rooftop Solar Interconnection Time

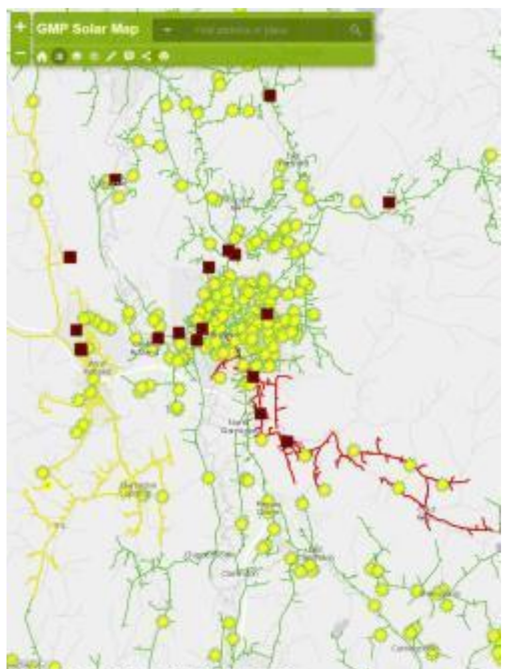


Interconnection Capacity and Mapping

Three levels of sophistication:

- Restricted zones (where can't I build a system?)
- Address-level search (can I build a system here?)
- Feeder mapping (where should I build a system?)

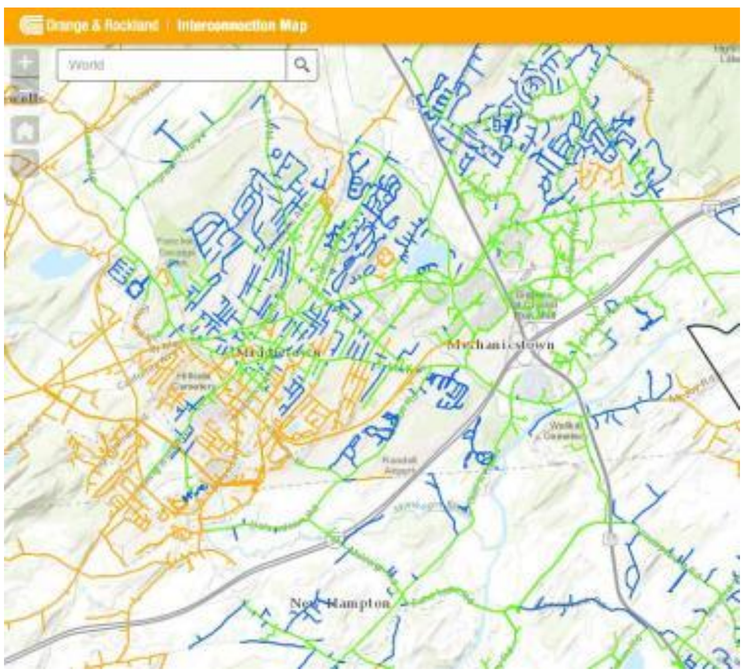
"Good-bad-maybe" : Burlington Electric (VT), Green Mountain Power (VT), PSE&G (NJ)

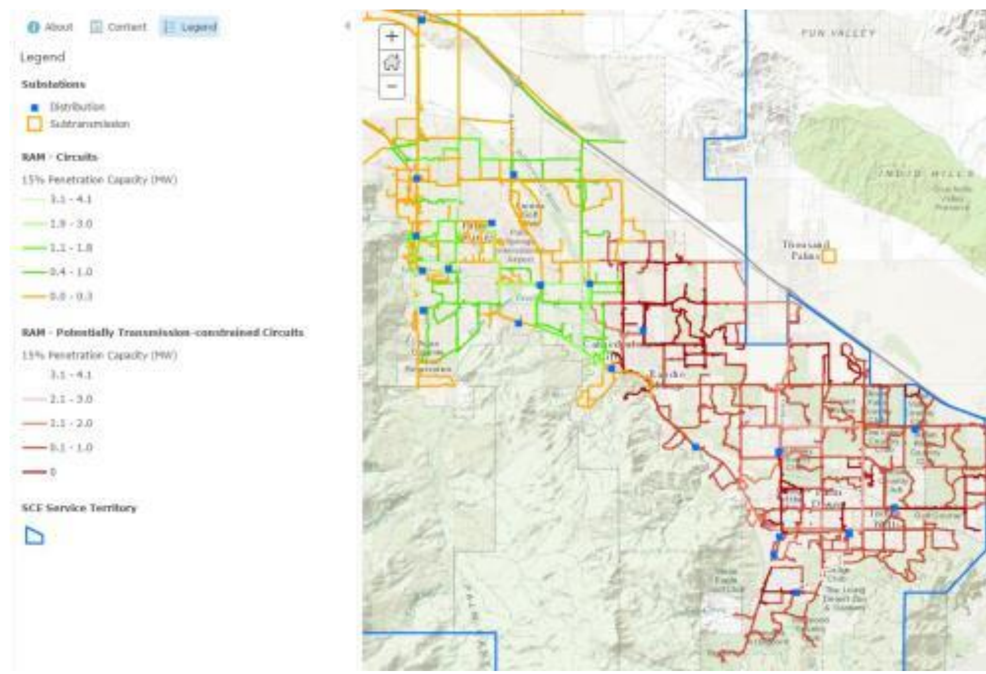


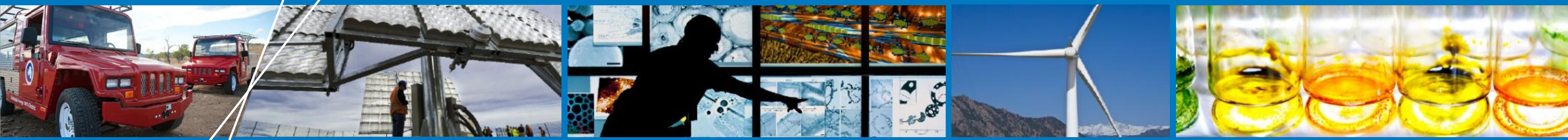
Interconnection Capacity and Mapping

- **CA moving toward regular updates of hosting capacity maps**
- **Maps provide developers with more information about where to site projects**
- **Ultimately, maps and feeder-data could be used to further expedite the interconnection process**

Electrical Information: Orange and Rockland (NY), Southern California Edison (CA)







Distributed Resource Aggregation

Distributed Resource Aggregation

California ISO Distributed Energy Resource Provider (DERP)

- Distributed energy resource aggregations (DERAs) participate in the CAISO day-ahead, real-time and ancillary services markets as a participating generator
- Must meet a 0.5 MW minimum capacity requirement; individual DERs must be <1MW
- Aggregation up to 20 MW
- https://www.caiso.com/participate/Pages/DistributedEnergyResourceProvider/Default.aspx

Federal Regulation Enabling Aggregation

- Federal Energy Regulatory Commission (FERC) Notice of Proposed Rulemaking (NOPR) issued Dec 2016 addresses storage participation in wholesale markets and rules for aggregation of distributed energy resources
- FERC Order 745 required ISOs and RTOs to pay customer-side capacity resources (e.g., demand response) an equivalent value to what power plants/supply-side resources earn
- FERC Order 755 required ISOs to create programs to reward "fast-responding" resources such as batteries for frequency regulation

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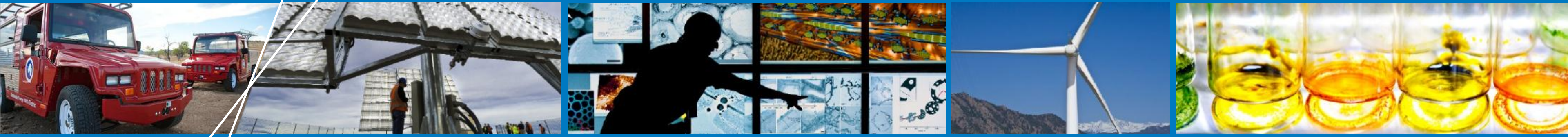

Lori.bird@nrel.gov