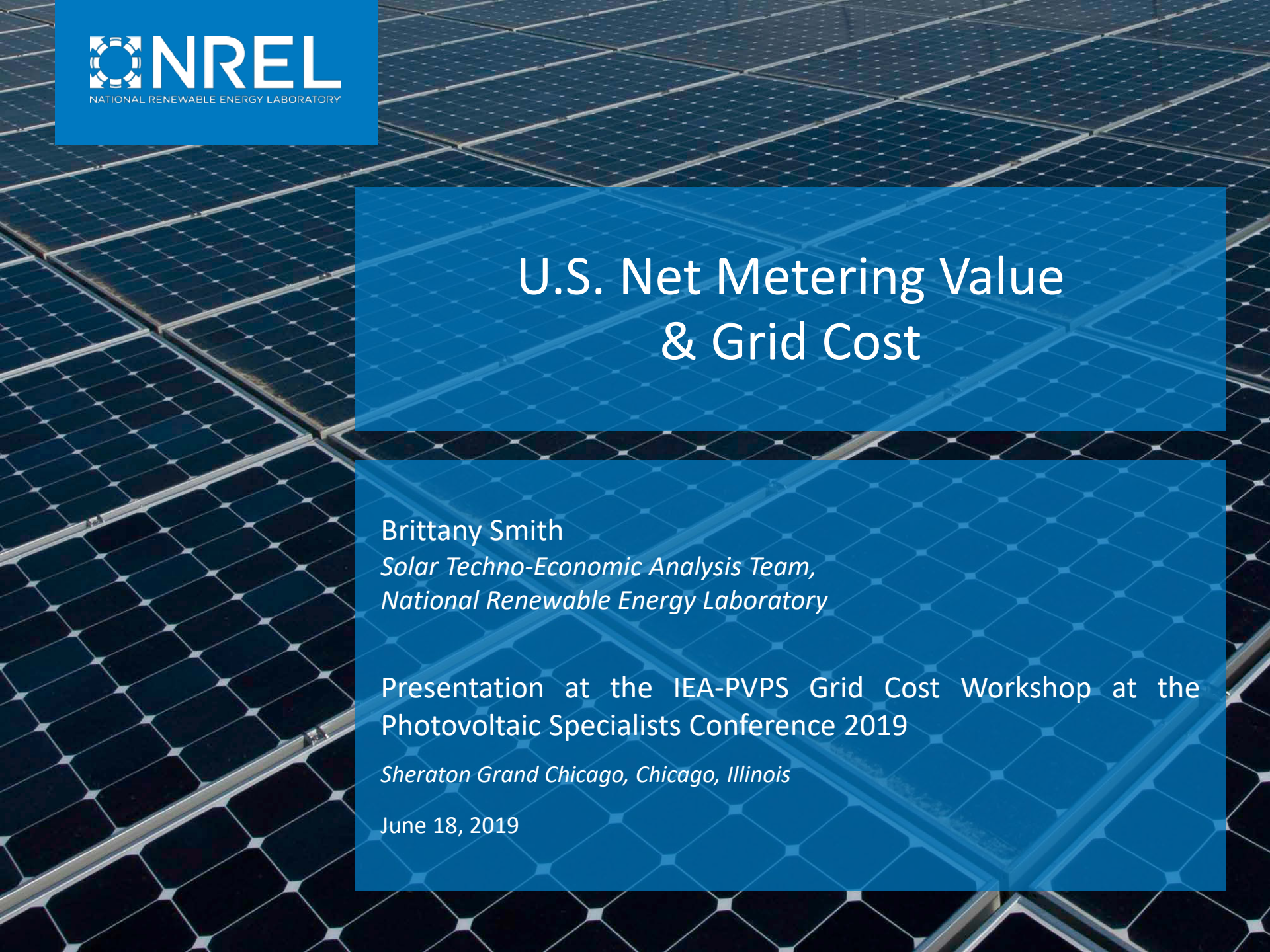

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U.S. Net Metering Value & Grid Cost

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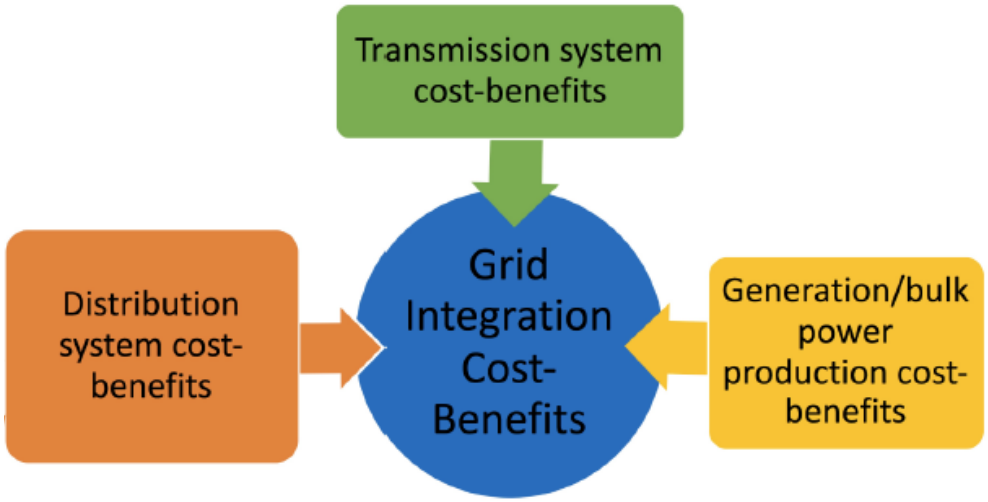
Presentation at the IEA-PVPS Grid Cost Workshop at the Photovoltaic Specialists Conference 2019

Sheraton Grand Chicago, Chicago, Illinois

June 18, 2019

PV Grid Costs (and benefits)



Distribution System Cost-Benefits

- Can avoid distribution losses since close to load
- Can replace or defer capital investments in distribution system
- Can increase losses at high penetration/over-production
- High penetration could require adding/upgrading wires, transformers, voltage-regulation devices, control systems, or protection equipment
- Can be used as voltage control service

Transmission System Cost-Benefits

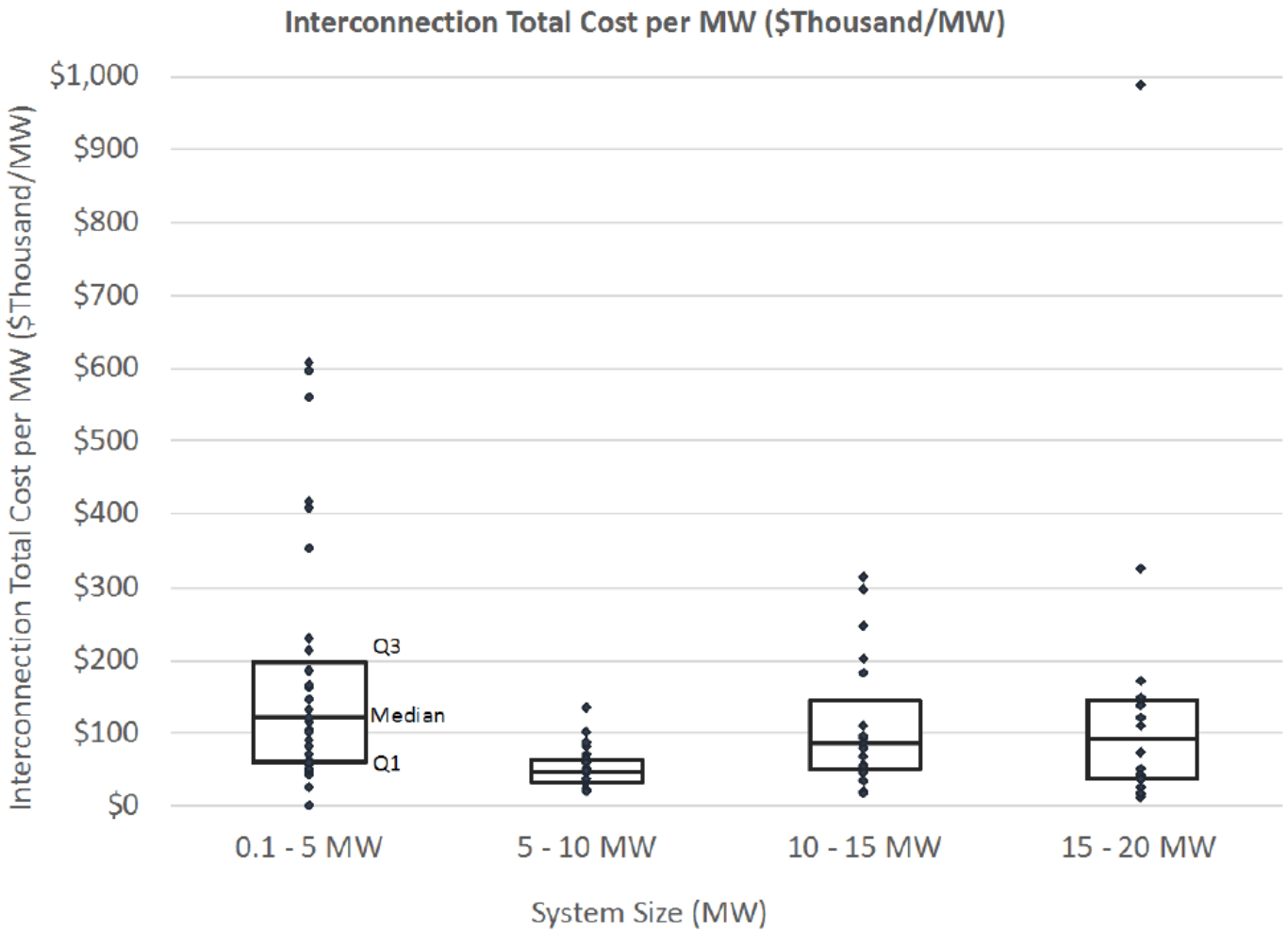
- Can avoid transmission losses since close to load
- Can replace or defer capital investments in transmission system
- Can increase losses at high penetration/over-production
- Can be used as voltage control service

Generation/Bulk Power Production Cost-Benefits

- Can reduce use of peaker generators
- Can replace or defer capital investments in new generation capacity
- Could exacerbate reserve requirements

https://www.nrel.gov/docs/fy18osti/70710.pdf, https://www.nrel.gov/docs/fy14osti/62447.pdf

Grid Interconnection Costs: Western United States, 2010-2017



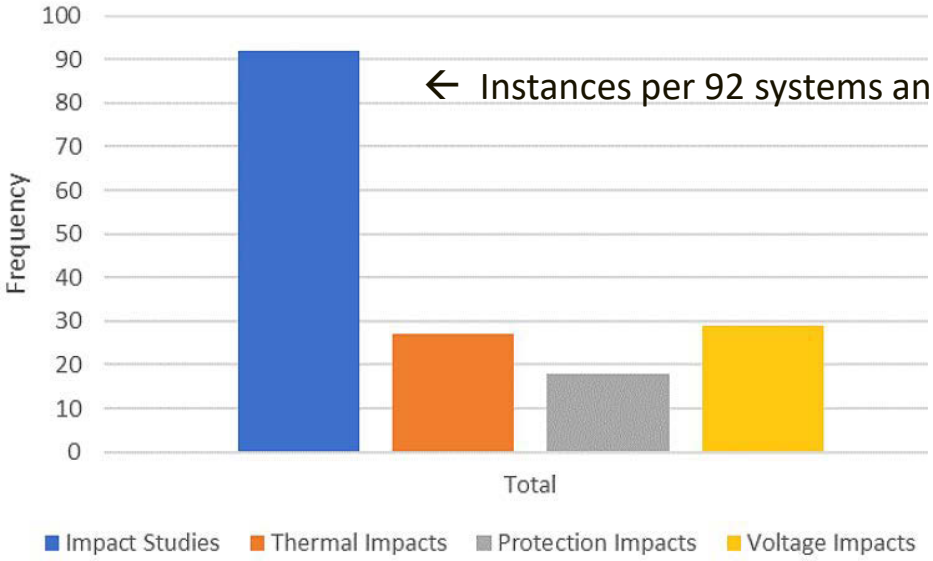
→ Includes permitting, inspections, and upgrades

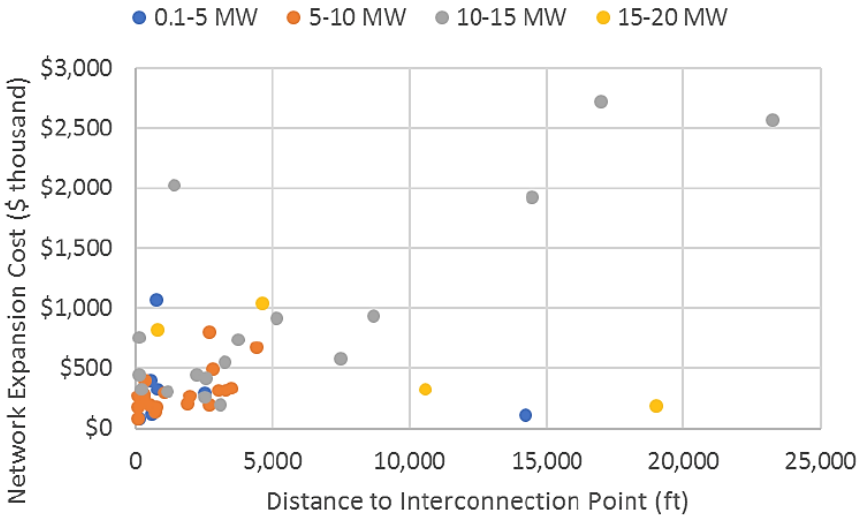
→ Medians are around $0.10/W

→ Out of 92 systems studied, 43% of systems did not require any upgrades

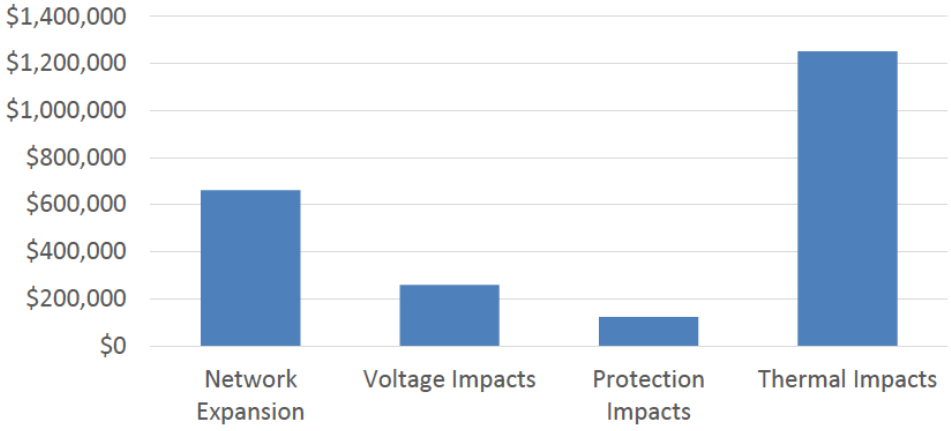
https://www.nrel.gov/docs/fy18osti/71232.pdf

Grid Interconnection Costs: Western United States, 2010-2017



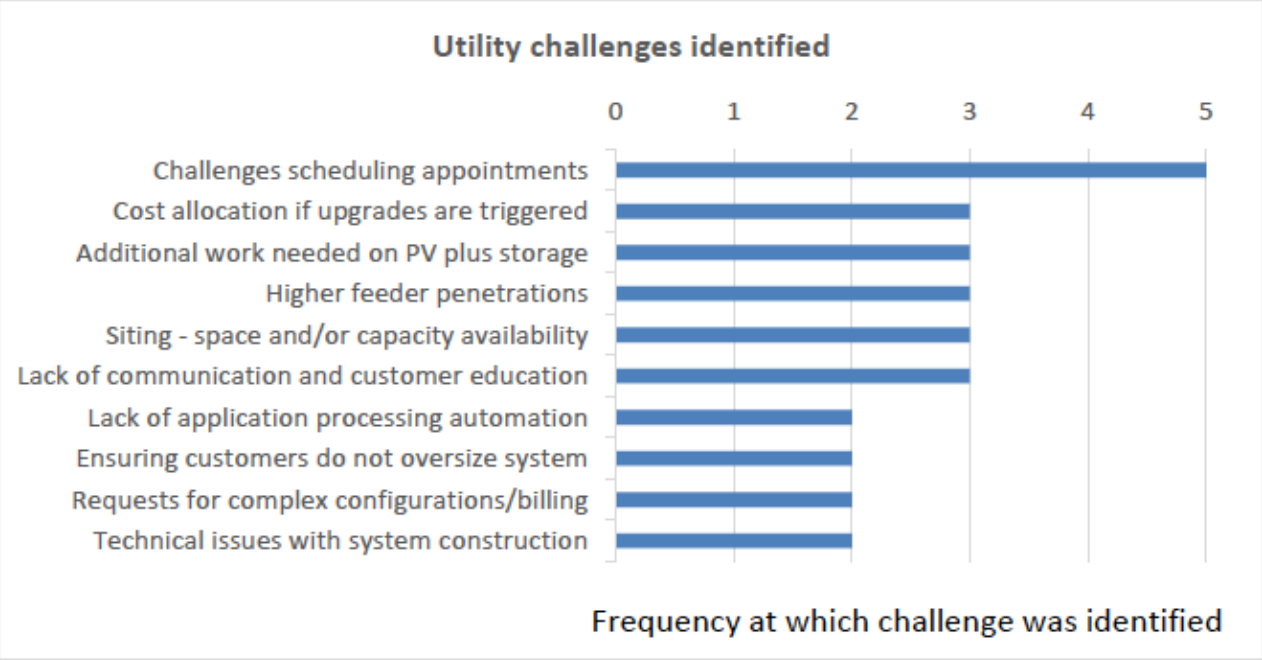


Average mitigation/upgrade cost per impact



https://www.nrel.gov/docs/fy18osti/71232.pdf

Grid Interconnection Challenges: Western United States, 2010-2017



- Who pays for grid costs? The utility, or is it built into the project cost?
- New challenges:
  - Higher levels of penetration
  - PV plus storage interconnection is not well established, though storage can offset some of the need for grid upgrades

https://www.nrel.gov/docs/fy18osti/71232.pdf

Curtailment

Monthly Delivered and Curtailed PV Output in the CAISO System

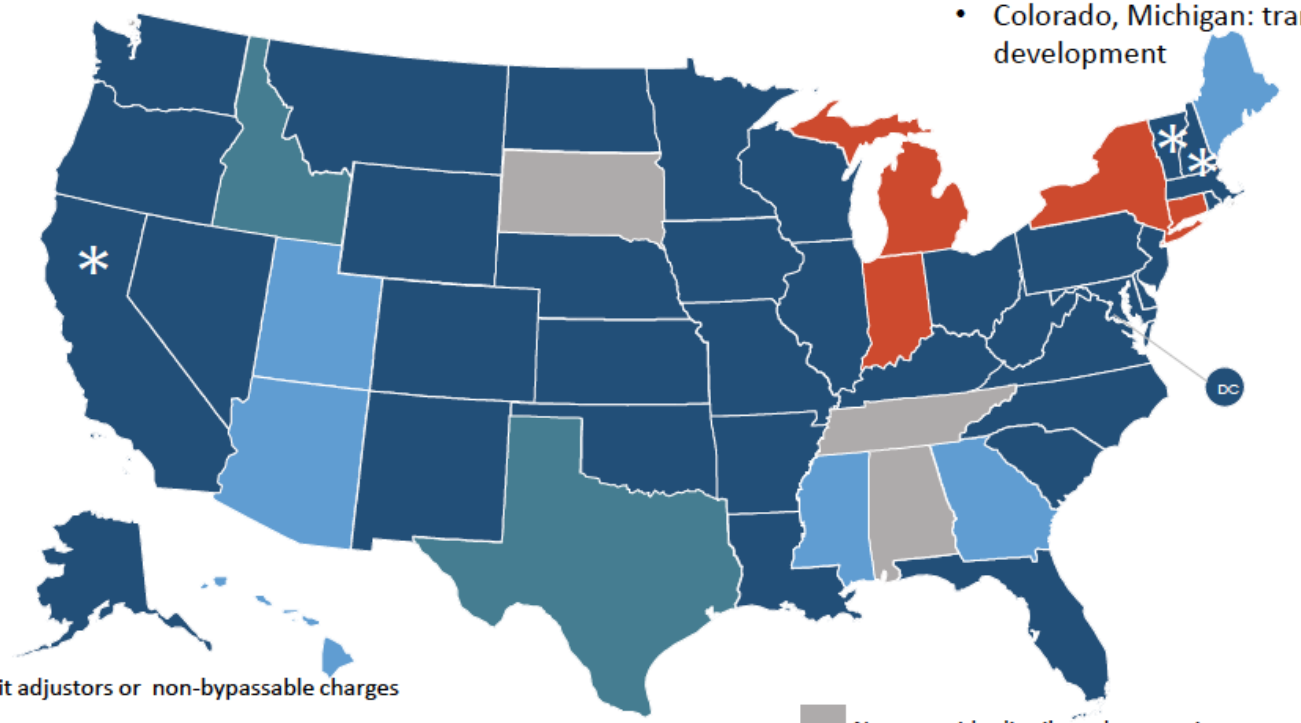
Based on data obtained from CAISO

- In 2018, ~19% of California electricity from solar[1]
  - CAISO curtailed approximately 1.6% of all solar electricity[2]
- Hawaii curtails 10-50% of all solar electricity

1. https://www.seia.org/state-solar-policy/california-solar
2. https://www.nrel.gov/docs/fy19osti/73234.pdf

Distributed Generation Compensation Mechanisms

- Arizona, Georgia, Hawaii, Maine, Mississippi, Utah: transitioned to net billing and other alternatives
- Indiana, New York: rates approved for alternative compensation mechanism
- Colorado, Michigan: transition approved, rates under development



Sources: North Carolina Clean Energy Technology Center, *The 50 States of Solar: Q2 2018 Quarterly Report*, July 2018.

* Per-kWh credit adjustors or non-bypassable charges

- No statewide mandatory net metering rules, but some utilities offer net metering
- State-developed mandatory net metering rules for certain utilities
- No statewide distributed generation compensation rules
- Statewide distributed generation compensation rules other than net metering
- In transition from net metering to other distributed generation compensation rules

https://www.nrel.gov/docs/fy18osti/72036.pdf

Net Metering Policies and Grid Cost Challenges

- Some market participants are concerned that net metering does not finely calculate the costs and benefits of distributed PV to the electricity grid.
- Some utilities are concerned that net metering may encourage cost shifting of grid costs from utility customers with PV to those utility customers without PV

Some actions that could be considered to control grid costs (or their allocation) through net metering include:

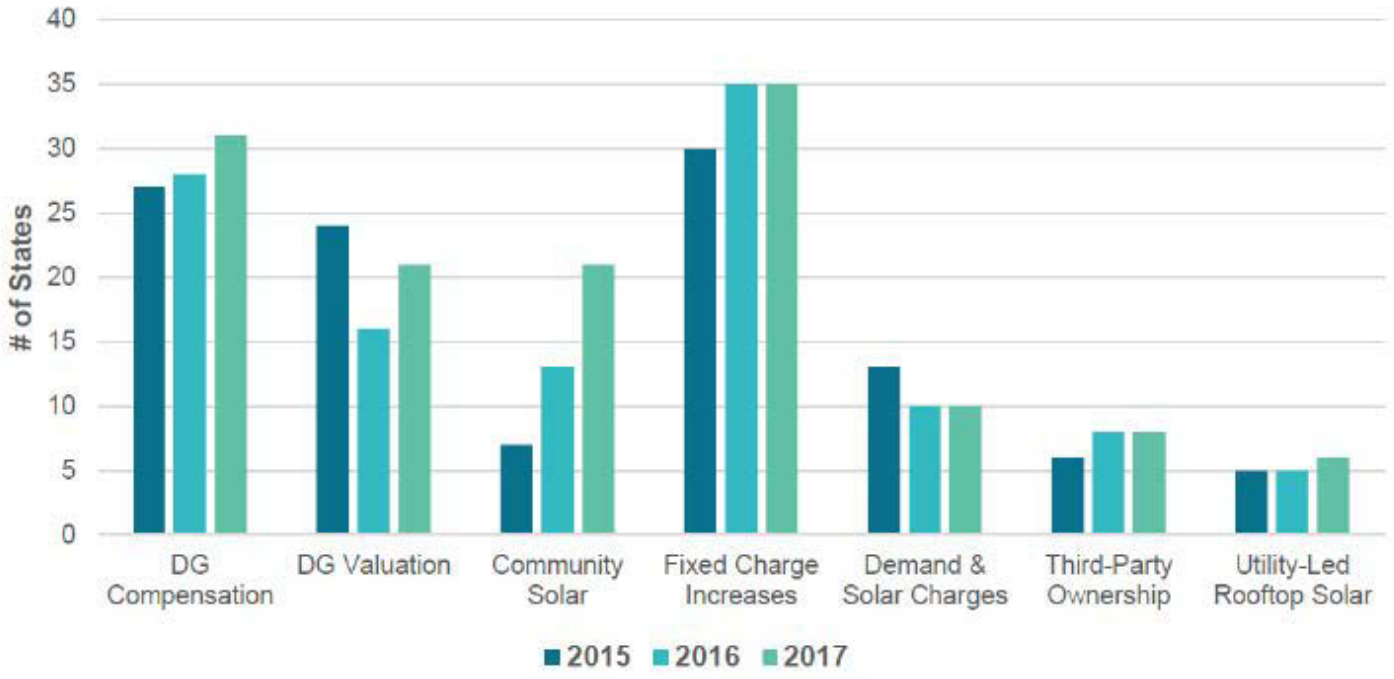
- **System Size Caps:** set the maximum individual system size that can net meter
- **Program Size Caps:** set a limit on the total amount of net-metering systems in a region
- **Net Excess Generation:** rates at which customers are credited for net excess generation (e.g., full retail, less than retail, no compensation)

Other compensation mechanisms

- Feed-in tariffs: a defined rate of return for solar projects to be profitable; limited examples in U.S.
- Two meters / net billing (allows for different rates incoming vs generated)
- Value of Solar tariffs (i.e. Minnesota & Austin, Texas) usually account for:
    - Utility variable costs (fuel and purchased power)
    - Utility fixed costs (generation capacity, transmission, and distribution)
    - Distribution system and transmission line losses
    - Ancillary services (to maintain grid reliability)
    - Environmental impacts (carbon and criteria pollutant emissions)

https://www.nrel.gov/state-local-tribal/basics-net-metering.html, https://www.nrel.gov/state-local-tribal/basics-value-of-solar-tariffs.html, https://www.eia.gov/todayinenergy/detail.php?id=11471

Other Relevant Policies



<u>More recently in 2018-2019</u>

Hawaii, Minnesota, and Nevada moving towards “performance-based ratemaking” which can affect grid costs by incentivizing utilities to:

- Adopt more renewables
- Encourage distributed PV (and storage) adoption
- Use distributed energy resources effectively
- Reduce interconnection costs

https://www.nrel.gov/docs/fy18osti/70917.pdf

Thank You

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