Engaging Utilities and Regulators

SolSmart Advisor Training
Washington, DC
January 25, 2017

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Session Objectives

**Overall Training Objective:** Provide interactive training for advisors on tools and practices that promote solar and reduce barriers to solar development, enabling their communities to achieve bronze, silver, and/or gold SolSmart designation.

Utility Engagement session will provide advisors with understanding of:

- Ownership, regulatory, and market landscape
- Utility-consumer regulatory and business contexts
- Utility perspectives and practices re: rooftop, community, and grid scale solar
- Utility, third party, and consumer solar opportunities
  - Case studies

*What utility strategies should I undertake to facilitate solar development in the region I will be serving as an advisor?*
Agenda

I. Utility Ownership, Structure and Oversight
II. The Utility-Customer Relationship
III. Beneficial Solar Resource Portfolios
IV. Utility, Third Party, Community and Consumer Solar Opportunities
I. Utility Ownership, Structure and Oversight
What is an Electric Utility?

- Electricity is an essential service that is “affected with the public interest”
- Universal electric service is required in the US
- Aspects of utility service are natural monopolies and thus must be regulated
What Does an Electric Utility Do?

Basic Elements of the Grid

Transmission
Distribution
Generation

Generating Station
Generator Step-Up Transformer
Transmission Customer 128 kV or 230 kV
Transmission Lines 765, 500, 230, and 138 kV
Substation Step-Down Transformer
Subtransmission Customer 26 kV or 69 kV
Primary Customer 13 kV or 4 kV
Secondary Customer 120 V or 240 kV
Are All Electric Utilities the Same?

- Utilities ownership structures vary
- Utilities oversight institutions vary
- Utilities scope of services vary
Ownership Structures - IOU

- The Investor Owned Utility (IOU)
  - Owned by equity and debt investors
  - Governed by a Board of Directors appointed by investors
  - Regulated by a Public Utility Commission
Ownership Structures - Muni

• The Municipal Utility (Muni)
  • Owned by a city, county or joint powers authority
  • Governed by a city council or a publicly elected board
  • Accountable to citizens
Ownership Structures - PUD

- The Public Utility District (PUD)
- A government owned electricity-only utility
- Governed by a publicly elected board
- Accountable to citizens
Ownership Structures - Coop

• The Rural Electric Cooperative (Coop)
  • Owned by the consumers served
  • Governed by a board elected by the consumers
  • Accountable to consumers
Utility Oversight – Scope of Regulation

Wholesale vs. Retail Segments of Electricity Service

1. Generating Station
   Electricity is typically generated by a steam- or hydro-driven turbine at the power plant.

2. Step-Up Transformer
   The power is then ramped up to high voltage for long-distance transmission.

3. Transmission
   Next, a series of high voltage lines transmit the electricity through the power grid.

4. Step-Down Transformer
   Power is then reduced to a lower voltage for use in homes and businesses.

5. Subtransmission
   Customer
   The electricity then passes through a series of switches to distribution lines.

6. Customers
   Power is then delivered to customers via local lines.

Source: NY ISO
Utility Oversight - Federal

• All utilities are subject to federal regulation by FERC on certain wholesale electric transactions and investments
• All utilities are subject to reliability organizations who establish standards that protect public health and safety
• In this session we are primarily concerned with local regulation
Utility Oversight - State

- The IOU is regulated by a public utility commission (PUC)
- The PUC Commissioners oversee a quasi-judicial regulatory process
- Commissioners are appointed by the Governor or elected
- The PUC is charged with ensuring “just and reasonable rates” and implementing guiding statutes with regulation
Utility Oversight - Local

- Munis, PUDs, and Coops are overseen by elected boards
- Utility management must justify investments, expenditures, and rates before their boards
- Utility goals and the scope of board oversight are locally determined
Scope of Service – Non-restructured

• The Vertically Integrated Electric Utility in a Non-restructured State
  • Own or purchase transmission, distribution, generation resources and distributed energy resources
  • Responsible for providing electric services to all customers in their franchise territory
States With Restructuring Activity As of 2010

Source: http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html
Scope of Services - Markets

Regional Transmission Organizations

- Alberta Electric System Operator
- Electric System Operator (IESO)
- Midcontinent ISO (MISO)
- New York ISO (NYISO)
- New England ISO (ISO-NE)
- PJM
- Electric Reliability Council of Texas (ERCOT)
- Southwest Power Pool (SPP)
- California ISO (CAISO)
“Restructuring”

• In some places it means the utility was required to divest its generation assets

• In some places it means the utility is distribution service only, and retail competitors provide services to customers

• In all places it means the utility operates in a market environment, but the nature of the market interaction and scope of regulation varies
Regulatory and State Policies

- Net Energy Metering (NEM) or other DG tariff policies
- IRP and Renewable Portfolio Standards (RPS)
- Decoupling
- Shared solar/community solar programs
- Interconnection policies
- Incentive regulation
II. The Customer – Utility Relationship
Rate Determination Overview

Rate Base × Rate of Return
+ Operating Expenses
= Revenue Requirement

÷ Sales
= Rate per kWh
How Does the Commission Regulate Revenue Requirement?

- **Rate Base**: Providing service or not? Prudently incurred?
- **Rate of Return**: What is the appropriate capital structure? The appropriate return on equity?
- **Operating Expenses**: Which expenses are allowable for ratemaking? Imprudent? Not related to providing service? Political?
Rate Base

• Rate Base
  - Total Plant in Service at Original Cost
  - Less Accumulated Provision for Depreciation
  - Adjustments
Plant in Service Example

- Generation
  - $40,000,000
- Transmission
  - +$10,000,000
- Distribution
  - +$60,000,000
- General Plant
  - +$20,000,000
- Total Plant in Service
  - =$130,000,000
Rate Base Example

• Plant in Service
• - Accumulated Depreciation
• = Net Plant in Service
• + Working Capital
• + Regulatory Assets
• - Deferred Taxes
• = Rate Base

• $130,000,000
• ($30,000,000)
• $100,000,000
• $ 5,000,000
• $ 1,000,000
• ($6,000,000)
• $100,000,000
Rate of Return

- Equity Ratio
  - \times \text{ Allowed Return on Equity}
  - = \text{ Weighted Equity Cost}

- Debt Ratio
  - \times \text{ Cost of Debt}
  - = \text{ Weighted Debt Cost}

- \text{ Sum} = \text{ Rate of Return}

\begin{itemize}
  \item 50\%
  \item 10\%
  \item 5\%
  \item 50\%
  \item 6\%
  \item 3\%
  \item 8\%
\end{itemize}
Operating Expense Example

- Production
- Transmission
- Distribution
- Administrative and General
- Taxes

Total Expenses:

- $10,000,000
- +$1,000,000
- +$5,000,000
- +$2,000,000
- +$2,000,000

- $20,000,000
Revenue Requirement Example

- Rate Base
- X Rate of Return
- = Return Requirement
- + Operating Expenses
- = Revenue Requirement

- $100,000,000
- x 8%
- $8,000,000
- $20,000,000
- $28,000,000
How Does the Commission Regulate Rates?

- **Cost Allocation**: How much of the revenue requirement is paid by each customer class?

- **Operating Expenses**: Which expenses are allowable for ratemaking? Imprudent? Not related to providing service? Political?

- **Rate Design**: How shall costs be divided between customer charges, energy charges, and other types of charges?
Rate Design Principles

• A customer should be able to connect to the grid for no more than the cost of connecting to the grid.

• Customers should pay for power supply and grid services based on how much they use and when they use it.

• Customers supplying power to the grid should receive full and fair compensation – no more and no less.
Key Issues in Rate Design

- Residential vs. Commercial/Industrial
- Fixed Charges
- TOU Rates
- Demand Charges
- Inclining Block Rates
- Single-Family vs. Multi-Family

The way in which rates are structured directly affects the economic value of solar to end users and utilities.
Cost Allocation between Classes

- “Cost of Service” is almost meaningless
- Embedded cost (backward looking)
- Marginal cost (forward looking)
- Different approaches for:
  - Production
  - Transmission
  - Distribution
Embedded Cost Example

• **Production**
  - Classification of costs between “demand” and “energy”
  - Differential treatment of baseload, intermediate, peaking, and variable renewables
  - Allocation of demand-related costs across 1-hour, 12-hours, 200-hours or a different metric
  - Allocation of costs over TOU periods
Marginal Cost Example

Production

- Peaker or Demand Response (new as DR proliferates) as the proxy for “capacity”
- 1 hour, 12 hours, 200 hours for peak?
- Long-run marginal costs (construction + operation) or only operating costs for the “energy” component?
Bottom Line: NO CORRECT ANSWER

- As many methods of calculating “cost of service” as analysts performing studies
- Devil is in the details
- A bad cost of service study often leads to bad rate design
## Regulatory and State Policies

<table>
<thead>
<tr>
<th>Policy</th>
</tr>
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<tbody>
<tr>
<td>Net Energy Metering (NEM) / Other DG Tariff Policies</td>
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<tr>
<td>IRP and Renewable Portfolio Standards (RPS)</td>
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<td>Decoupling</td>
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<td>Shared solar/community solar programs</td>
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<td>Interconnection policies</td>
</tr>
<tr>
<td>Incentive regulation</td>
</tr>
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</table>
Tariffs Matter

Net Energy Metering (NEM)

A *billing mechanism that compensates residential and commercial customers for the solar power they export to the electricity grid.*

Most commonly used tariff design for customers with behind-the-meter PV

- More than 90% of all U.S. rooftop PV, and nearly all residential PV systems

More than 40 states have adopted some form of a NEM policy

- NEM policies vary widely by state, notably with respect to
  - The amount of credit awarded to customers for net excess generation in a billing period.
  - The amount of time that the credit is valid

What is virtual net metering?

www.solismart.org
Tariffs Matter

Customer Credits for Monthly Net Excess Generation (NEG) Under Net Metering

www.dsireusa.org / July 2016

NEG credited at retail rate; credits do not expire
NEG credited at retail rate at first, then credits expire or are reduced (e.g., to the avoided cost rate at the end of year)
NEG credited at less than retail rate (e.g., avoided cost rate)
NEG is not compensated
No statewide mandatory net metering rules

NOTE: The map shows NEG credits under statewide policies for investor-owned utilities (IOUs); other utilities may offer different NEG credit amounts. IOUs in HI, NV, MS, and GA have other policies for compensating self-generators. Some IOUs in TX and ID offer net metering, but there is no statewide policy. IOUs in WI differ in their treatment of NEG.
### Tariffs Matter

#### Other DG Compensation Mechanisms

<table>
<thead>
<tr>
<th>Example</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feed-in Tariffs (FITs)</strong></td>
<td>Long-term, fixed-price contracts (price certainty), based on the cost of solar generation; degression</td>
</tr>
<tr>
<td><strong>Value of Solar Tariffs (VoS)</strong></td>
<td>Credit value set at calculated utility cost to generate and deliver a unit of solar energy to the point of consumption; aim: revenue neutrality</td>
</tr>
<tr>
<td><strong>Time-of-Use (TOU) Pricing</strong></td>
<td>Pricing base on rate structure that varies charges depending on the time of day and season the energy is used (peak and off peak times)</td>
</tr>
<tr>
<td><strong>Distributed Locational Marginal Pricing (DLMP)</strong></td>
<td>Location, real-time demand, and grid congestion conditions determine compensation</td>
</tr>
</tbody>
</table>
Other Incentives (CAPEX)

Incentives are variable across states and cities and reduce upfront installation costs, thus accelerating payback.

**Federal**
- Investment Tax Credit (ITC)
- Modified Accelerated Cost Recovery System (MACRS)

**State**
- Renewable Energy Tax Credit (%), Rebate ($/W), sales tax exemptions
- Solar Renewable Energy Credits (SRECs)

**Local**
- Subsidized loans, property tax exemptions, for solar energy system owners
Preference Policies Matter

Integrated Resource Planning (IRP)

A utility roadmap for providing reliable and least-cost electric service to customers according to forecasted annual peak and energy demand (load growth), through supply- and demand-side resources over a specified future period.

IRP often required by state legislation or regulation
Terms vary: planning horizon, frequency of plan updates (typically 3-4 years), required resources to be considered, stakeholder involvement, PUC responsibility

Resource Plan Considerations

- Load forecast
- Reserves and reliability
- Demand-side management
- Supply options
- Fuel prices
- Environmental costs / constraints
- Evaluation of existing resources
- Integrated analysis
- Time frame
- Uncertainty
- Valuing and selecting plans,
- Action plan
Preference Policies Matter

IRP Flow Chart

- Load Forecast
- Identify Goals
- Existing Resources
- Need for New Resources
  - Supply
  - Demand
  - T & D
  - Rates
  - Social Environmental Factors
- Define Suitable Resource Mixes
  - Uncertainty Analysis
  - Public Review/PUC Approval
- Acquire Resources
- Action Plans
- Monitor

Source: Oak Ridge National Laboratory
Preference Policies Matter

Renewable Portfolio Standard (RPS)

State policies that specify the percentage (and timing) of electricity that must be supplied by renewable resources.

• Variations include:
  • Technology eligibility
  • Percentage of electricity and timing
  • Presence of “carve-outs,” the required minimum share of electricity derived from specific resources
  • Utility responsibility (mandate vs. goal; application)
  • Provisions addressing ratepayer impacts (e.g., cost caps)
  • Use of tradable renewable energy credits
  • Non-compliance penalties
Preference Policies Matter
Renewable Portfolio Standard Policies

www.dsireusa.org / August 2016

Renewable portfolio standard

Renewable portfolio goal

Extra credit for solar or customer-sited renewables

Includes non-renewable alternative resources

Credit:
Preference Policies Matter
RPS w/Solar or DG Provisions

Renewable Portfolio Standard with solar/distributed generation (DG) provision

Renewable Portfolio Goal with solar/DG provision

(E): Solar Electric
PV: Solar Photovoltaic
DG: Distributed Generation
(M): Multipliers
(CST): Customer - Sited

Delaware allows certain fuel cell systems to qualify for the PV carve-out

Solar water heating counts toward solar/DG provision

22 States + DC have an RPS with solar or DG provisions

www.dsireusa.org / August 2016

Credit:
www.solsmart.org
Preference Policies Matter

Decoupling

The severing of the direct connection between a utility’s revenue/profits and kWh sales volume.

- Traditional regulation sets a revenue requirement, based on costs, then divides that by sales and calculates rates. The rates remain constant, even though the sales may vary.
- Decoupling aligns financial returns with meeting revenue targets, and adjusts rates up or down to meet the target at the end of an adjustment period.
- Decoupling is designed to make the utility indifferent to selling less product (energy) and improves the prospects for energy efficiency and distributed energy resource development.
Preference Policies Matter

Electric Decoupling in the U.S. (January 2016)

- Adopted Electric Decoupling (15)
- Pending Electric Decoupling (8)
- No Electric Decoupling (28)

Source: NRDC

www.solsmart.org
Preference Policies Matter

Community Solar

An arrangement in which customers subscribe to or own shares of an off-site PV array and are compensated (e.g., on-bill credit) for the electric production of their portion of the PV system.

Source: Smart Electric Power Alliance (SEPA)
Preference Policies Matter
Community Solar – Rising Popularity

**Consumer Drivers**
- Increased customer access to solar (via virtual NEM)
- More cost effective than distributed projects (scale economies)
  - Lower install / maintenance costs
  - Higher per kW energy production
  - Reduced upfront investment by spreading costs across multiple subscribers
- Increase customer equity from solar projects

**Utility Drivers**
- Proactive customer engagement
- Preserved customer base
- Model/structural flexibility
- Utility siting control / influence
- Lower cost of compliance, portability
- Support to local PV industry
- Gain experience in PV market

www.solsmart.org
Incentive Regulation

The use of rewards and penalties to induce the utility to achieve desired goals where the utility is afforded some discretion in achieving those goals.

Incentive regulation can be introduced through a variety of regulatory tools, including:

• Price setting regimes with inbuilt incentives
• Efficiency reviews focused on controllable costs
• Benchmarking
• Performance targets associated with both rewards and penalties
Interconnection Policies

Adherent to state-level standards

Efforts underway to streamline the interconnection process
  • Online portals, simplified forms, stipulated fees/timelines

Utility main concerns and objectives
  1. Safety
  2. Reliability
  3. Exported power is measurable; required voltage, frequency, and power quality are met
  4. Only certified equipment is used
Reliability Matters

The Challenge of Grid Integrating Variable PV: Is PV Coming to a Feeder Near You?

US Future? 302 GW PV by 2030

Germany – Power Demand for one week in May 2015

60 GW

DOE “SunShot” Vision Study, Released February 2012

Is the grid ready for PV?
Reliability Matters

Main Issue for Distribution: PV Variability

December 2011: Tennessee 1MW PV System Power

Calendar profiles are 1-minute averages derived from 1-sec data
Reliability Matters
Electric Grid Takes Advantage of Load Diversity and Smooths Demand

Residents on Feeder (ROF)

~2000  ~1000  ~300

![Diagram showing electric grid reliability and load diversity]
Reliability Matters

Common Utility Concerns Raised

Voltage
- Overvoltage
- Regulation
- Voltage quality

Equipment Operation
- Feeder regulators
- Load tap changers
- Switched capacitor banks

Demand
- “Masking” peak demand
- Reduced power factor

System Protection
- Relay desensitization
- Unintentional islanding

www.solismart.org
Reliability Matters
Feeder Hosting Capacity: A Brief Primer

Baseline – No PV
PV Penetration 1
PV Penetration 2
PV Penetration 3
Beyond…

Increase Penetration Levels Until Violations Occur
• voltage
• protection
• power quality
• thermal

Process is repeated 100’s of times to capture many possible scenarios
Key Factors that Determine How Much PV a Feeder Can Accommodate (Hosting Capacity)

- **Size** of PV
- **Location** of PV
- Feeder characteristics
- Electrical proximity to other PV
- Unique solar resource characteristics in the area
- PV control options (e.g., var control)
Depending on the context, there are a number of approaches that utilities can institute to integrate PV and other variable distributed energy resources.

- Smart Inverters
- Reconductoring
- Battery / Energy Storage
  - Not (yet) cost effective, but value stacking opportunities
- Locational deployment strategies
Reliability Matters

Inverter – Role in PV Plants

*PV inverter converts DC energy from solar modules into AC energy and interface the PV system with electricity grid*

**Traditional Inverter**
- Harvesting maximum power from PV array
- Matching plant output with grid voltage and frequency
- Providing unintentional islanding protection

**Smart Inverter**
- Voltage Management
- Bulk System Support
- Communication / Interactivity with grid

[Images of solar panels, inverter, and power grid]
Reliability Matters

Functions of Smart Inverters

Voltage Management
- Volt-Watt Control
- Fixed Power Factor
- Volt-VAR Control

Bulk System Support
- Voltage Ride-through
- Freq Ride-through
- Freq-Watt Control

Comm. & Interactivity
- Configuration
- Coordination
- R/T Feedback
### Reliability Matters

**Variable PV Grid Integration Challenges**

<table>
<thead>
<tr>
<th>Revenue/Margin Erosion</th>
<th>Net metering, solar rates/tariffs, other billing arrangements can affect utility volumetric sales; however, PV value can be harmonized.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-subsidization</td>
<td>Customer fairness re: power system cost shift to non-solar customers.</td>
</tr>
<tr>
<td>Customer Disintermediation</td>
<td>Rising third-party PV electricity sales and direct end-user purchases potentially minimize or sever utility relationships with retail customers.</td>
</tr>
<tr>
<td>Changes to Dist. &amp; Trans. Planning</td>
<td>Added layers of utility planning to account for the variable nature of distributed solar and its potential to alter load curves.</td>
</tr>
<tr>
<td>Grid Reliability Challenges</td>
<td>Grid integration and management processes and protocols—infrastructural upgrades (e.g., relays, reclosers, conductors, transformers), monitoring capabilities, and maintenance activities—must be adopted to accommodate two-way PV power flows.</td>
</tr>
<tr>
<td><strong>System Losses</strong></td>
<td>Avoided system losses given distributed PV siting at load pockets.</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Avoided Energy Value</strong></td>
<td>Avoided utility costs associated with procuring the displaced marginal resource needed to meet customer demand.</td>
</tr>
<tr>
<td><strong>Capacity Deferral</strong></td>
<td>Deferred central station generation additions and associated costs.</td>
</tr>
<tr>
<td><strong>Generation O&amp;M</strong></td>
<td>Energy produced by PV may reduce conventional asset run times along with their fixed and variable O&amp;M expenses. However, increased O&amp;M may also occur due to cycling.</td>
</tr>
<tr>
<td><strong>Distribution Costs/Benefits</strong></td>
<td>Net change in distribution infrastructure due to PV can be positive if PV reduces system constraints, extends asset life, enables grid and generation deferral, etc. It can be negative if PV requires infrastructure upgrades or increased O&amp;M for distribution assets.</td>
</tr>
<tr>
<td><strong>Transmission Cost/Benefits</strong></td>
<td>Same as above. Also, transmission capacity costs can be avoided to the extent that solar produces during peak demand periods that drive load related transmission investments.</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Environmental emissions reductions can be commensurate to the generation being displaced by PV. Potentially cost savings realized with a future national carbon adder or tax.</td>
</tr>
</tbody>
</table>
Reliability Matters
Variable Energy Resource Integration Impacts

Benefits
- Energy, Capacity & Ancillary
- Frequency Support
- Loss Reduction
  - T&D Avoided Capacity
  - Loss Reduction
  - Voltage Support
- Central Generation
- Transmission
- Sub-transmission
- Substation
- Distribution
- Customer

Challenges
- Generation Capacity & Ancillary Service
- Voltage & Frequency Stability
- Increasing Re-dispatch Transmission Constraint
- Reverse Power Flow Reactive Power Balance
- Prevalent Voltage, Capacity & Protection Issues
- Localized Voltage & Capacity in Long Circuits
III. Beneficial Solar Resource Portfolios and Integration Possibilities
For Discussion

- What are utility benefits, costs, challenges, and opportunities associated with different PV portfolios?
- Rooftop PV
- Shared Solar (Community Solar)
- Grid-Scale Solar
Rooftop PV: 1-10kW / 10-100kW

**Costs**
- Least cost competitive on $/kW basis
  - Though approaching cost parity in growing number of states

**Benefits**
- Grid investment deferral

**Challenges**
- Greater grid integration and utility planning challenges

**Opportunities**
- Financing: loan, lease, etc.
- In front-of-the-meter deployment
Shared Solar: 1-5MW

**Costs**

- More cost effective than distributed projects (scale economies)
  - Lower install / maintenance costs
  - Higher per kW energy production

**Benefits**

- Greater customer access
- Proactive customer engagement / Preserved customer base
- Increased customer equity from solar projects

www.solsmart.org
Shared Solar: 1-5MW

Challenges
- Policy supports
- Feasibility in regulated utility environments

Opportunities
- Model/structural flexibility
- Utility siting control / influence
- Support to local PV industry
- Gain experience in PV market
Grid Scale Solar: 5MW+

Costs

- Most cost effective on $/kW basis

Benefits

- RPS compliance
- Economies of scale

Challenges

- Performance and Reliability
- CAPEX vs OPEX tradeoffs

Opportunities

- Ownership, rate base
Beneficial Complementarities Among Solar Resources

- Locational value of rooftop PV
- Distribution deferral value of shared solar projects
- Cost performance of grid scale solar
- Locational diversity benefits
The Solar Integration Challenge

- What is the Duck Curve?
- DER integration opportunities
- Grid scale integration opportunities
What’s a “Duck Curve?”

Figure 1

California Independent System Operator Duck Curve

Net load - March 31

Ramp need
≈13,000 MW
in three hours

Overgeneration risk

Megawatts

12am 3am 6am 9am 12pm 3pm 6pm 9pm
Why is This an Issue?

- Solar helps meet daytime load.
- Loads still rise in the early evening.
- Compounded by wind coming and going.
How Do Utilities Manage This Now?
Ten Strategies to Align Loads to Resources (and Resources to Loads) with **Illustrative** Values for Each

1. Targeted energy efficiency
2. Peak-oriented renewables
3. Manage water pumping
4. Grid-integrated water heating
5. Storage air-conditioning
6. Rate design
7. Electricity storage in key locations
8. Demand response
9. Inter-regional exchanges
10. Retire inflexible older generating units

Not every strategy will be applicable to every utility.
The Objective:
An End-State Flatter than the Pre-Solar Load
There are Grid Scale Solutions as Well

- Grids
- Inter-connectors
- Market geography
- Market operations
- Generator flexibility
- Demand participation
- Electricity storage
- Energy & services markets
- CRM
IV. Utility, Third Party, Community and Consumer Opportunities
Positioning Utilities for an End Goal

Transitioning from a passive player …

…to a proactive partner with solar customers and developers

Note: Adapted from the Smart Electric Power Alliance (SEPA)
Identified Utility Business Model Strategies

Near-Term
- Solar Calculator
- Preferred Vendor List
- Solar Map
- Website FAQs
- Equipment Standards

Mid-Term
- On-Bill Financing
- Tailored Incentives
- Green Power Programs (PPA)
- REC Loan Programs / Leasing
- Development Fund Investment
- Community Solar
- Utility Asset Ownership
- Value-Added Consulting Services
- Interconnection Application Portal

Longer-Term
- TPO Partnership
- Franchise Programs
- O&M Services
- Smart Inverter Ownership / Control
- Virtual Power Plant Operation
- Energy Services via Unbundled Rates

Sources: SEPA and EPRI
Note: Ratemaking and rate design reform is largely not addressed in this list of opportunities.
Mapping efforts dynamically illustrate distribution system areas suitable for PV
Set expectations about the interconnection process and costs to the public
Available in CA, HI, NY

Snapshot: Near-Term Opportunity
Improved Info Transparency: Online Congestion Mapping

ConEd’s NYC Solar MAP
- Estimates solar rooftop potential for buildings in NYC
- Calculates financial paybacks
- Screening tool will interpret factors that can affect interconnection
- Public DB to catalog project locations and cost results
- Guide to present costs for typical mitigation strategies
Web-based tool provides high level information for customers on how much energy they can get from a solar system

Value and opportunity messaging driven by the utility

Potential to integrate cost estimates for the system and bill impacts
Snapshot: Mid-Term Opportunity

Renewable Energy Certificate Loan Program

Utility investment in customer projects or solar companies via rate basing, solar loans, or related services

Potential Benefits:
• Long-term, lower cost loans
• Could earn rate of return

Key Loan Program Components
• Invest money in solar loans to customers / 3rd-party developers
• Define eligible system size thresholds
• Determine loan terms
• Set up means for accepting RECs for loan repayment
• Determine feasibility of cost recovery
• Establish project development tranches of customer-sited solar
**Case Study**

**Solar Loans Program: Public Service Electric & Gas**

**Program Overview**
- PSE&G provides capital, covers 40-60% of upfront PV project costs
  - Residential: 10-year loan terms at 6.5%
  - Commercial: 15-year terms at ~11%
  - Max loan amounts based on expected system production over loan term
- Loans repaid with cash or through SRECs
  - PSE&G sells received SRECs in auction and credits customers; applies SRECs toward RPS compliance
- PSE&G recovers net monthly cost through electric tariff, that applies to all rate schedules equal percentage basis
- Customers responsible for system maintenance

**Value Drivers – Utility**
- Demand forecast fulfillment, RPS/GHG reduction compliance
- Broadened PV customer participation
- Earned rate of return
- Reduced SREC market volatility
- Enhanced customer relationship

**Value Drivers – Customers**
- Increasing financial access and flexibility to go solar
- Transferability
- Education and awareness

[Images of solar panels and homes]
• Smart inverter standards under development
  • Advanced functionality (left) similar to distribution system assets commonly deployed today e.g. load tap changers, voltage regulators, shunt capacitors
• Business case can be made that utilities should own smart inverters and provide to customers going solar

Numerous opportunities…
  … as well as challenges
<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Grid Impact Mitigation (Avoided Cost)</th>
<th>Revenue Generation</th>
<th>Customer Relations</th>
<th>Implementation Difficulty Level</th>
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<tr>
<td>Solar Calculator</td>
<td></td>
<td>X</td>
<td></td>
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<td>Preferred Vendor List</td>
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<td></td>
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<td>Solar Map</td>
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<tr>
<td>REC Loan Programs / Leasing</td>
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<td>Development Fund Investment</td>
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<td>2</td>
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<td>Community Solar</td>
<td>X</td>
<td>X</td>
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<td>2</td>
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<tr>
<td>Utility Asset Ownership</td>
<td>X</td>
<td>X</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Value-Added Consulting Services</td>
<td>X</td>
<td>X</td>
<td></td>
<td>2</td>
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<tr>
<td>Interconnection Application Portal</td>
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<td></td>
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<tr>
<td>TPO Partnership</td>
<td></td>
<td>X</td>
<td></td>
<td>3</td>
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<tr>
<td>Franchise Programs</td>
<td></td>
<td>X</td>
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<td>3</td>
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<td>O&amp;M Services</td>
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<td>X</td>
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<td>Smart Inverter Ownership / Control</td>
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<td>3</td>
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<td>Virtual Power Plant Operation</td>
<td>X</td>
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<td>X</td>
<td>3</td>
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<tr>
<td>Energy Services via Unbundled Rates</td>
<td></td>
<td></td>
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</table>
CASE STUDY: Controllable Loads as a Local Third Party Service

Two Examples:

- Multi-family Controllable Water Heaters
- Aggregated Commercial Load
Why Multi-Family

- Access and Crew Efficiency
- Communications and Controls
- Renters with few money-saving options
Emerging Technology: Multi-Family Shared Heat Pump

Source: Ken Eklund, WSU Energy Program
Mobile Home: Perhaps Half Convertible to Heat Pump
Water Heating Peak Load Impacts

Before: 23 GW
After: 2.5 GW

- Mobile Home
- Multi-Family
- Single-Family
Water Heating Energy Impacts

Before: 126 GWh
After: 79 GWh
Water Heating Load Shift Impacts

<table>
<thead>
<tr>
<th>GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
</tr>
<tr>
<td>120</td>
</tr>
<tr>
<td>100</td>
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<td>80</td>
</tr>
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<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

**Before**
- Low-Cost Hours
- Mid-Cost Hours
- High-Cost Hours

**After**
- Low-Cost Hours
Combined Peak Demand Impact

Need to amend to include water pumping
Combined Load Shift Potential

Need to amend to include water pumping
Bottom Line: Huge Potential for Peak Load Reduction and Load Shifting to Low-Cost Hours

1-2 MWh/day ≥ 1 kW of Renewable Generation Adaption
Maybe Enough to Adapt to ~50% Variable Renewables

RAP Rough Planning Level Estimates: Robust Analysis Needed
Second Example: Aggregated Commercial Loads

Pacific Northwest Aggregated Demand Response Project

Courtesy of: John Steigers, Energy Northwest
What is the Pilot?

- BPA, as balancing authority, is obliged to balance its system
  - 4,300(+) MW intermittent wind generation
  - Increasingly less capacity and flexibility of its hydroelectric resources
- EN’s Pilot provides BPA 35 MW of Fast Firm INC balancing reserve
  - “Fast” < 10-minute Response From Notification
  - “Firm” 24/7 obligation to perform; no “opt-out” in real time
  - “INC” Load Reduction (same net effect as a generation increase)
- BPA compensates EN with performance-based capacity fee
  - Incentives to participants from EN.
  - No event or energy-based compensation; capacity fee only
  - Limits on call frequency, number, and duration
- Timeline – February 2015 through Jan 2016
- Diverse load-response assets
<table>
<thead>
<tr>
<th>Location</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asotin County PUD</td>
<td>Clark Public Utilities</td>
</tr>
<tr>
<td>Benton County PUD</td>
<td>Cowlitz County PUD</td>
</tr>
<tr>
<td>Chelan County PUD</td>
<td>Ferry County PUD</td>
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<td>City of Port Angeles</td>
<td>Franklin County PUD</td>
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<td>City of Richland</td>
<td>Grant County PUD</td>
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<td>City of Centralia</td>
<td>Grays Harbor County PUD</td>
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<td>Clallam County PUD 1</td>
<td>Jefferson County PUD</td>
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<td>Kittitas County PUD</td>
<td>Klickitat County PUD</td>
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<tr>
<td>Lewis County PUD</td>
<td>Mason County PUD 1</td>
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<td>Mason County PUD 3</td>
<td>Mason County PUD 3</td>
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<td>Okanogan County PUD</td>
<td>Okanogan County PUD</td>
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<tr>
<td>Pend Oreille County PUD</td>
<td>Seattle City Light</td>
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<td>Skamania County PUD</td>
<td>Snohomish County PUD</td>
</tr>
<tr>
<td>Tacoma Public Utilities</td>
<td>Wahkiakum County PUD</td>
</tr>
</tbody>
</table>
Results

- 85 Events; 94% success; 98% availability
- Awarded national award for innovation and excellence in DR programs by Peak Load Management Alliance (PLMA)
- Strongly demonstrated:
  - Effective use of a demand response based resource as an in-hour balancing reserve for BPA.
  - High performance of an all-public-power aggregated demand resource team.
Interconnection Basics and Best Practices Case Study
Overview of Various DER Connection Requirements in U.S.

Review: Interconnection is the technical and administrative linking of a generator to the utility grid. The interconnection process is a series of required steps that verify a (solar) system’s compliance to the utility’s technical and administrative requirements.

Note: Upward arrows point at the requirements that are directly referenced.

Source: EPRI
Interconnection and permitting processes proceed in parallel:

- Local Permitting Jurisdiction: Submit building permit application and materials
- Building permit review and approval
- Installer completes PV construction
- Final building inspection and approval

- Utility Interconnection Approval: PV installer submits application for interconnection agreement
- Utility application review and approval
- PV installer submits paperwork for utility PTO, including verification of passed building inspection
- Utility issues permission to operate (PTO)

Coordinating interconnection and permitting processes represents a challenge and a time-saving opportunity.

Source: http://www.nrel.gov/docs/fy15osti/63556.pdf
Fast-track screens are the first stop, and often the only stop necessary, in the application review process. Incorporating fast-track screens into the review process is one of the most effective ways to decrease average application review response times.
Interconnection Best Practices Case Study
SDG&E’s Distributed Interconnection Information System (DIIS)

Setting the Context: Rising PV Demand in Southern California
→ 2012 to 2013 saw NEM installations in SDG&E service area more than double from 5,200 to ~11,000
→ SDG&E realized its manual interconnection review and authorization process would not be able to handle the increasing volume of applications.

Motivation: Utility and Solar Owner Economics are Aligned
Rising distributed PV demand

More Interconnection Applications
Increased cost for utility

Slower Turnaround Times
Increased cost for solar owner
The Solution: Distributed Interconnection Information System (DIIS)

A software tool designed to accelerate interconnections by offering a single online portal that benefits all parties:
1. **Contractors and end-use customers** can submit and track applications from any web-enabled device
2. **Local jurisdictions** can remotely coordinate the authorization process
3. **SDG&E’s** grid reliability and safety management capabilities are enhanced
Interconnection Best Practices Case Study

Benefits

A Closer Look: Contractors and End-use Customers

a) Provides a step-by-step pathway for submitting necessary forms online
b) Obligatory milestone progress monitoring in real time
c) Automated status updates
d) Access to a library of information and self-service tools to increase efficiency
Interconnection Best Practices Case Study

Benefits

A Closer Look: Local Jurisdictions

a) Ability to search for project applications by their electric permit numbers and access them from any web-enabled device
b) Ability update DIIS database remotely by uploading approved electrical releases
A Closer Look: SDG&E

a) Superior reporting and analytics
b) Internal and external workflow management
c) Remote Meter Configuration (RMC)
d) Reverse Power Flow Remediation (RPF)
e) Fast track supervision
# Interconnection Best Practices Case Study

## Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorization Time (&lt;30kW)</td>
<td>0</td>
<td>2.2 days</td>
<td>2.2 days</td>
<td>2 days</td>
<td>2.9 days</td>
</tr>
<tr>
<td>Authorization Time (&gt;30kW)</td>
<td>&gt;5 days</td>
<td>3.9 days</td>
<td>5 days</td>
<td>3.5 days</td>
<td>6.1 days</td>
</tr>
<tr>
<td>Authorized Application (month)</td>
<td>475</td>
<td>910</td>
<td>1,311</td>
<td>2,267</td>
<td>2,657</td>
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<tr>
<td>FastTrack Authorization</td>
<td>8%</td>
<td>11%</td>
<td>25%</td>
<td>50%</td>
<td>68%</td>
</tr>
</tbody>
</table>

* Through 9/30
Interconnection Best Practices Case Study
SDG&E’s Distributed Interconnection Information System (DIIS)

Achieved and Expected Savings

Note: Does not include contractor savings or other soft benefits.
Source: San Diego Gas & Electric
Utility practices to expedite and improve upon the administrative and technical review processes.

### Administrative review process

- **Online Applications:** Develop an online application.
- **Website Resources:** Introduce a process overview, FAQs, and informational resources into the utility website.
- **Status Communication:** Provide online, on-demand status communication for customers.
- **Automation of Common Tasks:** Automate data entry, document generation, and detection of errors or potential problems in applications.
- **Remote Meter Control:** Implement remote metering changes in lieu of a truck rolls and manual meter exchanges.
- **Developer Education:** Organize developer education programs.
- **Application Checklist:** Develop an application completeness checklist.

### Technical review process

- **Screening:** Apply screens to applications that require technical review, but do not need the time and monetary expense of a full impact study.
- **Local Infrastructure:** Incorporate unique local grid characteristics into screening methodology.
- **Up-To-Date Review Criteria:** Keep pace with screening methodology advances and related technical review research.
- **Data Reliability:** Update data promptly to reflect grid and model modifications.
- **Data Availability:** Centralize grid data for easy access.
CASE STUDY: Third Party Community Solar Models
Example: Vermont Group Net Metering

- Allows multiple customers to participate in a common DG system
- Ownership is non-utility only
- Established 2009
- Facility must be located on the property of one subscriber
- Originally subscribers has to be contiguous, law changed to allow non-contiguous if BPU determines in the public interest
Solar, Wind and certain other technologies qualify.

Sizes vary:
- Residential and Small Commercial: 500 kW
- Military System: 2.2 MW
- Municipal Landfill System: 5 MW

Compensation: at underlying energy rate
Example: New Hampshire Group Net Metering

- Maximum capacity is 1 MW
- May be solar, wind or other qualifying renewables
- Subscribers must be served by the same distribution utility
- For subscribers < 100 kW, rate based on all kWh based charges
- For subscribers > 100 kW, rate based on the utility default service rate
Example: Colorado Community Solar Gardens

- Allows multiple customers to participate in a common DG system
- Ownership may be utility or non-utility
  Established 2011
- Subscribers must be at least 1 kW (unless low income)
- Utilities must 5% of output for low income
- Subscribers must be customers of the same distribution utility
Continued …

• Subscription cannot exceed 120% of annual average consumption and cannot exceed 40% of facility production
• Solar only
• Systems < 2 MW
• Compensation: at the total aggregate retail rate excluding T&D and service charges
About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power sector. RAP has deep expertise in regulatory and market policies that:

• Promote economic efficiency
• Protect the environment
• Ensure system reliability
• Allocate system benefits fairly among all consumer

Learn more about RAP at www.raponline.org
About EPRI

The Electric Power Research Institute (EPRI) conducts research and development for the public benefit that is related to the generation, delivery, and use of electricity. An independent, nonprofit organization, the Institute brings together scientists, engineers, and experts from academia and industry to help address challenges in electricity.

Our Value

- *Thought Leadership*—thinking ahead to identify issues, technology gaps, and broader needs that can be addressed by effective research, development, and demonstration programs.

- *Industry Expertise*—providing expertise across all major technical disciplines and from every stage of electricity generation, transmission, distribution, and end use.

- *Collaborative Value*—bringing together our members and diverse scientific and technical communities to shape and drive research and development in the electricity sector.

For more information: [www.epri.com](http://www.epri.com)

Nadav Enbar, Principal Project Manager
nenbar@epri.com
Appendix
Number of U.S. Electricity Providers

<table>
<thead>
<tr>
<th>% of TOTAL</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Publicly Owned Utilities</td>
<td>2,013</td>
</tr>
<tr>
<td>Investor-Owned Utilities</td>
<td>189</td>
</tr>
<tr>
<td>Cooperatives</td>
<td>877</td>
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<tr>
<td>Federal Power Agencies</td>
<td>9</td>
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<tr>
<td>Power Marketers</td>
<td>218</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>3,306</td>
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</table>

Number of U.S. Customers by Provider

<table>
<thead>
<tr>
<th>Full-Service Customers</th>
<th>Delivery-Only Customers</th>
<th>Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publicly Owned Utilities</td>
<td>21,384,953</td>
<td>9,383</td>
<td>21,394,336</td>
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<tr>
<td>Investor-Owned Utilities</td>
<td>88,111,658</td>
<td>13,040,013</td>
<td>101,151,671</td>
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<td>Cooperatives</td>
<td>18,903,950</td>
<td>16,051</td>
<td>18,920,001</td>
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<td>Federal Power Agencies</td>
<td>38,870</td>
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<tr>
<td>Power Marketers</td>
<td>6,344,231</td>
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<td>6,344,231</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>134,783,662</strong></td>
<td><strong>13,065,447</strong></td>
<td><strong>147,849,109</strong></td>
</tr>
</tbody>
</table>

Delivery-only customers represent the number of customers in a utility's service territory that purchase energy from an alternative supplier.

Nearly all of power marketers’ full-service customers are in Texas.


Generation by Provider (1000s MWhs)

<table>
<thead>
<tr>
<th>Percent of Total</th>
<th>Value</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publicly Owned Utilities</td>
<td>411,168</td>
<td>9.9%</td>
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<tr>
<td>Investor-Owned Utilities</td>
<td>1,601,563</td>
<td>38.7%</td>
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<tr>
<td>Cooperatives</td>
<td>207,202</td>
<td>5.0%</td>
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<tr>
<td>Federal Power Agencies</td>
<td>266,441</td>
<td>6.4%</td>
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<tr>
<td>Non-Utility Generators</td>
<td>1,647,449</td>
<td>39.9%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4,133,823</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Net Metering
www.dsireusa.org / July 2016

KEY
- State-developed mandatory rules for certain utilities (41 states + DC + 3 territories)
- No statewide mandatory rules, but some utilities allow net metering (2 states)
- Statewide distributed generation compensation rules other than net metering (4 states + 1 territory)

U.S. Territories:
- AS
- PR
- VI
- GU

Credit:
www.solsmart.org