Objectives

- Build a collective understanding of technology and policy trends for clean energy in North Carolina, and across the United States
- Identify opportunities and tensions associated with these trends, and gain a deeper understanding of the policy tensions that are emerging
- Strengthen this community’s capacity to collaborate in this work
Welcome and Opening Remarks
Overview of Workshop Agenda and Objectives
Topic 1: New Clean Energy Opportunities Presentations and Q&A
  • Steve Kalland, NC-CETC
  • Ivan Urlaub, NCSEA
  • Charlie Bayless, NCEMC

BREAK

Topic 2: Evolving Regulatory Structures and Concepts Presentations and Q&A
  • Hannah Polikov, Advanced Energy Economy
  • Jonas Monast, UNC School of Law at UNC Chapel Hill

LUNCH

Topic 3: Grid Modernization and Planning Presentations and Q&A
  • Ric O’Connell, GridLab
  • Autumn Proudlove, NC-CETC
  • Robert Sipes, Duke Energy

BREAK

Small Group Breakouts to Discuss Tensions Resulting from Trends
Next Steps
Proposed Ground Rules

1. Be Present
2. Democracy of Time
Describe one trend that you think affects North Carolina and the development of the Clean Energy Plan.
Worksheet for Presentations

- National and state-level trends that present opportunities that I would like NC to explore
- Barriers to capturing these opportunities in NC that need to be addressed
- National and state-level trends that present challenges that I would like NC to avoid
Topic #1

New Clean Energy Opportunities
National Trends in New Clean Energy Opportunities – Distributed Energy Resources (DERs)

NC DEQ Clean Energy Plan Workshop #3
April 22, 2019

Steve Kalland
Executive Director
NC Clean Energy Technology Center

steve_Kalland@ncsu.edu
DSIRE Insight & 50 States Reports

- Extension of DSIRE, tracking legislative & regulatory changes related to solar, energy storage, grid modernization, & electric vehicles
- Offer a variety of subscriptions & reports (complimentary copies for policymakers & regulators)
- Visit www.dsireinsight.com to learn more!
What is a DER?

• Physical and virtual assets deployed across the distribution grid
• Typically close to load, and usually behind the meter
• Used individually or in aggregate to provide value to the grid, individual customers, or both
• Includes solar, storage, energy efficiency, (CHP/cogen), and demand management (and in NC, maybe biogas) — that can be aggregated to provide services to the electric grid

State Energy Policy Trends: 2018 Grid Modernization Actions in U.S. States

- Energy Storage Deployment
- AMI Rules
- Utility Business Model Reforms
- Smart Grid Deployment
- Distribution System Planning
- Grid Modernization Investigation
- AMI Deployment
- Data Access
- Energy Storage Study
- Non-Wire Alternatives
- Time-Varying Rates
- Integrated Resource Planning
- Energy Storage Target
- Energy Storage Rebate Program
- Microgrid Deployment
- Interconnection
- Wholesale Market Rules

# of Actions
Cost Trends for DER Solar

Sources:


Lazard’s Levelized Cost Of Energy Analysis, Version 12.0, November 2018

Lazard’s Levelized Cost of Storage, Version 4.0, November 2018
Levelized Cost of Energy Comparison—Historical Utility-Scale Generation Comparison

Lazard’s unsubsidized LCOE analysis indicates significant historical cost declines for utility-scale Alternative Energy generation technologies driven by, among other factors, decreasing supply chain costs, improving technologies and increased competition.

Selected Historical Mean Unsubsidized LCOE Values

Mean LCOE $/MWh

Source: Lazard estimates

(1) Reflects the average of the high and low LCOE for each respective technology in each respective year. Percentages represent the total decrease in the average LCOE since Lazard’s LCOE—Version 3.0.
Cost Trends for Renewables and Utilities

• Across the U.S., renewable energy is beating coal (and with storage, sometimes Natural Gas) on cost
  – Colorado’s Xcel will retire 660 megawatts (MW) of coal capacity ahead of schedule in favor of renewable sources and battery storage, and reduce costs in the process.
  – Midwestern utility MidAmerican will be the first utility to reach 100% renewable energy by 2020 without increasing customer rates
  – Indiana’s NIPSCO will replace 1.8 gigawatts (GW) of coal with wind and solar

## Levelized Cost of Energy Comparison—Unsubsidized Analysis

Certain Alternative Energy generation technologies are cost-competitive with conventional generation technologies under certain circumstances.

<table>
<thead>
<tr>
<th>Alternative Energy</th>
<th>Levelized Cost ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV—Rooftop Residential</td>
<td>$160</td>
</tr>
<tr>
<td>Solar PV—Rooftop C&amp;I</td>
<td>$170</td>
</tr>
<tr>
<td>Solar PV—Community</td>
<td>$145</td>
</tr>
<tr>
<td>Solar PV—Crystalline Utility Scale</td>
<td>$46</td>
</tr>
<tr>
<td>Solar PV—Thin Film Utility Scale</td>
<td>$44</td>
</tr>
<tr>
<td>Solar Thermal Tower with Storage</td>
<td>$181</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>$152</td>
</tr>
<tr>
<td>Geothermal</td>
<td>$111</td>
</tr>
<tr>
<td>Wind</td>
<td>$206</td>
</tr>
<tr>
<td>Gas Peaking</td>
<td>$189</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$143</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td>Gas Combined Cycle</td>
<td>$74</td>
</tr>
</tbody>
</table>

**Source:** Lazard estimates.

**Note:** Here and throughout this presentation, unless otherwise indicated, the analysis assumes 6% debt at 6% interest rate and 40% equity at 12% cost. Please see page titled “Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital” for cost of capital sensitivities.

(1) This observation does not include other factors that would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this analysis. These additional factors among others, could include: fuel costs, capital value vs. energy value, stranded costs related to distributed generation or otherwise, network upgrade, transmission, congestion or other integration-related costs, significant permitting or other development costs, unless otherwise noted, and costs of complying with various environmental regulations (e.g., carbon emissions offsets or emissions control systems). This analysis also does not address potential social and environmental externalities, including, for example, the social costs and rate consequences for those who cannot afford distribution generation solutions. As well as the long-term residual and societal consequences of various conventional generation technologies that are difficult to measure (e.g., nuclear waste disposal, airborne pollutants, greenhouse gases, etc.)

(2) Unless otherwise indicated here, the low end represents a single-axis tracking system and the high end represents a fixed-tilt design.

(3) Unless otherwise indicated here, the low end represents a single-axis tracking system and the high end represents a fixed-tilt design.

(4) Represents the estimated implied midpoint of the LOCE of offshore wind, assuming a capital cost range of approximately $2.20—$2.60 per watt.

(5) Represents the midpoint of the marginal cost of operating fully depreciated coal and nuclear facilities, inclusive of decommissioning, costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned coal plant is equivalent to the decommissioning and site restoration costs. Inputs are derived from a benchmark of operating, fully depreciated coal and nuclear assets across the U.S. Capacity factors, fuel, variate and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard’s research. Please see page titled “Levelized Cost of Energy Comparison—Alternative Energy versus Marginal Cost of Selected Existing Conventional Generation” for additional details.

(6) Unless otherwise indicated, the analysis herein reflects average of Northern Appalachian Upper Ohio River Barge and Pittsburgh Seam Rail coal. High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.
Figure 2.4 Modeled U.S. national average system costs by market segment

Source: Wood Mackenzie Power & Renewables
Energy Resources—Matrix of Applications

While the LCOE for Alternative Energy generation technologies is, in some cases, competitive with conventional generation technologies, direct comparisons must take into account issues such as location (e.g., centralized vs. distributed) and dispatch characteristics (e.g., baseload and/or dispatchable intermediate load vs. peaking or intermittent technologies).

- This analysis does not take into account potential social and environmental externalities or reliability-related considerations.

<table>
<thead>
<tr>
<th>Carbon Neutral/REC Potential</th>
<th>Location</th>
<th>Dispatch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distributed</td>
<td>Centralized</td>
</tr>
<tr>
<td>Solar PV(1)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Geothermal</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gas Peaking</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Nuclear</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Coal (3)</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Gas Combined Cycle</td>
<td>×</td>
<td>✓</td>
</tr>
</tbody>
</table>

Source: Lazard estimates.
(1) Represents the full range of solar PV technologies, low end represents thin film utility-scale solar single-axis tracking, high end represents the high end of rooftop residential solar.
(2) Qualification for RPS requirements varies by location.
(3) For the purposes of this analysis, carbon neutrality also considers the emissions produced during plant construction and fuel extraction.
Deployment Trends for DERs

Sources:

2019 Sustainable Energy in America Factbook, Bloomberg NEF in partnership with the Business Council for Sustainable Energy

Figure 2.6 U.S. PV installation forecast, 2010-2024E

Source: Wood Mackenzie Power & Renewables
Deployment: U.S. small-scale solar build by type

Annual U.S. small-scale PV build

In 2018, the U.S. residential and commercial solar market contracted for a second consecutive year. While there are signs that the California market is coming back to life, elsewhere the industry is facing headwinds as regulators dismantle net metering regimes at low penetration levels. Gains in Florida, Louisiana, Michigan, Nevada, Virginia, and the Carolinas couldn't offset slowing in more mature markets such as Hawaii, Maryland, Colorado, Pennsylvania, Utah, and Arizona.

The current downturn is not terminal. Rather, it is the result of an overdue transition away from marketing-fueled growth to a more sustainable industry model. Tesla and Vivint Solar are growing again, having restructured over the past two years. The firms are recapturing ground lost to the new market leader, Sunrun, which continues to grow.

Onsite commercial and institutional (C&I) solar build declined around 16% in 2018 after a bumper 2017 that was unlikely to be repeated. California, Colorado, Hawaii, Massachusetts, New Jersey, and Utah each experienced significant declines in commercial solar additions.

Source: BloombergNEF, company filings. Note: Q4 2018 data for individual vendors was not available at time of production.
Deployment: U.S. CHP build and generation

**U.S. CHP build and cumulative capacity**

- CHP capacity additions increased slightly in 2018 to 598MW, from 561MW in 2016. The increase came as the sector saw the largest number of commercial CHP build in at least a decade.
- The total operational CHP capacity in the U.S. has remained relatively stable in recent years as new build has displaced older, retiring units.
- Generation from CHP plants rose slightly to an estimated 362TWh in 2018, a 4% increase over 2017 levels, as gas prices remained historically low throughout much of the year and older, less efficient units retired.

**U.S. CHP generation (EIA-tracked plants)**

Source: BloombergNEF, DOE CHP Installation Database (maintained by ICF). Notes: EIA is the best available source for generation data, but is not comprehensive for CHP. The generation figures here are thus underestimated. Specifically, EIA does not collect data for sites <1MW and EIA categorizes some CHP systems as “electric power” rather than “industrial CHP,” among other reasons. Values for 2018 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2018).

Deployment: U.S. non-hydropower commissioned energy storage capacity

- Annual energy storage installations have increased significantly since 2014. Build ramped up in 2015 from projects seeking to participate in the PJM frequency regulation market – these assets represent most of the capacity in Illinois, West Virginia, Ohio and Pennsylvania.
- While PJM states are still, in aggregate, the biggest energy storage market in terms of commissioned capacity in the U.S., California is the largest single state market. California build surged in 2016 and early 2017 in response to emergency gas supply shortages expected from the Aliso Canyon gas storage facility leak-mitigation efforts.
- In 2018, markets began to expand beyond PJM and California. New Jersey, Texas, North Carolina, Illinois and Massachusetts each added more than 20MW of capacity.
- Falling lithium-ion battery pack prices have helped to lower costs for new stationary storage applications.

Source: BloombergNEF. Notes: *2018 includes expected but unconfirmed capacity as of December 5, 2018. Unconfirmed capacity is marked in white. Does not include underground compressed air energy storage or flooded lead-acid batteries. Minimum project size for inclusion in this analysis is 500kW or 500kWh. Cumulative capacity subtracts capacity that was decommissioned.
Deployment: U.S. announced and commissioned energy storage projects

**Source:** BloombergNEF  
**Note:** Includes projects that are larger than 500kW/500kWh, have announced a specific location, and have been confirmed by the relevant company through public data. Indiana NIPSCO capacity not included in state capacity because individual project capacity is not yet disclosed.
Deployment: U.S. smart electricity meter deployments

U.S. smart meter deployments

- Smart meter installations hit a peak in 2010 and 2011, supported by stimulus funding awarded in 2009. Many of the largest U.S. utilities took advantage of the Smart Grid Investment Grant to roll out smart meters across their territories. As grant funding dried up, deployments slowed, hitting a trough in 2014. Smart metering activity has since picked up though it remains well below the peak of 2011.

- Today 57% of U.S. electricity customers have a smart meter, but there is enormous regional variation. The top 10 states all have penetration greater than 80%. In contrast less than one in 10 customers has a smart meter in the bottom 10 states. Over 2016-17, Pennsylvania, Illinois, Texas and North Carolina were the most active smart metering markets, each deploying over a million meters according to estimates.

- The greatest cost saving for utilities from smart metering is replacing the need for manual meter reads. But a renewed focus on grid modernization and growing interest in dynamic retail tariffs is leading state regulators and utilities that have shied away from the technology to reassess the benefits of deployment. Hold-out states, such as New York and Rhode Island (where smart meters currently number in the hundreds), have both committed to extensive smart meter rollouts over the next five to 10 years.

Source: BloombergNEF, EIA. Note: there is a 10-month lag in official smart meter statistics, as a result 2018 figures include BloombergNEF estimates.
Deployment: U.S. wholesale demand-response capacity

By market

- U.S. wholesale demand response (DR) capacity returned to growth in 2018 for the first time in three years. Almost all regions saw flat or increasing capacity. Most notably, ISO-NE brought its seven-year decline in demand response to a close with a 14% jump to 464MW. PJM, the most significant market, also produced a recovery as demand response performed better in the restructured capacity market than had been expected.

By application

- The vast majority of wholesale demand response is concentrated in capacity markets and reliability mechanisms. Even in ERCOT, which has no formal capacity market, 948MW of DR has been contracted through its capacity-style Emergency Response Service. Ancillary service participation, which grew 9% annually on average over 2010-2015 but then stalled, has picked up again. In ERCOT there is almost 1.5GW of DR providing reserves and frequency regulation. Despite the furor surrounding FERC 745, demand response activity within the energy markets remains negligible.

Source: BloombergNEF. Note: Demand-response was only formally integrated with the CAISO market in 2015.
Policy Trends for DERs

Sources:


North Carolina Clean Energy Technology Center, The 50 States of Electric Vehicles: 2018 Review and Q4 2018 Report, February 2019

2019 Sustainable Energy in America Factbook, Bloomberg NEF in partnership with the Business Council for Sustainable Energy
Policy: ACEEE state-by-state scorecard for energy efficiency policies, 2017

- Massachusetts retains its position as the highest-ranked state in 2018. With its fuel-neutral savings target and adequate utility funding it achieved record-high electricity savings equal to 2.7% of sales.
- Second-placed California scored maximum points across a number of categories, including building energy codes, state government initiatives and appliance standards, reflecting a number of major policy initiatives.
- New Jersey was a notable climber in the middle-rankings, moving from 23rd to 18th year-on-year due to increased utility spending on efficiency, new energy efficiency targets and RPS goals.
- Iowa fell the furthest in points for the second time in a row. New policies that deregulate efficiency requirements, cut efficiency spending, and set opt-out provisions have led to large drops in electricity energy and natural gas savings.

Source: ACEEE, EIA, BloombergNEF. Note: Numbers in parentheses at the top denote the change in score from 2016 levels.

State Energy Policy Trends: DERs

1. Revisiting net metering and DG rate design
2. Pursuing transportation electrification
3. Addressing energy storage in new and existing policies
4. Developing community solar programs
5. Innovating in policy, regulation, and rate design
47 States + DC took action on distributed solar policy and rate design during 2018
DG Compensation Structures

• Net Metering
  – One-to-one offsetting of production & consumption over the entire billing period

• Net Billing
  – Electricity produced may be consumed directly on-site (effectively a retail rate credit)
  – Excess generation (real-time, 15-min, or 60-min netting) is credited at a separate rate (e.g. avoided cost, value of solar, location-based)

• Buy-All, Sell-All
  – Gross production is credited at one rate; gross consumption is charged at another rate
Net Metering and Distributed Generation Compensation Policies
www.dsireusa.org / April 2019

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

* Per-kWh credit adjustors or non-bypassable charges

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No statewide DG compensation rules

Statewide DG compensation rules other than net metering

In transition from net metering to other statewide DG compensation rules

No statewide mandatory net metering rules, but some utilities offer net metering

State-developed mandatory net metering rules for certain utilities
DG Compensation Structures

• Most common successor tariff structure is net billing, but very different export credit rates being applied:
  – Arizona – phasing down to avoided cost
  – Indiana – 1.25 times the avoided cost rate
  – Michigan – LMP or power supply rate
  – Mississippi – avoided cost plus non-quantifiable benefits adder
  – New York – value of DER
  – Utah – slightly below retail rate (transition rate)

• Two states making more extreme changes (Nevada – no grandfathering and Maine – buy-all sell-all structure) have changed course and restored retail rate net metering
Why are changes under consideration?

- **Concerns about cost-shifting**
  - Majority of fixed & demand-based costs for residential customers generally recovered through variable rates; bill reduced through net metering
  - Others suggest the benefits of DG negate or reverse cost shift

- **Efforts to become more granular in solar valuation and compensation**
  - Net metering is easy to understand, but a rough mechanism

- **Utilities reaching net metering aggregate caps**
  - Sometimes an impetus for considering changes (e.g. South Carolina)
**BENEFIT & COST CATEGORIES**

For the purposes of this report, *value is defined as net value, i.e. benefits minus costs*. Depending upon the size of the benefit and the size of the cost, value can be positive or negative. A variety of categories of benefits or costs of DPV have been considered or acknowledged in evaluating the value of DPV. Broadly, these categories are:

- **ENERGY**
  - energy
  - system losses

- **CAPACITY**
  - generation capacity
  - transmission & distribution capacity
  - DPV installed capacity

- **GRID SUPPORT SERVICES**
  - reactive supply & voltage control
  - regulation & frequency response
  - energy & generator imbalance
  - synchronized & supplemental operating reserves
  - scheduling, forecasting, and system control & dispatch

- **FINANCIAL RISK**
  - fuel price hedge
  - market price response

- **SECURITY RISK**
  - reliability & resilience

- **ENVIRONMENTAL**
  - carbon emissions (CO₂)
  - criteria air pollutants (SO₂, NOx, PM)
  - water
  - land

- **SOCIAL**
  - economic development (jobs and tax revenues)

Source: Rocky Mountain Institute
Value of Solar Studies

Cents/kWh

- Arizona Public Service (R.W. Beck)
- Michigan (NREL)
- California (Crossborder)
- Xcel Energy (ISAIC)
- Xcel Energy - CO (Xcel)
- North Carolina (Clean Power Research)
- Austin Energy (Clean Power Research)
- Minnesota (Clean Power Research)
- Vermont (Dept. of Public Service)
- Maine (Clean Power Research)
- Massachusetts (EPRI/Stakeholder Group)
- South Carolina (Crossborder)
- Nevada (SolarCity)
- District of Columbia (Crossborder)
- Entergy Arkansas (Crossborder)
- NorthWestern Energy - MT (Navigant)
- Maryland (Daymark)
State Energy Policy Trends: DERs

1. Revisiting net metering and DG rate design
2. Pursuing transportation electrification
3. Addressing energy storage in new and existing policies
4. Developing community solar programs
5. Innovating in policy, regulation, and rate design
2018 Action on Electric Vehicles & Charging Infrastructure

- No action in 2018
- 1 to 2 actions in 2018
- 3 to 5 actions in 2018
- 6 to 9 actions in 2018
- 10 or more actions in 2018
EV Charging Station Regulation

EVSE exempt from definition of public utility in certain jurisdictions
Currently under consideration
Transportation Electrification

- **Utilities taking broad approaches to transportation electrification**
  - Most utility proposals include a combination of new rate structures, rebates for charging infrastructure, & direct deployment of charging infrastructure

- **Ongoing debate around utility ownership of charging infrastructure**
  - Several states allowing utilities to own make-ready infrastructure or to own infrastructure in underserved areas

- **Growing attention to rate design and managed charging**
  - Tariffs designed to encourage off-peak charging
  - Demand charge alternatives or reductions to facilitate DCFC
State Energy Policy Trends: DERs

1. Revisiting net metering and DG rate design
2. Pursuing transportation electrification
3. **Addressing energy storage in new and existing policies**
4. Developing community solar programs
5. Innovating in policy, regulation, and rate design
2018 State & IOU Action on Energy Storage

NC STATE UNIVERSITY

2018 State & IOU Action on Energy Storage

NC CLEAN ENERGY TECHNOLOGY CENTER
Energy Storage Policy Activity

• Energy storage being addressed in many different ways by states

• Actions aimed at *preparing* for storage deployment:
  – Conducting studies, revising interconnection and utility planning rules, reviewing permitting requirements

• Actions aimed at *facilitating* storage deployment:
  – Developing new compensation tariffs and rate structures, enabling microgrids, implementing competitive procurements

• Actions aimed at *accelerating* storage deployment:
  – Adopting energy storage targets or clean peak standards, creating incentive programs
State Energy Policy Trends: DERs

1. Revisiting net metering and DG rate design
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Community Solar Policies and Programs

19 States + DC have a statewide community solar policy

Information from the NC Clean Energy Technology Center and the Smart Electric Power Alliance (2018 Solar Market Snapshot)
# Community Solar Credit Rates

<table>
<thead>
<tr>
<th>State</th>
<th>Credit Rate Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>Total aggregate retail rate</td>
</tr>
<tr>
<td>Hawaii</td>
<td>Phase I: Flat credit rates, based on mid-day rates; Phase II: Time-varying credit rates</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Value of solar rate</td>
</tr>
<tr>
<td>New Jersey</td>
<td>Retail rate</td>
</tr>
<tr>
<td>New York</td>
<td>Value-based rate plus market transition credit</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Avoided cost rate; utilities may propose avoided cost methodology</td>
</tr>
<tr>
<td>Vermont</td>
<td>Blended residential retail rate; all production is subject to credit adjustors based on system size, site location, and REC ownership</td>
</tr>
<tr>
<td>Virginia</td>
<td>Market value of energy and capacity</td>
</tr>
</tbody>
</table>
## Community Solar & Low-Income Customers

<table>
<thead>
<tr>
<th>State</th>
<th>Low-Income Provisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>The CPUC directed Pacific Gas &amp; Electric and Southern California Edison to solicit Community Solar Green Tariff projects to serve disadvantaged communities in the San Joaquin Valley.</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Connecticut’s program reserves 10% of total program capacity and 10% of each community solar project’s capacity for low to moderate income customers or low-income service organizations.</td>
</tr>
<tr>
<td>Illinois</td>
<td>The Illinois Solar for All program includes an additional 6 to 13 cents per kWh for low-income community solar projects.</td>
</tr>
<tr>
<td>Maryland</td>
<td>Maryland’s pilot program includes a 60 MW carve-out for projects focused on low to moderate income customers.</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>The SMART program includes an adder of 6 cents per kWh for community solar projects serving low to moderate income customers.</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Xcel Energy’s Rehabilitation and Efficiency: Neighborhood Energy Works (RENEWs) pilot program combines community solar subscriptions with energy efficiency improvements for certain low-income customers.</td>
</tr>
<tr>
<td>New Jersey</td>
<td>New Jersey’s community solar pilot program rules include a 40% carve-out for low to moderate income customers.</td>
</tr>
</tbody>
</table>
2019 Community Solar Legislation

• Several states considering legislation creating community solar policies
  – Florida (SB 1156)
  – Nevada (SB 210)
  – New Mexico (HB 210 – Passed House)
  – Pennsylvania (HB 136, HB 531)
  – South Carolina (HB 3659 – Passed House)
  – Utah (HB 411 – Recently Enacted)

• All of these bills include provisions to encourage low-income customer participation
State Energy Policy Trends: DERs

1. Revisiting net metering and DG rate design
2. Pursuing transportation electrification
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4. Developing community solar programs
5. Innovating in policy, regulation, and rate design
Significant innovation occurring in energy policy, regulation, and rate design

- Hawaii Smart Export Tariff
- Arizona R-TECH Rate
- PG&E and Xcel Energy subscription rate proposals for EV charging
- New York Smart Home Rate Pilots
Takeaways

• DERs (particularly solar and storage) continue rapidly dropping in price and becoming more cost competitive, but...
• Residential and C&I “behind the meter” solutions remain significantly more expensive than utility scale renewables
• Net metering remains key tool for emerging DER, but...
• Diminishing returns from NEM as markets mature, and...
• “Value of DER” analyses for successor tariffs are suspect because of a lack of agreement on what is included
• Lots of activity on EVs and other Electrification options, but...
• Rate structures and technology deployment to utilize potential benefits both have a long way to go
Questions?

Stephen Kalland
Executive Director
NC Clean Energy Technology Center
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New Clean Energy Opportunities

Ivan Urlaub
Executive Director,
NC Sustainable Energy Association
NCSEA is the leading non-profit organization driving public policy and market innovation that creates clean energy jobs, economic opportunities, and affordable energy to benefit all North Carolina.

**NCSEA is North Carolina’s Go To for All Things Clean Energy**
Current NC Renewable Systems, March 2019

Installed Renewable Energy Systems

<table>
<thead>
<tr>
<th>General System Type</th>
<th>Capacity (MW)</th>
<th>Number of Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>577.17</td>
<td>55</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>1,759.51</td>
<td>68</td>
</tr>
<tr>
<td>Solar</td>
<td>3,874.95</td>
<td>8,259</td>
</tr>
<tr>
<td>Wind</td>
<td>208.16</td>
<td>24</td>
</tr>
<tr>
<td>Grand Total</td>
<td>6,419.79</td>
<td>8,406</td>
</tr>
</tbody>
</table>
Energy Storage Deployment Accelerating

Southeastern Energy Storage Facilities

Source: www.energync.org, non-residential storage assets, not comprehensive yet, Nov 2018
Decreasing cost of Solar PV across system type creates opportunity

Source: NREL
NC REPS Compliance Costs vs Cost Cap

Incremental Cost of the NC REPS (2008-2015)

Source: Annual REPS Compliance Reports

Graph showing the annual incremental REPS cost from 2008 to 2018, with a rise in costs from 2010 onwards. The sources of cost are indicated by different colors for each year, with a total cost cap line. The graph includes years 2008 to 2018.
Decreasing cost of energy storage
Offshore Wind and Solar?

- NC has more than 22,000 MW of viable offshore wind resource

- Offshore wind compliments solar and batteries

- By 2025 in NC: solar below 3 c/kWh? Offshore wind at 7 c/kWh? Batteries in that price range?

Source: U.S National Renewable Energy Lab (NREL). Data Source: 4Coffshore
Provided to NCSEA by the South East Wind Coalition
Two rends affecting clean energy, grid mod procurement by utilities, consumers, independents

Two dominant characteristics of DER (including EE and DR), utility scale renewables, and storage procurement by utilities, customers, and independent power producers in NC today

1. In NC, policy is not keeping pace with technology

2. The brightest dividing line across the types of DER, RE, and storage disputes in NC seem to boil down to asset ownership. Why?
Trend 1: NC policy not keeping pace with tech

1. Policy is geared toward centralized and bulky resources, not DERs
2. Policy implementation is accustomed to considering one asset or type of asset at a time, instead of comprehensive or systematic consideration of an integrated portfolio of assets.
3. Under our traditional cost-of-service regulation, the regulated utility’s left hand of generation does not appear to be talking to its right hand of grid optimization.
Trend 1a: Policy not inclusive of DERs

Policy is geared toward centralized bulky resources, not DERs

- DERs can provide positive net value to the grid, such as avoided infrastructure investments, improved resilience and increased integration of clean energy.

- The value of DERs does not solely sit in single rooftop solar, a single smart thermostat, or a Tesla Power Wall installation. It is the functional aggregation and integration of these assets that maximizes benefits to consumers.

- NC does not have a planning process to look at the aggregate and integrated use of these grid assets. Have IRP but no Integrated Distribution Plan.
Trend 1b: Policy practice, UBM outmoded

Policy implementation is accustomed to considering one asset or type of asset at a time, instead of comprehensive or systematic consideration of an integrated portfolio of assets

– It is beyond the capabilities and common consideration in NC policy implementation to address questions of ownership, reliability, and affordability

– This is not the singular conversation in other markets with wholesale and/or retail competition
Trend 1c: Generation hand not talking to grid optimization hand

Under our traditional cost-of-service regulation, the regulated utility’s left hand of generation does not appear to be talking to its right hand of grid optimization

- Theoretically, Duke’s continued spending on centralized generation resources should negate the need to upgrade its grid, ostensibly to accommodate distributed energy resources (“DERs”); conversely, Duke’s spending to upgrade the grid to accommodate distributed energy resources should negate the need for continued spending on centralized generation resources.

- But both plans are being pursued simultaneously:
  - **Plan 1 build centralized generation**: 2018 IRP does not speak to grid improvement, focuses on building 9,000 MW new natural gas power plants.
  - **Plan 2 grid improvement**: 2017-18 rate cases and 2019 legislative proposal focus on grid spending, and do not significantly speak to power generation.
Trend 2: Disputes and utility proposals consistently focus on asset, data ownership

1. Arguments by utility for utility ownership:
   – Utility asset control necessary
   – Only utility assets can maintain and protect reliability
   – Utility opposes unfair cross-subsidy and reverse robin hood

2. Actual issue appears to be ownership that diminishes the regulated utilities’ earnings opportunity

3. Policy is giving too much power with a single narrow incentive to utility, resulting in new procurement and deployment roadblocks each quarter
Questions that NC policy, regulated utilities are not answering

If we were to look at what we already know from DER, Utility Scale RE, and storage deployment in NC...

• What is the least cost system approach that maintains reliability and is resilient?
• What is the most effective manner of planning and deployment for both grid efficiency and economic efficiency?
What we know

- As long as utility earnings are the dominant determinant of what is proposed and what is procured across the energy system, we will not efficiently and cost effectively realize our clean energy goals.

- What is more important to the state: affordable and reliable clean energy deployment or utility profits?
  - Under current system, policy implementation has made this a forced choice, often upstream in utility business model process, planning, and contracts that are not typically required and/or scrutinized by the regulator and nearly all consumers cannot see.
  - What needs to be changed so that we do not have to choose?
Info on DER / EE and DR, RE, and Storage

NCSEA can follow-up with specific information about current deployment and costs of renewables, storage, efficiency, processes, and rates in North Carolina if needed.

Due to lack of preparation time, had to choose between deployment data and what is affecting procurement and deployment.
Duke Energy Not Yet Planning for Clean Energy Future

---

2019 DEC + DEP Energy Mix
- Coal: 12%
- CC-DFG: 32%
- CT-CHP: 5%
- Nuclear: 52%
- EE + DSM: 6%
- Hydro: 1%
- Traditional NUG Purchases: 1%

2033 DEC + DEP Energy Mix
- Coal: 6%
- CC-DFG: 30%
- CT-CHP: 2%
- Nuclear: 40%
- EE + DSM: 6%
- Hydro: 1%
- Traditional NUG Purchases: 1%

2019 DEC + DEP Non-Nuclear Energy Mix
- Coal: 25%
- CC-DFG: 40%
- Hydro: 3%
- EE+DSM: 17%
- Traditional NUG Purchases: 2%

2033 DEC + DEP Non-Nuclear Energy Mix
- Coal: 14%
- CC-DFG: 55%
- Hydro: 2%
- EE+DSM: 9%
- Traditional NUG Purchases: 0%
A Cleaner Scenario Under Existing IRP Rules and Assumptions

NC Cumulative RE Capacity, 1890-2018

Installed Renewable Energy Systems Over Time

System Type
- Wind
- Solar
- Biomass
- Hydroelectric

Installed Capacity (MW)
~$10 billion was invested in clean energy development in NC between 2007 & 2016.

Since 2007, 87% of renewable energy project investments >$1M were in Tier 1 and Tier 2 counties; truly, an economic development success story for the most rural parts of the state.
## Property Taxes from Solar

### Annual Property Taxes Paid on Real Estate Parcels with Solar Projects

<table>
<thead>
<tr>
<th>County</th>
<th>Before Solar</th>
<th>After Solar</th>
<th># Solar Projects</th>
<th>Total Solar Capacity (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caswell</td>
<td>$1,366</td>
<td>$71,077</td>
<td>3</td>
<td>15 MW</td>
</tr>
<tr>
<td>Catawba</td>
<td>$19,371</td>
<td>$469,902</td>
<td>13</td>
<td>105 MW</td>
</tr>
<tr>
<td>Cumberland</td>
<td>$2,135</td>
<td>$478,497</td>
<td>6</td>
<td>93 MW</td>
</tr>
<tr>
<td>Johnston</td>
<td>$9,053</td>
<td>$377,889</td>
<td>15</td>
<td>66 MW</td>
</tr>
<tr>
<td>Rutherford</td>
<td>$6,228</td>
<td>$256,343</td>
<td>6</td>
<td>91 MW</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$38,153</strong></td>
<td><strong>$1,653,708</strong></td>
<td><strong>43</strong></td>
<td><strong>370 MW</strong></td>
</tr>
</tbody>
</table>

*Data represents taxes collected in the year after a large solar project was developed*

*Source*: County Tax Offices and NCSEA Renewable Energy Database
House Bill 589 / S.L. 2017-192

• Signed into law on July 27, 2017.
• NC House version was a compromise reached over 30 stakeholder meetings.
• Specifically House Bill 589:
  – Grandfathers at least 3,500 MW legacy PURPA PV
  – Establishes Competitive Procurement of 2,660 MW
  – Restarts Green Source Rider program (600 MW)
  – Formally legalizes leasing of renewable systems (capped at 1% of NC peak, or ~250 MW)
  – Creates rooftop solar rebate (100 MW, 5 years)
  – Creates Community Solar program (40 MW)
  – Allows for at least 200 MW of 10 year “standard contract” 1 MW or less for PURPA QFs
  – In total, will result in a minimum of 6,800 – 7,350 MW of PV in DEC and DEP territories by 2022
North Carolina Executive Order 80

• Reduce greenhouse gas emissions 40% by 2025, from 2005 emissions level
• 80,000 Zero Emission Vehicles on the road by 2025
• Reduce energy use in state government buildings by 40% from 2003-04 levels
Action by Municipal Governments

Sample NC Cities with Clean Energy Commitments

- City of Asheville/Blue Horizons
- City of Charlotte
- Wake County
- Town of Boone
- Others with varying plans and commitments
Decreasing costs of Wind and Solar PV

Source: Lazard’s Levelized Cost of Energy Analysis, Version 12.0
NC Net Generation 2008-2019

Net Generation by Fuel Source: All Sectors: Annual

Source: EIA Beta API
Topic #2

Evolving Regulatory Structure and Concepts
EVOLVING REGULATORY STRUCTURES & CONCEPTS—NATIONAL PERSPECTIVE

April 22, 2019
Hannah Polikov
Advanced Energy Economy

NC DEQ Clean Energy Plan Workshop
AGENDA: The Sampler

- Alternative forms of regulation, including PBR, PIMs, MYRP, decoupling, including lessons learned
- New utility procurement models, including green tariffs, competitive solicitations, aggregating DERs to provide services
- Trends in innovative rate design, including for accommodating DERs and electrification (especially vehicles)
- Benefits of organized markets for integrating renewable energy
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• **Benefits of organized markets for integrating renewable energy**
Alternative Forms of Regulation

A GROWING STABLE OF REFORM OPTIONS IS AVAILABLE TO REALIGN UTILITY BUSINESS PRACTICES

I. Adjustments to the Cost-of-Service Model

I.a Revenue Decoupling
Breaks the link between the amount of energy a utility delivers to customers and the revenues it collects.

I.b Multiyear Rate Plans
Fix the time between utility rate cases and compensate utilities based on forecasted efficient expenditures rather than historical costs of service.

I.c Shared Savings Mechanisms
Reward the utility for reducing expenditures from a baseline or projection by allowing the utility to retain some of the savings as profit.

I.d Performance Incentive Mechanisms (PIMs)
Create a financial incentive for a utility to achieve performance outcomes and targets consistent with customer and public policy interests.

II. Leveling the Playing Field

II.a Changes to Treatment of CapEx/OpEx
Change the treatment of capital expenditures (capex) and operational expenditures (opex) to make utilities indifferent between capital or operational solutions.

II.b New Procurement Practices
Expand utility resource procurement approaches to provide customers with the most cost-effective combination of supply- and demand-side resources.

III. Retirement of Uneconomic Assets

III.a Securitization
Refinances uneconomic utility-owned assets by creating a debt security or bond to pay down an early-retiring plant’s undepreciated capital balance.

III.b Accelerated Depreciation
Adjusts rates to speed up the depreciation of an asset so the utility and its customers are not left with stranded costs when an asset retires early.

IV. Reimagined Utility Business

IV.a Platform Revenues
Provide utilities with new revenues for integrating and coordinating third-party energy services and resources on the distribution system.

IV.b New Utility Value-Added Services
Provide utilities with the opportunity to earn revenues for providing customers with enhanced services made possible by new grid technologies.
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PBR as Set of Tools

United Kingdom's RIIO Model
- Multiyear rate plans
- Performance-incentive mechanisms
- Shared savings mechanisms

New York's Reforming the Energy Vision (REV)*
- Decoupling
- Multiyear rate plans
- Performance-incentive mechanisms
- Shared savings mechanisms

Hawaii Performance-Based Regulation**
- Decoupling
- Multiyear rate plans
- Performance-incentive mechanisms
- Shared savings mechanisms

* NY REV envisions combining PBR measures with other reform options, including platform revenues and changes to capex/opex.
** Hawaii has many elements of PBR already in place; at the time of publishing this paper, an active PBR proceeding is considering additional PBR measures for the Hawaiian Electric Company.
PBR Around the Country

Performance-Based Regulation (PBR)

Source: AEE’s PowerSuite, December 2018
Performance incentive mechanisms (PIMs) create a financial incentive for a utility to achieve performance outcomes and targets consistent with customer and public policy interests. Objectives should be determined according to state energy policy goals, ratepayer interests, and desired utility functions. Well-designed PIMs reward utilities for exemplary performance or penalize underperformance, rather than rewarding business-as-usual outcomes.

**THEORY**

- LBNL, 2016, *Performance-based Regulation in a High Distributed Energy Resources Future*
- **America’s Power Plan papers:** Going Deep on Performance-based Regulation: Incentive Mechanism Design

**DEVELOPMENT**

- Minnesota, Rhode Island, Hawaii, and Michigan have all initiated proceedings exploring usage of PIMs

**APPLICATION**

- Energy efficiency PIMs in MA, RI, MN, VT, CA, TX, and in 20 other states
- Illinois—FEJA PIM
- New York—REV: Earnings Adjustment Mechanisms as a form of PIM
- Reliability PIMs in HI, CA, and MN
PIMs: How Do They Work?

Set state objectives

- Customer Empowerment
- Operational Reliability & Efficiency
- Environmental Sustainability
- Market Innovation

Set specific metrics

- Safety & Reliability: SAIDI & SAIFI
- Peak load reduction: Targeted demand reductions during peak periods – a primary driver of utility costs

Tie carrots/sticks to metrics

- Earn/lose X basis points of ROE for succeeding/failing on Y metric

EXAMPLES

- Safety & Reliability: SAIDI & SAIFI
- Peak load reduction: Targeted demand reductions during peak periods – a primary driver of utility costs
- Earn/lose X basis points of ROE for succeeding/failing on Y metric
Under MRPs, utility revenue requirements are set for multiple years in advance (typically 3–5 years). Utility compensation is based on forecasted efficient expenditures rather than the historical costs of services. This can better reflect a competitive market paradigm, creating incentives to contain costs and reducing regulatory costs from rate cases. This often includes the following:

- Moratoriums on general rate cases for longer periods
- Attrition relief mechanisms (ARMs) in the interim to automatically adjust rates or revenue requirement to reflect changing conditions, such as inflation and population growth
- To maintain or pursue other regulatory and policy goals, MRPs should be combined with PIMs (sometimes considered “backstop” protections for reliability or other services) or other tools
The Danger of Doing MRPs w/o PIMs/PBR

Carte Blanche for Cost Cutting
Pacific Northwest Bell

Result:
- Cut customer service
- Charged for customer service phone access
- Incentive to keep customers on hold

Source: Regulatory Assistance Project
AGENDA: The Sampler

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### Best Practices for Green Tariffs

| Utility Renewable Energy Program ("Green Tariff") | Some utilities in vertically integrated markets have introduced renewable energy programs, sometimes called "green tariffs," which allow customers to purchase bundled renewable energy through their utility at long-term, competitive prices. |

States or utilities considering development of utility programs should consider the following:

1. **Rate Structure**: Select the most appropriate rate design from the several models available, taking into account existing rate structures and customer needs;

2. **Program Cap & Expansion**: Start with an initial offering large enough to enable C&I customers to make meaningful progress toward their renewable energy goals, while also including clear mechanisms for expansion;

3. **Customer eligibility**: Ensure that all C&I customers are eligible to participate in at least one renewable energy program that aligns with their needs;

4. **Resource Selection**: Rely on competitive procurement for resources to meet program needs, and give customers the option to source projects directly;

5. **Term Options**: Give customers a range of options, including mid-range (10-15 years);

6. **REC Treatment**: Transfer RECs to customers, or retire them on customers’ behalf;

7. **Administrative Fees**: Adopt reasonable and cost-based administrative fees;

8. **Termination**: Include clear, fair, and flexible termination provisions that allow for transfer to a different account.
# Competitive Solicitations in VI States

<table>
<thead>
<tr>
<th>State</th>
<th>Project Name</th>
<th>Offtaker</th>
<th>Developer</th>
<th>Technology</th>
<th>Size (MW)</th>
<th>Storage Size</th>
<th>PPA Price ($/MWh)</th>
<th>COD</th>
</tr>
</thead>
<tbody>
<tr>
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<td>AZ Solar 1</td>
<td>Central Arizona Project</td>
<td>Origis Energy USA</td>
<td>PV</td>
<td>30</td>
<td>None</td>
<td>$24.99</td>
<td>12/31/2020</td>
</tr>
<tr>
<td>AZ</td>
<td>AZ Solar Phase II (second project same site)</td>
<td>Central Arizona Project</td>
<td>Origis Energy USA</td>
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<td>20</td>
<td>60 MWh</td>
<td>Low $30s</td>
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<td>100</td>
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<td>None</td>
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<td>8minuteenergy</td>
<td>PV + Storage</td>
<td>30 M W 120 M Wh</td>
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<td>NV</td>
<td>Techren Solar V</td>
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<td>Cypress Creek Renewables</td>
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<td>Dodge Flat Solar</td>
<td>NV Energy</td>
<td>NextERA Energy</td>
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<td>$26.51</td>
<td>12/1/2021</td>
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<td>NV</td>
<td>Fish Springs Solar</td>
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<td>NextERA Energy</td>
<td>PV + Storage</td>
<td>25 M W 100 M Wh</td>
<td>$29.96</td>
<td>12/1/2021</td>
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<td>NM</td>
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<td>Southwest Public Service Co.</td>
<td>Wind</td>
<td>522</td>
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<td>None</td>
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<tr>
<td>CO</td>
<td>2017 All-Source Solicitation</td>
<td>Xcel</td>
<td>Wind</td>
<td>None</td>
<td>$19.30</td>
<td>Median bid prices</td>
<td></td>
<td></td>
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<tr>
<td>CO</td>
<td>2017 All-Source Solicitation</td>
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<td>PV</td>
<td>None</td>
<td>$30.96</td>
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<td>2017 All-Source Solicitation</td>
<td>Xcel</td>
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<td>$20.63</td>
<td>Median bid prices</td>
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<td>Xcel</td>
<td>PV + Storage</td>
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<td>MT</td>
<td>South Peak</td>
<td>NorthWestern Energy</td>
<td>ALLETE Clean Energy</td>
<td>Wind</td>
<td>80</td>
<td>None</td>
<td>$21.66</td>
<td></td>
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<tr>
<td>UT</td>
<td>UT 2017s RFP Results – Utah</td>
<td>PacifiCorp</td>
<td>Solar</td>
<td></td>
<td></td>
<td>$28.47</td>
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Source: https://westerngrid.net/cost/home/prices-and-states-information/
For Context: RE RFP PPA prices vs. LCOE of Conventional Resources

<table>
<thead>
<tr>
<th></th>
<th>CO 2017 All-Source Solicitation</th>
<th>Xcel</th>
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<tr>
<td>Nevada</td>
<td>Eagle Shadow Mountain Solar</td>
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<td>8minuteenergy</td>
<td>PV</td>
<td>300</td>
<td>None</td>
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</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>2017 All-Source Solicitation</th>
<th>Xcel</th>
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<th>None</th>
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### Gas Peaking

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Nuclear</th>
<th>Coal</th>
<th>Gas Combined Cycle</th>
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<tr>
<td></td>
<td>$152</td>
<td>$36</td>
<td>$41</td>
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<td></td>
<td>$206</td>
<td>$143</td>
<td>$74</td>
</tr>
<tr>
<td></td>
<td>$112</td>
<td>$60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$28</td>
<td>$60</td>
<td></td>
</tr>
</tbody>
</table>

**Levelized Cost ($/MWh)**

- **Nuclear**: $28
- **Coal**: $36
- **Gas Combined Cycle**: $41
- **Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital**

**Note**: Here and throughout this presentation, unless otherwise indicated, the analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital" for cost of capital sensitivities.

1. Such observation does not take into account other factors that would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this analysis. These additional factors, among others, could include: import tariffs; capacity value vs. energy value; stranded costs related to distributed generation or otherwise; network upgrade, transmission, congestion or other integration-related costs; significant permitting or other development costs, unless otherwise noted; and costs of complying with various environmental regulations (e.g., carbon emissions offsets or emissions control systems). This analysis also does not address potential social and environmental externalities, including, for example, the social costs and rate consequences for those who cannot afford distribution generation solutions, as well as the long-term residual and societal consequences of various conventional generation technologies that are difficult to measure (e.g., nuclear waste disposal, airborne pollutants, greenhouse gases, etc.).

2. Unless otherwise indicated, the low end represents a single-axis tracking system and the high end represents a fixed-tilt design.

3. Represents the implied midpoint of the LCOE of offshore wind, assuming a capital cost range of approximately $2.25 – $3.80 per watt.

4. Represents the midpoint of the marginal cost of operating fully depreciated coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned coal plant is equivalent to the decommissioning and site restoration costs. Inputs are derived from a benchmark of operating, fully depreciated coal and nuclear assets across the U.S. Capacity factors, fuel, variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard’s research. Please see page titled “Levelized Cost of Energy Comparison—Alternative Energy versus Marginal Cost of Selected Existing Conventional Generation” for additional details.

5. Unless otherwise indicated, the analysis herein reflects average of Northern Appalachian Upper Ohio River Barge and Pittsburgh Seam Rail coal. High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.
Aggregating DERs to Provide Services

Table 1. DER Aggregation Programs by Select DERs

<table>
<thead>
<tr>
<th>Lead Utility</th>
<th>Lead Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonneville Power Administration*</td>
<td>Southern California Edison</td>
</tr>
<tr>
<td>Great River Energy</td>
<td>Xcel Energy</td>
</tr>
<tr>
<td>Hawaiian Electric Co.</td>
<td>Glasgow Electric Plant Board</td>
</tr>
<tr>
<td>Austin Energy</td>
<td>Arizona Public Service</td>
</tr>
<tr>
<td>Maui Electric Co.</td>
<td>Salt River Project</td>
</tr>
<tr>
<td>Sacramento Municipal Utility District</td>
<td>Tucson Electric Power</td>
</tr>
<tr>
<td>ConEd</td>
<td>National Grid*</td>
</tr>
<tr>
<td>Green Mountain Power</td>
<td>Snohomish Public Utility District</td>
</tr>
<tr>
<td>NorthWestern Energy</td>
<td>Chattanooga Electric Plant Board</td>
</tr>
<tr>
<td>Pacific Gas &amp; Electric</td>
<td>Program in Development</td>
</tr>
<tr>
<td>San Diego Gas &amp; Electric</td>
<td>City of Riverside</td>
</tr>
<tr>
<td></td>
<td>PPL Electric</td>
</tr>
<tr>
<td></td>
<td>Liberty Utilities</td>
</tr>
<tr>
<td></td>
<td>Proposed</td>
</tr>
</tbody>
</table>

PV  Battery  Home appliances  EVs

Source: https://www.nrel.gov/docs/fy19osti/71984.pdf

Figure 2. DER aggregation initiatives in the United States, by utility (year launched in parentheses)
• Alternative forms of regulation, including PBR, PIMs, MYRP, decoupling, including lessons learned
• New utility procurement models, including green tariffs, competitive solicitations, aggregating DERs to provide services
• **Trends in innovative rate design**, including for accommodating DERs and electrification (especially vehicles)
• Benefits of organized markets for integrating renewable energy
Trends in Innovative Rate Design: Rates that Vary in Time

Residential Customers on Time Varying Rates

Time Varying Rates Dockets


Source: AEE PowerSuite, AEE Watch List: Time Varying Rates
Trends in Innovative Rate Design: Rates that Vary in Time and Place

VALUE OF DISTRIBUTED ENERGY RESOURCES (VDER)

New York has undertaken a comprehensive approach to determine the value of distributed energy resources (VDER). A market-based mechanism, VDER will ultimately lead to better understanding of the benefits of DER. More importantly, this holistic approach will encourage the deployment of DER in a manner that maximizes overall value to utility customers.

With VDER, utilities will compensate DER owners for the benefits their resources provide to the energy system based on prices that reflect specific values. Collectively, these values make up what is known as the value stack. Values include:

- **Energy (kWh)** is the market value for kWh delivered, inclusive of electrical losses
- **Capacity (kW)** is the market value for capacity delivered
- **Environmental impact** is value of reduced emissions as a result of using DER
- **Demand reduction** is the value of avoiding new distribution system capacity by reducing distribution system peak demand
- **Locational System Relief** is the location-specific value of the DER to a given utility location, for example due to voltage support or avoiding infrastructure upgrades.

The Public Service Commission is defining and delivering VDER in two phases. The new Phase One methodology takes the first step in moving beyond Net Energy Metering (NEM) to a more accurate valuation and compensation for defined categories of DER. The Commission set the Phase One VDER compensation values in the fall of 2017.

Source: https://nyrevconnect.com/rev-briefings/value-der-pricing-distributed-resources/

Being applied in NY to community DG, not residential
## Trends in Innovative Rate Design for EVs

### Examples of Rate Designs For Electric Vehicles

<table>
<thead>
<tr>
<th>Utility</th>
<th>Customer Class</th>
<th>Rate Type</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMUD</td>
<td>Residential</td>
<td>TOU with predefined blocks &amp; rates</td>
<td>Whole house</td>
</tr>
<tr>
<td>ComEd</td>
<td>Residential</td>
<td>Real-time price (RTP)</td>
<td>Whole house</td>
</tr>
<tr>
<td>PG&amp;E</td>
<td>Commercial</td>
<td>TOU with monthly subscription rate based on size of load in lieu of demand charge</td>
<td>EV only</td>
</tr>
<tr>
<td>(proposed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SoCalEd</td>
<td>Commercial</td>
<td>TOU with 5-yr demand charge holiday, then 5-yr demand charge phase-in</td>
<td>EV only</td>
</tr>
</tbody>
</table>
• Alternative forms of regulation, including PBR, PIMs, MYRP, decoupling, including lessons learned
• New utility procurement models, including green tariffs, competitive solicitations, aggregating DERs to provide services
• Trends in innovative rate design, including for accommodating DERs and electrification (especially vehicles)
• Benefits of organized markets for integrating renewable energy
Benefits of Organized Markets for Integrating Renewable Energy (RE)

- **RTOs/ISOs**
  - A bigger, more liquid, and transparent market enables easier integration of RE, allowing RE in the home state to be exported rather than curtailed and giving the home state access to good RE resources in other states— to the possible tune of saving CA alone $1.5B/ yr by 2030 if it formed a Western RTO with neighboring states.  
  
  (Source: https://www.next10.org/sites/default/files/regional-power-market-west.pdf)

- **Western Energy Imbalance Market (EIM)**
  - EIM produced $500+ million in gross benefits to its members between its inception in Nov 2014 thru 2018, in the form of reduced overall costs from fewer RE curtailments and lower reserve requirements. (Source: https://www.ferc.gov/market-oversight/reports-analyses/st-mkt-ovr/2018-A-3-report.pdf)

Source: https://www.ferc.gov/industries/electric/indus-act/rto.asp
Thank You!

Hannah Polikov
Managing Director
Advanced Energy Economy
hpolikov@aeec.net
Evolving Regulatory Structures: North Carolina Update

Jonas Monast
Rates and Public Policy

- Clean Smokestacks Act
- REPS
- HB 589
HB 589

- Competitive Procurement
- Green Tariff
- Community Solar
- Solar Leasing
Current Issues

• Securitization
• Grid modernization
• Multi-year rate plans
• Minimum system charges
• EV charging
Topic #3

Grid Modernization and Planning
EXPERTISE TO ENABLE GRID TRANSFORMATION

GridLAB
GridLab provides comprehensive technical expertise to policy makers, advocates and other energy decision makers on the design, operation and attributes of a flexible and dynamic grid.
AGENDA

- Why should we modernize our electric grids?
- What are typical grid modernization investments?
- What can go wrong? What are best practices?
- What are lessons learned from other states?
- What can stakeholders do?
What Is Grid Moderization?

**Integrate New Technologies**
- Demand Response
- Distributed Generation
- Storage

**Increase Reliability/Resilience**
- Automated outage management
- Situational Awareness

**Prepare for load growth**
- Electric Vehicles
- Building Electrification
Grid Modernization Investments

- Software (ADMS; DERMS; IVVO) -- $
- (Wireless) Communications Networks -- $$
- Field Hardware -- $$$
  - Line Sensors (voltage, current, power factor, etc.)
  - Remotely-controlled equipment (switches, circuit breakers, voltage regulators, load tap changers, capacitor banks, etc. etc. etc.)
  - Circuit ties (increase grid configuration flexibility)
  - Smart meters (enable conservation, time-varying rates)
Grid Modernization Software

• **Advanced Distribution Management Software (ADMS)**
  – Manages distribution system, outage management.
  – Also known as Fault Location, Isolation, and Service Restoration (FLISR)

• **Distributed Energy Resources Management System (DERMS)**
  – Manages Distributed Energy Resources, not as mature as ADMS, warrants caution.

• **Integrated Volt Var Optimization (IVVO)**
  – Voltage management for energy savings
  – Can include hardware as well as software
What Can Go Wrong?

- **Capital Bias** can lead to higher electric rates, and may lead to regulators viewing valid grid modernization value skeptically
  - Modernize more circuits than necessary, earlier than necessary
  - Build rather than rent (software, comm’s networks, “non-wires alternatives”)
- **Cost/Benefit** hard to quantify.
  - Many grid modernization benefits are diffuse and difficult to capture in a traditional regulatory framework
Distribution capital deployment is increasing faster than expected
Grid Modernization Best Practices

• Begin with **Integrated Distribution Planning**
• Next, deploy software (ADMS)
• Expand capabilities to grid through field hardware and comm network investments **AS NEEDED**, not before
• Apply risk-informed grid project prioritization & selection process to **ALL** grid investments to avoid capital bias
• Smart meters: can be had for free **IF BENEFITS ARE MAXIMIZED** for customers (including conservation)
• Define objective success metrics **IN ADVANCE**, securing baselines before deployment & measuring after
Lessons Learned From Other States

- Utility Grid Modernization plans have been ambitious in many states (California, Virginia, North Carolina, Ohio).
- Commissions have been mostly skeptical of proposals, questioning cost/benefit and concerned about ratepayer impact.
- In California, Southern California Edison’s proposal prompted the commission to create evaluation categories for grid modernization requests.
- Some states (Michigan, Nevada, Minnesota) kicking off integrated distribution planning processes.
What Can Stakeholders Do?

• Commit to GET INVOLVED, STAY INVOLVED in integrated distribution planning. Plan on more resources.
• Insist upon transparent, ongoing grid planning processes.
• Demand information on benefit-cost ratios for each grid project. Prioritize & select projects accordingly.
• MEASURE PERFORMANCE to ensure anticipated benefits are delivered and hold utilities accountable for promised benefits.
• Over time, seek to change the current ratemaking model.
Contact Information

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National Grid Modernization Trends

NC DEQ Clean Energy Plan Workshop #3
April 22, 2019

Autumn Proudlove
Senior Manager of Policy Research
NC Clean Energy Technology Center
afproudl@ncsu.edu
50 States of Grid Modernization

- Quarterly report tracking grid modernization activities across the country
  - Studies & Investigations
  - Planning & Market Access
  - Utility Business Model & Rate Reform
  - Policies
  - Financial Incentives
  - State & Utility Deployment
44 States + DC took action on grid modernization during 2018
Grid Modernization Activity 2017-2018

- Studies & Investigations
- Planning & Market Access
- Rate & Utility Business Model Reform
- Policies
- Financial Incentives
- Deployment

# of Actions

- 2017
- 2018

NC CLEAN ENERGY TECHNOLOGY CENTER
Grid Modernization Investigations

• Several states undertaking broad investigatory proceedings
  – Connecticut, DC, Illinois, Maryland, New Hampshire, Ohio, Rhode Island, and more

• Typically include a wide range of topics connected to grid modernization

• Emphasis on stakeholder engagement, typically a neutral facilitator

• Now seeing plans, policy proposals, and rulemakings coming out of these investigations & visioning exercises
Grid Modernization Investigations: NC

- No broad grid modernization proceeding to date
- Facilitated stakeholder workshops held to consider Duke Energy’s Grid Improvement Plan
- Several grid modernization topics are being addressed in separate proceedings in NC
  - Data access rules (E-100 Sub 161)
  - Interconnection (E-100 Sub 101, E-7 Sub 1156)
  - Energy storage (HB 589 study)
2018 Action on Utility Planning Processes

26 States + DC took action on Utility Planning Processes during 2018
Distribution System Planning

• States developing distribution system planning rules
• Utilities undertaking hosting capacity analyses
  – Can help identify locational value of DERs, optimal site, and opportunities for non-wires alternatives
  – Can help improve interconnection process
• Information can inform policy, program, & rate designs
  – United Illuminating in Connecticut pilot tariff providing an adder to storage or solar-plus-storage projects on certain circuits
  – Green Mountain Power in Vermont recently proposed an additional fee for new DG projects on certain circuits needing upgrades
Hosting Capacity Map

https://www.xcelenergy.com/working_with_us/how_to_interconnect/hosting_capacity_map
Distribution System Planning

- Increasing efforts to consider the impacts of electric vehicles, energy efficiency, demand response, storage, DG

- Movement toward more holistic planning procedures integrating generation, transmission, distribution, & DER planning
  - State-led: Proposed rules under consideration in Washington & Missouri
  - Utility-led: HECO utilities (“integrated grid planning”), Duke Energy NC & SC (“integrated system operations planning”)
Distribution System Planning: NC

- NC has integrated resource planning rules (NCAC R8-60), but not distribution system planning rules
- Utilities are required to file biennial Smart Grid Technology Plans (NCAC R8-60.1)
  - Focused on smart grid technologies currently being deployed or scheduled for deployment within the next 5 years, AMI installation status
- Duke is moving toward “integrated system operations planning”
2018 Action on Deployment By Technology Type

- Advanced Metering Infrastructure
- Smart Grid Technologies
- Energy Storage and/or Microgrid
- Demand Response
- 3 or More Technologies
Utility Grid Mod Proposals

- Utilities proposing investments in grid modernization
  - Often packaged as large proposals with many pieces
  - Many utilities are proposing new cost recovery mechanisms (such as riders) to recover grid mod costs
  - Some also include transportation electrification programs (e.g. National Grid - RI, PSE&G NJ)
  - Many proposals also include grid maintenance or more traditional reliability investments
Utility Grid Mod Proposals: NC

- Duke Energy filed its PowerForward Plan in 2017 with a new rider cost recovery mechanism
  - AMI deployment approved, remainder of plan rejected due to the proposed rider
  - Proposed settlement (ultimately not approved) would have included energy storage, EV charging investments
- Duke Energy presented its Grid Improvement Plan at a stakeholder workshop last Fall and has filed for approval in SC as part of a general rate case
Takeaways

• Grid modernization is a very complex issue – many different goals and options to weigh
• States are taking diverse approaches to grid modernization, but some common themes and areas of focus are emerging
• Will be a continuing process – even states that have done significant work in modernizing the grid are still actively engaged in these topics
Questions?

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Agenda

- Why?
  - Facts, Assumptions, & Beliefs
  - Megatrends
  - Implications

- How?
  - Infrastructure & Technology
  - System Planning
  - Choices and Decisions
Facts
- Legacy system largely designed for centralized generation and one-way power flow
- Legacy business and regulatory models are rooted in legacy system model
- Reliable and affordable electricity is essential to our society

Assumptions
- Future grid will be foundational to enable solutions for clean, smart, affordable, and reliable electricity
- Reliability must be maintained or improved
- Investments must be affordable, provide value to customers, and carefully prioritized

Beliefs
- We must take a holistic approach
- Regulatory reform is required to enable successful grid transformation
- Customer needs and choices will ultimately determine our path
- Transformation is inevitable
Megatrends

- Physical & Cyber Security

- Technology advancements – Renewables and DER

- Climate Change & Weather Events
- **Grid Improvement**

  ![](grid improvement image)

- **Concentrated Population Growth**

  ![](population growth image)

- **Customer Expectations**

  - Customers want their power to be on all the time as much as this is reasonably possible
  - Customers want their power to be safe
  - Customers do not want their power company to harm the environment
  - Customers want their power to be as cheap as reasonably possible
  - Customers want their interactions with the power company to be as easy and user-friendly as possible
  - Customers want increases to their power bills to be minimal, infrequent, and predictable as possible
  - Customers want to be informed of problems and issues in advance where possible and want to be updated with status reports as problems are being resolved

  - Customers know and accept that there are things beyond our control that will cause power outages no matter what actions we take to prevent them
  - Customers are more accepting of power outages when they know what caused the outage and how long it will take to restore power
  - The frequency of outages and power quality issues are generally more important to customers than the duration of outages and events
  - Most non-residential customers have built the effects of outages and power quality issues into their business costs and are not willing to pay significantly more to prevent them
  - Only some highly power-dependent customers (mostly complex businesses) have taken or are willing to take extraordinary measures to ensure a virtually uninterrupted supply of power
Our customers are impacted by the megatrends, and, under business as usual (BAU), our customers’ expectations will not be met and we will miss the opportunity to optimally use advanced technology.

I. Increased costs

II. Reduced reliability and resiliency

III. Reduced ability to manage and integrate distributed energy resources (DER)

IV. Reduced ability to meet customer expectations and commitments

V. Reduced economic competitiveness for North Carolina

VI. Increased geographic and demographic disparity
North Carolina Grid Improvement Plan

Megatrends

causing...

Implications

requiring...

Grid Capabilities

leading to Duke’s strategy...

North Carolina Grid Improvement Plan

Protect

Modernize

Optimize

Improvement Programs

generating...

Value to Customers
DUKE ENERGY'S NC GRID IMPROVEMENT PLAN FRAMEWORK

MODERNIZE
Leverage enterprise systems and technology advancements

OPTIMIZE
Optimize the total customer experience

PROTECT
Reduce threats to the grid

MAINTAIN¹
Serve customers in a manner that meets industry safety, reliability and environmental standards

¹ Maintain base work not included in NC Grid Improvement Plan
<table>
<thead>
<tr>
<th>OPTIMIZE</th>
<th>MODERNIZE</th>
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</tr>
</tbody>
</table>

**OPTIMIZE**
- Energy Storage
- EV Charging
- Hardening and Resiliency [T]
- Hardening and Resiliency [D]
- Integrated Volt-Var Control
- Long Duration Interruptions

**MODERNIZE**
- Advanced Metering
- DER Dispatch Tool
- Distribution Automation
- Enterprise Applications
- Enterprise Communications

**PROTECT**
- Physical & Cyber Security

**MAINTAIN**
- Line Extensions
- Capacity Expansions
- Substation Additions
- Outage Follow-up
- Pole Replacements
- Vegetation Management
- End-of-life Asset Replacement
- Equipment Inspection & Maintenance
- General System Protection

(1) Maintain base work not included in NC Grid Improvement Plan
Integrated System Operations Planning (ISOP)
- Holistic and optimized system planning
  - Generation – Transmission – Distribution
  - Transparent investment decisions
- Ensures stable & reliable system operation
- Enables non-traditional, Distributed Energy Resources (DER’s)
- New, specialized tool requirements
  - Circuit level forecasting
  - Advanced Distribution Planning Tool (ADP)
  - Expanding transmission power flow analysis
  - Integration of G – T – D Planning Models

Where are we?
- Industry leading work-in-progress
- Developing stakeholder engagement approach
- Process illustrated in 2021 IRP
- Implemented in 2022 IRP
Choices and Decisions

- **Challenges**
  - Mind boggling array of options
  - Competing priorities
  - Value is in the eye of the beholder
  - Limited resources

- **Solutions**
  - Evolving & emerging technology and innovation
  - Stakeholder engagement
  - Regulatory reform
Group Activity to Identify Tensions Resulting from Trends

• To provide valuable input for DEQ’s final report
Breakout Groups Topic Areas

1. **Customer access to renewables**
   - How can we give customers choices with respect to their energy source while maintaining affordability, reliability, and fairness for all customers?

2. **Interconnection and compensation**
   - What are the best ways to interconnect greater amounts of DER and compensate them for the values they provide to the grid without compromising fairness for all customers and reliability?

3. **Grid modernization to support clean energy**
   - What are the key grid upgrades or investments needed to enable greater adoption of clean energy by customers and utilities while maintaining affordability for ratepayers and reliability?

4. **Utility business model**
   - How do we better align utility incentives with desired electricity system outcomes while protecting ratepayers and maintaining the financial health of utilities?

5. **Utility system planning and investment**
   - How do we balance reliability and certainty in planning with achieving the most economically efficient outcomes and flexibility?

6. **Equitable access and just transition**
   - How can we ensure energy affordability and environmental justice while maintaining just and reasonable rates for all customers?

7. **Grid resiliency enhancements**
   - How can we strengthen the resilience and flexibility of the grid while ensuring affordability for customers?

8. **Clean energy economy**
   - How can we ensure that those most negatively affected by a transition to clean energy benefit from new economic opportunities while keeping our state attractive to businesses?
Questions for Breakout Groups for Report Out

Create a plan to work with your group focused on these questions:

• Is this the right question? If not, how will your group refine or change it to move forward?
• Who is your group leader, that DEQ will contact to check on progress?
• Who else is in your group? (list names)
• How/when you will collaborate to answer these questions?
• What is the one thing you’re most excited to tell us more about at the next meeting?
Instructions for Memos and Presentations

• Prepare up to a 2-page memo with group
• Presentation will be 10 minutes with 5-10 minutes of discussion and questions
• In addition to answering the 5 questions, we want to hear about if/where there was agreement and disagreement amongst the group
Questions to Address in Memo

1. Briefly describe the nature of this policy tension/question - what is happening?
2. To what extent does this policy tension exist in NC? If it exists, why is it relevant to the state?
3. What policy or regulatory action might be required to address the tradeoffs you see? What entity would need to take the action you’ve identified?
4. How are people in other places responding to this tension? What are the most innovative and promising solutions? Do these responses seem feasible in NC?
5. Are there ways you think NC should consider responding to this tension? What entity would need to take the action you’ve identified?
Memo Format

• General summary statement (1-2 sentences) on how well things related to their topic are working currently in NC

• Address the suggested 5 questions

• Include anything else the group would like to share related to the topic not already addressed
Is electricity an essential service in society (in Oregon), and if so, how does regulation ensure affordability and reliability for all customers going forward?

The regulatory process ensures access through principles of non-discriminatory, universal service and a cost-of-service, utility business model. But what this approach promises as broadly affordable and reliable leads to disparities at the household level. These principles are not experienced equitably, but our current energy system does not account for this. Historical and growing inequities, including the disproportionate effects of climate change require more targeted strategies to specifically address communities that are most impacted.

**Universal Strategies**

Structural inequity produces consistently different outcomes for different communities.

Traditional policy-making makes no distinctions among communities and operates under broad assumptions about what is in the public interest. It is encapsulated in the residential rate class that exists in Oregon -- all households pay the same rate, regardless of income or whether they are a renter or homeowner, whether they live in single, multi-family, or manufactured dwellings. Moreover, rate-making and resource planning do not sufficiently take into account external effects of the energy system, such as health, housing, economic development, or recovery from catastrophic events.

**Affordability:** Service is priced at rates that are deemed fair, just, and reasonable broadly across customer classes. New resources and infrastructure are acquired in cost prudent ways to keep energy costs low and energy assistance is available as a means to reduce a monthly bill but is not reflected in the price those customers pay, and resources may not be sufficient to meet demand.

**Reliability:** The power system delivers electricity in a sufficient quantity and with the quality demanded by users, measured by system-wide disruptions (SAIFI, SAIDI, MAIFI).

**Targeted Universalism**

Targeted universalism responds with universal goals and targeted solutions.

Targeted universalism alters the traditional approach but serves the same universal goals through targeted strategies that account for different systemic experiences and a more equitable balance of benefits and burdens; they specifically address marginalized communities.

**Affordability:** Low rates for broad customer classes may not be felt by all ratepayers as some households contribute a significant portion of their income toward energy bills. A targeted approach to affordability would directly address and alleviate energy burden and ensure that energy bills do not interfere with other essential needs.

**Reliability:** A system-wide definition does not account for individual disruptions in service due to disconnections, nor does it account for disparities in reliability in remote communities that experience more frequent and longer disruptions. A targeted approach reduces or eliminates disconnections and distributes resources, like generation and storage to communities who experience less reliable service. It also accounts for the fact that some households and communities cannot afford, and are not provided through public investment, technologies which increase resiliency.
Check-Out

What is one insight from today’s work that you are looking forward to discussing further in the next workshop?