Considerations for Planning for Resilience and Equity

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This presentation was funded by the U.S. Department of Energy’s Grid Modernization Laboratory Consortium.
Resilience and equity are emerging objectives for the electric grid, but to date, most utilities have not applied rigorous criteria for these objectives to electricity system planning.

Emerging objectives require assessing new technologies, interactions, and data and integrating stakeholders into planning processes. This presentation discusses pathways to build rigor around the emerging objectives of resilience and equity.

Optimizing for individual objectives will not lead to the same results. For example, the most aggressively decarbonized system is not the most reliable or affordable. Multi-objective decisionmaking involves tradeoffs. We present initial methods to balance disparate objectives.

Credit to Imre Gyuk and Joe Paladino in U.S. Department of Energy’s Office of Electricity for sponsorship, and Sandia National Laboratories in partnership for the suite of research in which this work is rooted.
Emerging Objectives in Grid Planning

► Traditionally, electric grid planning strives to maintain safe, reliable, efficient, and affordable service for current and future customers.

► As policies, social preferences, and the threat landscape evolve, additional considerations for power system planners are emerging, including decarbonization, resilience, and energy equity.

► Relative to traditional objectives, these emerging objectives are not well integrated into grid planning paradigms.
Dimensions & Approaches of Energy Equity

Distributive Justice (where?)
- The unequal allocation of benefits and burdens and unequal distribution of the consequences

Recognition Justice (who?)
- The practice of cultural domination, disregard of people and their concerns, and misrecognition

Procedural Justice (how?)
- The fairness of the decision-making process

Restorative Justice
- The response to those impacted by the burdens of energy projects

**Key Principles:**
- Availability
- Transparency and accountability
- Due process
- Intergenerational equity
- Affordability
- Sustainability
- Intrigenerational equity
- Responsibility

**Key Terms**

<table>
<thead>
<tr>
<th>Key Terms</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Energy Burden</td>
<td>Percent of household income spent to cover energy cost.</td>
</tr>
<tr>
<td>Energy Insecurity</td>
<td>The inability to meet basic household energy needs.</td>
</tr>
<tr>
<td>Energy Poverty</td>
<td>A lack of access to basic, life-sustaining energy.</td>
</tr>
<tr>
<td>Energy Vulnerability</td>
<td>The propensity of a household to suffer from a lack of adequate energy services in the home.</td>
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</tbody>
</table>
Observations from Utility Engagements

• **Utilities lack the mechanisms to successfully communicate infrastructure needs.** It may be difficult for utility planners to communicate resilience needs to utility customers, regulators, and even to their own utility executives.

• **Utilities lack reliable funding sources for resilience investments.** When competing for limited capital funding, long-term investments in system hardening and resilience are frequently crowded out by more immediate needs.

• **Making long-term resilience investments today is challenging.** Growing and changing risk profiles make long-term forecasting difficult. Future-proofing and least-regrets investments are needed.

• **Utilities’ perception of non-wires alternatives is evolving.** They may view non-wires alternatives less as long-term solutions and more as temporary stopgaps to assist in managing and spreading out capital expenditures on large infrastructure upgrades.

• **Distribution planning standards vary by utility.** While some states have established distribution planning requirements for regulated utilities, there are very limited universal standards or scenario-based planning applications like there are for generation and transmission.
# State of Current Practice

<table>
<thead>
<tr>
<th>Planning Paradigms</th>
<th>Traditional Objectives</th>
<th>Emerging Objectives</th>
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<tr>
<td></td>
<td>Safety</td>
<td>Reliability</td>
</tr>
<tr>
<td><strong>Integrated Resource Planning</strong></td>
<td>Connected</td>
<td>Robust</td>
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<tr>
<td><strong>Transmission Planning</strong></td>
<td>Robust</td>
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<tr>
<td><strong>Distribution System Planning</strong></td>
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<tr>
<td><strong>Reliability Planning</strong></td>
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<tr>
<td><strong>EE &amp; DSM Planning</strong></td>
<td>Connected</td>
<td>Robust</td>
</tr>
<tr>
<td><strong>Integrated Distribution Planning</strong></td>
<td>Robust</td>
<td>Robust</td>
</tr>
</tbody>
</table>
Equity in Grid Planning: Current Practice

Remain tied to decarbonization goals and/or environmental justice

- **Michigan**: 2020 Executive Order (EO) requires PUC to expand its environmental review of integrated resource plans (IRPs) to evaluate whether utilities are meeting state decarbonization goals
  - Also requires PUC to assess whether IRPs consider environmental justice and health impacts
- **Washington**: 2019 Clean Energy Transformation Act requires IRPs to include an assessment of energy and non-energy benefits and reductions of burdens to vulnerable populations
- **Connecticut**: 2019 EO requires the Public Utilities Regulatory Authority (PURA) to analyze decarbonization pathways consistent with the state's goal of 100% carbon-free electricity by 2040
  - EO also calls for PURA oversight to ensure energy affordability and equity for all ratepayers during the resource planning process (but this is loosely outlined)
- **California**: 2018 CPUC decision requires IRPs with LSEs to assess their impacts on disadvantaged communities
  - CA defines disadvantaged communities as those with the highest pollution burden (top 25% statewide)

<table>
<thead>
<tr>
<th>Planning Paradigm</th>
<th>Treatment of Equity Within Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Resource Planning</td>
<td>Limited</td>
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<tr>
<td>Transmission Planning</td>
<td>None</td>
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<tr>
<td>Distribution System Planning</td>
<td>Limited</td>
</tr>
<tr>
<td>Reliability Planning</td>
<td>None</td>
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<tr>
<td>EE &amp; DSM Planning</td>
<td>Limited</td>
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<tr>
<td>Integrated Distribution Planning</td>
<td>Limited</td>
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</tbody>
</table>
Creating Comparable Objectives

► New Analytical Framework Required: Different from siting a facility or a discrete decision under environmental justice framework

► Grid Planning Scales: Distribution system planning is useful starting point – spatial in nature, closely connected to community experience

► Missing Insights on Investments to Effects: No one single attribute of the grid is sufficient for energy equity – may be composite or index until clearer insights about which are the most meaningful in practice

► Tradeoffs and Co-Optimization: Strong relationships, including tradeoffs, with other objectives
Example: Energy Storage and Community Objectives

WHY ENERGY STORAGE?
- Locational flexibility
- Wide applications
- Broad uses for storage

HOW CAN ENERGY STORAGE SUPPORT COMMUNITY GOALS AND ADDRESS NEEDS?
- Access
- Affordability
- Environmental Impact
- Social Impact
- Decarbonization
- Resiliency
Formulating Resilience Objectives as Part of Planning Practices

**Objectives:**
- Cross-sectoral evaluation of critical loads
- Inclusive approach captures current inequities
- Model-grade needs identification

**Objectives:**
- Identify a *portfolio* that meets resilience needs and offers other strategic benefits such as reliability services and equity
- Identify communication and control needs to enable project functionality
Stakeholder Roles and Responsibilities

Policy Translation to Grid Investment Strategy

Objective Formulation

Planning Practice

Balancing Multiple Objectives

Implementation and Performance Metrics

Integrated Distribution Planning (IDP)

Resiliency & Reliability Assessments, Asset Management

Resource & Transmission Planning

Near & Long Term Plans

Stakeholders

Climate & System Forecasts

Data gathering & updates (ex: GIS, CIS, OMS, EMS, etc.)

Stakeholders

Policy Makers

Regulators

Utilities

Advocates, Coalitions, Communities

Steering Committees, Advisory Groups

Government Agencies (FEMA, Cities, Counties, Emergency Response, HUD, etc.)
Multiple Objectives and Tradeoffs

Policy Translation to Grid Investment Strategy
Objective Formulation
Planning Practice
Balancing Multiple Objectives
Implementation and Performance Metrics

Cost:
- Bounding cost with investment outcome
- Relationship between public/ratepayer costs
- Relationship between ratepayer and resilience benefit
- Least cost individual measures vs. best fit portfolio standard

Decarbonization:
- Reliable backup power alternatives to diesel
- Central vs. distributed resources
- Role of clean energy transition in resilience drivers
- Reduce health harms to vulnerable and disadvantaged communities

Equity
- Recognition of most impacted communities
- Remedial strategies and prioritization for acute or long-term conditions
- Cost pressure and affordability (energy burden, insecurity, poverty, democracy)
- Transitional effects

Reliability
- SAIDI, SAIFI, CAIDI improvements
- Improvement in daily disruptions
- Asset Management Portfolio
- Reliability project prioritization

Multi-Objective Tradeoffs with Resilience
Pathways to Evaluating Tradeoffs: Multi-Objective Decision Analysis

- Priorities among objectives
  - Determine “must haves” which can be represented as constraints (e.g., fixed investment, minimum reliability performance in identified disadvantaged communities)
  - Requires understanding relationship between investment and effect

- Analytical process to show trade-offs in achieving objectives between investment decisions and portfolios
  - Fixed hierarchy
  - Optimization
  - Multi-criteria decisionmaking analysis (subjective weighting)

- A portfolio approach with performance metrics supports planning decisions as well as post-investment validation.

CREDIT: Brian Pierre, Sandia National Laboratories
Performance Metrics

- **Metrics** for new objectives lack national standardization and quantification practice.
- Grid performance metrics can support evaluating in a planning context and also validating cause-effect relationships between plans and outcomes.

### RESILIENCE

<table>
<thead>
<tr>
<th>Attribute-Based</th>
<th>Performance-Based</th>
</tr>
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<tbody>
<tr>
<td>Power System Performance</td>
<td>Economic Consequence</td>
</tr>
</tbody>
</table>

### EQUITY

| Procedural and Recognition (due process and accountability) | Distributive (affordability and availability) | Restorative (intra- and inter-generational sustainability and responsibility) |

### DECARBONIZATION

| Emissions | Resources |
## Grid Performance Metrics for Emerging Objectives: Resilience

<table>
<thead>
<tr>
<th>Attribute-Based</th>
<th>Performance-Based</th>
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<tbody>
<tr>
<td></td>
<td>Power System</td>
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<tr>
<td></td>
<td>Performance</td>
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<tr>
<td>• Absorptiveness</td>
<td>• Cumulative</td>
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<tr>
<td>• Adaptiveness</td>
<td>electricity demand</td>
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<tr>
<td>• Robustness</td>
<td>not served (e.g.,</td>
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<tr>
<td>• Resourcefulness</td>
<td>MWh load unserved)</td>
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<tr>
<td>• Recoverability</td>
<td>Average number/</td>
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<tr>
<td>• Resilience indices</td>
<td>percentage of</td>
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<td>(e.g., Resilience</td>
<td>customers</td>
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<td>Measurement</td>
<td>experiencing outage</td>
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<td>Index)</td>
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<td></td>
<td>• Duration of load</td>
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<td>curtailment</td>
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<td>• Recovery</td>
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<td>• Frequency of</td>
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<td>• Unserved load</td>
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<td>facilities</td>
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<td>• Degradation of</td>
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<td>mission readiness,</td>
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<td>assurance, or</td>
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<td></td>
<td>performance</td>
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<td></td>
<td>• Effort to access</td>
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<tr>
<td></td>
<td>critical services</td>
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</table>
Measuring Energy Equity

Target Population Identification
- Program equity index
- Program accessibility
- Energy cost index
- Energy burden index
- Late payment index
- Appliance performance
- Household-human development index

Investment Decision Making
- Community acceptance rating
- Program funding impact
- Energy use impacts
- Energy quality
- Workforce impact

Program Impact Assessment
- Profits
- Program acceptance rate
- Energy savings (MWh)
- Energy cost savings ($)
- Energy burden change
- Change in household-human development index score

See Review of Energy Equity Metrics
**Effects from Equitable Outcomes**

### Recognition
- Ending disconnections (e.g., commitment to reduce or end disconnections, moratorium on shutoffs for customers with severe or extreme energy burdens)
- Maximizing resilience, minimizing vulnerabilities (e.g., targeted program investments for communities and households facing severe climate and health risks)

### Distributive
- Maximizing co-enrollments in affordable rates, payment plans, and clean energy programs (e.g., notify disadvantaged customers of the programs they qualify for)
- Enabling energy affordability (e.g., commitment for reducing the distribution of high energy burdens)

### Restorative
- Integration in cross-sector and long-term planning (e.g., quantitative and qualitative treatment of equity in long term plans and models)
- Wealth building (e.g., on-bill financing with special terms for disadvantaged customers, effective caps on DERs and storage)

### Procedural
- Enabling participation (e.g., participation stipends, intervenor funding for disadvantaged community engagement)
- Unbiased evaluation (e.g., no conflict-of-interest with third party evaluators, evaluation open for public input, access to original data)
### Extending Energy Equity Metrics

#### Procedural and Recognition
(due process and accountability)
- Representativeness and inclusiveness of planning processes for all affected stakeholders
- Responsiveness of planning processes to public participation and fairness of decisions
- Transparency of planning processes and decisions

#### Distributive
(affordability and availability)
- Electricity cost burden (i.e., household electricity bills/income)
- Electricity affordability gap
- Electricity quality (e.g., geographic disaggregation of outage frequency/severity; restoration efficiency)
- Electricity program (e.g., tax credits; energy efficiency) and technology (e.g., BTM solar and storage) accessibility and performance (e.g., participation/investment demographics; distribution of savings/costs, reliability/resilience, or other benefits/burdens)
- Social burden (i.e., effort and ability to access critical services)

#### Restorative
(intra- and inter-generational sustainability and responsibility)
- Economic (e.g., job training/job quality; energy resource ownership/governance; reparation of electricity cost burden shouldered by energy burdened communities)
- Environmental (e.g., natural resource replenishment; generation/storage resource siting)
- Social (e.g., improvements in household-human development index; establishment of safeguard/grievance redress mechanisms)
Inclusion of energy equity within planning models is a complex process and is not yet well explored by utilities or existing literature.

Most utilities are not likely to have sufficient data and approaches to model energy equity effects. Unclear where to stop when collecting data related to communities (education, health, medical condition).

Purpose of laboratory analysis is to provide insights into trade-offs among emerging objectives such as equity/resiliency and traditional objectives such as affordability/efficiency etc.

**Impact on Outcome**

- Major focus on cost and reliability
- Potentially different investment strategy
- Insights into what part of the feeder needs to be prioritized
- Insights into how to reduce energy burden and increase resiliency of disadvantaged communities (DAC)
DSP Plan and Modeling Equity

1. Load/BTM-DER Forecast
   - Identification of critical loads, DAC
   - Energy assistance
   - Load growth
   - EV adoption
   - DER adoption

2. U-DER investment (total capacity & mix)
   - Decarb goals
   - Investment strategy

3. U-DER Optimal Locational Distribution
   - Energy input
   - DER locational profile to minimize infra upgrades with equity constraint

4. Infrastructure Upgrades Assessment
   - List of transformers, lines, voltage devices upgrades

5. Monte-Carlo Simulation Analysis
   - Statistical post-processing

6. Performance Measurement via Metrics
   - Go to step 1 and repeat process with improved inputs

Base Case Assessment
- System awareness - equity, DER levels

Distribution system planning
- Output metrics generation
Equity in Planning Simulation

To analyze the impact of equity considerations on DER allocation and asset upgrade planning through hosting capacity analysis.

- Identify a synthetic feeder
- Distribute baseline DERs
- Identify random DAC regions
- DER hosting capacity analysis for DAC and non-DAC regions
- Load growth EV growth
- DER allocation planning
- Associated infra upgrade planning

- Most DERs at high hosting capacity regions: 
  - less cost
  - low DER equity
- Each region has equitable DER allocation:
  - Infra-upgrade cost
  - high DER equity
PNNL Prototype Feeder

- A 300-node taxonomy feeder representing west-coast heavy suburban area

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Service transformers</td>
<td>50</td>
</tr>
<tr>
<td>Residential customers</td>
<td>380</td>
</tr>
<tr>
<td>Commercial customers</td>
<td>12</td>
</tr>
<tr>
<td>Total load</td>
<td>5.3 MW</td>
</tr>
</tbody>
</table>

- Randomly identified DAC regions
  - Average DAC customer load: 1.8 kW
  - Non-DAC: 5 kW
  - DAC: 70 customers
  - Non-DAC: 310 customers
Planning: BAU

- **Utility-level DER allocation** - Most DERs should be located:
  - Closer to high EV load locations to avoid asset upgrade
  - In high hosting capacity locations without voltage violations to avoid voltage mitigation solutions

- **Asset Upgrade** - Transformer upgrades at locations obtained from the analysis in non-DAC region
  - DAC regions are not likely to be part of asset upgrades and DER allocation in this case, making them vulnerable to resiliency events.

- Transformer and line upgrade
- Utility-level DER allocation
Planning with Equity

- DAC regions should have equitable PV hosting capacity
  - Requires solutions such as voltage regulator installation in DAC-region
  - TODO: simulation analysis to demonstrate increased hosting capacity in DAC-1 region with voltage regulator device
  - TODO: cost analysis

- Asset upgrades in non-DAC region due to high EV load also improve resiliency of these regions compared to DAC
  - TODO: observe the impact of high EV and asset upgrades on resiliency

- Transformer and line upgrade
- Utility-level DER allocation
- Voltage regulator installation
## Equity Objective, Dimensions, Concepts, Metrics, and Measurement Approaches

### Objective
- Equity
- Distributive (& Recognition)
- Procedural (& Recognition)
- Restorative (& Recognition)

### Dimensions
- Due Process
- Accountability
- Affordability
- Availability

### Concepts
- Intra-/Inter-Generational Sustainability & Responsibility
- Representativeness & Inclusiveness of Planning & Investment Approval Processes
- Transparency of Planning Processes & Decisions
- Responsiveness of Planning Processes to Participation & Fairness of Decisions
- Electricity Cost Burden & Affordability Gap
- Transparency of Planning Processes & Decisions
- Efficiency
- Availability & Accessibility of Relevant Materials & Spaces
- Perceived Input Legitimacy (for DACs)
- Availability & Accessibility of Relevant Materials & Spaces
- Perceived Output Legitimacy (for DACs)
- Electric Bill/Household Income (- Target)

### Metrics
- Economic Impacts (for DACs)
- Environmental Impacts (for DACs)
- Social Impacts (for DACs)
- Natural Resource Replenishment; Pollution/Waste Removal; Land Use & Resource Siting
- Pollution Exposure Reductions & Health Outcome Investments; Safeguard/Grievance Redress Mechanisms Establishment

### Measurement Examples
- Demographics of Program Participation, Investment, & Resources (including DERs)
- Demographics of Outage Frequency/Duration/Restoration Efficiency
- Hours to Access Critical Services/Income
- Reinvestment to Address Electricity Burden; Energy Resource Ownership/Governance; Job Training & Quality; Other Non-Energy Econ Impact
- Outcome Investments; Safeguard/Grievance Redress Mechanisms Establishment
## Equity Objective, Dimensions, Concepts, Metrics, and Measurement Approaches

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Measurement Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representativeness &amp; Inclusiveness of Planning &amp; Investment Approval Processes</td>
<td>Perceived Input Legitimacy (for DACs)</td>
</tr>
<tr>
<td>Transparency of Planning Processes &amp; Decisions</td>
<td>Availability &amp; Accessibility of Relevant Materials &amp; Spaces</td>
</tr>
<tr>
<td>Responsiveness of Planning Processes to Participation &amp; Fairness of Decisions</td>
<td>Perceived Output Legitimacy (for DACs)</td>
</tr>
<tr>
<td>Electricity Cost Burden &amp; Affordability Gap</td>
<td>Electricity Bill/Household Income (- Target)</td>
</tr>
<tr>
<td>Electricity Program &amp; Technology Performance</td>
<td>Distribution of Savings/Costs, Reliability/Resilience, or Other Benefits/Burdens</td>
</tr>
<tr>
<td>Electricity Program &amp; Technology Accessibility</td>
<td>Demographics of Program Participation, Investment, &amp; Resources (including DERs)</td>
</tr>
<tr>
<td>Electricity Quality</td>
<td>Demographics of Outage Frequency/Duration/Restoration</td>
</tr>
<tr>
<td>Economic Impacts (for DACs)</td>
<td>Hours to Access Critical Services/Income</td>
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<tr>
<td>Environmental Impacts (for DACs)</td>
<td>Reinvestment to Address Electricity Burden; Energy Resource Ownership/Governance</td>
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<td>Pollution Exposure Reductions &amp; Health Outcome Investments; Safeguard/Grievance Redress Mechanisms Establishment</td>
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</table>
Questions public utility commissions can ask

► How should a grid planning process handle a large, conflicting, and variable amount of social information? Once I start, where do I stop?
► How do modeling strategies vary between planning processes? For example, how does a transmission planning process use highly local information?
► What are the tradeoffs between resilience and equity? Shouldn’t some of those objectives be standard requirements, like cost and reliability?
► What are some of the most innovative practices from utilities and commissions in energy equity and resilience?
► What about technology mandates, such as legislative requirements for energy storage solutions?
► What are some of the ways that business models can affect whether a set of solutions shows up in grid performance metrics as more or less resilient or equitable?
Resources for more information

https://doi.org/10.1007/s40518-021-00184-6

https://www.pnnl.gov/sites/default/files/media/file/Metrics%20for%20Energy%20Equity_0.pdf

► Multi-Objective Grid Planning
https://energy.sandia.gov/programs/electric-grid/mod-plan


► Advancing Equity in Utility Regulation, 2021.
Contact

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Movements of Environmental, Climate, and Energy Justice

1970s and 1980s: Environmental Justice Movement
Key Claims:
• Access to environmental decision making
• Equitable distribution of benefits and harms of development

1990s and 2000s: Climate Justice Movement
Key Claims:
• Access to decision making on climate change mitigation
• Shaping policy efforts to avert inequitable social conditions exacerbated by climate change

2010s to present: Energy Justice Movement
Key Claims:
• Right to make energy decisions
• Access to clean and affordable energy
• Access to economic benefits of the new energy system

Energy justice refers to the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system (“frontline communities”). Energy justice explicitly centers the concerns of marginalized communities and aims to make energy more accessible, affordable, and clean and democratically managed for all communities.

https://iejusa.org/section-1-defining-energy-justice/
# Dimensions and Approaches of Energy Justice

## Distributive Justice: Where?
- Addressing the unequal allocation of benefits and burdens and unequal distribution of the consequences
- Increasing affordability and availability

## Procedural Justice: How?
- The fairness of the decision-making process
- Allowing for due process, transparency, and accountability

## Recognition Justice: Who?
- Addressing the practice of cultural domination, disregard of people and their concerns, and misrecognition

## Restorative Justice
- The response to those impacted by the burdens of energy projects
- Addressing intra- and inter-generational inequities
- Creating sustainability
- Establishing responsibility

[https://iejusa.org/section-1-defining-energy-justice/](https://iejusa.org/section-1-defining-energy-justice/)
Performance Metrics

- Energy Burden
- Energy Vulnerability to Outages
- Access to black-start DERs
- Loss of load (SAIFI/SAIDI)
- Energy Served from DERs
- Cost of Assets Upgrade
- Impact on Energy Consumption due to Energy Assistance Program

Example Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Burden</td>
<td>$\frac{\text{Annual utility bills}}{\text{Annual household income}}$</td>
</tr>
<tr>
<td>SAIFI</td>
<td>$\frac{\text{Total # of customers interrupted}}{\text{Total # of customers served}}$</td>
</tr>
<tr>
<td>E3B Investment*</td>
<td>$\frac{% \text{ of low income population} \times \text{Total residential EE investment}}{$}$</td>
</tr>
</tbody>
</table>

*Energy Efficiency Equity Baseline (E3B)
## Stakeholder Roles for Resilience Planning within IDP

<table>
<thead>
<tr>
<th>Stakeholder Roles for Resilience Planning within IDP</th>
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<tbody>
<tr>
<td><strong>Utility</strong></td>
</tr>
<tr>
<td>Set Planning Goals and Define Metrics and Targets</td>
</tr>
<tr>
<td>- Identify current requirements and foundational needs</td>
</tr>
<tr>
<td>Forecast Load and DER Adoption, EVs, and Scenarios</td>
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<tr>
<td>- Localized threat forecasts, customer and grid vulnerability analysis</td>
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<td><strong>PUC</strong></td>
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<tr>
<td>Baseline Analysis and Identify Critical Gaps</td>
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<tr>
<td>- Calculate baseline consequence with defined metrics</td>
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<tr>
<td>Systems Analysis to Design Alternative Portfolios to Fill Gaps</td>
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<tr>
<td>- Identify DER-inclusive resilience investment alternatives</td>
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<tr>
<td>Evaluate Tradeoffs and Prioritize Solutions</td>
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<tr>
<td>- Evaluate improvement in resilience metrics for each alternative</td>
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<tr>
<td>Implement and Track Performance</td>
</tr>
<tr>
<td>- Execute distribution investment plan across asset categories</td>
</tr>
<tr>
<td><strong>Other Stakeholders</strong></td>
</tr>
<tr>
<td>Forecast Load and DER Adoption, EVs, and Scenarios</td>
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<tr>
<td>- Define forecasting requirements</td>
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<tr>
<td>Baseline Analysis and Identify Critical Gaps</td>
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<tr>
<td>- Identify resilience gaps versus targets using defined metrics</td>
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<tr>
<td>Systems Analysis to Design Alternative Portfolios to Fill Gaps</td>
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<tr>
<td>- Ensure candidate alternatives meet screening requirements</td>
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<tr>
<td>Evaluate Tradeoffs and Prioritize Solutions</td>
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<tr>
<td>- Ensure preferred alternative meets resilience goals, and are feasible and equitable</td>
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<td>Implement and Track Performance</td>
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<td>- Execute distribution investment plan across asset categories</td>
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<tr>
<td><strong>DOE</strong> Work across industry to collect data, standardize resilience metrics, and support goal-setting</td>
</tr>
<tr>
<td><strong>FEMA Regional Offices</strong> Regional threat forecast and multi-infrastructure vulnerability analysis</td>
</tr>
<tr>
<td><strong>Local Govts</strong> Identify and connect initiatives and stakeholders</td>
</tr>
<tr>
<td><strong>Local Govts</strong> Integrate improved grid resilience into local resilience plan, identify public investments</td>
</tr>
</tbody>
</table>
MOD-Plan: Multi-Objective Decision Making

Funded by the Office of Electricity

- **Planning frameworks with stakeholder roles.** Develop a framework that applies multiple emerging objectives in electric grid planning processes with stakeholder roles throughout.

- **Emerging objectives and trade-offs.** Advance innovative and practical methods for formulating planning objectives for decarbonization, resilience, and energy equity to indicate trade-offs.

- **Metrics for success.** Develop and report on metrics that can measure the performance of the grid with respect to these emerging objectives.
MOD-Plan Strategic Purpose

- Identify measurable effects to underserved communities, connected to operational change that can occur within a grid planning and investment context.
- Incremental and idealized approaches needed: address low-data-quality/simpler distribution system plans as well as integrated planning paradigms.
- Complexity in the multi-objective tradeoffs space: where laboratory contribution and insights can be strong.
- Case studies, pilots, and other external partnerships for validation will be material to project outcomes.
Creating Transparent Process with Stakeholders

Identify Stakeholders
- Community members
- Disadvantaged Communities
- National Agencies
- Regional Agencies
- State Agencies
- Local Agencies
- Policy Makers
- Regulators
- Utilities
- Industry Experts

Roles & Responsibilities
- Meet with stakeholders to:
  - Define roles for each stakeholder
  - Identify responsibilities for stakeholders in relation to timing in IDSP process

Iterative Feedback Process
- Incorporate stakeholder feedback in creation of iterative process
- Include policy and regulation schedules
- Address accessibility of community members in feedback process (ex: transportation, technology, language, etc.)
- Incorporate feedback into policies

Implementation into Planning Objectives & Criteria
- Transparency and communication of the following:
  - Final policies and regulations
  - Planning Objectives and timing of implementation
  - Criteria, metrics, and reporting
  - Performance and feedback to stakeholders