NREL
NATIONAL RENEWABLE ENERGY LABORATORY

The Treatment of Solar Generation in Electric Utility Resource Planning

NREL Webinar

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Logistics

- **Participants are joined in listen-only mode.**
- **Use the Q&A panel to ask questions during the webinar. We will hold all questions until the end of the webinar.**
  - **To ask a question:**
    - Click Q&A at the top of the Live Meeting Window
    - Type your question in the Q&A box
    - Click “Ask” to send question
- **The webinar is being recorded and a link will be sent to all online participants once it is available.**

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Overall Goals of this Webinar

Attendees will learn:

- How utilities conduct resource planning activities
- The benefits and challenges of incorporating solar generation into the resource planning processes
- Potential analysis options for more accurately incorporating solar generation into utility long-term planning processes
- Utility analysis needs that would better inform solar supply planning.

➔ Based on interviews with 13 entities (including 9 utilities) and a questionnaire with 28 utilities (22 states)

Speakers

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Who is NREL?

NREL's Mission: Only National Laboratory Dedicated Solely to Energy Efficiency and Renewable Energy

Energy Efficiency

- Residential Buildings
- Commercial Buildings
- Personal and Commercial Vehicles

Renewable Energy

- Solar
- Wind and Water
- Biomass
- Hydrogen
- Geothermal

Systems Integration

- Grid Infrastructure
- Distributed Energy Interconnection
- Battery and Thermal Storage
- Transportation

Market Focus

- Private Industry
- Federal Agencies
- Defense Dept.
- State/Local Govt.
- International

Who is SEPA?

SEPA
solar electric power association

SEPA is an educational non-profit (501 c3)

Researching and disseminating unbiased information and solutions to 1,000 members and the public focused on utility-solar nexus

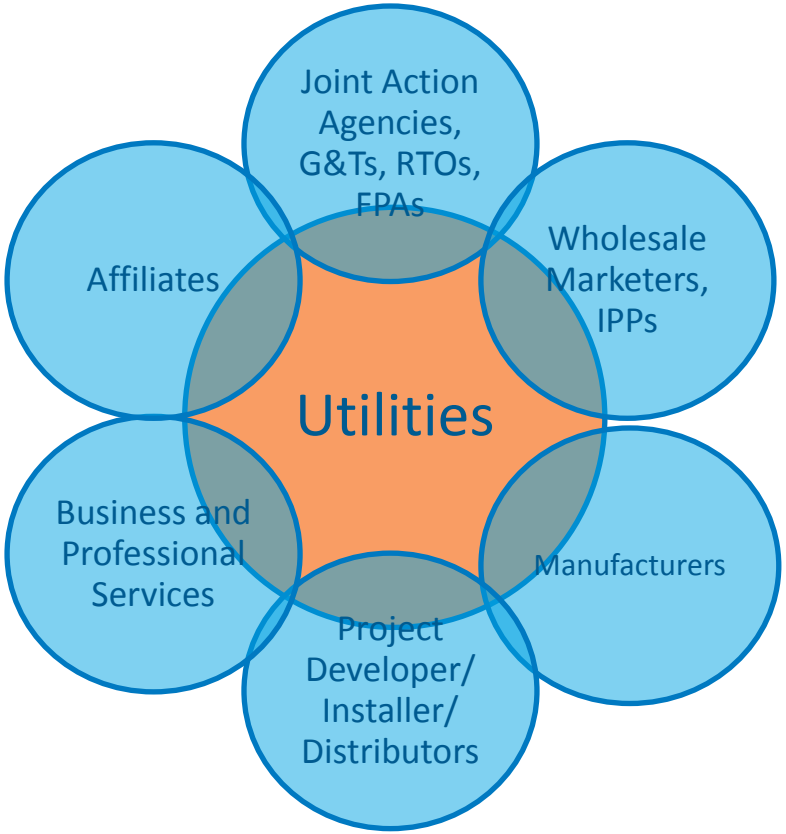
Membership

430+ Utility

460+ solar industry & stakeholder

52% of electricity customers

+90% of installed solar capacity

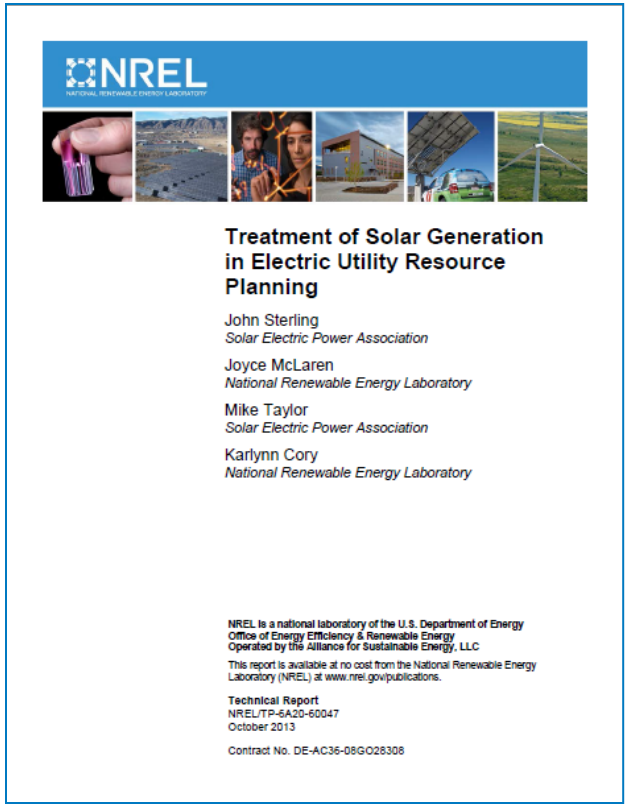


WHY ARE WE HERE?

Photo by Dennis Schroeder, NREL 21771

Treatment of Solar Generation in Electric Utility Resource Planning

- Understand utility solar supply planning methods, models, and approaches
- Build awareness, capture challenges, and identify solutions for:
  - Approach to long-range resource planning
  - Methods and tools for conducting resource planning
  - How solar is considered in the resource planning process
- Method:
  - Interviewed 13 entities, including 9 utilities
  - Questionnaire with 28 utilities (22 states)
- **Report issued on October 31, 2013**
  - http://www.nrel.gov/docs/fy14osti/60047.pdf.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Treatment of Solar Generation in Electric Utility Resource Planning

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October 2013

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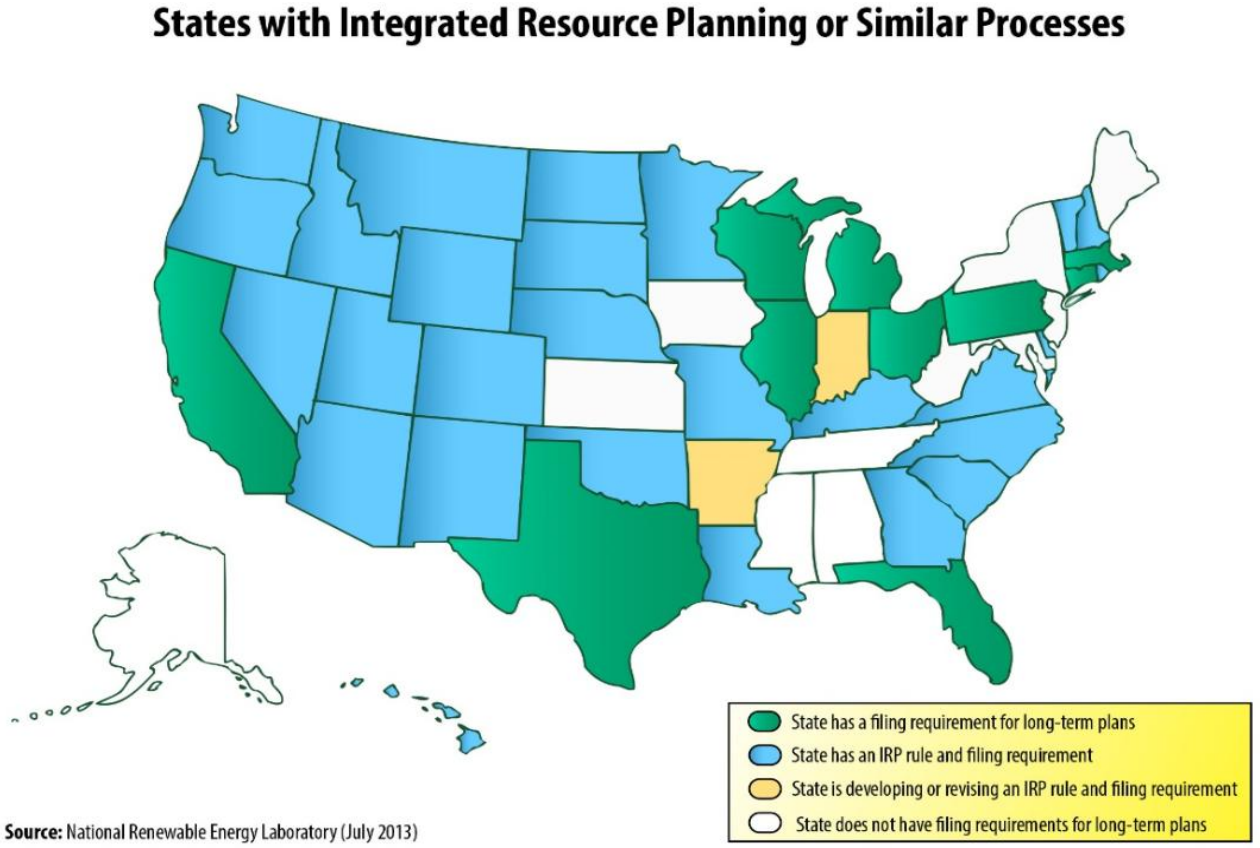
UTILITY SUPPLY PLANNING "CRASH COURSE"

Photo by Dennis Schroeder, NREL 21771

Integrated Resource Planning



Resource planning balances supply-side and demand-side resources over a long-term window to meet anticipated future load requirements (plus reserves).

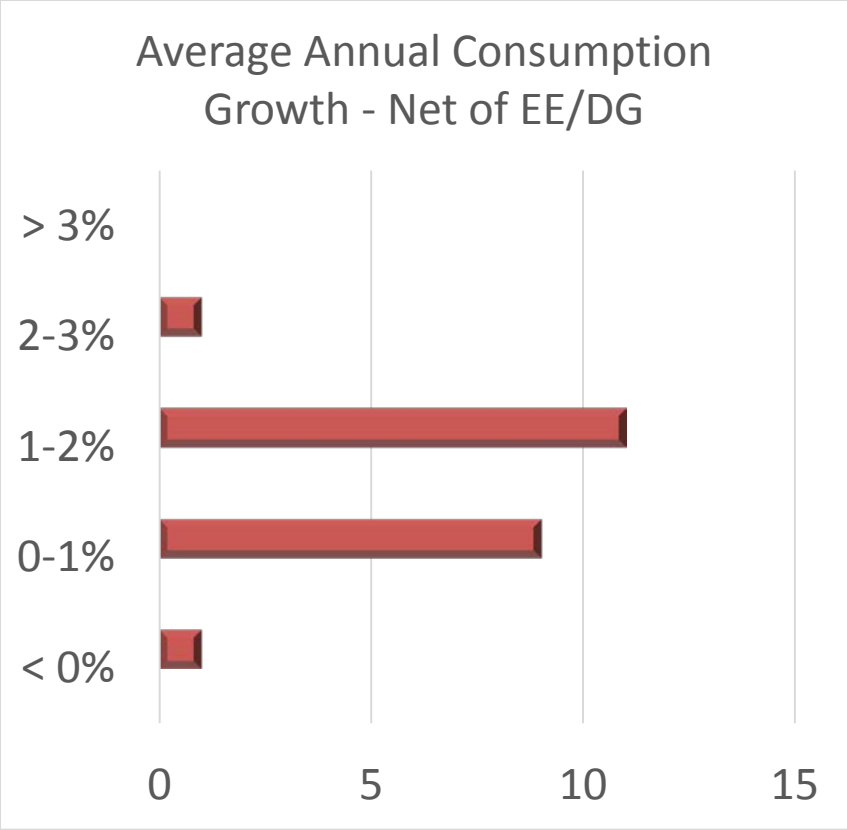
Load Growth

EIA Data

Time Period	Average Annual Load Growth
1981 – 2005	2.3%
2006 – 2012	0.23%
2013 – 2040 (est.)	0.78%

Source: EIA 2013

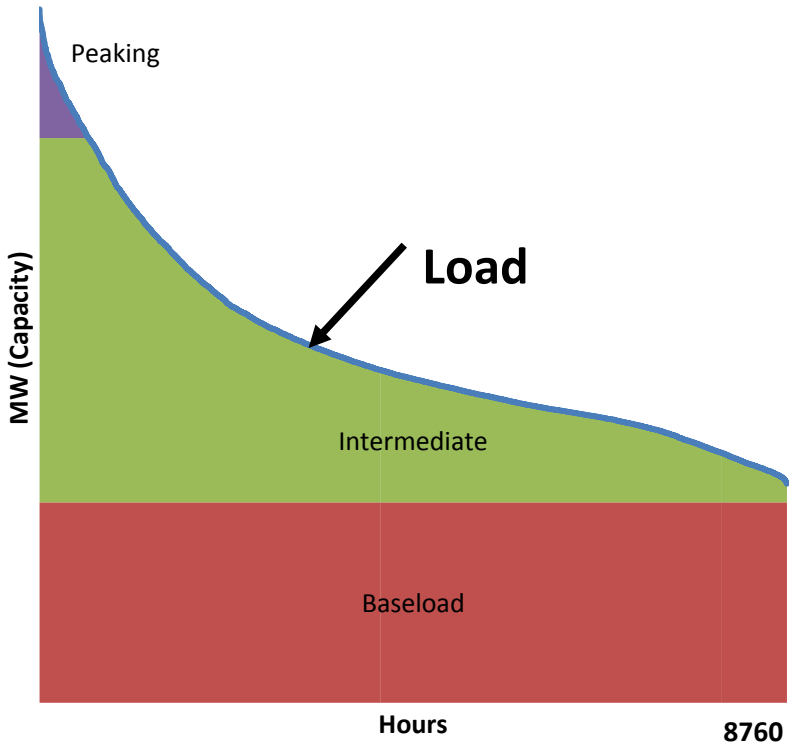
Utility Planning Assumptions



Source: NREL/SEPA questionnaire performed as part of this study (Sterling et al. 2013)

Resource Options and Availability

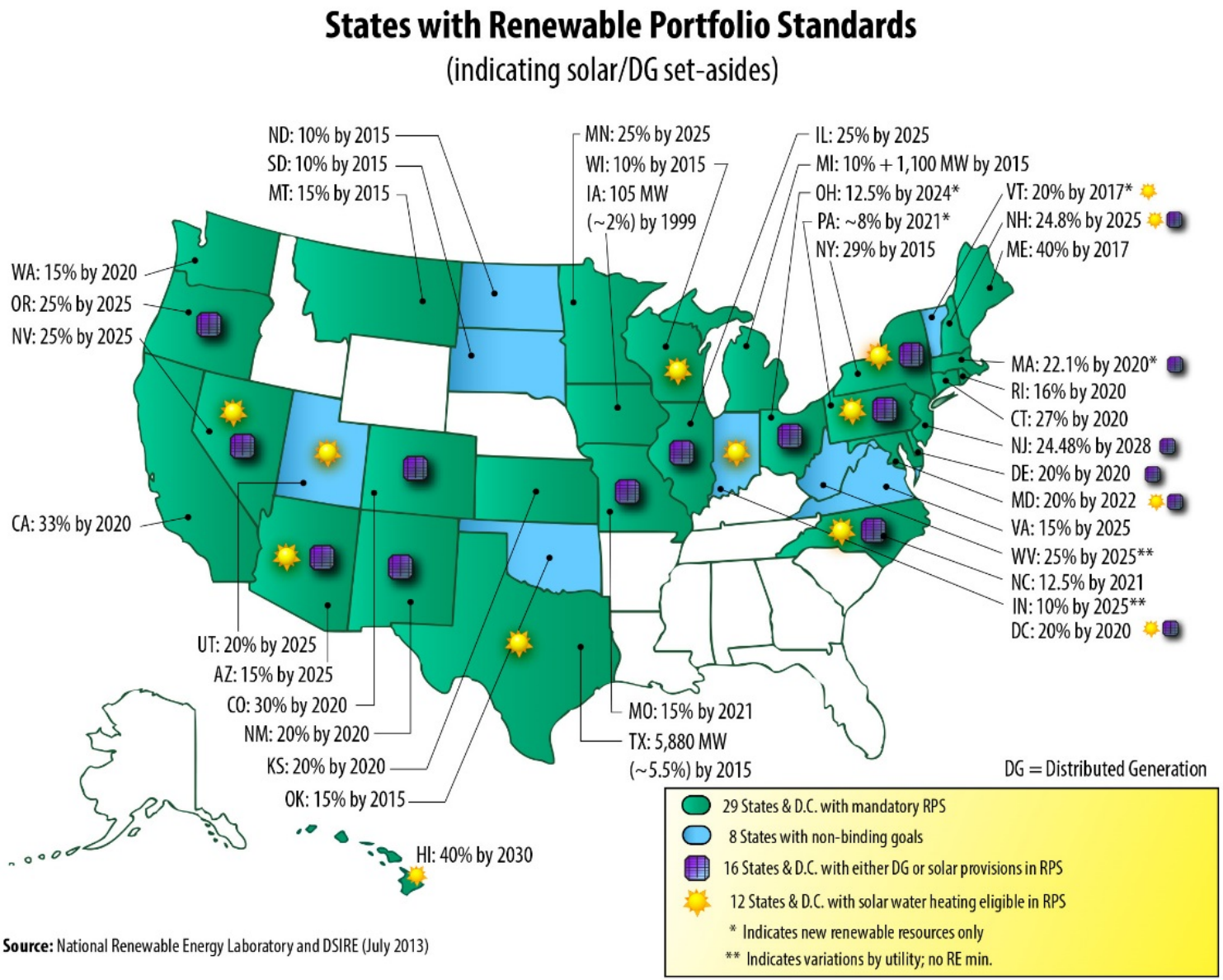
Load Duration Curve



Resource Considerations

- Existing Assets
  - Planned life
  - Repair or replace
- Contracts
  - End dates
  - Extension options
- EE/DR/DG
  - Customer adoption rates
- New Resources
  - Needs identification.

States with RPS



How Utilities Conduct Long-Term Planning

Capacity Expansion Planning

- Create a series of future resource plans, often using software tools
- Take an array of assumptions on their generation fleet, growth, fuel costs, etc.
- Optimize future resource additions based on lowest potential revenue requirements.

Potential Capacity Expansion Constraint Criteria

- Limit the number of specific resources that can be added in a given window
- Set a minimum level of capacity or energy from a specific resource type
- Restrict certain resources from being selected
- Require a specific resource to be built at a point in time
- Force a plant retirement prior to end of book life.

Resource Characteristics

Plant Statistics

- Nameplate MW
- Summer/Winter Net Dependable Capacity
- Capacity Value (RE only)
- Construction Time
- Useful Life

Plant Operating Characteristics

- Capacity Factor
- Heat Rate (combustion only)
- Water Use
- Emissions
- Ramp Rate, Minimum Load, Start Times
- Planned/Unplanned Outages

Plant Economics

- Capital Cost ($/kW)
- Incentives (e.g., tax credits, MACRS, state incentives)
- Variable O&M ($/MWh)
- Fixed O&M ($/kW-yr)
- Integration Costs

Capacity Expansion Modeling

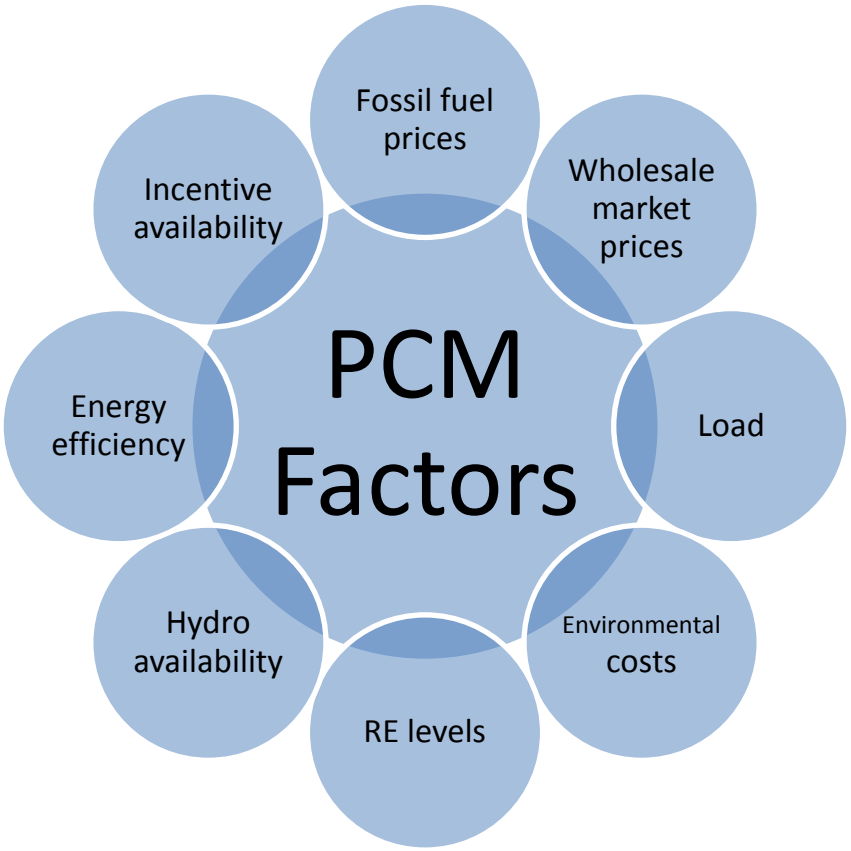
Example Results

Portfolio A	• Gas-heavy
Portfolio B	• Exceeds compliance of RPS
Portfolio C	• Contemplates new nuclear capacity

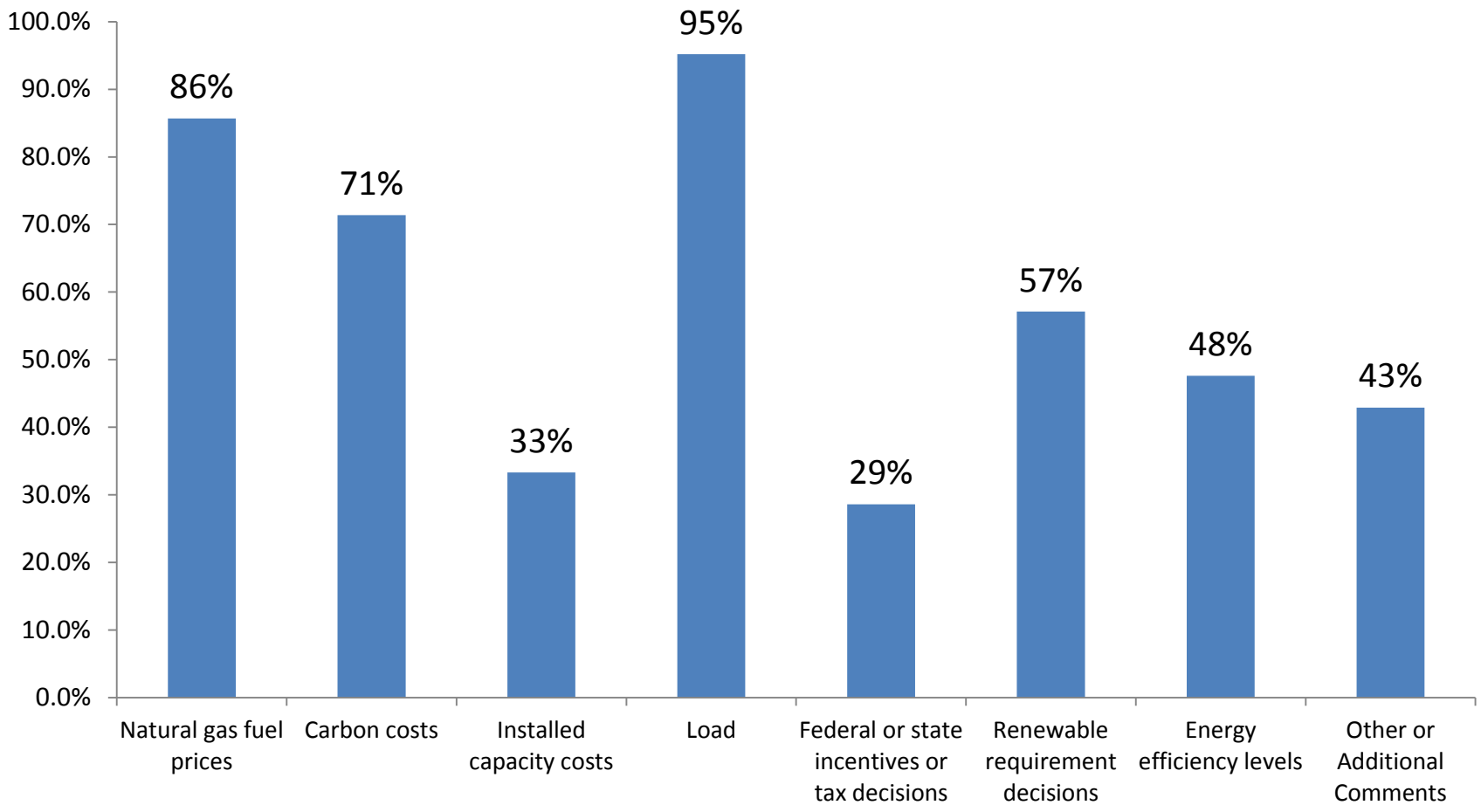
How Utilities Conduct Long-Term Planning

Production Cost Modeling

- **Production cost models take the set of future plans created in the capacity expansion process and runs them through an hourly dispatch model across the planning horizon (15+ years)**
  - Can identify fuel mix, gas burn, emissions, and cost information
- **Utilities often run sensitivity analytics around key variables where future values are uncertain**
- **The goal here is to identify portfolios that are more robust against upward risk.**

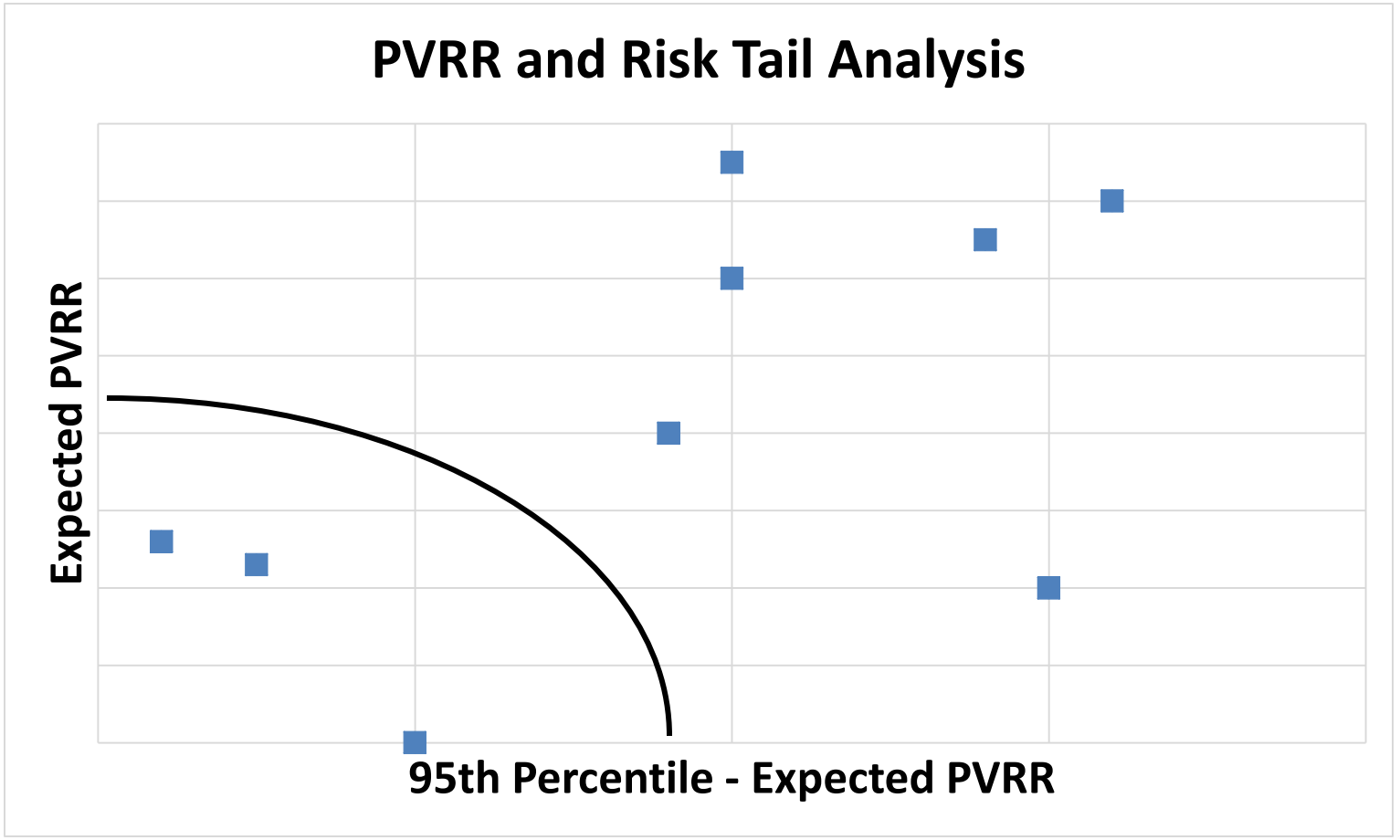


Commonly Stressed Variables



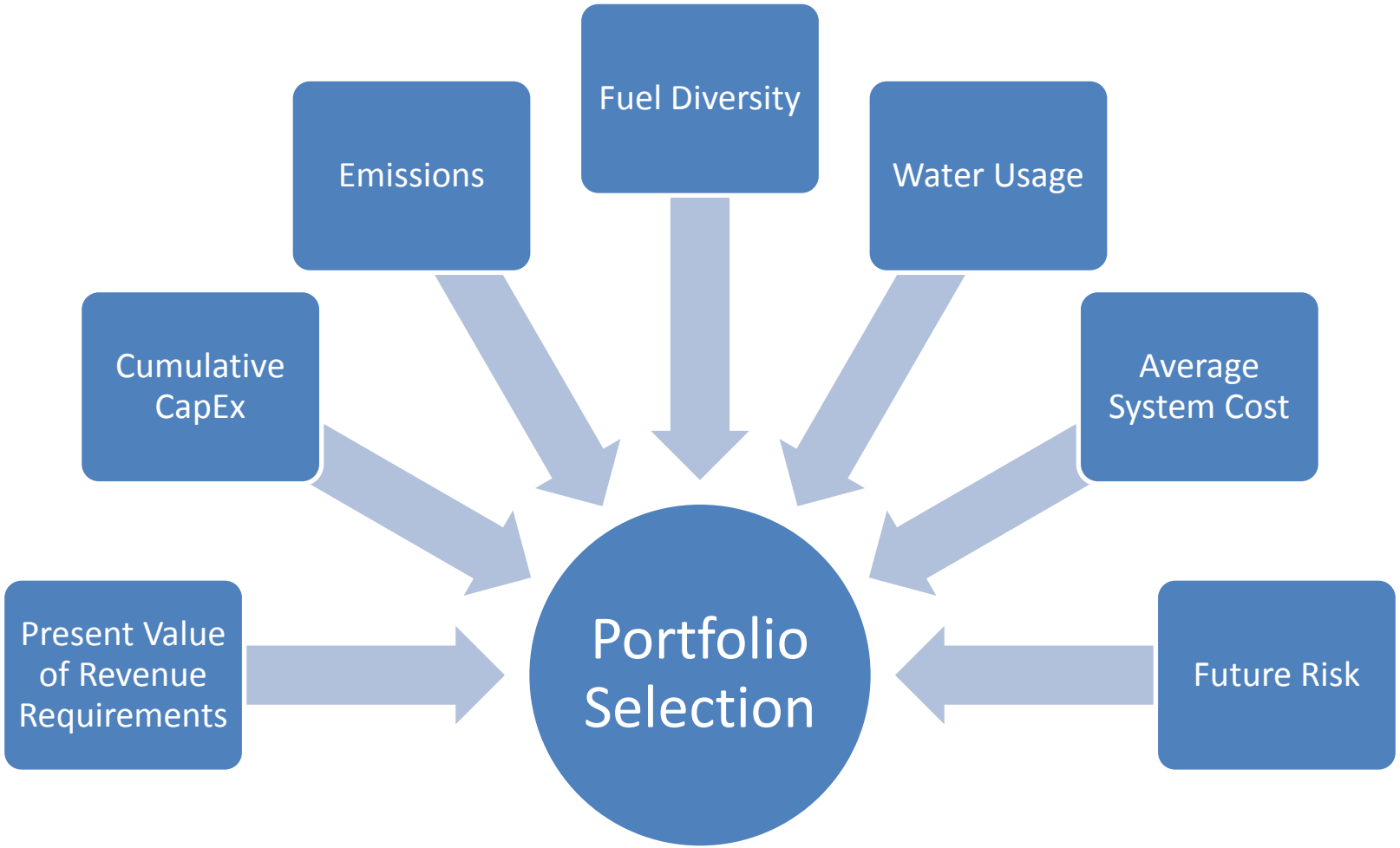
Based on SEPA-NREL utility questionnaire (21 respondents), performed as part of this study (Sterling et al. 2013).

Risk Analytics



Source: Sterling et al. 2013

Production Cost Modeling: Key Metrics



What do utilities think about solar energy today?

Utility Perspectives on Solar

Benefits of Solar

- Meet renewable standard requirements
- Fuel diversification
- Cost stability
- Geographic dispersal benefits and incrementality
- Partial correlation to peak demand
- Environmental compliance risk mitigation
- Avoid line losses (DG only).

Challenges of Solar

- Integration due to variable output (within and between years)
- Economics
- Lack of current capacity need
- Cross-subsidization
- Ramping issues (especially for DG that cannot be controlled by the utility; doesn't provide reserves)
- Reduced capacity benefit over time with increasing penetration.

CONSIDERATIONS FOR IMPROVED INTEGRATION OF SOLAR INTO RESOURCE PLANNING ANALYTICS

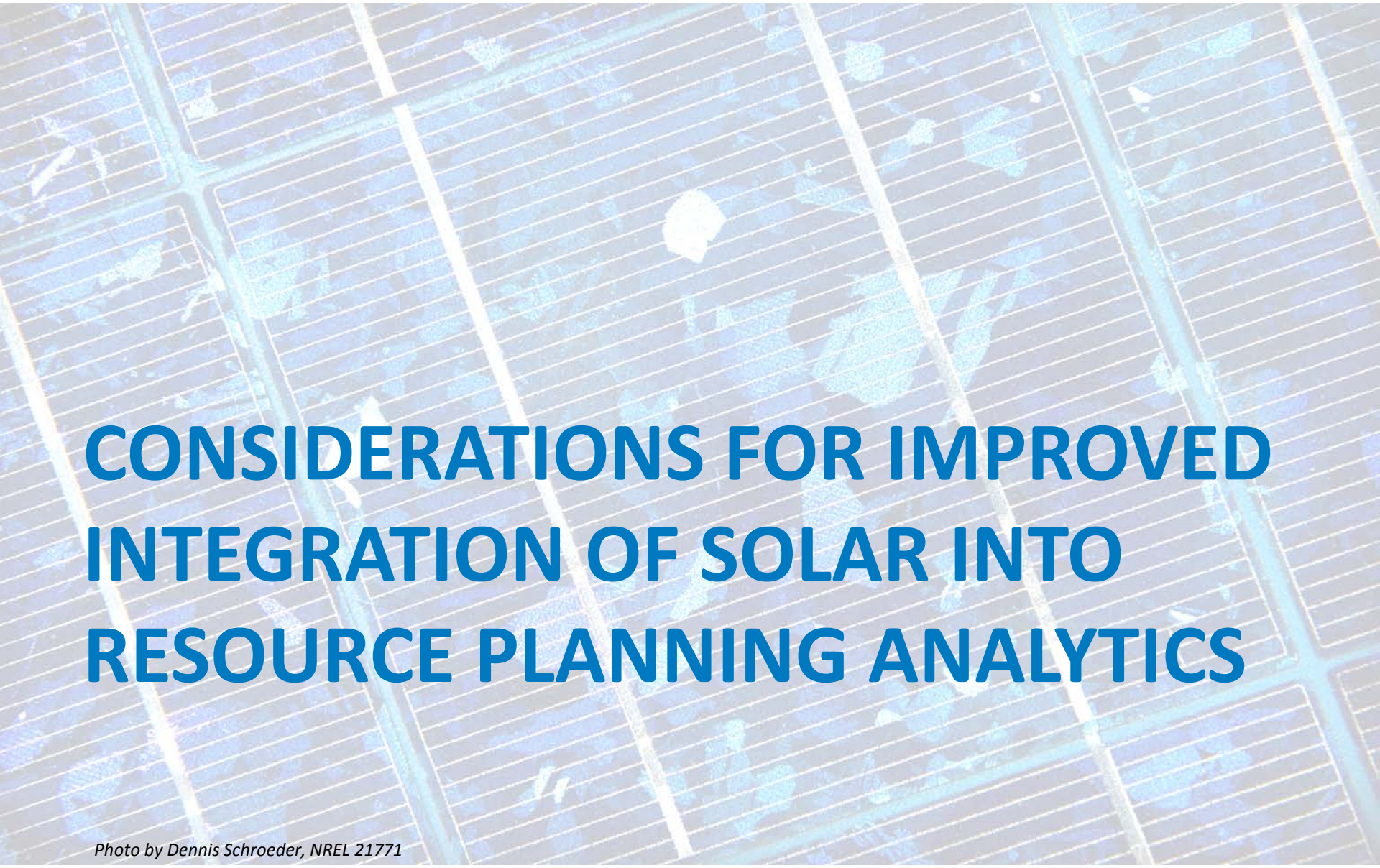


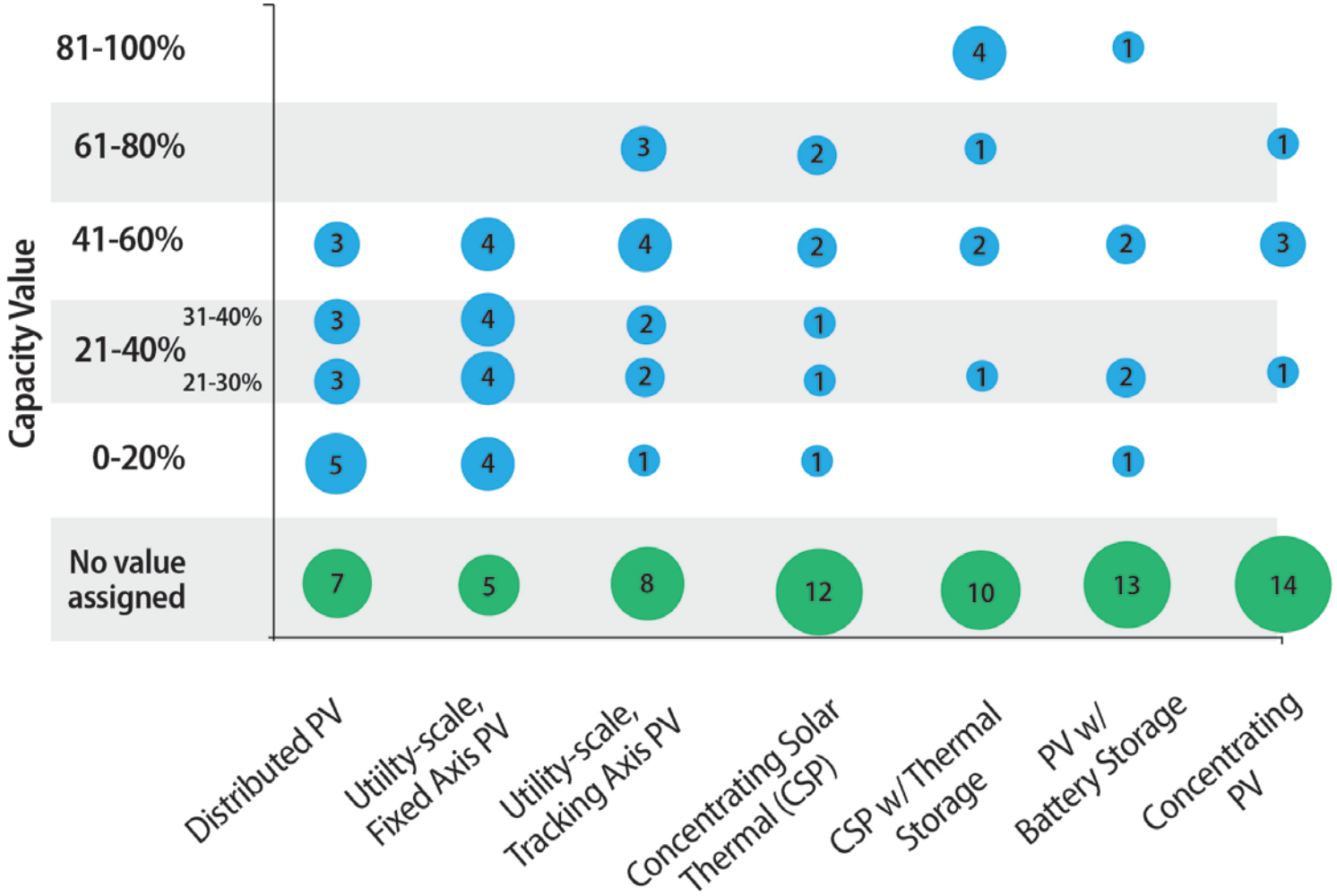
Photo by Dennis Schroeder, NREL 21771

Where are there gaps between utility practices and solar incorporation?

Top Considerations

1. Estimate solar capacity value
2. Improve DG treatment in planning
3. Incorporate solar cost and performance
4. Modify how solar is analyzed in existing planning tools.

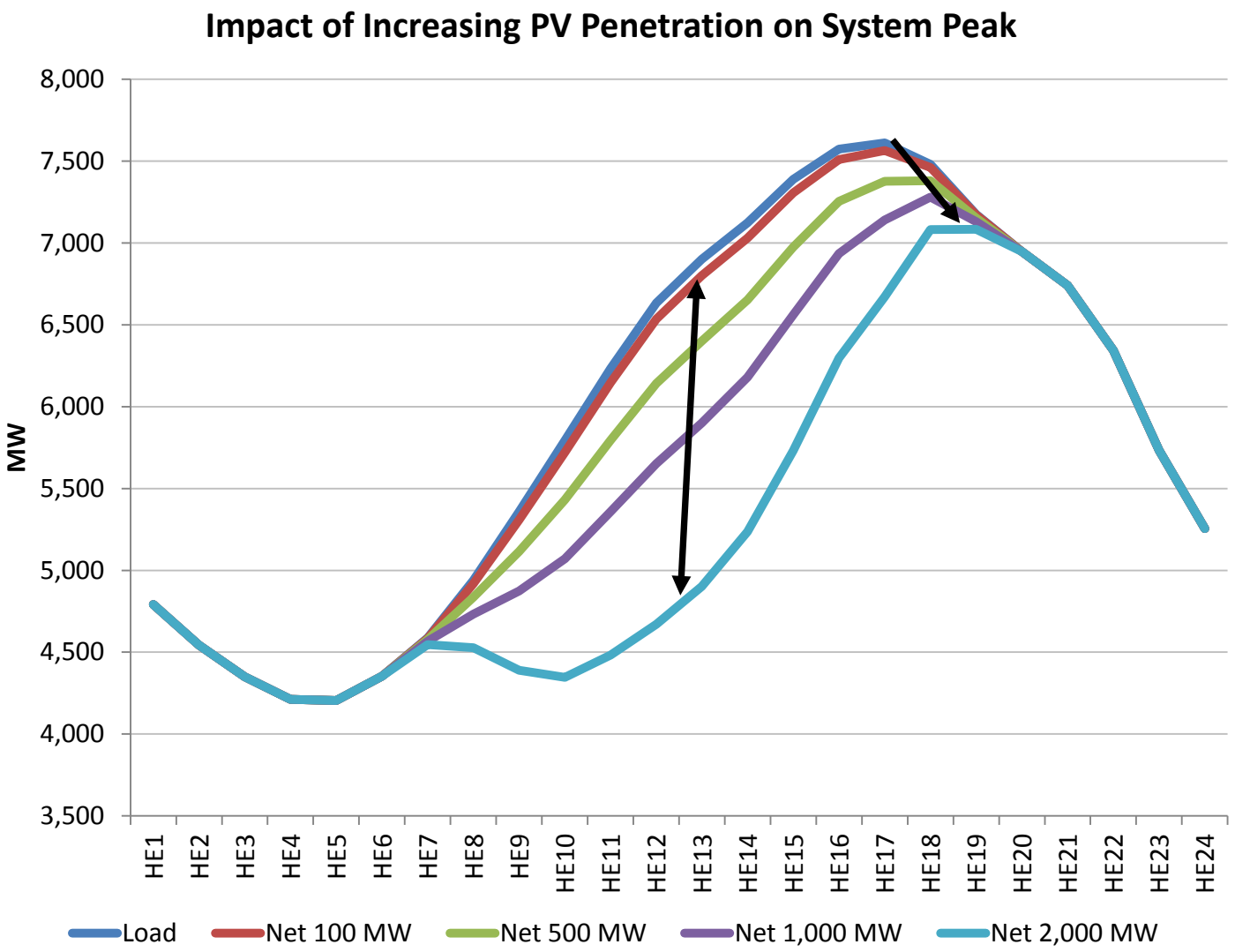
Solar Capacity Value: Utility Treatment Today



Note: Numbers in circles represent the number of utility responses

Source: SEPA-NREL questionnaire (up to 21 respondents), as part of this study (Sterling et al. 2013).

Capacity Value Changes Based on Penetration



Source: Sterling et al. 2013

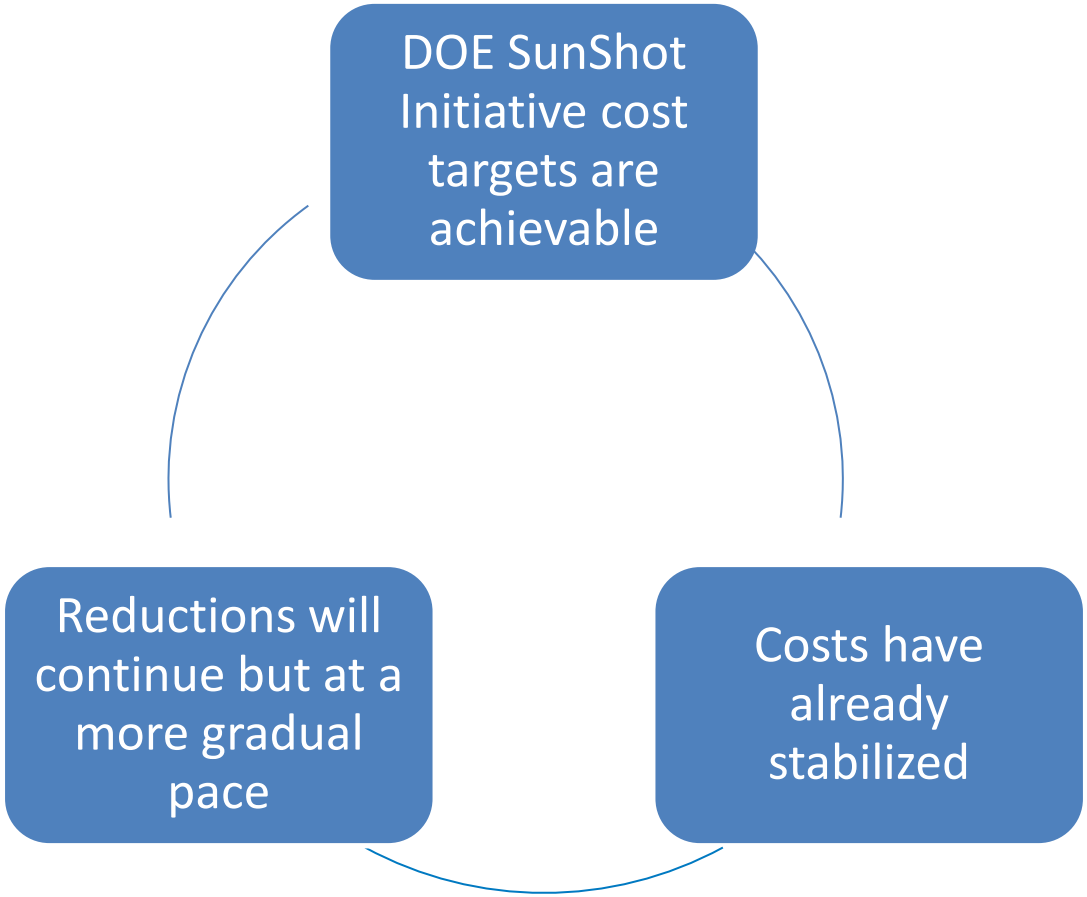
Key Points

- **Capacity Value is location-, technology-, and utility-specific**
  - No "one size fits all" value
  - Utilities should perform their own analyses for different technology types and locations
- **Capacity Value is not static**
  - The more solar that gets added to the system, the lower that incremental solar's Capacity Value will be – unless storage is available.

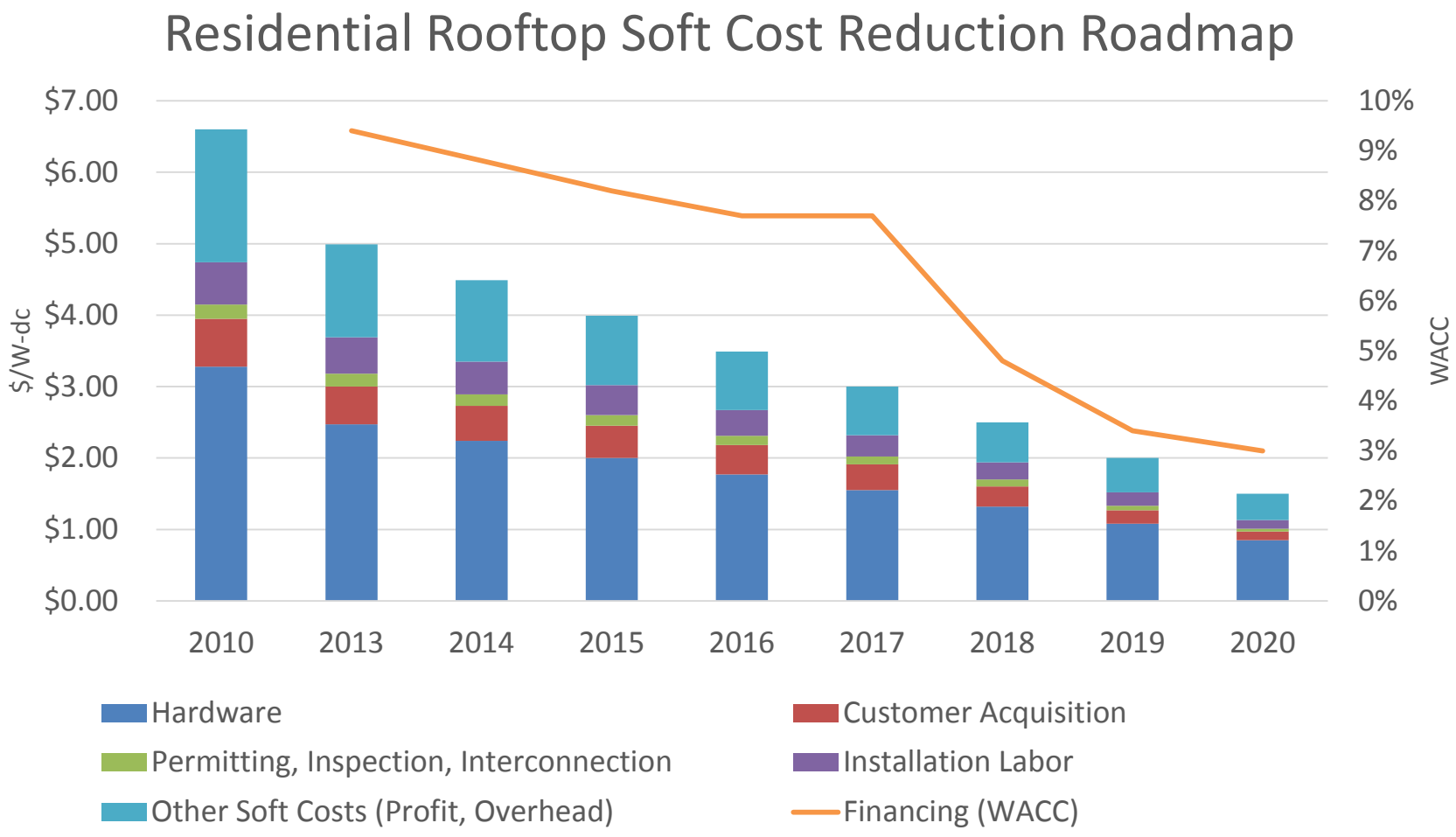
Distributed Generation

- **Virtually all utilities treat distributed PV as a net load reduction**
  - Simple, and at low penetration levels an appropriate approach
- **Utilities could consider treating DG as a resource**
  - Utilities could optimize the level of DG included in their resource plans
  - Utilities can perform sensitivity analytics around solar price curves.

Direction of Solar Costs: What We Heard



Cost Declines: Key Focus of DOE



Non-hardware ("soft") cost-reduction roadmap for residential and small commercial solar photovoltaics, 2013-2020 (NREL/RMI Report, Aug 2013).

Solar Cost Data

- **NREL's Transparent Cost Database – utility-scale data** http://en.openei.org/wiki/Transparent_Cost_Database
- **NREL's Energy Technology Cost and Performance Data for Distributed Generation** http://www.nrel.gov/analysis/tech_cost_data.html
- **NREL's Open PV Project – captures voluntary historical cost and performance data** https://openpv.nrel.gov/
- **LBNL's *Tracking the Sun* report** http://emp.lbl.gov/sites/all/files/LBNL-5919e-REPORT.pdf

Regularly updated

- **U.S. Department of Energy November Technical Report: *PV Pricing Trends: Historical, Recent, and Near-Term Projections*** http://www.nrel.gov/docs/fy13osti/56776.pdf
- **U.S. Department of Energy November Technical Report: *Benchmarking Non-Hardware Balance of System (Soft) Costs for U.S. Photovoltaic Systems Using a Data-Driven Analysis from PV Installer Survey Results*** http://www.nrel.gov/docs/fy13osti/56806.pdf
- ***Western Wind and Solar Integration Study - Phase 2* (integration costs)** http://www.nrel.gov/electricity/transmission/western_wind.html.

Snapshots in time

Solar Cost Models

Analysis Tools

- **NREL's System Advisor Model (SAM) – advanced tool for estimating levelized cost of energy (LCOE)** http://sam.nrel.gov/
- **NREL's Cost of Renewable Energy Spreadsheet Tool – simplified spreadsheet tool for estimating LCOE** https://financere.nrel.gov/finance/content/crest-cost-energy-models
- **NREL's PVWatts – tool for modeling production profiles of solar resources at different geographic locations** http://www.nrel.gov/rredc/pvwatts/about.html.

Modifying Planning Analytics

- **Analyze solar on an aggregate and geographically dispersed basis**
- **Enhanced risk/uncertainty analysis methods and/or updated modeling software**
  - Ex: Ability to run sub-hourly dispatch sensitivities
- **Linking supply planning to other utility planning, procurement, and operations procedures**
- **Solar-battery storage nexus.**

TAKEAWAYS

Photo by Dennis Schroeder, NREL 21771

Project Learnings

- **All utilities have some level of sophistication for modeling generation resources**
- **Utilities universally see solar as providing:**
  - Stable-priced energy
  - Fuel diversification
  - Risk mitigation for natural gas price volatility and potential future carbon costs
- **General agreement that the future cost curve for solar will continue to decline, but at a flatter rate than was experienced over the last several years**
- **Some utilities are more detailed and accurate in their inclusion of solar (and many generalize certain aspects)**
  - Primary drivers: cost efficacy of utility-scale generation and robustness of customer-sited PV adoption.

Areas of Focus for Solar Analytics

Profiles matter	• The more specific the 8760 profile is to a utility's system, the better • Dispersing solar over wide geographic areas requires a blending of profiles • Dynamic system size instead of fixed blocks can be used to fit needs more closely
Solar provides capacity value	• Utilities still analyzing the right approach to allocate capacity value to solar • Utility-, site-, and technology-specific values can differ
Technology and design flexibility drives cost-effectiveness	• Fixed vs. tracking • Orientation • Inverter clipping
Treatment of customer-sited solar	• Majority of utilities treat customer-sited solar as a net load today • Increased penetration and transition from NEM to other models (like feed-in tariffs or value of solar) may warrant treating as a resource
Intra-hour dynamics	• At low levels of penetration, not a concern • With increasing penetration, utilities may start looking at capacity expansion implications due to intermittency

Thank You!


Photo by Dennis Schroeder, NREL 19794

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