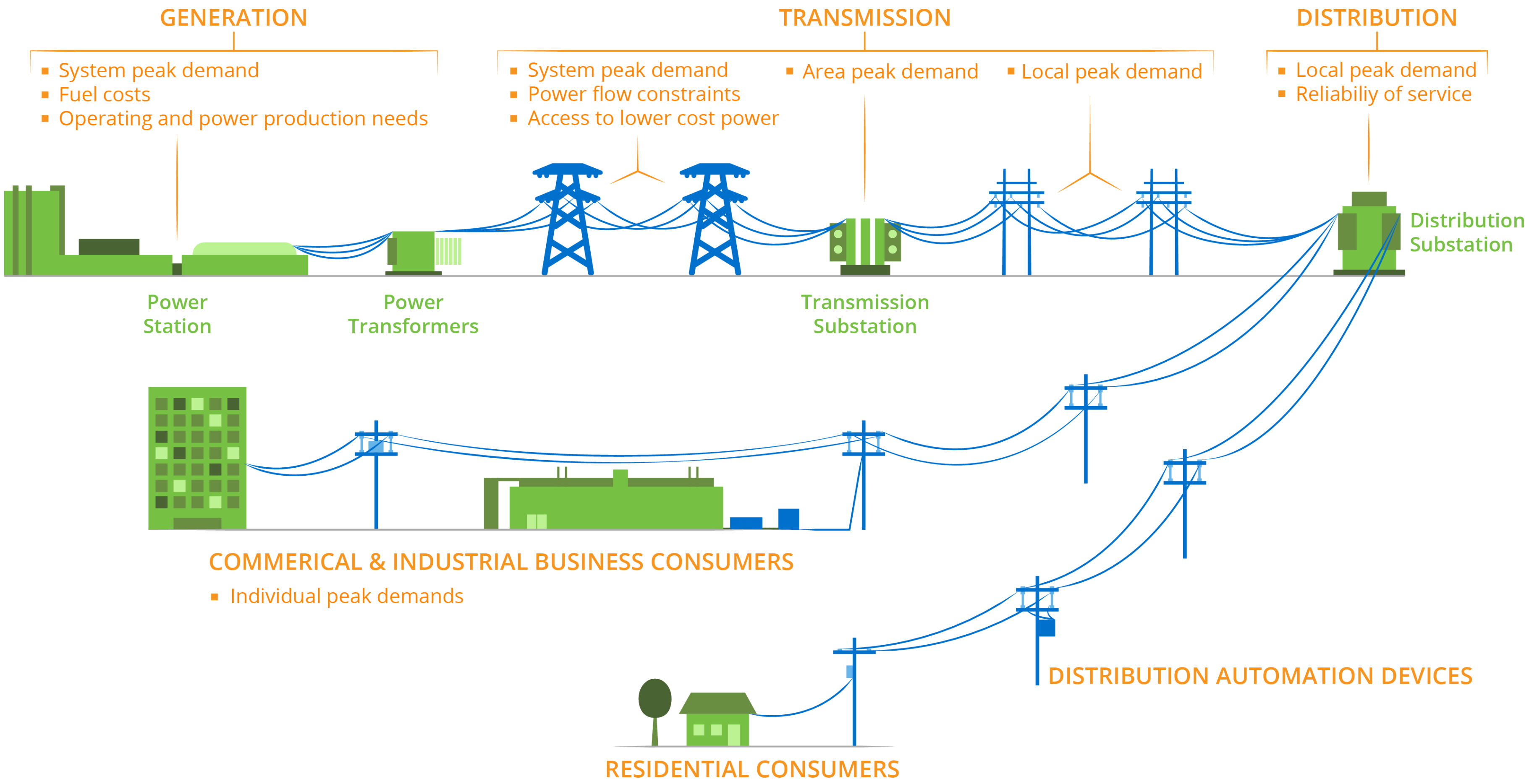
# BEST PRACTICES FOR EVALUATING USE OF DISTRIBUTED ENERGY RESOURCES AS NON-WIRE ALTERNATIVES

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

PUC PEER-SHARING WEBINARS ON INTEGRATED DISTRIBUTION SYSTEM PLANNING
HOSTED BY NARUC, BERKELEY LAB AND PACIFIC NORTHWEST NATIONAL LABORATORY
MAY 22, 2023

# PEAK DEMAND AFFECTS PLANNING AT MULTIPLE LEVELS




One of the most unique attributes of DERs is that they can affect all aspects of the electric grid's infrastructure upstream of the customer, including investments in the central, or bulk, electricity system, and in distribution grids.

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

# DISTRIBUTED ENERGY RESOURCES INCLUDE A WIDE RANGE OF TECHNOLOGIES WITH DIVERSE OPERATING CHARACTERISTICS AND UNDERLYING LOADS

| KEY QUESTION | CONSTRAINT | DEFINITION |
|---|---|---|
| **Is the DER tied to a specific load shape?** | Load profile | Structural shape of load reductions deliverable by a resource. For example, energy efficiency will deliver loads aligned with underlying consumption patterns (e.g., lighting or HVAC); solar PV will deliver loads varying by time of day, peaking in early afternoon; batteries of fuel based generation have no such limits. |
| | Seasonal availability | Availability year round versus summer only. |
| **Is the resource flexible?** | Availability window (start and end hours) | Hours of the day during which the resource is available. May be longer than the duration category. If duration category is shorter than the availability window, optimal window is used (e.g., the window with the most peak load). |
| | Ramp speed | Length of time it takes for resource to achieve maximum load reduction. |
| | Dispatch delay | Advance notice which must be given for resource to be dispatched. |
| **Are there specific operating constraints?** | Dispatch duration | Maximum number of consecutive hours during which a resource is able to deliver load reduction. May be limited by technology constraints (battery discharge time) or program limits (demand response event window). |
| | Max dispatch hours per year | Limit to total number of dispatchable hours in a year. |
| | Max events per year | Limit to total number of dispatch events (days) in a year. |
| | Max consecutive | Limit to total number of consecutive dispatch events (days) in a year. |
| | Events per year | (Days) in a year. |

Source: Bode, Lemarchand and Schellenberg (2015). Addressing the Locational Valuation Challenge for Distributed Energy Resources. Available at: https://sepapower.org/resource/beyond-the-meter-addressing-the-locational-valuation-challenge-for-distributed-energy-resources/

# KEY LESSONS

1. Provide enough lead time
2. Clearly define the need by hour and year (avoid blocks)
3. Require bidders to stack hourly resources and show they fulfill the need for each hour and year
4. Require use of standard end-use load shapes and transparent impact assumptions
5. Assess the net costs of the resource – what is the cost after you account for other benefits (besides deferral)?
6. View lump loads as an opportunity
7. Ensure you can measure the impacts
8. Use standardized inputs and contracts

# #1 PROVIDE ENOUGH LEAD TIME

To avoid or defer distribution investments, incremental DER distribution capacity needs to be procured in advance. If they show up at the last minute, unannounced and unaccounted for, there may not be enough lead time to incorporate them into planning

### Emergency Load Reductions (<2 years)

- Construction needs to happen quickly
- Often, there is insufficient time to build a DER portfolio large enough to defer investments

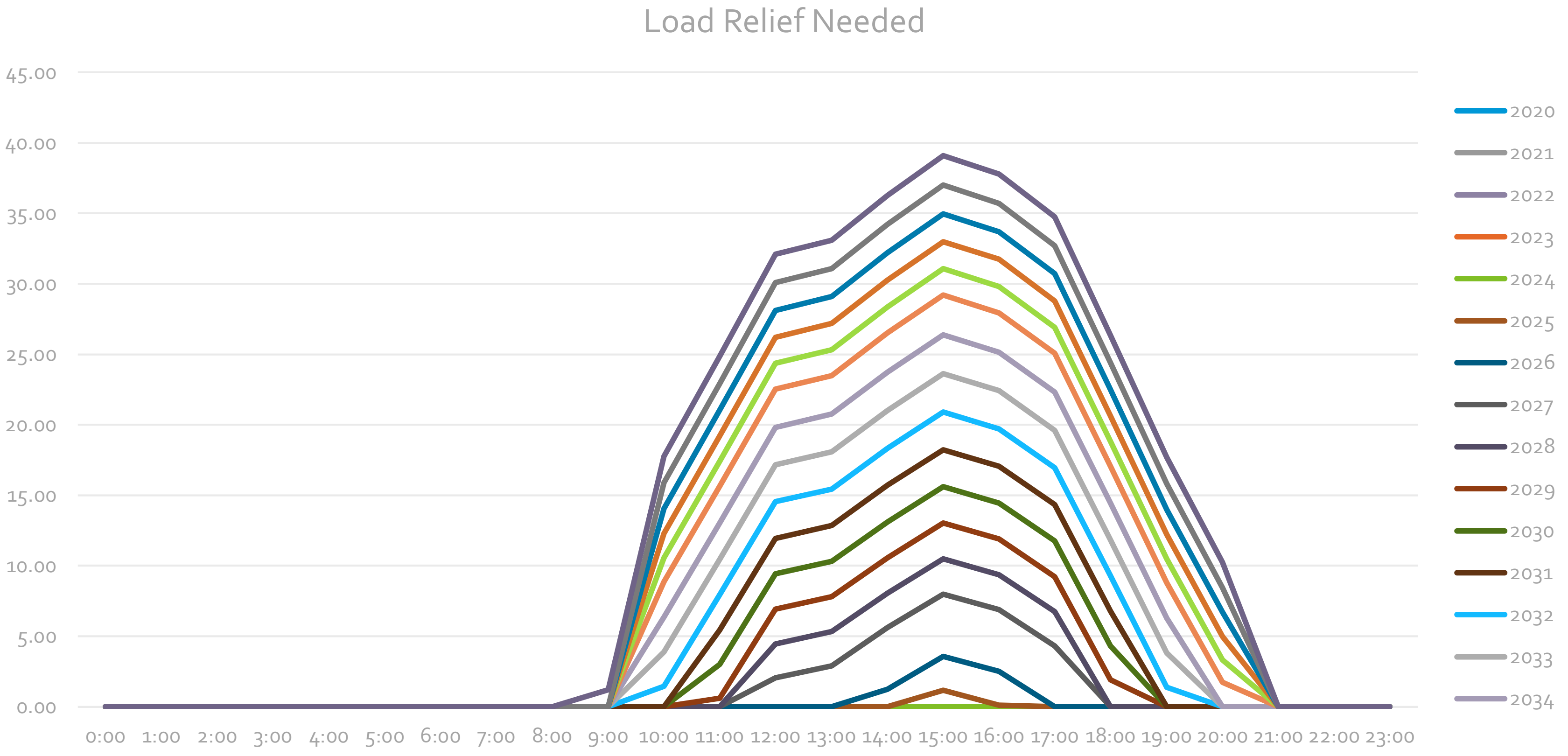
### Contractual Obligations (3-6 years out)

- Specify the need and request DER bids
- Once resources are contracted, treat them as incremental capacity (but watch and reassess performance)
- Dispatchable resources can play a role

### Incentivize permanent reductions and shifting (6+ years)

- Focus on bending the growth trajectory
- Focus on permanent shifting and resources with a long useful life such battery storage, solar, and energy efficiency

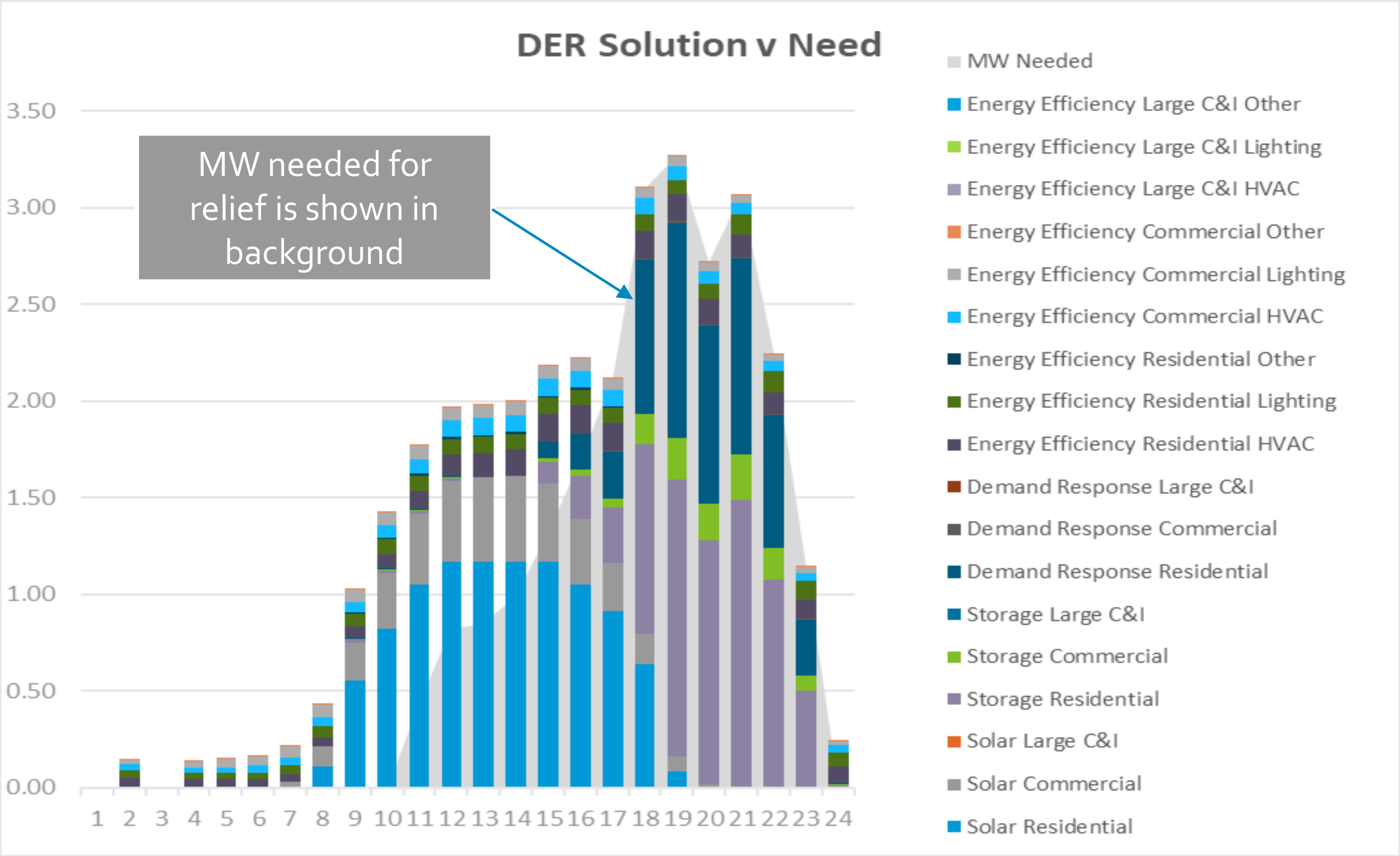
# #2 CLEARLY DEFINE THE NEED BY HOUR AND YEAR (AVOID BLOCKS)




- The magnitude, timing, and duration of resources needed vary based on the forecast year
- Providing specific information allows bidders to craft DER portfolios to meet the needs
- Requiring blocks (e.g., 12-6 pm) is too blunt and can disqualify portfolios that meet the needs
- Clearly define frequency of resource needs by year

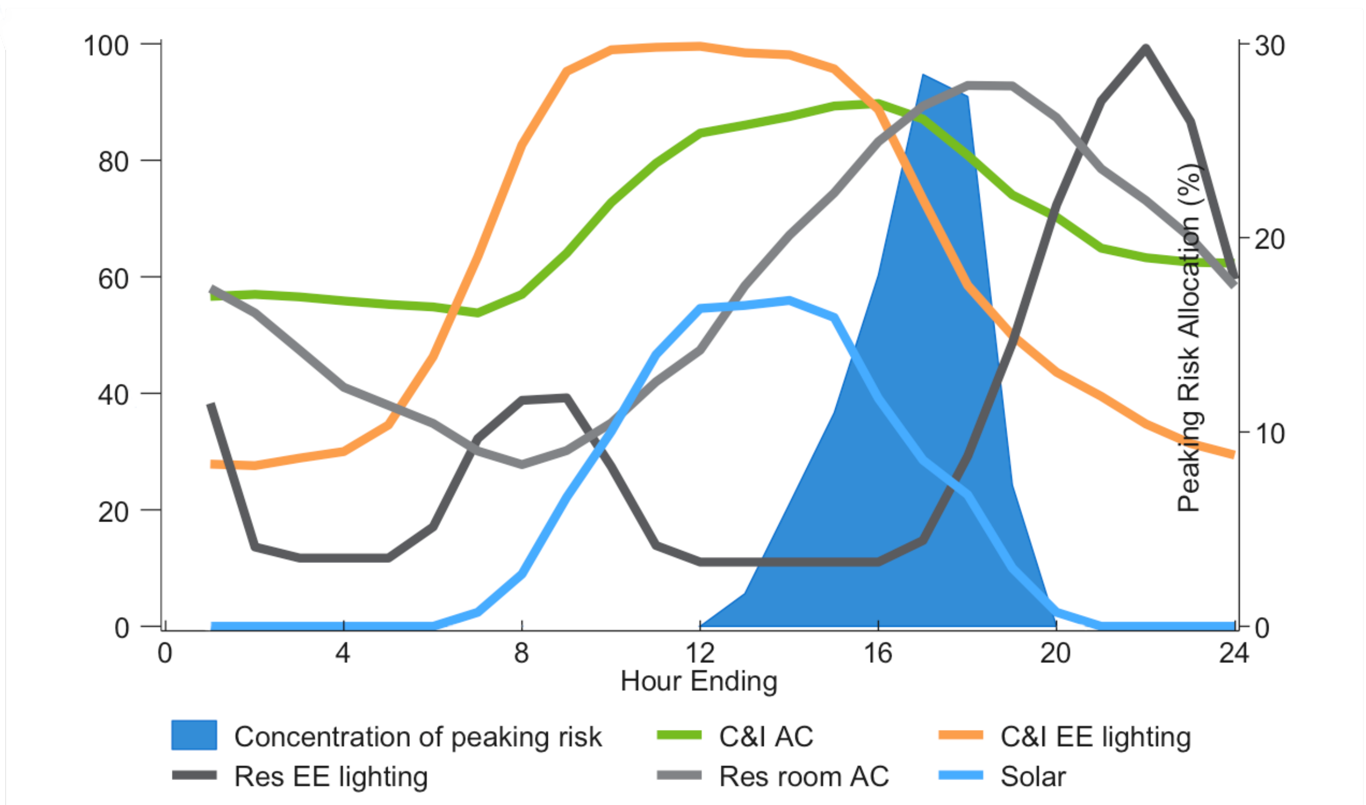
Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

# #3 REQUIRE BIDDERS TO STACK HOURLY RESOURCES AND SHOW THEY FULFILL THE NEED IN FULL




- Provide a bidder's template that requires the following for each resource:
  - Resource type (use a pick list)
  - Customer class
  - kW and kWh per customer
  - Hourly change in demand the resource will deliver by hour
  - # of times the resource can be dispatched per year
- The bidder template can stack those resources to show bidders how their resource performs against the need
- The approach ensures a clear definition of MWs, where they come from, and when they show up – and avoids crosstalk

# #4 REQUIRE USE OF STANDARD END-USE LOAD SHAPES AND TRANSPARENT IMPACT ASSUMPTIONS




Source: Bode, Lemarchand and Schellenberg (2015). Addressing the Locational Valuation Challenge for Distributed Energy Resources. Available at: https://sepapower.org/resource/beyond-the-meter-addressing-the-locational-valuation-challenge-for-distributed-energy-resources/

- Bidders sometimes provide unrealistic timing and magnitude of resources
- Use published end-use load shapes (NREL/Berkeley Lab)
  - End-Use Load Profiles for the U.S. Building Stock go down to the county level
  - Practical Guidance on Accessing and Using the Data
- User can modify resource shapes – e.g., for battery storage – but should explain why and quantify the differences in shape from the standard
- Require users to cite source of demand reduction/impact estimates

# #5 ASSESS THE NET COSTS OF THE RESOURCE – WHAT IS THE COST AFTER YOU ACCOUNT FOR OTHER BENEFITS?

| DER Type | Purchased kW (Nameplate) | Potential kW (Nameplate) | Max duration | Total Cost | Total Other Benefits | Costs per Nameplate kW | Other Benefits per Nameplate kW |
|---|---|---|---|---|---|---|---|
| Solar Residential | 2,280 | 6,456 | 24 | $1,512,346.24 | $2,271,179.89 | $663.23 | $996.02 |
| Solar Commercial | 612 | 1,388 | 24 | $615,014.14 | $657,703.28 | $1,004.90 | $1,074.65 |
| Solar Large C&I | 100 | 208 | 24 | $100,752.65 | $103,292.29 | $1,004.90 | $1,030.23 |
| Storage Residential | 2,478 | 6,621 | 2 | $4,212,634.05 | $1,562,849.98 | $1,700.00 | $630.68 |
| Storage Commercial | 381 | 608 | 4 | $648,067.74 | $331,109.44 | $1,700.00 | $868.56 |
| Storage Large C&I | 0 | 0 | 24 | $0.00 | $0.00 | $0.00 | $0.00 |
| Demand Response Residential | 2,081 | 2,100 | 4 | $2,651,485.46 | $2,521,378.21 | $1,273.91 | $1,211.40 |
| Demand Response Commercial | 21 | 41 | 4 | $16,272.57 | $25,268.90 | $771.50 | $1,198.03 |
| Demand Response Large C&I | 16 | 31 | 4 | $8,062.69 | $54,093.16 | $513.11 | $3,442.51 |
| Energy Efficiency Residential HVAC | 148 | 311 | 24 | $1,081,245.40 | $214,825.71 | $7,283.74 | $1,447.16 |
| Energy Efficiency Residential Lighting | 112 | 188 | 24 | $19,326.99 | $249,293.80 | $172.39 | $2,223.61 |
| Energy Efficiency Residential Other | 10 | 21 | 24 | $92,560.19 | $14,862.21 | $9,031.82 | $1,450.22 |
| Energy Efficiency Commercial HVAC | 91 | 186 | 24 | $550,086.30 | $122,261.28 | $6,048.43 | $1,344.31 |
| Energy Efficiency Commercial Lighting | 70 | 127 | 24 | $15,477.68 | $158,597.43 | $221.32 | $2,267.86 |
| Energy Efficiency Commercial Other | 2 | 4 | 24 | $8,992.94 | $4,910.08 | $5,043.70 | $2,753.83 |
| Energy Efficiency Large C&I HVAC | 0 | 0 | 24 | $0.00 | $0.00 | $0.00 | $0.00 |
| Energy Efficiency Large C&I Lighting | 0 | 0 | 24 | $0.00 | $0.00 | $0.00 | $0.00 |
| Energy Efficiency Large C&I Other | 0 | 0 | 24 | $0.00 | $0.00 | $0.00 | $0.00 |
| Marketing Acquisition Costs | 0 | $0.00 | | $951,107.72 | | | |
| TOTAL | 8,403 | 18,290 | | $12,483,432.75 | $8,291,625.66 | | |

- DERs often provide other benefits
- What is the net cost after accounting for other benefits (excluding T&D)?
- Is the net cost lower than the deferral value?
- Key pitfalls
  - Not including the other benefits
  - Excluding real benefits that are not in the deferral contract
  - Only including hours in the deferral contract

# #6 VIEW LUMP LOADS AS AN OPPORTUNITY

## WHAT ARE LUMP LOADS?

- They are large new loads for facilities that are being built (e.g., large distribution warehouse)
- Developer provides a spec of max loads per circuit
- It's hard to forecast when and where they pop up and how much actual load shows up

## WHY DO THEY MATTER?

- A substantial number of distribution upgrades are driven by lump loads
- Shorter timelines – it is often not possible to go through an RFP process
- Asymmetric – planners pay a lot of attention to new lump loads, less so to lump loads that retire

## WHAT CAN BE DONE?

- Add solar, storage, energy efficiency, and demand response at the site to limit loads they are in the process of building
- Ensure they use these  technologies to limit maximum demand or that they follow a load shape that reduces impacts on the substation or circuit peak demand
- Allow utilities to bypass a lengthy RFP process to address lump load additions at the site

### Forecast Loads

| | Weather Year Conditions and assetid | | | | | |
|---|---|---|---|---|---|---|
| | 1in10 | | | 1in2 | | |
| year | MY_5072 | Maybrook | Montgomery | MY_5072 | Maybrook | Montgomery |
| 2021 | 1.32 | 20.94 | 7.90 | 1.23 | 19.38 | 6.90 |
| 2022 | 1.38 | 21.53 | 8.28 | 1.28 | 19.93 | 7.23 |
| 2023 | 1.44 | 22.14 | 8.67 | 1.34 | 20.49 | 7.57 |
| 2024 | 1.50 | 22.76 | 9.08 | 1.40 | 21.06 | 7.93 |
| 2025 | 1.56 | 23.40 | 9.51 | 1.46 | 21.65 | 8.31 |
| 2026 | 1.63 | 24.05 | 9.97 | 1.52 | 22.26 | 8.70 |
| 2027 | 1.71 | 24.73 | 10.44 | 1.59 | 22.89 | 9.12 |
| 2028 | 1.78 | 25.42 | 10.94 | 1.66 | 23.53 | 9.55 |
| 2029 | 1.86 | 26.14 | 11.45 | 1.74 | 24.19 | 10.00 |
| 2030 | 1.94 | 26.87 | 12.00 | 1.81 | 24.87 | 10.48 |
| 2031 | 2.03 | 27.63 | 12.57 | 1.89 | 25.57 | 10.98 |
| 2032 | 2.11 | 28.40 | 13.17 | 1.97 | 26.29 | 11.50 |

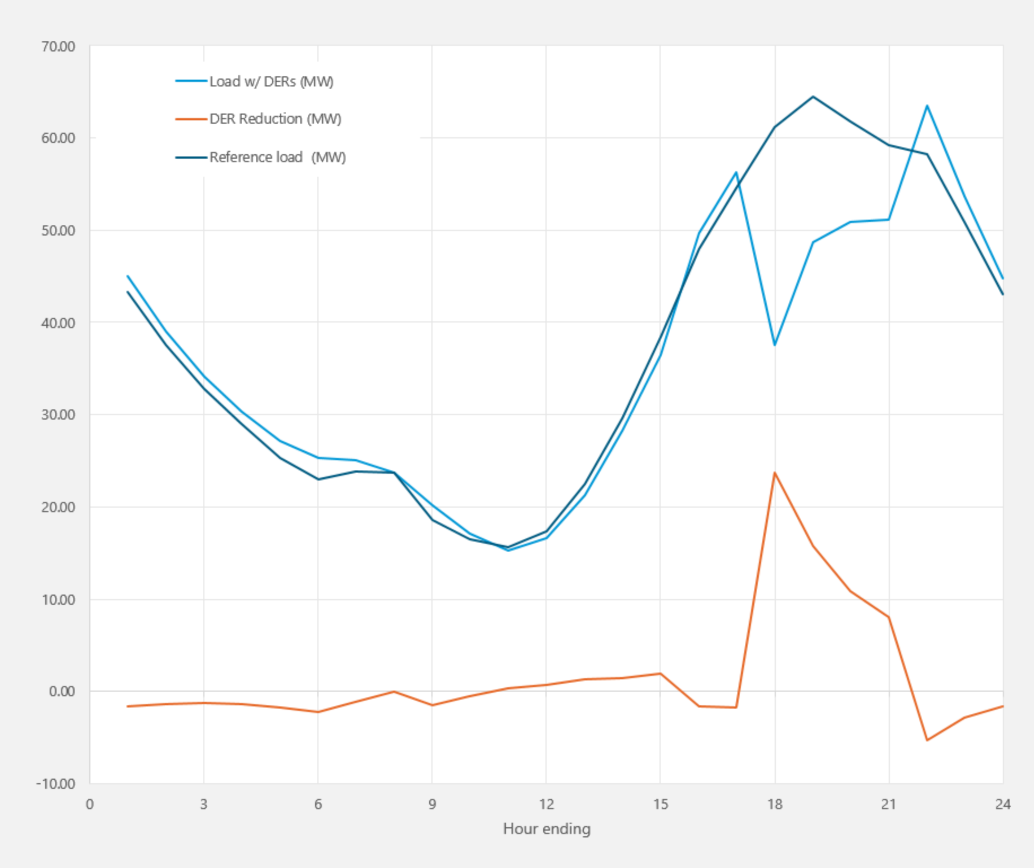
### + Coincident Lump Loads

| | Weather Year Conditions and assetid | | | | | |
|---|---|---|---|---|---|---|
| | 1in10 | | | 1in2 | | |
| year | MY_5072 | Maybrook | Montgomery | MY_5072 | Maybrook | Montgomery |
| 2021 | 1.42 | 0.00 | 1.42 | 1.84 | 0.00 | 4.71 |
| 2022 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.97 |
| 2023 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.97 |
| 2024 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.97 |
| 2025 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.97 |
| 2026 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2027 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2028 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2029 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2030 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2031 | 5.21 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |
| 2032 | 5.16 | 0.00 | 8.50 | 4.82 | 0.00 | 7.74 |

### = Loading

| | Weather Year Conditions and assetid | | | | | |
|---|---|---|---|---|---|---|
| | 1in10 | | | 1in2 | | |
| year | MY_5072 | Maybrook | Montgomery | MY_5072 | Maybrook | Montgomery |
| 2021 | 2.73 | 20.94 | 9.32 | 2.77 | 19.38 | 10.27 |
| 2022 | 6.52 | 21.53 | 16.78 | 6.06 | 19.93 | 15.01 |
| 2023 | 6.57 | 22.14 | 17.17 | 6.12 | 20.49 | 15.34 |
| 2024 | 6.63 | 22.76 | 17.59 | 6.17 | 21.06 | 15.69 |
| 2025 | 6.70 | 23.40 | 18.02 | 6.23 | 21.65 | 16.06 |
| 2026 | 6.76 | 24.05 | 18.47 | 6.30 | 22.26 | 16.45 |
| 2027 | 6.83 | 24.73 | 18.94 | 6.36 | 22.89 | 16.86 |
| 2028 | 6.90 | 25.42 | 19.44 | 6.43 | 23.53 | 17.29 |
| 2029 | 6.97 | 26.14 | 19.96 | 6.50 | 24.19 | 17.75 |
| 2030 | 7.05 | 26.87 | 20.50 | 6.57 | 24.87 | 18.22 |
| 2031 | 7.13 | 27.63 | 21.07 | 6.65 | 25.57 | 18.72 |
| 2032 | 7.22 | 28.40 | 21.67 | 6.73 | 26.29 | 19.24 |

# #7 ENSURE YOU CAN MEASURE THE IMPACTS




| Hour ending | Reference load (MW) | Load w/ DERs (MW) | DER Reduction (MW) | Total Reduction |
|---|---|---|---|---|
| 1 | 43.32 | 45.00 | -1.68 | -1.68 |
| 2 | 37.59 | 39.00 | -1.41 | -1.41 |
| 3 | 32.80 | 34.09 | -1.29 | -1.29 |
| 4 | 28.92 | 30.29 | -1.37 | -1.37 |
| 5 | 25.35 | 27.16 | -1.81 | -1.81 |
| 6 | 23.03 | 25.28 | -2.25 | -2.25 |
| 7 | 23.88 | 25.07 | -1.19 | -1.19 |
| 8 | 23.67 | 23.74 | -0.07 | -0.07 |
| 9 | 18.63 | 20.12 | -1.49 | -1.49 |
| 10 | 16.52 | 17.10 | -0.58 | -0.58 |
| 11 | 15.66 | 15.31 | 0.35 | 0.35 |
| 12 | 17.39 | 16.65 | 0.74 | 0.74 |
| 13 | 22.53 | 21.25 | 1.27 | 1.27 |
| 14 | 29.57 | 28.19 | 1.37 | 1.37 |
| 15 | 38.36 | 36.45 | 1.91 | 1.91 |
| 16 | 47.95 | 49.63 | -1.67 | -1.67 |
| 17 | 54.60 | 56.30 | -1.69 | -1.69 |
| 18 | 61.21 | 37.54 | 23.67 | 23.67 |
| 19 | 64.44 | 48.68 | 15.75 | 15.75 |
| 20 | 61.74 | 50.92 | 10.82 | 10.82 |
| 21 | 59.23 | 51.20 | 8.03 | 8.03 |
| 22 | 58.21 | 63.49 | -5.28 | -5.28 |
| 23 | 50.87 | 53.74 | -2.87 | -2.87 |
| 24 | 43.07 | 44.76 | -1.69 | -1.69 |
| **Daily** | **Reference load (MWh)** | **Estimated load w/ DR (MWh)** | **DR Energy savings (MWh)** | **Total Energy savings (MWh)** |
| Daily kWh | 898.53 | 860.95 | 37.58 | 37.58 |

- Have an evaluation plan that leaves no ambiguity
- Test the full resource potential early, over the hours required
- Is the resource delivering the magnitude of load relief required?
- Is the resource meeting the shape requirements?
- Beware of custom baselines and asymmetry
- Assess impacts using hourly data
  - Advanced metering infrastructure
  - End-use data
  - SCADA data

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

# #8 USE STANDARDIZED INPUTS & CONTRACTS

| Measure Type | Residential - Room AC control | Residential - Lighting | Residential - Solar | Commercial - Solar | Residential - Pool pump switches | |
|---|---|---|---|---|---|---|
| Customer Type | Residential | Residential | Residential | Commercial (Small) | Residential | |
| KW/customer | 4.00 | 0.80 | 3.58 | 74.00 | 0.30 | |
| KWh/customer | | | 8585.00 | 125093.00 | | |
| Measure Useful Life (Calculated) | 10 | 20 | 20 | 20 | 10 | |
| Measure Useful Life (Please Enter Manually if Different than | | | | | | |

| Resource Profile (kW) | Residential - Room AC control | Residential - Lighting | Residential - Solar | Commercial - Solar | Residential - Pool pump switches | |
|---|---|---|---|---|---|---|
| 0:00 | 1.68 | 0.00 | 0.00 | 0.00 | 0.01 | |
| 1:00 | 1.51 | 0.27 | 0.00 | 0.00 | 0.01 | |
| 2:00 | 1.36 | 0.00 | 0.00 | 0.00 | 0.01 | |
| 3:00 | 1.22 | 0.23 | 0.00 | 0.00 | 0.01 | |
| 4:00 | 1.18 | 0.24 | 0.00 | 0.03 | 0.01 | |
| 5:00 | 1.11 | 0.26 | 0.00 | 0.65 | 0.01 | |
| 6:00 | 1.00 | 0.31 | 0.00 | 5.50 | 0.02 | |
| 7:00 | 1.14 | 0.40 | 0.34 | 17.43 | 0.03 | |
| 8:00 | 1.45 | 0.50 | 1.70 | 33.33 | 0.08 | |
| 9:00 | 1.98 | 0.55 | 2.52 | 48.53 | 0.17 | |
| 10:00 | 2.59 | 0.57 | 3.23 | 60.97 | 0.24 | |
| 11:00 | 3.08 | 0.56 | 3.58 | 70.05 | 0.28 | |
| 12:00 | 3.49 | 0.57 | 3.58 | 73.33 | 0.29 | |
| 13:00 | 3.74 | 0.57 | 3.58 | 74.04 | 0.29 | |
| 14:00 | 3.91 | 0.58 | 3.58 | 67.96 | 0.27 | |
| 15:00 | 4.02 | 0.59 | 3.23 | 56.20 | 0.24 | |
| 16:00 | 3.81 | 0.57 | 2.80 | 41.57 | 0.17 | |
| 17:00 | 3.69 | 0.57 | 1.97 | 25.77 | 0.13 | |
| 18:00 | 3.48 | 0.50 | 0.26 | 12.79 | 0.08 | |
| 19:00 | 3.29 | 0.55 | 0.00 | 2.70 | 0.04 | |
| 20:00 | 3.05 | 0.71 | 0.00 | 0.01 | 0.02 | |
| 21:00 | 2.81 | 0.80 | 0.00 | 0.00 | 0.02 | |
| 22:00 | 2.63 | 0.70 | 0.00 | 0.00 | 0.02 | |
| 23:00 | 2.47 | 0.50 | 0.00 | 0.00 | 0.01 | |

Provide a brief description of Measure

| Number of Customers (by year) | Residential - Room AC control | Residential - Lighting | Residential - Solar | Commercial - Solar | Residential - Pool pump switches | |
|---|---|---|---|---|---|---|
| 2022 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2023 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2024 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2025 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2026 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2027 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2028 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2029 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2030 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2031 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2032 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2033 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2034 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2035 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2036 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2037 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2038 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2039 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2040 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2041 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |
| 2042 | 8.4 | 45.65 | 19.4 | 2.45 | 2.1 | |

Instructions | Bidder Information | Measure Capacity & Profile | Price Information | Price Breakdown (Informational) | PSEC

Drop down menus with pick lists

Resources delivered by hour

Magnitude of resources over time

Stand pricing templates and clear definition of resource needs

- If you don't use standardized inputs, you'll end up with more work and ambiguity.
  - For example, what does a MW of a resource mean?
- Ensure stackability of resources
- Allow comparison of multiple bids
- Reduce effort for bidders and reviewers

# KEY LESSONS RECAP

1. Provide enough lead time
2. Clearly define the need by hour and year (avoid blocks)
3. Require bidders to stack hourly resources and show they fulfill the need for each hour and year
4. Require use of standard end-use load shapes and transparent impact assumptions
5. Assess the net costs of the resource – what is the cost after you account for other benefits (besides deferral)?
6. View lump loads as an opportunity
7. Ensure you can measure the impacts
8. Use standardized inputs and contracts

# QUESTIONS?

Josh Bode
Partner
Demand Side Analytics
jbode@demandsideanalytics.com
415.786.0707