



NATIONAL
LABORATORY
OF THE ROCKIES

Large Load Planning, Siting, and Interconnection

February 10, 2026

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The Power System Is Changing



Electricity Demand

Is Growing

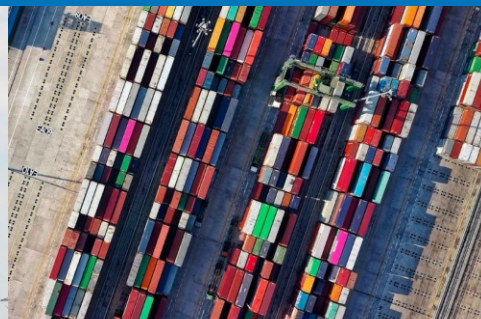


NLR's Vision: An Affordable and Secure Energy Future



Abundance

NLR harnesses America's abundant energy supply by improving the performance of existing energy technologies while innovating energy solutions.



Affordability and Powering Economic Growth

NLR's innovative research reduces costs and increases efficiency for energy production and systems integration—improving affordability, unlocking economic opportunity, and fueling America's global competitiveness.



Security and Reliability

NLR strengthens America's energy supply, delivery, and use through science and engineering that advances technologies and integrated systems that are secure, resilient, and reliable.

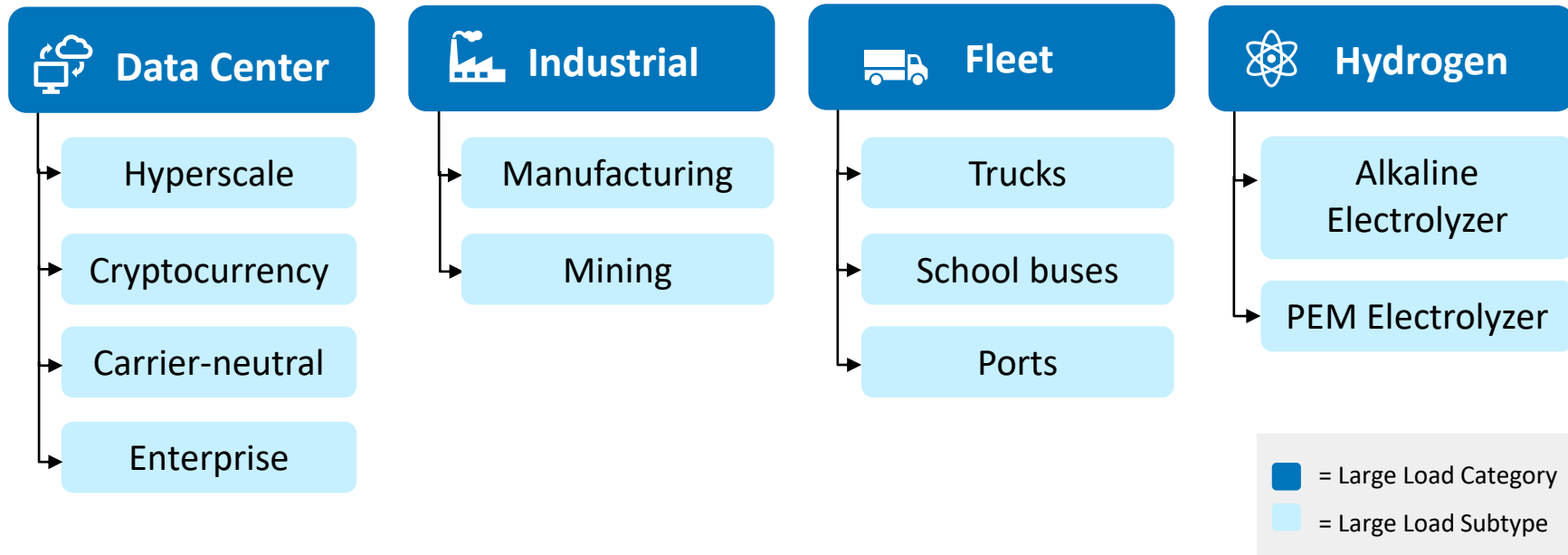


Collaboration

NLR's world-class researchers and capabilities enable collaborations and partnerships to accelerate energy innovation and systems integration.

What Is a Large Load*?

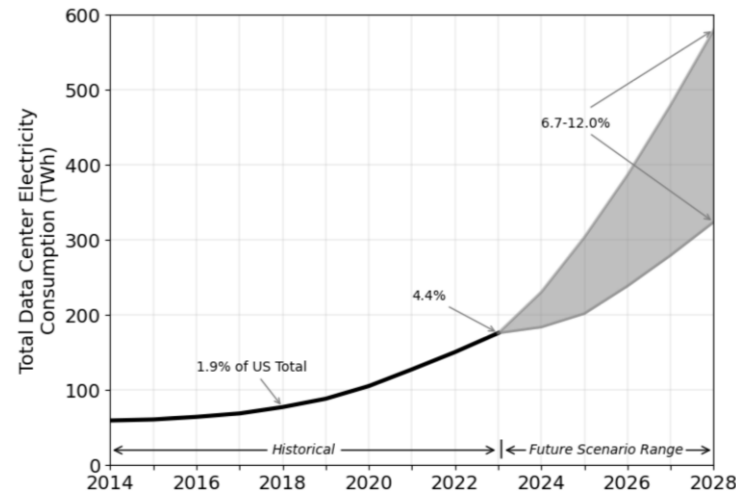
- Common definitions seem to cluster around **50–100+MW**, but many types
- A lot of focus specifically on data centers (including in these slides)



*Categories with non-comprehensive examples

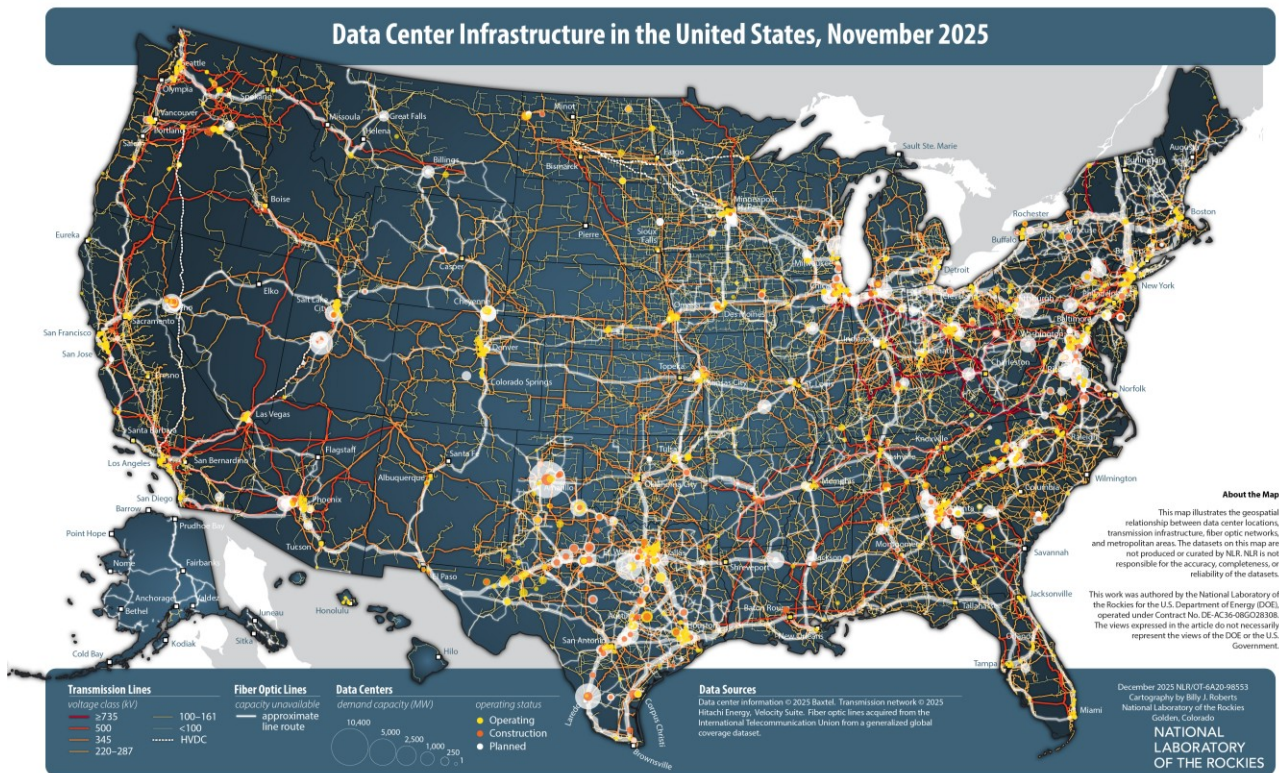
Estimates of Data Center Demand Growth are Very High and Highly Uncertain

- Data center demand was around 180 TWh in 2023, representing 4.4% of total U.S. electricity consumption (LBNL 2024)
 - 3x growth from 2014
- Total energized capacity now over 47,000 MW with 8,600 MW added in 2025 (Baxtel)
- 35,000 MW under construction at the end of 2025 and additional 93,000 MW planned through 2030 (Baxtel)
 - By 2028, estimated ~90% of compute energy consumption will be AI workloads (LBNL 2024)



Source: LBL 2024 https://eta-publications.lbl.gov/sites/default/files/2024-12/lbnl-2024-united-states-data-center-energy-usage-report_1.pdf

Where Can a Capacity-Strained Grid Quickly and Flexibly Add Tens-to-Hundreds of Gigawatts of New Load from Data Centers?

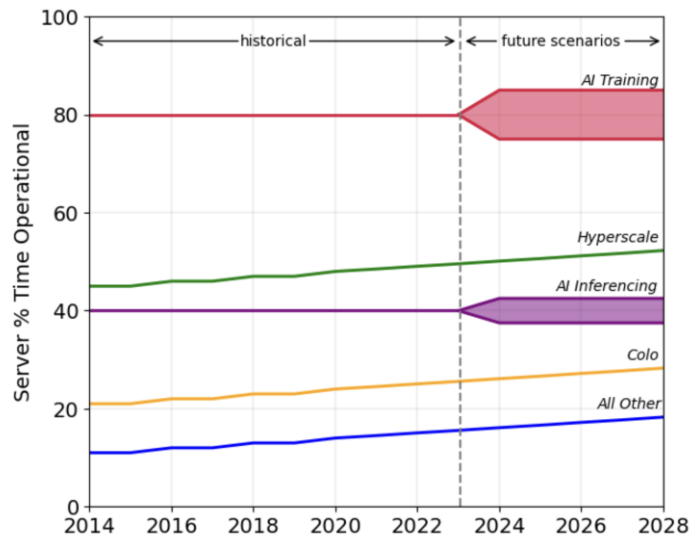


What Can Utilities do to Reduce Uncertainty in Large Load Forecasting?

- Use a range of metrics to characterize likelihood and impact of large load interconnection requests
- Incentivize accurate customer-supplied data about technical design, project maturity, and alternative sites
- Differentiate among large load types to anticipate new load shapes
 - AI Training
 - AI Inference
 - Cloud compute
 - Data storage

“ERCOT calculated that of the large load projects with load expected to be in service in 2024, 55.4% were actually in service by February 2025”

- ESIG Large Load Forecasting Task Force



Source: LBL 2024 https://eta-publications.lbl.gov/sites/default/files/2024-12/lbnl-2024-2024-united-states-data-center-energy-usage-report_1.pdf

Breaking Down Data Center Siting

Utilities are increasingly being challenged to say: “**Here’s where you should be looking to connect.**”

Breaking down the data center developer’s problem:

- 1) Siting for speed
- 2) Reliability
- 3) Market opportunity

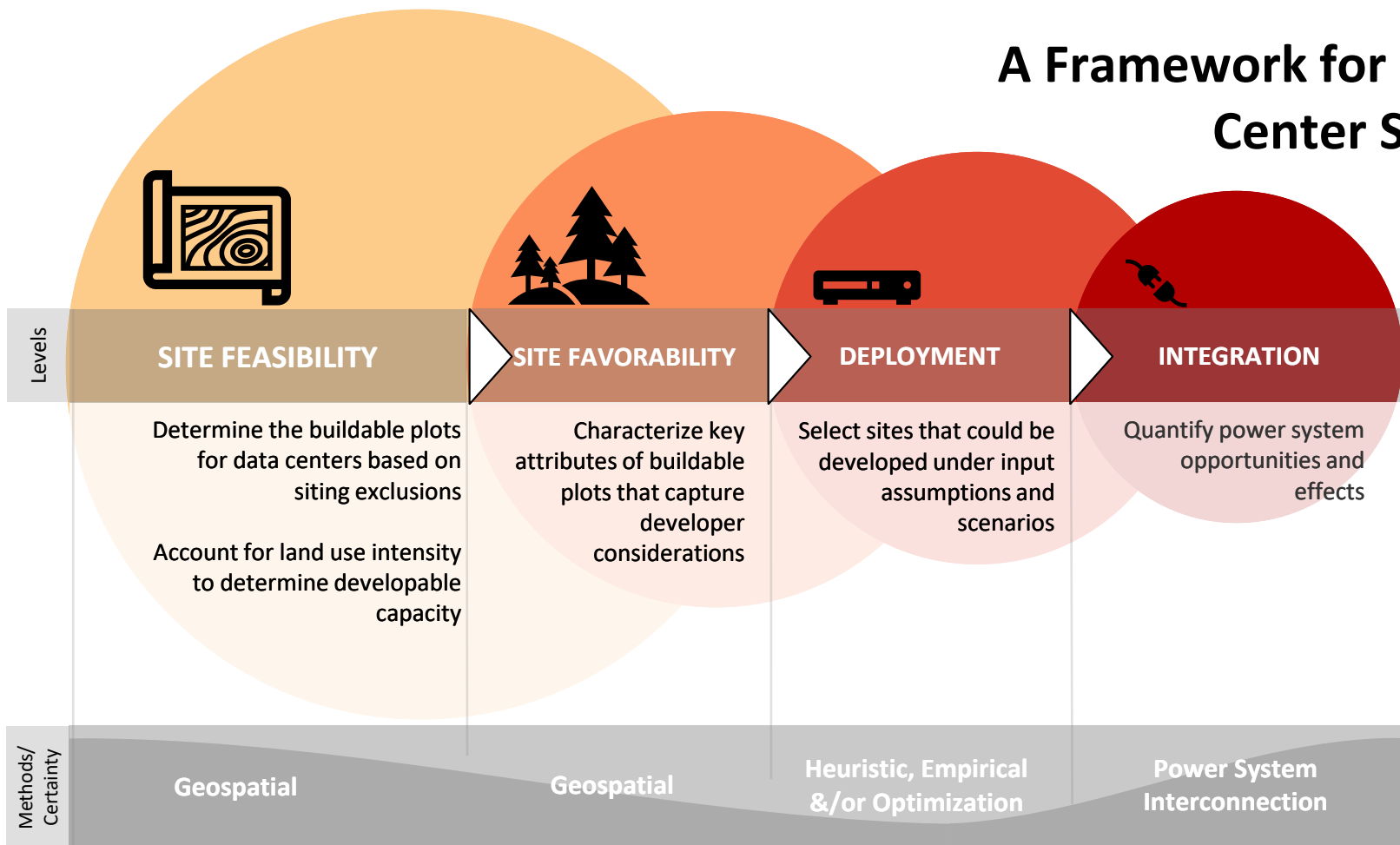
What land is **feasibly** available for building data centers?

How **favorable** is each plot of buildable land for development?

Based on site favorability, where might data centers be **deployed**?

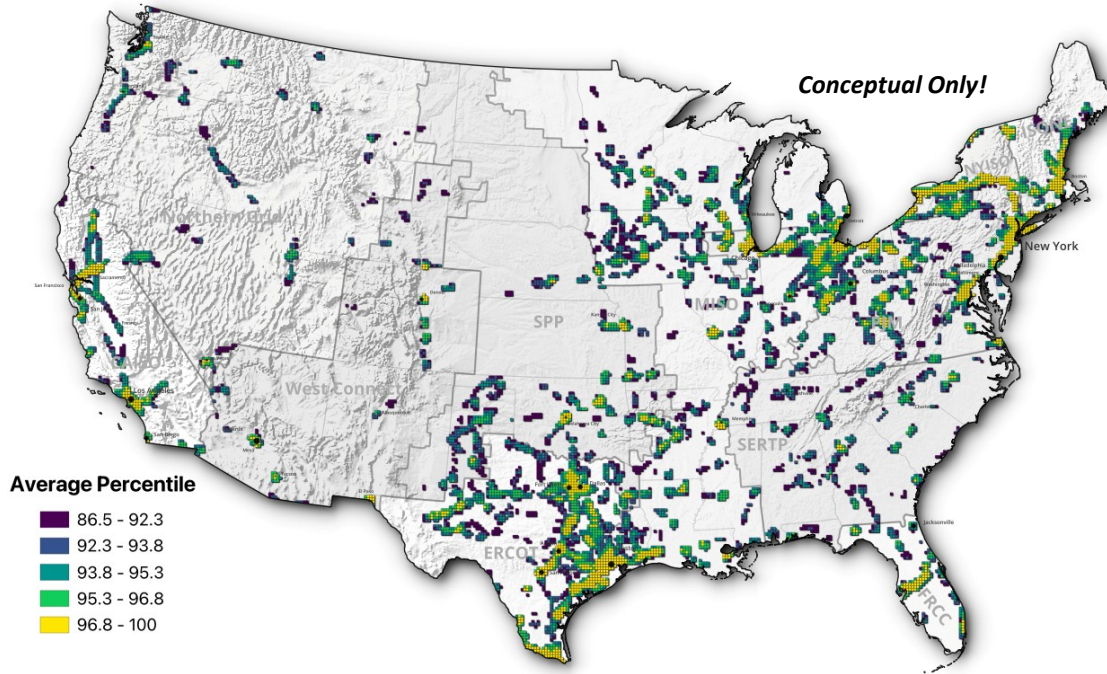
What would be the effects of **integrating** those sites onto the electric grid?

A Framework for Data Center Siting



Example of Weighted Site-Selection:

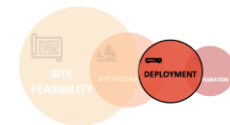
Prioritize long-haul fiber connectivity, access to natural gas, and existing electric generation



Percentiles Assigned to:

- Count of nearby electric generators (20 km radius)
- Count of nearby long-haul fiber nodes (20 km radius)
- Length of nearby long-haul fiber lines (10 km radius)
- Length of nearby nat. gas pipelines (10km radius)

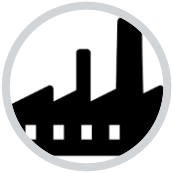
Sites filtered for cells in over 80th percentile in each category



Data Center Siting Deployment

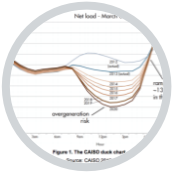
Based on site favorability, where might data centers
be **deployed**?

Four Pillars of Power System Reliability



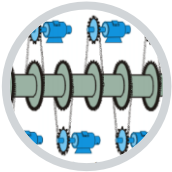
Capacity

Power generation and transmission capacity must be sufficient to meet peak demand for electricity.



Flexibility

Power systems must have adequate flexibility to address variability and uncertainty in demand (load) and generation resources.



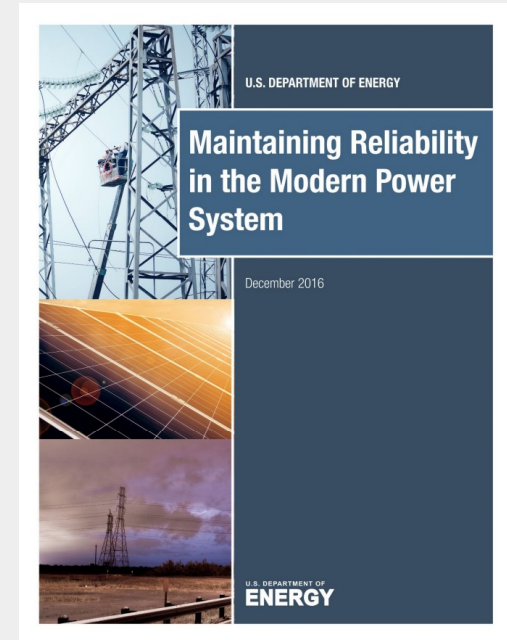
Frequency

Power systems must be able to maintain steady frequency.



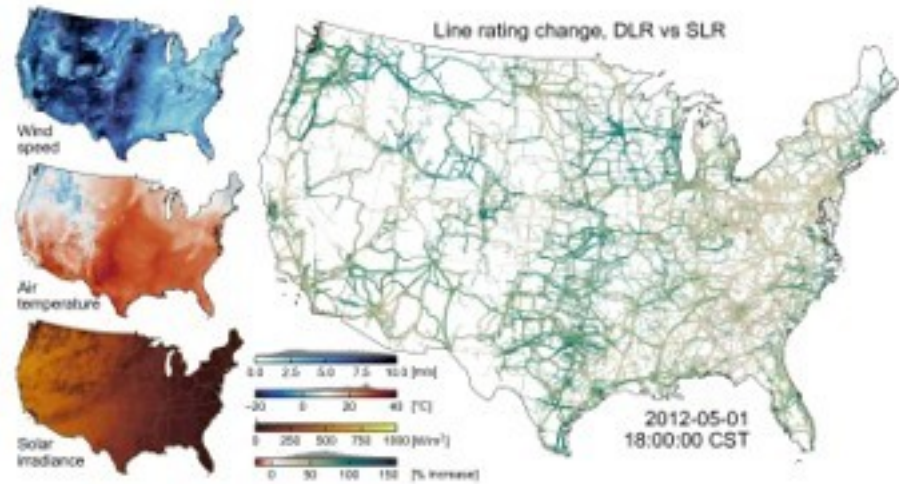
Voltage

Power systems must be able to maintain voltage within an acceptable range.



Transmission Expansion and GETs

Unlocking the full value of existing capacity and rights-of-way



Transmission expansion spans many topics, including:

- Planning and operations
- Electricity and gas market interactions
- Testbeds for hardware
- Dynamic interactions with inverter-based resources (IBRs)
- Cyber-resilience
- Interactions with distribution networks and distributed energy resources
- Impacts on the broader economy

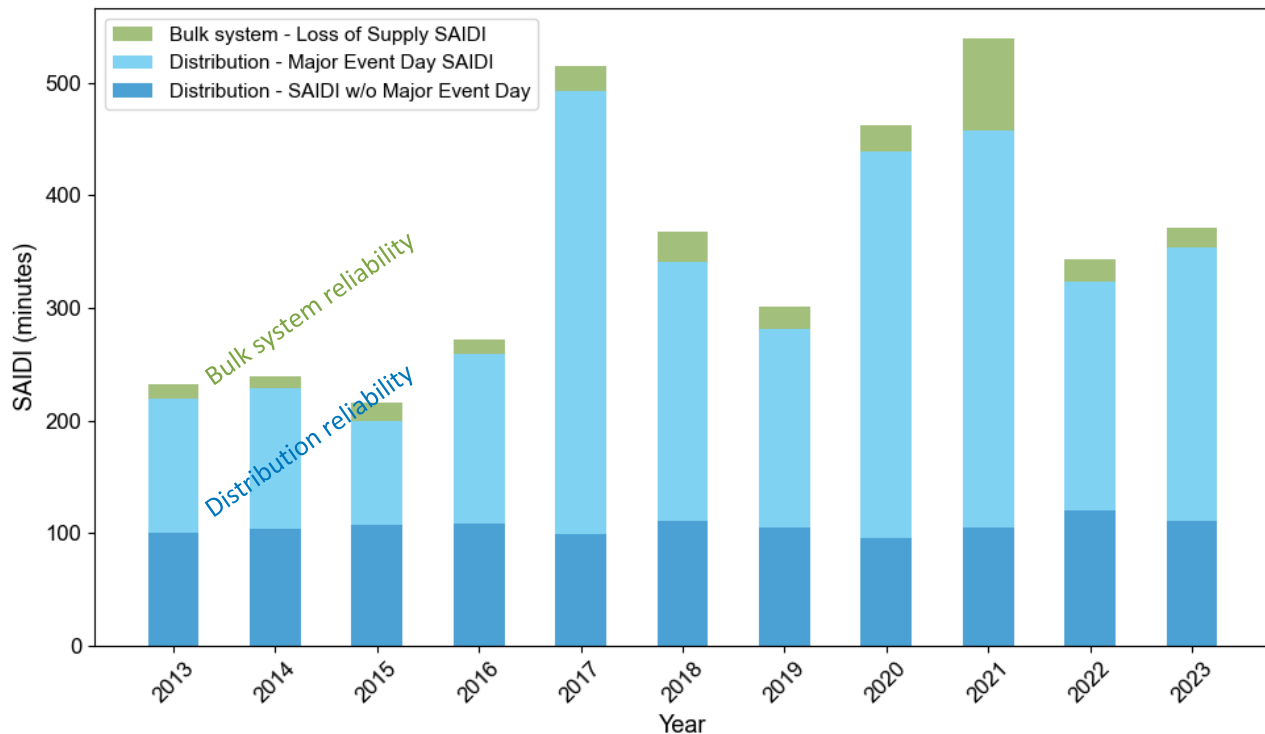
Transmission planning approaches and models integrate data and expertise for impactful integrated and multi-model planning at various geographical scales.

www.nlr.gov/analysis/reeds
www.nlr.gov/analysis/sienna
<https://github.com/NLR/R2X>

Grid modernization and hardening can help improve distribution system reliability and resilience

Reliability Challenges

The electric distribution system is the major driver of interruptions, in particular major event days

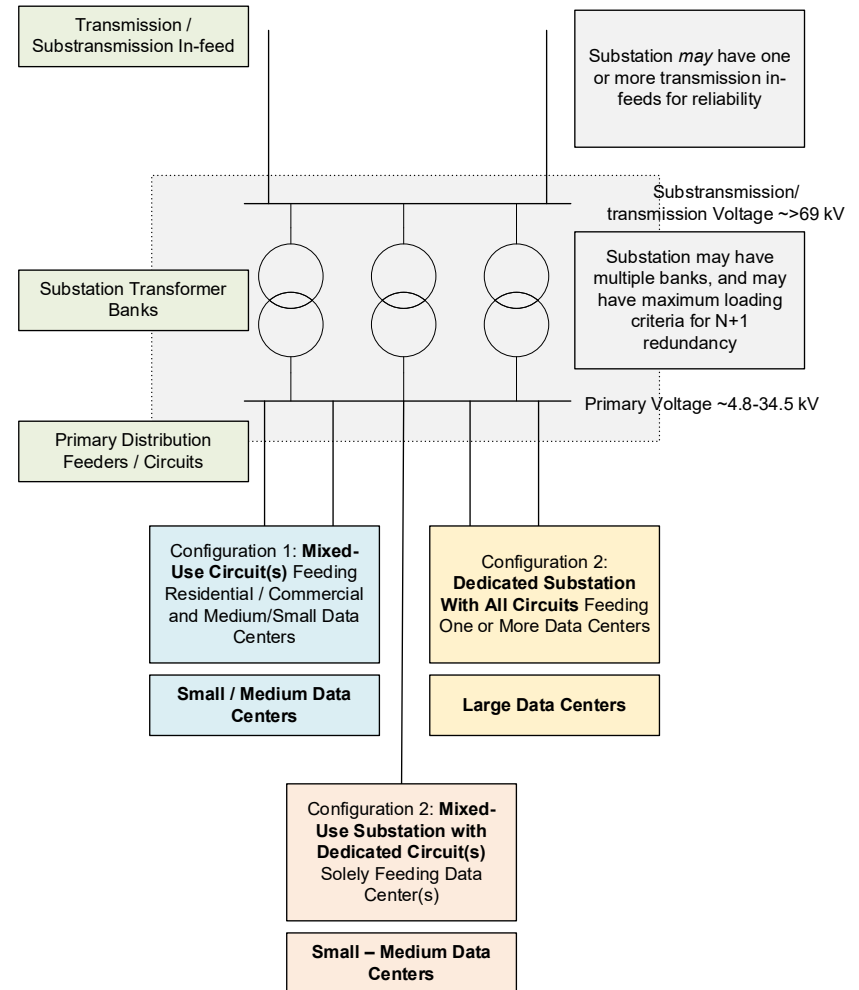


System average interruption duration index (SAIDI) – minutes across U.S. utilities, NLR analysis on EIA 861

All Data Centers Go Through Some Form of Electrical Distribution System

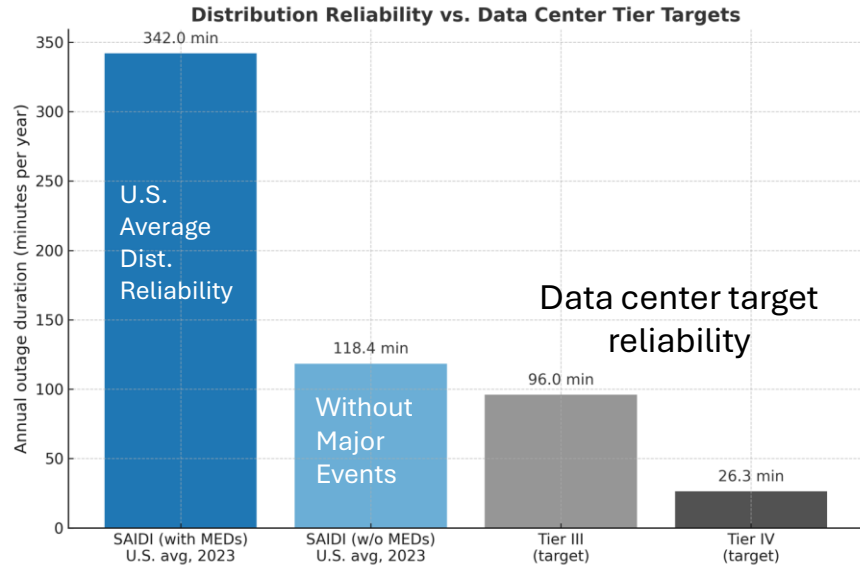
Depending on data center size and reliability requirements, there are typically three forms of distribution service:

- Dedicated substations
- Substation expansion with dedicated feeders
- Dedicated feeders

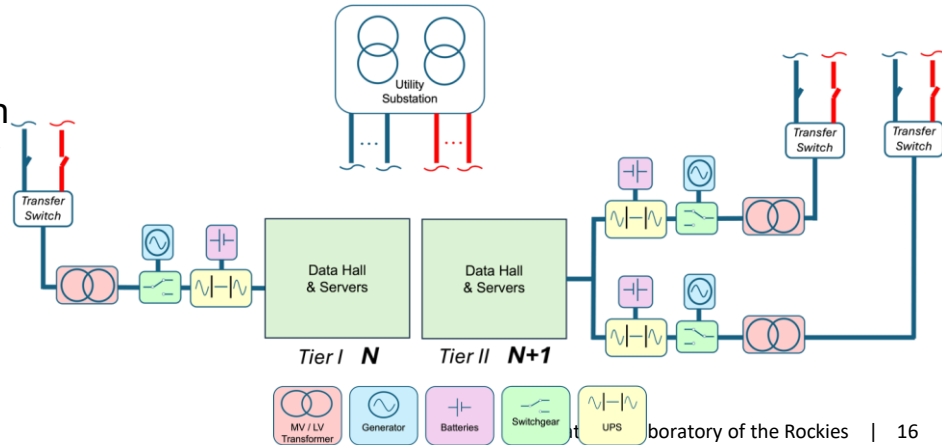


Reliability Mismatch – Electric Grid and Data Centers

There is a major mismatch in distribution system reliability and target data center reliability



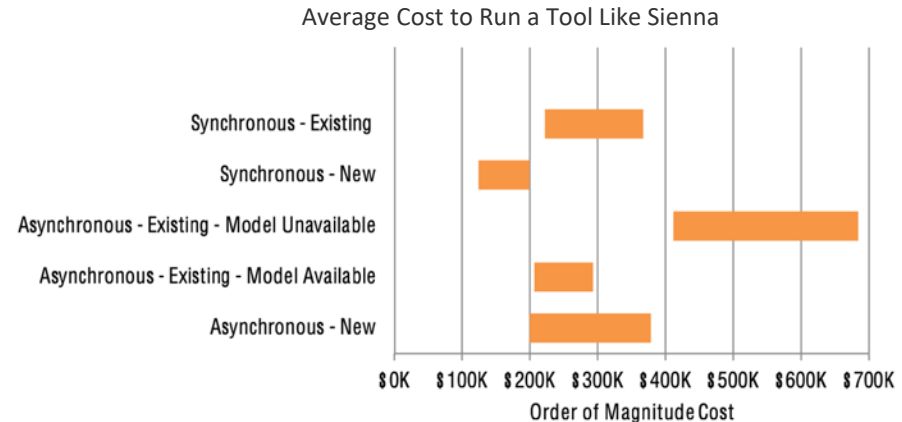
Poor distribution reliability is resulting in significant data center behind-the-meter reliability investment (UPS, batteries, backup generators)



Accelerating Interconnection Studies

- ✓ Computation time
- ✓ Developer time
- ✓ **Interconnection process**

- Inverter-based resources create new control opportunities and challenges
- Industry standard tools can't represent relevant timescales and are too complex to scale
- Novel modeling methods and AI can be used to balance complexity and scalability to accurately simulate electro-magnetic transients of large systems



Source: "EMT and RMS Model requirements." Australian Energy Market Commission, ABN: 49 236 270 144, 16-June-2017.

Evaluating rate impacts of different tariff designs for large load customers

Utilities are exploring a variety of approaches to mitigate impacts on customer energy affordability:

- Upfront contributions, “make-ready” payments
- Contracted demand charges (“take-or-pay”)
- Differentiated tariffs for marginal capacity
- Risk-sharing mechanisms

Translate:

Customer loads, regulatory guidance on rates, utility revenue assumptions...



Into:

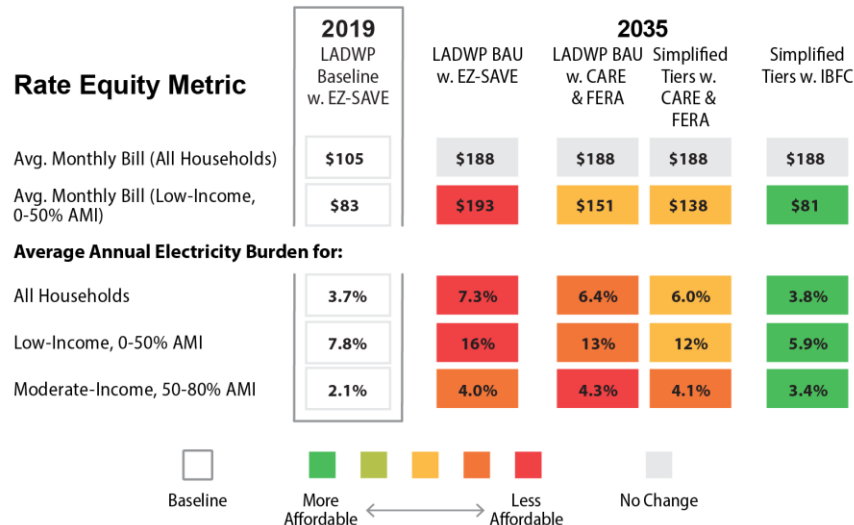
Utility revenue requirements, multiple rates designs, demand response, customer bills, cost-shifting between customers.

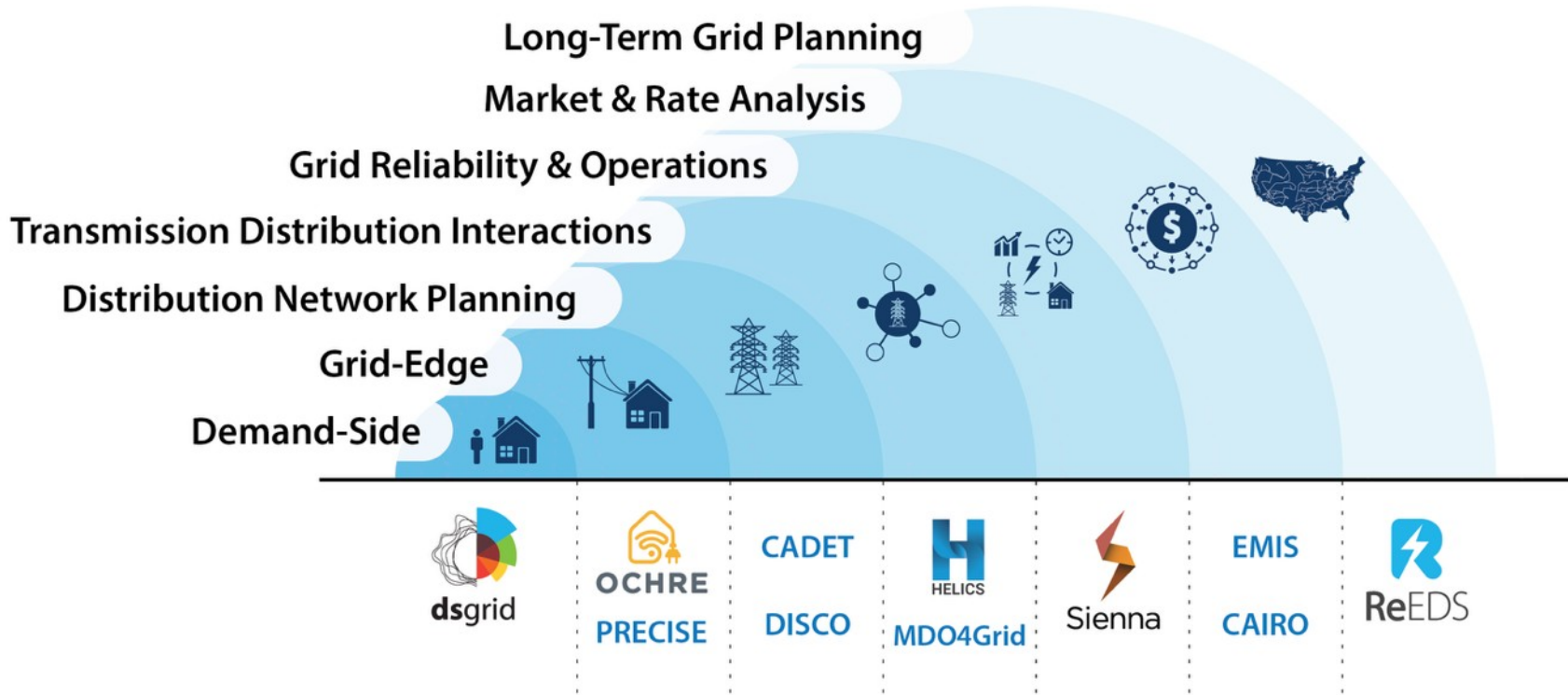


www.nlr.gov/grid/cairo

Example Results:

Los Angeles Department of Water and Power





Integrated Grid Solutions for Large Load Challenges

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Thank you

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