

Bringing Data Center Flexibility into Resource Adequacy Planning

A Case Study of NV Energy

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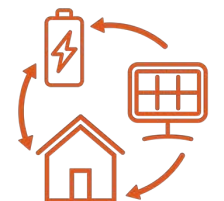


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Agenda

- 01** Introduction & Motivation
- 02** Methodology
- 03** Capacity Contributions of Data Center Flexibility
- 04** Characterizing Flexibility Needs
- 05** Policy and Planning Implications



Disclaimer and Study Limitations

Local Case Study

This report analyzes the benefits of data center flexibility for a single utility, NV Energy, in the Western Interconnection. While methods and results are intended to be indicative of potential benefits more broadly, each system has unique considerations.

Data Center Utilization

The analysis conducted for this study utilized a projected, 8760-hourly data center demand profile developed by NV Energy and utilized in its 2024 Integrated Resource Plan. This study did not attempt to characterize individual data center demand profiles or flexibility considerations.

Data Center Participation

This analysis assumed that a large portion of data center loads would opt in to provide flexibility (50-100% based on the scenario). These figures were selected to demonstrate what meaningful levels of participation could achieve. Reaching this level of adoption will require targeted policy and regulatory actions, new market mechanisms, and technological innovations

Model Calibration

This analysis relied on data provided by NV Energy as part of its 2024 Integrated Resource Plan, but did not use the NV Energy model directly. Telos Energy developed its own PLEXOS database and model for this analysis, which was benchmarked against historical data and NV Energy's forecasted results.

Tax Credits

This analysis was conducted prior to the signing into law of the latest tax and spending bill on July 4, 2025. As a result, it does not incorporate an early sunset of investment tax credits in the financial analysis.

Introduction & Motivation

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Motivation and Policy Context

- Data center loads are growing rapidly, increasing from 1.9%–4.4% of total annual U.S. electricity consumption from 2018–2023, and projected to reach 6.7%–12.0% by 2028.¹
- Globally, \$200B–\$600B in electric sector capital investment projected by 2030 at stake in planning decisions.²
- These capital investment decisions need to be made *up front* in the utility planning process (e.g., IRP), even as there is uncertainty around *where*, *when*, and *how much* data center loads will materialize in a given region.
- Where data centers are being considered in IRP, planners have been making a key assumption — that data center operations are *inflexible*.

2. <https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-cost-of-compute-a-7-trillion-dollar-race-to-scale-data-centers>

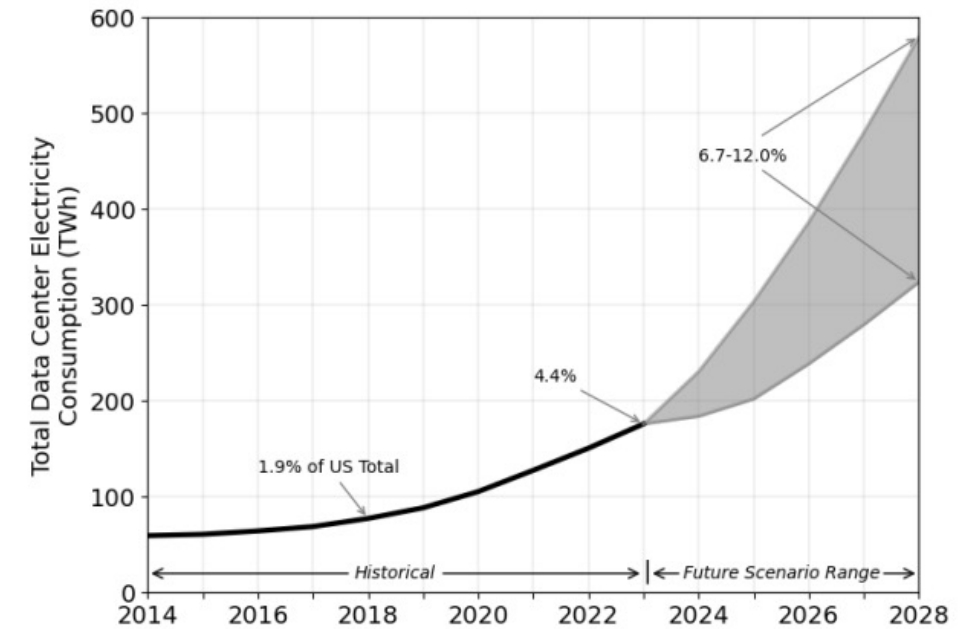
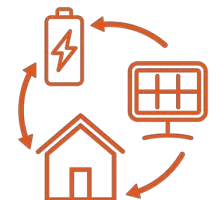


Figure ES-1. Total U.S. data center electricity use from 2014 through 2028.

1. Source: Shehabi, A., Smith, S.J., Hubbard, A., Newkirk, A., Lei, N., Siddik, M.A.B., Holecek, B., Koomey, J., Masanet, E., Sartor, D. 2024. *2024 United States Data Center Energy Usage Report*. Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-2001637

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Implications of Inflexible Data Centers in Integrated Resource Planning



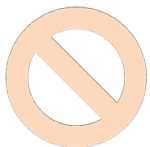
Increased total capacity needs
(IRPs must reliably support a higher load than if data centers were flexible)



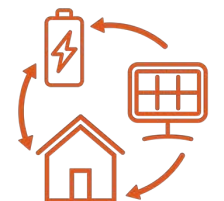
Supply chain constraints → delayed timelines/high costs for new capacity



Does not incentivize use of on-site generation when it might be more economical from a system / utility perspective



Once utility contracts have been set, there is limited capabilities/incentives for flexibility.



Capturing Large Load Flexibility Value Through Accreditation

Where supply-side resources are assigned accreditation values, calculate a capacity accreditation value for load flexibility

Today's Framework: a 100 MW data center is counted as firm load and requires 115 MW of firm capacity today (i.e., assuming a 15% planning reserve margin).

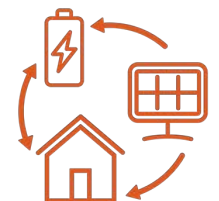
Proposed Framework: With data center flexibility, the same data center can provide 50 MW of accredited "capacity" (e.g., ELCC) from load flexibility by dropping load or using on-site generation.

Capacity Savings: Difference in capacity requirements with flexibility as compared to without flexibility (based on rerunning the capacity expansion model or capacity market)

Example ELCC matrix for load flexibility

		Availability (% Uptime Required by DCs)		
Depth of Response		99.9%	99.7%	99.5%
	1 GW			
	2 GW			

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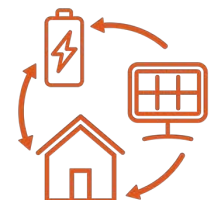


Objectives of the Study

This study fills a crucial gap in utility planning methods to allow data center flexibility to be considered up front in resource planning

- Validate a framework for incorporating large load flexibility into resource planning by allowing it to count towards a PRM requirement via a **demand-side ELCC**.
- Develop a **case study** that can be utilized by other utilities in their IRP process.
- Evaluate the **system benefits** of data center flexibility on an example system.
 - Avoided **capacity needs** (MW and by type of generation)
 - Avoided **costs** (NPV)
 - Avoided **emissions** (MMT)

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Flexibility Fits into the Existing Resource Adequacy Planning Framework



Flexibility reduces total capacity needs



Flexibility allows for deferred investment, driving system cost savings



Flexibility can be quantified and incorporated into planning using familiar RA metrics (LOLE, PRM, ELCC)



Once its capacity value has been quantified, data center flexibility can be compared directly against supply-side resource options

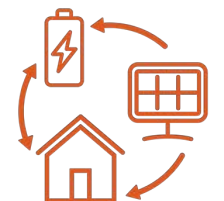
Important note for Resource Adequacy use cases...

Flexibility is not required on a regular basis, but can be reserved for exceedingly rare events that may only occur a couple times per year or less.

In contrast, flexibility for energy or ancillary markets would require regular, day-ahead and real-time use.

Adopted from: ESIG Large Load Task Force

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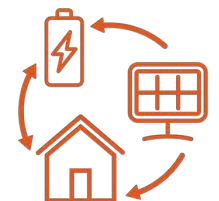


Why NV Energy?

NV Energy's 2024 IRP proceedings had a spotlight on data center load growth assumptions and the impact it had on system planning

- NV Energy's system is rapidly changing, with data centers going from relatively nascent to being a main driver of load growth in the demand forecast.
- Forecasts of data center loads, and the resources required to support that growth, drew strong attention and was heavily debated in the IRP.
- Data center loads are expected to quickly become a large share of the total load.
 - Expectations have only increased since the release of IRP forecasts.
- This topic is relevant and time sensitive – the RA and capacity expansion models were turn-key ready as a result of recent work performed as interveners in NVE's 2024 IRP – this allowed us to focus on developing our methodology and delivering our analysis rather than building a new model from the ground up.

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NV Energy System Overview

NV Energy has a peak load of ~9GW and is the combination of two utilities: Sierra Electric (~25% of load) and Nevada Power (~75% of load) – most data center growth is concentrated in Sierra Electric near Reno, given proximity to Silicon Valley, existing fiber infrastructure, low environmental risks, and available land

Near-Term Demand Growth

Peak Loads (GW)

	2025	2030	% Change
NVE	8.9GW	11.0GW	23.3%
Data Centers	0.4GW	2.0GW	373.4%
DC as % of Total	4.7%	18.1%	

Annual Energy (TWh)

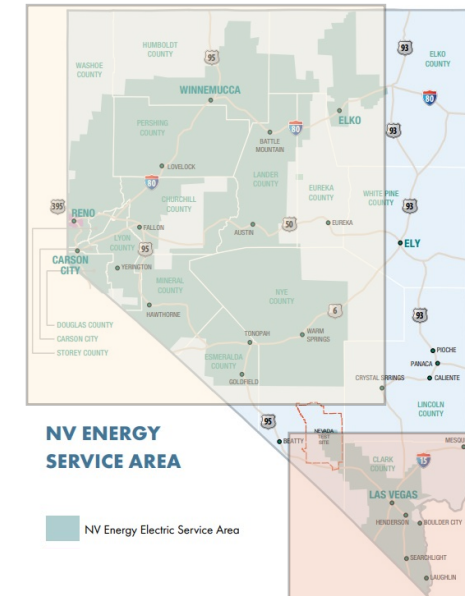
	2025	2030	% Change
NVE	36.9	51.4	39.5%
Data Centers	3.1	14.7	373.4%
DC as % of Total	8.4%	28.6%	

Service Territory Details

Sierra Electric

2024 Statistics:
Peak Load: 2.1 GW
Gen. Capacity: 1.4 GW
Customers: 384k

*Expected to
Receive Majority
of Center Growth*

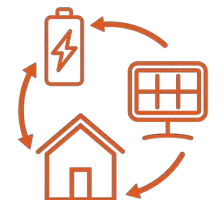


Nevada Power

2024 Statistics:
Peak Load: 6.6 GW
Gen. Capacity: 5.3 GW
Customers: 1,050k

Source: https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/help/brochures/Power-Facts-Flyer.pdf

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Methodology

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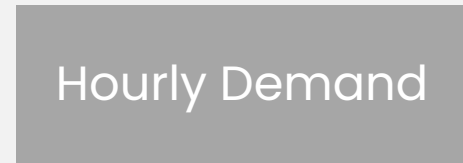
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Overview of Analytical Framework

1

Step 1: Prepare Load Data



↓ Pull Out DC Load



↓ Adjust DC Load



Adjusted DC Load

Output: Adjusted hourly load shapes

2

Step 2: Run CEM Baseline w/o DC Flexibility (LT)



Base Portfolio

Output: Baseline capacity, costs, & emissions

3

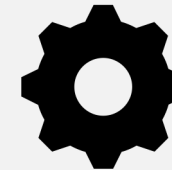
Step 3: ELCC Study (MT/ST)

	99.9%	99.7%	99.5%
1 GW	A	B	C
2 GW	D	E	F

Output: DC flexibility ELCCs

4

Step 4: Run CEM Baseline w/ DC Flexibility (LT)



ELCC Matrix Scenario A

ELCC Matrix Scenario B

ELCC Matrix Scenario C

...

ELCC Matrix Scenario F

Output: Capacity, costs, & emissions across ELCC scenarios

F

Final Output (for each scenario):

- Avoided capacity needs (MW)
- Avoided costs (NPV)
- Avoided emissions (MMT)

Modeling Tools and Key Datasets

Capacity expansion and RA models were developed in PLEXOS using publicly available data from NVE's 2024 IRP, supplemented with EIA and NREL data

Modeling Tools

PLEXOS LT: Capacity Expansion Simulations

PLEXOS ST: Probabilistic RA/Production Cost Simulations

Datasets



Information released in Nevada Energy's 2024 Integrated Resource Plan was used as the basis for most modeling inputs, including:

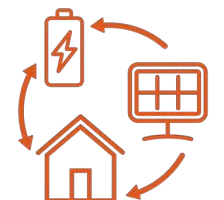
- Generator characteristics
- Contracted/Planned installations
- Retirements
- Load



Public sources (EIA & NREL) were used in lieu of confidential IRP assumptions

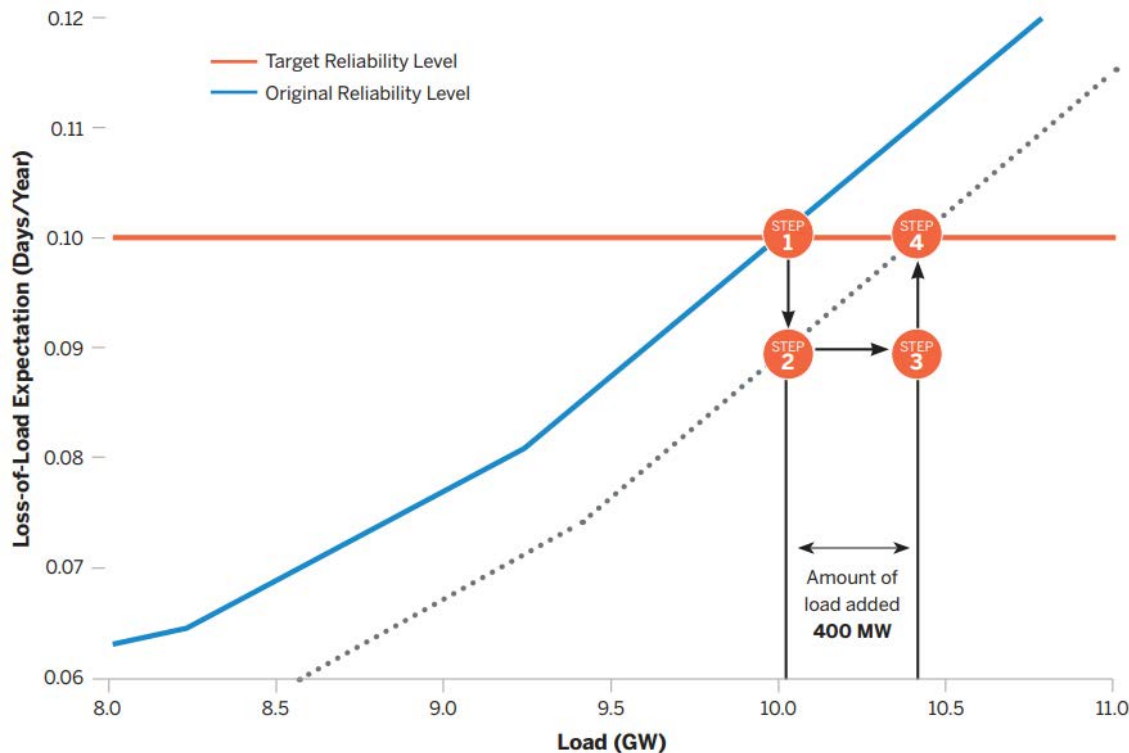
- Capital Costs
- Fuel Prices
- Implied External Market Heat Rates

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4-Step ELCC Calculation Methodology

Illustration of the Four Steps in the ELCC Methodology



Source: ESIG, Ensuring Efficient Reliability. New Design Principles for Capacity Accreditation, 2023.

We can compute a **"demand-side ELCC"** of large load flexibility the same way that we compute the ELCC of supply-side resources.

- 1. Calibrate case to reliability criterion:** Calibrate system to meet 1-day-in-10-year LOLE for a future load year. Include data center load, but assume no flexibility.
- 2. Re-Run Reference Case with Large Load Flexibility:** Re-run the calibrated reference case with load flexibility allowed. This will *reduce* LOLE.
- 3. Add increments of firm load** to increase LOLE until we are back to the reliability criterion.
- 4. Compute ELCC:** Added load in Step 3, divided by the amount of load flexibility in Step 2.

We can repeat steps 2 and 3 to compute the ELCC of different types of flexibility (e.g., different size, frequency, and duration of calls).

Methodology

Perform sequential, Monte-Carlo, probabilistic production cost simulations across multiple weather years, to calculate loss of load probability



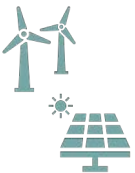
Sequential: annual, 8760 hour-by-hour dispatch of the system, including changes in load, wind and solar variability, time varying generator outages, and storage scheduling



Monte Carlo: repeated random sampling of individual, generator outages using outage rates and repair time distributions

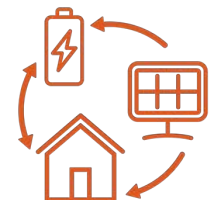


Generator Dispatch: A simplified generator dispatch was applied without the use of minimum up/down times to balance results accuracy with runtimes



Weather-synchronized: 25-years of hourly load and solar data (1998-2022) was used, and 8-years of hourly wind data (2007-2014) was used. We preserved correlation in resource availability and demand in overlapping years and mapped wind to the remaining years

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Evaluating chronological system operations across multiple weather years



Increase in variable renewable energy and energy limited resources requires resource adequacy to consider *chronology* and *correlation*

- Hundreds of hourly dispatch simulations, considering generating characteristics, hourly changes in load and renewable output, forced outages (randomly occurring)
- Storage scheduling is based on arbitraging energy margins temporally and spatially, but high value of lost load (VoLL) ensures sufficient state of charge is available during scarcity events
- Hydro sampling was performed across weather years to account for variability in Hoover's output

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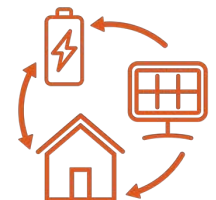


Table of Key Assumptions

		Data Source
Transmission Topology	Transmission within Nevada Energy, between Sierra Electric and Nevada Power, was not modeled in this analysis. Imports into the state were allowed in the RA analysis, up to the level of 'Open Position' selected by the capacity expansion model	<u>NVE's 2024 IRP</u>
Generator Capacities	Existing and planned/under-construction capacity and announced retirements at a unit level were modeled with generator specific summer/winter ratings	<u>NVE's 2024 IRP</u>
Peak Demand Forecast	2024 IRP peak demand forecasts were applied. Data center load was stripped out of this forecast and adjusted	<u>NVE's 2024 IRP</u>
Load Profiles	Utilized load profiles from the GridPath RA Toolkit study of the Western United States and developed for Weather Years 1998–2022. Hourly load profiles by weather year were scaled to meet NVE's median peak and energy forecast, excluding load layers for data centers.	<u>GridPath RA Toolkit</u>
Hourly Wind Profiles	Wind site-specific profiles developed from NREL Wind Toolkit for Weather Years 2007–2013. Wind years were sampled independently of solar and/or temperature observations.	<u>NREL Wind Toolkit</u>
Hourly Solar Profiles	Solar site-specific profiles developed from NREL National Solar Radiation Database for Weather Years 1998–2022.	<u>NREL NSRDB</u>
Forced Outage Rates	Unit-level outage rates provided in NVE's 2024 IRP filings were used	<u>NVE's 2024 IRP</u>

Capacity Contributions of Data Center Flexibility

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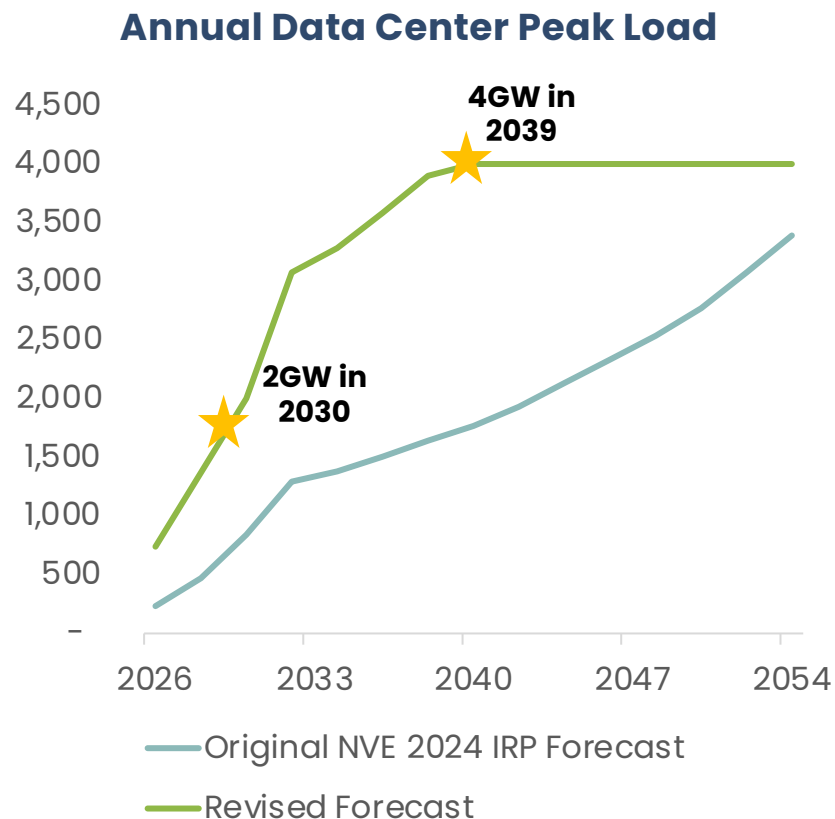


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Data Center Load Forecast

NVE's 2024 IRP originally projected ~840MW of DC peak load by 2030, growing to ~2,800MW by 2050. We increased this forecast, given recent company & industry commentary



- Since the release of its IRP, NVE's leadership has publicly stated they expect significantly higher data center demand growth
- As a result, we increased our datacenter forecast to achieve 2GW of peak demand in 2030, growing to 4GW by 2039



*"So it is **absolutely foreseeable in the next several years that you could double, triple, even quadruple** the size of the total electric grid in Northern Nevada"*
— Doug Cannon, Former CEO of NVE



*"Tract...which develops master plans and builds infrastructure for data-storage centers, said last year that **it plans to invest \$100 billion into Storey County over the next 10 years** for its data-storage centers." (2/15/25)*

Source: <https://www.nevadaappeal.com/news/2025/feb/15/data-centers-could-quadruple-regions-electrical-grid-nv-energy-ceo-says/>

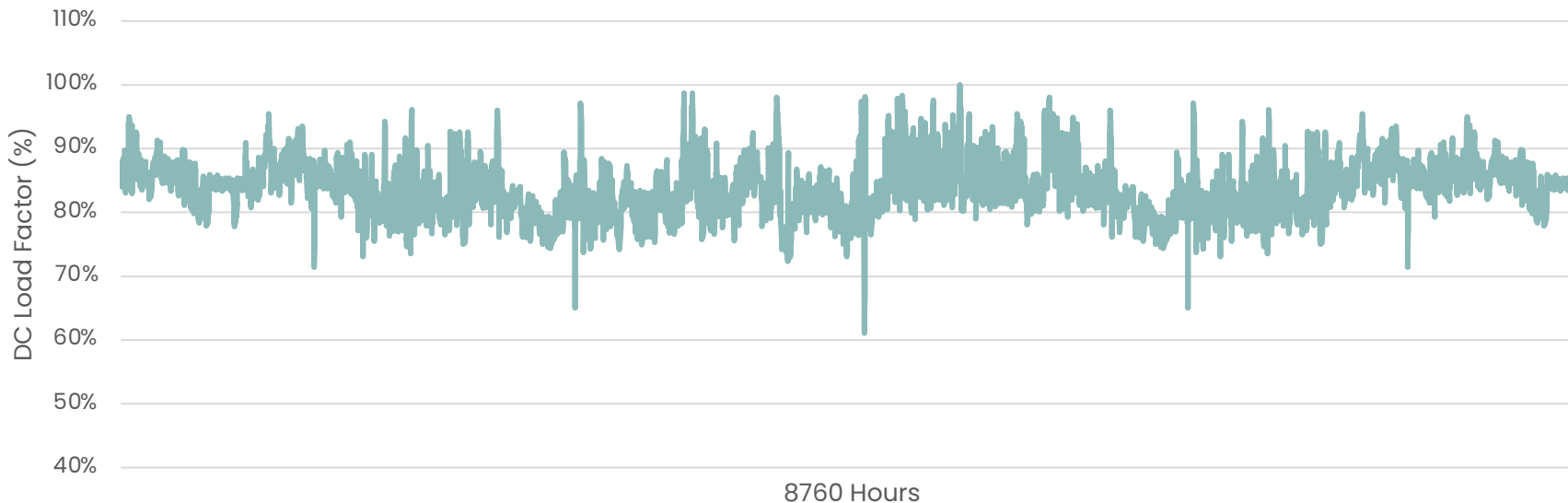
Data Center Load Characteristics

Data center 8760 loads were disaggregated and sourced directly from NVE's 2024 IRP workpapers, with corrections for data anomalies.

To adjust for data anomalies, we overwrote the Jan-April loads with the Sept-Dec loads in reverse order (to approx. match temperatures)
Jan = Dec, Feb = Nov, Mar = Oct, April = Sept

Data Center load factors in the ~80-90% range

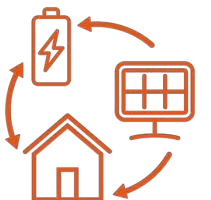
Normalized and Adjusted DC Load Profile



Month	Data Center Load Factor
Jan	87%
Feb	85%
March	84%
April	80%
May	84%
June	81%
July	88%
Aug.	88%
Sept.	80%
Oct.	84%
Nov.	85%
Dec.	87%

The dataset lacks segmentation details by end use, and the scaling of historical data center load profiles to higher demand levels may be inaccurate. This is an opportunity for future refinement.

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Implementation of Flexibility

Data center response was modeled as an energy-limited resource in the RA model. Power limits were applied hourly based on data center demand

Availability (% Uptime) required by the data centers determined how much flexibility they can provide → modeled as an energy budget

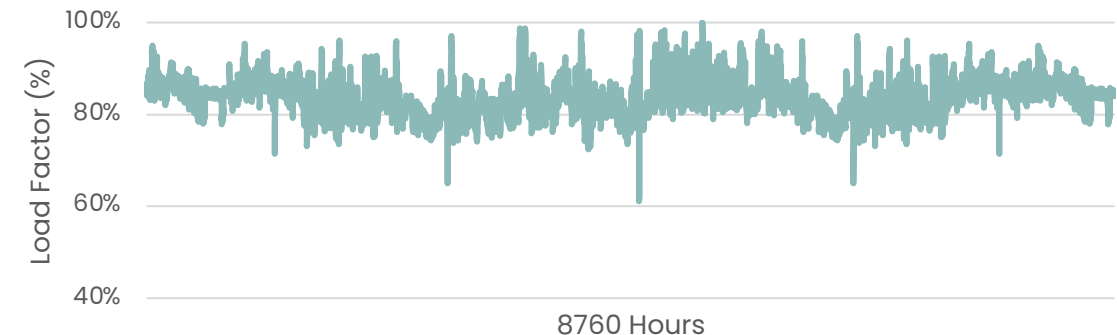
Availability (% Uptime Required by DCs)

Max Response		99.9%	99.7%	99.5%
	1 GW	8.8 GWh	26.3 GWh	43.8 GWh
	2 GW	17.5 GWh	52.6 GWh	87.6 GWh

*Total Annual Energy from Flexibility =
Hours Flexibility Available x Magnitude of Flexibility,*
Example:
 $1\text{GW}, 99.9\% = (1 - 0.999) \times 8760\text{hr} \times 1\text{GW} = 8.76\text{ hr} \times 1\text{GW} = 8.76\text{ GWh/yr}$

In any given hour, data center flexibility is limited by the depth of response and load factor in that hour

Data Center Load Factor



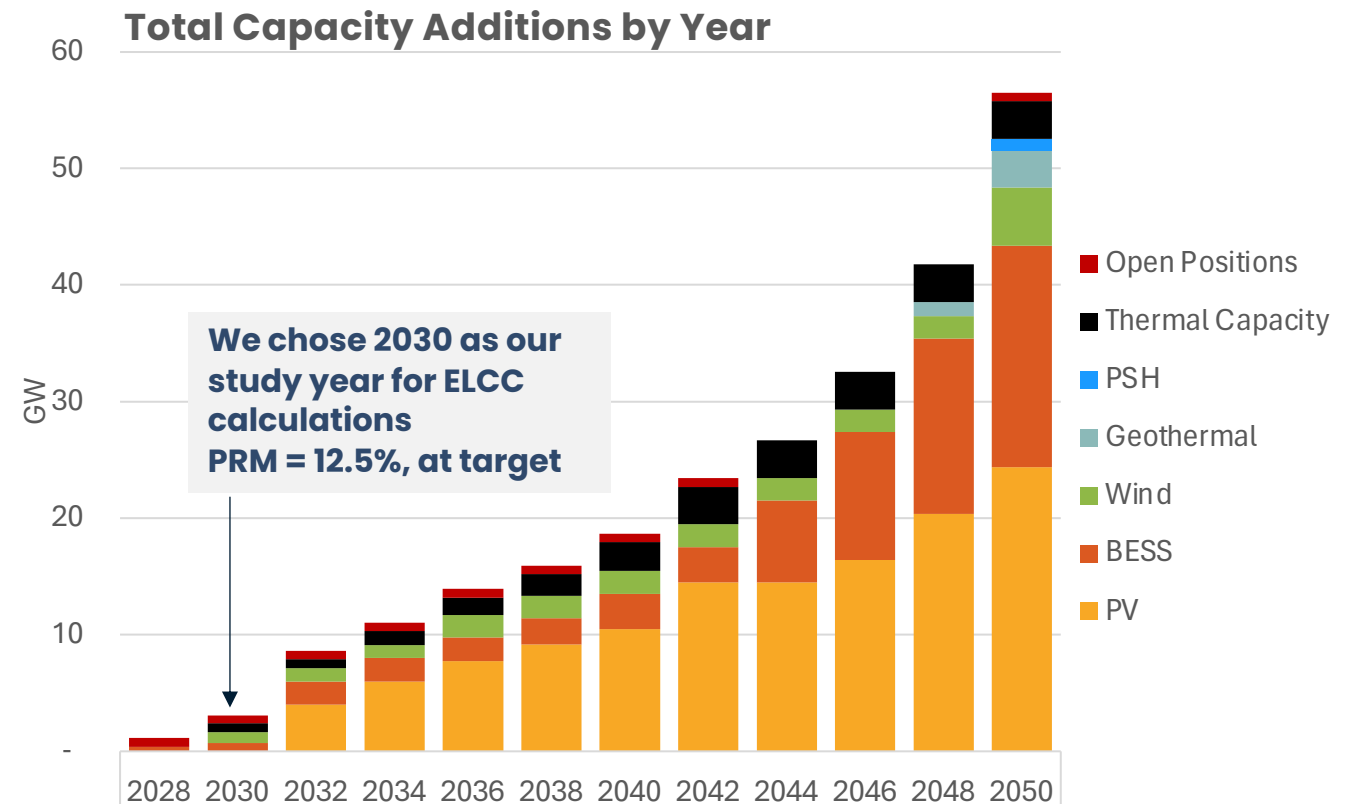
Depth of Flexibility = Load Factor x Maximum Magnitude of Flexibility
Depth of flexibility in hour 3800 = load factor, hour 3800 x Maximum Magnitude of Flexibility = 85% x 1 GW = 850 MW

Quantifying Capacity Needs Without Flexibility

A capacity expansion model was run to generate forecasted capacities through 2050 while meeting the planning reserve margin, prior to accounting for DC flexibility

- Capacity expansion plan adds significant amounts of solar and battery energy storage to meet projected load growth and capacity needs.
- Natural gas CTs and market purchases (“open position”) are used to meet the planning reserve margin across the horizon.
- In 2050, geothermal and pumped storage hydro is also used to close the gap in planning reserve margin due to retirement of existing gas resources.

****Note, this study did not include a long-term emissions reduction constraint. Instead, it assumes that incremental emissions compliance attributed to incremental data center load is managed outside of the utility resource additions through REC contracts or other cross-sector emissions reductions.**



ELCC Results

- Data center flexibility provided significant firm capacity contribution, particularly for the first GW of participation
- At 1GW of participation, we saw very little difference between 99.5% and 99.7% uptime
- Saturation effects are apparent as we move from 1GW to 2GW — marginal ELCCs are 20-40 percentage points lower
- Even in our most conservative case (99.9% uptime), going from 1GW to 2GW of flexible data center load still provided 245MW of incremental firm capacity

Total Supported Load (MW)

DC Uptime	1GW	2GW
99.5%	865	1530
99.7%	862	1318
99.9%	665	910

Data Center Total ELCC by Desired Uptime and Participation

DC Uptime	1GW	2GW
99.5%	87%	77%
99.7%	86%	66%
99.9%	67%	46%

Data Center Marginal ELCC (From 1GW to 2GW)

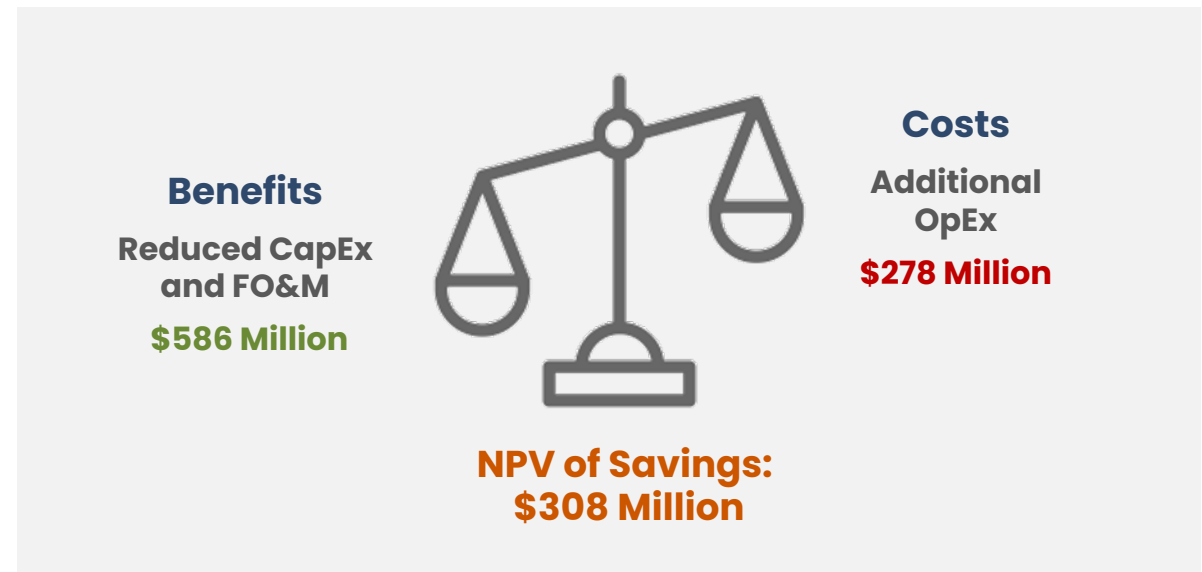
DC Uptime	1GW	2GW
99.5%	87%	67%
99.7%	86%	46%
99.9%	67%	25%

Avoided Capacity With of Data Center Flexibility (1 of 2)

After calculating the ELCCs, we reran our capacity expansion model with flexible Data Centers modeled as supply-side capacity resources to count towards the planning reserve margin based on the calculated ELCC. This generated a new, least-cost future resource mix.

The capacity contributions from data center flexibility resulted in fewer resources being selected for its firm capacity (gas), and a delay in resources being selected primarily for its energy (solar/batteries), resulting in lower costs

- 2 GW of data center flexibility, contributing ~1.5 GW towards the planning reserve margin, increases solar and battery storage buildout (energy resources) and reduces natural gas buildout (firm capacity resources)
- This equates to ~\$300 million in NPV savings over the study horizon

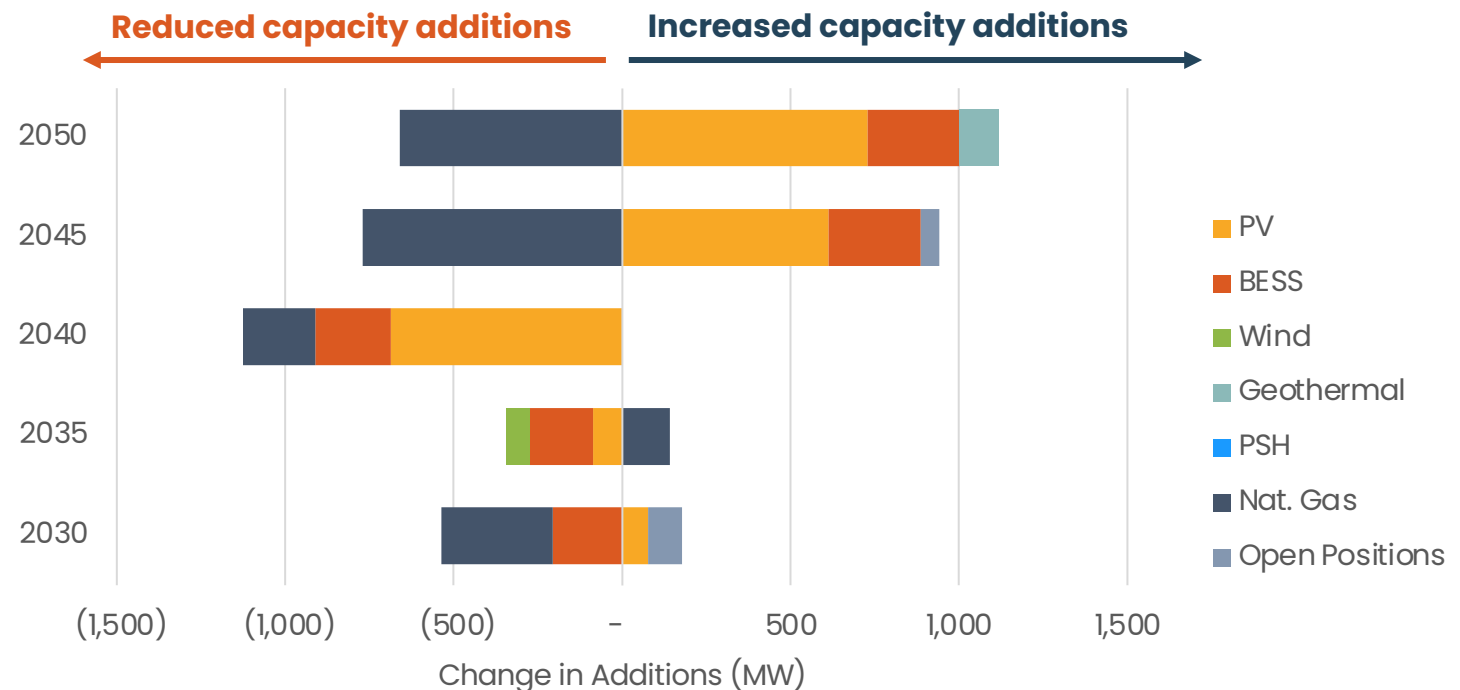


Note: NPVs are calculated using a 7.08% discount rate, consistent with NV Energy's 2024 IRP assumption

Avoided Capacity With of Data Center Flexibility (2 of 2)

After calculating the ELCCs, we reran our capacity expansion model with flexible Data Centers modeled as supply-side capacity resources to count towards the planning reserve margin based on the calculated ELCC. This generated a new, least-cost future resource mix.

The capacity contributions from data center flexibility resulted in fewer resources being selected for its firm capacity (gas), and a delay in resources being selected primarily for its energy (solar/batteries), resulting in lower costs



Avoided Capacity by Scenario and Availability

We see saturation effects in the NPV benefits of firm flexibility for Nevada Energy's system — capital costs decline, but operating costs rise

- Across scenarios, Data Center flexibility resulted in ~300–400 million in savings on a present value basis over the projection period (2025–2050)
- Saturation effects were evident in this particular system — data center flexibility relieved the capacity constraints, but the need for energy still drove significant additions, regardless of the level of flexibility modeled

Scenario Details			Present Value of Costs vs. Base Case (\$ Millions)			
Depth of Response	% Availability	Firm Capacity Value Based on ELCC	Change in PV of OpEx	Change in PV of Fixed O&M	Change in PV of CapEx	Total Net Change
1 GW	99.9%	665 MW	193	(140)	(430)	(378)
1 GW	99.7%	862 MW	190	(142)	(452)	(404)
1 GW	99.5%	865 MW	188	(142)	(452)	(407)
2 GW	99.9%	910 MW	191	(142)	(438)	(389)
2 GW	99.7%	1318 MW	368	(171)	(508)	(312)
2 GW	99.5%	1530 MW	278	(146)	(440)	(308)

Saturation of capacity benefits – similar across cases

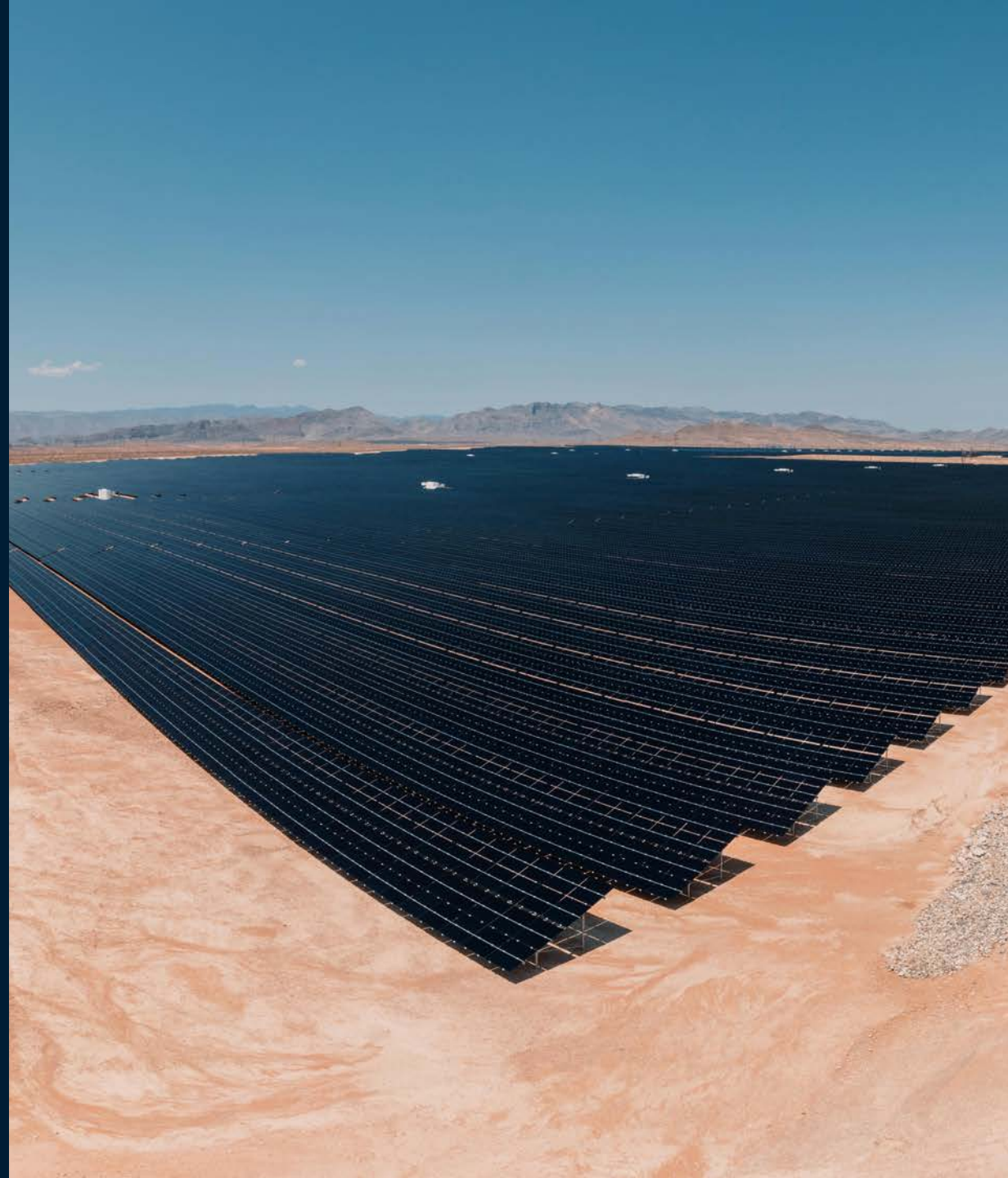
Note: NPVs are calculated using a 7.08% discount rate, consistent with NV Energy's 2024 IRP assumption

Characterizing Flexibility Needs

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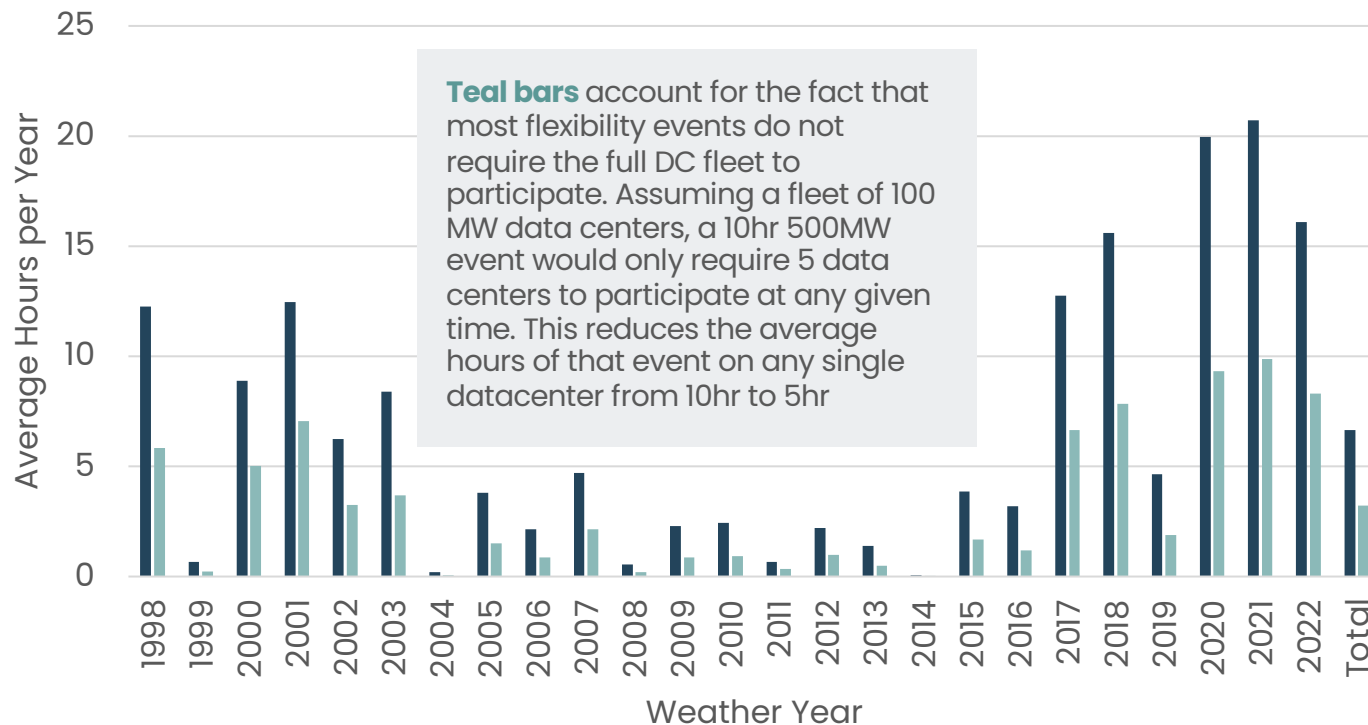
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Flexibility needs by weather year

Flexibility needs in any given weather year are manageable, especially when spread across a fleet of data centers

1 GW, 99.5% Availability



Avg Hours of Flexibility per Year

Depth of Response	% Availability	Hours of flexibility per year	
		Data Center Fleet	Individual Data Center*
1 GW	99.9%	3.1	1.4
1 GW	99.5%	6.6	3.2
2 GW	99.5%	41.9	13.5

While the 2 GW, 99.5% availability case requires, on average, 42 hours per year of flexibility, when spread across 20 data centers, this is reduced to 13.5 hours for an individual customer

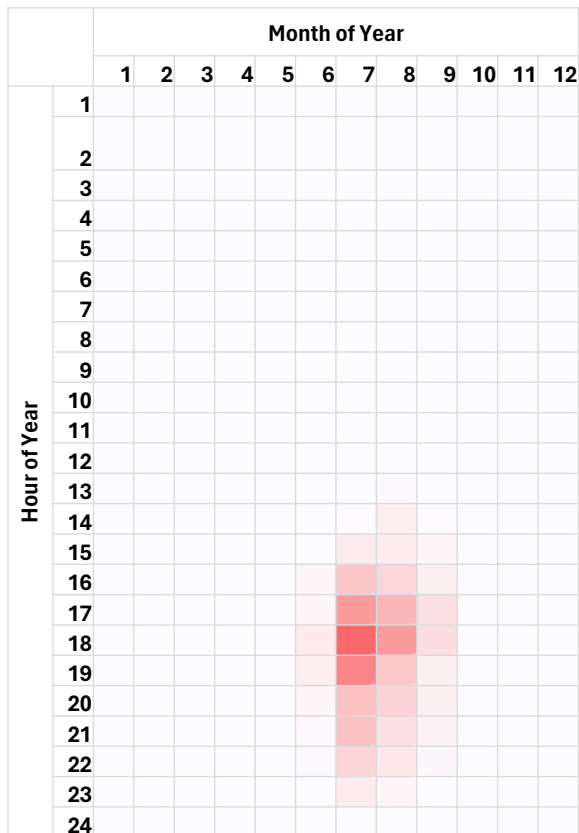
Data Center Fleet (assumes that all data centers in the fleet participate identically, prorating flexibility needs across all data centers)

Individual Data Center (assumes that each data center is flexed one at a time up to its full capacity until sufficient capacity is provided)

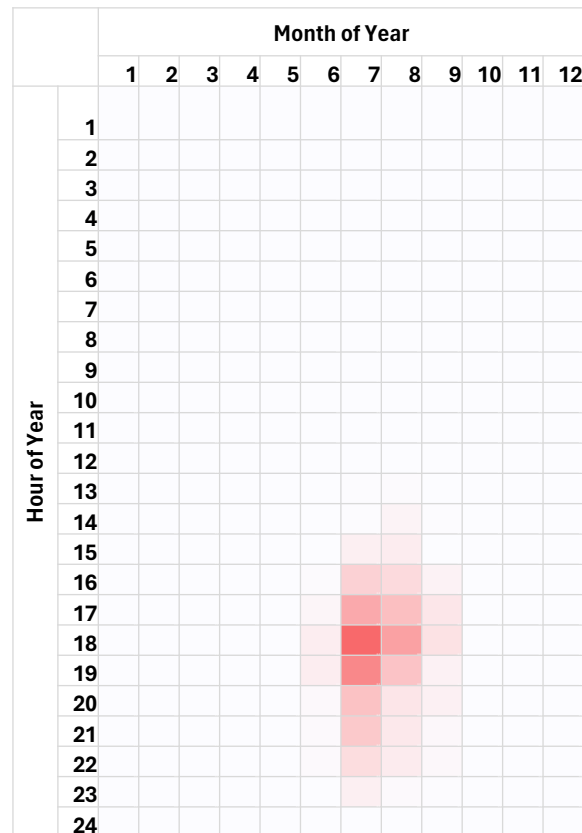
*(assuming 100 MW size)

Data center flexibility requirements are concentrated to summer evenings

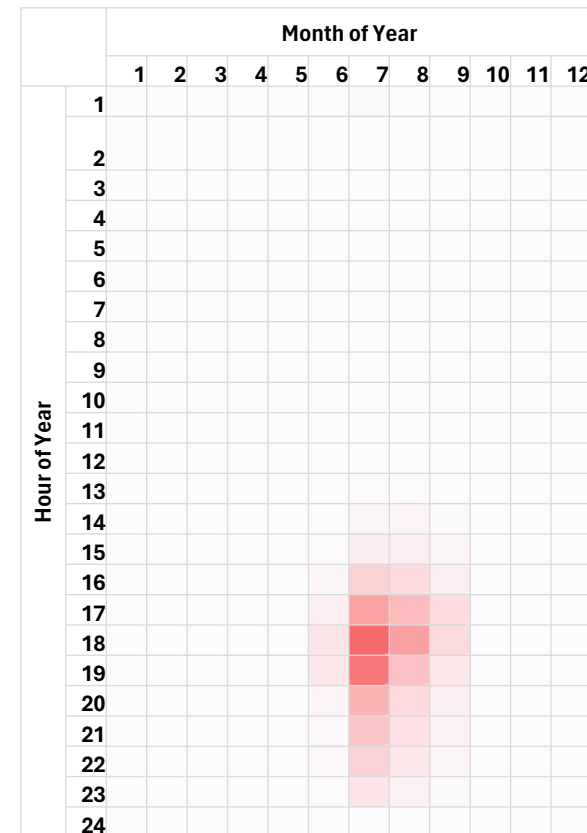
1GW Depth - 99.5%
Uptime



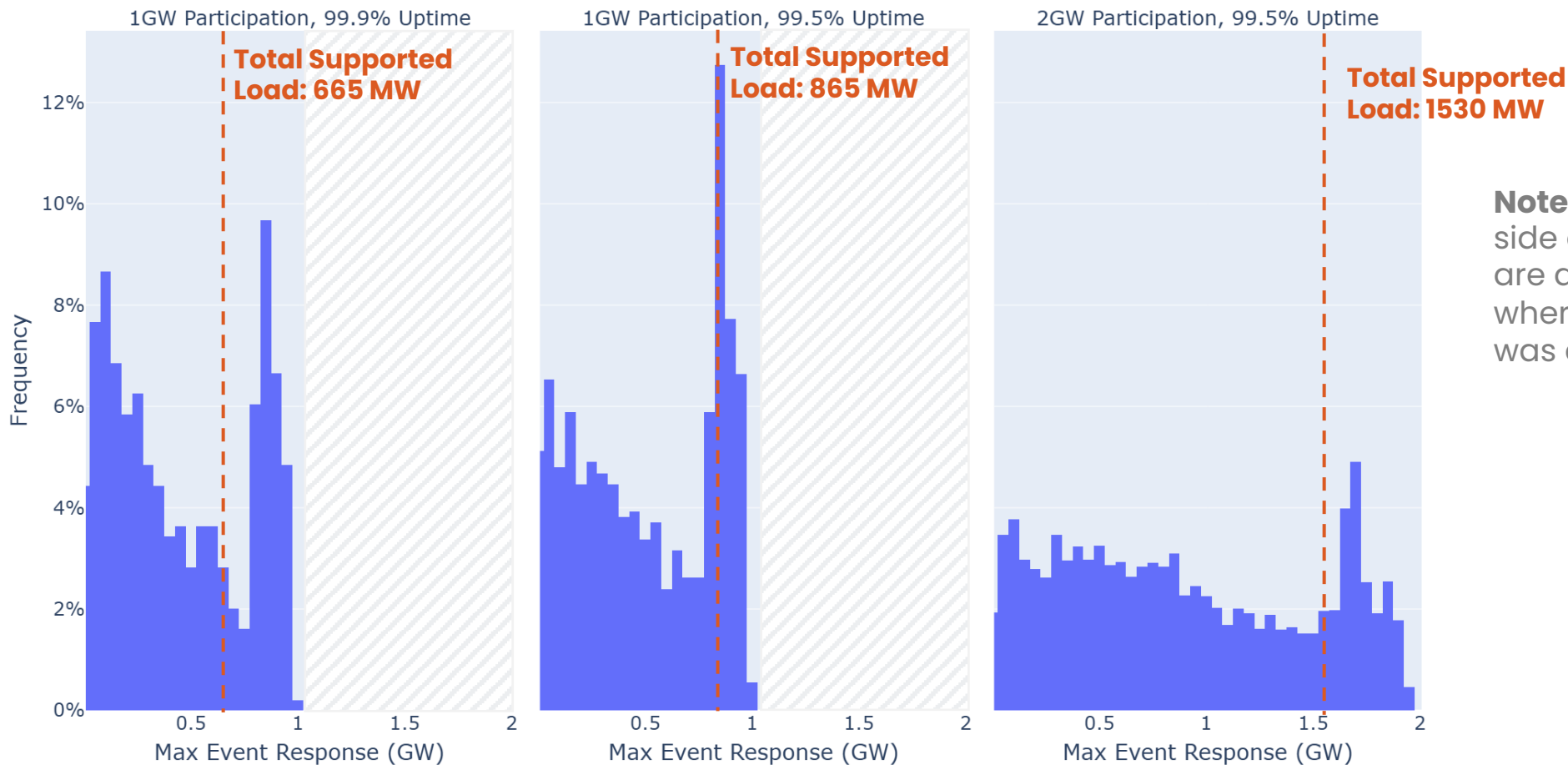
1GW Depth - 99.9%
Uptime



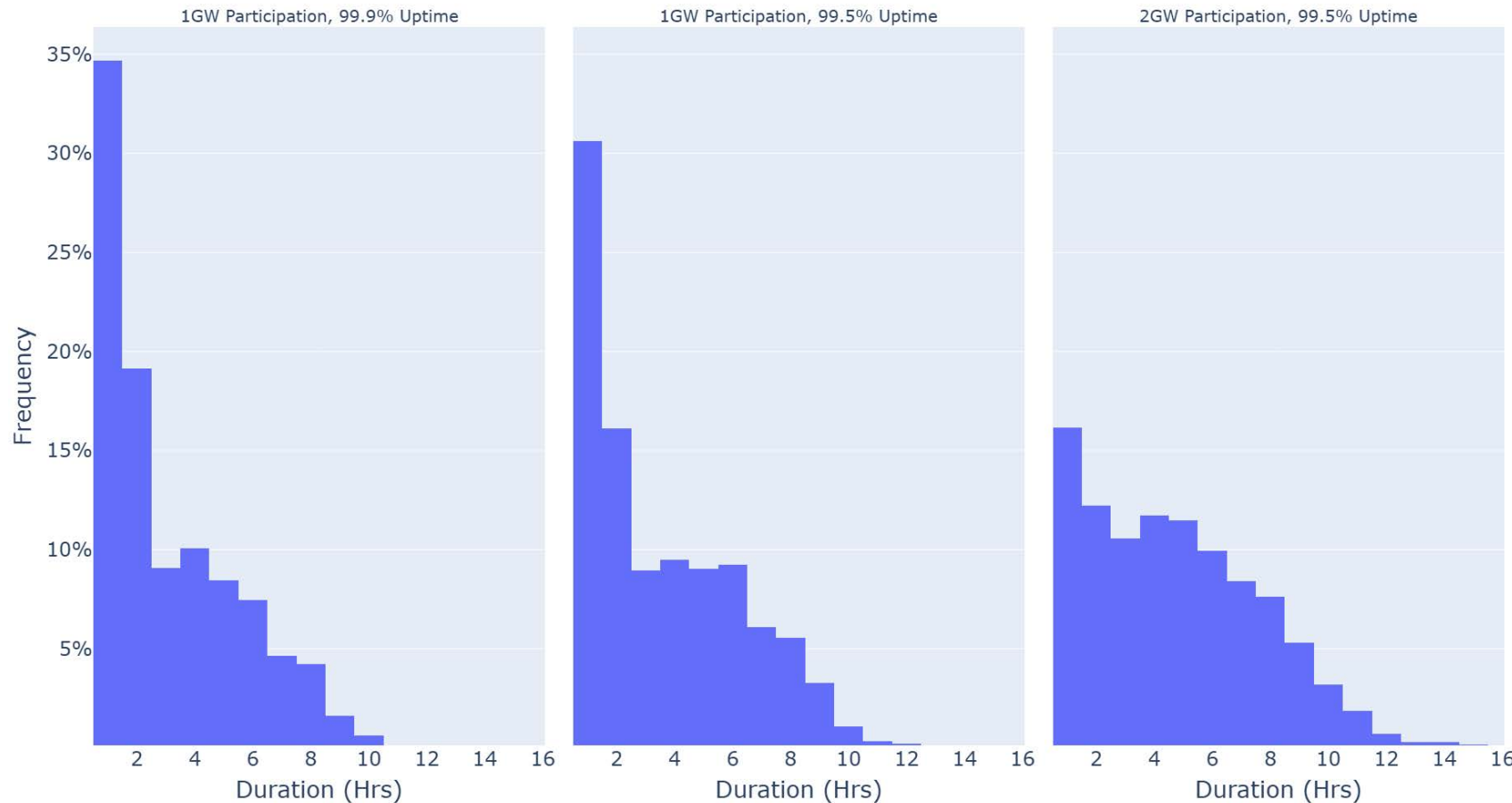
2GW Depth - 99.5%
Uptime



Max event power histogram shows a bimodal distribution, w/ peaks around small and large events



Nearly all flexibility events are < 15 hours;
majority of events <5 hours across scenarios

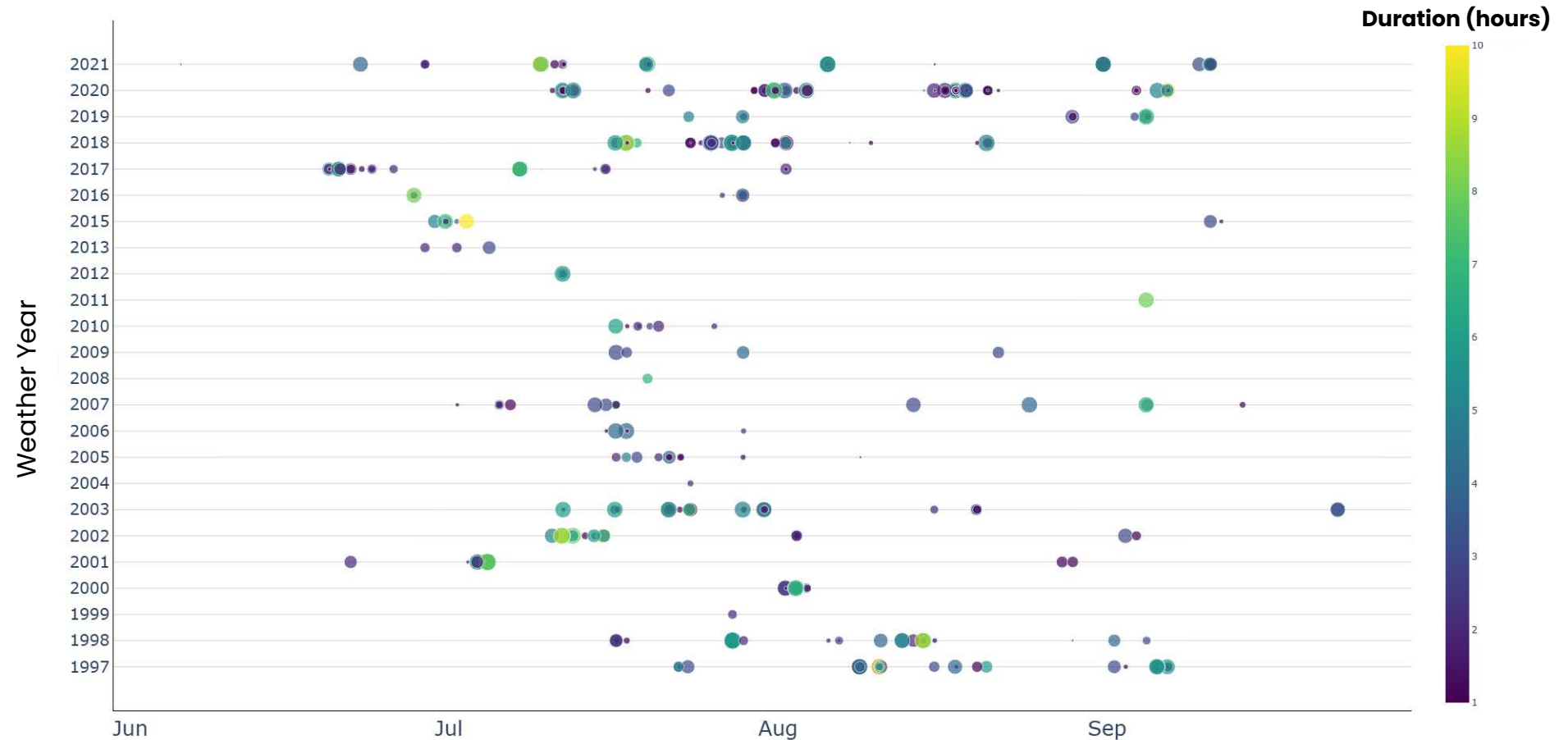


Event duration is reported for the entire data center fleet. Long duration events can be spread across multiple data centers, limiting the impact for any one customer. Follow-on analysis forthcoming

Size, frequency, duration and timing of data center flexibility

**Flexibility needs by
weather year, 1 GW
participation,
99.9% availability**

**Max Data Center
Curtailment (MW)**



Policy and Planning Implications

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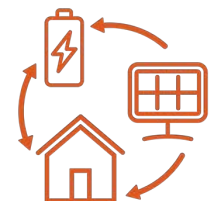


Key Findings

Data center flexibility has the potential to offset capacity requirements and costs under the conditions we analyzed (namely, tight reserve margins and high fixed capacity costs relative to variable costs)

- **Incentivizing small levels of participation can yield large benefits** – We found that 1 GW of data center flexibility was able to defer 60–85% of its capacity needs, depending on the required availability percentage.
- **The burden placed on data centers appears manageable** – Assuming a fleet of data centers, the number of times load response is required is small, and the durations are short.
- **Data center supply drives demand for flexibility** – Growth in data center capacity will push systems closer to their reserve margin targets and produce more scarcity events. This will increase the value/need for data center flexibility.
- **Energy needs start to offset capacity needs** – While capacity needs are an early pinch point for data center integration, eventually the systems become energy constrained and need to add resources to provide energy throughout the year.

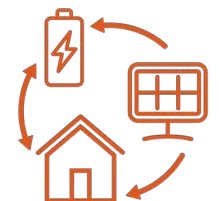
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Lessons Learned

Data center flexibility can saturate across both ELCC and cost savings — quantifying these saturation effects across different systems, and studying its effectiveness based on each system's unique conditions, will be critical to assessing and incentivizing its value.

- We observed declining marginal ELCCs moving from 1GW to 2GW of participation, particularly for modeling high availability requirements (99.9% uptime).
- We saw little change in the NPV of cost savings at varying levels of flexibility. Flexibility can reduce the need for firm capacity, but this can come at the cost of higher operating costs, as the marginal cost of energy may be higher.
- The effectiveness of data center flexibility will be system-dependent. For example, in systems with significant absolute emissions reduction targets (relative to a baseline year), where capacity and the PRM may not be the binding constraint (applicable in NVE and California), data center flexibility may be less effective.

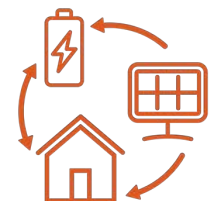


Making Flexibility Plannable

The benefits of load flexibility must be considered up front in the planning process

- Market prices or traditional demand response programs are unlikely to be sufficient to incentivize data center flexibility due to **high willingness to pay** for electricity.
- Planners and operators should not expect flexibility from data centers after they come online.
- Instead, flexibility should be incentivized in terms of **avoided capital (\$/MW)** and **accelerated interconnection**, before interconnecting the data center to the grid.
- The methods outlined in this report allow utilities and grid operators to identify the potential capacity savings of data center flexibility **up front** in the planning process.
- Large load rates, incentives, and interconnection agreements can be informed by data center flexibility studies similar to this one.

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Applying this method to other regions and planning practices

This case study provides an analytical approach that can be adopted in various planning, market, and procurement processes



- **Utility IRPs:** This method can be utilized in IRPs to calculate NPV of capacity expansion portfolios with and without data center flexibility to calculate avoided costs, emissions, and deferred resource additions attributed to data center flexibility..



- **Wholesale Capacity Markets:** ISOs can utilize this method to calculate capacity obligations and capacity accreditation participation for data centers and load serving entities, allowing data centers to offer in flexibility to offset a portion of their capacity requirement.



- **Rate Design:** Outcomes of this method can be used to calculate incremental costs of data center deployment and avoided costs attributed to data center flexibility. This can be used to facilitate large load rate design at the Commission and support bilateral negotiations between data centers and utilities.

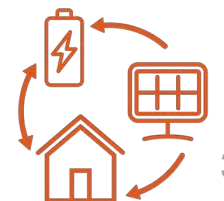


- **Transmission Interconnection:** Data center flexibility can also be used to avoid necessary transmission upgrades. This flexibility construct can be used in conjunction with flexibility evaluations in the transmission interconnection process, avoiding transmission upgrades and accelerating interconnection.



- **Data Center Design and Configuration:** This process can be used by data center developers to create novel solutions for flexibility, identifying the size, frequency, duration and timing of flexibility needs.

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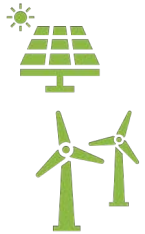


Opportunities for Improvements and Future Research



Data Center Specific Demand

This study utilized a single, aggregated data center demand profile. Data center demand will vary significantly between data centers and compute loads.



Future Clean Energy Portfolios

The ELCC calculations were conducted on a single future portfolio year (2030). Changes to load profiles, resource mix, and climate will change ELCC calculations. Additional study work should evaluate future ELCC.



Weather Dependent Data Center Demand

This analysis assumed a static data center demand profile across all weather years. Future research should develop weather-dependent data center demand profiles and evaluate correlated RA risk.



Data Center Flexibility Characteristics

This study evaluated data center flexibility in an end-use, technology agnostic manner. Future analysis can consider options of behind-the-meter generation and storage, load curtailments, and load shifting options.



Locational Considerations

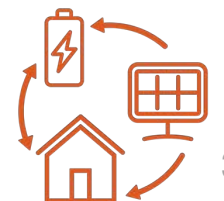
This case study was performed in a single region, “copper sheet” model. Transmission considerations may be required if data center development occurs in specific locations of the grid



RPS and Emissions Compliance

Capacity requirements can be more or less costly depending on emissions and renewable constraints. Data center flexibility can be evaluated across a range of other environmental policies.

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► See gridlab.org/DataCenter_Flex
for this report and a fact sheet.

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