San Francisco Local Agency Formation Commission
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July 19, 2024

TO: LAFCo Commissioners

FROM: Jeremy Pollock, Executive Officer

SUBJECT: LAFCo Introduction to Study for CleanPowerSF on Battery Energy Storage Systems: Why BESS Is Important

The following memo was presented at the July 19, 2024 LAFCo meeting as introduction to Arup International's "LAFCo Study for CleanPowerSF on Battery Energy Storage Systems" to discuss why BESS is such an important consideration in San Francisco's climate efforts.

This memo contains the following sections:

Battery Storage and San Francisco's Climate Goals

Battery energy storage systems (BESS) are a critical technology in San Francisco's 2021 Climate Action Plan. To meet San Francisco's goal of 100% renewable electricity by 2025 and 100% renewable energy by 2040, we must dramatically increase our capacity for storing this renewable electricity for use when it is needed. Specifically, BESS play key roles in these strategies for eliminating greenhouse gas emissions in the energy sector:

- **Energy Supply Strategy 2: Invest in local renewable energy and energy resilience projects**
  - ES.2-1: Assist affordable housing developments with installing on-site solar and battery storage and meeting City energy efficiency and solar energy requirements.
  - ES.2-3: Explore developing grid-independent solar and storage at critical municipal facilities and other critical or vulnerable community sites.
  - ES.2-4: Support the development of local renewable electricity production by scaling up programs such as net metering, community solar, feed-in tariffs, and battery storage.
  - ES.2-6: Continue to encourage private sector investment in local renewable energy solutions by engaging in public advocacy, educating consumers about their options (such as financing), and serving as a strategic partner.

- **Energy Supply Strategy 3: Design and develop the reliable and flexible grid of the future**
  - ES.3-1: Plan for the change in electricity demand and usage due to electrification of transportation and buildings through efforts such as the SFPUC's Integrated Resource Plans and ensure community engagement in these efforts.
  - ES.3-3: Invest in distribution infrastructure (including acquisition of PG&E assets) and smart-grid technologies, such as advanced metering infrastructure, demand response, and distribution automation.

BESS Use Cases

In residential systems, batteries are predominantly installed to complement rooftop solar power systems. Residential BESS has two primary uses cases in San Francisco:

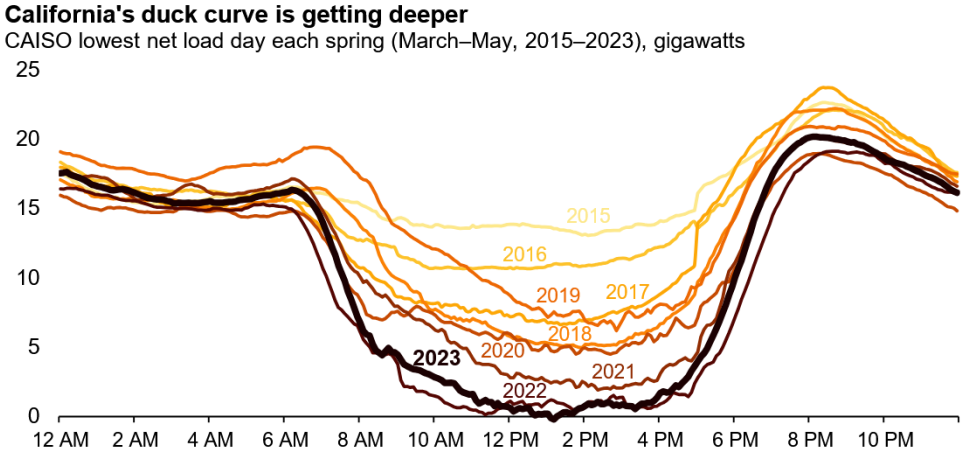
- **Resilience and Backup Power**: BESS provides the ability for maintaining power during grid outages. This has become increasingly important since PG&E adopted the practice of Public Safety Power Shutoffs (PSPS), where PG&E intentionally turns power off during times of severe wildfire danger where high winds could damage PG&E equipment and cause fires in areas with dry vegetation. While San Francisco has not yet experienced any PSPS, backup power remains a vital concern for disaster resilience, particularly in preparing for earthquakes. The City's SF72 program recommends San Franciscans prepare for 72 hours of self-reliance in case of serious emergencies. The typical size of residential BESS systems will not support 72 hours of full backup power, but would support critical needs, such as refrigeration and medical equipment. Backup power will become a more important consideration as the City progresses on electrification of transportation and other building operations, such as space heating, water heating, and cooking.

- **Load Shifting**: BESS enables the storage of excess electricity generated by rooftop solar systems to be used during times of peak demand. CleanPowerSF and PG&E have transitioned most customers to time-of-use (TOU) rates that charge different rates based on the supply and demand of electricity. This load shifting can provide significant savings for ratepayers and help recover the costs of the BESS installation.

The Duck Curve

The "duck curve" is a term that was coined by the California Independent System Operator (CAISO) in 2013, to describe the chart showing the difference in electricity demand and the available solar energy throughout the day in California. The chart (Figure 1) resembles the silhouette of a duck, with demand for electricity being lowest during the middle of the day, when solar generation peaks, before demand rapidly spikes in the evening as solar generation decreases and electricity usage peaks in the mid-evening hours.

Figure 1: California Duck Curve, 2015 to 2022 (Source: CAISO)

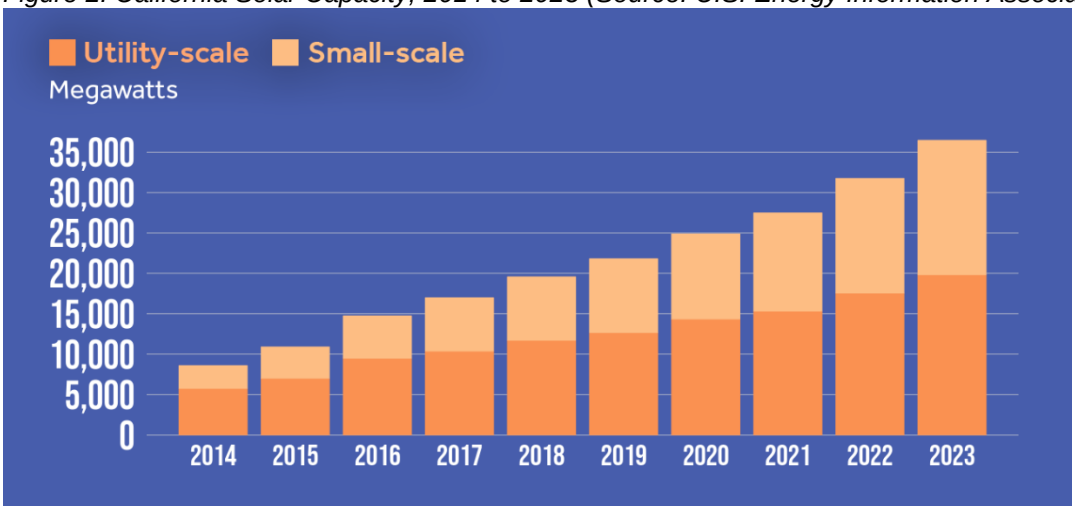


The steepness of this duck curve has increased in California because of several factors:

- Increased solar capacity
- Increased temperatures from global warming, which increases the need for air conditioning
- Increased electric vehicles and home electrification, which increases the amount of electricity demand in the evening when people typically return home from work

California's solar capacity (Figure 2) has increased dramatically in recent years.

Figure 2: California Solar Capacity, 2014 to 2023 (Source: U.S. Energy Information Association)



The duck curve provides dual challenges for utilities and electricity providers:

- The need to rapidly ramp up electricity production for these evening peaks in demand. This is often accomplished by peaking power plants that can quickly be turned off and on. These are typically highly polluting plants powered by natural gas.
- The need to prevent oversupplies of electricity on the grid during the midday peak in solar production. This can lead to the curtailment of solar power generation where the grid operator is not able to use all of the solar power being produced.

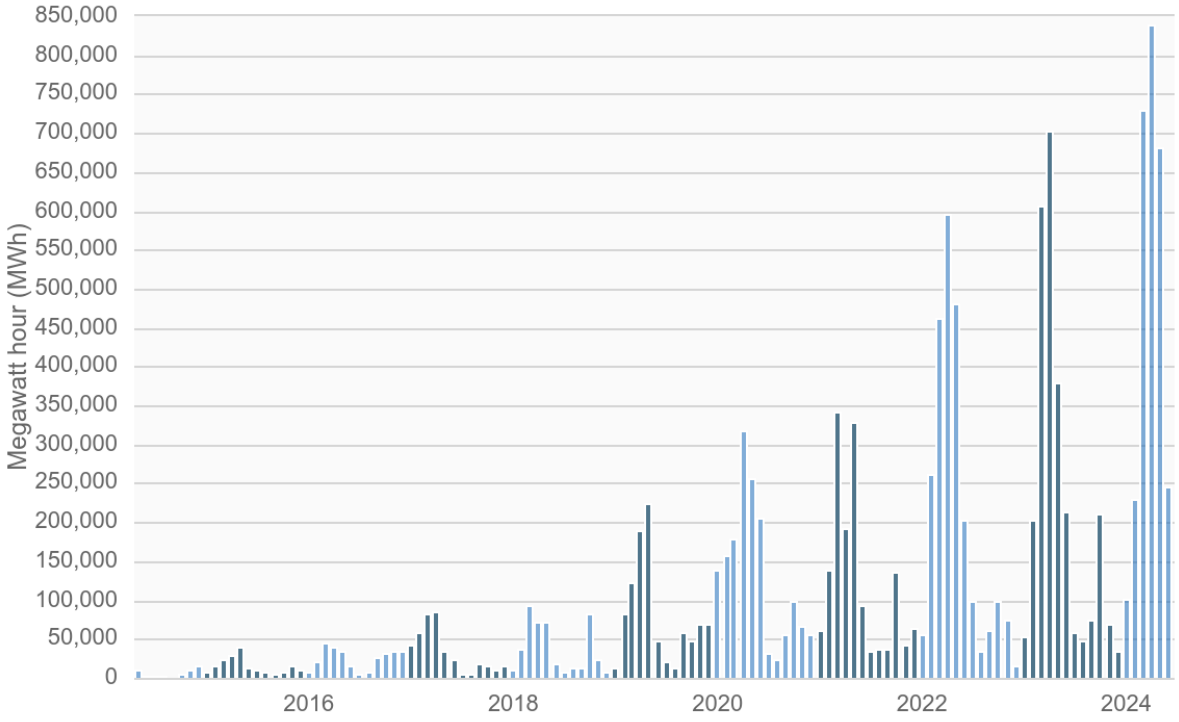
CAISO data (Figure 3) shows how curtailment has increased significantly with the increased solar capacity in recent years. CAISO states, "solar curtailment occurs most frequently in spring and fall when demand is low because of moderate weather, and sunny, breezy days produce an abundant supply of renewable generation."

Because the electricity grid must always be built to meet peak demand, some amount of electricity curtailment is inevitable. However minimizing the duck curve and curtailment offer significant benefits:

- Reducing GHG emissions by minimizing the need for peaker plants
- Reducing the total amount of electricity generation needed
- Reducing the need for new electricity transmission infrastructure

BESS is the primary solution to smoothing out the duck curve by storing the excess electricity produced during the midday peak in supply for usage during the early evening peak in demand.

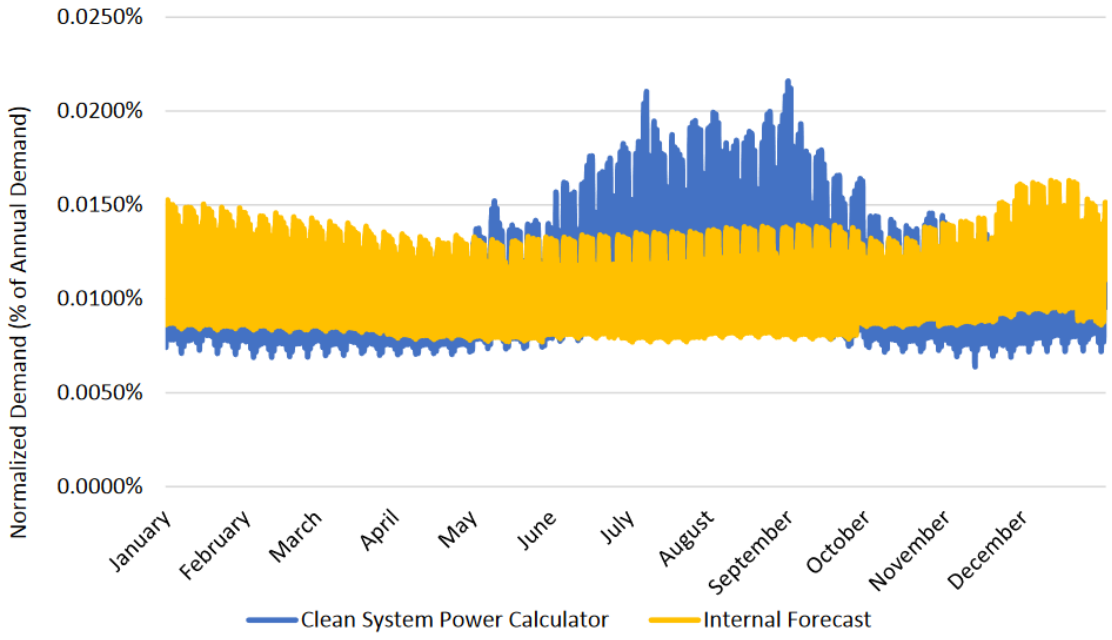
Figure 3: California Wind and Solar Curtailment Totals by Month (Source: CAISO)



San Francisco's Climate and Electricity Usage Profile

The California electric grid is built to meet the state's peak electricity demand, which typically occurs between late June and early September, when high temperatures increase the demand for air conditioning. San Francisco is one of the very few parts of the state where demand peaks in the winter.

Figure 4: CleanPowerSF Electricity Load Forecast vs Statewide Forecast



CleanPowerSF's 2022 Integrated Resource Plan states that "CleanPowerSF is a winter peaking program and has lower demand than the CAISO system average during the summer months, due in part to San Francisco's unique weather which has cooler than average summer months and lower load during this time of the year."

Figure 4 shows how the statewide electricity load forecast developed by the California Public Utilities Commission has a significant peak in the summer. CleanPowerSF's electricity load forecast is shown in yellow, with a smaller peak in the winter.

San Francisco's winter peak presents a challenge for CleanPowerSF's ability to meet the City's 100% renewable electricity targets, because solar energy is more available and affordable in the summer. Purchasing sufficient solar power to meet San Francisco's winter peak would result in surplus power during the summer. This power can be resold to other areas of the state during the summer, when electricity prices are typically highest, but this introduces additional complexity and potential financial uncertainty for CleanPowerSF.

This dynamic emphasizes the critical role BESS plays in San Francisco's ability to simultaneously maximize our renewable energy resources while minimizing costly investments required for electricity production and transmission.

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Item 3 – CleanPowerSF Updates: LAFCo Updates on CleanPowerSF Studies

July 19, 2024

Battery Energy Storage Systems (BESS) Study

- On July 11, 2024, LAFCo contractor, Arup International, delivered the final version of its “LAFCo Study for CleanPowerSF on Battery Energy Storage Systems”
- We plan for a full presentation on the study for LAFCo’s next meeting to allow time for City departments and interested parties to comments.
- This presentation discusses why BESS is important for San Francisco’s climate goals
- To meet San Francisco’s goal of 100% renewable electricity by 2025 and 100% renewable energy by 2040, we must dramatically increase our capacity for storing this renewable electricity for use when it is needed.

Battery Storage & SF's Climate Action Plan

- Energy Supply Strategy 2: Invest in local renewable energy and energy resilience projects
  - ES.2-1: Assist affordable housing developments with installing on-site solar and battery storage and meeting City energy efficiency and solar energy requirements.
  - ES.2-3: Explore developing grid-independent solar and storage at critical municipal facilities and other critical or vulnerable community sites.
  - ES.2-4: Support the development of local renewable electricity production by scaling up programs such as net metering, community solar, feed-in tariffs, and battery storage.
  - ES.2-6: Continue to encourage private sector investment in local renewable energy solutions by engaging in public advocacy, educating consumers about their options (such as financing), and serving as a strategic partner.
- Energy Supply Strategy 3: Design and develop the reliable and flexible grid of the future
  - ES.3-1: Plan for the change in electricity demand and usage due to electrification of transportation and buildings through efforts such as the SFPUC's Integrated Resource Plans and ensure community engagement in these efforts.
  - ES.3-3: Invest in distribution infrastructure (including acquisition of PG&E assets) and smart-grid technologies, such as advanced metering infrastructure, demand response, and distribution automation.

BESS Use Cases

- **Resilience and Backup Power**:
  - Increasingly important because of PG&E's Public Safety Power Shutoffs (PSPS)
  - SF72 program recommends preparing for 72 hours of self-reliance in case of emergency
  - Backup power will become more important as we electrify transportation, heating, cooking, etc.

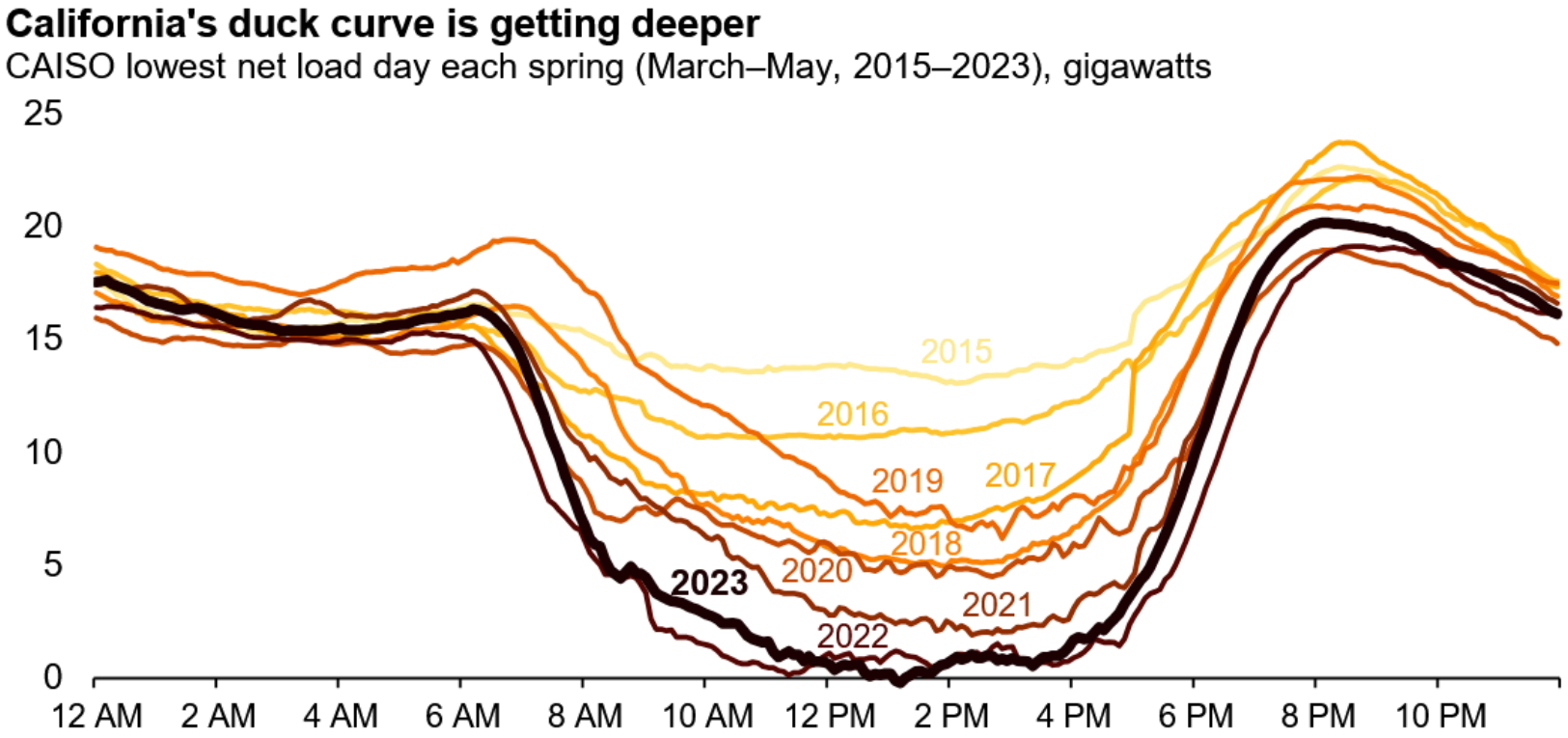
- **Load Shifting**:
  - BESS enables the storage of excess electricity generated by rooftop solar systems to be used during times of peak demand
  - CleanPowerSF and PG&E have transitioned most customers to time-of-use (TOU) rates that charge different rates based on the supply and demand of electricity
  - This load shifting can provide significant savings for ratepayers and help recover the costs of the solar+BESS installation

NEM 3.0: New CPUC Rule Makes Batteries More Important for Rooftop Solar

- Net Energy Metering (NEM) requires utilities to pay for excess power produced by rooftop solar
- The CPUC implemented “NEM 3.0” last year that significantly reduced how much utilities pay customers for this electricity
- Because residents are now paid less for excess solar, they can save more by storing that electricity in batteries for use during the evening peak time when rates are higher

The Duck Curve

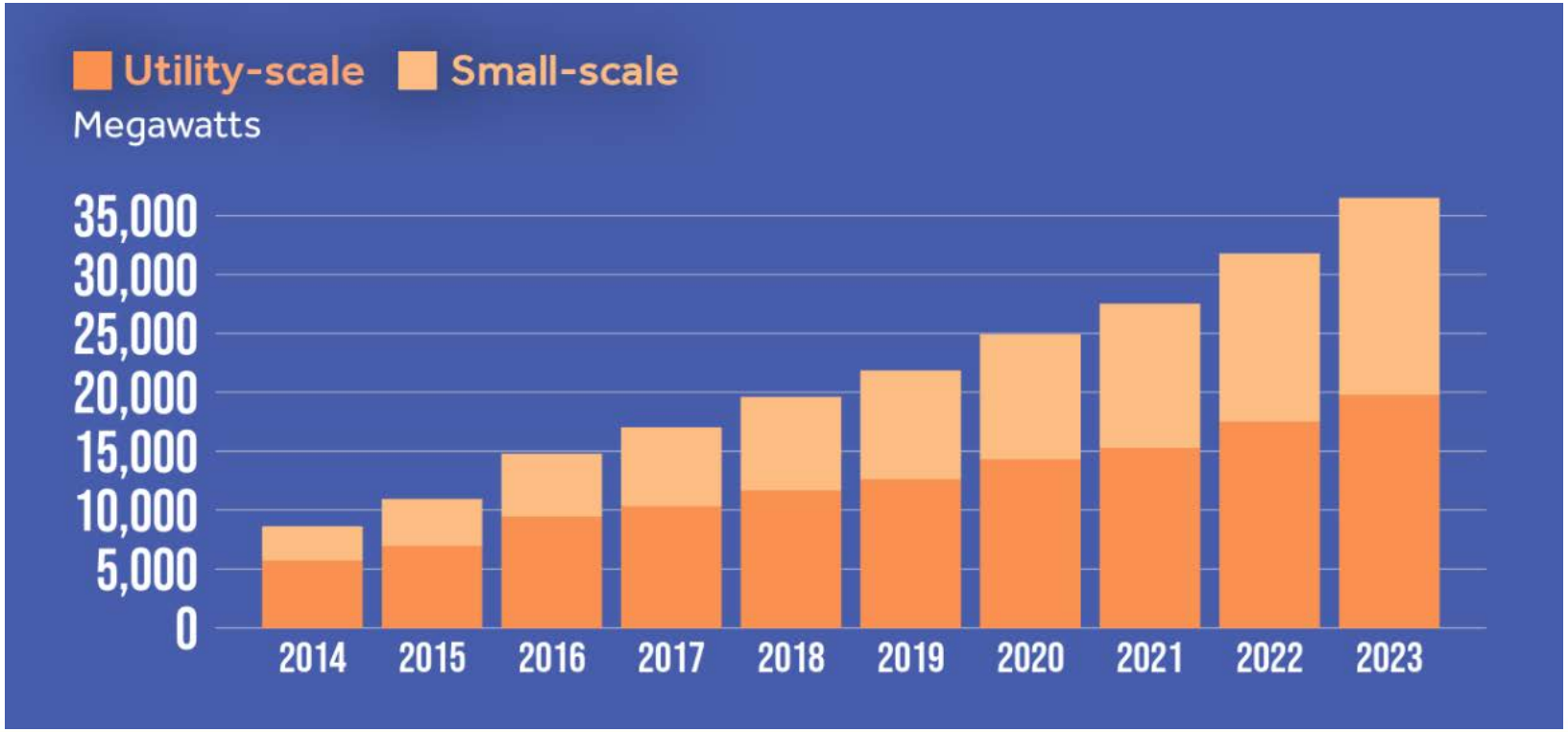
- Chart showing net electricity load: difference between available solar power and electricity demand
  - Demand is lowest when solar power is strongest
  - Demand is highest in the early evening when the sun goes down



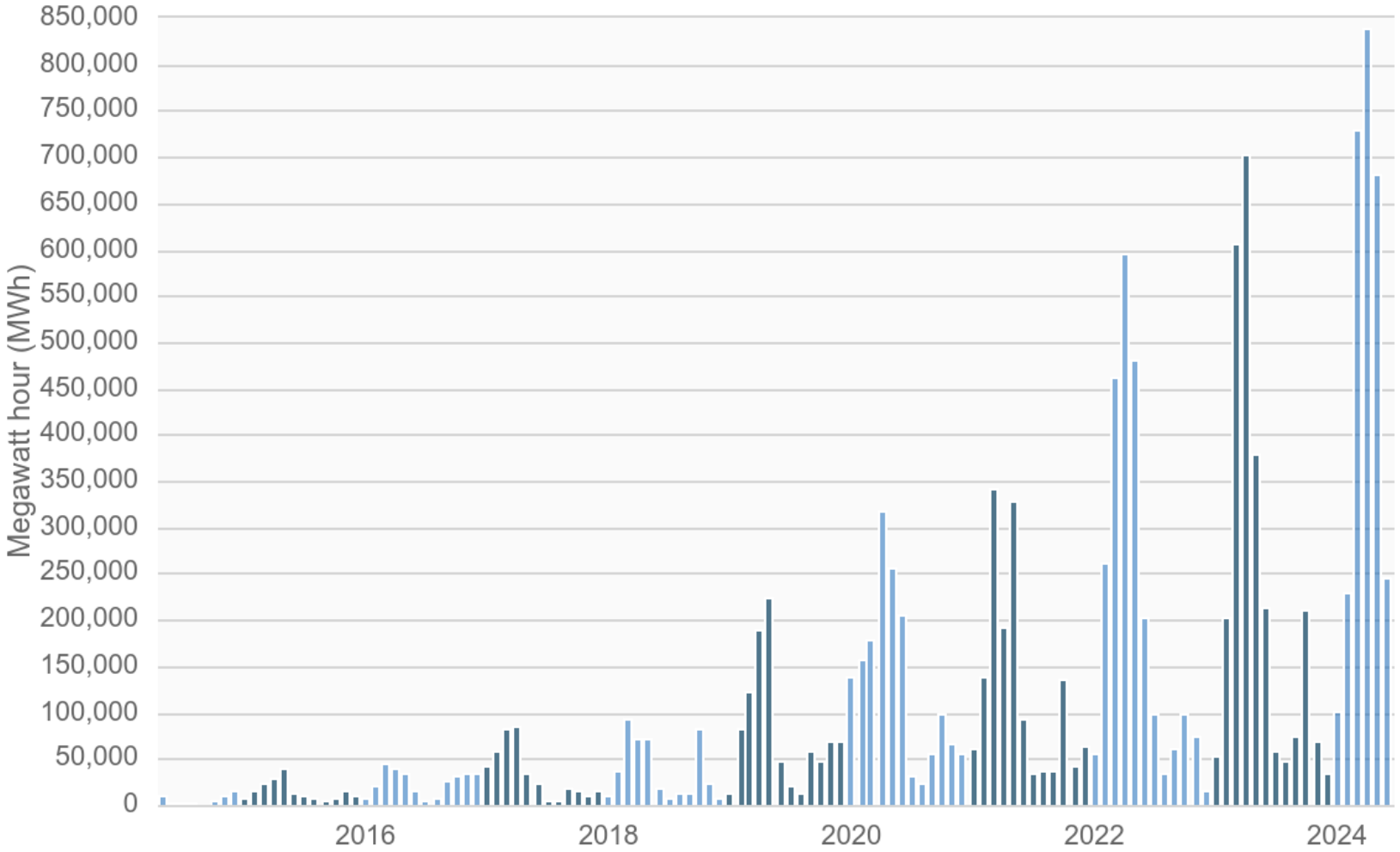
Duck Curve is Getting Steeper

- Solar capacity is increasing
- Demand for electricity is increasing because of global warming:
  - Hotter temperatures increase demand for air conditioning
  - EVs and home electrification also increase demand

California Solar Capacity



Curtailment: Unused Electricity

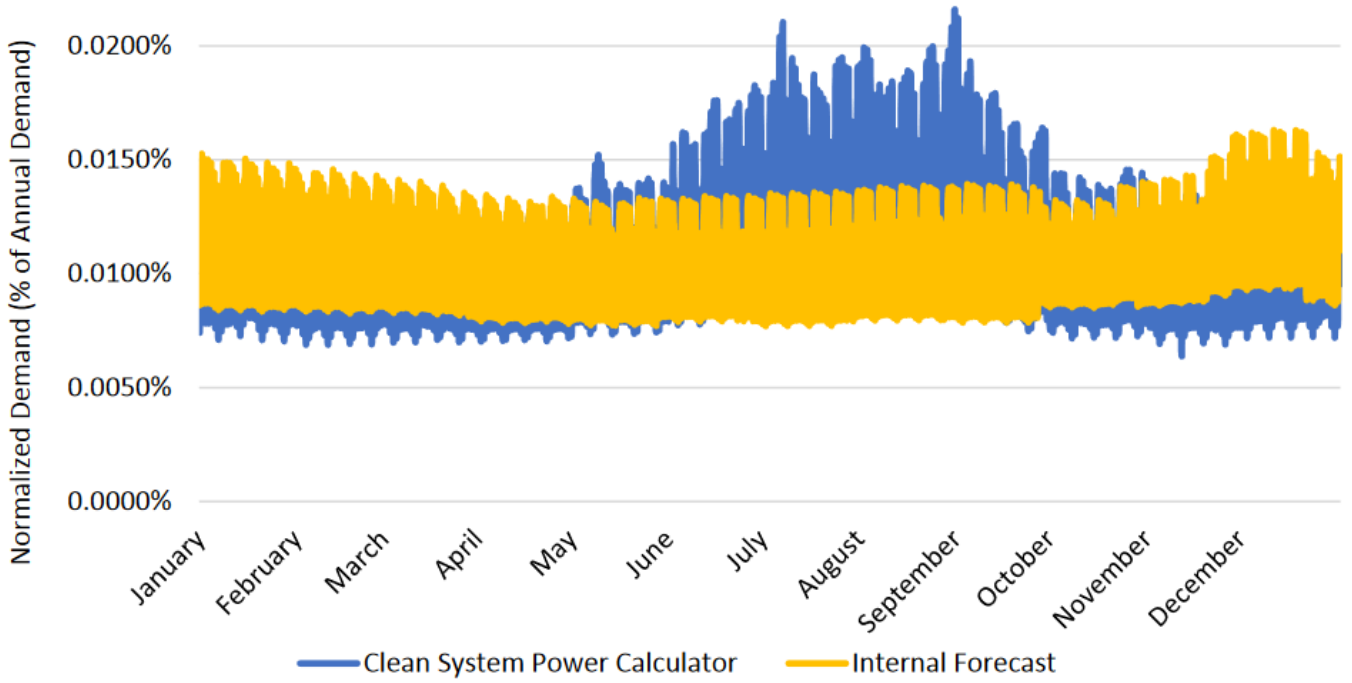


- Solar curtailment occurs in spring and fall when demand is low because of moderate weather, and sunny, breezy days produce an abundant supply of renewable generation
- Chart shows the total solar and wind curtailment in California by month

SF's Unique Climate & Electricity Profile

- California's peak electricity demand is in the Summer, but SF's is in the winter
  - Challenge: solar power is most available and affordable in the summer
  - Opportunity: CleanPowerSF can resell surplus power during the summer when demand is high
- Increasing SF's battery storage capacity maximizes our solar resources and minimizes need for additional investments in electricity production and transmission

CleanPowerSF's Power Profile vs. California's



Batteries are the Best Solution to the Duck Curve

- The Duck Curve presents dual challenges for electricity providers:
  - The need to rapidly ramp up electricity in the evening, often using natural gas peaker plants
  - The need for curtailment to shutdown renewables to avoid too much electricity on the grid

- Some curtailment is inevitable because the grid needs to be built to meet peak demand

- But minimizing the duck curve and curtailment offer significant benefits:
  - Reducing GHG emissions by minimizing the need for peaker plants
  - Reducing the total amount of electricity generation needed
  - Reducing the need for new electricity transmission infrastructure

- Battery storage smooths out the duck curve by storing the excess electricity produced during the midday peak in supply for usage during the early evening peak in demand