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CPUC Electric Grid Reliability Modeling

IEPR Commissioner Workshop on Forecast Use in Electricity System Planning
October 2, 2024

California Public
Utilities Commission

Objectives

- Describe components of CEC – CPUC - CAISO Electric Grid Reliability Modeling Framework
  - CEC: IEPR, QFER, NAMGas
  - CPUC: IRP, RA, TPP
  - CAISO: TPP
- Describe CPUC Climate Informed Forecasting (CIF) Approach
  - Why this is necessary under current reliability modeling framework
  - Existing study quantifying impact of CIF electric demand profiles
  - Preliminary results comparing Cal-Adapt downscaled localized models to current approach

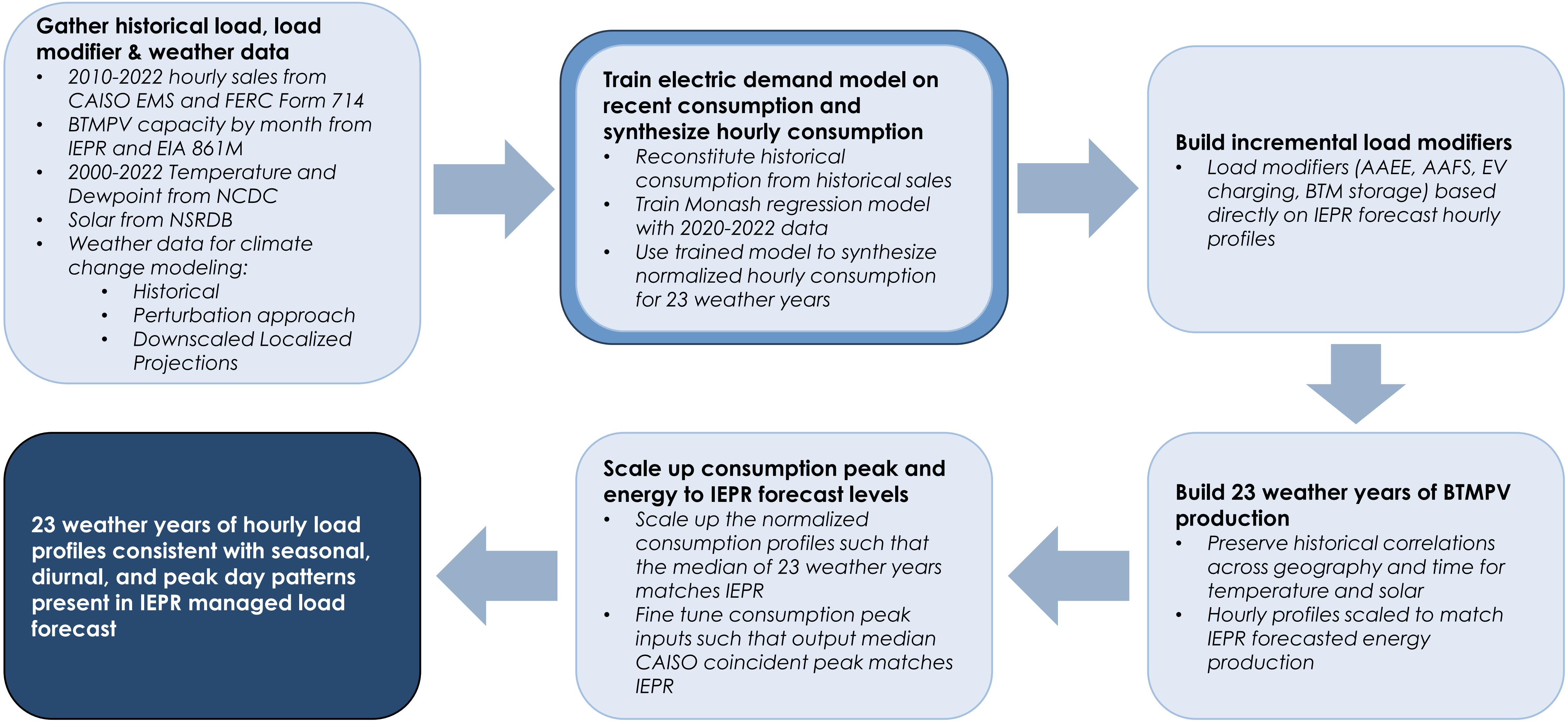
Components of CEC – CPUC Electric Grid Reliability Modeling Framework

- CEC provides CPUC with IEPR California Energy Demand (CED) Single Forecast Set (SFS), which, for each forecast year, is a single set of 8,760 hour profiles corresponding to 1-in-2 (median) weather:
  - **Sales**: Measured at System Bus Bar
    - Drives CPUC Load Serving Entity Resource Adequacy Obligations
    - "Sales" in this context is equivalent to "Managed Load" in the IEPR
  - **Consumption**: Counterfactual
    - *Consumption = Sales + BTMPV + Other Load Modifiers*
    - Drives Total Reliability Need (TRN) to meet 0.1 Loss Of Load Expectation (LOLE) reliability target
- CPUC is mandated to calculate TRN which requires stochastic modeling
  - CEC SFS is not sufficient for CPUC to calculate TRN and LOLE because stochastic modeling requires a multiple weather year distribution of hourly electric demand, including both average and extreme weather years
  - Therefore, CPUC produces its own stochastic dataset and uses the IEPR peak and energy forecast to determine the magnitude of the stochastic dataset
  - Via the JASC interagency process, CPUC has requested that the CEC consider taking on the task of creating a stochastic dataset (for California electric demand)

		Agency		
Electric Demand		CPUC	CEC	WECC
Magnitude	In-State		IEPR	
	Out-Of-State			Anchor Data Set
Shape	In-State	Current: ERM	Proposed: IEPR	
	Out-Of-State	ERM		

ERM: CPUC Energy Division, Energy Resource Modeling Section

The process for developing 23-weather-year loads and load modifiers for CPUC modeling:



Gather historical load, load modifier & weather data

- *2010-2022 hourly sales from CAISO EMS and FERC Form 714*
- *BTMPV capacity by month from IEPR and EIA 861M*
- *2000-2022 Temperature and Dewpoint from NCDC*
- *Solar from NSRDB*
- *Weather data for climate change modeling:*
  - *Historical*
  - *Perturbation approach*
  - *Downscaled Localized Projections*

Train electric demand model on recent consumption and synthesize hourly consumption

- *Reconstitute historical consumption from historical sales*
- *Train Monash regression model with 2020-2022 data*
- *Use trained model to synthesize normalized hourly consumption for 23 weather years*

Build incremental load modifiers

- *Load modifiers (AAEE, AAFS, EV charging, BTM storage) based directly on IEPR forecast hourly profiles*

Build 23 weather years of BTMPV production

- *Preserve historical correlations across geography and time for temperature and solar*
- *Hourly profiles scaled to match IEPR forecasted energy production*

Scale up consumption peak and energy to IEPR forecast levels

- *Scale up the normalized consumption profiles such that the median of 23 weather years matches IEPR*
- *Fine tune consumption peak inputs such that output median CAISO coincident peak matches IEPR*

23 weather years of hourly load profiles consistent with seasonal, diurnal, and peak day patterns present in IEPR managed load forecast

Challenges with CEC – CPUC Electric Grid Reliability Modeling Framework

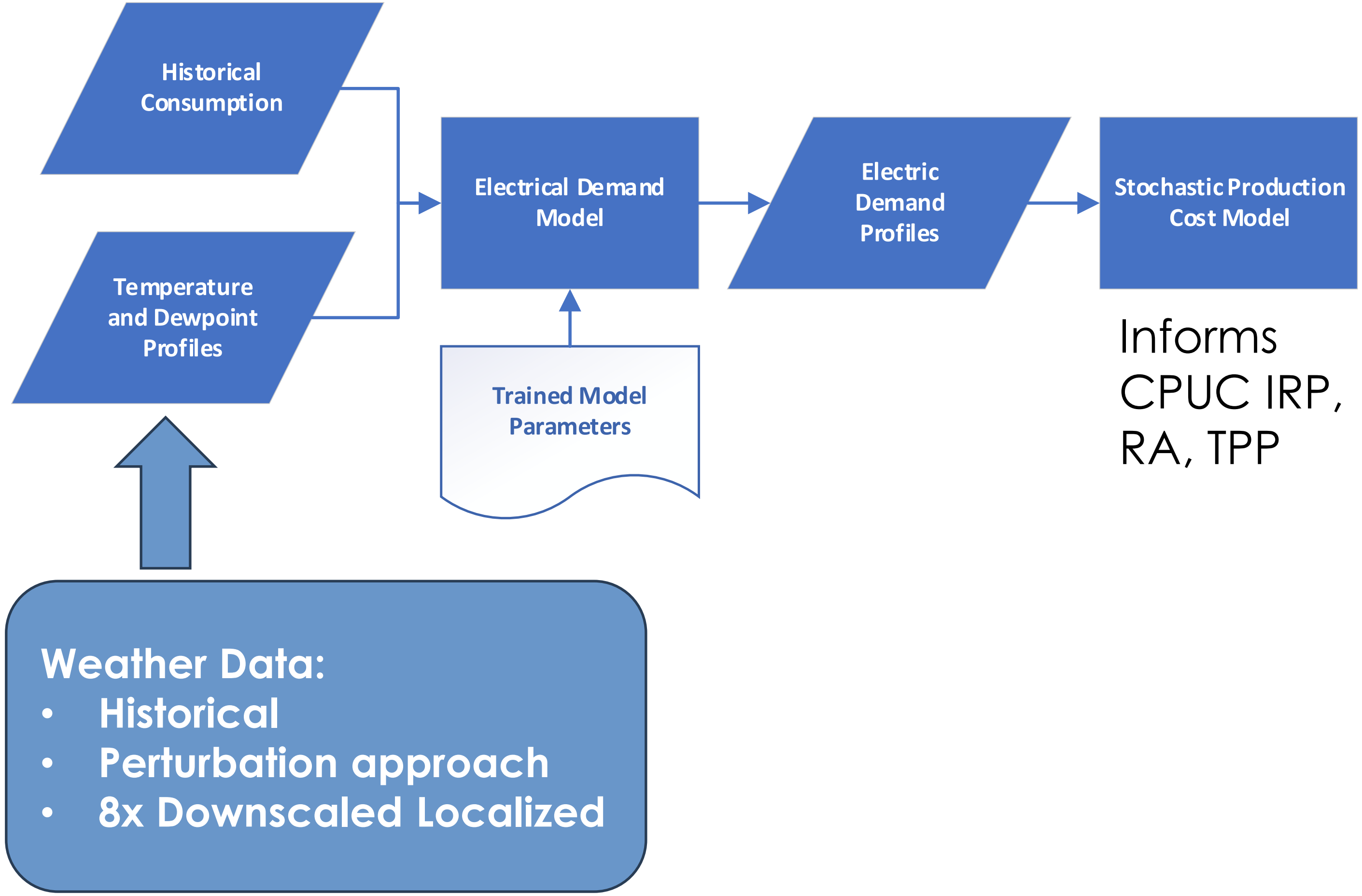
- Tuning the CPUC's stochastic load dataset such that the median matches both the IEPR SFS consumption peak AND managed peak is difficult
  - Independent data development processes at CEC and CPUC working with similar data can lead to differences in respective hourly consumption and BTMPV profiles that determine managed peak. This means:
    - CPUC can tune its stochastic load dataset to match IEPR consumption peaks OR IEPR managed peaks but NOT both
  - This is consequential since consumption peak drives TRN in CPUC IRP modeling whereas managed peak drives CPUC LSE RA obligations
    - A choice of tuning to match IEPR consumption peaks can result in CPUC IRP modeling a managed peak that is **different** than the IEPR managed peak which is directly used for RA obligations
  - This issue becomes moot for California modeling if the IEPR includes a stochastic dataset in future cycles
    - Modeling WECC-wide reliability still requires Out Of State stochastic profiles, which CPUC staff will continue to develop
- Other challenges
  - The IEPR includes forecasts of EV charging and AAFS growth becoming very large post-2035, making these factors more dominant in determining TRN. Uncertainty in these forecasts translates to uncertainty in forecasting the TRN.
  - Primarily because of the large projected AAFS growth, the 2023 IEPR also shows that by 2040 the CAISO system could switch to winter annual managed peaks which may require significant changes to the current paradigm of planning for summer reliability only
  - To aid in long-term planning, the IEPR should provide data out to 2050 if available

CPUC Climate Informed Forecasting (CIF) Approach

- CEC IEPR forecast accounts for climate change
  - Uses detrended downscaled climate data along with consumption – temperature elasticities to develop 1-in-2 CIF consumption Single Forecast Set (SFS)
- Existing CPUC stochastic dataset
  - 23 historical weather years of temperature and dewpoint data (2000-2022) across WECC
  - Represents current climate
- Historic weather data is no longer sufficient to develop stochastic electric demand profiles
  - Electric demand profiles are scaled to IEPR SFS consumption magnitude (peak and annual average)
  - Shapes based on historical weather data do not capture climate change
    - Electric grid reliability depends on magnitude AND shape of electric demand profiles
- Electric demand profiles can now be developed from 3 different sources of weather data:
  - Historical: Current approach – used to train electric demand model
  - Perturbation approach: Based on historical and ensemble averaged CMIP6 climate data
  - Downscaled Localized Projections: High resolution projections of CMIP6 climate data

Developing Weather Normalized Hourly Electric Demand Profiles from Historical or Synthetic Climate Data

- Electric Demand Model trained on recent historical consumption data (2020 – 2022) and weather data for same period
- Trained Model Parameters then used to develop 23 years of hourly weather normalized electric consumption
- Once model is trained, we can swap in alternative synthetic temperature and dewpoint profiles
- Perturbation approach:
  - Same underlying CMIP6 climate data
  - Assumes variability of future climate is consistent with current climate
- Downscaled Localized Projections
  - Cal-Adapt / Eagle Rock Analytics Engine



Informs CPUC IRP, RA, TPP

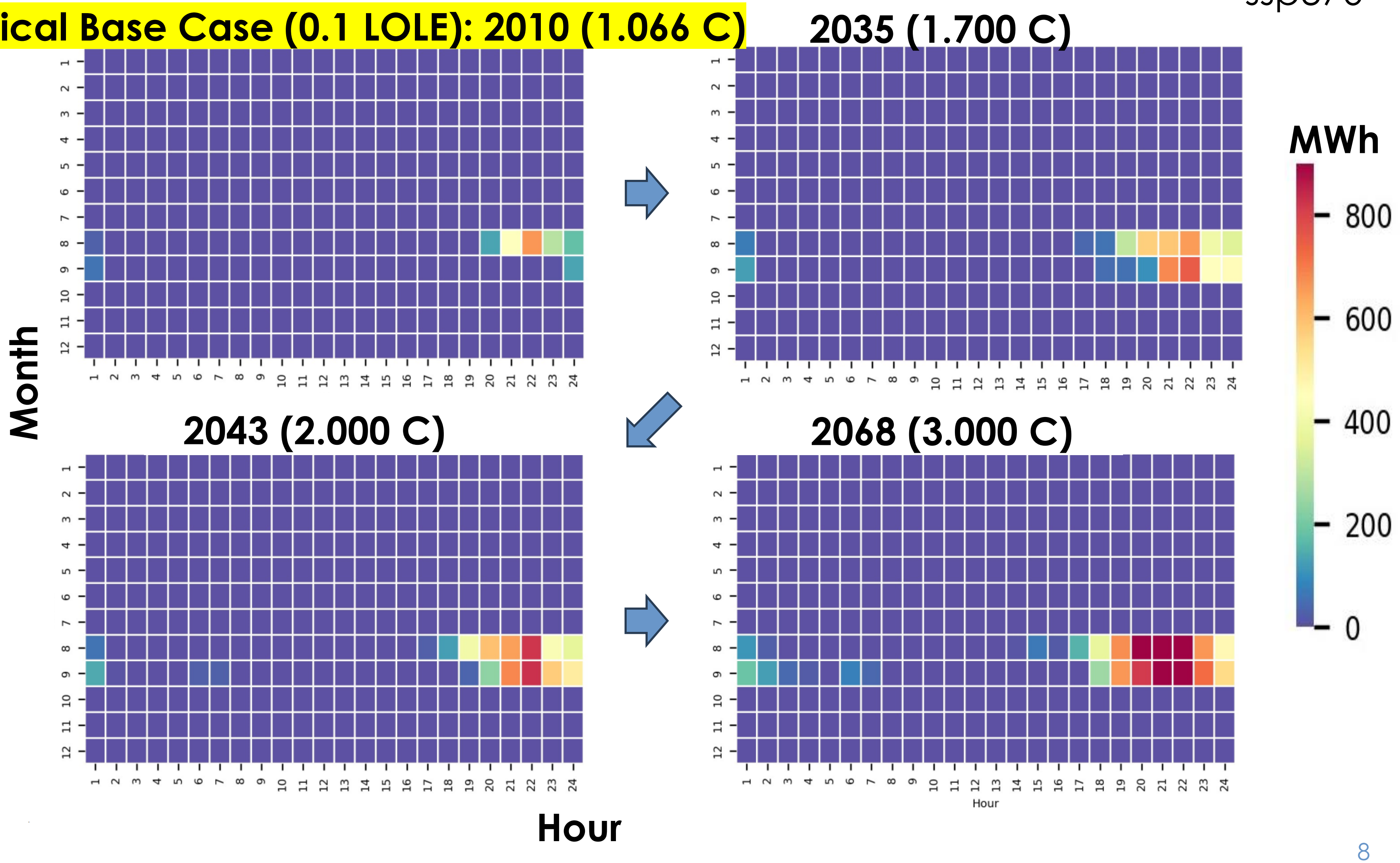
Weather Data:
- **Historical**
- **Perturbation approach**
- **8x Downscaled Localized**

Examining Impacts of CIF v non-CIF Electric Demand Profile Shapes on Operation of Electric Grid

CMIP6
ssp370

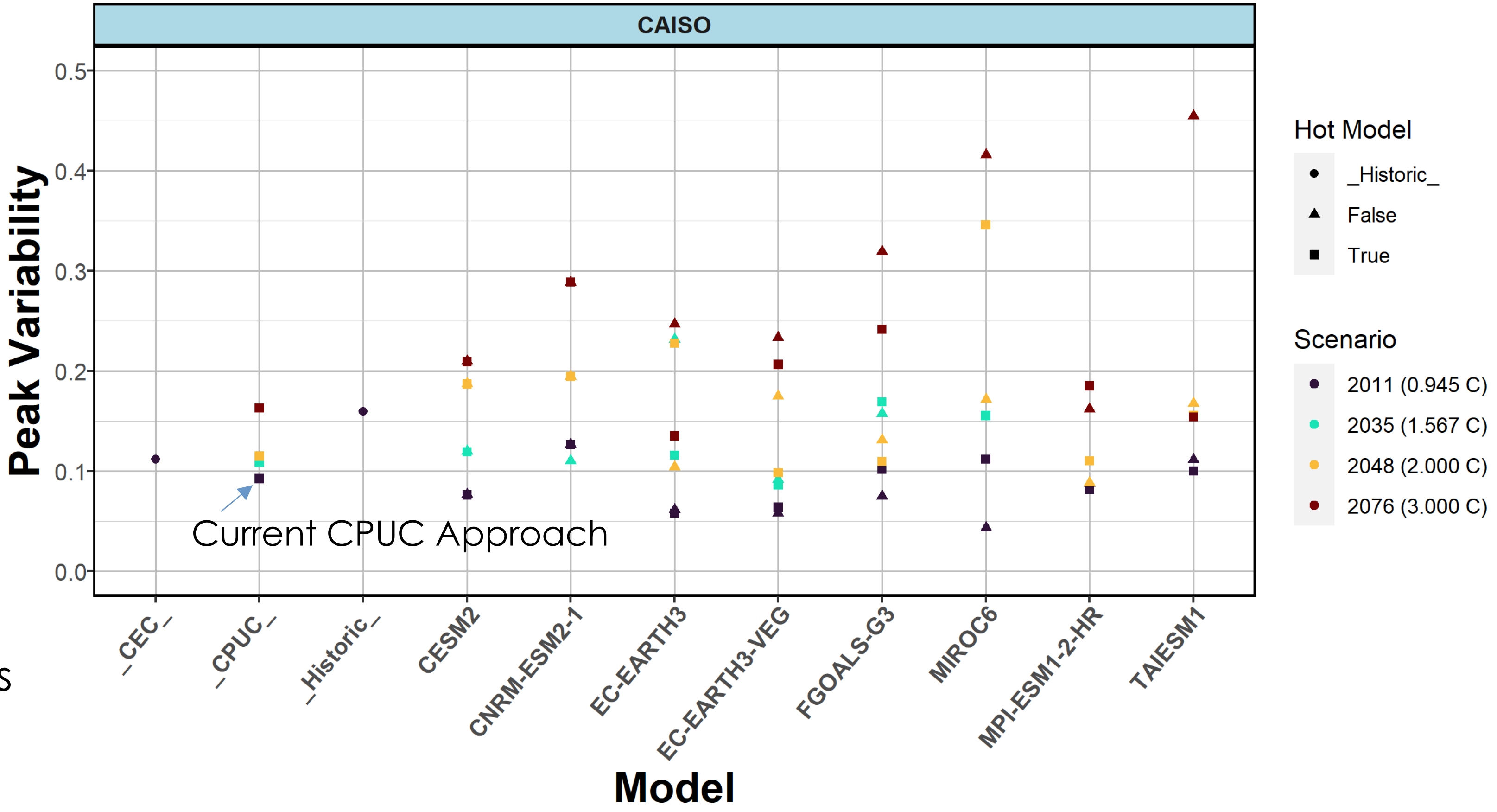
Expected Unserved Energy (MWh)

- Heat maps correspond to highest load day for historical and hypothetical climate simulations
- Synthetic weather data (1998 – 2020) based on perturbation approach
- IEPR 2022: 2035 target
  - Defines magnitude (peak and mean) consumption for all scenarios
  - Scenarios are identical apart from CIF Electric Demand Profiles
- We estimate that 825 MW of additional perfect capacity needed to maintain 0.1 LOLE in 2035 (1 - 2 % of peak)



Comparison Of Historical, Perturbation and Downscaled Localized Projection Approaches

- Preliminary Results
- Peak variability is equivalent to 1-in-23 year response relative to 1-in-2
  - CEC is 1-in-20 from 2022 IEPR: 2026
- Variants are not detrended
  - Consistent with current CPUC but not CEC Approach
- CPUC results include synthetic historical along with CIF perturbation approach results
- Hot model approach is Assessment Report 6 (AR6) recommendation
  - Hot model only reduces variability
- Downscaled models show high levels of variability



Current CPUC Approach

Next Steps

- Examine impacts of Downscaled Localized Temperature and Dewpoint data on reliable operation of electric grid.
  - Use synthetic electric demand profiles from downscaled localized projections in Production Cost Model
  - Compare to updated perturbation approach
- CEC – CPUC Alignment
  - Lack of alignment creates challenges in implementing IRP and RA programs
  - Align CEC Single Forecast Set with CPUC IRP and RA / Slice Of Day approaches
    - CEC ultimately providing stochastic dataset in lieu of SFS within CA
    - CPUC still develops stochastic dataset outside CA
  - Align Climate Change Approaches