2019-20 IRP: Calibration and Validation with SERVM production cost modeling

CPUC Energy Division

October 4, 2019

Purpose of Presentation

- Present process of modeling portfolios to be considered for the 2019 Reference System Plan, which involves use of a consistent dataset and two different models
- Present CPUC staff modeling results with SERVM model
- Make data available for stakeholders to review or conduct their own analysis

1. OVERVIEW OF IRP MODELING TOOLS AND PROCESS

Review of Objectives for IRP Analysis

Objective of IRP modeling: To develop an optimal portfolio of new resources to add to the existing fleet in the CAISO area to plan for:

- Achievement of long-term GHG reduction targets and other policy goals
- Maintaining reliability
- Keeping costs reasonable
- Accounting for uncertainty and expected energy market conditions (i.e., "real world" conditions)

- The role of the RESOLVE model in IRP is to select portfolios of new resources that are expected to meet our goals at least cost.
- The role of the SERVM model in IRP is to verify the reliability, operability, and emissions of resource portfolios generated by RESOLVE.
- Use of each model serves the overall objective of identifying optimal portfolios of resources under specific conditions that are suitable for use in guiding policy and procurement.

RESOLVE Model Review

- RESOLVE is a capacity expansion model designed to inform long-term planning questions around renewables integration.
- RESOLVE co-optimizes investment and dispatch for a selected set of days over a multi-year horizon in order to identify least-cost portfolios for meeting specified GHG targets and other policy goals.
- Scope of RESOLVE optimization in IRP 2019-20:
  - Covers the CAISO balancing area including POU load within the CAISO
  - Optimizes dispatch but not investment outside of the CAISO
    - Resource capacity outside of CAISO cannot be changed by the optimization
- The RESOLVE model used to develop the preliminary Reference System Plan results, along with accompanying documentation of inputs and assumptions, model operation, and results is available for download from the CPUC's website at: [2019-20 IRP Events and Materials]

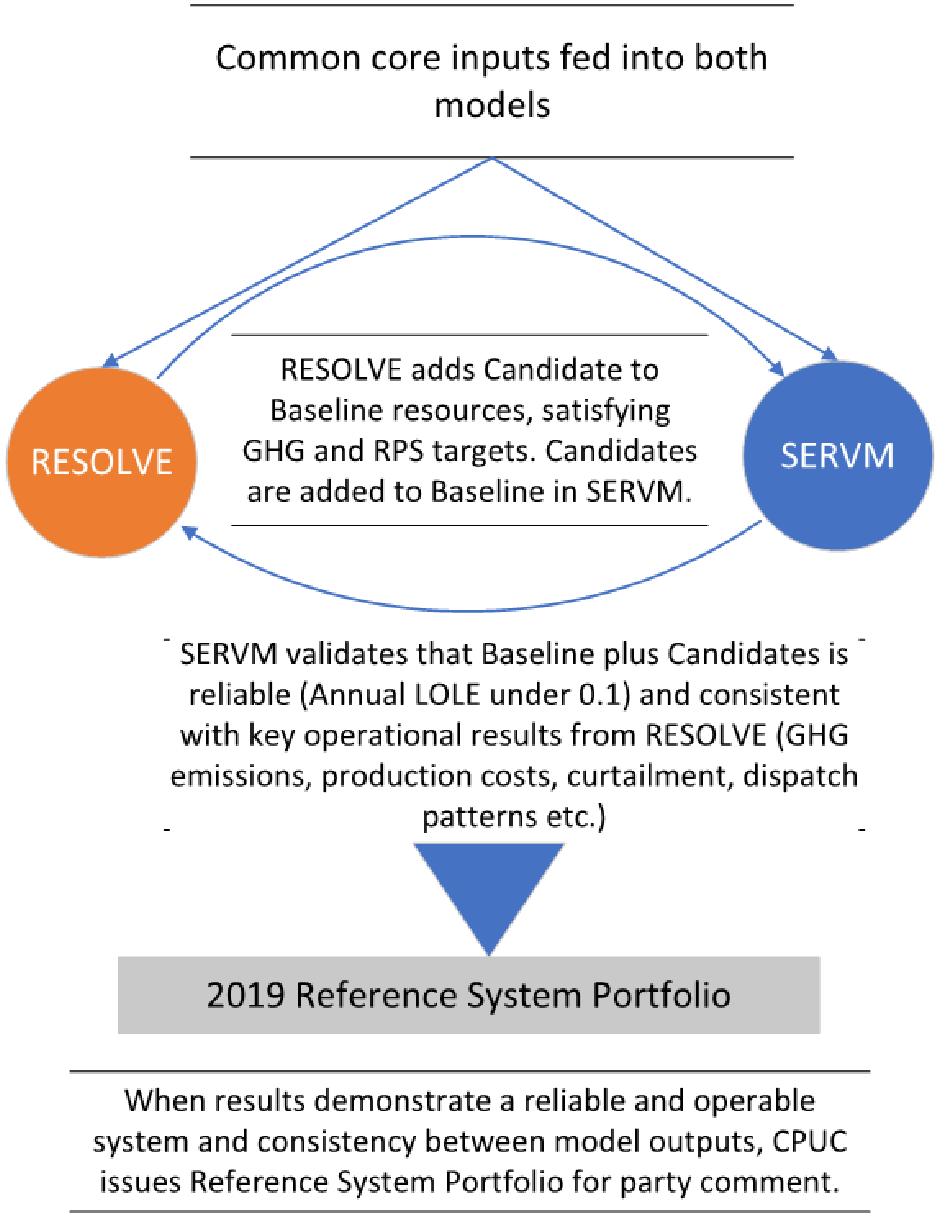
SERVM Model Review

The Strategic Energy Risk Valuation Model (SERVM)* is a probabilistic system-reliability planning and production cost model – primary objective is to reduce risk of insufficient generation to an acceptable level (e.g. security-constrained planning)

- Configured to assess a given portfolio in a target study year under a range of future weather (20 weather years), economic output (5 weighted levels), and unit performance (30+ random outage draws)
- Hourly economic unit commitment and dispatch
  - Reserve targets to reflect provision of subhourly balancing and ancillary services
  - Multiple day look-ahead informs unit commitment
  - Individual generating units and all 8,760 hours of year are simulated
  - Unit operating costs and constraints
- Pipe and bubble representation of transmission system
  - 8 CA regions, 16 rest-of-WECC regions
  - Includes region-to-region flow limits and hurdle rates as well as simultaneous flow limits

*Commercially licensed through Astrape Consulting: http://www.astrape.com/servm/

Iterative RESOLVE – SERVM Calibration Process



Opportunities for Parties to Vet Staff Modeling or Conduct Their Own Modeling

- Staff posted the following information to the CPUC website:
  - Unified RA and IRP Modeling Datasets 2019 updates since the 6/17 Modeling Advisory Group webinar
  - New RESOLVE model, User Manual, and results for cases presented at 10/8 IRP workshop
  - IRP Inputs and Assumptions documentation
  - All of the above can be reached via the 2019-20 IRP Events and Materials page
- Parties may download and vet this information and conduct their own modeling and analysis
  - Develop modeling capacity now and update when Proposed Reference System Plan is identified later this month
  - Submit any modeling work as part of formal comments expected in November

Highlighting modeling milestones in 2019 IRP Reference System Portfolio Development Schedule

Step #	Activity	Estimated Date
1	Data Development	March-June 2019
2	**Informal release: core model inputs + MAG presentation [Data posted to website]**	**June 2019**
2a	Informal party comment on Step 2 content	July 2019
3	Input validation for RESOLVE & SERVM models	July 2019
4	Develop calibrated modeling results	July-Sept 2019
5	**Informal release of complete RESOLVE model and draft results [RESOLVE model and guide, Inputs and Assumptions document, and updated SERVM datasets posted to website]**	**October 2019**
5a	**Stakeholders may perform analysis with RESOLVE, SERVM, or other model to test and validate portfolios (6 weeks)**	**October – November 2019**
6	**Formal release of Proposed 2019 IRP Reference System Plan [Modelers may update their analysis to focus on Proposed Reference System Portfolio]**	**October 2019**
7	**Formal party comment on Proposed 2019 Reference System Plan [Modelers may include analysis results]**	**November 2019**
8	Formal release of 2019 Reference System Plan Proposed Decision	January 2020
9	Formal party comment on 2019 Reference System Plan PD	January 2020
10	Commission Decision on 2019 Reference System Plan	February 2020
11	Transmittal of 2019 IRP portfolios to 2020-21 CAISO TPP	February 2020

2. OVERVIEW OF MODELING INPUTS

Key Updates to SERVM from Version Used in 2017-18 IRP Cycle

Staff performed a full data update at the beginning of the IRP cycle. Updates included:

- Updated weather-based hourly profiles to cover weather years 1998-2017: includes scheduled hydro, hourly electric demand, hourly wind and solar generation profiles as described at the 6/17 MAG
- Updated operating parameters for individual resources (and aggregated to RESOLVE categories) based on January 2019 CAISO MasterFile information and WECC 2028 Anchor Data Set Phase 2 V1.2
- Added the ability for storage to provide spinning and load following reserves (in addition to already providing regulation and frequency response)
- Updated forced and scheduled outage statistics from 2013-2017 GADS data
- Installed capacity adjustment to align CPUC-derived solar generation shapes with expected energy from IEPR BTM solar installations

Key Changes from 6/28/19 Core Inputs Data Release

During RESOLVE-SERVM calibration, staff updated some of the data posted to the CPUC website. Updates are posted to the Unified RA and IRP Modeling Datasets 2019 page:

- Transmission flow limits and hurdle rates in SERVM
- SERVM hydro profiles updated to cover 1998-2017 weather years (previous data was for 1980-2014)
- SERVM normalized hourly electric consumption profiles for 1998-2017 weather years
- Baseline generator unit list for both RESOLVE and SERVM
- SERVM normalized wind and solar shapes updated to account for more facilities matched to latitude/longitude locations and weather stations

2019 Core GHG Cases

- **46 MMT* Case (Default)**
  - Achieves the Commission-established electric sector planning target
  - Demand forecast: CEC 2018 IEPR Mid AAEE
  - Baseline resources assumed to be online as defined in Section 2.3 of this presentation
  - Considered "Default" case in 2019 IRP modeling as it most closely resembles adopted policy from the 2018 IRP Preferred System Plan (PSP)
- **38 MMT Case**
  - Represents the midpoint between 46 MMT and the low end of CARB's established range for the electric sector
  - Includes all constraints and assumptions from Default Case
- **30 MMT Case**
  - Represents the low end of CARB's established range
  - Includes all constraints and assumptions from Default Case

*In the IRP 2017-18, emissions from behind the meter CHP facilities were not included as part of the electric sector emissions. To align with CARB’s GHG accounting methodology, emissions from behind-the meter CHP, which were estimated as 4 MMT in the last cycle, are now included as electric sector emissions in the 2019/2020 Reference System Plan. Thus, the 46 MMT target in IRP 2019-20 translates to approximately a 42 MMT GHG target in IRP 2017-18.

Translating Statewide GHG Targets to CAISO Targets

- Staff expresses the core modeling cases throughout this analysis in terms of the statewide electric sector GHG targets.
- However, the CPUC's IRP modeling covers only the CAISO balancing authority area; the RESOLVE model allows specification of a GHG planning target in tons of CO2 equivalent to constrain the portfolio at the CAISO system level on an annual basis.
- For IRP modeling, statewide electric sector GHG targets are translated to CAISO targets based on CARB's proposed Cap and Trade allowance allocation methodology for 2021-2030 (~81% in 2030).

2030 Statewide Target	2030 CAISO Target
46.0 MMT	37.3 MMT
38.0 MMT	30.8 MMT
30.0 MMT	24.3 MMT

2.1. ELECTRIC DEMAND FORECAST

IEPR-derived CAISO Area Demand Forecast Inputs Summary

Planning Area	PG&E		SCE		SDG&E		CAISO [5]	
Electric Demand Component [1]	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**
Consumption, MW peak [2]	22,838	25,760	25,353	28,753	4,825	5,517	53,017	60,029
Managed non-coincident demand, MW peak	20,174	20,537	22,934	22,310	4,187	4,371	47,440	47,390
Consumption, GWh load [2]	111,274	123,640	110,047	123,337	22,123	24,691	243,444	271,668
Light-duty electric vehicles, GWh load	2,528	7,531	1,851	5,398	562	1,662	4,941	14,591
Time of use rate effects, GWh load [3]	-	23	-	13	0.03	2	0.03	38
Additional Achievable EE, GWh savings	2,939	12,949	2,881	14,108	572	3,029	6,393	30,086
Committed BTM PV installed capacity MW	5,493	10,269	3,476	7,292	1,504	2,458	10,473	20,020
Additional Achievable PV installed capacity MW	63	720	67	740	14	168	144	1,627
BTM storage installed capacity MW [4]	122	469	167	566	65	198	354	1,233

[1] All values are at the system level (includes gross up for losses)
[2] Consumption in this table is electric demand without the effects of all the other line items. Effects from IEPR projections of BTM CHP, load-modifying demand response, and other transportation electrification are left embedded in consumption.
[3] TOU effects have a tiny increase in annual energy while decreasing hourly demand during peak hours
[4] BTM storage capacity represents the amount projected in the IEPR. Additional BTM storage capacity is also modeled after considering recent data collected from LSEs and the CPUC storage procurement target (from AB 2514).
[5] CAISO includes Valley Electric Association in addition to the three major IOU TAC areas
Detailed data for production cost models are posted to the Unified RA and IRP Modeling Datasets 2019 page.

2.2. BASELINE RESOURCES

Defining “Baseline Resources”

- **<u>Baseline resources</u>** are resources that are included in a capacity expansion model run as an assumption rather than being selected by the model as part of an optimal solution.
- Within CAISO, the baseline resources are intended to capture:
  - Existing resources, net of planned retirements (e.g. once-through-cooling plants)
  - Future resources that are deemed sufficiently likely to be constructed, usually because of being LSE-owned or contracted, with CPUC and/or LSE governing board approval
    - e.g. CPUC- or LSE governing board-approved renewable power purchase agreements, CPUC storage procurement mandate (i.e., AB 2514)
  - Projected achievement of demand-side programs under current policy
    - e.g. forecast of EE achievement, BTM PV adoption under NEM tariff
- RESOLVE optimizes the selection of additional resources in the CAISO area needed to meet policy goals, such as RPS, a GHG target, or a planning reserve margin; these resources that are selected by RESOLVE are *not* baseline resources.
- SERVM and RESOLVE start with the same baseline. New candidates and economic retention are first selected by RESOLVE. The new portfolio is then added to SERVM so that both models have the same operating fleet.
- The baseline developed for 2019 IRP modeling includes data collected in the spring of 2019 and differs from the baseline used in the IRP's 2018 Preferred System Plan Decision (D.19-04-040).

Master WECC-wide Baseline Generator List

- Aligning generator data in SERVM and RESOLVE is crucial for comparison and consistency between model outputs.
- The same baseline resources are assumed in the 46, 38, and 30 MMT Core Policy Cases
- As described at the 6/17 MAG, staff developed and posted a public dataset of baseline generators.
  - Updated as of 10/4 and available at the Unified RA and IRP Modeling Datasets 2019 page
  - Derived from the January 2019 version of CAISO Masterfile, the 2028 WECC ADS Phase 2 v1.2 (Anchor Data Set), and the CPUC RPS Contracts database
  - Includes technology types, zonal locations, contract information, in-service dates, and operational parameters for both models (heat rates, ramp rates, startup fuel/cost/time, etc.)
  - Confidential data aggregated or redacted before posting

WECC Baseline Installed Capacity by Type and RESOLVE Zone in August 2030, MW

	BANC	**CAISO**	IID	LDWP	NW	SW	Other WECC [4]	**TOTAL**
Biogas [1]	0	291	0	0	0	0	0	**291**
Biomass [1]	18	611	77	0	590	108	1,147	**2,551**
Combined Cycle	1,798	16,261	255	2,755	9,573	19,741	9,489	**59,873**
Cogeneration [2]	0	2,320	0	0	53	0	3,487	**5,860**
Coal	0	0	0	0	7,364	6,141	5,628	**19,132**
Geothermal	0	1,852	792	0	142	667	820	**4,273**
Hydro [6]	1,560	6,353	48	438	21,927	2,303	13,723	**46,351**
Nuclear	0	635	0	407	1,757	2,998	0	**5,797**
Peaker [2]	818	8,598	252	1,647	2,277	5,979	6,930	**26,501**
Pumped Storage [5]	0	1,599	0	1,460	500	220	543	**4,322**
Reciprocating Engine [2]	49	255	0	0	391	323	287	**1,306**
Solar [3]	146	14,783	166	948	2,661	1,912	1,175	**21,790**
Steam [2]	0	0	75	197	272	967	3,096	**4,606**
Wind	0	7,459	0	725	12,421	1,893	7,346	**29,844**
Battery Storage [7]	0	3,265	31	0	0	0	0	**3,296**
Demand Response	0	1,749	0	0	0	0	0	**1,749**
TOTAL [8]	**4,388**	**61,018**	**1,665**	**8,577**	**59,928**	**43,250**	**53,672**	**237,542**

This table shows August 2030 capacity without ambient derates (explained on next slide). Capacity varies by month due to intra-year planned retirements and the availability of demand response resources.

[1] Biogas is grouped with biomass for non-CAISO areas to reduce model complexity.

[2] In RESOLVE, certain non-CAISO area gas generator types are grouped with Peaker types to reduce complexity.

[3] BTM solar PV is not represented in the table above and is presented in the demand-side inputs section.

[4] “Other WECC” refers to areas that are within WECC but are not represented in RESOLVE, such as Alberta, British Columbia, and Colorado. RESOLVE models hydro from the NW separately. SERVM models each area explicitly.

[5] RESOLVE does not model pumped hydro storage in non-CAISO areas to reduce model complexity.

[6] Individual hydro units are not modeled in SERVM; the model uses region-wide profiles instead.

[7] Includes BTM storage assumed from all data sources (IEPR projection, AB 2514, LSE data request responses).

[8] Not shown in this table, RESOLVE also assumes small amounts of new renewables in non-CAISO zones to model compliance with known policy targets outside CAISO.

Ambient Derating of CAISO Combined Cycles and Combustion Turbines

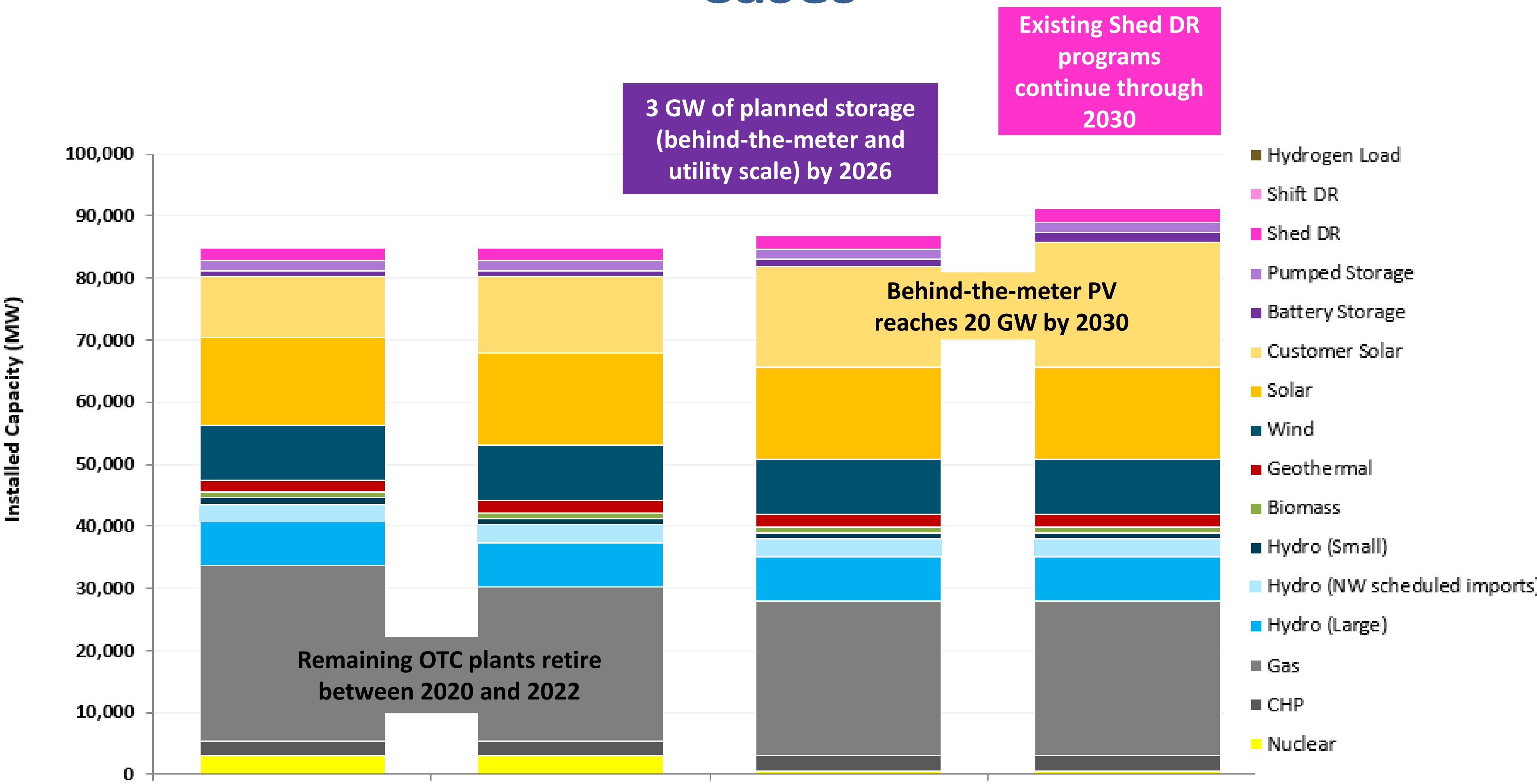
- To account for the effects of summer heat on reliability, staff reduced the capacities of CAISO combined cycles and combustion turbines to their 2020 Draft NQC values (available here: http://www.caiso.com/Documents/2020DraftFinalNetQualifyingCapacityList.xls)
- In summer months these resources may show reductions in NQC relative to other months reflecting reduced output capability during hot weather conditions.
- The derate resulted in a loss of approximately 1,080 MW from the CAISO for August, as shown in the table below.

MW reduction due to ambient derate for August NQC values

	MW
CAISO Combined Cycle	507
CAISO Combustion Turbine	574
Total	1,081

- Note that this loss is incremental to the capacity in the previous slides, which showed nameplate

CAISO Area Baseline Resources Included in All Cases



Diablo Canyon PP retired in 2024/25

Palo Verde PP remains in 2026 and 2030

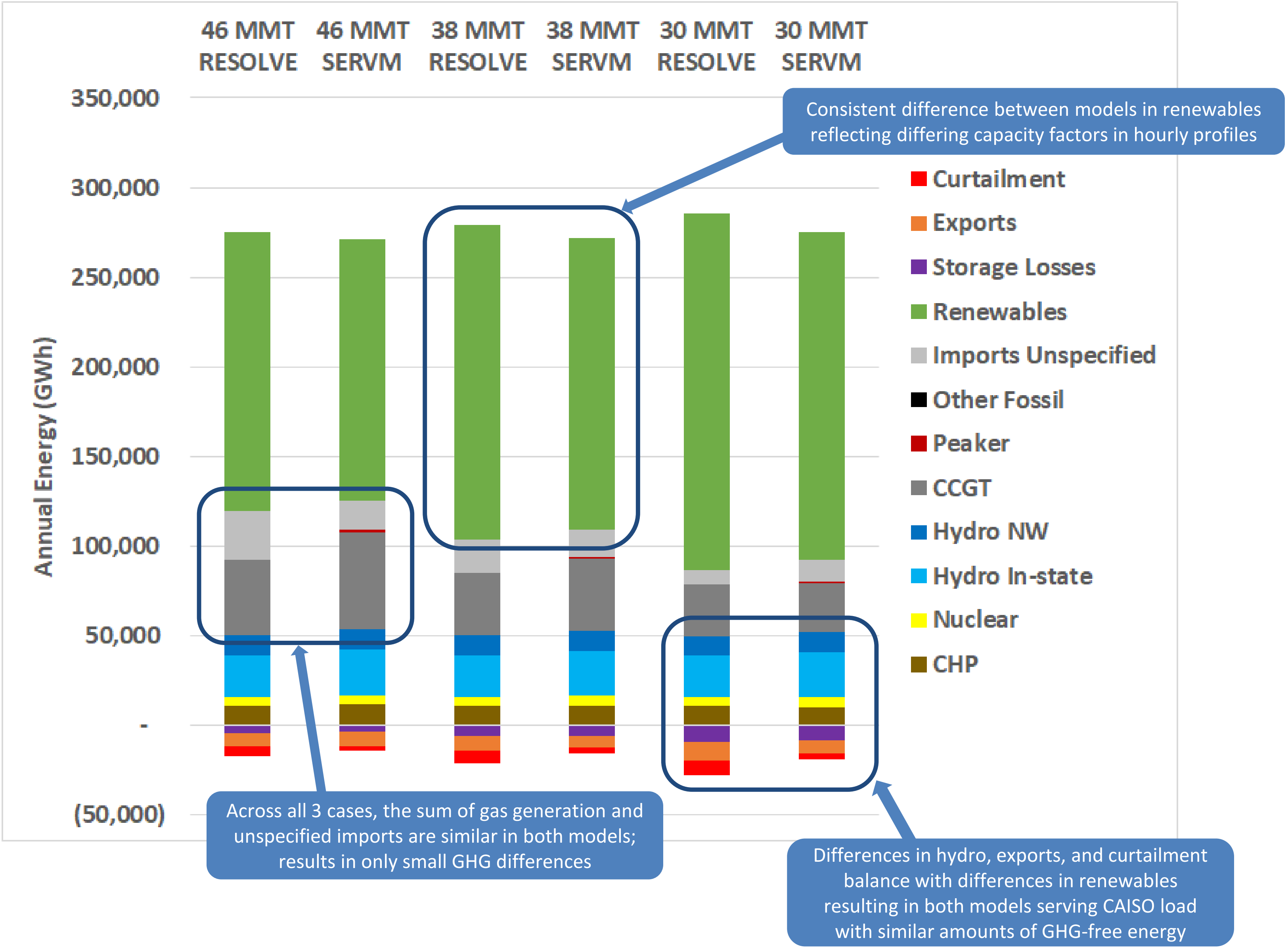
*Existing load modifying EE, DR & TOU rates also included in baseline, but not shown in this chart

RESOLVE – SERVM CALIBRATION RESULTS

Model Calibration Process

- Baseline resources in both models sourced from common datasets and aligned to maximum extent possible
- Staff set RESOLVE to the desired GHG target and generated a portfolio of candidate resources
- Staff added the new resource portfolio to SERVM, ran the model, and extracted key metrics (GHG emissions, production costs, LOLE, energy production by resource categories, etc.)
- If metrics between models differed, staff made changes to one or both models (increased/decreased capacity factor of wind, increased or decreased start times of CCGT, etc.) and reran to check calibration. If staff made changes to RESOLVE then a new portfolio of candidates is created, added to SERVM, and then rerun in SERVM.
- Staff eventually calibrated within reasonable bounds of GHG emissions and resource dispatch, and confirmed that the modeled baseline and new resource portfolio was reliable and operable
- Generation from different classes of generation were compared, and even though there were some differences in dispatch, the outcome of GHG emissions was close
- Staff then used the calibrated RESOLVE to explore additional sensitivities and scenarios as explained in the presentation of IRP Modeling Preliminary Results

CAISO 2030 Energy Balance for 3 Core Policy Cases



Energy Balance Table for 3 Core Policy Cases

2030 CAISO Energy Balance (GWh)	46 MMT		38 MMT		30 MMT	
Category	**RESOLVE**	**SERVM**	**RESOLVE**	**SERVM**	**RESOLVE**	**SERVM**
CHP	10,881	11,769	10,881	11,148	10,881	10,395
Nuclear	5,108	5,136	5,108	5,136	5,108	5,136
Hydro In-state	22,995	25,391	22,995	25,391	22,995	25,391
Hydro From NW	11,222	11,000	11,160	11,000	10,908	11,000
CCGT	42,117	54,467	35,219	40,082	28,540	27,784
Peaker	76	1,306	-	883	-	604
Reciprocating Engine	37	173	18	111	11	63
Coal	-	-	-	-	-	-
Steam	-	-	-	-	-	-
BTM PV	38,046	37,949	38,046	37,949	38,046	37,949
Solar (pre-curtailment)	72,281	70,294	88,010	85,412	107,921	104,595
Wind (pre-curtailment)	25,002	19,092	29,755	21,000	31,347	21,533
Geothermal	13,042	13,254	13,042	13,403	14,808	13,716
Biomass	6,764	4,964	6,764	5,089	6,764	5,098
Pumped Storage Roundtrip Losses	(986)	(798)	(950)	(770)	(1,035)	(893)
Battery Storage Roundtrip Losses	(3,193)	(2,902)	(5,368)	(4,899)	(8,152)	(7,471)
Curtailment	(5,305)	(2,698)	(6,680)	(2,754)	(7,745)	(3,306)
Imports (Unspecified)	27,397	16,095	17,916	15,340	8,177	12,188
Exports	(7,637)	(7,992)	(7,994)	(7,017)	(10,519)	(7,263)
Load	257,010	256,497	257,010	256,502	257,010	256,515

Curtailment levels less different in absolute amounts than last year's modeling exercise – significant improvement. SERVM levels somewhat lower due to lower wind and solar generation.

Storage utilization is similar between models – improvement from last year's modeling.

GHG Emissions Table for 3 Core Policy Cases

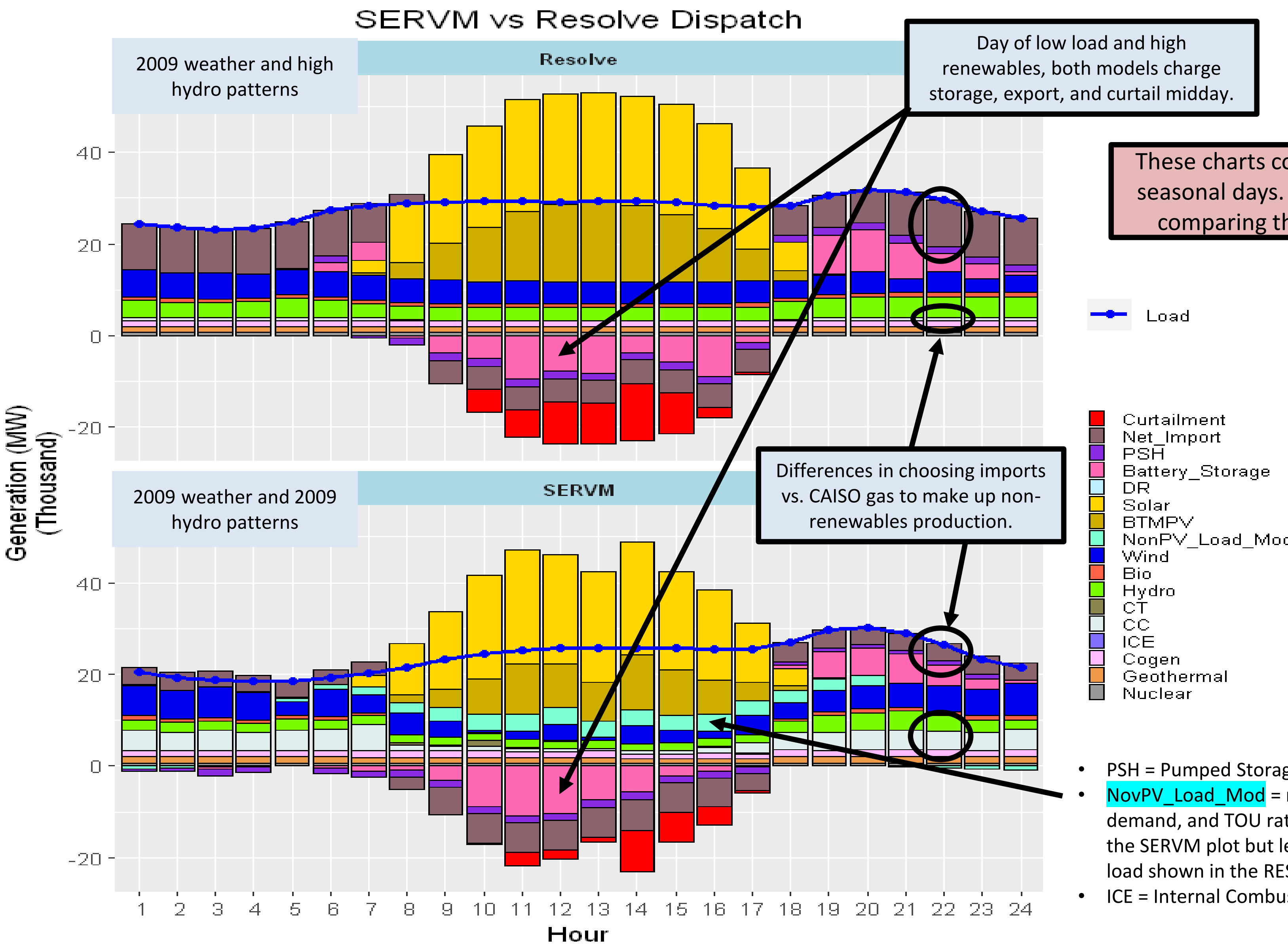
2030 CAISO Emissions (MMtCO2/Yr)	46 MMT Case		38 MMT Case		30 MMT Case	
	RESOLVE	SERVM	RESOLVE	SERVM	RESOLVE	SERVM
CAISO Generator Emissions	20.7	27.0	18.0	20.7	15.3	15.4
Unspecified Import Emissions	11.7	6.9	7.7	6.6	3.5	5.2
CAISO Emissions w/o BTM CHP	32.4	33.9	25.6	27.3	18.8	20.6
CAISO BTM CHP Emissions	5.5	5.5	5.5	5.5	5.5	5.5
CAISO Emissions w/ BTM CHP	**37.9**	**39.4**	**31.1**	**32.8**	**24.3**	**26.1**
Emissions Delta		1.50		1.66		1.85
2030 CAISO Generation and Imports (GWh)						
Zero-GHG	177,337	172,689	193,886	188,940	210,447	205,483
GHG-emitting	80,508	83,809	64,034	67,563	47,608	51,033

- Zero-GHG generation: Nuclear, Hydro from in-state and NW imports, Renewables net of storage losses, exports, curtailment
- GHG-emitting generation: CHP, CAISO gas, Unspecified Imports

The sum of CAISO gas and unspecified imports in both models is similar. The relative amounts of CAISO gas and unspecified imports vary between models and across cases, but the differences generally net each other out for each case resulting in similar emissions between models.

The net amounts of zero-GHG energy serving CAISO loads are similar.

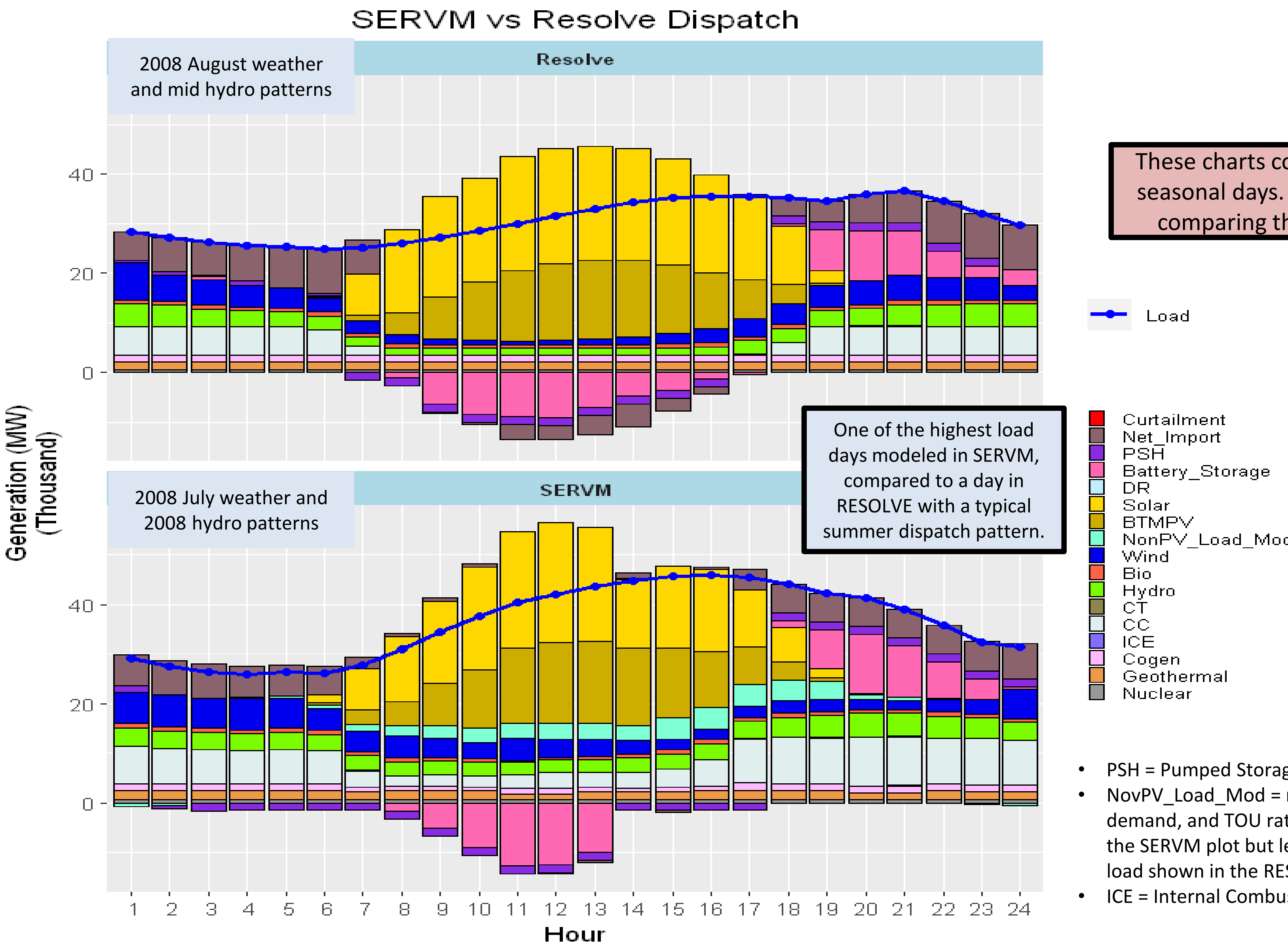
Comparison of Dispatch Patterns – 2030 March day, 46 MMT Case



These charts compare similar seasonal days. They are NOT comparing the same day.

- PSH = Pumped Storage Hydro
- NovPV_Load_Mod = net effect of AAEE, EV demand, and TOU rates, shown explicitly in the SERVM plot but left embedded in the load shown in the RESOLVE plot
- ICE = Internal Combustion Engine

Comparison of Dispatch Patterns – 2030 summer day, 46 MMT Case



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Reliability Assessment of Core Policy Cases

- Staff performed Loss-of-Load Expectation (LOLE) reliability assessments of the core policy cases
  - Annual LOLE study over 20 weather years (1998-2017) and at five levels of economic/demographic forecast error. The CAISO area is reliable in 2030 with a probability-weighted LOLE of less than 0.1 in the Core Policy Cases.
  - Staff also demonstrated that with the projected penetration of storage and renewables in 2030, the system was "energy sufficient" - meaning that consecutive days of low renewable production did not lead to more loss-of-load.
  - When the Proposed Reference System Portfolio is identified, staff will conduct LOLE reliability assessments on that portfolio for study years 2022, 2026, and 2030 to cover the IRP planning horizon.
  - These LOLE studies are not statements of how much firm capacity is needed to maintain reliability. In other words, staff did not estimate firm capacity requirements by removing capacity until the LOLE metric just meets 0.1.

Hours of Expected Unserved Energy (EUE) Occur in the Evening

EUE (MWh), 46 MMT case												
Hour Ending	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.13	7.47	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.12	11.88	21.30	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	27.73	3.82	0.00	0.00	0.00	0.00

EUE (MWh), 38 MMT case												
Hour Ending	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.66	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
20	0.00	1.25	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.00
21	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

- Hours of EUE indicate <u>when</u> loss-of-load events occur and quantify the <u>magnitude</u> of those events.
- Total EUE for all 3 core policy cases was very small, consistent with the finding that LOLE was well under 0.1 for each case.
- No appreciable EUE was observed in the 30 MMT case so no table is shown for it.
- Likely LOLE and EUE hours are consistently in the <u>evening hours of 6-9pm</u>

Remaining Issues

Some differences in dispatch between models remain and were not reconciled – the net effect of differences did not lead to a significant emissions difference between models

- Differences in resource-specific annual amounts of zero-GHG-emitting energy
  - Wind capacity factor materially lower in SERVM (19 TWh in SERVM vs. 25 TWh in RESOLVE for the 46 MMT case in 2030) – related to SERVM's wider range of wind weather years
  - In-state hydro energy was slightly higher in SERVM as well (25 TWh in SERVM vs. 23 TWh in RESOLVE for the 46 MMT case in 2030) – related to SERVM's wider range of historical hydro years
  - Differences tend to cancel each other out and do not cause emissions to differ significantly
- Differences in how RESOLVE and SERVM dispatch thermal resources
  - SERVM dispatches units individually with unit-specific heat rates and constraints, RESOLVE dispatches units in relatively uniform unit sizes with weighted-average heat rates and constraints
  - The combination of effects contributes to differences in thermal dispatch and use of unspecified imports
- SERVM produces significant intrahour import and export energy, presumably buying and selling reserves and economic energy transactions.
  - Upon comparison with current EIM market operation (using CAISO OASIS data) staff concluded that it was safe to assume that the volume of transactions in SERVM were not meant to serve CAISO load, and staff has netted unspecified imports and exports each hour (not over the day, week, or year) and reported the hourly netted unspecified imports in the energy balance.
- SERVM did not create a special "CAISO NW hydro zone" like in RESOLVE to estimate the amount of NW imports that is zero-GHG hydro
  - Staff assumed that 11 TWh of imports were attributable to NW Hydro and adjusted total unspecified imports downwards to allocate 11 TWh to NW hydro in accounting. The 11 TWh was selected to reflect what RESOLVE was estimating as the amount of NW hydro. This is similar to the NW Hydro adjustment used in last cycle's modeling.

RESOLVE – SERVM Calibration Takeaways

- SERVM validated that the 3 Core Policy portfolios produced by RESOLVE are reliable, operable, and meet the GHG emissions objective
  - CAISO area GHG emissions in 2030 differ between models by less than 2 MMT
  - Considering the new resources added and economic retirements assumed by 2030, reliable CAISO system operation is maintained (a loss-of-load event is expected to occur less than once in 10 years)
- RESOLVE sensitivities outside the Core Policy Cases are likely to also be consistent with the SERVM and RESOLVE calibrated modeling results
- This calibration process can be repeated for future IRP cycles. Staff achieved sufficient calibration between the models in this IRP cycle.
- RESOLVE and SERVM are both useful and accurate models
  - Both models are robust in doing what they are designed to do and both models are necessary to have confidence in IRP modeling results