



Energy+Environmental Economics

CPUC Avoided Cost DRAFT Results

CEWG Workshop
May 31, 2016

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+ Overview of Model Changes

- Data Updates
- Methodology Enhancements

+ Results

+ Appendix



OVERVIEW OF MODEL CHANGES



Simple Data Updates

+ All scenario assumptions consistent with LTPP “Default – AAEE Sensitivity Scenario”

- Assumes 1x AAEE to account for effects such as electrification

+ Generation capacity costs

- From CEC Cost of Generation Report March 2015

+ Ancillary service costs

- 0.7% of energy value

+ T&D marginal capacity costs

- See appendix

+ Carbon price forecast

- Mid-IEPR price forecast

+ Avoided marginal RPS costs

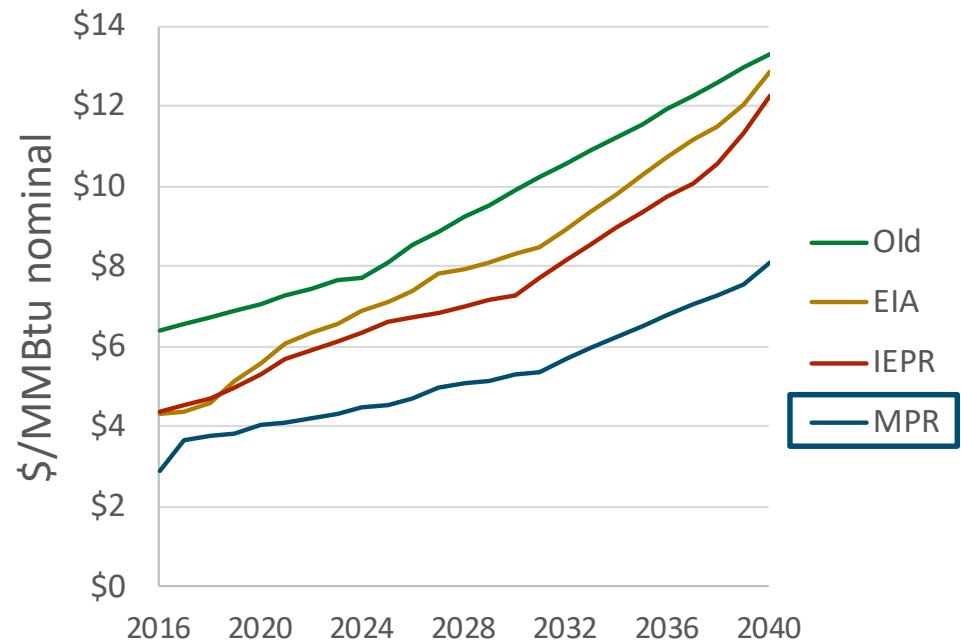
- From RPS Calculator version 6.2



Natural Gas Price Forecast

+ Natural gas price forecast calculated using MPR methodology

- NYMEX prices used through 2021 for PG&E CityGate and SoCalBorder
- After 2021, prices are escalated proportionally to the EIA AEO Henry Hub forecast
- Transportation rates, franchise fee surcharges, and hedging transaction costs added to NYMEX commodity prices
- Model uses average of SoCal, PG&E BB, and PG&E LT





Methodology Enhancements

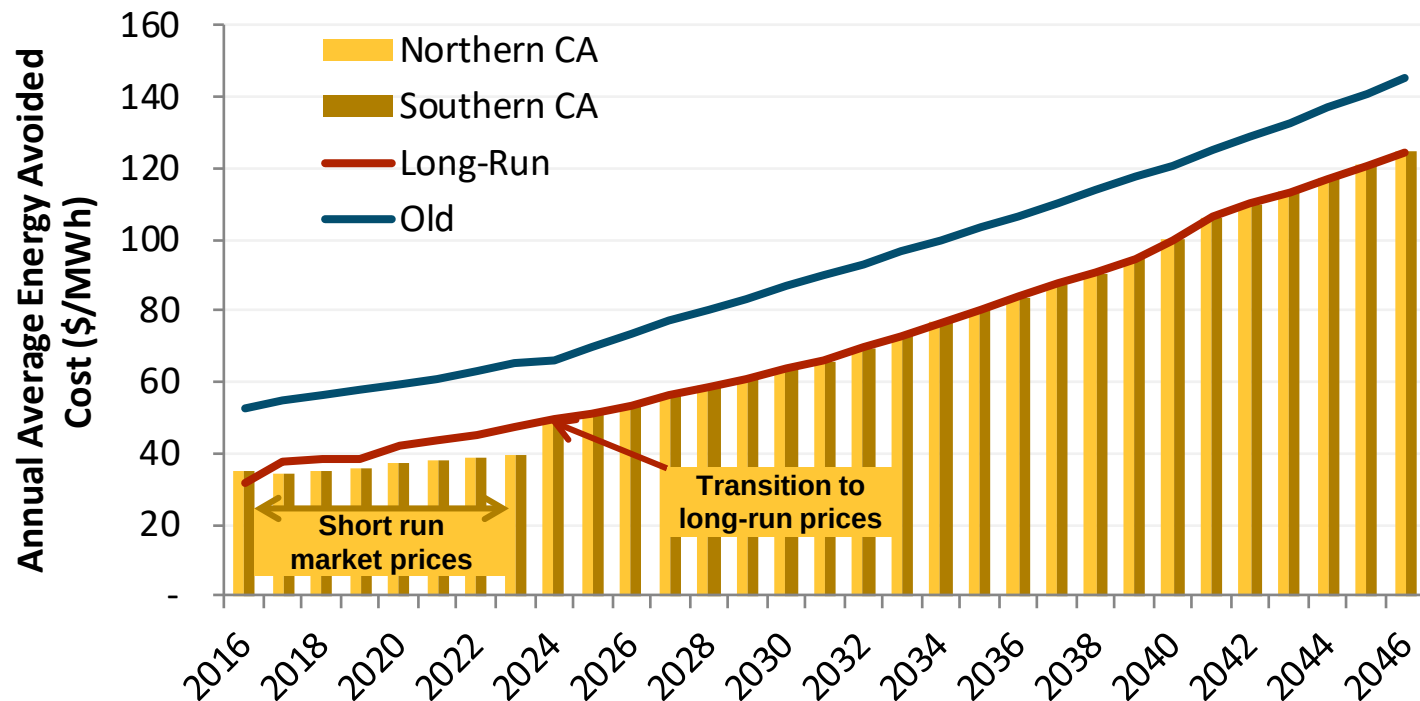
- + Resource balance year for capacity set to today (2016)**
- + Carbon price and variable O&M now included in dispatch logic for calculating net cost of new entry (net-CONE)**
- + Hourly capacity allocation value are based on expected unserved energy (EUE) outputs from E3 RECAP model**
- + T&D allocation factors now based on actual utility loads instead of temperature**



Annual Energy Price Forecast

+ Currently, forecasted average annual energy prices are based on a combination of

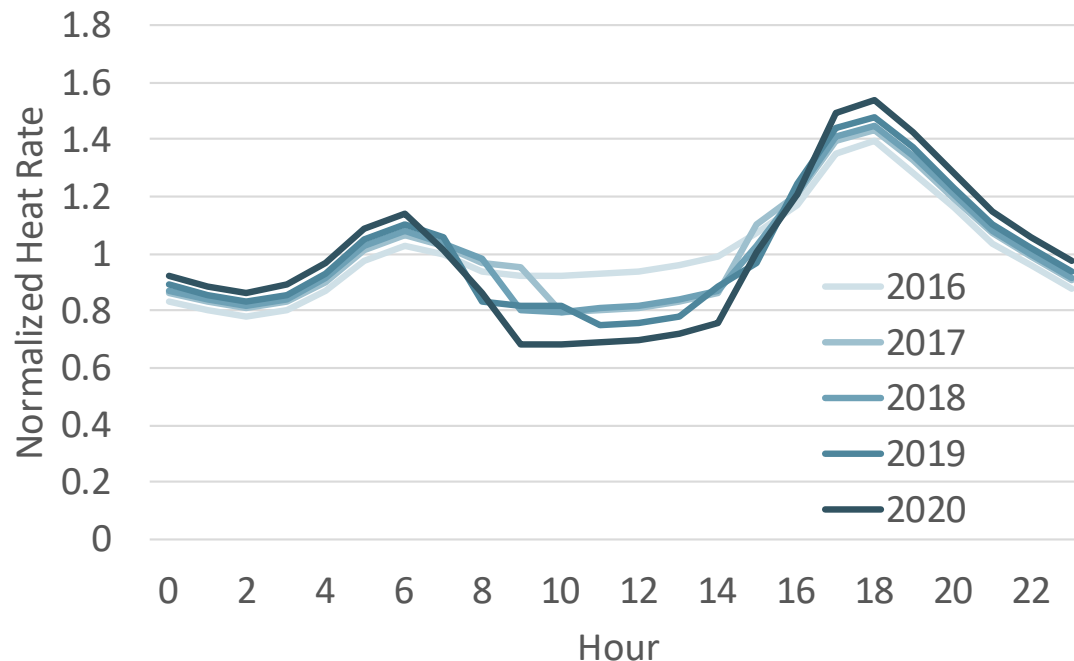
- Market price forwards
- Transition to annual average price that can support a fully capitalized CCGT





Hourly Market Price Profiles

- + The model uses 2015 CAISO hourly prices as the basis for all future hourly prices profiles
- + For years 2016 through 2020, the model uses the RPS Calculator to adjust the 2015 hourly heat rate profile
- + Hourly price profile is held constant beyond 2020 due to large uncertainty about renewable integration scenarios





Energy+Environmental Economics

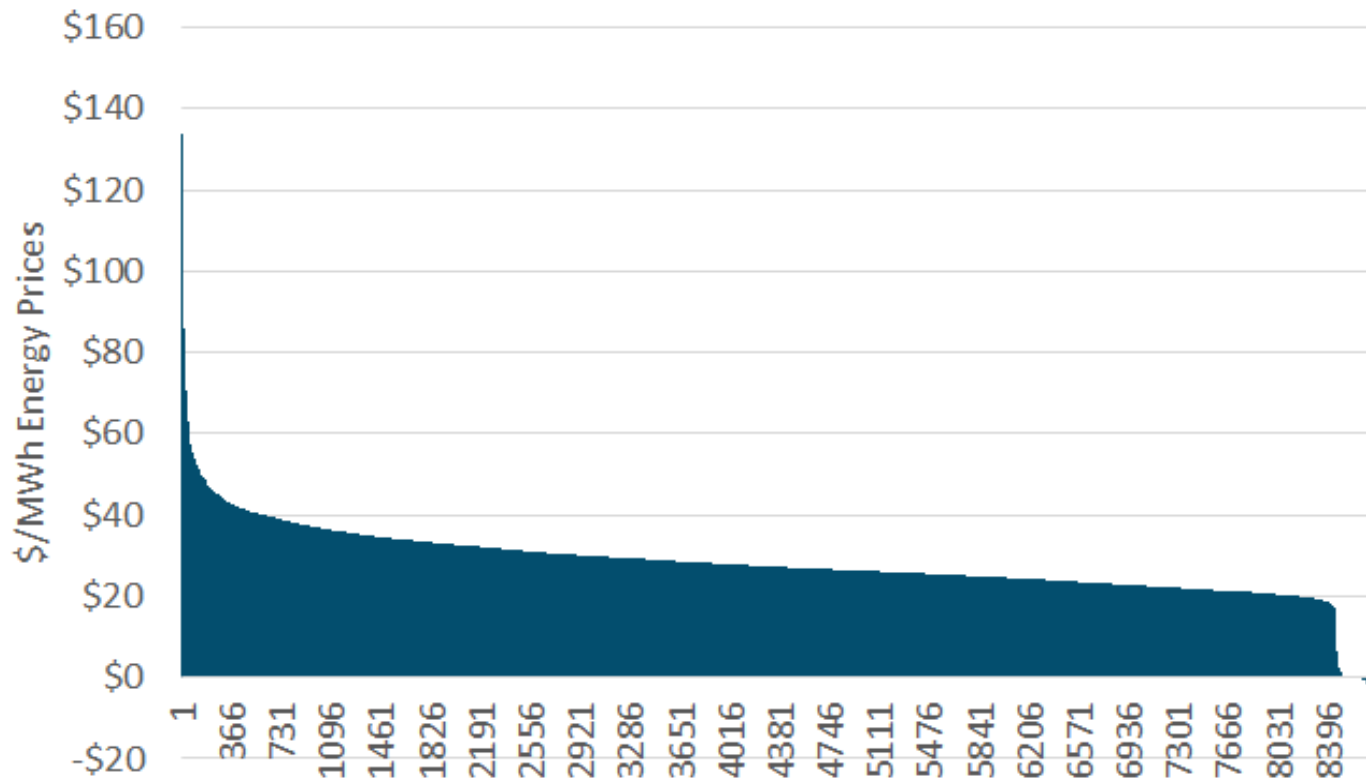
RESULTS



Energy Prices

+ 2017 Energy Price Duration Curve

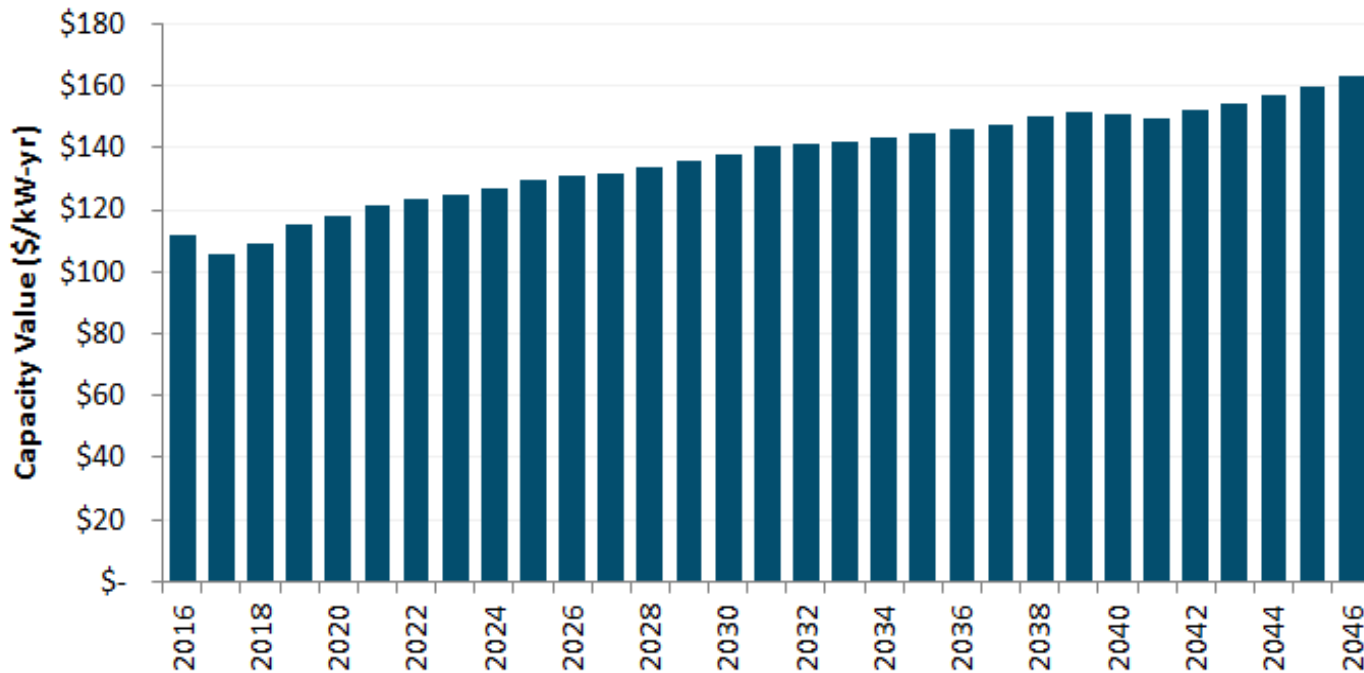
- Does not include carbon





Capacity Prices

+ Temperature adjusted capacity value forecast





Capacity Allocation Factors

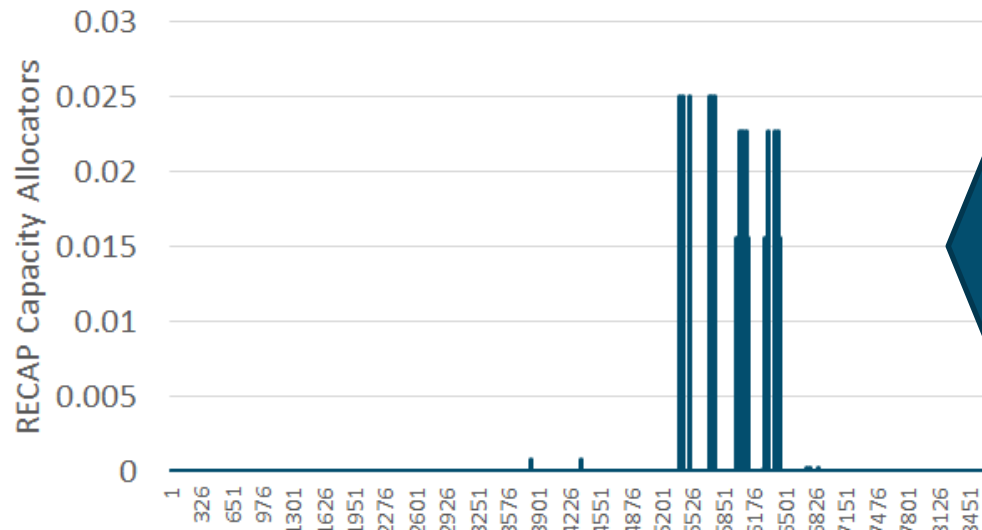
Weekday

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10	0	0	0	0	0	0	5.66E-11	5.95E-15	1.07E-12	0	0	0
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12	0	0	0	0	0	2.32E-15	1.27E-06	4.12E-10	1.29E-07	0	0	0
13	0	0	0	0	0	3.3E-13	1.26E-05	1.97E-06	4.89E-06	0	0	0
14	0	0	0	0	0	1.73E-10	8.21E-05	0.000149	0.000178	3.83E-17	0	0
15	0	0	0	0	2.36E-14	1.44E-08	0.001125	0.007563	0.005466	3.11E-11	0	0
16	0	0	0	0	9.1E-13	9.16E-07	0.004592	0.021677	0.017763	9.16E-09	0	0
17	0	0	0	0	8.18E-10	1.66E-06	0.006291	0.022581	0.018713	0.000149	0	0
18	3.7E-14	0	0	0	5.87E-10	2.76E-05	0.009768	0.036938	0.150035	9.59E-05	3.59E-13	3.31E-08
19	0	0	0	0	1.52E-07	0.000647	0.038944	0.118919	0.131879	0.000265	0	1.1E-10
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24	0	0	0	0	0	0	0	0	0	0	0	0

Weekend

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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14	0	0	0	0	0	6.39E-18	3.06E-07	7.3E-12	3.4E-06	0	0	0
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16	0	0	0	0	0	1.71E-12	1.76E-05	1.89E-06	0.000501	0	0	0
17	0	0	0	0	2.12E-18	9.79E-12	6.53E-05	4.32E-06	0.00085	3.67E-10	0	0
18	5.31E-14	0	0	0	0	5.24E-10	0.000102	1.44E-05	0.074815	2.98E-10	1.11E-14	3.14E-14
19	0	0	0	0	2.99E-13	1.01E-07	0.013717	3.9E-05	0.104481	1.57E-09	0	0
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23	0	0	0	0	0	0	0	0	0	0	0	0
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Month/hour/day-
type capacity
allocation factors
from RECAP
(expected
unserved energy)

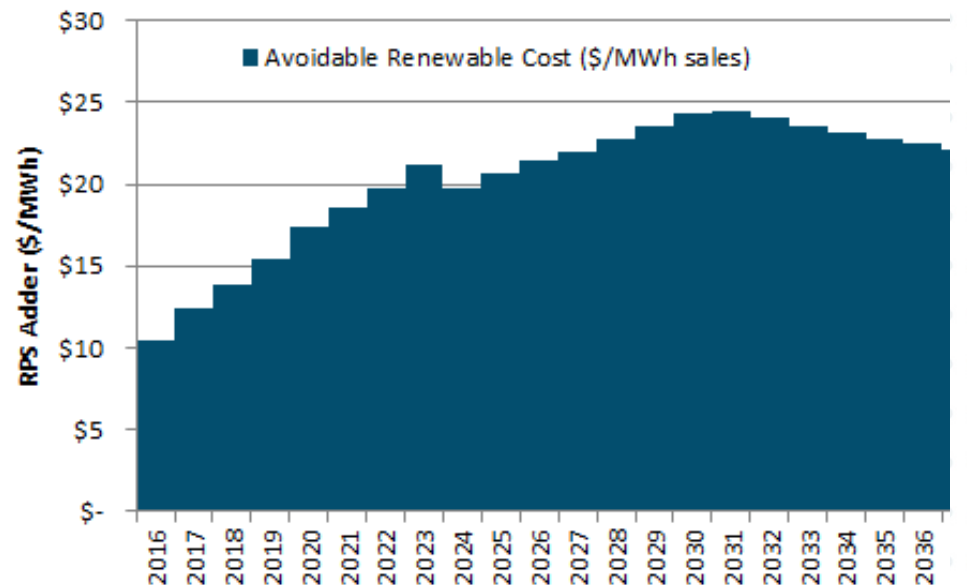
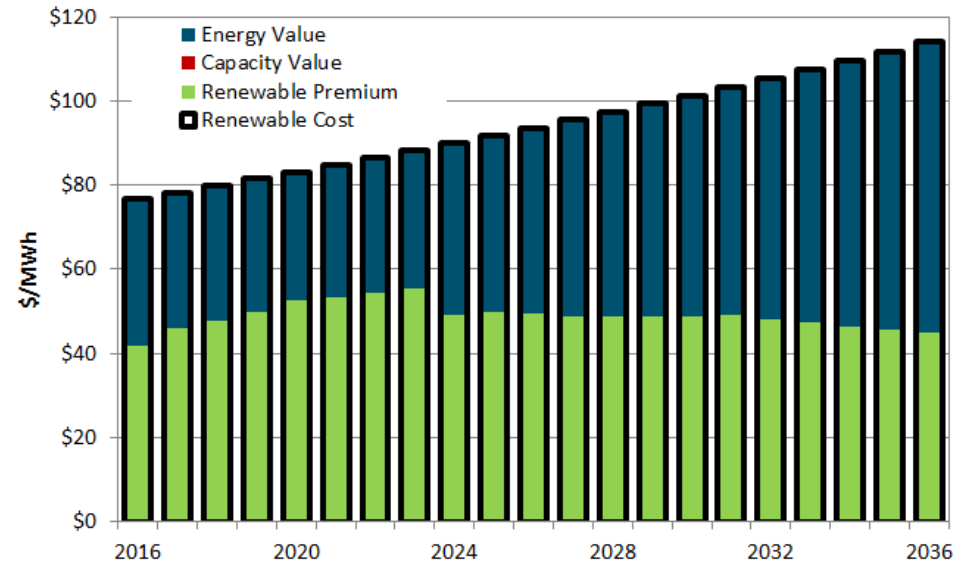


RECAP
month/hour/day-
type factors
allocated to
8760 using
2015
temperatures



Renewable Premium

+ Renewable Premium = (Renewable Cost – Energy Value) * RPS %





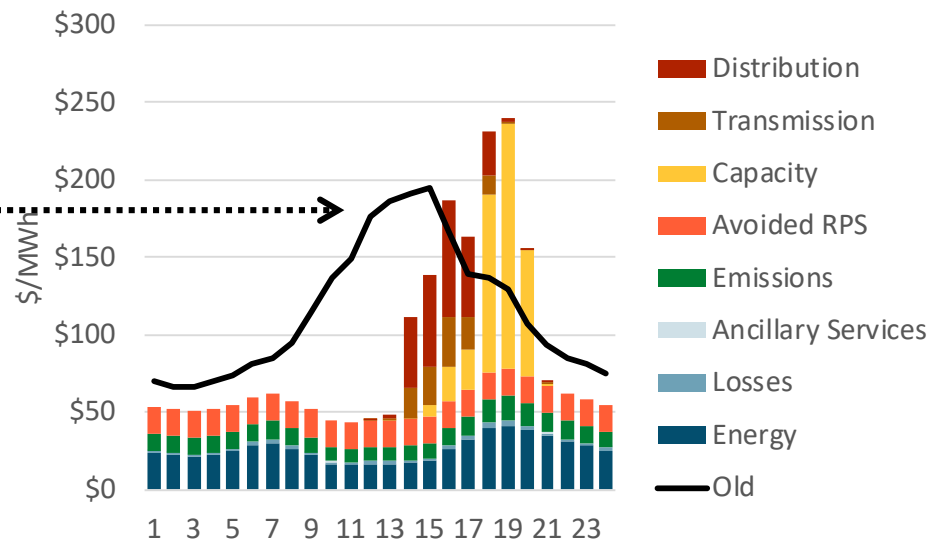
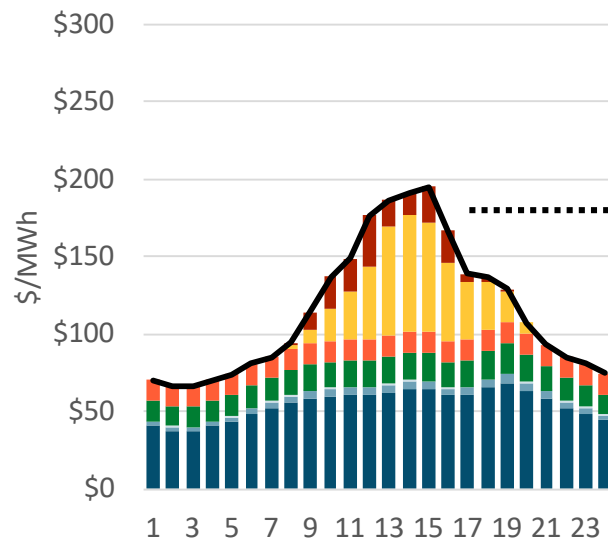
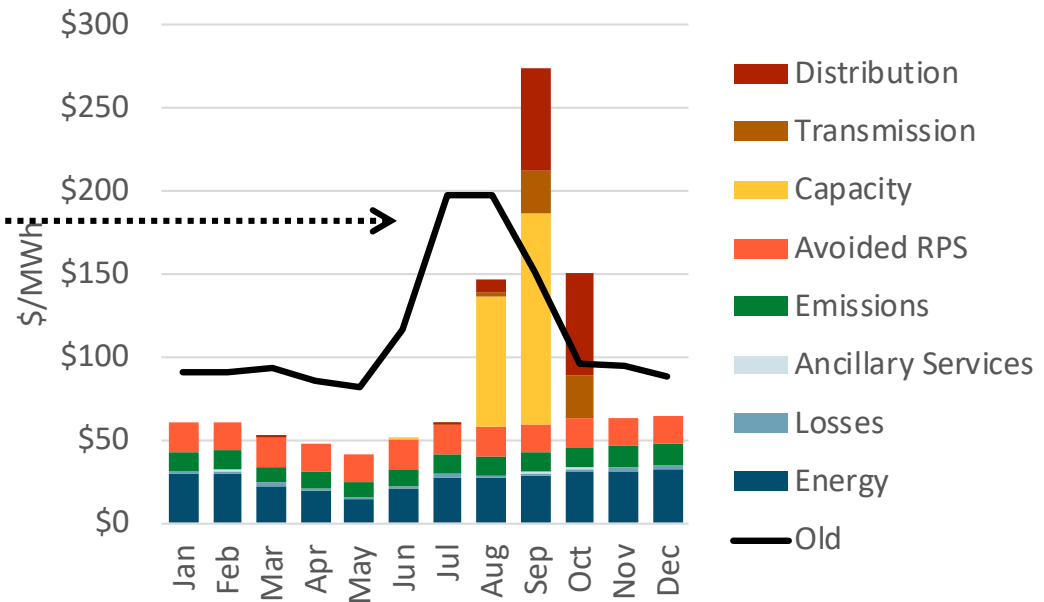
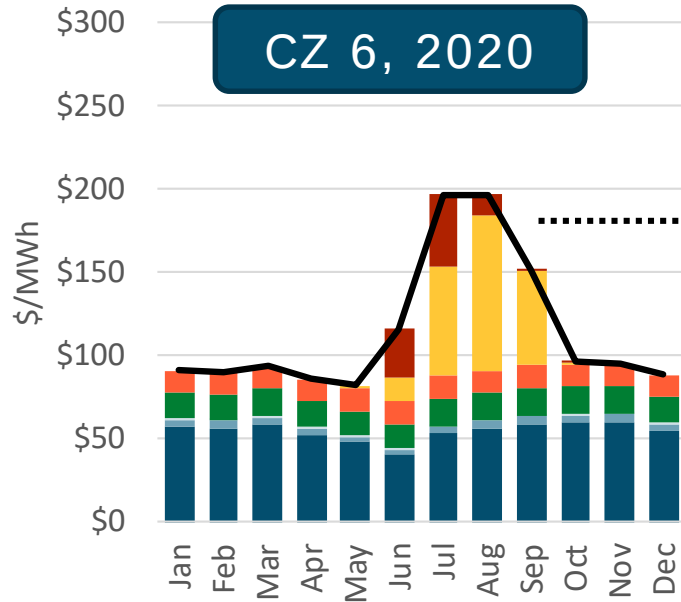
Changes from 2011 Avoided Cost Calculator

+ Overall, avoided cost values shift

- Down in magnitude 
- Later in the day (afternoon to evening) 
- Later in the year (summer to summer/fall) 

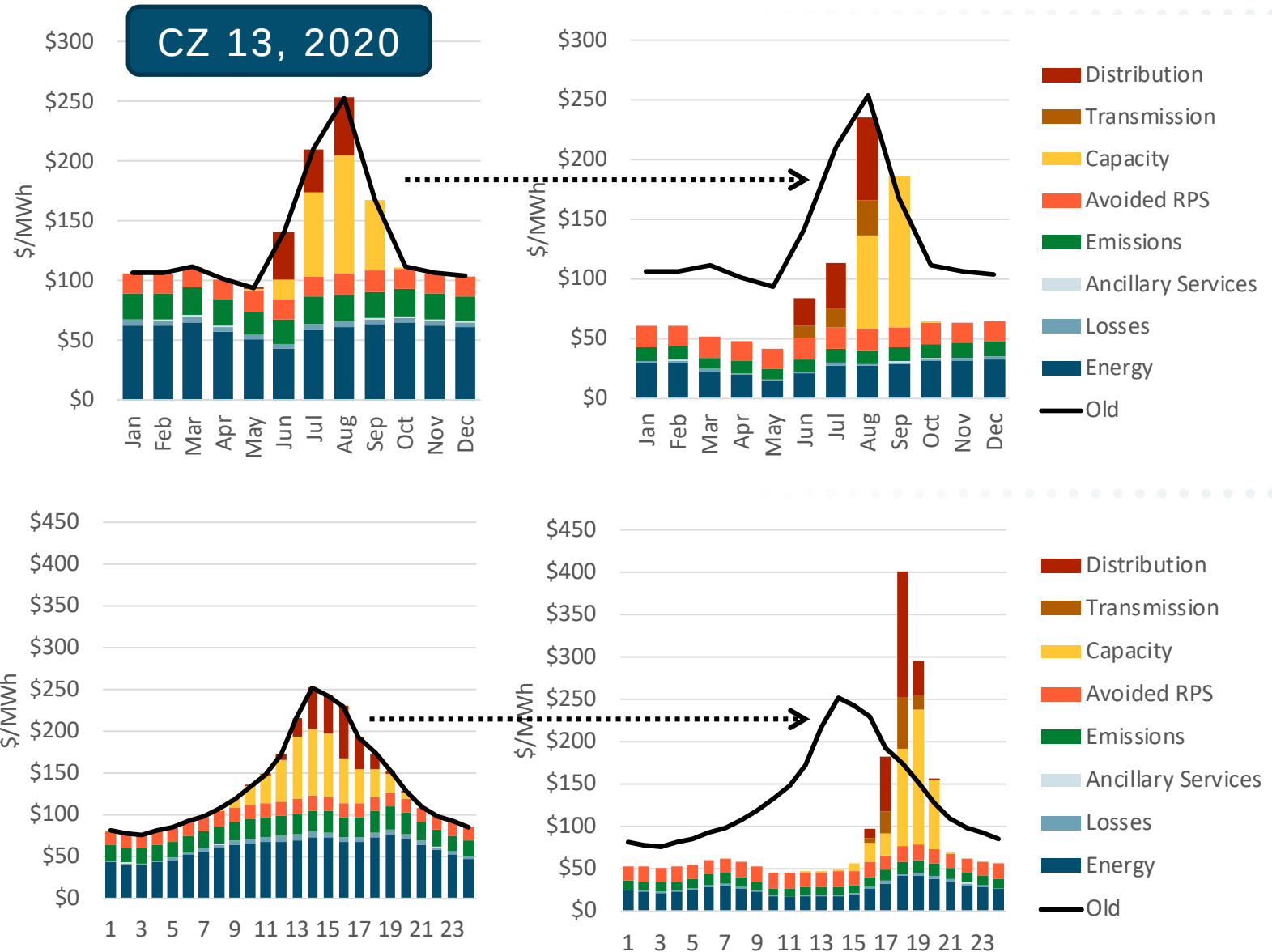


CZ 6: Changes from 2011 Avoided Cost Calculator





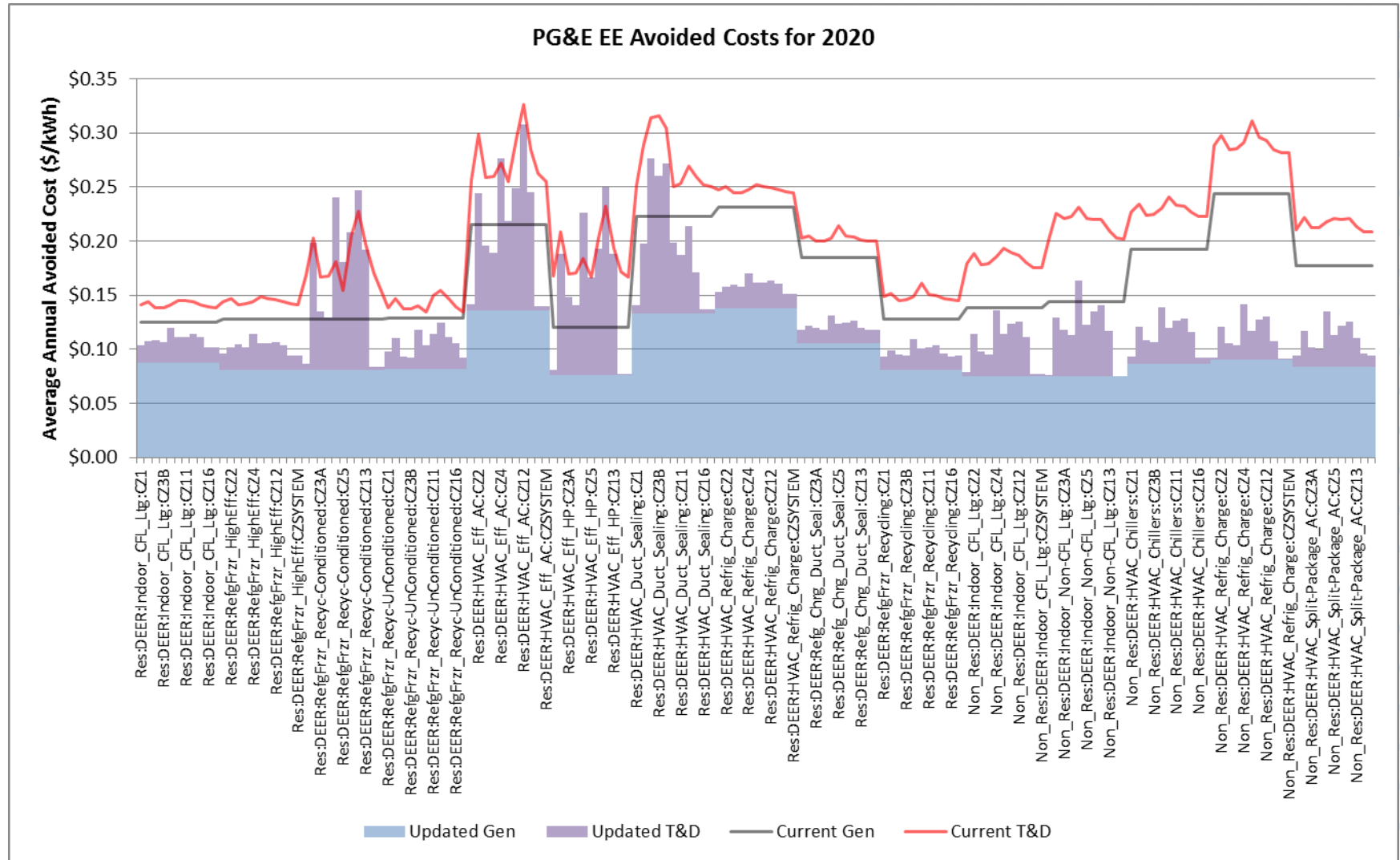
CZ 13: Changes from 2011 Avoided Cost Calculator





Energy Efficiency Avoided Costs

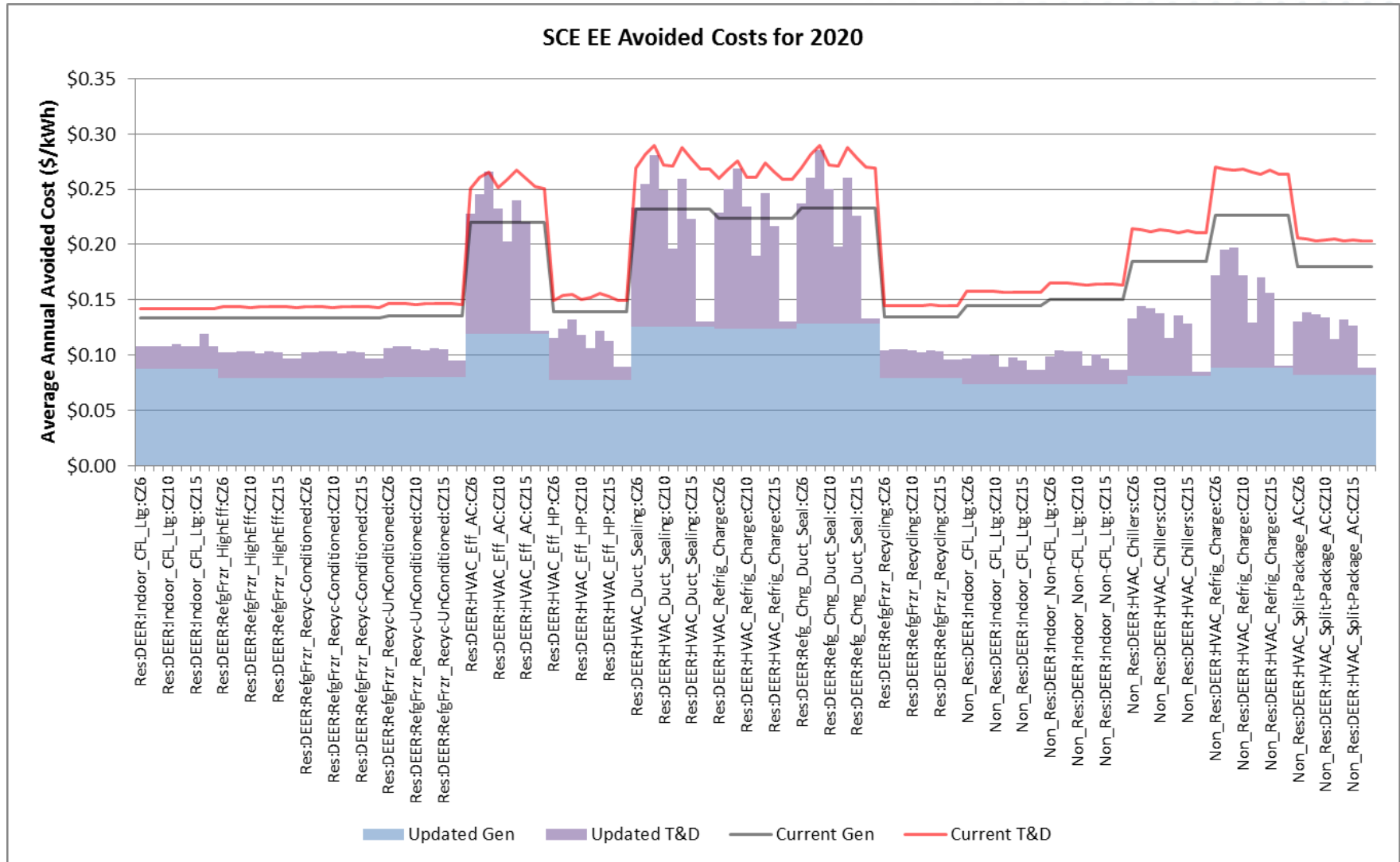
PG&E 2020





Energy Efficiency Avoided Costs

SCE 2020







APPENDIX



Combustion Turbine Costs

Advanced Combustion Turbine		
	Old Assumptions	Updated Assumptions
Operating Data		
Heat rate (Btu/kWh)	9300	9880
Lifetime (yrs)	20	20
Scheduled Outage Factor	3%	3.18%
Forced Outage Rate	4%	4.13%
Plant Costs		
Installed Cost (\$/kW)	\$1,230	\$1,069
Fixed O&M (\$/kW-yr)	\$17	\$23.87
Variable O&M (\$/MWh)	\$4	\$0
Plant Cost Escalation Rate	2%	2%
Cost Basis Year for Plant Costs	2009	2013
Financing		
Debt-to-Equity	60%	67%
Debt Cost	8%	4.52%
Equity Cost	12%	13.25%

Note: Administrative costs such as labor¹ and overhead² are included in the CT cost estimates.

Source: ESTIMATED COST OF NEW RENEWABLE AND FOSSIL GENERATION IN CALIFORNIA, March 2015 (<http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SF.pdf>)



T&D Capacity Costs

	2020 \$/kW-yr (adjusted for losses to the meter)	
IOU	Old T&D Capacity Cost	Updated T&D Capacity Cost
PG&E*	\$92.17	\$137.99
SCE	\$66.23	\$147.57
SDG&E	\$92.08	\$112.91

- + In addition, the model will have the optionality of letting the user override the T&D capacity costs and the corresponding allocation shapes**
- + Reporting of sub-transmission and distribution avoided costs can be separated**
 - Would need corresponding allocation factors
 - Bulk system transmission costs assumed to be embedded in the market energy price forecasts

*For PG&E, system average is shown. Actual update will use values that vary by zone



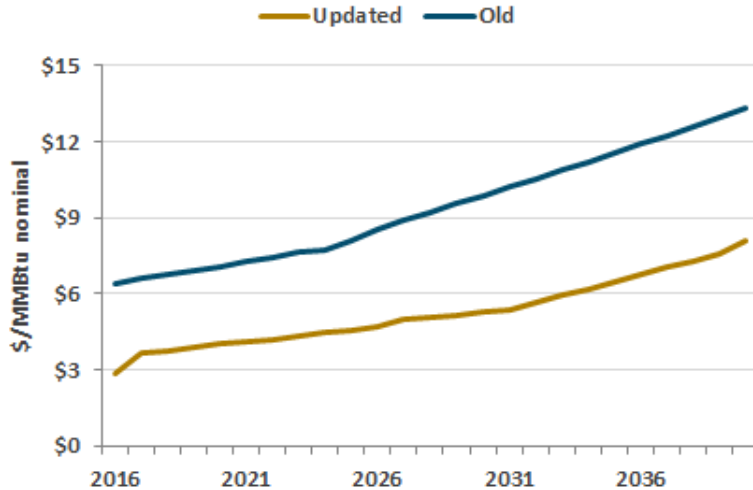
RPS Calculator Energy Price Profile Adjustment

- + Start with 2015 hourly day-ahead and real-time CAISO market prices**
- + Calculate market prices using RPS Calculator for 2015 - 2020**
 - RPS Calculator produces 12 month x 24 hour price profiles
 - Each year calculated using different RPS % but same gas price
- + Adjustment process**
 - Take the % difference between the 2015 RPS Calculator profile and the 2016-2020 RPS calculator profiles for each 12x24 value
 - Add the 12x24 % difference from step 1 to the corresponding hour in the normalized day ahead shape
 - Re-normalize the adjusted shapes to average 1.0

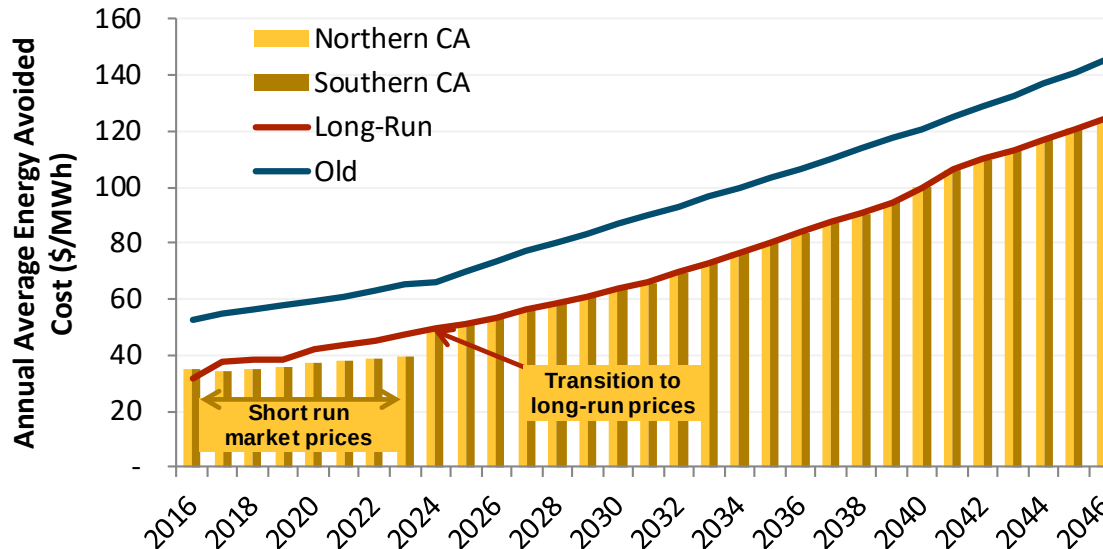
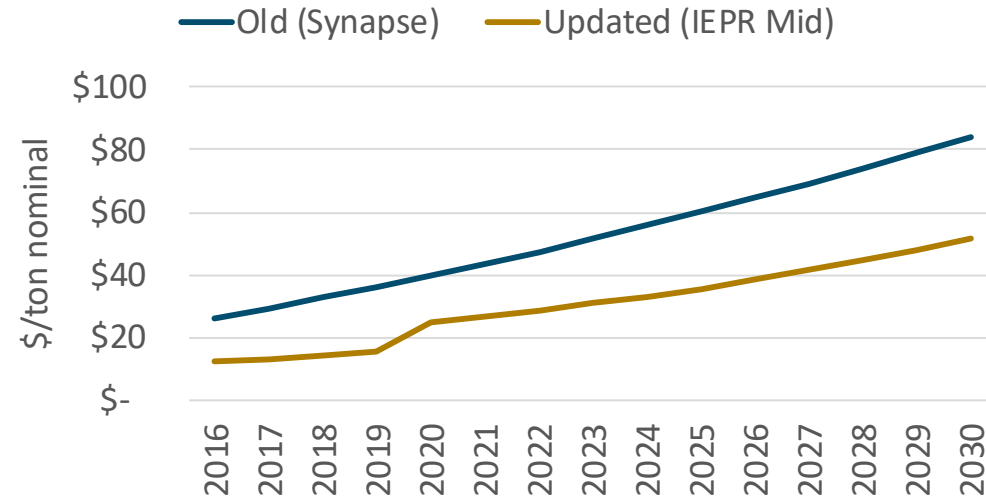


Price Forecasts

Gas Price Forecast



Carbon Price Forecast





Avoided RPS Costs

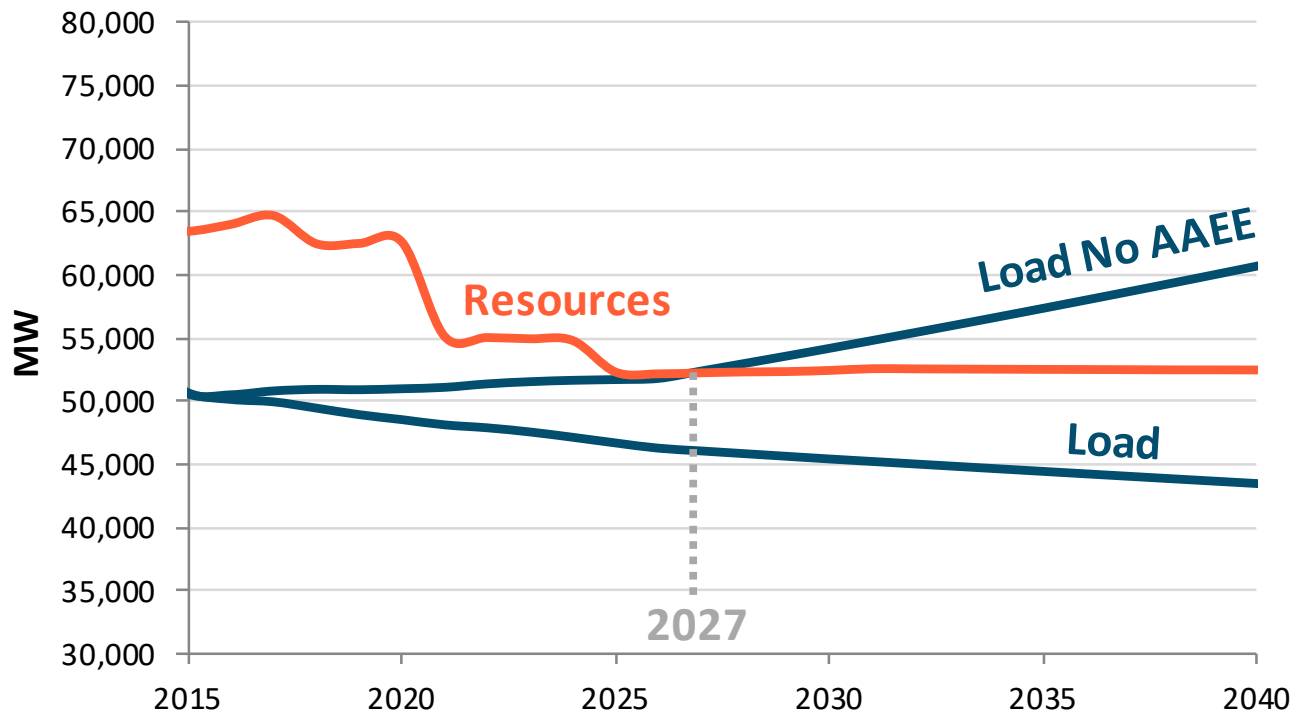
- + Avoided RPS costs now based on 50 % RPS and latest data from RPS calculator**
- + Marginal RPS resource is assumed to be energy-only, solar PV – tracking, >20 MW**
 - \$75/MWh (2015 dollars)
 - Energy-only means no incremental transmission cost applied to PPA price and no capacity value given in calculating avoided RPS cost
- + RPS calculator used to estimate marginal RPS resource cost:**
<http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=10347>



Resource Balance Year

+ If the model were to continue to use a resource balance year for capacity, the system would reach resource balance in 2027

- This does not include any future EE or DR





Capacity Value Methodology Change

- + Net cost of new entry (CONE) now includes a carbon price when dispatching the CT for energy market revenues as well as variable O&M**
- + CO2 emission rate calculated based on implied hourly market heat rate**
 - Will be capped at a maximum of 12,500 Btu/kWh
 - When implied heat rate drops below 6900, marginal emission rate will drop be based on a plant heat rate of 6900
 - If implied heat rate drops below zero (i.e. negative pricing), marginal emission rate will be set to zero to signify renewable curtailment hour
- + Resource balance year will now be set to present (2016) based on CPUC proposed decision (May 2016)**

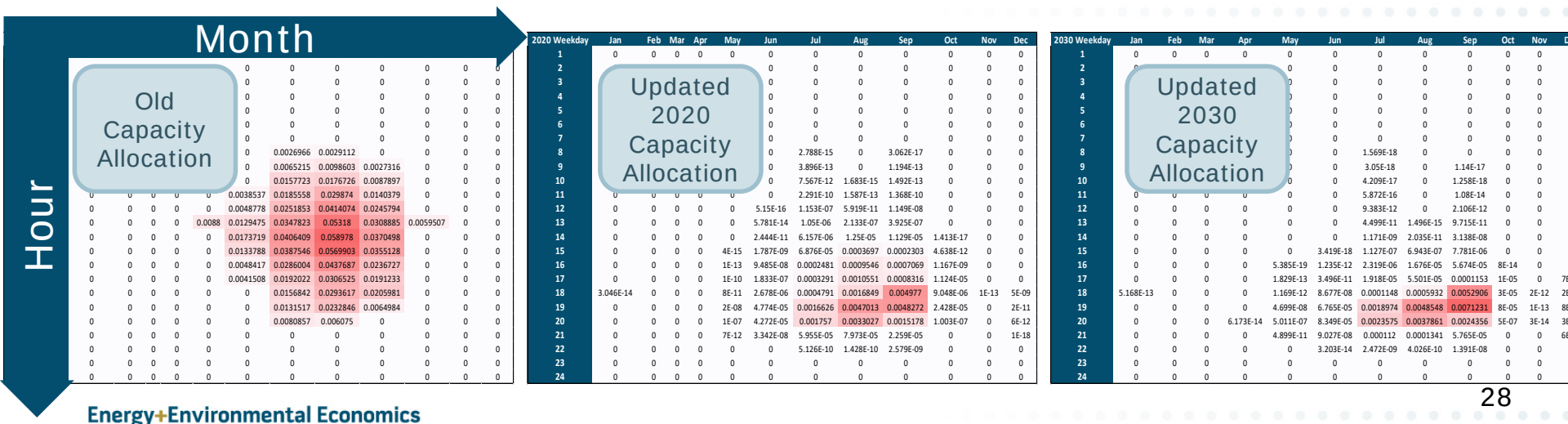


Generation Capacity Allocation

+ Capacity allocation will use E3 RECAP model

- Hourly expected unserved energy (EUE) probability model
- Uses 63 years of historical weather, historical renewable profiles, hydro flows and generation forced outage rates

+ Model will also allow user-override of capacity allocation



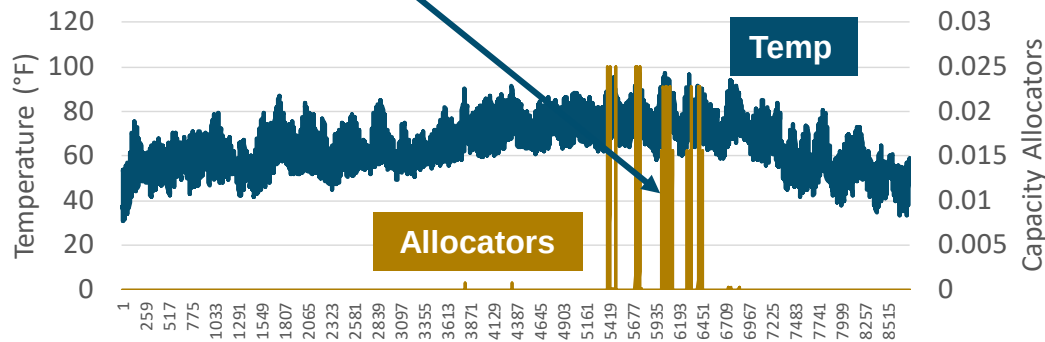


Creating 8760 Hourly Allocators

- + Once a month/hour/day-type table of EUE has been created using RECAP for each year, these values are allocated to an 8760 using a given temperature year
- + Days with load-weighted temperature averages greater than 90° F are assigned EUE capacity allocators

Date	Avg Daily Temp (F)	Hour	LOLP
Sep 5	87° F	17	0
Sep 5	87° F	18	0
Sep 5	87° F	19	0
...	...	...	...
Sep 6	93° F	17	0.0001
Sep 6	93° F	18	0.005
Sep 6	93° F	19	0.007

2030 Weekday	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	1.569E-18	0	0	0	0	0
9	0	0	0	0	0	0	3.05E-18	0	1.14E-17	0	0	0
10	0	0	0	0	0	0	4.209E-17	0	1.258E-18	0	0	0
11	0	0	0	0	0	0	5.872E-16	0	1.08E-14	0	0	0
12	0	0	0	0	0	0	9.383E-12	0	2.106E-12	0	0	0
13	0	0	0	0	0	0	4.499E-11	1.496E-15	9.715E-11	0	0	0
14	0	0	0	0	0	0	1.171E-09	2.035E-11	3.138E-08	0	0	0
15	0	0	0	0	0	3.419E-18	1.127E-07	6.943E-07	7.781E-06	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	1.829E-13	3.496E-11	1.918E-05	5.501E-05	0.0001153	1E-05	0	7E-17
18	5.168E-13	0	0	0	1.169E-12	8.677E-08	0.0001148	0.0005932	0.0052906	3E-05	2E-12	2E-08
19	0	0	0	0	4.699E-08	6.765E-05	0.0018974	0.0048543	0.0071721	8E-05	1E-13	8E-11
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22	0	0	0	0	0	0	3.203E-14	2.472E-09	4.026E-10	1.391E-08	0	0
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Temperature Load Weights

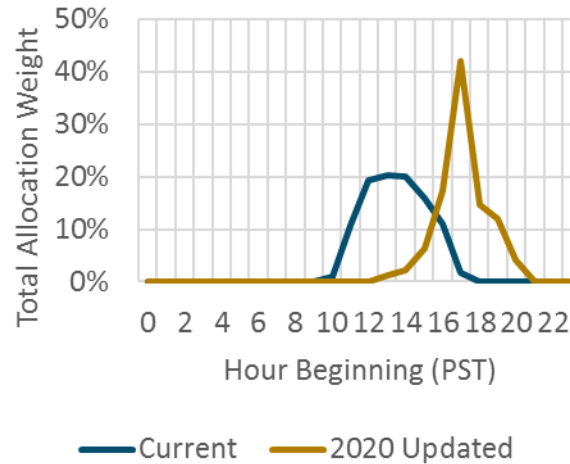
15%	Burbank
19%	Fresno
25%	Longbeach
19%	Riverside
5%	Sacramento
1%	San Francisco
12%	San Jose
3%	Ukiah



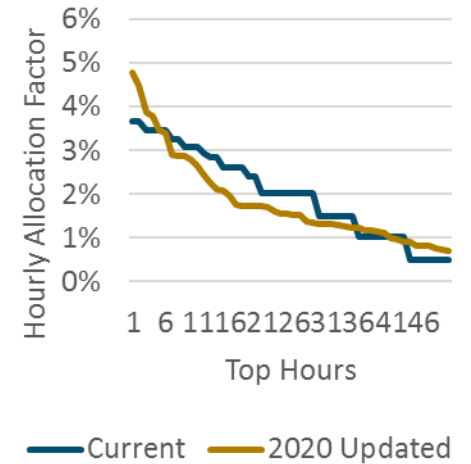
Climate Zone 2

+ Marin

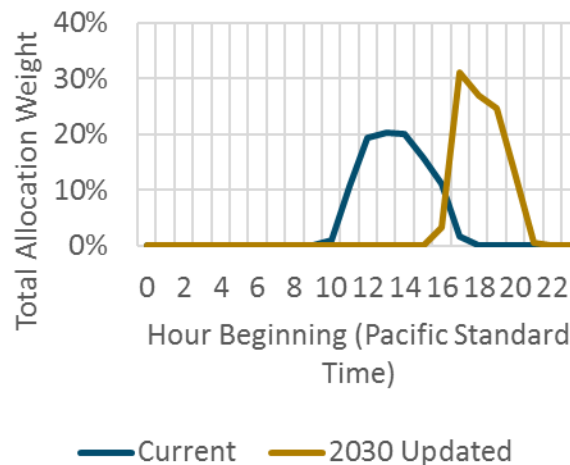
CZ2 2020 T&D Allocators



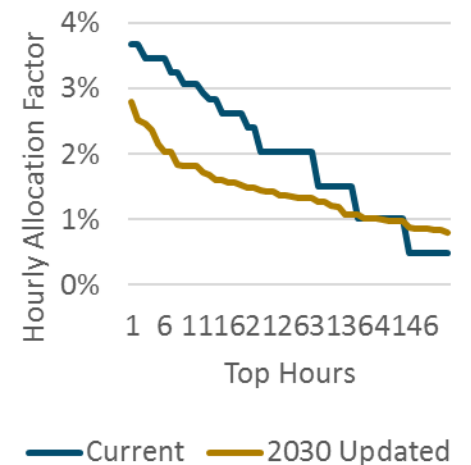
CZ2 Top Hourly Factors



CZ2 2030 T&D Allocators



CZ2 Top Hourly Factors

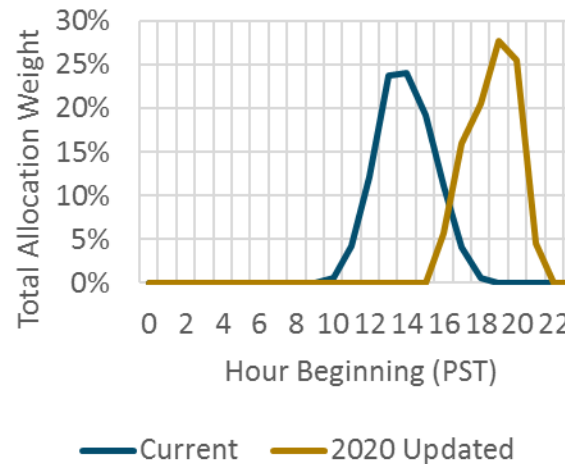




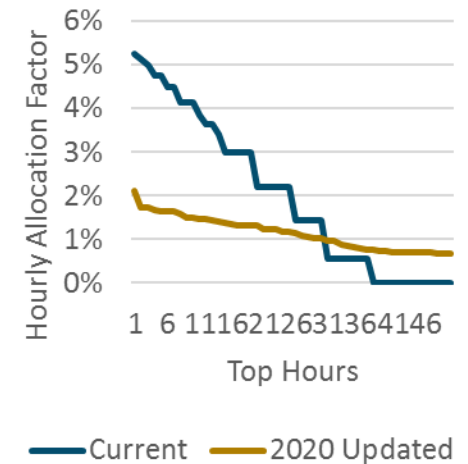
Climate Zone 3

+ Alameda

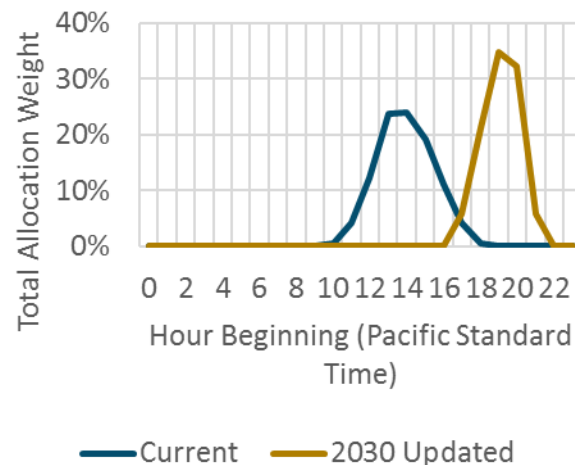
CZ3 2020 T&D Allocators



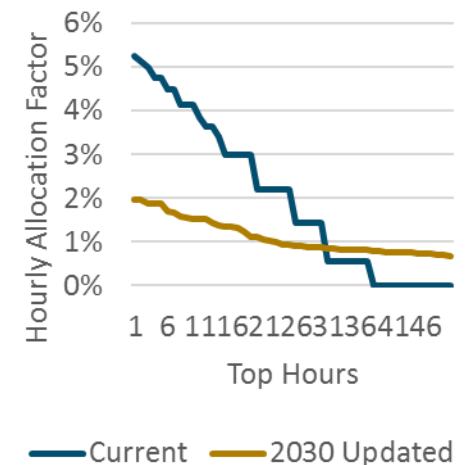
CZ3 Top Hourly Factors



CZ3 2030 T&D Allocators



CZ3 Top Hourly Factors

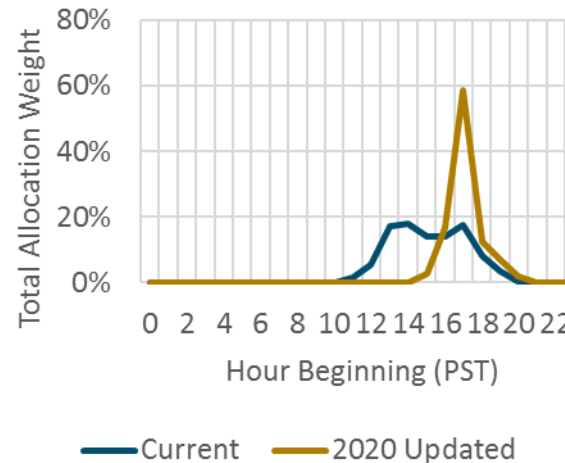




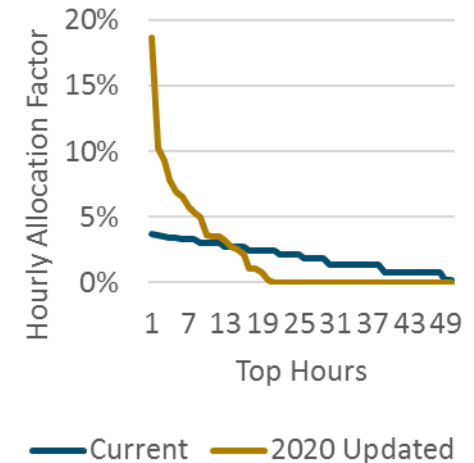
Climate Zone 4

+ San Luis Obispo

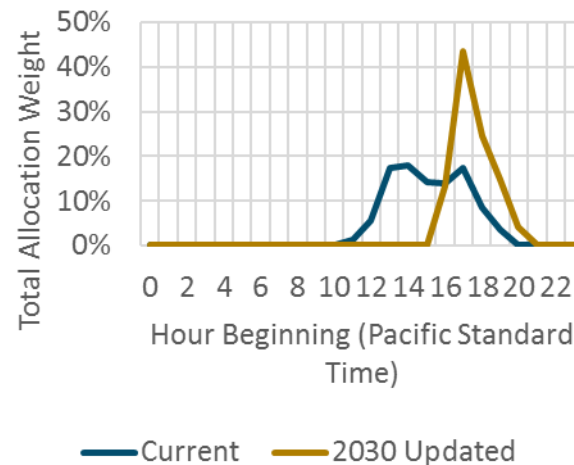
CZ4 2020 T&D Allocators



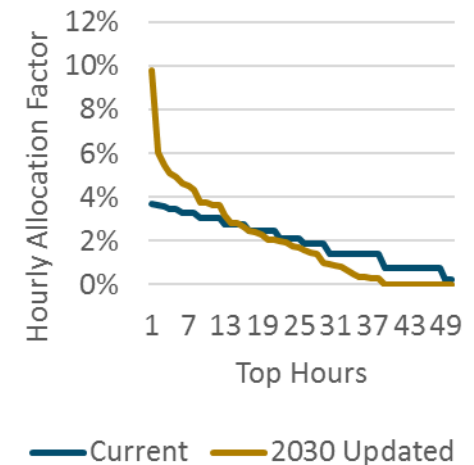
CZ4 Top Hourly Factors



CZ4 2030 T&D Allocators



CZ4 Top Hourly Factors

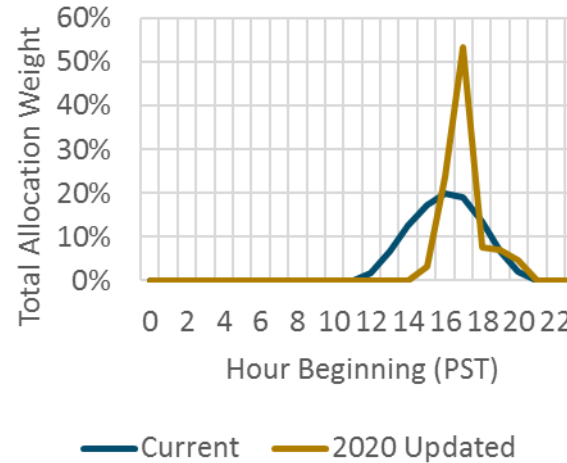




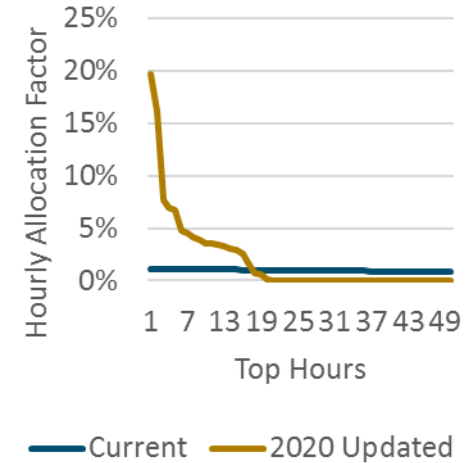
Climate Zone 12

+ Pleasanton

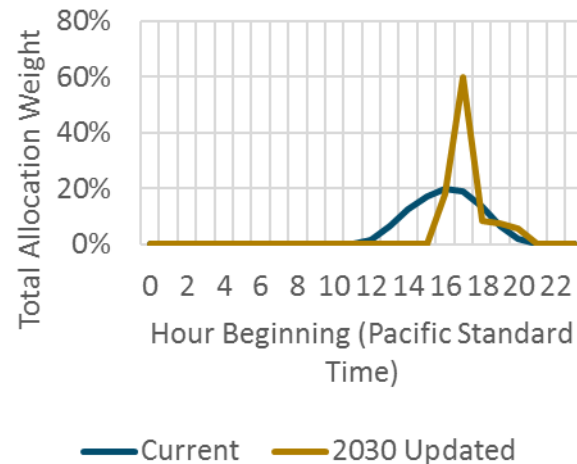
CZ12 2020 T&D Allocators



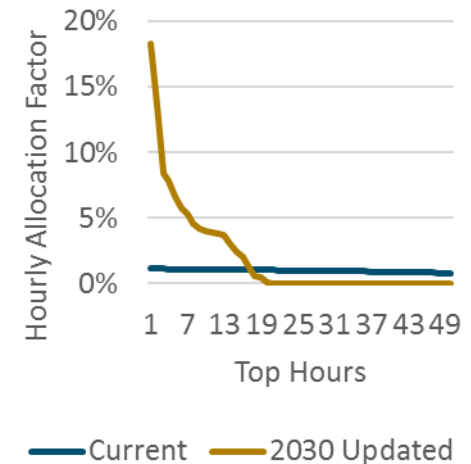
CZ12 Top Hourly Factors



CZ12 2030 T&D Allocators



CZ12 Top Hourly Factors

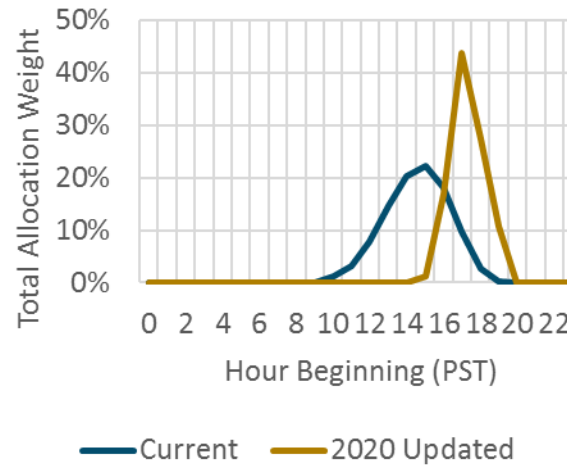




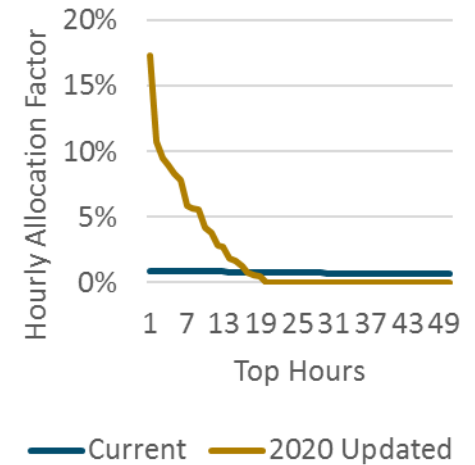
Climate Zone 13

+ Fresno

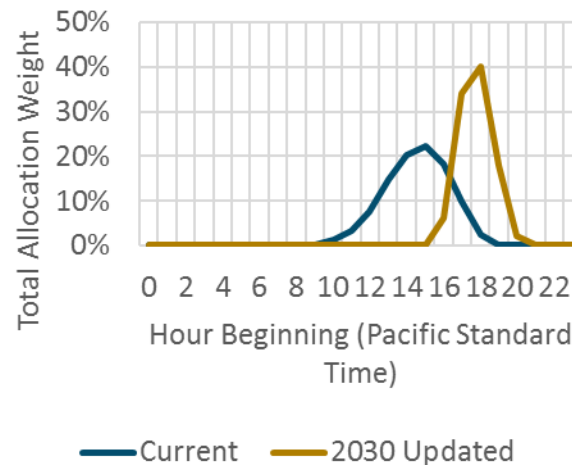
CZ13 2020 T&D Allocators



CZ13 Top Hourly Factors



CZ13 2030 T&D Allocators



CZ13 Top Hourly Factors

