Avoided Cost Calculator 2022 Update

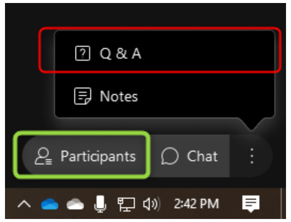
August 25, 2021 Workshop

California Public Utilities Commission

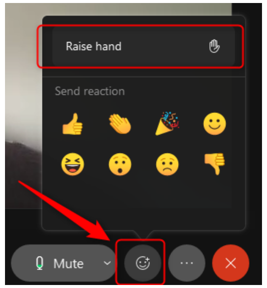
General Information

- Please use the Q&A function to ask questions. (That leaves the chat free for general announcements.)
- Please use the “raise hand” function if you want ask a question verbally and we will unmute you.
- This workshop will be recorded and the recording and the slides will be made available.

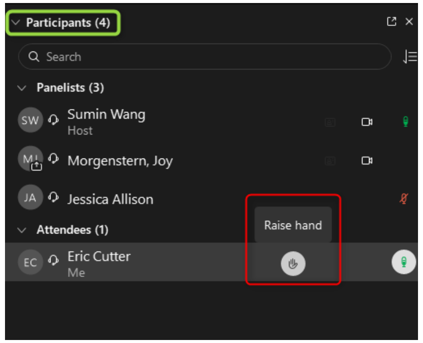
Q&A Panel
Lower-Right



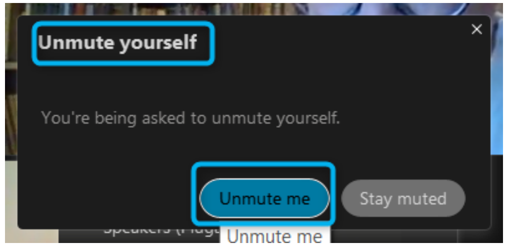
Raise Hand
Lower-Middle



Participants Panel
Upper-Right



Unmute
A host will unmute you –
then you must click button to unmute yourself



IDER Proceeding

- R.14-10-003 remains open for the 2022 ACC update
- R.14-10-003 will *not* address ACC-related issues that are not pertinent to the 2022 ACC update (e.g., defining "minor" and "major" updates)
- However, some of these issues will be discuss during the workshop
- An IDER successor proceeding will open (likely before the end of 2021)
- The new proceeding will focus on customer programs (as opposed to DERs in general), including:
  - Other ACC-related issues
  - Other cost-effectiveness-related issues
  - Other customer program issues

Topics

Topic 1
E3 Proposal: Develop Resource Adequacy, GHG and 'Clean Energy' values from IRP
Topic 2
Energy Division/E3 proposal: SERVM results review
Topic 3
E3 Proposal: Allocation of Capacity Value
Topic 4
E3 Proposal: Gas Price Forecasts
Topic 5
E3 Presentation on proposed topics for possible additional research:
Topic 6
Discussion: Application of Avoided Costs/Using the ACC
Topic 7
Discussion: GHG adder value, gas transportation rates, and other issues related to natural gas
Topic 8
Discussion: Clarify definition of major vs. minor ACC updates
Topic 9
Energy Division presentation: Use of inputs, modeling and results from other CPUC proceedings

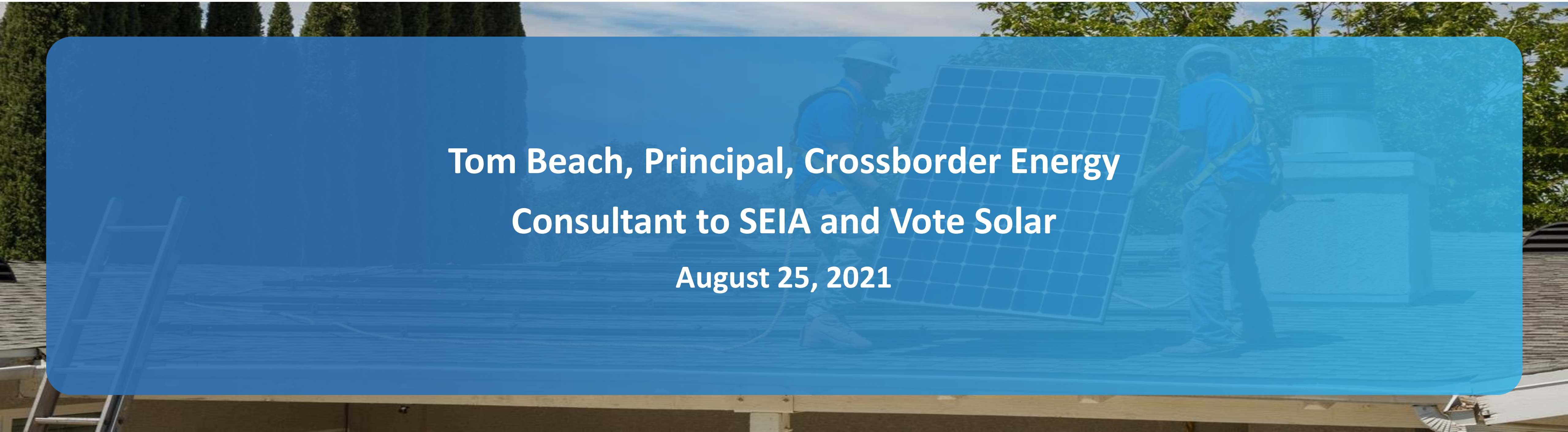
Agenda

Session	9:00	Introductory remarks and procedural matters
1	9:15	SEIA presentation on multiple topics and discussion
2	10:00	E3 Proposal: Develop Resource Adequacy, GHG and ‘Clean Energy’ values from IRP (Topic 1)
	10:35	*break*
3	10:45	E3 Proposal: Allocation of Capacity Value (Topic 3)
4	11:05	E3 Proposal: Gas Price Forecasts (Topic 4)
5	11:20	E3 Presentation on proposed topics for possible additional research (Topic 5)
	12:05	*lunch break*
6	1:00	Use of the Avoided Cost Calculator (Topic 6)
7	2:00	Energy Division presentation: Use of inputs, modeling and results from other CPUC proceedings (Topic 9)
	2:45	*break*
8	3:00	Energy Division/E3 proposals: SERVM results review and related issues (Topic 2)
9	3:45	Discussion: GHG adder value and other issues related to the natural gas ACC (Topic 7)
10	4:15	Discussion: Clarify definition of “major” and “minor” updates (Topic **8**)
	4:30	Additional discussion, questions, and clarifications (if needed)
	5:00	*end*

Session 1

Presentation by Solar Energy Industries Association (SEIA)

2022 Avoided Cost Calculator: Issues for a Major Update



Tom Beach, Principal, Crossborder Energy

Consultant to SEIA and Vote Solar

August 25, 2021

About SEIA and Vote Solar

- The **Solar Energy Industries Association** (SEIA®) is the national trade association of the U.S. solar energy industry, which now employs more than 250,000 Americans. SEIA represents its 1,000 member organizations that promote, manufacture, install and support the development of solar energy.
- **Vote Solar** advocates to make solar affordable and accessible to more Americans. Founded in 2002, Vote Solar works at the state level across the U.S. to support the policies and programs needed to repower the electric grid with clean energy.

Caveats

- Issues may overlap with other topics presented today.
- Issues are still under review.
- We reserve the right to address other issues not listed.
- Overarching concerns not addressed:
  - Volatility of ACC results
  - Lack of transparency in ACC modeling with RESOLVE / SERVM
  - Complexity of ACC modeling

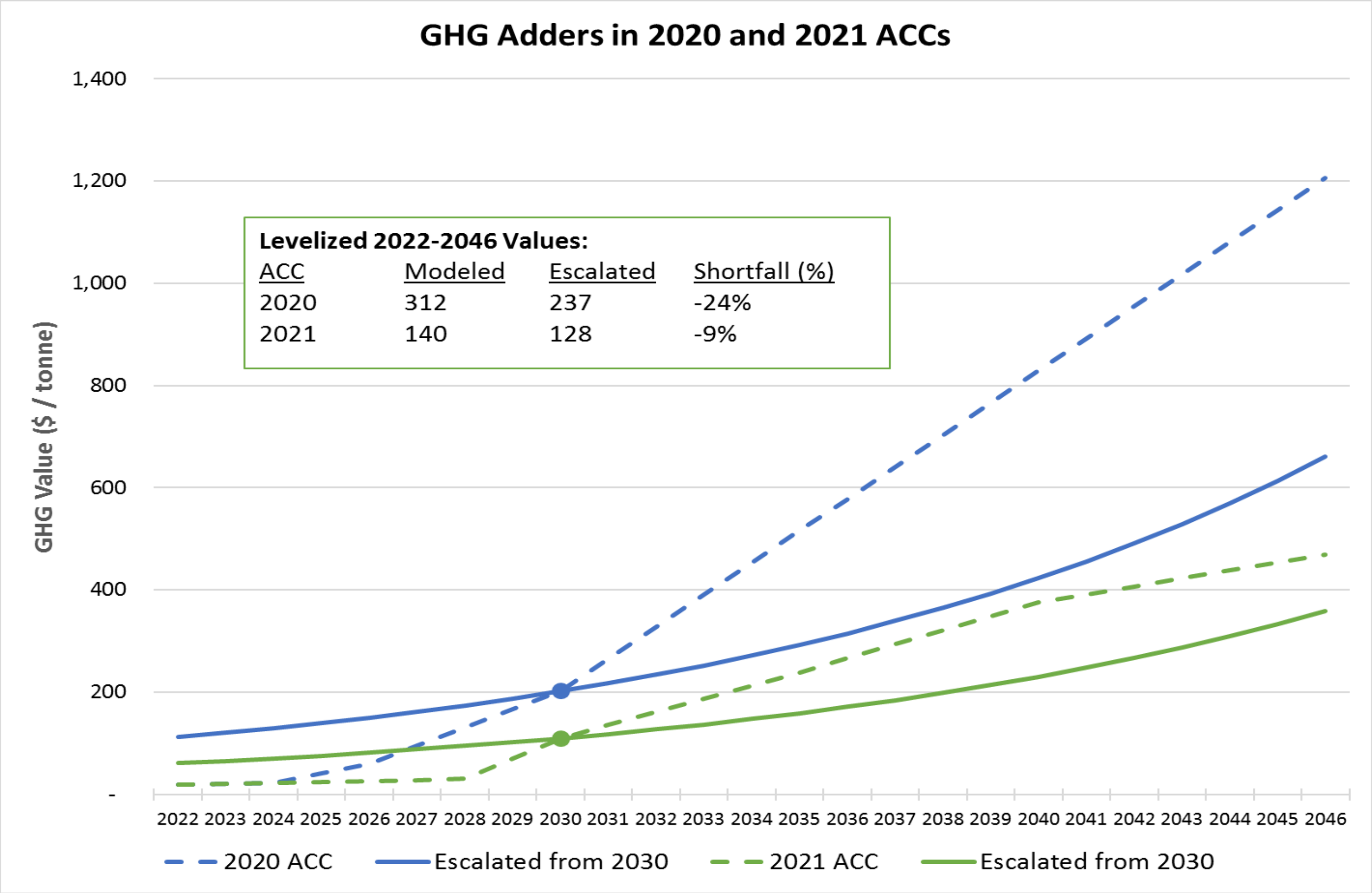
Use of the RESOLVE GHG Adder [1]

- Shift to use of the 2032 GHG Adder
  - 10 years in the future
  - PSP will have detailed resource choices for the 2023-2032 decade

- Alternative #1 – use yearly GHG Adders from 2023-2052
  - Without discounting or escalating
  - Uses more data from the IRP results

- Alternative #2 – use the 2032 GHG Adder, but adjust the rate used to discount or escalate the rate so that the NPV of the discounted/escalated GHG Adder from 2023-2052 equals the NPV of the yearly GHG Adders from RESOLVE

Use of the RESOLVE GHG Adder [2]



Comparing RESOLVE and/or SERVM to **Other Models**

- Other PCMs are available, and are used in California
  - PLEXOS

- New models that combine resource planning with full PCM
  - Vibrant Clean Energy's WIS:domP

- Parties should have the opportunity to present other modeling at the appropriate time in this proceeding
  - As a check on reasonableness of RESOLVE/SERVM results
  - To use to replace RESOLVE and/or SERVM
  - As research toward possible future use in the ACC

Other Avoided Cost Issues to be explored

- Allocating marginal / avoided costs to hours
  - Use of Peak Capacity Allocation Factors
  - Use of GRC methods
- Scarcity Pricing adjustment to SERVM results
- Include non-TOD marginal costs, similar to PG&E secondary distribution
- Add avoided congestion as well as avoided losses
  - Is congestion included in PCM results?
  - Use DLAP prices instead of trade hub prices
- Avoided methane leakage
  - Explore the use of wellhead-to-burner-tip values for methane leakage associated with all natural gas burned in California power plants and with gas-fired imports
  - Similar to the wells-to-wheels assessment for LCFS

Session 2 (Topic 1)

E3 Proposal to develop Resource Adequacy, GHG and 'Clean Energy' values from IRP

Energy+Environmental Economics

Topic 1: Develop Resource Adequacy, GHG and ‘Clean Energy’ values from IRP

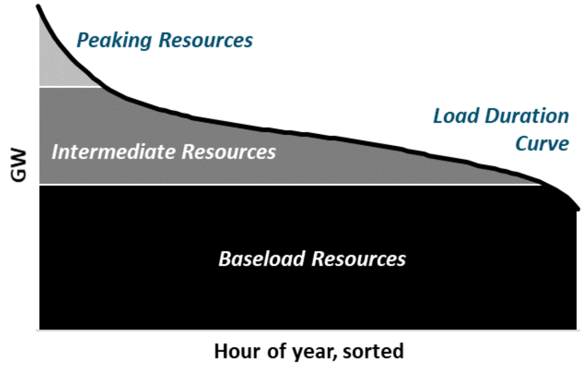
Better definition of discrete avoided cost values

- **Historically the ACC has relied on a single ‘proxy’ marginal resource to calculate values for some categories:**
  - e.g., net cost of new entry (CONE) of a combustion turbine, and now of energy storage
- **Solar + storage simultaneously provides GHG, Renewable/Clean Energy and Resource Adequacy (RA) value**
- **IRP RESOLVE capacity expansion modeling does not provide discrete values for each ACC category**
  - Multiple constraints are incorporated in a single optimization and a given resource can provide multiple values
- **Challenge: Defining discrete, mutually exclusive avoided cost values for GHG, Renewable/Clean Energy and RA without double counting**

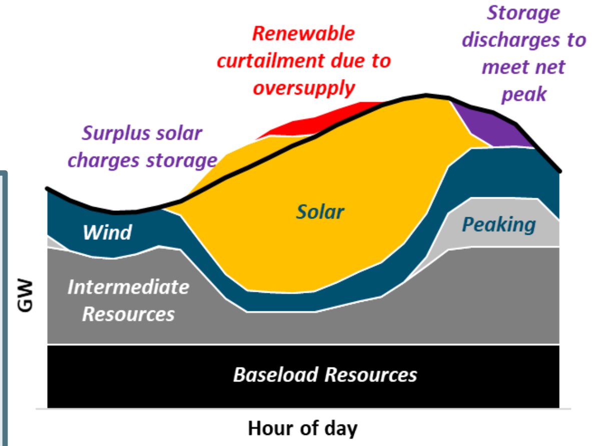
Renewable Portfolio Standard (RPS): Renewable energy that helps meet an RPS target has a premium Renewable Energy Credit (REC) or RPS value.

SB100 Clean Energy Standard: SB100 introduces a new, related Clean Energy Standard (CES). Carbon free resources that help meet a CES target have a commensurate Clean Energy or CES value.

Old Paradigm



New Paradigm



Cost recovery in decarbonized system

Historically, costs have been covered by **energy revenues** and capacity markets

Cost recovery in decarbonized system

Four basic building blocks to recover cost of resource additions

GHG policies increase revenues for low/zero GHG resources

Historically, costs have been covered by **energy revenues** and capacity markets

Renewable Portfolio Standards add a price premium for renewables

GHG + Energy + AS Margins | Capacity + Renew/Clean

Gross Cost of New Entry (CONE)

Cost recovery in decarbonized system

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Renewable Portfolio Standards add a price premium for renewables

GHG + Energy + AS Margins | Capacity + Renew/Clean

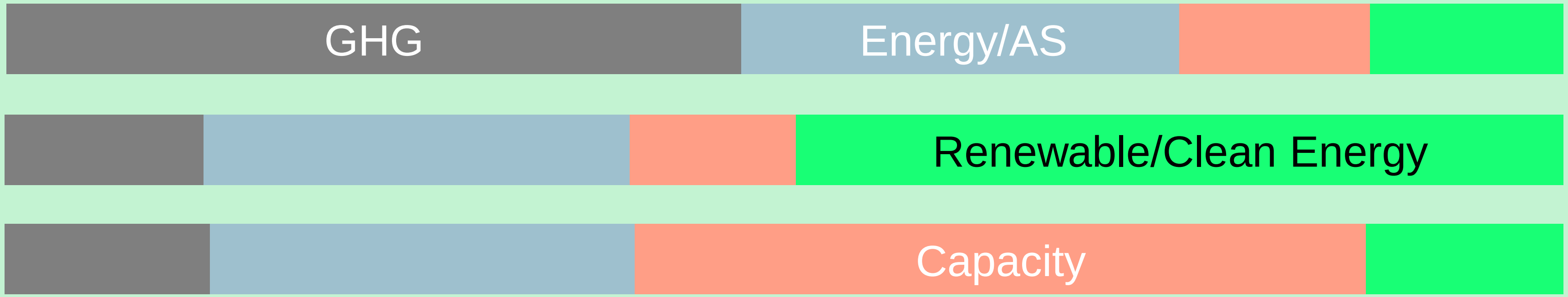
Gross Cost of New Entry (CONE)

Level of GHG, Energy + AS, Capacity and Renewable/Clean Energy values will depend on relative need for each attribute in resource planning – e.g., which attributes are most scarce

Dominant Planning Value

- GHG target
- Renewable/Clean Energy
- Generation Capacity

Distribution of value across four building blocks (*Illustrative*)



Proposed Approach

Resource Portfolio Builds

+ From IRP RESOLVE capacity expansion modeling

Energy and AS Prices

+ Run SERVM production simulation model with IRP portfolios
+ Used to calculate market revenue for each resource in portfolio

Calculate Net CONE for each resource

+ Remaining cost be recovered through a combination of:
  - GHG
  - Resource Adequacy
  - RPS / CES

Calculate projected GHG, RA, RPS/CES prices

+ Develop supply stack for planning value streams to determine marginal planning value avoided cost
+ Subject to cost recovery & risk requirements for each resource type

Guiding Principles

+ **Increasingly stringent policy targets will increase value for GHG and Renewable/Clean energy over time**
+ **IRP will develop least cost resource portfolios to achieve policy targets that include a combination of wind, solar, storage and other supply (and demand) side resources**
+ **In total, each resource should earn sufficient energy, ancillary service, GHG, renewable/clean energy and RA revenues to achieve target rates of return**
    - Some value will be compensated in competitive wholesale markets (higher risk/less bankable)
    - Some value will be compensated in contracted PPAs with Local Service Entities (LSEs) (lower risk/more bankable)
+ **Efficient markets will trend toward equilibrium with new entry limiting opportunity for excess rents over time**

Questions for Stakeholders: *Other key guiding principles crucial for developing approach?*

Questions?

Session 3 (Topic 3)

E3 Proposal on Allocation of Capacity Value

Energy+Environmental Economics

Topic 3: Allocation of Capacity Value

The issue: month-hour heat maps concentrate value in September

- Multiple projects have used "heat-map" format outputs from RECAP, either as a tool to display results or as a means to translate LOLP outputs to other models (e.g. CPUC ACC)
- These efforts have raised some concern that RECAP may be artificially concentrating reliability value in September
- Multiple theories have been offered:
  - Extreme load events in historical record artificially concentrated in September?
  - Probability of high loads combined with seasonal waning solar output?

Heat Map of LOLH Based on California, 2019

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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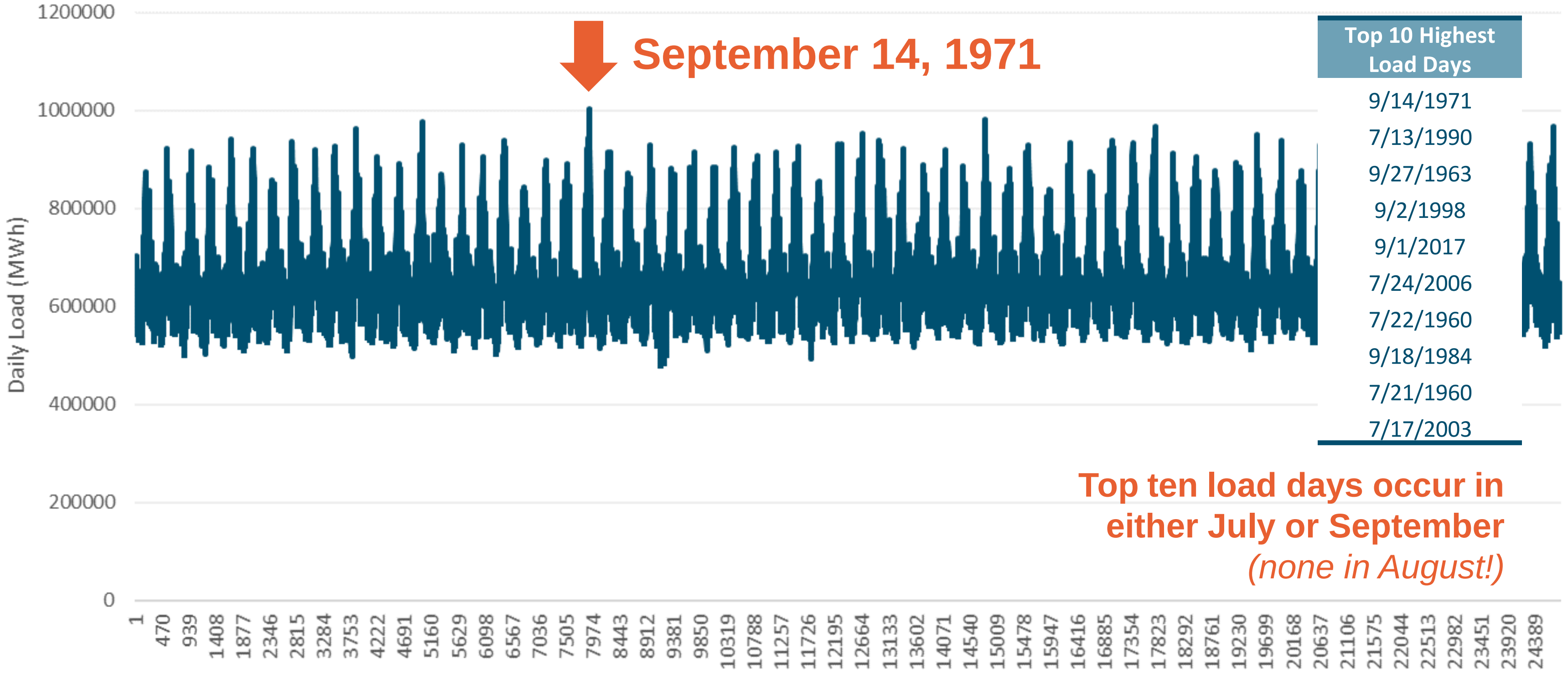
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.25	0.33	0.18	0.12	0.01	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.01	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

91% of loss-of-load hours in RECAP occur in September

What makes September 14, 1971 so bad?

Daily California load, 1950-2017



Top 10 Highest Load Days
9/14/1971
7/13/1990
9/27/1963
9/2/1998
9/1/2017
7/24/2006
7/22/1960
9/18/1984
7/21/1960
7/17/2003

Top ten load days occur in either July or September
(none in August!)

+ **It is not necessarily a problem that there is a single day with the highest load conditions—but it is probably problematic that we always map that day to September**

Is spreading the answer? It helps…

Heat Map of LOLH Based on California, 2019

Based strictly on calendar dates of RECAP simulation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.25	0.33	0.18	0.12	0.01	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.01	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

91% of loss-of-load hours in RECAP occur in September

Heat Map of LOLH Based on California, 2019 (Smoothing Applied)

Assuming each day is equally likely to fall within a window of +/- 7 days of its calendar date

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.09	0.01	0.01	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.21	0.26	0.15	0.10	0.01	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.03	0.02	0.01	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

75% of loss-of-load hours in RECAP still occur in September

Topics for Discussion

- Improvements to Loss of Load Probability (LOLP) to account for climate change will progress in other proceedings
- In the meantime, is spreading of available LOLP results to other months a reasonable approach for ACC?
- Alternatively, should SERVM be used to allocate generation capacity annual values to the hours in place of RECAP?

Comparison of Expected Served Energy (EUE) from RECAP and SERVM

Heat Map of EUE Based on California, 2030 (RECAP)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.5	1.6	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.8	115.0	56.8	109.4	431.0	143.1	8.7
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Expected Unserved Energy in **RECAP concentrates in September**

Heat Map of EUE Based on California, 2030 (SERVM)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	0.0	7.1	0.2	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-
4	-	-	-	-	-	-	-	0.0	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	0.8	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	16.3	47.1	20.6	-	0.2
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	3.0	11.7	3.7	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	2.1	22.0	21.9	14.1	1.6	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Expected Unserved Energy in **SERVM spreads over in summer late afternoon and early winter morning**

Questions?

Session 4 (Topic 4)

E3 Proposal on Gas Price Forecasts

Energy+Environmental Economics

Topic 4: Gas Price Forecasts

Avoided Cost Gas Price Forecast

- The ACC uses near-term market forward prices in place of the CEC IEPR gas price forecast
- This approach has its roots in the Market Price Referent (MRP) comparing the cost of renewables to a combined cycle combustion turbine (CCGT)
- In the current planning paradigm market-based gas price forecasts are less important than consistency across planning proceedings and in evaluation of electrification.
- Proposal is to remove unnecessary complexity of alternative gas price forecast for ACC and simply use the same CEC IEPR forecast as other proceedings

SoCal Border
Full Value

Future/Forward	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021
4/12/2021	$ 2.61	$ 3.11	$ 3.80	$ 3.97	$ 3.62	$ 3.42
4/9/2021	$ 2.56	$ 3.02	$ 3.73	$ 3.90	$ 3.57	$ 3.37
4/8/2021	$ 2.47	$ 2.98	$ 3.67	$ 3.84	$ 3.52	$ 3.32
4/7/2021	$ 2.46	$ 2.96	$ 3.61	$ 3.78	$ 3.47	$ 3.26
4/6/2021	$ 2.40	$ 2.92	$ 3.58	$ 3.75	$ 3.44	$ 3.22
4/5/2021	$ 2.40	$ 2.89	$ 3.51	$ 3.67	$ 3.37	$ 3.18
4/1/2021	$ 2.58	$ 3.06	$ 3.69	$ 3.84	$ 3.53	$ 3.33
3/31/2021	$ 2.51	$ 2.99	$ 3.62	$ 3.77	$ 3.46	$ 3.26
3/30/2021	$ 2.54	$ 2.98	$ 3.60	$ 3.75	$ 3.43	$ 3.14
3/29/2021	$ 2.59	$ 3.01	$ 3.63	$ 3.78	$ 3.47	$ 3.17
3/26/2021	$ 2.56	$ 2.97	$ 3.57	$ 3.73	$ 3.41	$ 3.15
3/25/2021	$ 2.52	$ 2.93	$ 3.51	$ 3.66	$ 3.35	$ 3.08
3/24/2021	$ 2.47	$ 2.88	$ 3.47	$ 3.62	$ 3.31	$ 3.03
3/23/2021	$ 2.50	$ 2.92	$ 3.53	$ 3.69	$ 3.38	$ 3.06
3/22/2021	$ 2.59	$ 3.00	$ 3.63	$ 3.78	$ 3.47	$ 3.15
3/19/2021	$ 2.54	$ 2.95	$ 3.51	$ 3.66	$ 3.34	$ 3.05
3/18/2021	$ 2.46	$ 2.84	$ 3.41	$ 3.56	$ 3.25	$ 2.97
3/17/2021	$ 2.46	$ 2.80	$ 3.35	$ 3.50	$ 3.19	$ 2.95
3/16/2021	$ 2.54	$ 2.90	$ 3.45	$ 3.61	$ 3.30	$ 3.05
3/15/2021	$ 2.45	$ 2.81	$ 3.37	$ 3.52	$ 3.21	$ 2.96
3/12/2021	$ 2.56	$ 2.92	$ 3.47	$ 3.62	$ 3.31	$ 3.04
3/11/2021	$ 2.66	$ 3.01	$ 3.56	$ 3.70	$ 3.39	$ 3.14
22-Day Average	$ 2.52	$ 2.95	$ 3.56	$ 3.71	$ 3.40	$ 3.15

ACC averages 1 month (21-22 business days) of forward gas prices for each contract month

Questions?

Session 5 (Topic 5)

E3 Proposals on topics for possible additional research:

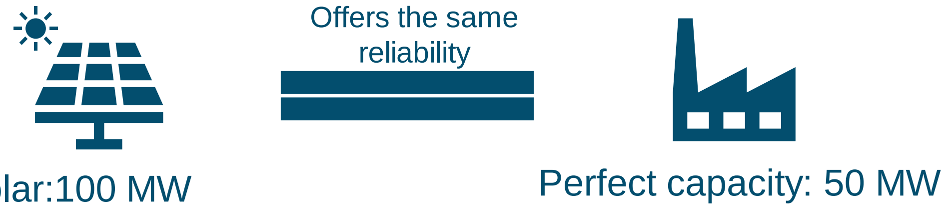
- **ELCC in Avoided Costs**
- **Capacity Value of Dispatchable DERs**
- **Marginal Distribution Costs**

Energy+Environmental Economics

Topic 5: Proposed Topics for Possible Additional Research

Effective Load Carrying Capability (ELCC) in Avoided Costs

+ **IRP proceedings have been undertaken work to implement and enhance the modeling of ELCC values for different types of supply-side resources. But this hasn't been done for the demand-side resources evaluated in ACC**
+ **Effective load carrying capability (ELCC) measures the capacity contribution of a resource**
+ For example, 50% ELCC of a solar generator



+ Any resource that doesn't offer perfect capacity will have an ELCC value less than 100%

ELCC Calculation Process

1. **Calculate System Reliability**
2. **Add desired resource to portfolio**

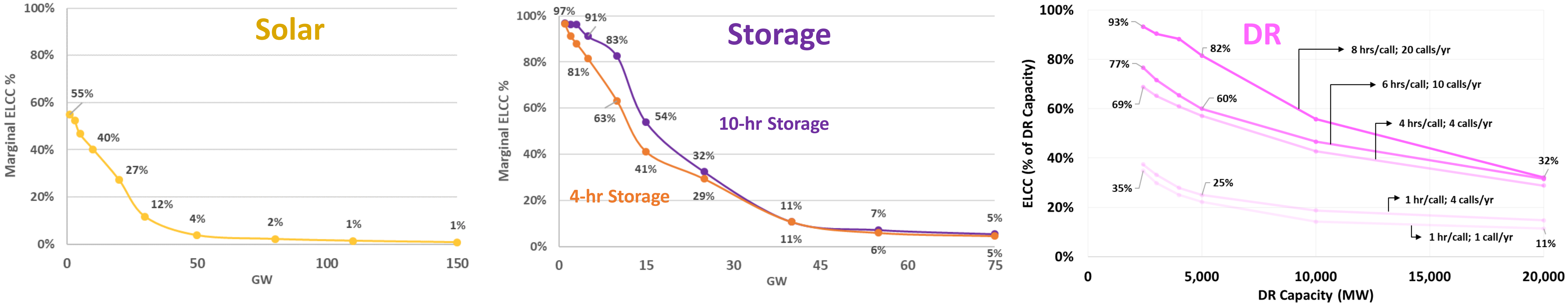
   Addition of new source of generation will improve reliability relative to measurement in Step 1
3. **Remove perfect capacity until system reliability is restored**

   Removal of perfect capacity results in reduces reliability until original level is met

A resource's ELCC is equal to the amount of perfect capacity removed from the system in Step 3

ELCC differs by resource type and declines with increasing penetration

+ **Recent proceedings have identified declining ELCC value associated with increasing penetrations of energy storage, solar and demand response (DR)**
  - Solar ELCC decays quickly due to day-time saturation which shifts the net peak load to the night-time
  - Storage ELCC decays quickly due to its energy limitations and lack of available energy to charge
  - DR ELCC declines owing to saturation of energy-limited resources on the system, particularly storage



Effective Load Carrying Capability (ELCC) in Avoided Costs

+ **Currently, ACC only provides a single set of capacity value based on the Net CONE of energy storage, with a corresponding declining ELCC based on IRP modeling**
+ **Currently, DR is the only distributed resource that has a resource specific ELCC calculation for determining capacity value**
  - Applied outside the ACC in the DR Reporting Template
+ **The capacity value of DER is receiving increased attention in a number of proceedings, and specific ELCC values are modeled for wind, solar, storage and DR in the IRP proceedings**

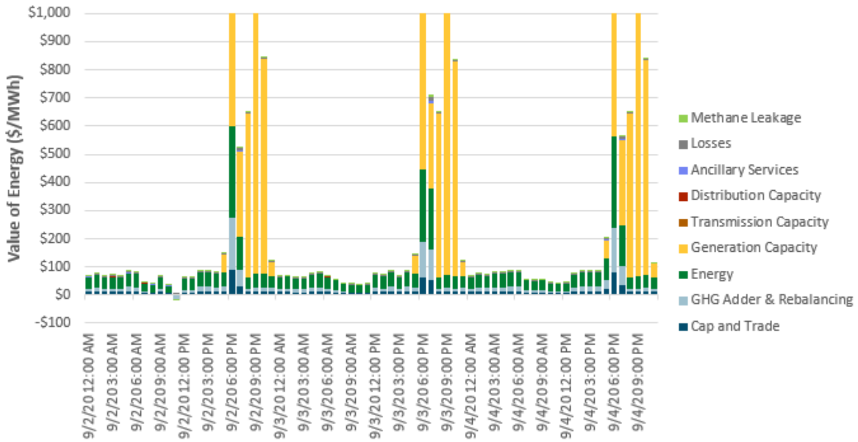
Questions for Stakeholders:

- Should the ACC also provide resource specific calculations of ELCCs for different types of DER, to be more consistent with the IRP?
- Should different ELCCs for specific DER be incorporated in the 2022 ACC Update?

Questions?

Capacity Value of Dispatchable DER

- **The ACC allocates $/kW-Yr. generation capacity value to individual peak hours on a $/kWh basis**
  - For cost-effectiveness evaluation, the generation capacity value depends on how well the DER load shapes are coincident with the peak hours
- **The fixed load shape approach might not work well for dispatchable DER because**
  - Dispatchable DER are flexible to be shifted to meet capacity needs and a fixed shape approach might not capture its full value
- **Should other potentially dispatchable resources such as energy storage or EVs also be permitted to use an alternative ELCC based approach to calculate generation capacity value?**
- **This would be an alternative, not in addition to, the current approach of allocation capacity value to individual hours**

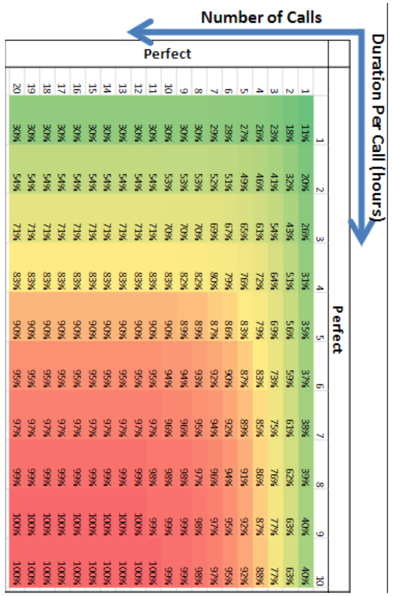


Allocation of generation capacity value to peak hours over three days in September

Capacity Value of Dispatchable DER

- **In the DR proceeding, DR uses an alternative ELCC based method (A Factor) to account for when the program can be potentially called and the frequency and duration limits of calls**
  - A Factor = Availability Factor X Dispatchability Factor

Weekday												
	January	February	March	April	May	June	July	August	September	October	November	December
1	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	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	0	0	0	0	0	0
9	0	0	0	0	0	0	2.675E-13	2.062E-13	0	0	0	0
10	0	0	0	0	0	0	1.313E-08	7.171E-11	2.185E-13	0	0	0
11	0	0	0	0	0	0	1.045E-06	4.362E-07	2.632E-09	0	0	0
12	0	0	0	0	0	2.03E-13	5.756E-05	8.374E-05	4.143E-06	0	0	0
13	0	0	0	0	1.816E-13	9.366E-12	0.0017541	0.0004761	0.0003559	1.886E-13	0	0
14	0	0	0	0	5.05E-12	4.108E-08	0.0175846	0.0089215	0.0095088	9.202E-13	0	0
15	0	0	0	0	8.296E-10	1.001E-05	0.0418717	0.0609029	0.026851	4.728E-10	0	0
16	0	0	0	0	1.356E-08	0.0001713	0.0958275	0.154044	0.0529714	1.389E-08	0	0
17	0	0	0	0	1.051E-08	0.0002752	0.0863699	0.1643968	0.0468803	2.642E-10	0	0
18	0	0	0	0	5.911E-10	5.262E-05	0.0235108	0.0685829	0.0151693	5.297E-12	0	0
19	0	0	0	0	1.487E-12	1.162E-06	0.0033193	0.0233013	0.0244126	0	0	0
20	0	0	0	0	2.557E-13	2.037E-07	0.003468	0.0056573	0.0148689	4.159E-13	0	0
21	0	0	0	0	2.613E-13	5.463E-08	0.0002864	0.001502	0.0004685	0	0	0
22	0	0	0	0	0	3.257E-12	1.6E-07	1.285E-06	3.183E-10	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
1	n.a.	n.a.	0	0	0	0	0	0	0	0	n.a.	n.a.
											Sum =	0.95



- Availability factor is the sum of normalized LOLP values during which DR is available
- Dispatchability factor is a function of call frequency and duration limits of DR program

Questions for Stakeholders:
- Should the ACC direct or permit alternative calculations of capacity value for dispatchable DER?
- Should the approach used for DR also be applicable for other dispatchable DER?
- Should the approach also be directed or permitted for T&D capacity value?

Questions?

Two approaches to marginal distribution costs…

Identify load growth related distribution costs
(*that can be avoided with DER*)

Top Down
FERC & GRC Data

+ **Identify load growth related distribution cost categories**
+ $\frac{Distribution\ Costs\ (\$)}{Load\ Growth\ (kW)}$ = $/kW-Yr.*

Title of the FERC Account	12/31/2015	12/31/2014
4. DISTRIBUTION PLANT		
Land and Land Rights	30,914	29,994
Structures and Improvements	66,625	63,410
Station Equipment	481,520	468,114
Storage Battery Equipment	0	0
Poles, Towers, and Fixtures	416,490	401,293
Overhead Conductors and Devices	360,295	345,450
Underground Conduit	121,776	114,567
Underground Conductors and Devices	469,695	450,387
Line transformers	517,697	491,463
Services	342,869	327,062
Meters	109,902	106,881
Installations on Customer Premises	55,853	54,659
Leased Property on Customer Premises	47	47
Street Lighting and Signal Systems	63,417	62,372
Asset Retirement Costs for Distribution Production	235	235
TOTAL Distribution Plant (Total of lines 60 thru 74)	3,037,337	2,915,934

SNL FERC Form 1 Excel Template

Bottom Up
Distribution Resource Plans

+ **Identify grid needs over next 5 years circuit by circuit**
+ **Counterfactual analysis of grid needs without DER included in forecast**
+ **'x' kW of DER avoids smaller 'y' kW of upgrades**
+ $\frac{Avoided\ Upgrade\ Costs\ (\$)}{DER\ Forecast\ (kW)}$ = $/kW-Yr.*

** OK, it is more complicated but you get the idea*

… lead to very different results

		PG&E	SCE	SDG&E
	Climate Zone:	CZ1	All	All
2019	Historical	$14.49	$29.13	$3.66
2020	Near Term	$14.85	$29.81	$3.74
2021	Near Term	$15.22	$30.51	$3.81
2022	Near Term	$15.60	$31.22	$3.89
2023	Near Term	$15.99	$31.94	$3.96
2024	Near Term	$16.39	$32.69	$4.04
2025	Transition	$43.69	$90.65	$44.15
2026	Transition	$70.99	$148.61	$84.26
2027	Long Term	$98.29	$206.57	$124.36
2028	Long Term	$100.75	$211.39	$126.85
2029	Long Term	$103.27	$216.31	$129.39

Bottom Up
Distribution Planning Data

Top Down
GRC Data

2020 DER Avoided Cost Calculator

+ Distribution Resource Plan approach much lower

- Distribution systems built with headroom
- 5-year distribution plan will not include all long-term costs
- FERC and GRC categories are very broad and include more ‘unspecified’ costs

Questions?

Session 6 (Topic 3)

Application of Avoided Costs/Using the ACC

Discussion Questions

- How should we define "avoided cost?" Which avoided costs (or types of avoided costs) should be in the avoided calculator?
- How should we deal with avoided costs that are not marginal and/or hourly costs?
- Should the ACC incorporate the avoided cost of natural gas infrastructure adopted in the EE proceeding?
- Are there other avoided costs that should be adopted in 2022?
- Can the ACC provide accurate information for all uses (ex ante and ex post cost-effectiveness, GHG emission estimates, total system benefits, informing potential & goals studies and rates design, etc.)?
- Should the ACC be used to estimate increased supply costs (resulting from fuel substitution and fuel switching programs)?

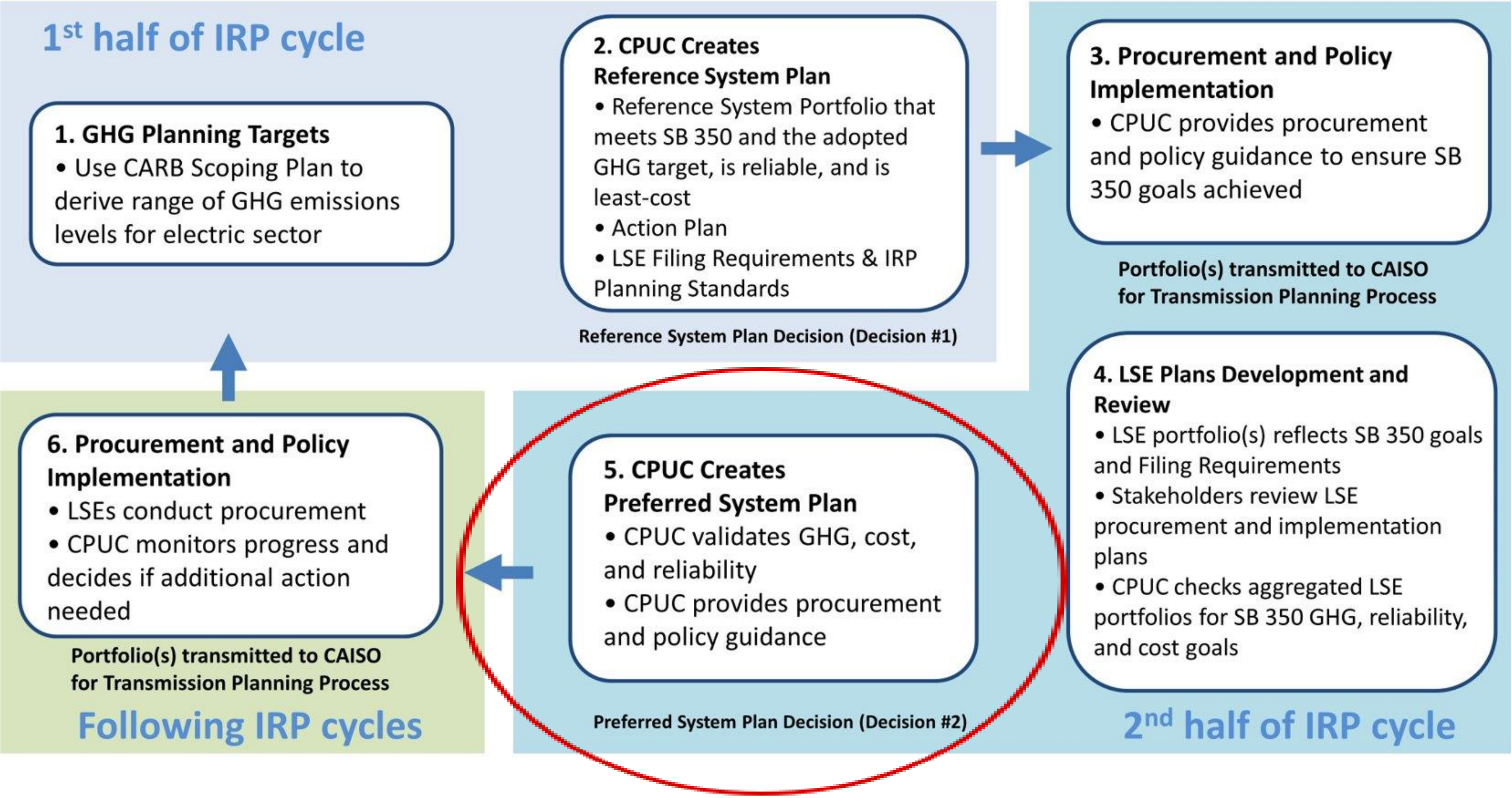
Session 7 (Topic 9)

Energy Division presentation on use of inputs, modeling and results from other CPUC proceedings

Distribution Planning

- Grid Needs Assessment and Distribution Deferral Opportunity Reports are filed annually on August 15 by PG&E, SDG&E, and SCE.
- The GNA identifies grid needs and is used to develop the DDOR.
- The DDOR identifies traditional infrastructure projects that could be avoided or deferred with DERs to address a need identified in the GNA.
- An advisory group of stakeholders called the Distribution Planning Advisory Group reviews the GNA/DDOR filings. After review, the utilities seek to procure DERs for the selected opportunities.
- This information is used as inputs to the ACC to determine short term avoided distribution costs.
- In 2020, there was little additional data as compared with 2019, so the 2021 ACC did not update this avoided cost.

Integrated Resource Planning (IRP) Process Overview



Where we are in the IRP Process

- **RESOLVE updates have been included in the** Preferred System Plan (PSP) **ruling**
  - **Party opening comments due September 27**
  - **Party reply comments due October 11**

- **PSP final decision by the end of 2021**

Activity	Timing
Ruling on PSP & TPP (Including RESOLVE updates)	August 2021
Party comments and replies due	September – October 2021
Comment review, PSP portfolio adjustments including RESOLVE runs and production cost modeling of PSP portfolio	September – October 2021
Proposed Decision	November 2021
Final Decision	December 2021

IRP RESOLVE Modeling for ACC

- Using the 2021 Preferred System Plan for 2022 ACC
  - In what proceeding(s) should the No New DER assumptions and results be released?
  - What should be the timing of the release?
  - What should be included in this release?

- Long-term Avoided Costs from IRP RESOLVE Modeling
  - While the next IRP cycle schedule is in flux, we anticipate continuing to support IDER proceeding and their need for updated RESOLVE modeling.
  - Given the uncertainly of IRP timing, and the need to use current IRP data in the ACC, how do we develop a long-term ACC update schedule?

Session 8 (Topic 2)

SERVM/RESOLVE/ACC results review

Energy+Environmental Economics

Topic 2: SERVM Results Review

Energy component of the avoided costs come from SERVM and adjusted by E3

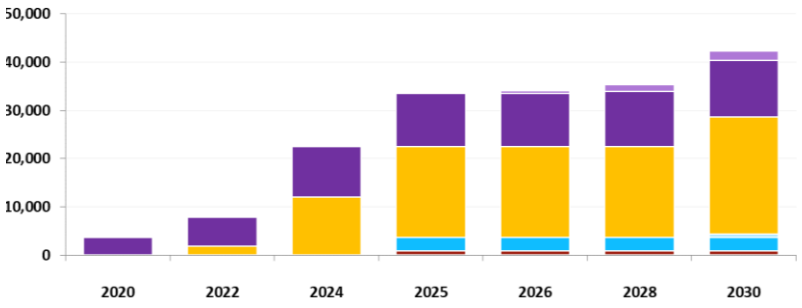
+ Methodology to calculate energy avoided costs

Integrated Resource Plan (CPUC + E3)

CPUC Integrated Resource Planning (IRP) determines the resource portfolio that needs to be built in California

- Uses E3's RESOLVE model

Took out DERs in IRP Preferred System Plan and created a counterfactual scenario to identify resource portfolio without DERs (No New DER)

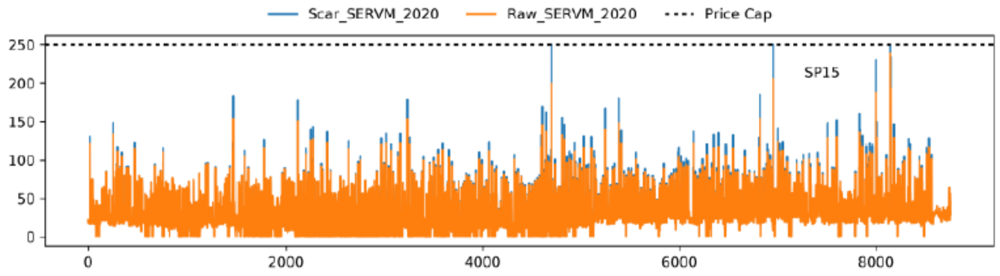


CPUC Energy Division

CPUC ran production simulation model (SERVM) to get hourly energy and ancillary services prices under the **No New DER scenario**

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Avg
Jan	62	53	44	44	44	53	69	65	47	41	37	35	34	35	35	51	90	151	67	66	65	91	80	62	59
Feb	61	56	46	45	50	49	71	50	41	26	28	19	18	25	22	26	58	140	74	80	76	94	67	55	53
Mar	53	35	40	39	42	50	67	47	17	8	7	6	3	4	11	11	40	91	101	105	96	77	46	45	43
Apr	28	34	31	18	51	45	39	15	1	0	0	0	11	0	1	13	12	44	99	116	101	57	26	29	32
May	39	28	24	27	23	37	47	6	1	1	0	1	3	3	2	8	23	52	60	122	102	87	53	33	33
Jun	42	29	34	29	35	38	56	19	15	9	5	6	7	10	15	24	54	67	103	129	100	74	52	37	41
Jul	39	30	35	17	33	27	39	15	3	4	2	3	4	14	16	34	77	115	105	170	89	80	51	35	43
Aug	43	39	47	40	44	44	40	30	22	20	18	21	29	37	48	78	52	82	192	186	63	49	50	43	55
Sep	45	43	55	47	55	57	45	29	19	20	11	13	16	22	33	37	57	108	176	94	52	56	50	42	49
Oct	51	47	43	42	44	63	62	35	28	23	17	16	17	20	33	56	71	125	92	78	79	55	48	53	50
Nov	63	44	52	53	43	46	63	44	26	21	15	14	15	20	22	43	87	81	78	86	122	77	45	51	51
Dec	44	44	43	43	44	59	80	71	53	40	38	34	32	31	33	50	115	77	75	67	85	61	53	47	55
Avg	47	40	41	37	42	47	56	36	23	18	15	14	16	19	23	36	61	94	102	109	86	71	52	44	47

E3 Scarcity Price Adjustment



SERVM results and ACC results are in Pacific Standard Time (PST)

SERVM Results Review

+ In previous ACC, SERVM was only run up to 10 years and E3 inflated the prices to extrapolate avoided energy costs to 2050
+ In the 2022 ACC, E3 proposes a 2045 SERVM run to better represent prices and heat rates after 2030 so that it will be more consistent IRP
+ To improve the efficiency of the review, E3 will continue to release new data to help review the price results
+ Examples of the types of data we will release are shown on the next slides

Data provided in the 2021 ACC Review

- **RESOLVE portfolio build (PSP, No New DER) on the IRP website**
- **E3 shared the raw dispatch results of two example weeks in 2023 and 2029, removing individual plant identifiers**
- **In the 2021 ACC documentation, E3 also published**
  - Comparisons of the historical and SERVM prices in timeseries and price duration curve format
  - Heatmaps of energy, ancillary service prices in snapshot years

Figure 8. Comparing Historical and SERVM Simulated Energy Prices, Showing Price Cap

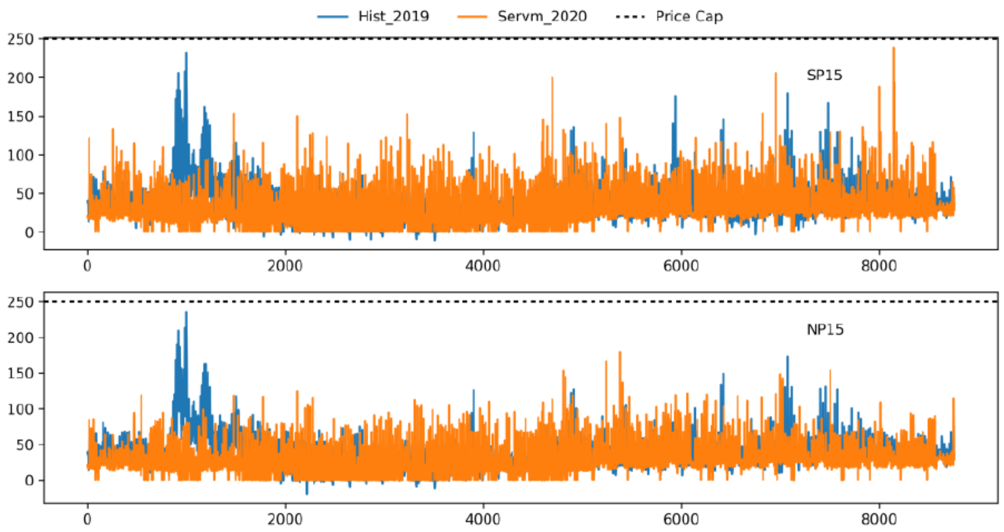


Figure 11. Impact of current year's scarcity adjustment on raw SERVM prices relative to historical data

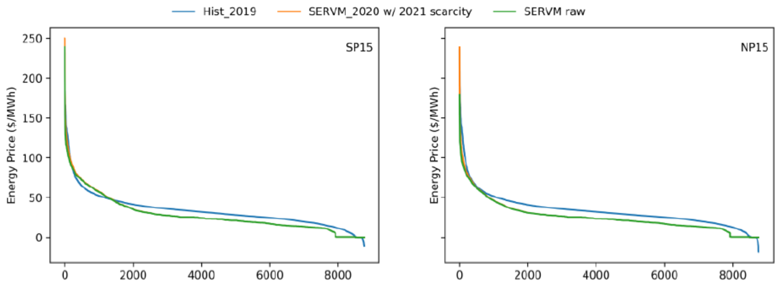


Figure 14. 2030 NP-15 Day Ahead Market Prices from SERVM

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Avg
Jan	55	48	46	45	44	53	53	53	45	40	41	34	34	35	35	52	90	126	64	52	55	74	70	50	54
Feb	53	50	45	45	45	48	65	51	38	24	26	19	17	25	21	26	57	96	74	66	66	89	65	50	48
Mar	54	36	40	40	43	51	65	35	17	9	7	6	3	4	5	11	39	72	114	133	86	64	40	43	42
Apr	26	33	25	16	46	29	39	13	1	0	0	0	11	0	1	13	10	44	91	130	70	33	20	18	28
May	35	24	21	24	21	34	44	4	1	1	0	1	5	3	3	14	29	59	64	121	83	59	42	29	30
Jun	40	29	32	30	37	45	53	18	16	8	5	6	8	12	18	39	59	75	100	136	100	60	45	38	42
Jul	47	28	35	17	32	28	35	18	3	4	2	3	4	9	17	35	62	77	102	172	105	68	48	34	41
Aug	45	39	46	42	42	43	37	29	22	20	18	21	32	32	39	46	46	74	199	166	57	51	43	41	51
Sep	44	43	47	49	53	48	42	29	19	20	11	13	16	22	28	36	55	115	184	82	56	64	45	41	49
Oct	48	43	42	42	44	47	50	36	27	23	18	16	17	21	33	57	63	116	97	63	67	49	49	43	46
Nov	46	46	47	50	41	45	58	40	25	21	16	14	15	16	22	42	64	71	72	74	99	61	43	51	45
Dec	44	48	52	43	44	55	56	56	45	38	38	34	31	31	32	48	106	70	92	64	76	57	46	46	52
Avg	45	39	40	37	41	44	50	32	21	17	15	14	16	18	21	35	57	83	105	105	77	61	46	40	44

Proposal for 2022 ACC SERVM Results Benchmarking

+ **For the 2022 ACC, E3 could provide additional benchmarking to compare results from SERVM model with other production simulation models, acknowledging that there will be differences in modeling assumptions**

2030 Energy Prices from SERVM for 2021 ACC Update

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Avg
Jan	55	48	46	45	44	53	53	53	45	40	41	34	34	35	35	52	90	126	64	52	55	74	70	50	54
Feb	53	50	45	45	45	48	65	51	38	24	26	19	17	25	21	26	57	96	74	66	66	89	65	50	48
Mar	54	36	40	40	43	51	65	35	17	9	7	6	3	4	5	11	39	72	114	133	86	64	40	43	42
Apr	26	33	25	16	46	29	39	13	1	0	0	0	11	0	1	13	10	44	91	130	70	33	20	18	28
May	35	24	21	24	21	34	44	4	1	1	0	1	5	3	3	14	29	59	64	121	83	59	42	29	30
Jun	40	29	32	30	37	45	53	18	16	8	5	6	8	12	18	39	59	75	100	136	100	60	45	38	42
Jul	47	28	35	17	32	28	35	18	3	4	2	3	4	9	17	35	62	77	102	172	105	68	48	34	41
Aug	45	39	46	42	42	43	37	29	22	20	18	21	32	32	39	46	46	74	199	166	57	51	43	41	51
Sep	44	43	47	49	53	48	42	29	19	20	11	13	16	22	28	36	55	115	184	82	56	64	45	41	49
Oct	48	43	42	42	44	47	50	36	27	23	18	16	17	21	33	57	63	116	97	63	67	49	49	43	46
Nov	46	46	47	50	41	45	58	40	25	21	16	14	15	16	22	42	64	71	72	74	99	61	43	51	45
Dec	44	48	52	43	44	55	56	56	45	38	38	34	31	31	32	48	106	70	92	64	76	57	46	46	52
Avg	45	39	40	37	41	44	50	32	21	17	15	14	16	18	21	35	57	83	105	105	77	61	46	40	44

2030 Energy Prices from SERVM from CEC TDV Plexos 2022 Update

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Avg
Jan	74	74	74	74	74	74	74	74	63	42	40	39	39	40	40	42	68	75	75	75	75	75	75	75	64
Feb	71	71	71	71	71	71	71	71	42	22	21	20	20	21	21	24	41	71	71	71	71	71	71	71	54
Mar	58	58	58	58	58	58	58	38	9	1	1	1	1	1	1	2	19	58	58	58	58	58	58	58	37
Apr	50	50	50	50	50	50	48	13	0	-3	-4	-4	-4	-4	-4	-3	1	44	50	50	50	50	50	50	28
May	48	48	48	48	48	48	28	3	-2	-3	-4	-4	-4	-3	-3	-2	8	39	48	48	48	48	48	48	26
Jun	51	51	51	51	51	51	26	9	5	4	4	4	4	4	4	4	15	43	53	62	53	53	53	52	31
Jul	65	65	65	65	65	65	64	33	22	21	21	21	21	21	21	22	31	60	66	70	66	66	66	66	48
Aug	72	72	72	72	72	72	71	46	29	27	27	27	27	27	28	28	42	71	73	73	73	73	72	72	55
Sep	71	71	71	71	71	71	71	44	19	18	18	18	18	18	19	22	48	71	71	71	71	71	71	71	52
Oct	69	69	69	69	69	69	69	52	22	19	19	19	19	20	19	20	65	69	69	69	69	69	69	69	52
Nov	69	68	68	68	68	69	69	68	29	26	26	25	25	25	26	35	69	69	69	69	69	69	69	69	55
Dec	72	71	71	72	72	72	73	73	60	39	38	38	37	37	39	42	73	73	73	73	73	73	73	72	62
Avg	64	64	64	64	64	64	60	44	25	18	17	17	17	17	18	19	40	62	65	66	65	65	65	65	47

Discussion Questions

- Is there a need for review of RESOLVE and SERVM outputs before they are used as inputs to the ACC?
- Is there a need for review of ACC outputs before the ACC is released as part of a Resolution or Decision?
- How much time would be needed for review?
- How should the review fit in with the current structure of the proceeding?

Which files should be made available for review?

Category	Possible Data to be Released
Inputs	IRP resource build by scenario, gas forecast, fossil plant heat rates and renewable profiles
Modeling Docs	Key changes made to SERVM since the 2020 ACC
Raw Results	SERVM dispatch raw results for a typical week in each season for a subset of years, and post-processed results from SERVM
Benchmarking Results	Month-hour average heatmap of raw energy and ancillary service prices, compared with 2021 historical prices for a subset of years
Benchmarking Results	Price duration curve for prices, compared with 2021 historical prices for a subset of years
OTHER?	OTHER?

Note: Production simulation models are proprietary, and require a license fee and substantial expertise to run, so it is not feasible to provide stakeholders direct access to the model and case files.

Session 9 (Topic 7)

Issues related to natural gas

Natural Gas

- Natural Gas GHG Adder
  - Should the Natural Gas ACC and the Electric ACC use the same GHG adder?
  - Should (someone) develop a Natural Gas GHG adder based on the cost of renewable natural gas?
  - If so, who should do this (or where should it be done)?
- Are other changes needed to the Natural Gas ACC?
- Gas Transportation Rates (SEIA presentation)

Natural gas transportation rate issues

- Split between northern (PG&E) and southern (SoCalGas) California
- Choice of the marginal Electric Generation (EG) transportation rate
- Use currently-effective and approved gas transportation rates
- Use of the IEPR forecast – limit it to the market cost of gas at the California border?
- Future escalation in gas transportation rates – the general inflation rate is too low.
  - Gas throughput will decline.
  - Gas utilities continue to incur significant safety & replacement costs.
  - Look at historical trends since the San Bruno explosion.
  - Recent studies of future gas transport rates
    - Gridworks, *California's Gas System in Transition: Equitable, Affordable, Decarbonized and Smaller*, available at https://gridworks.org/initiatives/cagas-system-transition/.

Session 10 (Topic 8)

Definition of major vs. minor ACC updates

Discussion Questions

- Are "minor" and "major" ACC updates clearly defined?
- If not, what should we change?

D.16-06-007, Section 2.2:
The annual data update shall also include updates to the inputs contained in…Attachment 2. However, the annual update shall not add to or delete from the list of avoided costs in the calculator, or modify (except for correcting errors) the methods or models used to estimate the various avoided costs.

D.19-05-019, Section 7:
We clarify that minor changes include data and input updates as indicated in D.16-06-007 but can also include changes to the modeling method that most parties can reasonably agree are minor in scope and impact.

California Public Utilities Commission

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Appendix

Energy+Environmental Economics

Annualized Storage Costs

Declining Storage Capital Costs in RESOLVE and ACC Modeling

- **There are multiple ways to skin a cat and no one ‘right’ way to annualize capital costs of a long-lived asset**
- **Capital costs of energy storage are modeled in RESOLVE and in the ACC**
- **RESOLVE**
  - Is multi-period optimization that considers declining technology costs for energy storage endogenously. All else equal, the model will delay adoption of storage to take advantage of declining costs
  - RESOLVE models project risk and financial structure specific to each resource assuming cost recovery via long-term PPA with detailed financial pro-forma modeling. This approach reflects the timing of cash flows more accurately than a RECC calculation.
- **ACC**
  - Uses Capital, Fixed O&M, Periodic Replacement and Augmentation costs for energy storage directly from RESOLVE
  - For any year, you can select and view the detailed financial pro forma that calculates the annualized costs in the ACC Net Cone spreadsheet. (https://willdan.box.com/v/2021CPUCAvoidedCosts)

Annualized Storage Costs

Storage Cost Inputs (IRP)

Resource			Utility-scale Battery - Li [Capacity] - No ITC	Utility-scale Battery - Li [Energy] - No ITC
Category for Cost Reductions	Resource Category		Battery Storage-Standalone	Battery Storage-Standalone
	Technology Type		Lithium ion (Grid) - Capacity	Lithium ion (Grid) - Energy
	Techno-Resource Group			
	Active Cost Trajectory Scenario		Mid	Mid
Performance Inputs		**Units**		
Plant Output	Installed Capacity	MW-ac	1	4
	Capacity Factor	%	15.0%	
	Degradation	%/yr	0.0%	
Plant Cost Inputs				
Capital Costs	Installed Cost, 2018	$/kW-ac	$208	$244
	Progress Multiplier	%	94%	94%
	Installed Cost, 2020	$/kW-ac	$196	$230
Interconnection Costs	Interconnection Fraction of CapEX	%		
	Interconnection Cost	$/kW	$0	
Fixed O&M	Annual Fixed O&M, 2018 COD	$/kW-yr	$1.7	$2.0
	Progress Multiplier	%	94%	94%
	Annual Fixed O&M, 2020 COD	$/kW-yr	$1.57	$1.84
	Annual Escalation	%/yr	2.00%	2.00%
Variable O&M	Variable O&M	$/MWh	$0	$0
	Annual Escalation	%/yr	2.00%	2.00%
Fuel Costs	Fuel Type			
	Unit Fuel Cost	$/MMBtu	0	0
	Annual Escalation	%/yr	0.02	0.02
	Heat Rate	Btu/kWh		
Warranty & Augmentation Costs	Annual Warranty Extension Cost	%	1.5%	1.5%
	Initial Warranty Length	yrs	2	2
	Annual Augmentation Cost	%	0.0%	4.2%
Property Tax	Property Tax	%	0.0%	0.0%

Detailed Financial Pro Forma

Levelized Cost Calculation - Utility-scale Battery - Li [Energy] - No ITC,	
Pro_Forma tab from RESOLVE Resource Costs and Build	
Resource Cost, Performance, & Financing	
System Cost	
System Size (MW)	1.00
Duration (hours)	4
Capacity Costs ($/kW)	$196
Energy Costs ($/kWh Installed)	$230
System Cost ($/kW)	$1,116
Capacity Costs ($)	$195,861
Energy Costs ($)	$920,578
System Cost ($)	$1,116,440
Initial debt service reserve funding ($)	0
Total System Cost ($)	$1,116,440
Interconnection Cost ($/kW)	$0
Interconnection Cost ($)	$0
Performance Inputs	
Capacity Factor (AC)	15.0%
Annual Output for Year 1 (kWh)	1,314
Degradation Factor	0.00%
System Economic Life (=PPA Term)	20
Ongoing Costs	
Fixed O&M Costs Capacity ($/kW-yr)	$1.57
Fixed O&M Costs Energy ($/kWh Installed-yr)	$1.84
Fixed O&M Costs ($/kW-yr)	$8.93
Fixed O&M Costs Escalator (%/yr)	2.00%
Variable O&M Costs ($/MWh)	$0.00
Variable O&M Costs Escalator (%/yr)	2.00%

Levelization of Cost by Category	1	2	3
Capital Costs	$28,902	$60,661	$38,679
Investment Tax Credit	$0	$0	$0
Fixed Operations & Maintenanc	($6,561)	($6,692)	($6,826)
Warranty	$0	$0	($12,798)
Augmentation	($28,402)	($28,970)	($29,549)
Total	($6,060)	$25,000	($10,494)
Total Fixed Cost	*($6,060)*	*$25,000*	*($10,494)*
Discount Rate			
NPV Energy			
NPV Capacity			
Levelized All-In Costs ($/MWh)			
Levelized Fixed Costs ($/MWh)			
Variable Cost Pass Through	$0	$0	$0

Cash Flow	1	2	3
Energy Production (MWh)	**1,314**	**1,314**	**1,314**
Capacity (MW)	**1**	**1**	**1**
Cost of Generation ($/MWh)	$138.20	$140.96	$143.78
Operating Revenue	$181,596	$185,228	$188,932
Total Revenue	**$181,596**	**$185,228**	**$188,932**
Fixed O&M Costs	($9,110)	($9,292)	($9,478)
Warranty	$0	$0	($17,772)
Augmentation	($39,438)	($40,226)	($41,031)
Total Costs	**($48,548)**	**($49,519)**	**($68,281)**
Operating Profit	**$133,048**	**$135,709**	**$120,651**
Interest Expense	($10,555)	($10,170)	($9,767)
Loan Repayment Expense (Principal)	($8,141)	($8,526)	($8,929)

Summary Annualized Costs

RESOLVE and ACC models match

Outputs	$/MWh	$/kW-yr
Capital	$88.89	**$116.81**
Interconnection Cost	$0.00	$0.00
Property Tax & Insurance	$0.00	$0.00
ITC	$0.00	$0.00
Fixed O&M	$6.80	**$8.93**
Warranty	$10.37	$13.63
Augmentation	$29.42	$38.66
Periodic Replacement	$0.00	$0.00
Variable O&M	$0.00	
Fuel	$0.00	
Carbon	$0.00	
PTC	$0.00	$0.00
Total	**$135.49**	**$178.03**