Technical Workshop #3 – Aliso OII I.17-02-002
Final Production Cost Modeling Results, Econometric Modeling, Hydraulic Modeling Updates, and PCM Updates

Energy Resource Modeling Team

Energy Division, CPUC

WebEx only

July 28, 2020

TODAY'S AGENDA

9:30 – 9:45 Introduction. Ground Rules, Review Purpose and Goals

Donald Brooks, *Program and Project Supervisor*

9:45 – 10:00 Review of Phase II Schedule and Order of Modeling Steps

Donald Brooks, *Program and Project Supervisor*

10:00 – 11:15 Production Cost Modeling Results

Mounir Fellahi, *Regulatory Analyst*

- 45 min presentation / 30 min Q/A

11:15 – 11:30 Break

11:30 – 12:30 Overview of Hydraulic Modeling–

Results and Sensitivities of Simulation 01 (Winter 2020),

Lisa Cosby, *Regulatory Analyst*

- 30 min presentation / 30 min Q/A

12:30 – 1:30 Lunch Break

1:30 – 2:30 1-in-10 Winter Peak and Summer Hydraulic Modeling Results– Simulations 1-6

Anatoly Zlotnik, Ph.D., *Los Alamos National Laboratory*

- 30 min presentation / 30 min Q/A

2:30 – 2:45 Break

2:45 - 4:00 - Hourly Profiles and Zonal Capacities Studies

Khaled Abdelaziz, Ph.D., Utilities Engineer

- 45 min presentation / 30 min Q/A

4:00 – 4:30 – Wrap Up/Next Steps

Workshop Logistics

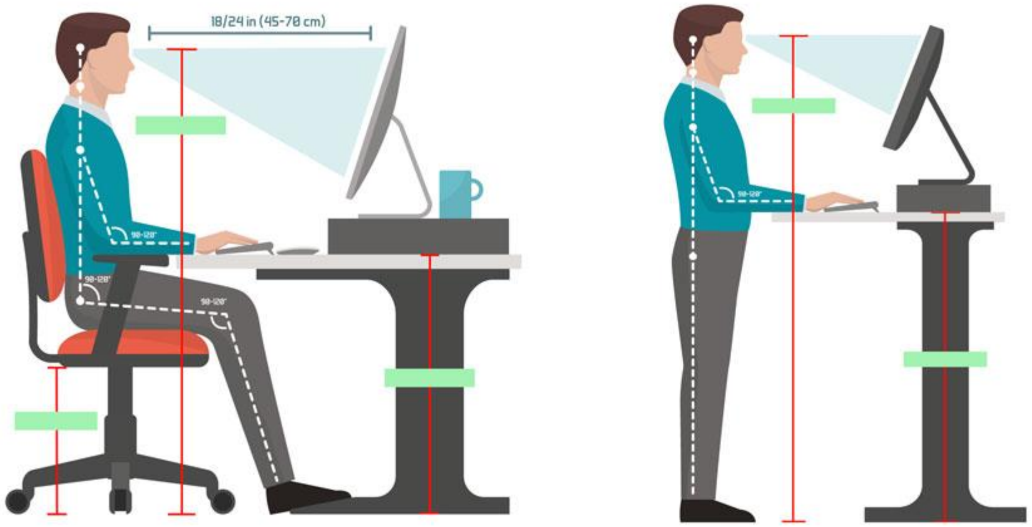
- Online only

Join through this link:
https://cpuc.webex.com/cpuc/onstage/g.php?MTID=e416740e7b54e0e73271e2fdb92beba5d

  - Audio through computer or phone
  - Toll-free 1-855-282-6330
  - Access code: 146 549 8460
  - ***This workshop is being recorded***

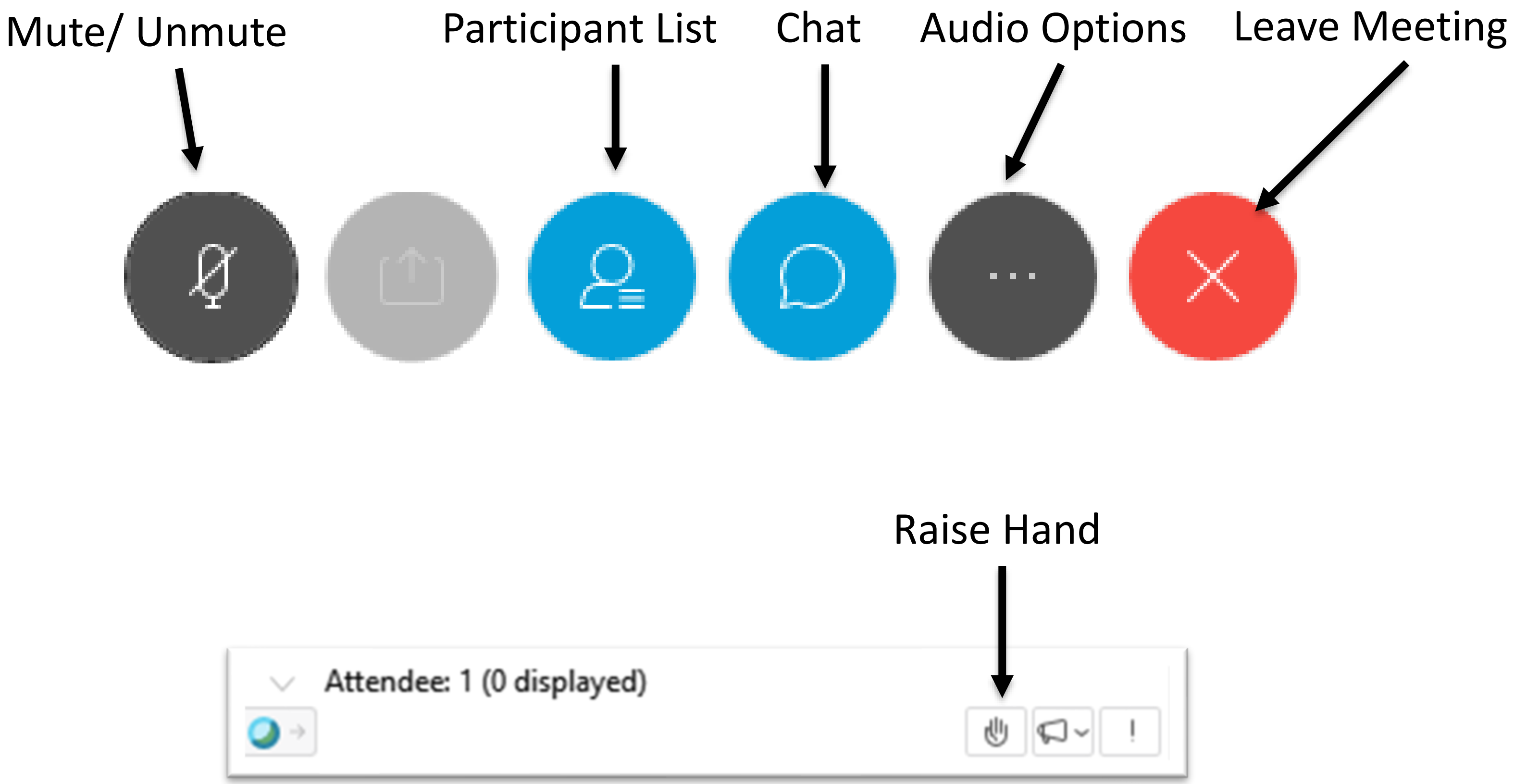
- Hosts:
  - Commissioner Randolph
  - Energy Division Staff:
    - Christina Ly Tan
    - Donald Brooks

- Safety
  - Note surroundings and emergency exits
  - Ergonomic Check



Workshop Logistics

- Today's presentations (.pdf) and agenda are available on the WebEx link under "Event Material." Type password "Aliso123" into the box and click "View Info,"
- Please submit questions for speakers in the Chat box or raise your hand to be unmuted by staff
- Questions will be read aloud by staff (Reminder: Mute back!)



Discussion Logistics

- Scope of the workshop today:
  - This Webinar will address issues in Phase 2 of the Aliso OII I.17-02-002 but is not intended to address Phase 3 issues.
- Workshop is structured to stimulate an honest dialogue and engage different perspectives
- Keep comments friendly and respectful
- Chat feature is only for Q&A or technical issues. Do not start or respond to sidebar conversations
  - This will be held via WebEx Events, where everyone is muted at the beginning of the webinar.
  - Speakers are asked to state their name and their organization before speaking.
  - To speak during the Q/A times, please send your questions to the moderator via the Chat feature or via email: AlisoCanyonOII@cpuc.ca.gov

Workshop Objectives

- Information sharing:
  - Review overall objectives and analysis required for I.17-02-002.
  - Present the results for Production Cost Modeling.
  - Present an Overview of Hydraulic Modeling.
  - Present the 1-in-10 Winter Peak and Summer Hydraulic Modeling Results.
  - Present the Hourly Profiles and Zonal Capacity Studies.
- Solicit feedback, answer questions from parties, and promote open, informal discussion.

Review of Objectives - Phases of Proceeding

- The CPUC opened I.17-02-002 pursuant to SB 380 to "determine the feasibility of minimizing or eliminating the use of the Aliso Canyon Natural Gas Storage Facility while maintaining energy and electric system reliability."
- CPUC staff have engaged in an extensive stakeholder process to evaluate the effects of minimizing or eliminating Aliso.
- The CPUC published a Final Scenarios Framework on Jan 4, 2019, which described the overall sequence and process of studies in Phase 1 of the proceeding.

Review of Objectives - Phases of Proceeding

- The Scenarios Framework sought to answer the following questions:
  - Is the Aliso Canyon storage field needed for reliability?
  - If so, what is the minimum inventory level required?
  - What are the cost and affordability impacts to gas and electric customers if the Aliso storage field is closed or operated at reduced inventory?
- This Phase 2 workshop presents results of studies designed to identify the gaps or the needs that could result if Aliso Canyon is minimized or eliminated given the gas infrastructure currently in place and current statutes, rules, and regulations.
- Once we identify these gaps, we can begin to discuss what changes could be made to gas infrastructure, rules and regulations to eliminate the need for Aliso Canyon in Phase 3.

Unconstrained and Minimum Local Generation Production Cost Modeling Results for Aliso OII

Mounir Fellahi

Energy Resource Modeling Team, Energy Division

July 28, 2020

California Public Utilities Commission

Outline of Presentation

- Overview and Objectives of the Production Cost Model
- Overview of Modeling Inputs and Study Approach
- Production Cost Model Results
- Use of PCM Results to Develop Hydraulic Modeling Inputs – Hourly Gas Usage Profiles
- Q/A

Summary of Findings

- Reliability (expected outage events/year):
  - ➢ There is a significant degradation in reliability in all study years.
    - ➢ The Minimum Local Generation scenario has higher LOLE than the Unconstrained scenario.
    - ➢ When CAISO and LADWP generation was curtailed in the Minimum Local Generation scenario, there was an increase in LOLE; the deficit was partially made up with increased imports into CAISO.
- Production cost ($MM)
  - ➢ Production costs in the Minimum Local Generation Scenario were $121.3 million higher than the Unconstrained Scenario in 2030.
- Emissions (MMT CO2)
  - ➢ In 2030, there is a slight decrease in emissions in the Minimum Local Generation scenario compared to the Unconstrained scenario due to inability to fully serve all the electric demand.

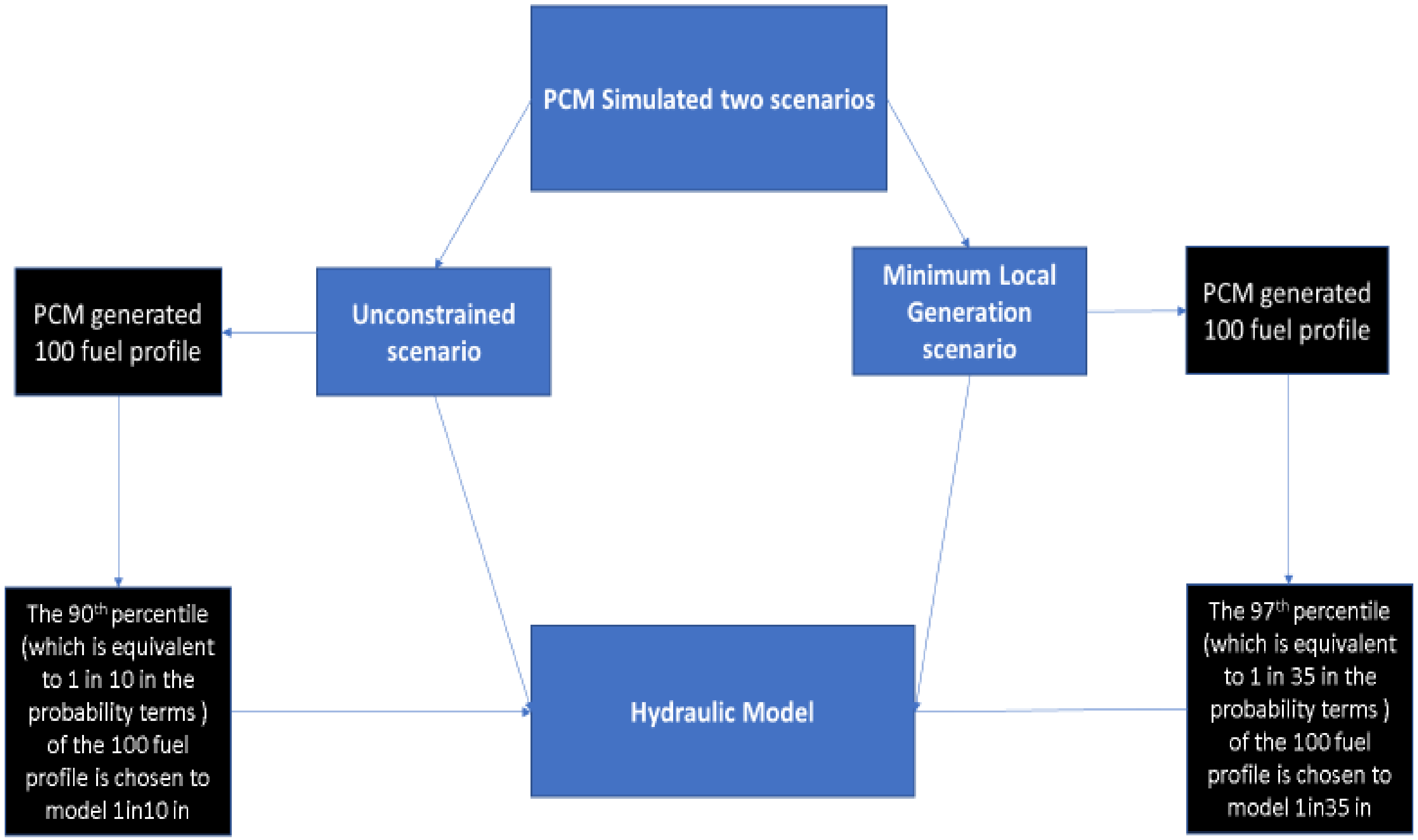
OVERVIEW AND OBJECTIVES OF THE PRODUCTION COST MODEL

Production Cost Modeling in Aliso OII - Objectives

Production Cost Modeling (PCM) serves two necessary purposes in the Aliso Proceeding.

1. To determine whether the Minimum Local Generation scenario degrades reliability and/or increases economic costs relative to the Unconstrained Gas scenario
   - Reliability is expressed in Loss of Load Expectation (LOLE) greater than 0.1 LOLE (one event in 10 years) in 2020, 2025, and 2030.
   - Economic costs are calculated as increased production cost ($/MWh) in 2020, 2025, and 2030.
2. Provide hydraulic modeling with gas demand profiles from electric generation in future study years in order to update assumptions for the hydraulic modeling.
   - Future gas demand scenarios were updated to reflect the significant renewable and storage investments anticipated in the Integrated Resource Plan (IRP)

Process to Develop Gas Use Profiles

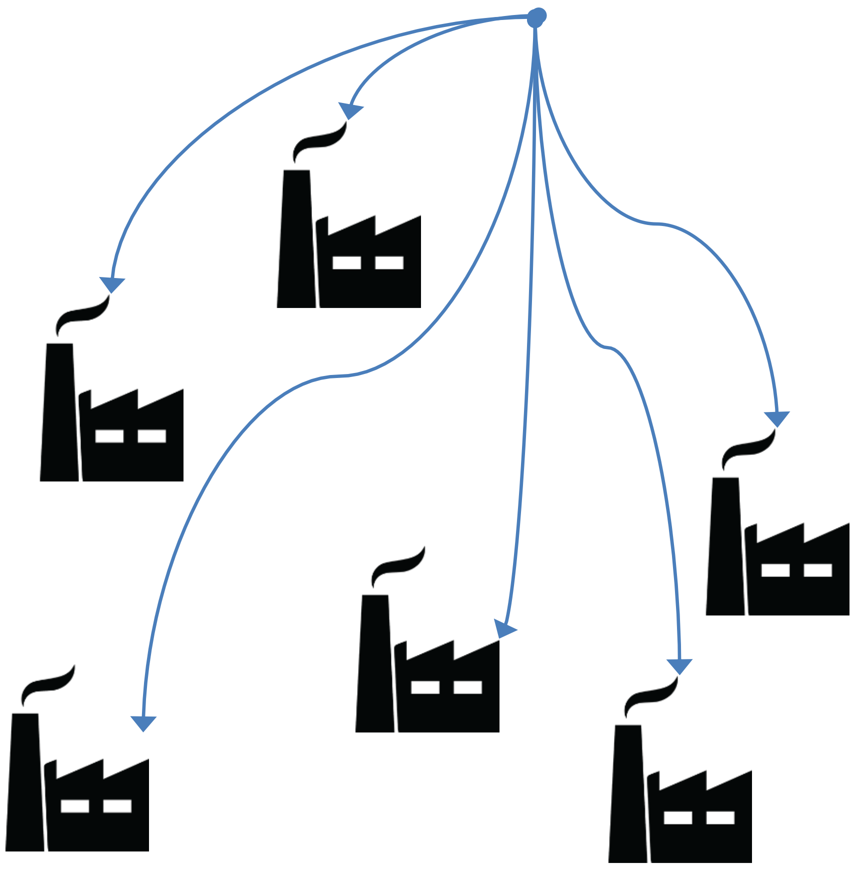


- **September was chosen as the representative month for summer and December for winter.**
- **The 100 fuel burn results for a given month (September or December) are ranked from the lowest to the highest for each scenario.**
- **Fuel burn cases are selected as the basis for the hydraulic modeling.**

Unconstrained Scenario Modeling Outline

- Staff used a PCM approach to produce a plan of what electric generators (EG) will be operating and what their likely production patterns would be under two operating scenarios.
- Staff modeled all regions in WECC but are presenting- results for the CAISO region only.
- The two scenarios:
  1. Unconstrained scenario - no electric curtailment.
     - Corresponds to the 2019-20 Reference System Plan recently adopted in the Integrated Resource Plan (IRP).

Unconstrained gas flow



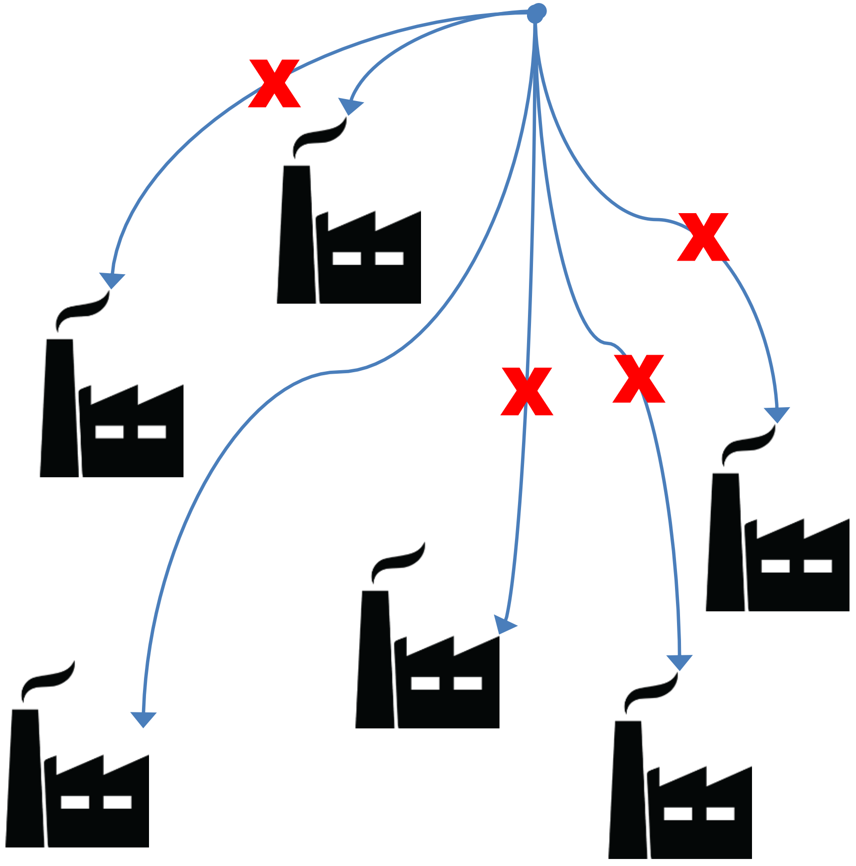
Refer to the Scenarios Framework for more info on PCM

Minimum Local Generation Scenario Modeling Outline

2. Minimum Local Generation (Minimum Local Generation) scenario – Electric Generation in SoCalGas system curtailed down to the minimum needed to meet Local Reliability Criteria, according to FERC.

  - This scenario simulates the expected electric reliability effect in the event of a significant curtailment of the availability of gas to supply generation in the SoCalGas gas network.

Minimum Local Generation gas flow



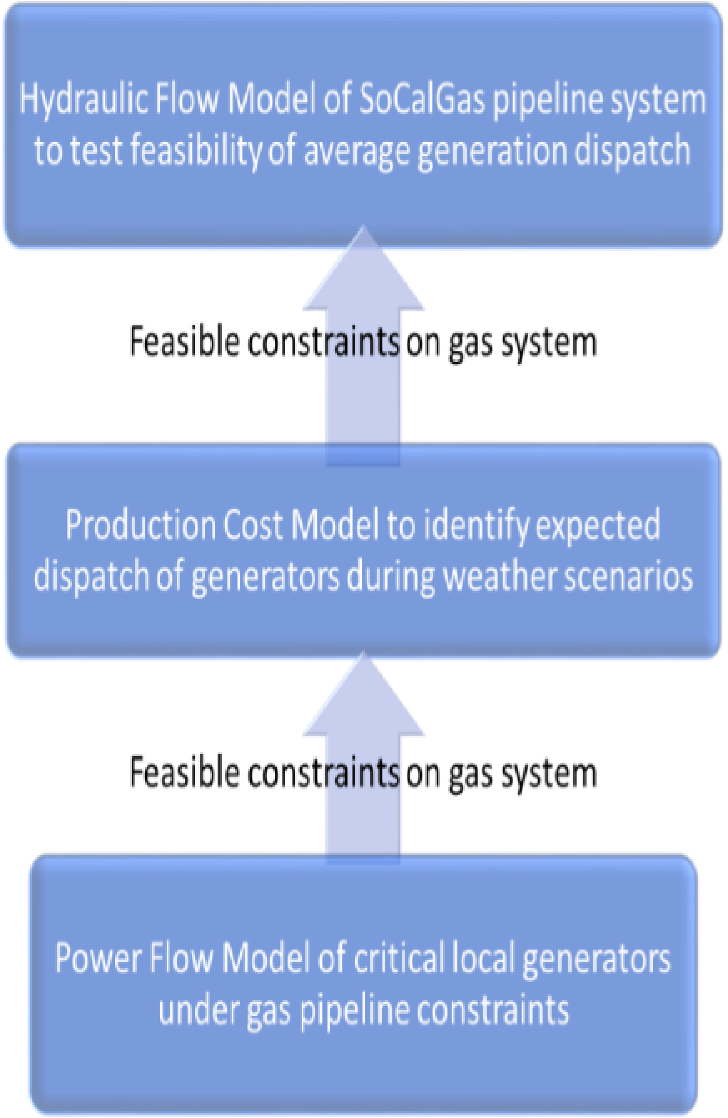
Bottom up Approach

- PCM fits in between power flow studies (Minimum Local Gen scenario) and Hydraulic Modeling

- PCM provides two products that are used in hydraulic modeling:

1. Unconstrained scenario hourly gen gas demand profiles

2. Minimum Local Generation scenario hourly gas demand profiles



OVERVIEW OF MODELING INPUTS AND STUDY APPROACH

SERVM Model Overview

The Strategic Energy Risk Valuation Model (SERVM)* is a probabilistic system-reliability planning and production cost model. The primary objective is to meet the reliability risk and minimizing the costs.

- 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
  - Individual generating units and all 8,760 hours of year are simulated
  - Unit operating costs and constraints
  - Generating units are modeled individually across all of the Western Electricity Coordinating Council (WECC) area
- Zonal 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
- For more information regarding modeling inputs please see Appendix

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

Review of SERVM Reliability Metrics

- Staff validates the reliability of portfolios through Loss-of-Load Expectation (LOLE) studies with SERVM
  - Output metrics include expected frequency of events (LOLE), expected duration of unserved energy (Loss-of-Load Hours or LOLH), and expected volume of unserved energy (Expected Unserved Energy or EUE)
  - Staff considered the electric system sufficiently reliable if the probability-weighted LOLE was less than or equal to 0.1. This corresponds to about 1 day in 10 years where firm load must be shed to balance the grid.

Unconstrained Scenario

Staff used results of the IRP proceeding Reference System Plan as the basis for the Unconstrained Scenario

i. Staff modeled three study years, 2022, 2026, and 2030 and calibrated each study year to ensure that the fleet of resources was reliable (meaning LOLE of 0.1 or below).

ii. All generating units and electric demand forecasts were the same as the PUC adopted Reference System Plan.

iii. Staff measured GHG emissions and production costs.

Minimum Local Generation Scenario

Staff modified the Unconstrained scenario to reflect the Minimum Local Generation Scenario.

I. Staff curtailed generation in September (matching the peak summer month power flow results) and December (matching peak winter month power flow results) based on power flow modeling results provided to the CPUC from the CAISO and LADWP.

II. Staff simulated three study years 2020, 2025, and 2030. These study years represent the three study years simulated in hydraulic modeling, but are different than the study years from the Unconstrained Scenario. Unconstrained Scenario meant to closely match the Reference System Plan.

III. Differences in study years did not produce significantly different results.

IV. Loss of Load results are compared across all study years; 2030 study year only GHG emissions and production costs are compared between Unconstrained Scenario and Minimum Local Generation scenario.

Thermal Generation Modeled in SCE, SDGE, IID and LADWP in Unconstrained and Minimum Local Gen Scenarios

2020 Unit Type	Unconstrained	MinLocGen	Percentage Generation Removed
Combined Cycle	9580	7255	24%
Peaker	6179	5072	18%
Cogen	1126	592	47%
Total	16885	12919	23%
2025 Unit Type	**Unconstrained**	**MinLocGen**	**Percentage Generation Removed**
Combined Cycle	10274	9120	11%
Peaker	6281	4802	24%
Cogen	1126	592	47%
Total	17681	14514	18%
2030 Unit Type	**Unconstrained**	**MinLocGen**	**Percentage Generation Removed**
Combined Cycle	10043	6991	30%
Peaker	6245	3749	40%
Cogen	1126	592	47%
Total	17414	11332	35%

- The graph shows the gas power plant generation capacity in Unconstrained and Minimum Local Generation scenarios.
- This chart shows how much capacity of each resource type is curtailed in the Minimum Local Generation scenario.

BREAK FOR QUESTIONS

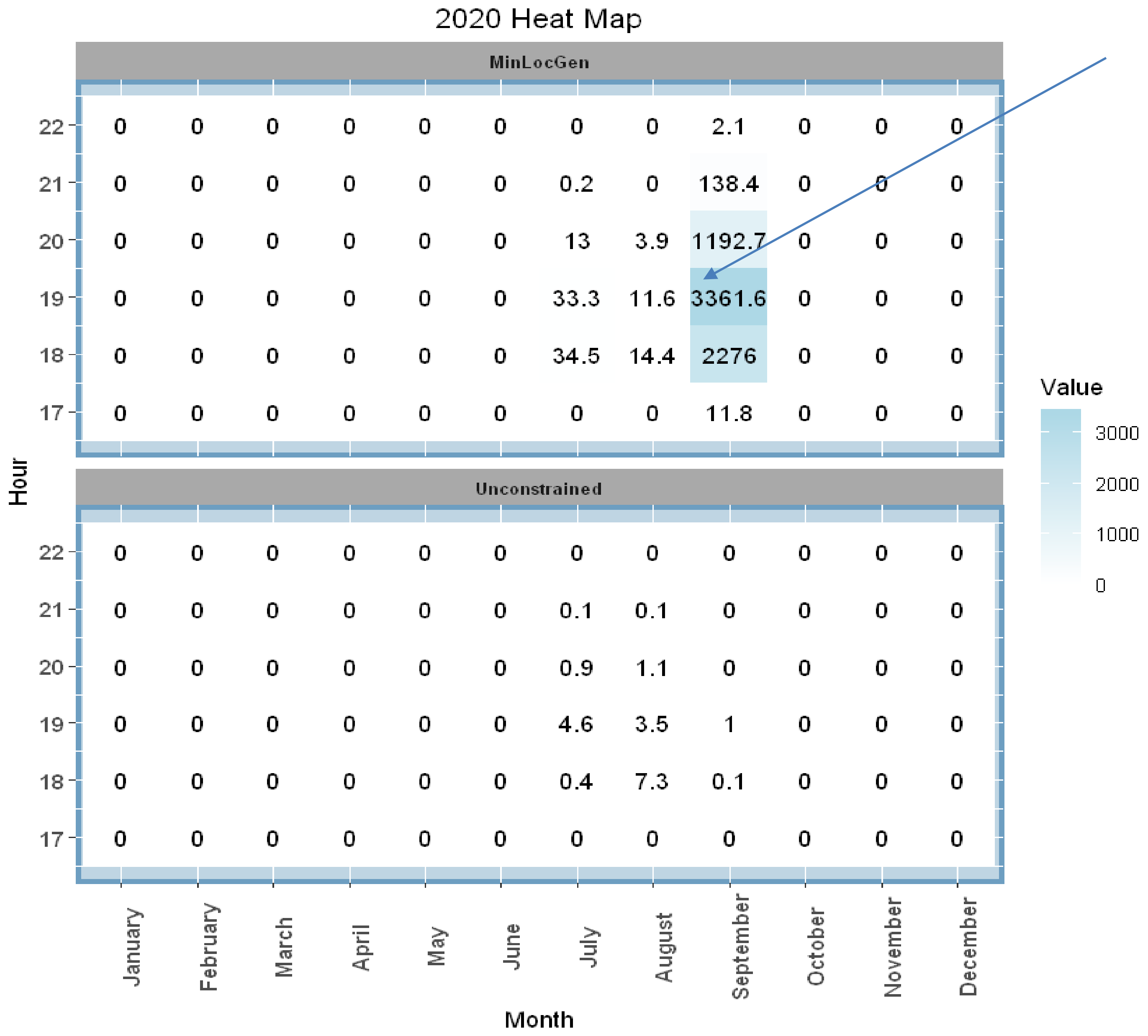
PRODUCTION COST MODEL (SERVM) RESULTS

Minimum Local Generation Scenario Experienced a Higher LOLE

Year	2022	2026	2030	2020	2025	2030
Reliability Metrics	1 in 10	1 in 10	1 in 10	1 in 35	1 in 35	1 in 35
LOLE (expected outage events/year)	0.03	0.11	0.11	2.42	0.68	2.13
LOLH (hours/year)	0.04	0.25	0.26	5.14	1.63	5.39
LOLH/LOLE (hours/event)	1.29	2.24	2.37	2.13	2.41	2.54
EUE (MWh)	19.16	292.72	598.75	7,093.51	3,061.14	14,165.02
Annual load (MWh)	246,957,298	252,862,208	255,838,470	241,931,674	251,926,877	255,830,240

Average length of LOLE event is similar in all cases

Significant increase in EUE (MWh) from Unconstrained to Minimum Local Generation Scenarios

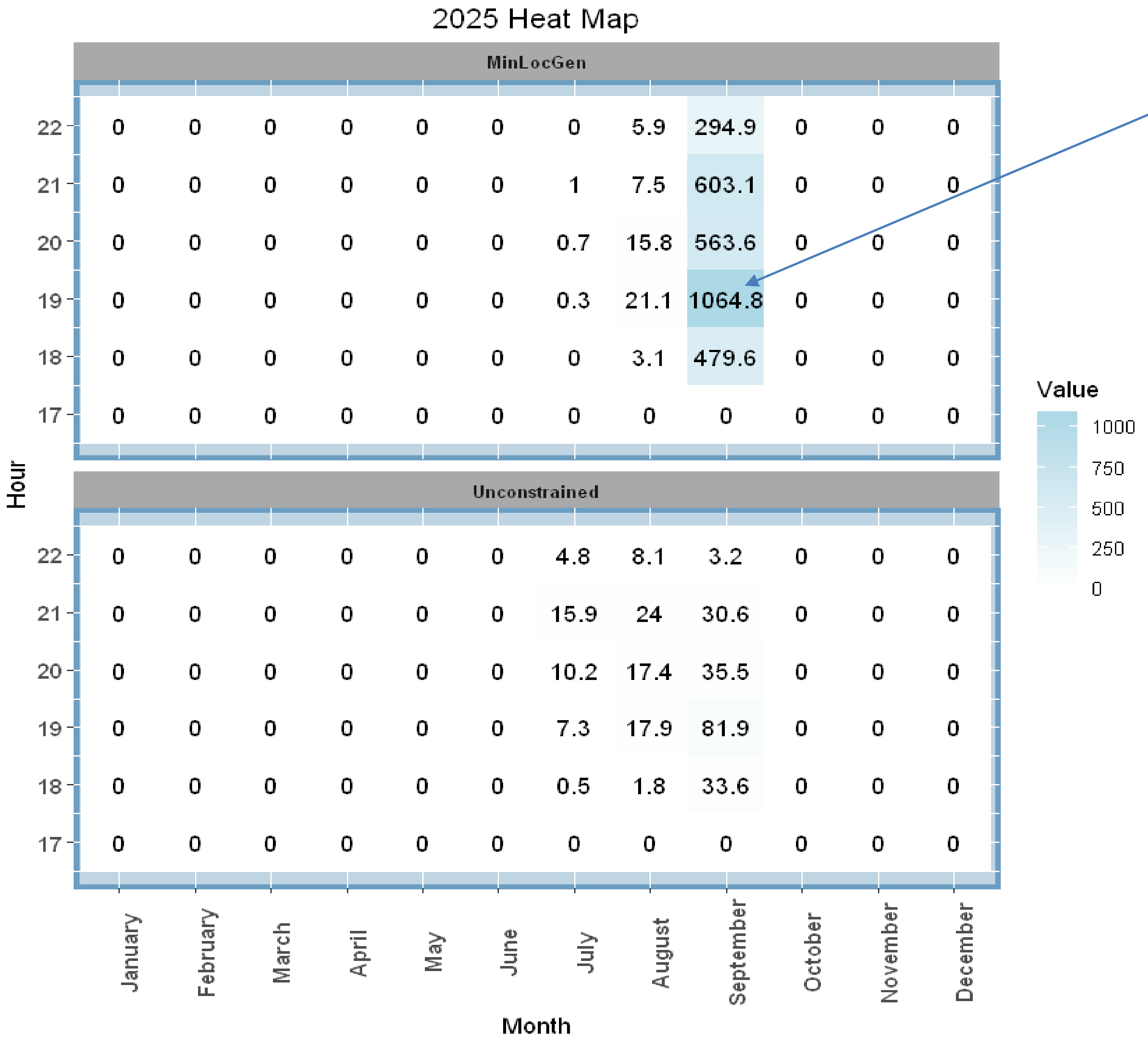


- **Significant increase in EUE in September in Constrained scenario.**
- **The EUE in July and August in both scenarios are roughly the same because no constraints were added to those months.**
- **Constrained scenario causes approximately 6,800 MWh of unserved load in September 2020.**

Note:

- Heat maps illustrating the month-hour where Expected Unserved Energy (EUE) occurs is an intuitive way of showing <u>when</u> loss-of-load events are likely to occur and quantifying the likely <u>magnitude</u> of those events
- Likely LOLE and EUE hours are consistently in the summer <u>evening hours of 5-10pm</u> and shift later for each study year – an expected outcome as solar PV penetration shifts the peak hour later in the evening

Significant increase in EUE (MWh) from Unconstrained to Minimum Local Generation Scenario

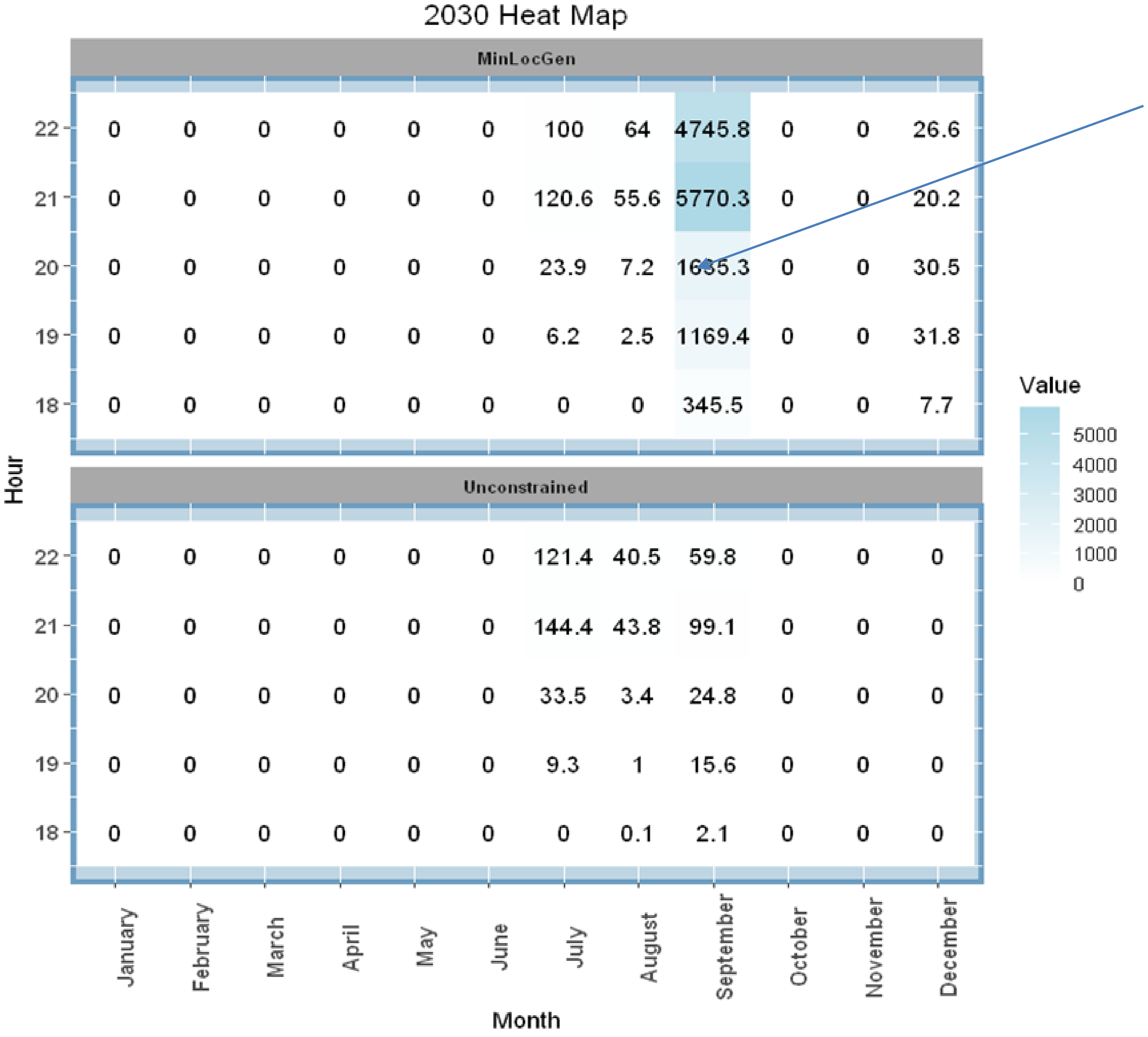


- **Significant reliability decrease in September in the Minimum Local Generation scenario.**
- **The EUE in July and August in both scenarios are roughly the same.**
- **Minimum Local Generation scenario causes approximately 3,600 MWh of unserved load in September 2025.**

Note:

- Heat maps illustrating the month-hour where Expected Unserved Energy (EUE) occurs is an intuitive way of showing <u>when</u> loss-of-load events are likely to occur and quantifying the likely <u>magnitude</u> of those events
- Likely LOLE and EUE hours are consistently in the summer <u>evening hours of 5-10pm</u> and shift later for each study year – an expected outcome as solar PV penetration shifts the peak hour later in the evening

Significant increase in EUE (MWh) from Unconstrained to Minimum Local Generation Scenarios



- **Significant reliability decrease in September in Minimum Local Generation scenario.**
- **The EUE in July and August in both scenarios are roughly the same.**
- **Minimum Local Generation scenario causes approximately 13,664 MWh of unserved load in September 2030.**
- **2030 was only study year to have EUE in December due to Minimum Local Generation scenario.**

Note:

- Heat maps illustrating the month-hour where Expected Unserved Energy (EUE) occurs is an intuitive way of showing when loss-of-load events are likely to occur and quantifying the likely magnitude of those events
- Likely LOLE and EUE hours are consistently in the summer evening hours of 5-10pm and shift later for each study year – an expected outcome as solar PV penetration shifts the peak hour later in the evening

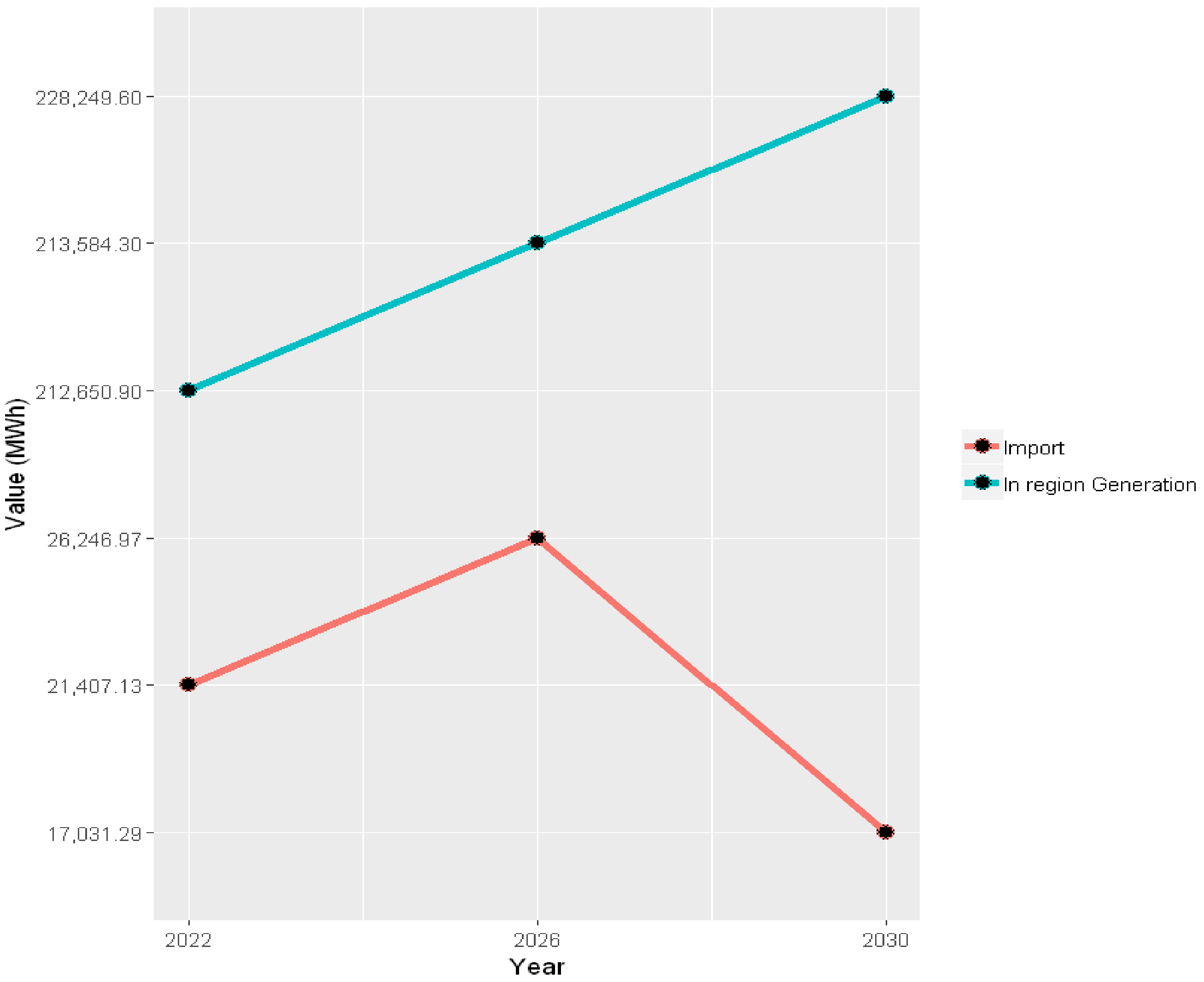
Energy Generation Compared to Electric Demand in Unconstrained vs. Minimum Local Generation Scenario

CAISO System Balance (GWh)	2030	2030
Category	Unconstrained	Minimum Local Generation
In-region Generation serving CAISO load, including BTMPV, and excluding storage discharge	228,249.60	224,664.30
Non-PV Load Modifiers (net effect of AAEE, EV, TOU)	15,848.77	15,855.36
Unspecified carbon-emitting imports netted hourly (no NW Hydro)	17,031.29	20,328.44
Load (not including net effects of non-PV load modifiers: AAEE, EV, TOU)	255,838.50	255,830.20
Non-PV Load Modifiers (net effect of AAEE, EV, TOU)	15,848.77	15,855.36
Unspecified carbon-emitting exports netted hourly	7,562.65	7,419.62
Battery and Pumped Storage Hydro losses (net of charge and discharge)	3,610.99	3,582.23
Curtailment	1,056.69	1,092.73

Minimum Local Generation scenario curtailed thermal generation in September and December, which decreased overall generation by a small amount

Decrease in CAISO generation made up for by increased imports

Decrease in Imports; Increased Reliance on In-State Generation



- **The Reference System Plan anticipates increased reliance on in-state generation between 2022 and 2030. That outcome drives the Unconstrained and Minimum Local Generation scenarios**

- **Reason: Imports from outside CAISO decrease over time as other states transition from fossil to more renewables and retire a large amount of coal generation.**

Total Production Costs ($MM/Year) Higher in Minimum Local Generation Scenario (2030)

CAISO Production Costs $MM/year	2030	2030
Category	Unconstrained	Minimum Local Generation
Emissions	718.26	680.54
Fuel	2,069.94	1,969.00
Startup	246.95	243.52
VOM	68.78	66.77
Unspecified Imports	1,194.42	1,493.48
Unspecified Exports	-646.66	-680.30
Total Production Costs ($MM)	3,652.27	3,773.60

Production costs were higher in the Minimum Local Generation scenario by $121.326 million

Fuel Use and GHG Emissions in CAISO Territory were lower in Minimum Local Generation Scenario (2030)

Emissions in MMT CO2	2030	2030
Category	Unconstrained	Minimum Local Generation
CAISO_CCGT1	16.88	16.03
CAISO_CCGT2	2.29	2.24
CAISO_Peaker1	2.99	2.7
CAISO_Peaker2	2.08	2.04
Steam	0	0
Biomass	0	0
Geothermal	0	0
Cogen	4.3	4.01
Nuclear	0	0
ICE	0.05	0.06
Emissions total	28.6	27.08

Fuel burn (MMBTU)	2030	2030
Category	Unconstrained	Minimum Local Generation
CAISO_CCGT1	318,120,022.20	302,060,519.20
CAISO_CCGT2	43,192,377.23	42,198,899.64
CAISO_Peaker1	56,315,520.42	50,945,155.96
CAISO_Peaker2	38,806,375.17	38,014,431.28
Steam	0	0
Cogen	80,641,355.73	75,183,996.84
ICE	938,143.65	1,136,177.81

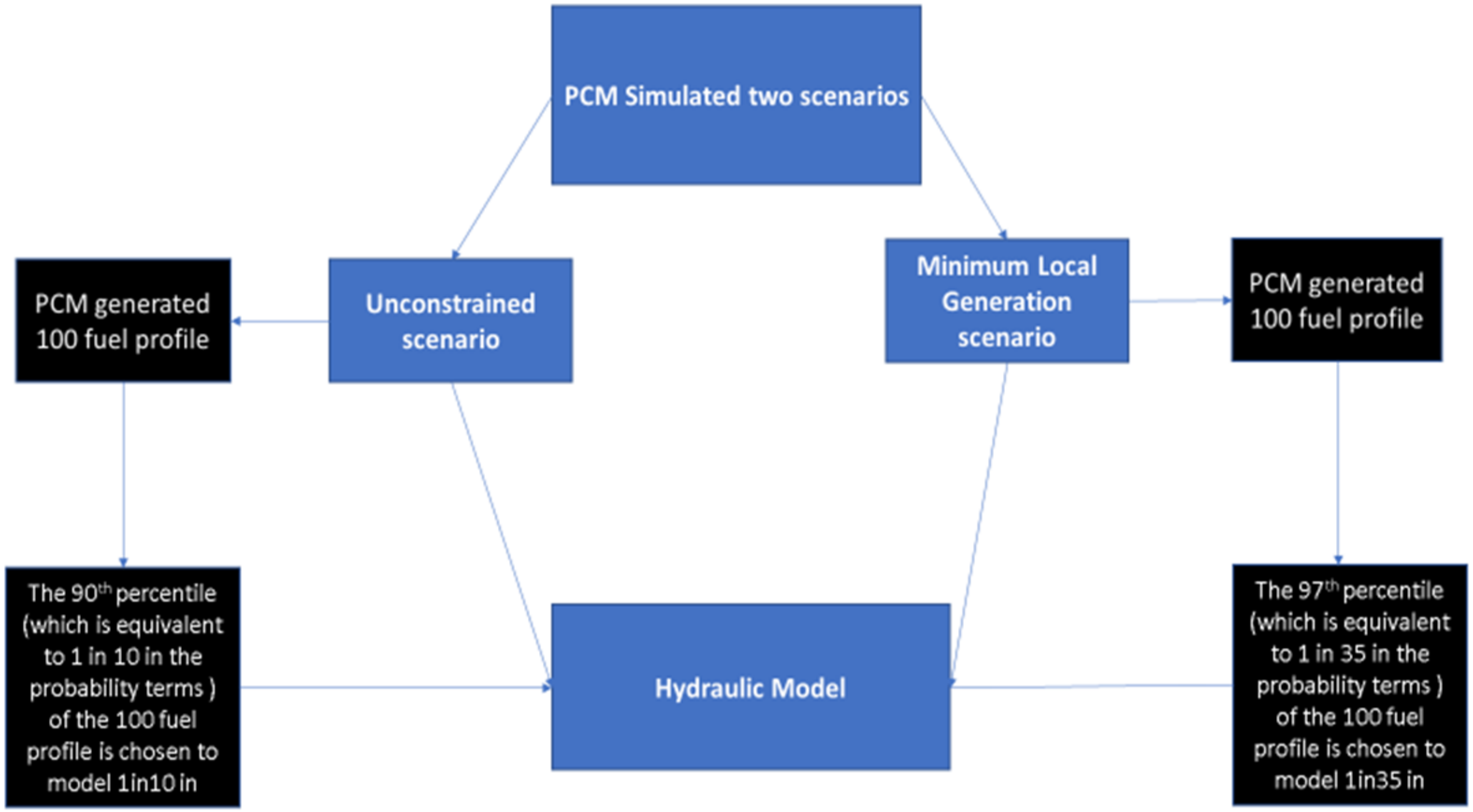
The Minimum Local Generation scenario leads to more electric demand unmet ad less generation from thermal generation overall. That leads to slightly lower emissions.

Summary of Findings

- Reliability (expected outage events/year):
  - ➢ There is a significant degradation in reliability in all study years.
    - ➢ The Minimum Local Generation scenario has higher LOLE than the Unconstrained scenario.
    - ➢ When CAISO and LADWP generation was curtailed in the Minimum Local Generation scenario, there was an increase in LOLE; the deficit was partially made up with increased imports into CAISO.
- Production cost ($MM)
  - ➢ Production costs in the Minimum Local Generation Scenario were $121.3 million higher than the Unconstrained Scenario in 2030.
- Emissions (MMT CO2)
  - ➢ In 2030, there is a slight decrease in emissions in the Minimum Local Generation scenario compared to the Unconstrained scenario due to inability to fully serve all the electric demand.

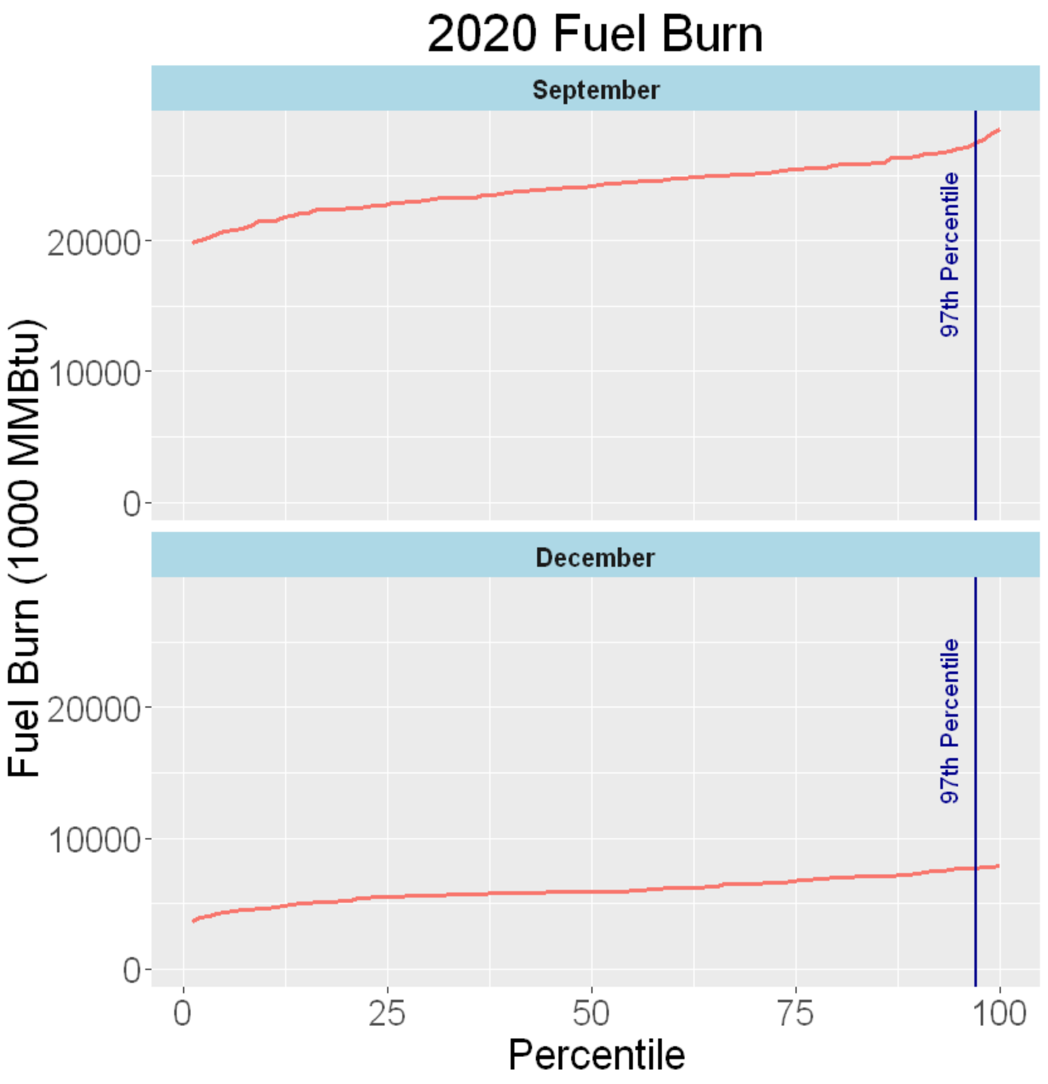
USE OF PCM RESULTS TO DEVELOP HYDRAULIC MODELING INPUTS – HOURLY GAS USAGE PROFILES

Process to Develop Gas Use Profiles



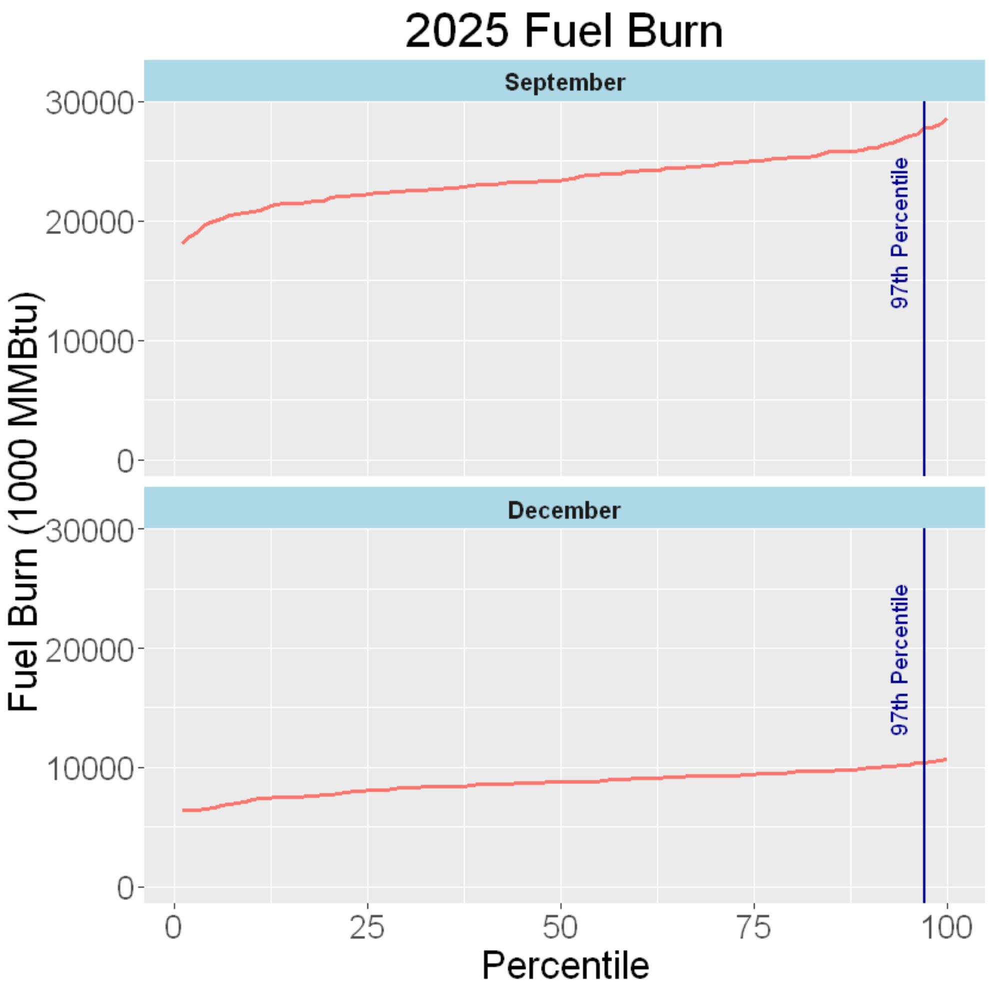
- **September was chosen as the representative month for summer and December for winter.**
- **The 100 fuel burn results for a given month (September or December) are ranked from the lowest to the highest for each scenario.**
- **Fuel burn cases are selected as the basis for the hydraulic modeling.**

Minimum Local Generation 2020 Fuel Burn Profiles for SCE and SDGE Based on 97th Percentile



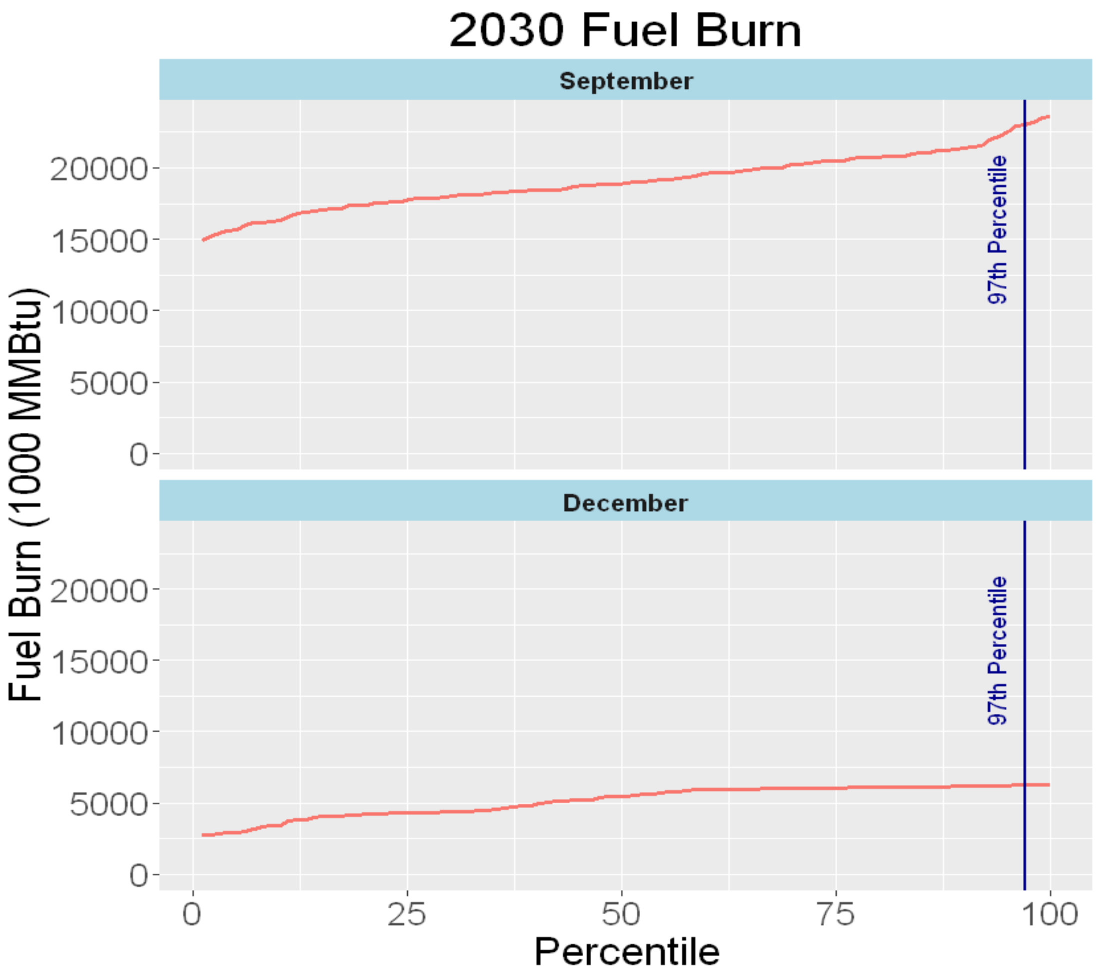
- **For 2020, the PCM generated fuel burn totals for 100 cases representing different weather scenarios for both September and December.**
- **The 100 values are ranked from the lowest to the highest for September and December.**
- **For September, the 97th percentile results in 277,580,80 MMBtu of fuel burn.**
- **For December, the 97th percentile results in 7,735,890 MMBtu of fuel burn.**
- **The case corresponding to the 97th percentile is used to generate hourly electric generation gas demand profiles to input into the hydraulic model.**

Minimum Local Generation 2025 Fuel Burn Profiles for SCE and SDGE Based on 97th Percentile



- For 2025, the PCM generated 100 values of fuel burn for both September and December.
- The 100 values are ranked from the lowest to the highest for September and December.
- For September, the 97th percentile results in 27,809,922 MMBtu of fuel burn.
- For December, the 97th percentile results in 10,491,876 MMBtu of fuel burn.
- The case corresponding to the 97th percentile is used to generate hourly electric generation gas demand profiles to input into the hydraulic model.

Minimum Local Generation 2030 Fuel Burn Profiles for SCE and SDGE based on 97th Percentile



- For 2030, the PCM generated 100 values of fuel burn for both September and December.
- The 100 values are ranked from the lowest to the highest for September and December.
- For September, the 97th percentile results in 23,147,167 MMBtu of fuel burn.
- For December, the 97th percentile results in 6,264,620 MMBtu of fuel burn.
- The case corresponding to the 97th percentile is used to generate hourly electric generation gas demand profiles to input into the hydraulic model.

Questions?

THANK YOU

Appendix

CAISO Supply-Side Generation by resource type, annual GWh

CAISO Supply-Side Generation by resource type, annual GWh	2030	2030
Category	Unconstrained	Minimum Loca l Generation
CAISO_CCGT1	43,246.45	41,029.64
CAISO_CCGT2	5,173.90	5,014.98
CAISO_Peaker1	5,215.65	4,708.58
CAISO_Peaker2	2,890.82	2,844.88
Steam	0.00	0.00
Coal	0.00	0.00
Biomass	5,338.50	5,434.20
BTMPV	37,948.56	38,001.18
All Solar: fixed PV, tracking PV, solar thermal	76,054.70	76,088.77
wind	21,694.06	21,708.61
Scheduled Hydro Plus ROR Hydro	25,391.03	25,121.52
Geothermal	13,597.54	13,709.27
Cogen	10,574.14	9,856.97
Nuclear	5,135.88	5,135.88
ICE	115.81	137.00
Generation Subtotal Before Curtailment	240,313.30	236,727.90
Non-PV Load Modifiers (net effect of AAEE, EV load, TOU)	15,848.77	15,855.36
Curtailment not included inline above	-1,056.69	-1,092.72
TOTAL not including Non-PV load modifiers	251,320.40	247,698.80

Input Data Development For SERVM Model

- Unified RA and IRP Inputs and Assumptions document describes data development, sources, and modeling methods in detail (download here)
  - Generator unit data
  - Fuel and carbon prices
  - Transmission topology and constraints
  - Load, wind, solar, and hydro shapes
  - Load forecast
  - System operating constraints
- Some changes made to IRP dataset for Aliso Canyon modeling purposes

Generator Unit Data For SERVM Model

- CAISO Masterfile
  - Generator capacity, location, and operating costs and attributes
  - Unit-specific heat rates, ramp rates, startup profiles, minimum up/down times
- WECC 2028 Anchor Data Set
  - Used to populate non-CAISO generation data
  - New units under construction or units retired by study years
- RPS contracts database
  - Planned projects not yet in CAISO Masterfile
- RESOLVE model output portfolio consistent with IRP modeling
  - Incremental resource portfolio based on IRP Reference System Plan 46 MMT scenario calibrated with the 2018 IEPR forecast
  - Staff used the RSP that was adopted in the IRP proceeding in March 26, 2020, the Decision number is 20-03-028
- Generator Availability Data System (GADS) database
  - Planned and forced outage data