2020 Annual Interregional Information

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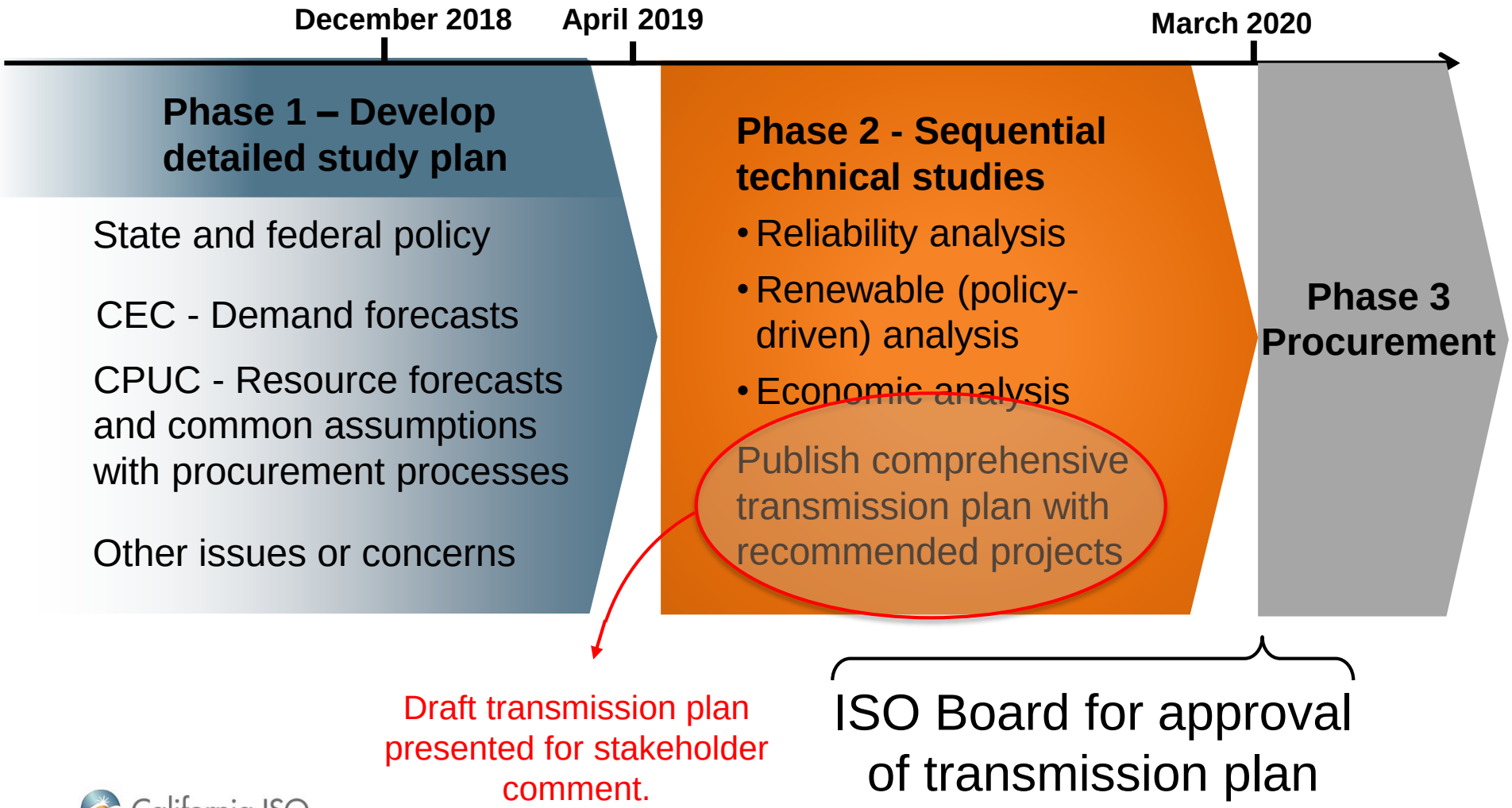
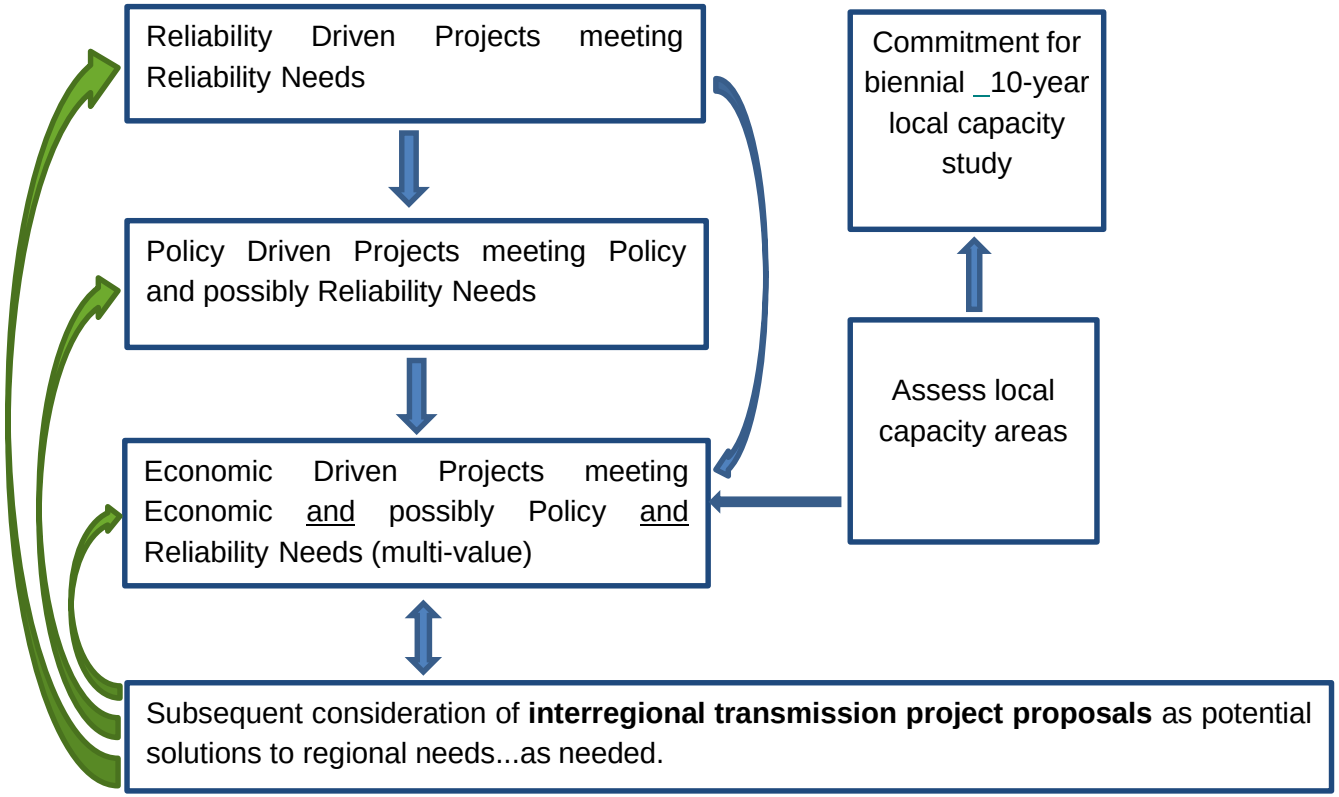
Annual Interregional Transmission Coordination Stakeholder Meeting

February 27, 2020

2019-2020 Transmission Planning Process



Studies are coordinated as a part of the transmission planning process



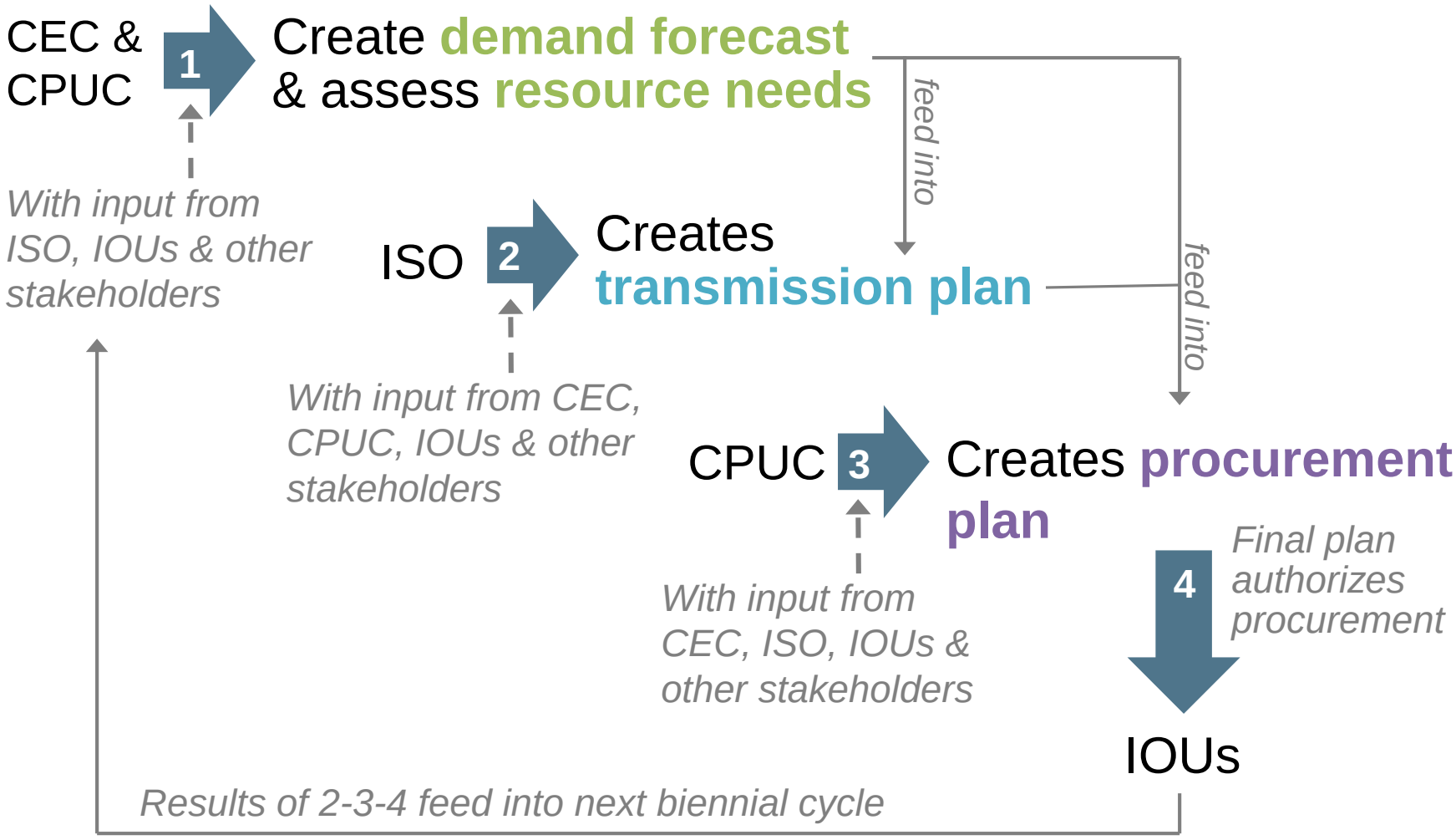
Forecast coordination with CPUC and CEC was continued, with a focus on renewable generation:

- Load forecast based on California Energy Demand Updated Forecast 2018-2030 adopted by California Energy Commission (CEC) on January 9, 2019 https://ww2.energy.ca.gov/2018_energypolicy/documents/

- RPS portfolio direction for 2019-2020 transmission planning process was received from the CPUC and CEC
  - The CPUC IRP Base Case portfolio – is used for the reliability, policy and economic assessment
  - Two sensitivity portfolios assessed in the policy assessment

  https://www.cpuc.ca.gov/General.aspx?id=6442460548

Planning and procurement overview



Key Issues in 2019-2020 Transmission Plan Cycle:

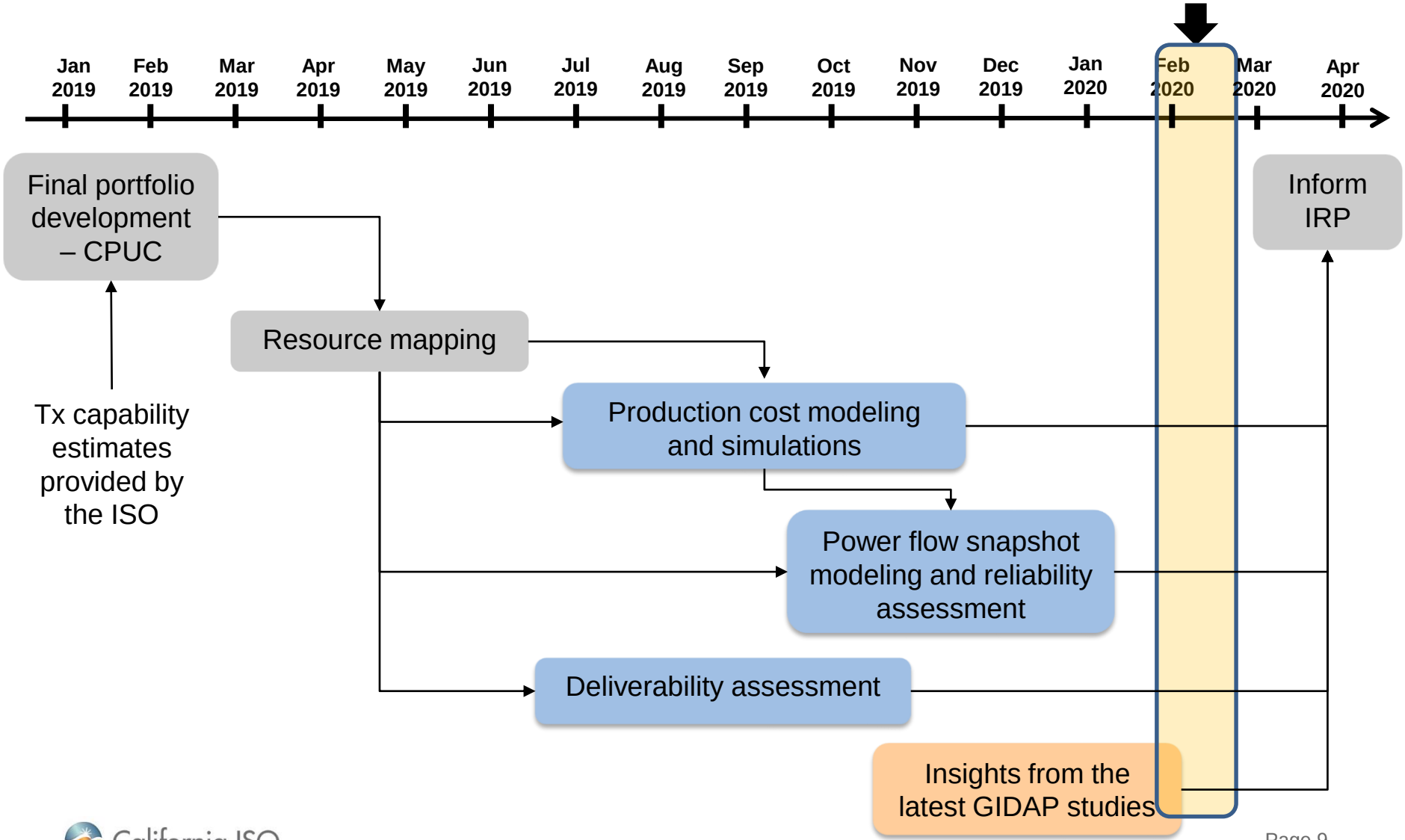
- ISO incorporated renewable resource portfolios from the CPUC
  - Baseline portfolio – achieving 60% Renewable Portfolio Standard
    - Reliability, Policy and Economic Assessments
  - Sensitivity portfolios – approximately 71% Renewable Portfolio Standard
    - Policy Assessment (to inform future resource planning)
- Interregional Transmission Planning Process
  - In year two (odd year) of 2 year planning cycle – none carried forward from year 1
- A number of studies were incorporated into the “other studies”
  - Frequency Response
  - Flexible Capacity Deliverability
- As a follow up to 2018-2019 transmission planning process, the remaining local capacity areas not studied in the 2018-2019 cycle were assessed for alternatives to relying on gas-fired generation

Key focus area of the ISO's 2019-2020 transmission plan to touch on:

- Policy assessment
- Economic assessment
- Frequency response assessment
- Frequency response of inverter based resources (IBRs)
- Updating generator models

Policy Assessment
Draft 2019-2020 Transmission Plan

2019-2020 policy-driven assessment



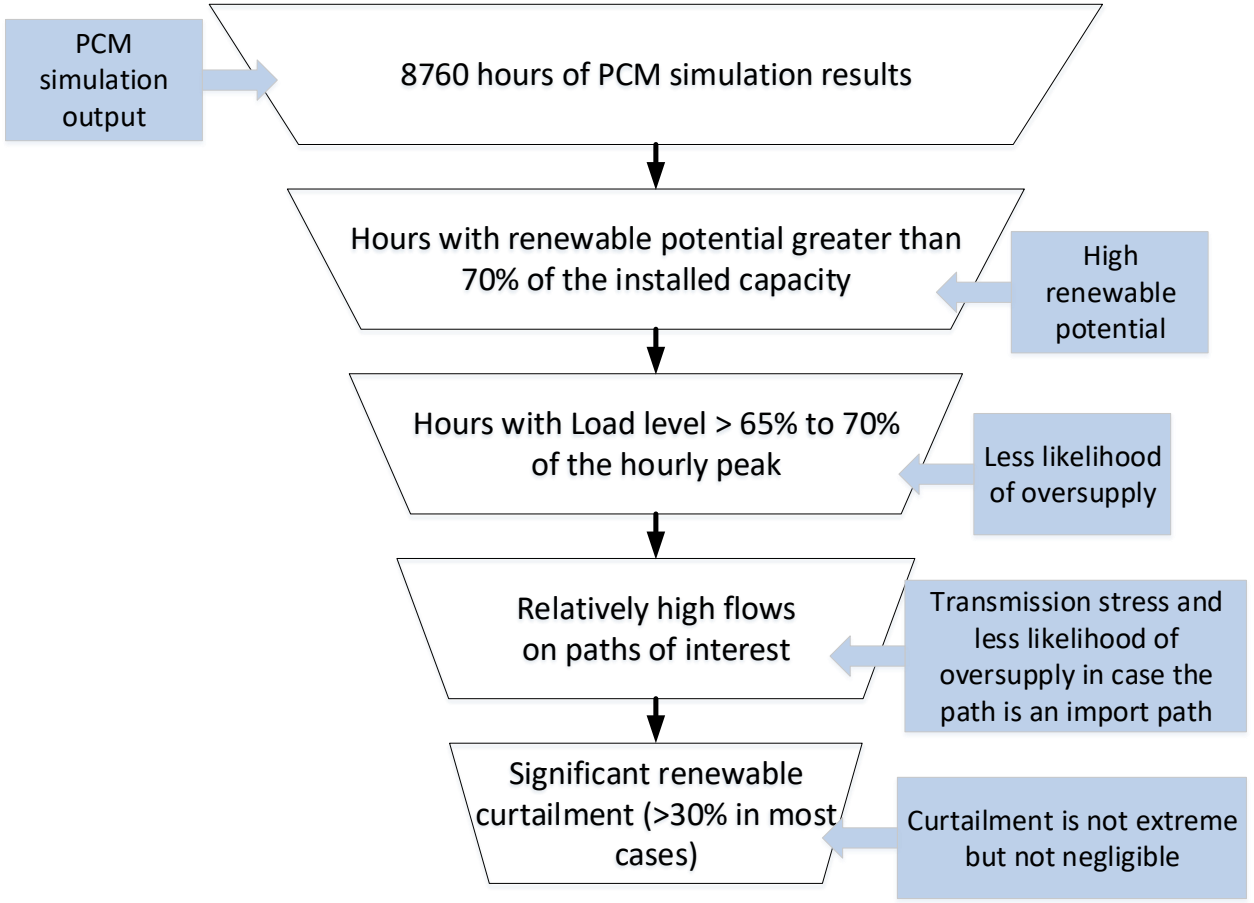
Scope of power flow snapshot assessment of renewable portfolios

- Reliability studies performed in order to identify transmission system limitations above and beyond the constraints monitored in the production cost simulations.

- The 8,760 hours of snapshots created during production cost simulations were used to identify high transmission system usage patterns to be tested using the power flow models.

- Power flow contingency analysis was performed in order to capture any additional area-wide constraints or significant interconnection issues that need to be modeled in the production cost simulations in order to more accurately capture the renewable curtailment caused by transmission congestion.

Identifying study hours when oversupply is unlikely but renewable curtailment is significant



	Northern CA and Southern PG&E	Southern CA
BASE	None	August 17 Hour Ending (HE) 12
SENS-01	March 08 HE 10	August 16 HE 12
SENS-02	July 20 HE 20	July 31 HE 15

Conclusions from the Policy Assessments

- The ISO did not identify any Category 1 or Category 2 policy-driven upgrade.

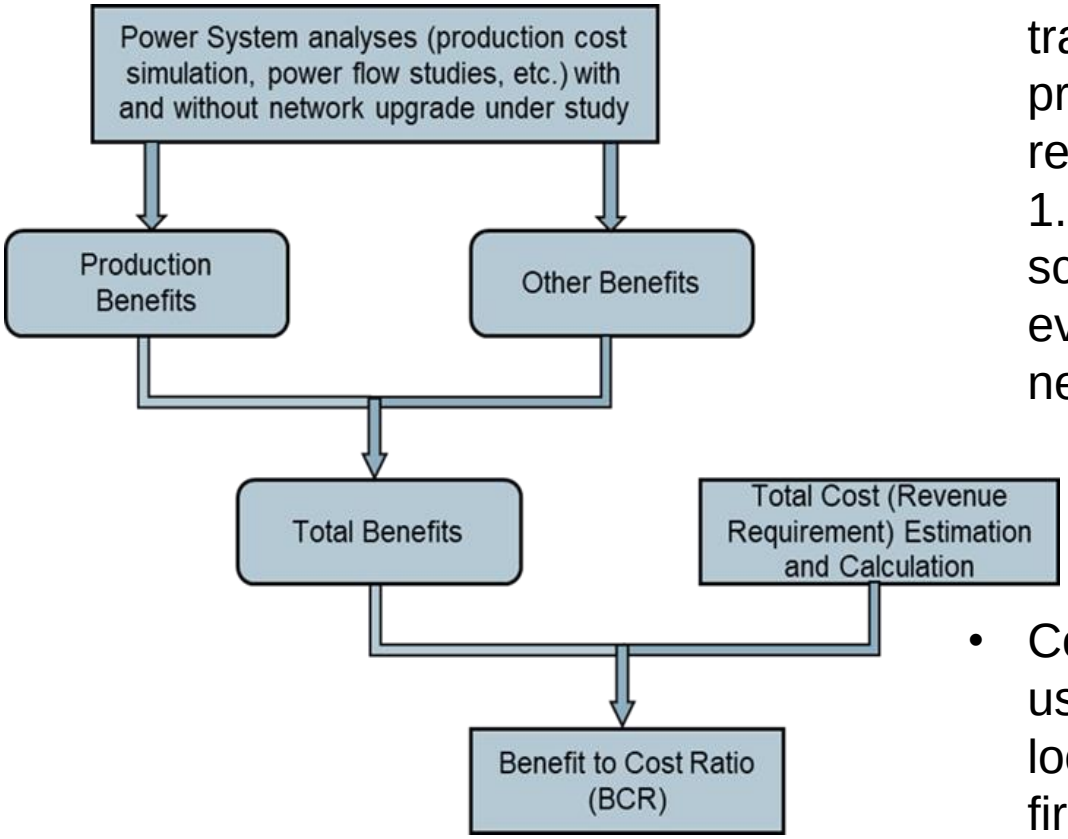
- Although no upgrade needs were identified, a need for the portfolio resources to participate in RASs and/or experience congestion management was evident in several zones – a growing concern.

Next steps

- Provide the updated transmission capability estimates to the CPUC and assist with incorporating these into the RESOLVE model through remainder of the 2019 IRP cycle.
- Inform IRP with insights regarding zonal renewable curtailment.
- Incorporate findings from this study in coordinating with the CEC staff and the CPUC staff into the busbar mapping process for future portfolios.
- Continue to support the CPUC on siting generic storage resources selected in the IRP process.

Economic Assessment
Draft 2019-2020 Transmission Plan

Technical approach of economic study



- A simple ratio to convert transmission capital costs to the net present value of annualized revenue requirements – currently 1.3 – is generally used for screening purposes, with detailed evaluations conducted as necessary.
- Conservative benefit values have been used in assessing projects that reduce local capacity requirements for gas-fired generation, as those resources are being relied upon for system capacity over the 10 year planning horizon.

Summary of economic studies

- Five congestion related and twelve LCR reduction related economic assessments were conducted in 2019-2020 planning cycle
- No transmission upgrade was recommended for approval as economically driven upgrade in this planning cycle
- Pardee-Sylmar 230 kV Line Rating Increase project is a reliability driven project with economic benefit

Conclusions and recommendations

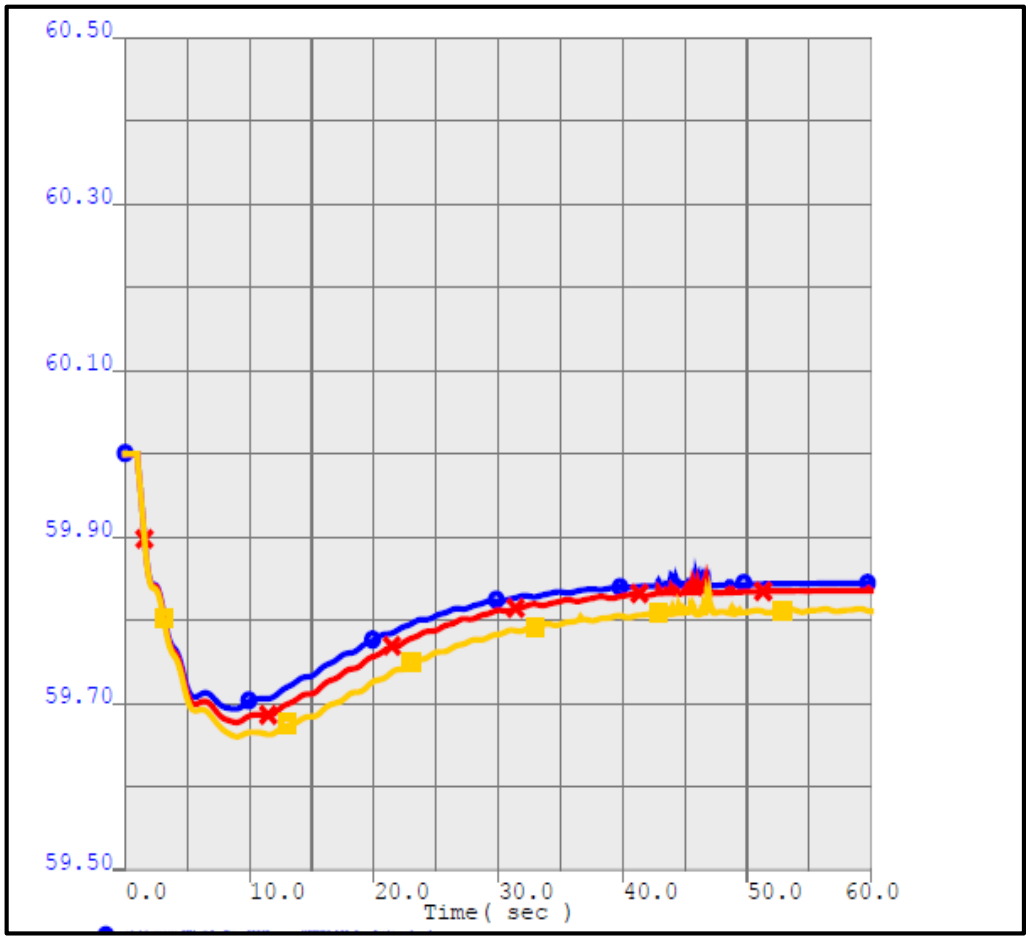
- The 2019-2020 Transmission Plan provides a comprehensive evaluation of the ISO transmission grid to identify upgrades needed to adequately meet California's policy goals, address grid reliability requirements and bring economic benefits to consumers
- This year's plan identified 9 transmission projects, estimated to cost a total of approximately $141.7 million, as needed to maintain the reliability of the ISO transmission system, meet the state's renewable energy mandate, and deliver material economic benefits
- The ISO identified that for one of those projects, an earlier in-service date than would otherwise be needed for reliability purposes was warranted to capture economic benefits
- The ISO has also conducted sensitivity studies regarding 2030 RPS levels exceeding current SB 100 requirements, that will be used to inform future CPUC integrated resource planning and portfolio development processes

Frequency Response Assessment and Data Requirements Draft 2019-2020 Transmission Plan

Generator Response to Frequency Events

- Generating units play a major role in controlling system frequency through their governors
- For studies of off-nominal frequency events, it is essential to properly characterize the response of each generator
- The headroom of the generator and the droop and deadband of the governor determine a generator response to frequency events.

Frequency on the Midway 500 kV bus following the trip of two Palo Verde units.



Conclusions of Frequency Studies in Previous TPPs

- The WECC base cases and dynamic data include number of frequency-responsive units and the study shows that the ISO system meets BAL-003-1.1 requirements.
- With lower commitment of the frequency-responsive units, frequency response from the ISO could below the FRO specified by NERC.
- With more inverter-based resources (IBR) online, frequency response from the ISO will most likely become insufficient.
- Compared to the ISO's actual system performance during disturbances, the simulation results seem optimistic. A thorough validation of the models is needed.

Frequency Response of Inverter Based Resources (IBRs)

Frequency Response of IBRs

- The total installed transmission-connected IBRs (wind, solar, storage) in the ISO grid is expected to go from around 18 GW today to around 26 GW in 2024.
- NERC has number of standards related to resource and demand balancing which is becoming challenging for the ISO to meet due to the variability of wind and solar generation.
- FERC Order 842 requires all new IBRs to have frequency response capability.
- This study is to evaluate the potential impact of activating the FR of the existing IBRs and changing the droop and frequency deadband settings of the new IBRs on system frequency response.

Study Methodology and Scenario

- In this analysis, the trip of two Palo Verde units was simulated under number of scenarios with both the existing and the proposed droop and frequency deadband settings for the new IBRs.

- The scenario selected for this study is an spring off-peak case (middle of the day in early spring) which is the most challenging scenario with regards to meeting FRO requirement.
  - The challenge is due to the low load and high solar generation which results in many gas units that are the main sources of FR to be are switched off.

Conclusions of FR Impact Assessment

- If there is headroom, just enabling the FR of the IBRs significantly improved frequency response in this study even with 5% droop and ±0.036 Hz deadband.
- 4% droop and ±0.0167 Hz deadband would slightly increase the ISO generator output.
- The reason changing the setting have minimal impact is that the trip of two Palo Verde units causes a significant drop in frequency that results in IBRs responding to almost the same frequency drop, independent of the deadband or droop parameters.

Updating Generators Models

Generator Model Update

- The ISO added a data collection framework to its Transmission Planning Process BPM regarding data collection (Section 10) that relies on existing tariff authority
- The ISO developed data templates for the generator owners to provide the data
- Five categories of participating generators were developed based on size and interconnection voltage
- ISO is requesting validated modeling data from all generators according to the plan set out in the BPM
- The process started in May 2019 and the plan is to have updated models for all generators by 2022.

Generator Data Template

- Generator data templates have been posted on the CAISO website. [1]

- Generator owners will provide governor data (droop and deadband) as part of their submission.

II.19	Upward frequency response droop (increase output for low frequency)		%
II.20	Downward frequency response droop (reduce output for high frequency)		%
II.21	Frequency response deadband	+/-	Hz

[1] http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=95422303-C0DD-43DF-9470-5492167A5EC5

Next Steps

- Efforts will continue to collect modeling data and update the dynamic database. Validated models will be sent to WECC.

- Future work will include validation of models based on real-time contingencies and studies with modeling of behind the meter generation.

- Further work will also investigate measures to improve the ISO frequency response post contingency. Other contingencies may also need to be studied, as well as other cases that may be critical for frequency response.

2020-2021 Transmission Planning Process

- Stakeholder meeting on the Unified Planning Assumptions will be on February 28, 2020

- The CPUC Integrated Resource Plan Proposed Decision released on February 21, 2020 recommended portfolios for use in the ISO 2020-2021 transmission planning process
  - Proposed Decision: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M327/K750/327750339.PDF
    - Base portfolio (for Reliability, Policy and Economic Assessment)
    - Sensitivity portfolio #1 (for Policy Assessment)
    - Sensitivity portfolio #2 (for Policy Assessment)

Base portfolio: (Reliability, Policy and Economic Assessment) Adjusted Preferred System Plan (2017-2018 IRP)

- The base portfolio for reliability, policy and economic assessment is based on the 2018 Preferred System Portfolio (PSP) adopted in D.19-04-040, with certain updates.

- GHG target for the electric sector used in this portfolio is 46 million metric tons (MMT) by 2030.

Sensitivity portfolio #1: (Policy Assessment) Reference System Portfolio (2019-2020 IRP)

- GHG target for the electric sector used in this portfolio is 46 million metric tons (MMT) by 2030.
- This portfolio significantly varies from the previous portfolios analyzed for TPP purposes and warrants analysis as a sensitivity prior to moving to investment stage.
- Consists new buildout of ~11,000 MW in-state solar, ~2,800 MW in-state wind, ~600 MW out-of-state wind and ~9,800 MW energy storage.

Sensitivity portfolio #2: (Policy Assessment) High energy-only buildout (2019-2020 IRP)

- A portfolio to test areas in which the benefits of inexpensive transmission solutions could help reduce curtailment of renewables.
- Relaxed the energy-only transmission capability estimates in zones that are expected to offer relatively low-cost upgrade options to mitigate renewable curtailment.
- GHG target for the electric sector used in this portfolio is 30 million metric tons (MMT) by 2030.