



California ISO

Annual Interregional Information 2017-2018 Transmission Planning Process

Annual Interregional Coordination Meeting

Folsom, CA

February 22, 2018



California ISO

Introduction and Overview

Draft 2017-2018 Transmission Plan and transmission project approval recommendations

2017-2018 Transmission Planning Process

January 2017

April 2017

March 2018

Phase 1 – Develop detailed study plan

State and federal policy
CEC - Demand forecasts
CPUC - Resource forecasts and common assumptions with procurement processes
Other issues or concerns

Phase 2 - Sequential technical studies

- Reliability analysis
- Renewable (policy-driven) analysis
- Economic analysis

Publish comprehensive transmission plan with recommended projects

Phase 3 Procurement

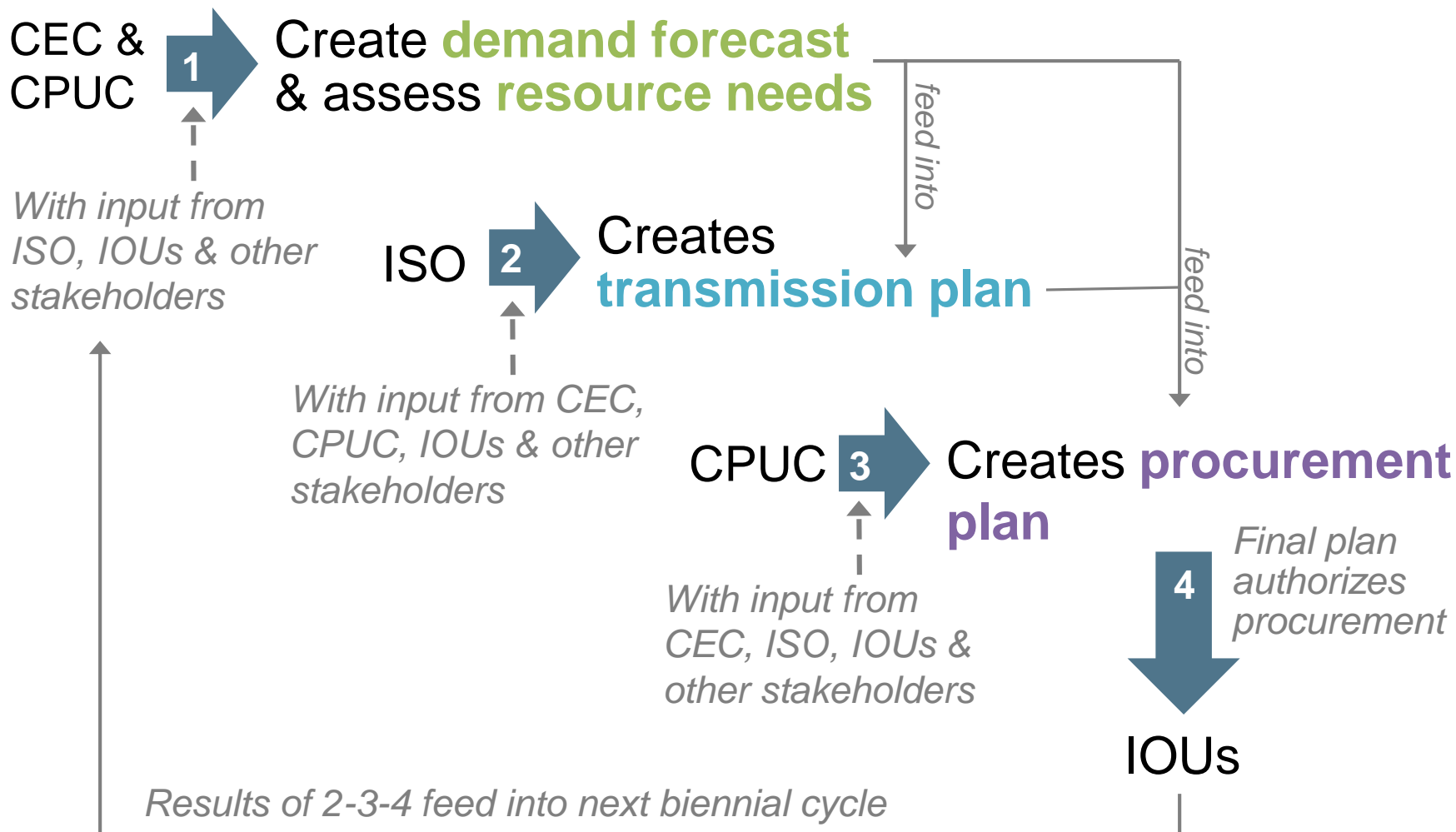
Draft transmission plan presented for stakeholder comment.

ISO Board for approval of transmission plan

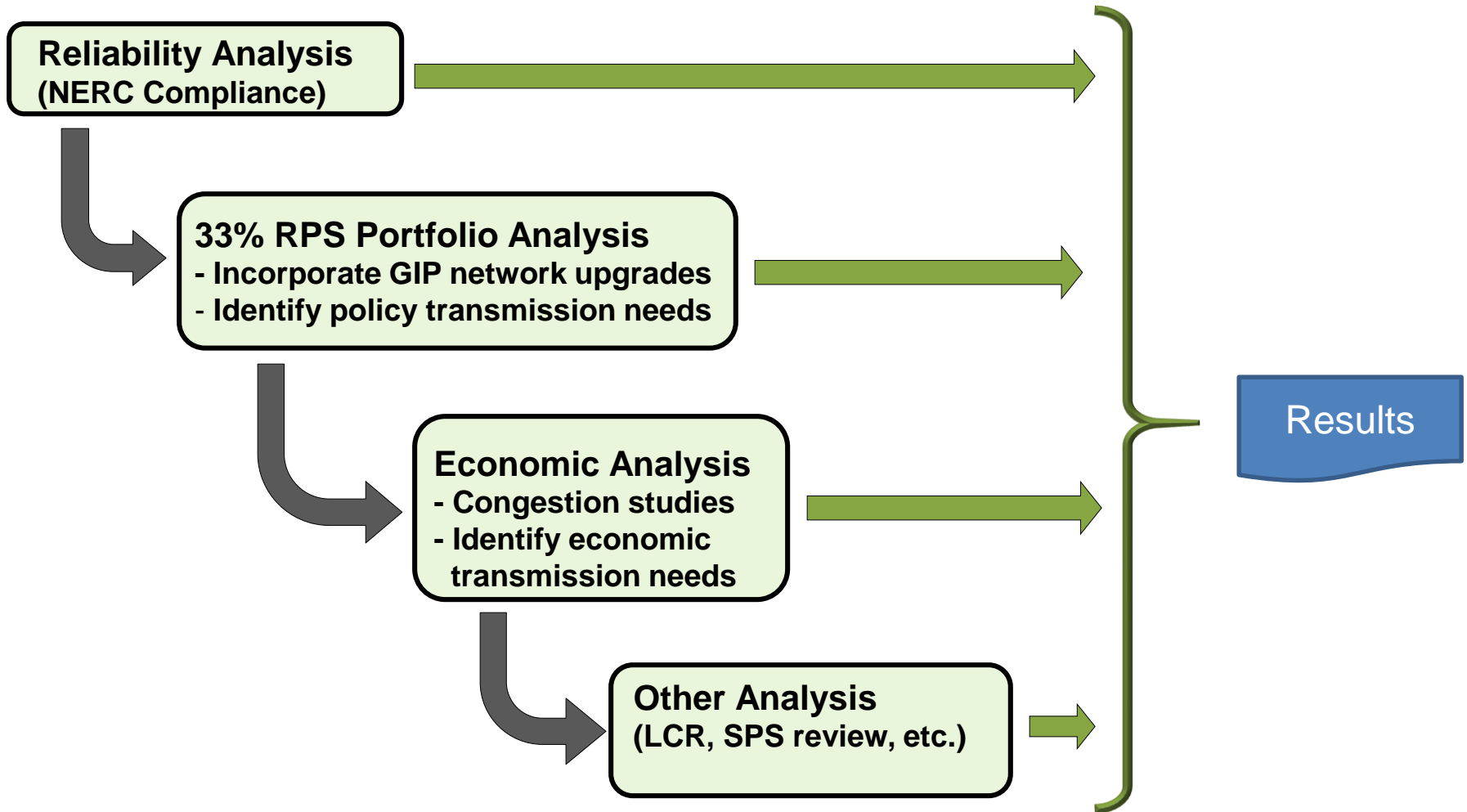
2017-2018 Ten Year Plan Milestones

- Preliminary reliability study results were posted on August 15
- Stakeholder session September 21st and 22nd
- Comments received October 6
 - (slow response resource special study extended to October 10)
- Request window closed October 15
- Preliminary policy and economic study results and update on other issues November 16
- Comments received November 30
- Draft plan posted February 1, 2018
- Comments due February 22
- Revised draft for approval at March Board of Governor meeting

Planning and procurement overview



Development of 2017-2018 Annual Transmission Plan



Emphasis in the transmission planning cycle:

- A modest capital program, as:
 - Reliability issues are largely in hand, especially with load forecasts declining from previous years and behind the meter generation forecasts increasing from previous projections
 - Policy work was largely informational as we await actionable renewable portfolio policy direction regarding moving beyond 33% (for approvals)
 - Modestly-sized economic-driven projects emerging as evolving industry circumstances create some new opportunities
- A major effort in this third and final year of the programmatic review of previously-approved projects
- Preferred resources and transmission upgrades playing a critical role in the integrated solutions in several areas
- Emerging issues continuing to drive re-thinking on how we study and assess transmission system issues

Consideration of the impacts of behind the meter photovoltaic generation on load shapes – and shifting the time of load peaks to later in the day – is evolving:

- In CED 2015 (2016-2026 Forecast), the CEC determined peak loads through downward adjustments to the traditional mid-day peak loads and acknowledged the issue of later-day peaks. In the 2016-2017 planning cycle the ISO conducted its own sensitivities
- In CEDU 2016 (2017-2027), the CEC provided sensitivities of later day peaks. The ISO used those sensitivities in this 2017-2017 planning cycle to review previously-approved projects, but not as the basis for approving new projects
- Through CED 2017 (2018-2028) the ISO is anticipating hourly load shapes

The ISO's reliability analysis led to the following:

- 12 new reliability projects are recommended – firming up the February 1 posted plan
- In the PG&E service territory ,19 previously-approved projects are recommended to be canceled and 21 have been re-scoped, paring over \$2.7 billion from current estimates. 6 have been identified as needing further review
- Two previously-approved projects in the SDG&E service territory are recommended to be canceled

Policy-driven analysis for approval purposes was not needed - no policy-driven approvals are recommended

- Portfolio direction received from the CPUC and CEC on June 13, 2016:
 - “Recommend reusing the “33% 2025 Mid AAEE” RPS trajectory portfolio that was used in the 2015-16 TPP studies, as the base case renewable resource portfolio in the 2016-17 TPP studies”*
 - “Given the range of potential implementation paths for a 50 percent RPS, it is undesirable to use a renewable portfolio in the TPP base case that might trigger new transmission investment, until more information is available”*
- This policy direction remained in place for the 2017-2018 transmission planning cycle
- Portfolios used in the ISO’s informational 50% RPS special studies and evaluation of interregional projects were provided by CPUC staff

The ISO is recommending a number of economic-driven projects:

- One – in the VEA service territory – provides production simulation benefits
- One – in the Imperial Valley area – provides both local capacity requirement reduction benefits and production simulation benefits
- Two – in the East Bay/Moss Landing Sub-area – focus on reducing local capacity requirements in the area

Status of proposal to add Phasor Measurement Units (PMUs) to all CAISO Interties:

- In November 2017, the ISO introduced the proposal that PMUs be added to all ISO intertie transmission facilities to other balancing areas
- Phasor measurement units will enhance accuracy of measurements to demonstrate compliance with NERC Reliability Standard BAL-003-1.1
- The ISO must meet frequency response obligation based on net actual interchange measurements
- The ISO is continuing to refine the scope of the effort and will bring forward a recommendation in the future

Special studies performed as part of the 2017-2018 planning process will help inform future studies

- The six special studies conducted in 2017 have been summarized in the 2017-2018 Transmission Plan
 - Interregional Transmission Project (ITP) Evaluation and 50% RPS Out-of-State Portfolio Assessment (extension of 2016-2017 studies)
 - Risks of early economic retirement of gas fleet (extension of 2016-2017 studies)
 - Benefits analysis of large energy storage (extension of 2016-2017 studies)
 - Frequency response assessment
 - Gas/Electric coordination special study
 - Characteristics of slow response local capacity resources

The ISO Board has approved the proposal to remove the conceptual statewide plan requirement

- Since 2010, the ISO has prepared and published the statewide plan as part of its annual planning process, initially developed to facilitate coordination with the California Transmission Planning Group (CTPG)
- Implementation of FERC Order No. 1000 has supplanted the need to develop the statewide plan
 - CTPG is no longer functioning and its members are focused on regional planning through Order 1000
 - The statewide plan no longer facilitates the coordination function it was intended to provide
 - ISO developing the plan on its own diverts resources away from Order 1000 activities
- After an ISO stakeholder process in May and June, the ISO Board approved the proposal on July 26.
- The change was filed with FERC on August 26 and we are awaiting a decision



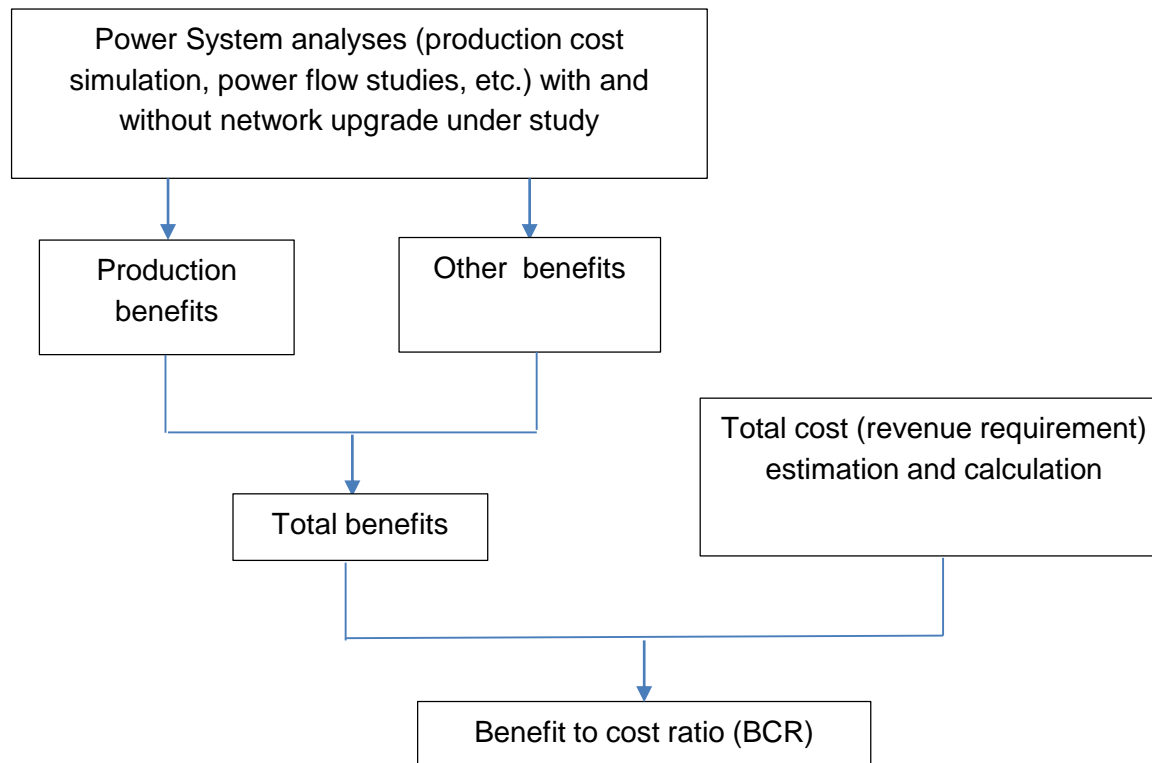
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Economic Assessment

Draft 2017-2018 Transmission Plan and transmission project approval recommendations

Overview of economic planning methodology

- ISO's economic planning study follows the updated TEAM documentation updated in 2017
- Study approach:



Overview of ISO's planning PCM development and enhancement (cont.)

- Database development with more accurate representation of network models
 - Identical network models for the ISO system in PCM and in the reliability power flow cases
 - Transmission topology, generator location, load distribution
 - Load modifiers were modeled as generators at the locations as in power flow cases
 - Coordinated with other regions to update their system models
- Most recently updated operational data and models
 - Updated solar profiles (in collaboration with WPR ADS process) with higher granularity based on NREL measurements
 - Updated thermal unit ramp rates based on industry average
 - IV PFC dispatchable

Summary and recommendations

Four upgrades were found to be needed as economic-driven projects in the 2017-2018 planning cycle:

- S-Line Upgrade
- Bob SS to Mead S 230 kV Line Upgrade,
- South Bay-Moss Landing enhancements comprising of the San Jose-Trimble 115 kV series reactor and the Moss Landing–Panoche 230 kV Path Upgrade

Congestion or study area	Production benefit (\$M)	Capacity benefit (\$M)	Estimated total cost (\$M)	Economic justification
S-Line	40	85~110	46~72	Yes
Bob SS-Mead S	180	Not applicable	37	Yes
San Diego North	27	Not applicable	101~116	No
South Bay-Moss Landing area	Not applicable	400-600 MW LCR benefit	\$14	Yes

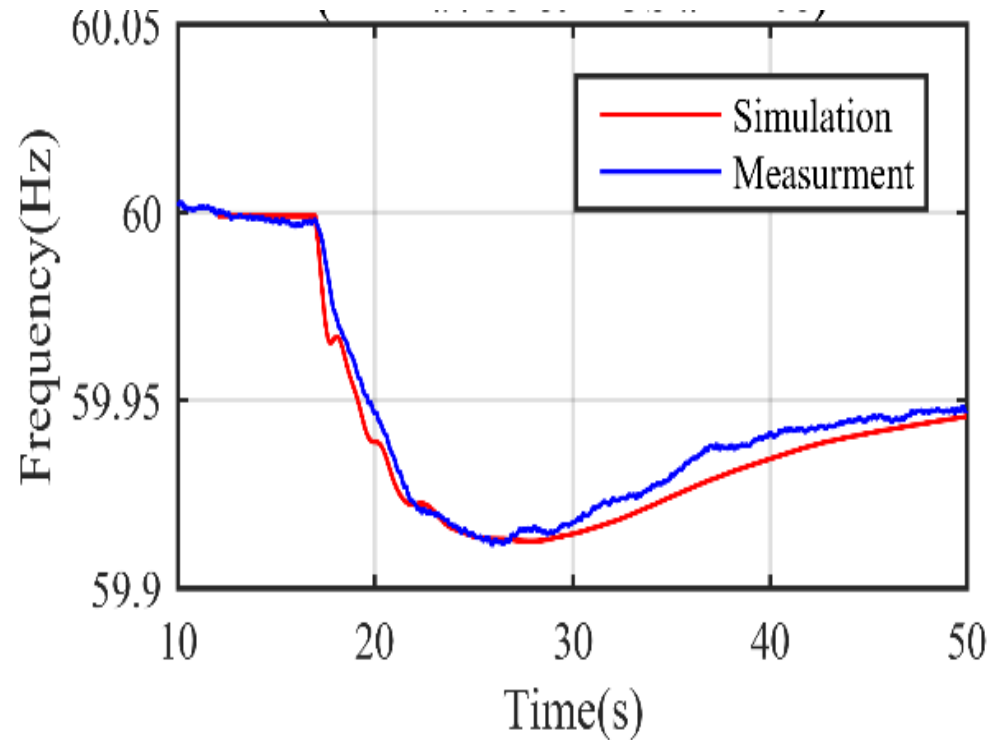


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Special Study Frequency Response Assessment-Generation Modeling

Frequency Response Studies

- Frequency response studies performed in the previous Transmission Plans showed optimistic results
- Actual measurements of the generators' output were lower than the generators' output in the simulations
- Therefore models update and validation is needed
- After improvement of models, more frequency studies will be performed



Update of Generator Models

- The ISO reviewed, and identified issues with dynamic stability models for multiple units
- Issues
 - Missing models
 - Suspicious models
 - Models with generic parameters
 - Models no longer approved by WECC
- Currently working with the PTOs to get results from generator testing and improve the models
- Challenges:
 - Challenges in getting fully validated models from generation owners
 - Difference between NERC Standards and WECC Policy on generator testing

Standards on Generator Testing

- NERC dynamic data related compliance (MOD-26 and MOD-27) applies to the following to Western Interconnection
 - Individual generating unit greater than 75 MVA (gross nameplate rating)
 - Individual generating plant consisting of multiple generating units that are directly connected at a common BES bus with total generation greater than 75 MVA (gross aggregate nameplate rating)
- WECC Policy applies to
 - Generating facilities connected to the Western Electricity Coordinating Council (WECC) transmission grid at 60 kV or higher voltage (both new and existing, synchronous and non-synchronous) with single unit capacity of 10 MVA and larger, or facilities with aggregate capacity of 20 MVA and larger

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Interregional Transmission Project (ITP) Evaluation and 50% RPS Out-of-State Portfolio Assessment

*An information-only study performed as a continuation of 2016-
2017 Transmission Planning Process*

Continuation of the information-only 50% RPS special study (2016-2017 TPP)

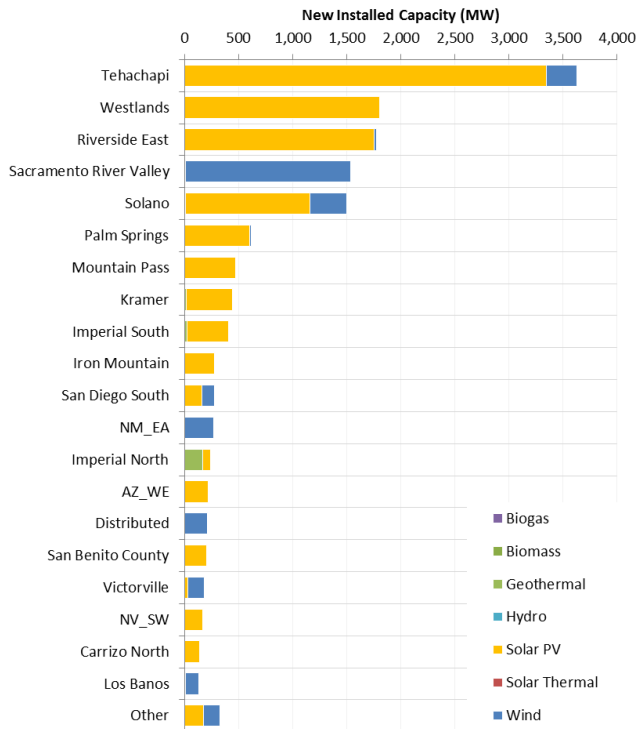
The 2016-2017 50% RPS study focused on

- Investigating the transmission impacts of moving beyond 33 percent RPS requirements in California;
- Testing the transmission capability estimates used in RPS calculator v6.2 and where appropriate, updating these transmission capability estimates; and
- Investigating transmission implications on in-state facilities of meeting part of California's 50 percent RPS requirement by assuming California's procurement of 2000 MW of wind resources in Wyoming and 2000 MW of wind resources in New Mexico.

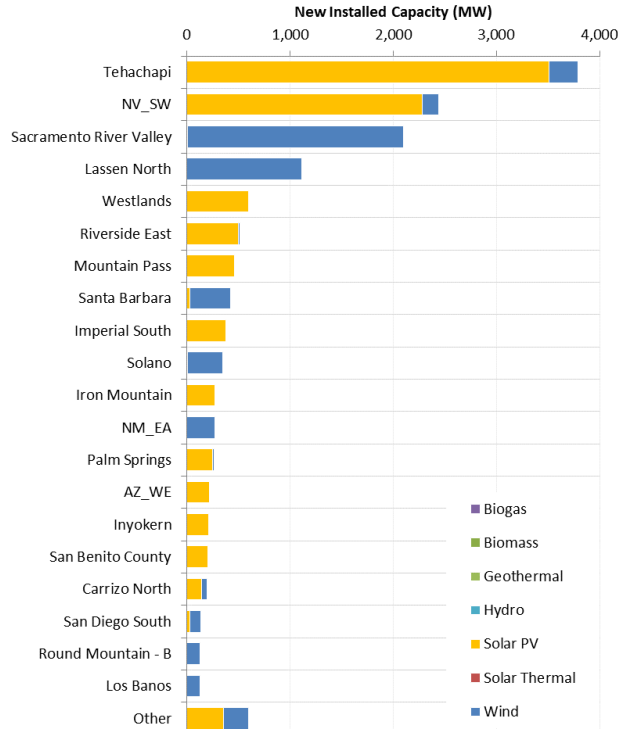
Portfolios provided by the CPUC; the Out-of-state portfolio shows a shift to higher WY and NM wind

Portfolio	In-state FCDS	In-state EODS	OOS EODS/FCDS
MW Capacity	14,842	14,814	11,093

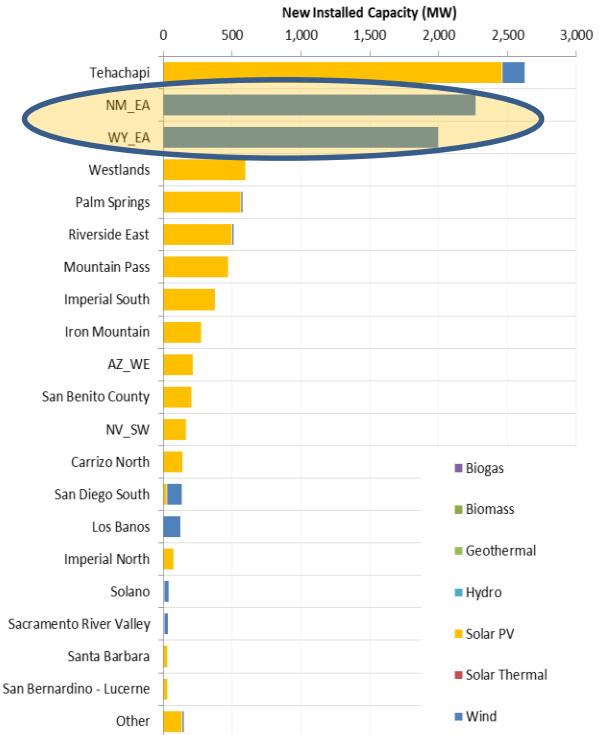
In-state FCDS



In-state EODS



Out-of-state FCDS/EODS



Note - RPS calculator v6.2 was used to generate the portfolios

Findings from 2016-2017 out-of-state portfolio assessment helped us identify three action items

Assessment	Key findings pertaining to OOS portfolio (2016-2017 50% special study)
Production Cost Simulation	<ul style="list-style-type: none"> • Curtailment: OOS portfolio showed the lowest curtailment • Transmission congestion: OOS portfolio showed the least amount of intra-CA congestion • <u>Further coordination is expected on stressed scenario identification and reviewing study results</u>
Reliability Assessment	<ul style="list-style-type: none"> • OOS portfolio was the least severe one • No major issues in the Northern CA system due to lower amount of resource selection • One potential issue in Southern CA observed in all portfolios • <u>The snapshots identified with CA transmission in mind were not the most stressed ones for the system outside of CA</u>
Deliverability	<ul style="list-style-type: none"> • Evaluated the need for MIC expansion and found that adequate import capacity exists to deliver OOS resources (NM and WY) from injection point into CAISO BA to CAISO loads



Three action items identified based on ISO's analysis and stakeholder feedback –

1. Refining the assumptions and models
2. Using the out-of-state portfolio to test ITP evaluation framework in preparation for the next planning cycles; and
3. Exploring a way to capture the Available Transmission Capacity (ATC) for out-of-state RPS resources

Regional coordination efforts resulted in model refinement and contingency list creation

- Considered the four ITPs submitted to the planning regions in 2016
- Received input from WestConnect and NTTG about the location and size of wind resources in NM and WY respectively
- WPRs provided input regarding transmission topology enhancements in alignment with the ongoing WECC Anchor Data Set work
- Shared power flow models with WPRs and received feedback
- Shared contingency files with ColumbiaGrid, WestConnect and NTTG; the WPRs provided crucial information regarding additional contingencies to be tested
- APS and NV Energy provided specific input regarding contingencies to be tested

Test the system outside of CA using OOS portfolio and leverage the findings to gain insights about ITPs

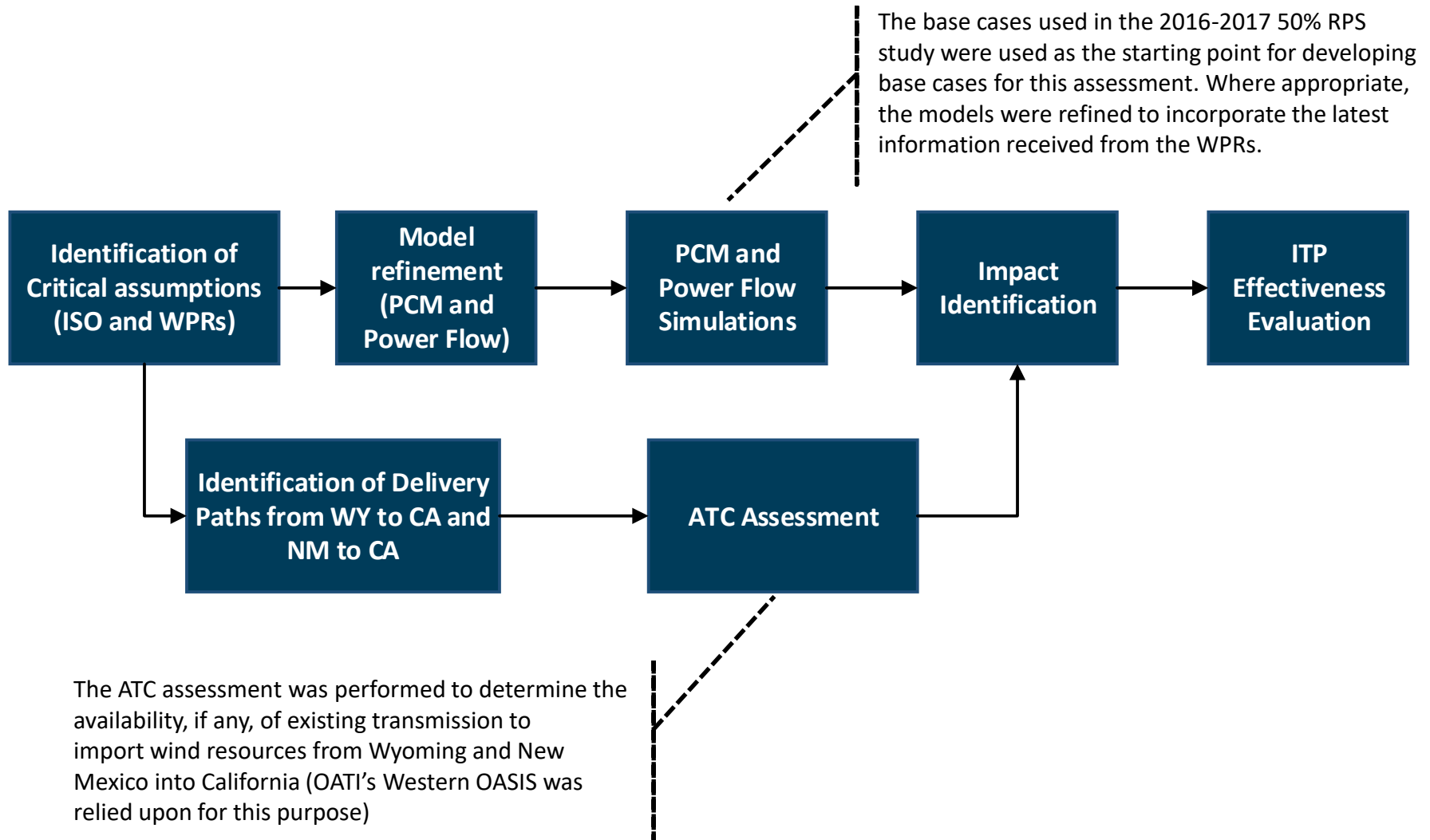
Refine the out-of-state resource and topology modeling

Identify Available Transfer Capability that can be used by the wind resources in WY and NM in order to deliver to CA

Identify transmission constraints outside of CA while trying to meet part of the 50% RPS obligation by relying on wind resources in WY and NM

Test effectiveness of ITPs in mitigating observed transmission issues outside of CA and test a framework for comparing ITPs

Study methodology and sequence



Study Components

ITP-out-of-state 50% portfolio assessment

PCM simulations

The expected outcome of PCM simulations was:

- Extent of curtailment of out-of-state renewables
- Identification of transmission constraints outside of California that may result in significant amount of congestion when delivering wind resources from WY and NM to CAISO BAA
- Stressed snapshot identification for the purpose of power flow studies
- Impact of ITPs on PCM results

Power flow and stability studies

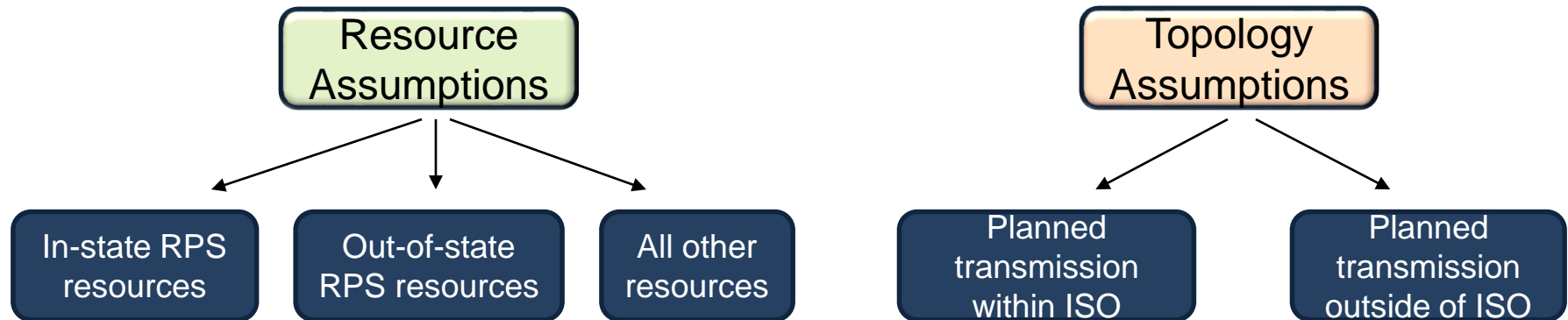
- Power flow studies were performed in order to (i) identify additional transmission limitations that may not be captured by PCM studies and (ii) to confirm the transmission system limitations identified by PCM simulation and (iii) capture the impact of ITPs
- The 8,760 hours of snapshots created during PCM simulations were used to identify high transmission system usage patterns to be tested using the power flow models for reliability assessment.
- Contingency assessment was performed with a focus on the system outside of California

ATC assessment

- The ISO tested for ATC adequacy for delivering renewable resources from Wyoming and New Mexico to the ISO BAA
- At a conceptual level, this effort can be viewed as a “loose” proxy for testing “deliverability” of these out-of-state resources
- However, the ISO believes it reasonable to assume that large out-of-state resource installations cannot serve California load without viable long-term firm transmission service from the point of receipt to the CAISO BAA boundary

Key modeling enhancements and topology/resource assumptions

Starting study model: 2016-2017 TPP 50% RPS out-of-state portfolio case



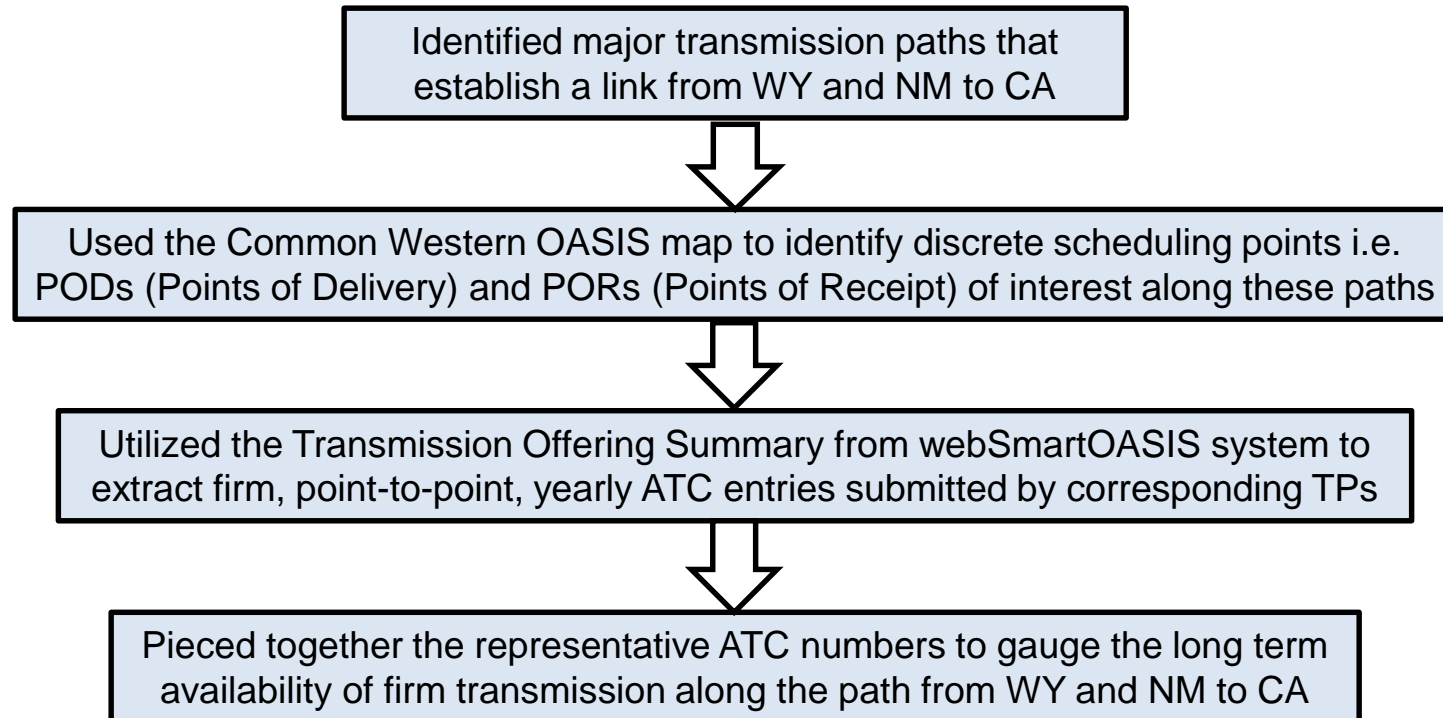
- No change to in-state RPS
- WY and NM RPS resources identified in the out-of-state portfolio
- Additional wind resources identified in WY as part of PacifiCorp's IRP (~1,100 MW)
- Minor generation adjustments per the latest WPR ADS seed case (as of May 2017)

- Modeled projects approved in the 2016-2017 TPP
- Relied on the information received from the Anchor Data Set work being performed by WPRs
- Gateway Energy Project
- SunZia Project

Overview of Production Cost Model for ITP studies

- Started from the PCM for OOS 50% portfolio in 2016/17 planning cycle
- Updated ISO's network model to reflect the changes identified in 2017/2018 planning cycle reliability assessment
- Updated WPR (NTTG, WestConnect, and ColumbiaGrid) system models based on recommendations of the corresponding planning regions
- Load forecast and NG/CO2 prices remained the same as in the last planning cycle
- WY local 230 kV line limits were not enforced

Stakeholders raised a question about the availability of ATC outside of California



- OATI's webSmartOASIS system was utilized to extract ATC data
- Transmission Offering Summary in OASIS was utilized; this is what each Transmission Provider(TP) has submitted as available on a facility over a particular timeframe
- We looked for the active offerings in the first month of 2027 as a proxy for long-term availability

Summary of Findings

PCM simulations

1. The ISO renewable curtailment did not show a noticeable reduction after adding any of the ITPs.
2. Relaxation of ISO Net Export Limit resulted in almost zero renewable curtailment. This indicates that the renewable curtailment under 2,000 MW ISO Net Export scenario is not primarily related to transmission congestion.
3. ITPs show a variation in transmission congestion performance. It is important to note that this congestion is driven by overall dispatch which includes non-renewable resource

Power flow studies

1. Power flow performance of TWE, SWIP-N (with Gateway West) and Cross-tie (with Gateway South) is comparable
2. SWIP-N and Cross-tie projects without the corresponding Gateway segments do not provide much thermal relief when delivering resources from WY to CA
3. REX HVDC project does not greatly impact power flow performance when delivering resources from NM to CA

ATC assessment

1. ATC assessment shows severe shortage of contractual capacity to deliver WY and NM resources to CA over the existing transmission system
2. TWE would provide ~1,500 MW of ATC from Southwestern WY to Southern CA
3. SWIP-N and Cross-tie would rely corresponding segments of Gateway project and some existing facilities to establish ~1,500 MW ATC between WY and CA
4. REX HVDC would not add ATC at the most constrained locations along the NM to CA path

Summary of directional insights about ITPs

	SWIP-N with Gateway West*	Cross-Tie with Gateway South*	TransWest Express	REX HVDC with SunZia
Total ISO renewables including WY and NM wind	—	—	—	—
Impact on only WY and NM wind curtailment	↓ ↓ ↓	↓ ↓	↓	—
	—	—	—	↓ ↓
	—	—	—	—
	↓ ↓	↓ ↓	↓ ↓	—
	\$2B - \$3.9B	\$1.5B - \$2.1B	\$2.4B - 3.2B	\$1.9B - \$4.6B

↓ Reduction in curtailment or overload

— No impact relative to baseline

* SWIP-N and Cross-Tie without certain segments of Gateway were studied and were found to be decisively inadequate for the purpose of delivering Wyoming resources to California

** Curtailment under 2,0000 MW Net ISO Export Limit

*** Based on (i) the request window submittals and (ii) cost information specified in RETI 2.0 Western Outreach Project Report – http://docketpublic.energy.ca.gov/PublicDocuments/15-RETI-02/TN214339_20161102T083330_RETI_20_Western_Outreach_Project_Report.pdf

ATC Assessment

- The ISO’s examination of yearly, firm, point-to-point ATC data from the Western OASIS points to a severe lack of scheduling capability to deliver Wyoming and New Mexico wind to California
- None of the ITPs except TWE will create sufficient long-term, firm ATC from the renewable resource area all the way to the ISO without relying on other transmission not owned by the project sponsor. Note the proponent of the SWIP North project cites having pre-existing arrangements to secure transmission rights on the One Nevada Transmission Line (ON Line), addressing one of two transmission paths needing ATC on other transmission.

Attributes requiring further consideration given the differing nature of the projects and dependencies:

- How the transmission would be procured – interregional project, regional project, or component of generation procurement?
- Arrangements with other non-ISO transmission owners for capacity, and for development of non-ISO transmission
- Costs and cost responsibilities
- Staging and sequencing of transmission and generation resources

Recommendations for next steps

- Utilize the results obtained from this study for future out-of-state RPS portfolio creation
- Create a framework for accounting for interdependencies of ITPs and other non-ITP infrastructure projects while evaluating ITPs
- Incorporate ATC assessment as part of the ITC evaluation framework for future ITP RW submittals
- Explore further the other attributes that would be taken into account in selecting a “preferred” project to access out of state wind resources

Focus in 2018-2019 Transmission Planning Cycle:

- Focus on renewable integration issues – both in-front-of and behind-the-meter resources
- A major economic study being focused on local capacity areas
- Special studies targeting:
 - ISO support for CPUC proceeding re Aliso Canyon
 - Potential for increasing opportunities for transfers of low carbon electricity with the PAC Northwest, and for PAC Northwest Hydro to play role in reducing dependence on resources impacted by Aliso Canyon
- Interregional projects will be addressed as per tariff-defined processes:
 - The ISO is not planning additional “special study” efforts at this time focusing on out-of-state renewables given the recently completed studies spanning the 2016-2017 and 2017-2018 planning cycles.

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