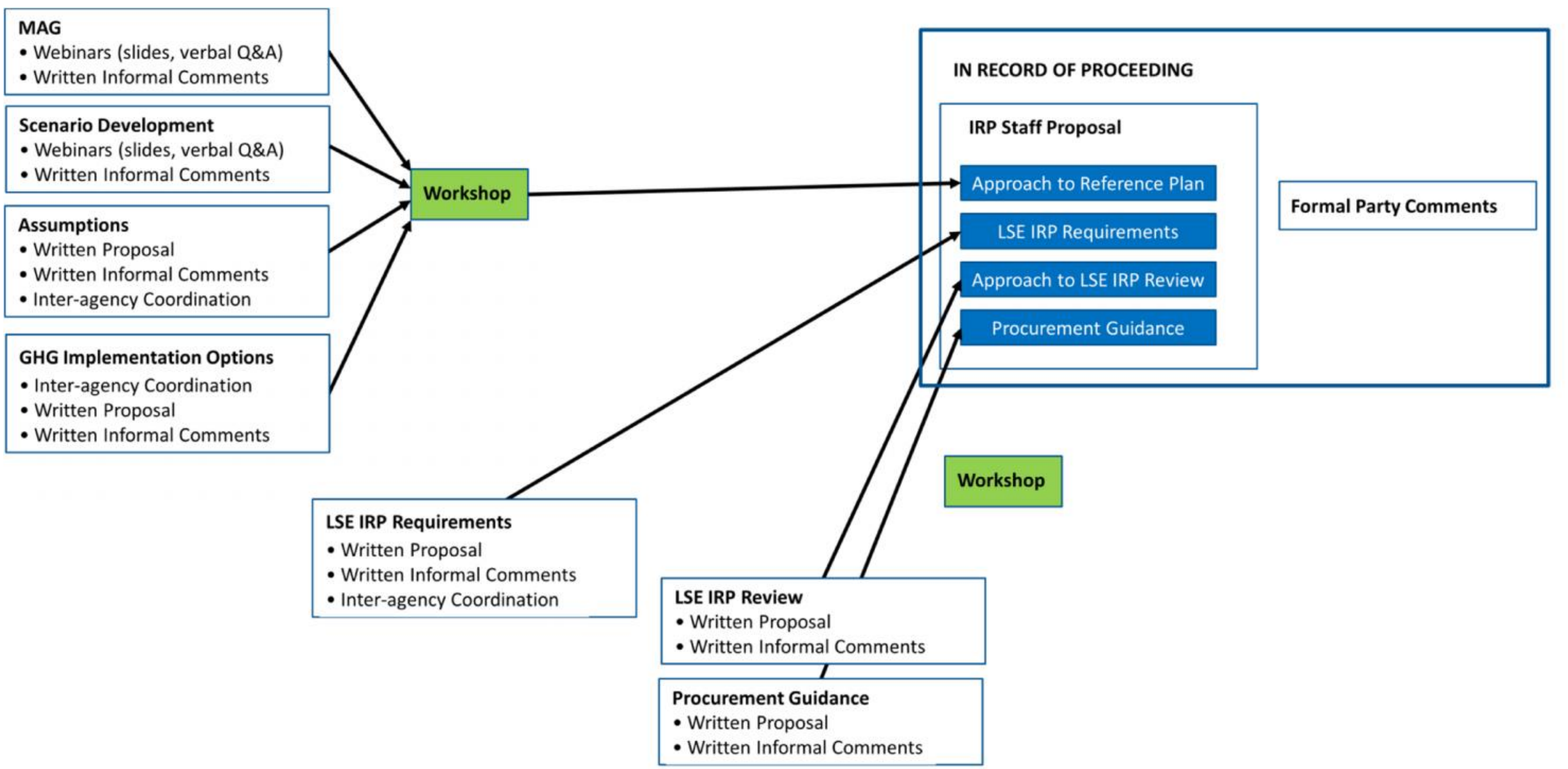
IRP Modeling Advisory Group
Webinar #2

11/3/2016

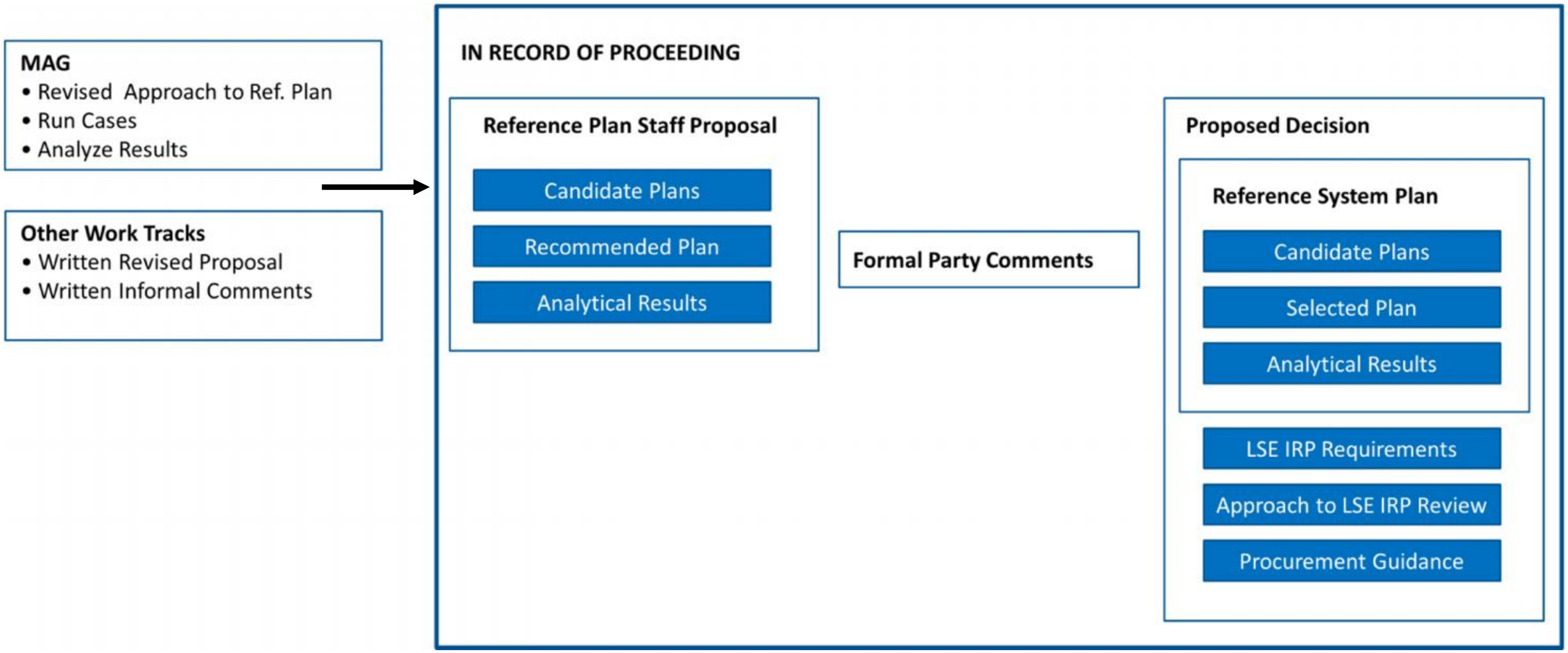
Modeling Advisory Group Background

- Energy Division is developing a staff proposal for implementing Integrated Resource Planning in 2017
- Core component of proposal is approach to developing a Reference 40% By 2030 Plan that would inform development of individual LSE plans
- Modeling Advisory Group formed to increase transparency and create an opportunity for public feedback during development of approach to developing Reference 40% By 2030 Plan

MAG Will Inform IRP Staff Proposal on Modeling to Develop Reference Plan



MAG Will Also Inform Staff Proposal After Model Runs Are Completed



All MAG Materials Are Public

- IRP Modeling Advisory Group Webinar #1 Held 10/20/16
- Supporting materials are posted on the IRP Events and Materials page*
  - Draft Charter describes purpose of group and ground rules for participation
  - Presentations
  - Draft Meeting Notes
  - Survey Results
- First webinar was not recorded, but this webinar will be recorded

*http://www.cpuc.ca.gov/General.aspx?id=6442451195

Survey Results

- Online survey posed questions to help shape future webinars to needs of participants
- Results are public: https://www.surveymonkey.com/results/SM-MCZYT7LN/
- Based on results:
  - Webinar changed from 1.5 hours to 2 hour format
  - No face-to-face meeting is planned prior to December
  - Developed Webinar #2 content to focus on presenting a case study of RESOLVE - attention to illustrating detailed inputs and outputs
  - Deeper discussion of areas identified in priority list and other specific areas of interest will be addressed in Webinar #3

Energy+Environmental Economics

RESOLVE Model: Case Study of the SB350 CAISO Regionalization Study

IRP Modeling Advisory Group #2

November 3, 2016

Nick Schlag, Sr. Managing Consultant
Arne Olson, Partner
Jimmy Nelson, Consultant

Agenda

- RESOLVE modeling framework review
- Case study: SB350 CAISO Regionalization Study analysis
  - Study overview
  - Key inputs and assumptions
  - Summary of results

Purpose of SB350 CAISO Regionalization Study Case Study

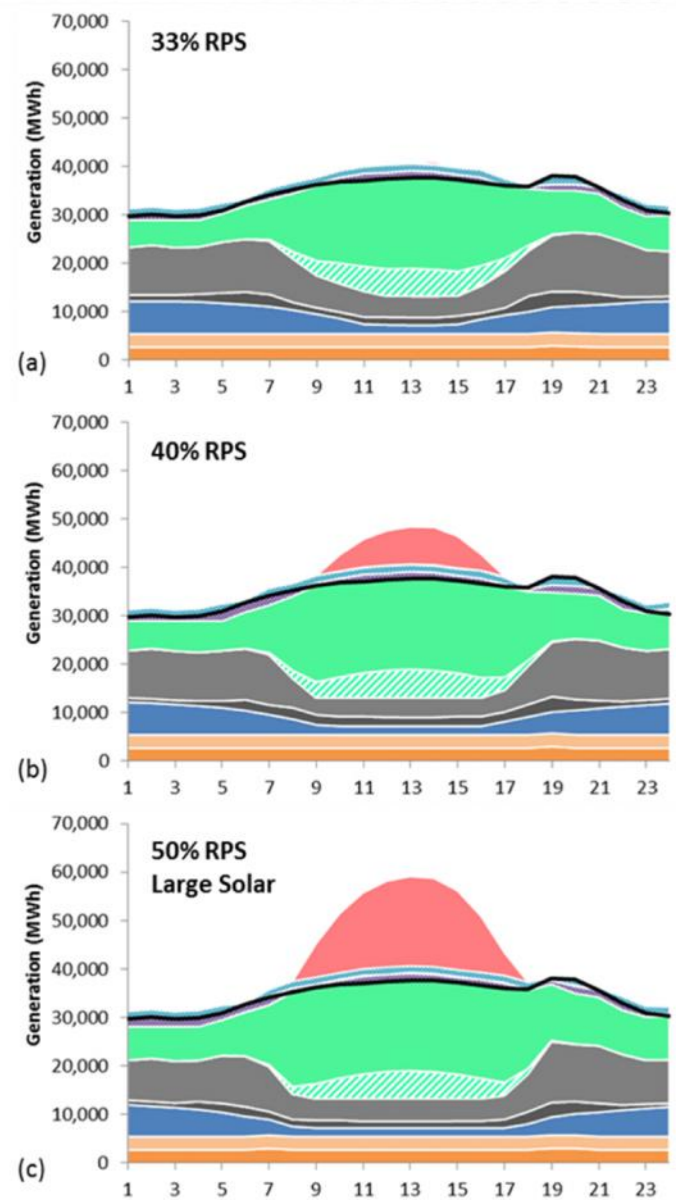
+ Today's MAG webinar focuses on E3's work in SB350 CAISO Regionalization Study as a case study to illustrate the functionality of RESOLVE
  - Analysis conducted for SB350 provides a concrete example of how RESOLVE can be used to create portfolios
  - Parties are encouraged to ask clarifying questions and provide comments related to model functionality
+ While the Regionalization Study provides a useful demonstration of RESOLVE's capability, its design is inherently different from the CPUC's current IRP effort
  - Assumptions and scenarios in Regionalization Study may not be applicable in the CPUC's IRP process
  - Rationale behind study design decisions made in Regionalization Study is outside the scope of the Modeling Advisory Group

Energy+Environmental Economics

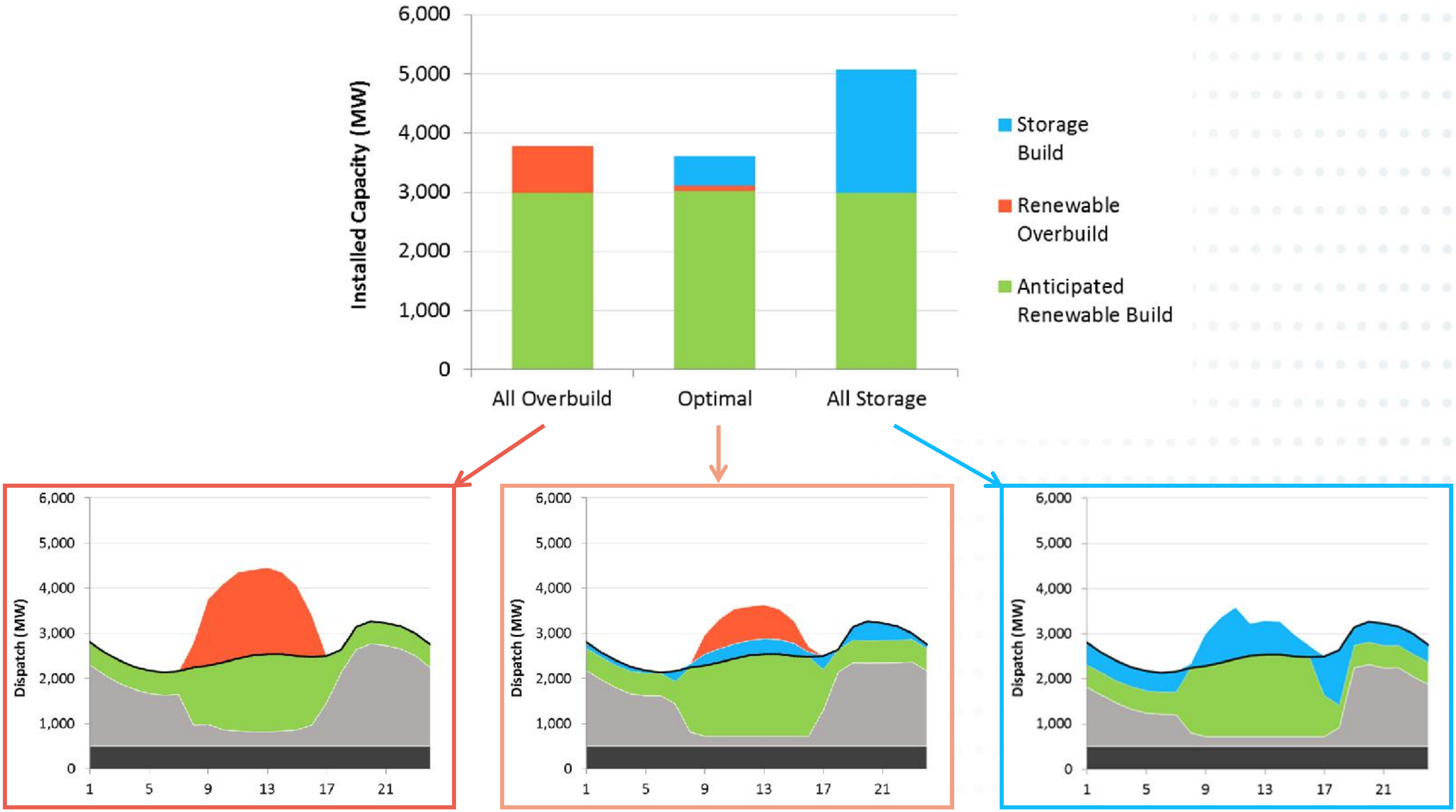
RESOLVE OVERVIEW

The Renewable Integration Challenge

+ Primary drivers of renewable integration challenges at high penetrations:
  - Renewable oversupply during low load periods
  - Inflexible conventional generation
    - Must-run resources
    - Technical constraints on ramping, minimum stable levels, minimum up and down times
    - High costs associated with cycling
  - Small balancing areas or constrained interactions with neighboring regions
+ Research has shifted to focus on grid integration solutions



Optimal Solution Balances Non-Renewable Solutions with Overbuild



RESOLVE Co-optimizes Investment and Operational Decisions

- RESOLVE allows portfolio optimization across a long time horizon (10-20 years)
- Fixed costs capture capital, financing, and fixed O&M associated with new physical infrastructure
- Operational detail focuses on primary drivers of renewable integration challenges
- RESOLVE may select portfolio from a variety of potential "solutions," including:
  - Renewable overbuild
  - Energy storage
  - Advanced demand response
  - Conventional gas generation
  - Gas retrofits

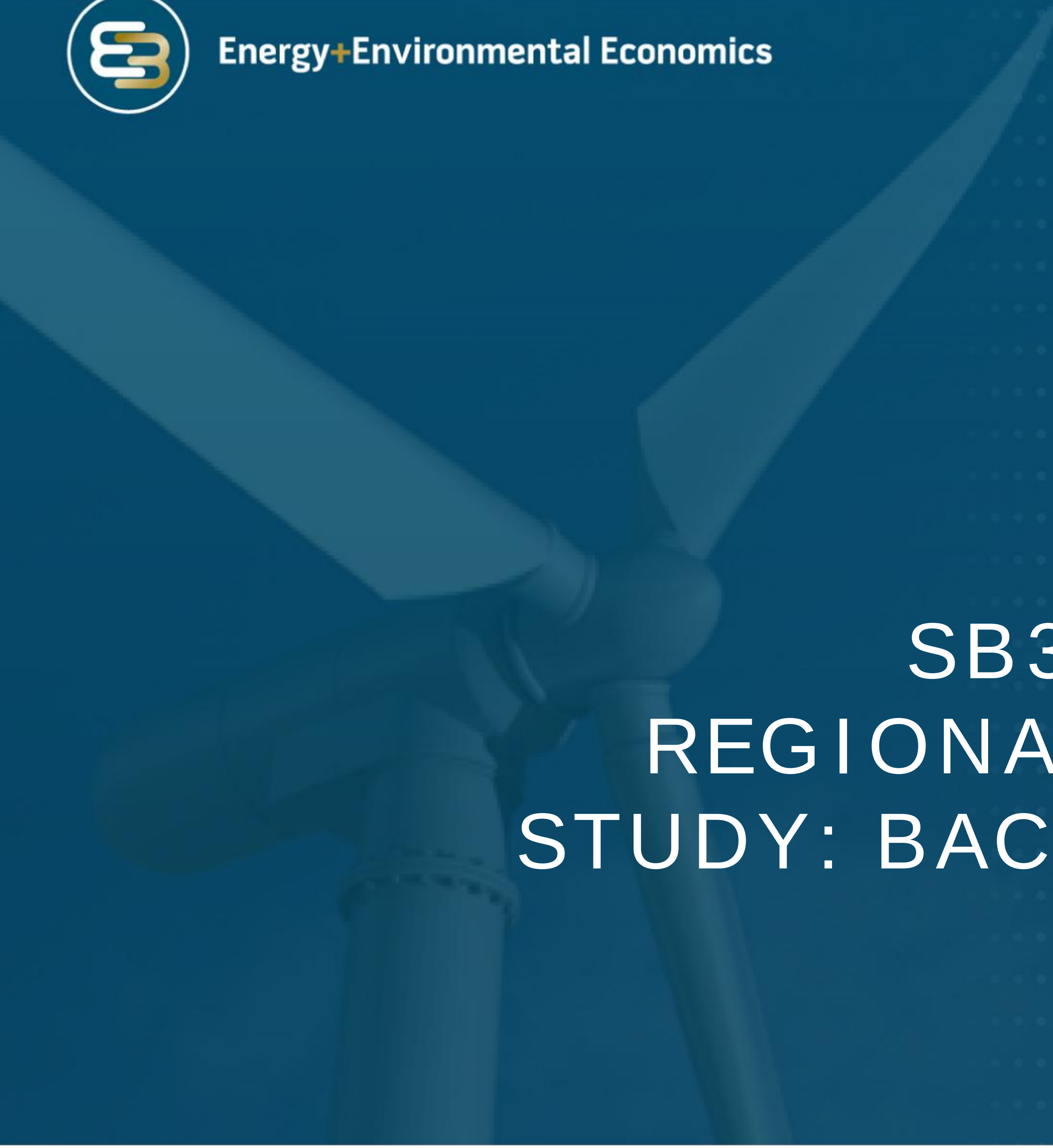
RESOLVE Objective Function

+ **Fixed Costs of New Resources**
  - Renewables
  - Energy storage
  - Demand response
  - Thermal

+ **Fixed Costs of New Transmission**

+ **System Operating Costs**
  - Variable O&M
  - Start costs
  - Fuel costs
  - Carbon

Energy+Environmental Economics



SB350 CAISO REGIONALIZATION STUDY: BACKGROUND

Scope of CAISO Regionalization Study

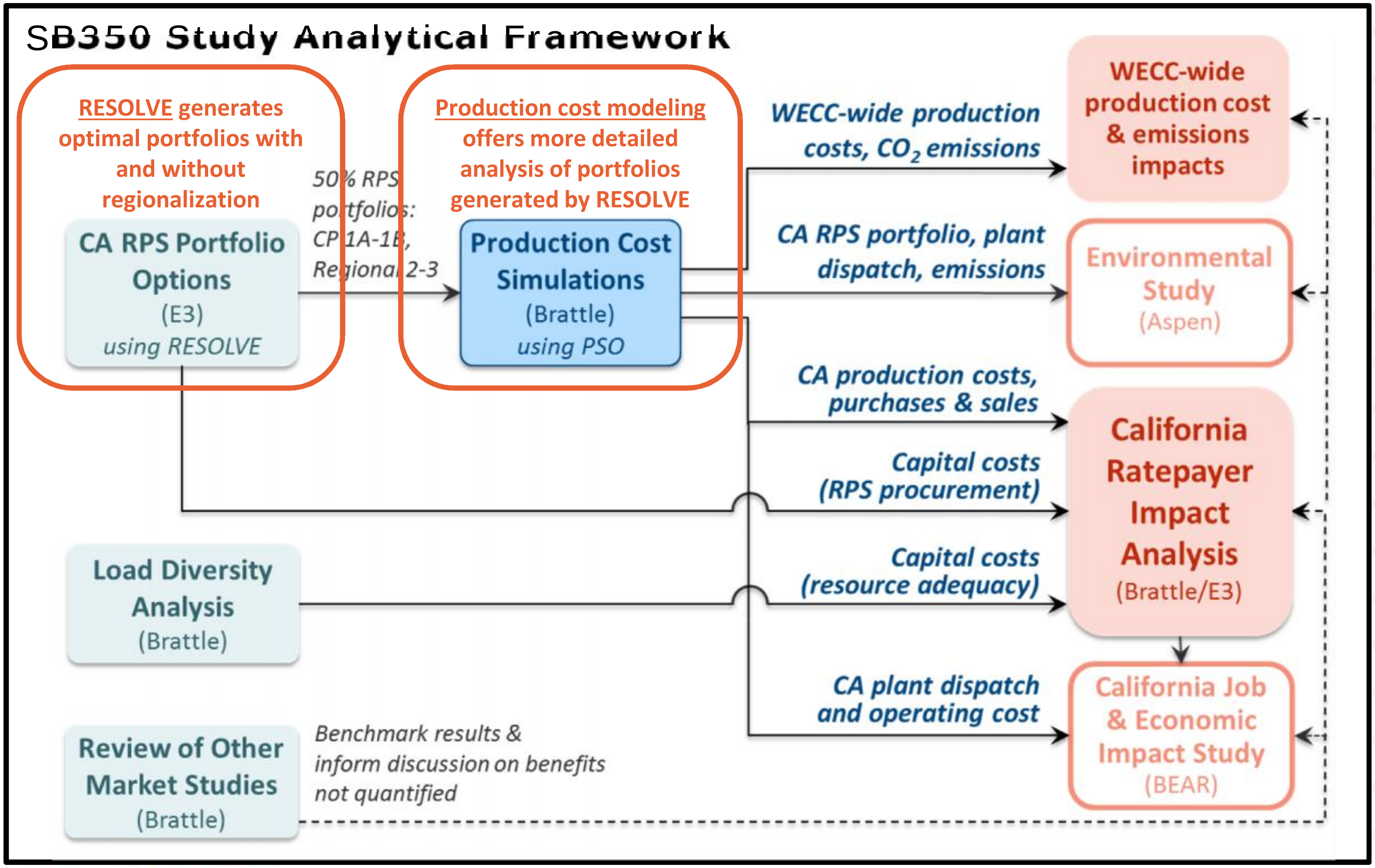
- SB350 established the intent of the California legislature to transform CAISO into a regional entity—provided it is found to be in the interest of the state—requiring a study to examine potential impacts:

> "The Independent System Operator conducts one or more studies of the impacts of a regional market enabled by the proposed governance modifications, including overall benefits to ratepayers, including the creation or retention of jobs and other benefits to the California economy, environmental impacts in California and elsewhere, impacts in disadvantaged communities, emissions of greenhouse gases and other air pollutants, and reliability and integration of renewable energy resources."

- E3 worked with The Brattle Group, Aspen Environmental Group, and the Berkeley Energy and Resources, Inc. (BEAR) to complete this study in July 2016

CAISO Regionalization Study: Analytical Framework

- E3's RESOLVE constituted the first step of analysis in CAISO's Regionalization Study, used to answer the question of how the optimal portfolio changes under a successful effort at regionalization

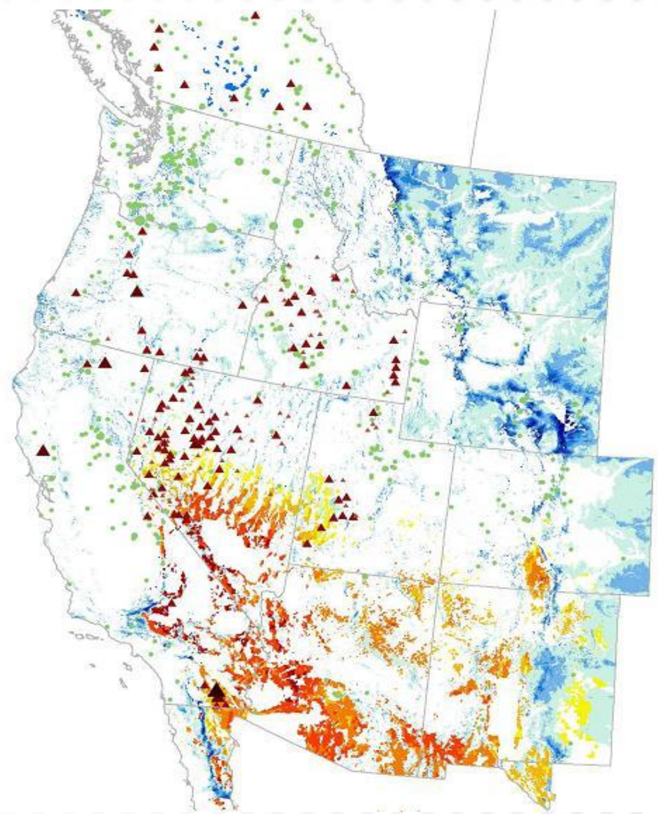


SB350 Study: Impact of a Regional Market on Renewable Procurement

Two major effects are tested in RESOLVE:

1. Effect of regional operations
    - Increased access to latent flexible capacity across a broad, diverse region
    - Increased ability to export surplus energy
    - Could result in changes to least-cost portfolio
2. Effect of regional transmission tariff
    - Reduces wheeling costs across the region
    - Provides a mechanism for needed new transmission infrastructure to be studied and approved for inclusion in rates
    - Provides access to high-quality wind in the Rockies and solar in the Southwest

Renewable Resource Potential in the West



Source: NREL

Three Scenarios Studied

1. Current Practice Scenario
   - Renewable energy procurement is largely from in-state resources, with 5,000 MW of out-of-state resources available over existing transmission
   - No regional market to help reduce curtailment
2. Regional market operations with 'Current Practice' renewable energy procurement policies
   - Assumes no increase in availability of out-of-state resources, but transmission wheeling charges are de-pancaked
   - Curtailment of renewables is reduced through better integration
3. Regional market and renewable energy procurement
   - Like Scenario 2, but with additional high-quality wind resources made available, requiring new transmission facilitated by the regional entity

Scenario-Specific Assumptions

- Specific inputs for each scenario are chosen to capture major differences among them

Assumption	Scenario 1 (a/b)	Scenario 2	Scenario 3
CAISO Export Limit	2,000/8,000 MW	8,000 MW	8,000 MW
Wheeling Charges	Included	Ignored	Ignored
Available Incremental OOS Renewables	5,000 MW	5,000 MW	11,000 MW

Scenario 1 is designed to reflect Current Practices in procurement and operations

Scenario 2 relaxes operational constraints to simulate benefits of regional market

Scenario 3 increases the availability of out-of-state renewables to meet California's RPS goals

Energy+Environmental Economics

SB350 CAISO REGIONALIZATION STUDY : KEY INPUTS & ASSUMPTIONS

Summary of RESOLVE in SB350

- RESOLVE requires a wide range of inputs to determine the optimal portfolio of future resources

Fixed Inputs

Supply-Side
- Existing resources
- Planned retirements
- Planned additions

Demand-Side
- Load
- Energy efficiency
- Behind-the-meter PV
- Electric vehicles
- TOU rates
- Demand response

Candidate Resources

Supply-Side
- Renewables
- Storage
- Conventional

Demand-Side
- Demand response

RESOLVE

NPV cost minimization subject to constraints

Constraints
- RPS target
- Reliability
- Hourly load
- Reserves & freq response
- Generator capabilities
- Interregional flows

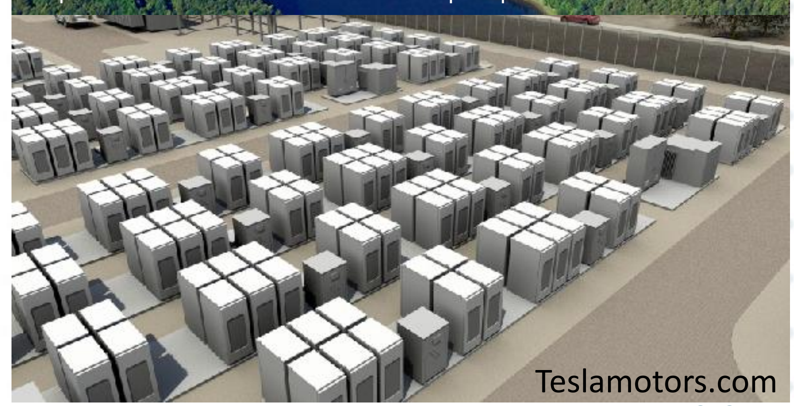
Least-Cost Portfolio

Many Renewable Integration Solutions Assumed in All Scenarios

- Time-of-use rates that encourage daytime use
- 5 million electric vehicles by 2030 with near-universal access to workplace charging
- 500 MW of pump storage manually added
- 500 MW of geothermal manually added
- 5,000 MW of out-of-state renewable resources available to be selected on a least-cost basis
- Unlimited storage available to be selected on a least-cost basis
- Renewables provide operating reserves
- Storage and hydro provide operating reserves and frequency response

https://www.linkedin.com

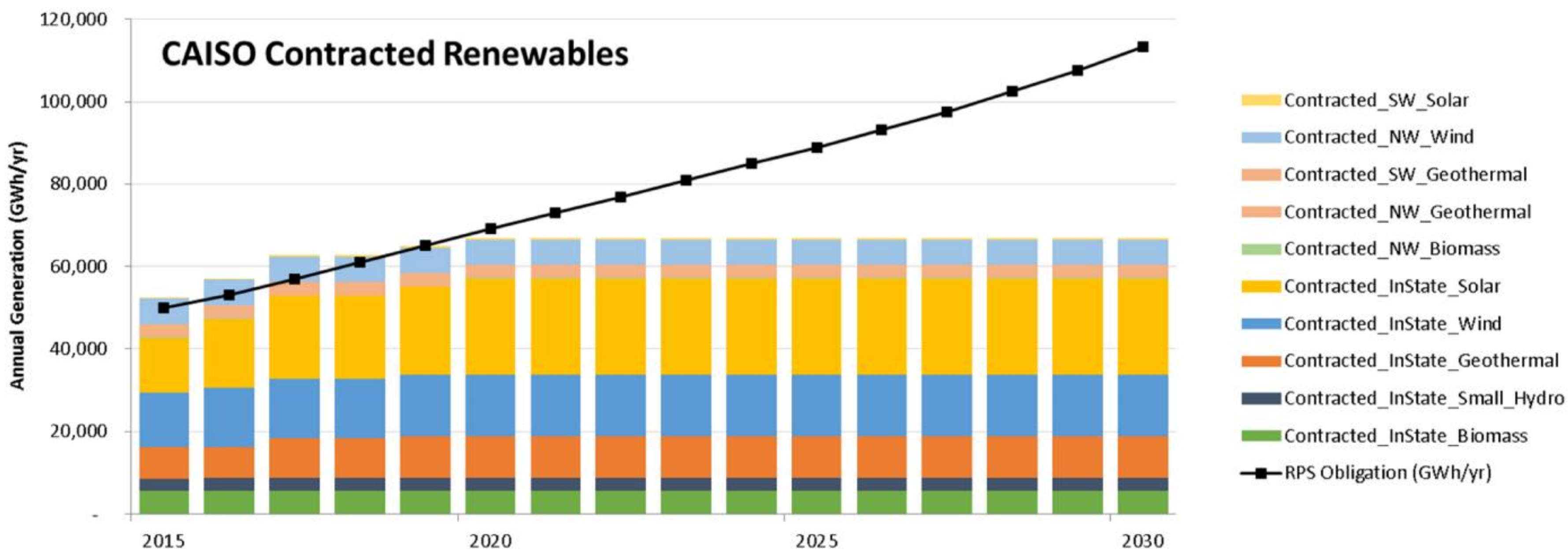
http://renews.biz/67193/vattenfall-pumps-new-life-into-80mw



Teslamotors.com

Existing & Contracted Renewable Resources

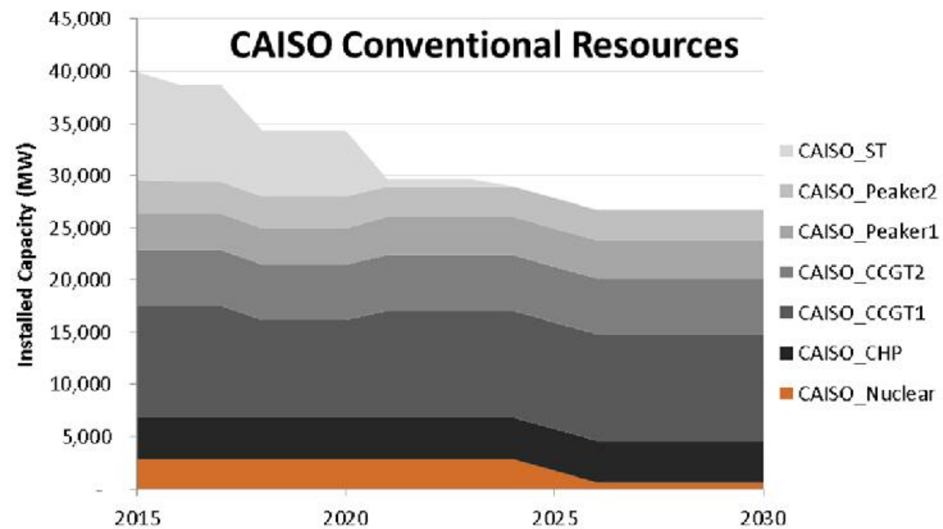
- Existing and contracted renewables for IOUs are from the RPS Calculator v6.1
- Municipal utility existing and contracted renewables are from TEPPC 2024 data
- 18 GW of rooftop PV statewide (16.6 GW in CAISO) by 2030 based on extrapolation of CEC 2015 IEPR “mid” forecast



Conventional Generator Additions and Retirements

+ Retirements

  - Nuclear: Assumes retirement of Diablo Canyon in 2025
  - California Once-through-cooling (OTC) units are retired per 2014 LTPP thermal stack assumptions



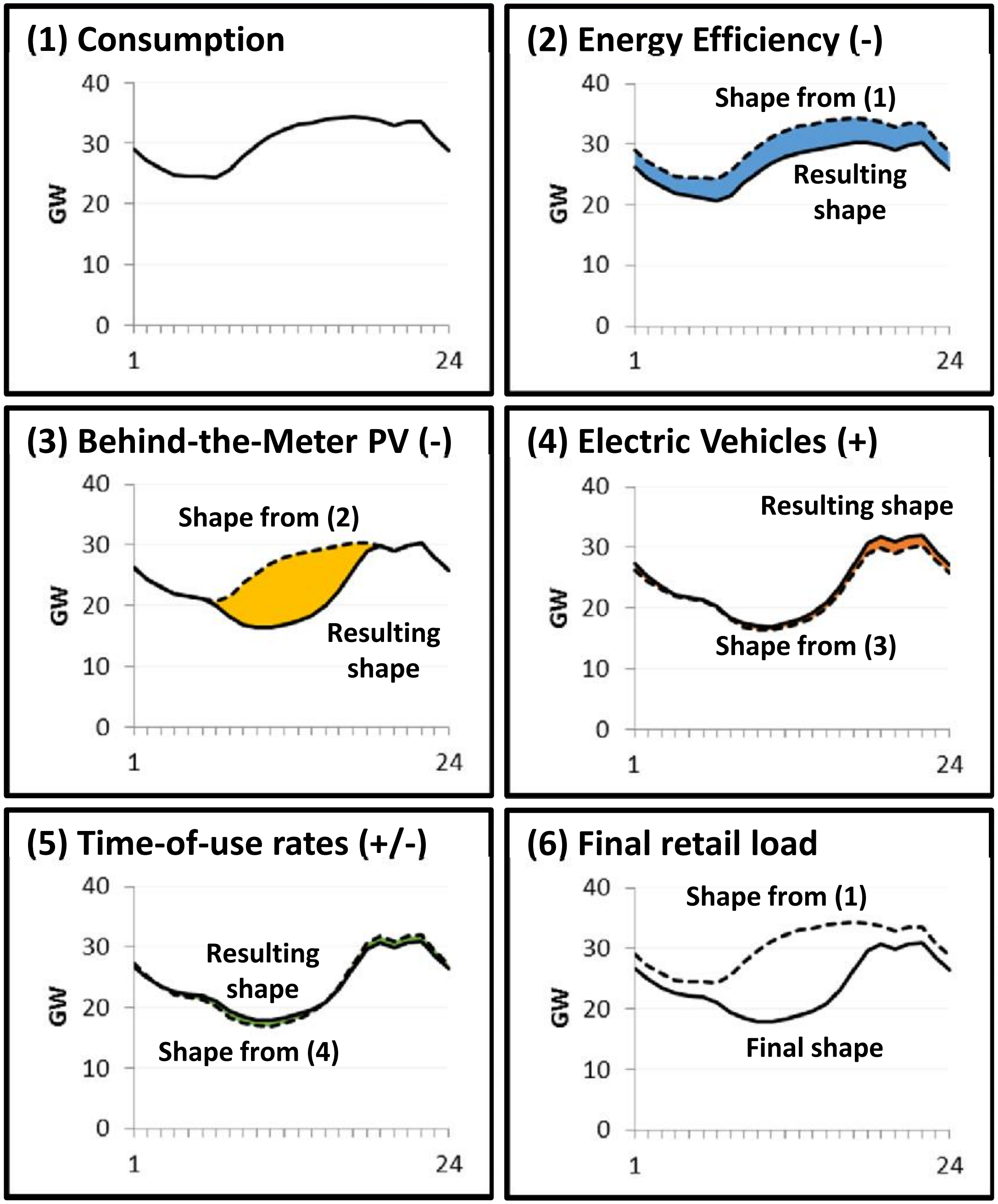
  - Out of state coal retirements are based on announced retirements (including retirements assumed in PacifiCorp IRP)

+ Additions

  - RESOLVE adds new capacity if resource adequacy needs are not met with preferred resources
    - No new capacity additions are triggered

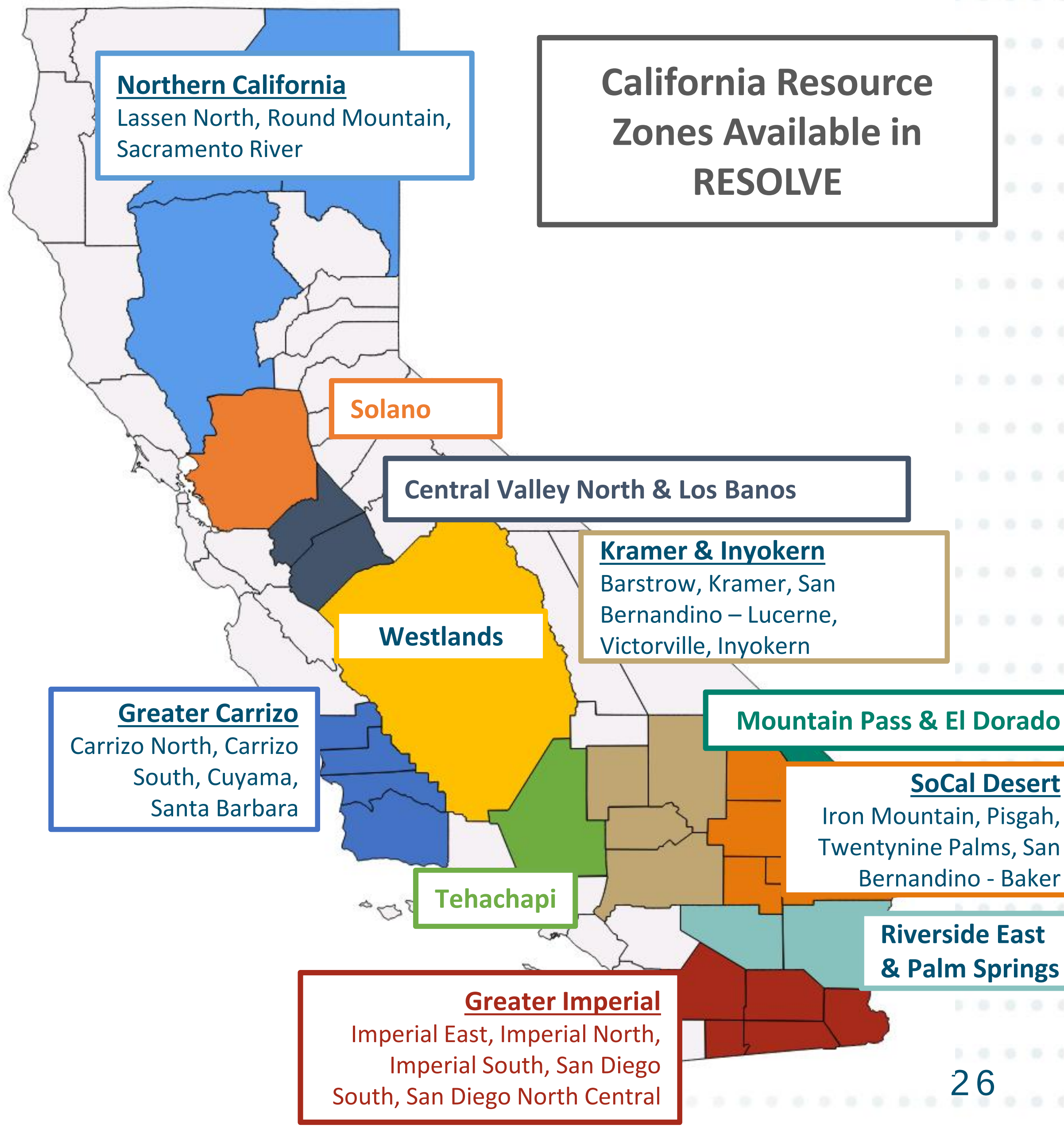
Load Forecast by Component

- Load forecast incorporates multiple demand-side adjustments:
  - Energy efficiency
  - Behind-the-meter PV
  - Electric vehicles
  - Time-of-use rates
- Each adjustment is modeled with an independent profile, allowing RESOLVE to capture changes in the load shape through time



Overview of In-State Resource Potential

+ Initial renewable resource supply curve developed based on RPS Calculator 6.1, adjustments made based on stakeholder feedback
  - Model includes extensive data on renewable resource potential and performance in California, as well as transmission cost and availability provided by CAISO
  - Renewable cost assumptions adjusted from Black & Veatch assumptions based on stakeholder feedback



Out-of-state Resource Availability Varies by Scenario

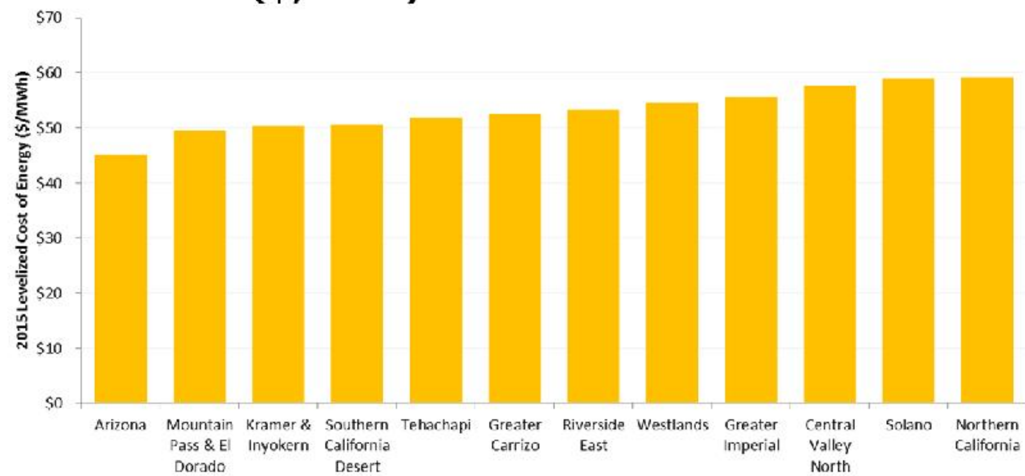
- Three categories of out of state resources are made available for selection by RESOLVE: RECs, Existing Transmission, New Transmission
  - Selection based on least portfolio cost; not all out-of-state resources are picked
- Pancaked wheeling and loss charges apply in Scenario 1 only
- Regional transmission organization facilitates new transmission development for highest-quality WY and NM wind in Scenario 3

Renewable resource potential (MW) (not all resources are selected)	**Scenarios 1 and 2**	**Scenario 3**
NW Wind RECs	1,000	1,000
NW Wind, Existing Transmission	1,000	500
WY Wind, Existing Transmission	500	1,000
WY Wind, New Transmission	-	3,000
SW Solar RECs	1,000	1,000
SW Solar, Existing Transmission	500	500
NM Wind, Existing Transmission	1,000	1,000
NM Wind, New Transmission	-	3,000
Total Out of State Resources for IOUs	*5,000*	*11,000*

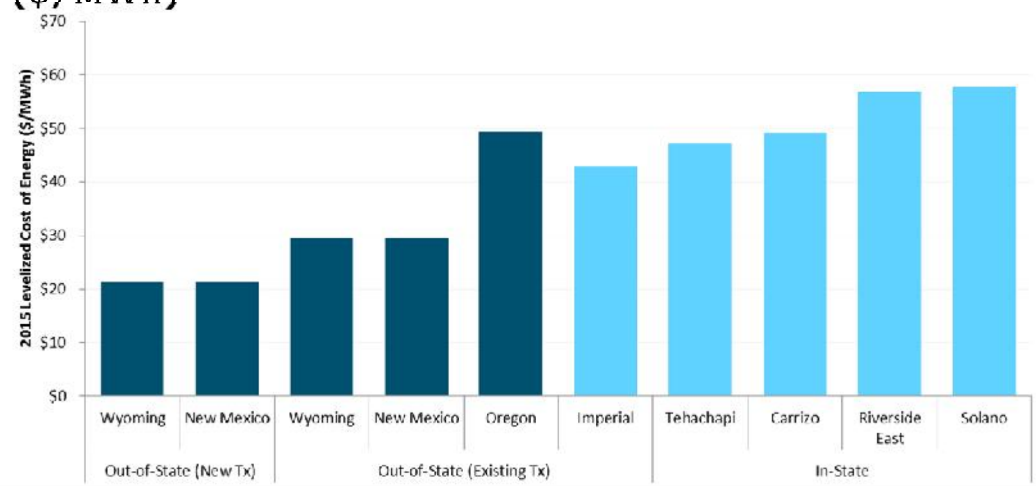
Renewable Resource Costs

+ Renewable resource cost assumptions are based on the CPUC's RPS Calculator v.6.1, then modified based on stakeholder feedback to reflect current renewable market
+ Pro-forma cash flow model translates costs into estimated PPA prices used in RESOLVE
+ Cost and performance characteristics for new renewable resources vary from one region to the next

Regional Variations in Solar PV LCOE, 2015 Installations ($/MWh)



Regional Variations in Wind LCOE, 2015 Installations ($/MWh)



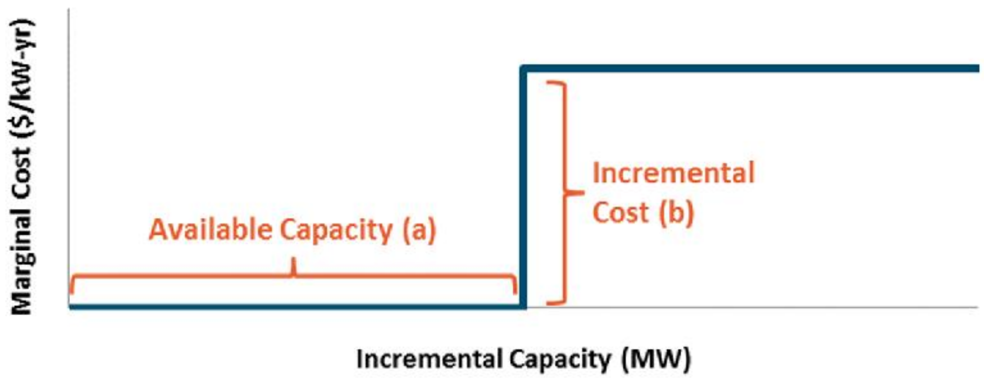
Renewable Cost Assumptions Change Over Time

- Power purchase agreement prices are projected through 2030 based on long-term industry trends:
  - Capital cost reductions: technological improvement expected to reduce renewable resource costs
  - Long run financing: financing costs expected to increase over time due to rising interest rates
  - Property tax exemption: the exemption of solar facilities from California property tax is not available to facilities installed after 2024
  - Federal tax credit sunsets: Federal PTC and ITC phase out by 2019 for wind and by 2021 for solar and geothermal
    - Solar PV & geothermal eligible for 10% ITC after 2021

California In-State Renewable Transmission Cost Assumptions

- California transmission cost assumptions are based on CAISO's 50 Percent Renewable Energy Special Study conducted as part of the 2015-2016 Transmission Plan
  - https://www.caiso.com/Documents/Draft2015-2016TransmissionPlan.pdf
- 'Available Capacity (a)' represents the limit of a system to accommodate new renewables at no cost; and 'Incremental Cost (b)' reflects the cost of new transmission upgrades once the available capacity has been exhausted.

Illustrative two-step transmission costing model for a renewable resource zone in California



Availability of energy only capacity and cost of transmission upgrades in California renewable resource zones

Zone	Available Capability (MW)	Incremental Cost ($/kW-yr)
Central Valley & Los Banos	2,000	$ 29
Greater Carrizo	1,140	$ 114
Greater Imperial	2,633	$ 68
Kramer & Inyokern	750	$ 52
Mountain Pass & El Dorado	2,982	$ 65
Northern California	3,404	$ 95
Riverside East & Palm Springs	4,917	$ 85
Solano	1,101	$ 13
Southern California Desert	-	$ 64
Tehachapi	5,000	$ 21
Westlands	2,900	$ 58

Energy Storage Cost Assumptions

- Battery cost estimates are based on literature review and quotes from manufacturers, updated based on stakeholder feedback
  - Installed cost of Li-ion is lower even at long durations, but flow battery has longer lifetime and requires fewer/no replacements
- Capital investment and O&M costs are annualized using E3's WECC Pro Forma tool

Technology	Charging & Discharging Efficiency	Financing Lifetime (yr)	Replac-ement (yr)	Minimum duration (hrs)	Resource Potential (MW)
Lithium Ion Battery	92%	16	8	0	N/A
Flow Battery	84%	20	N/A	0	N/A
Pumped Hydro	87%	40	N/A	12	4,000

Type	Cost Metric	2015	2030
Lithium Ion Battery	Storage Cost ($/kWh)	375	183
	Power Conversion System Cost ($/kW)	300	204
	Fixed O&M Battery/Reservoir ($/kWh-yr)	7.5	3.7
	Fixed O&M PCS ($/kW-yr)	6.0	4.1
Flow Battery	Storage Cost ($/kWh)	700	315
	Power Conversion System Cost ($/kW)	300	204
	Fixed O&M Battery/Reservoir ($/kWh-yr)	14.0	6.3
	Fixed O&M PCS ($/kW-yr)	6.0	4.1
Pumped Hydro	Storage Cost ($/kWh)	117	117
	Power Conversion System Cost ($/kW)	1,400	1,400
	Fixed O&M Battery/Reservoir ($/kWh-yr)	-	-
	Fixed O&M PCS ($/kW-yr)	15	15

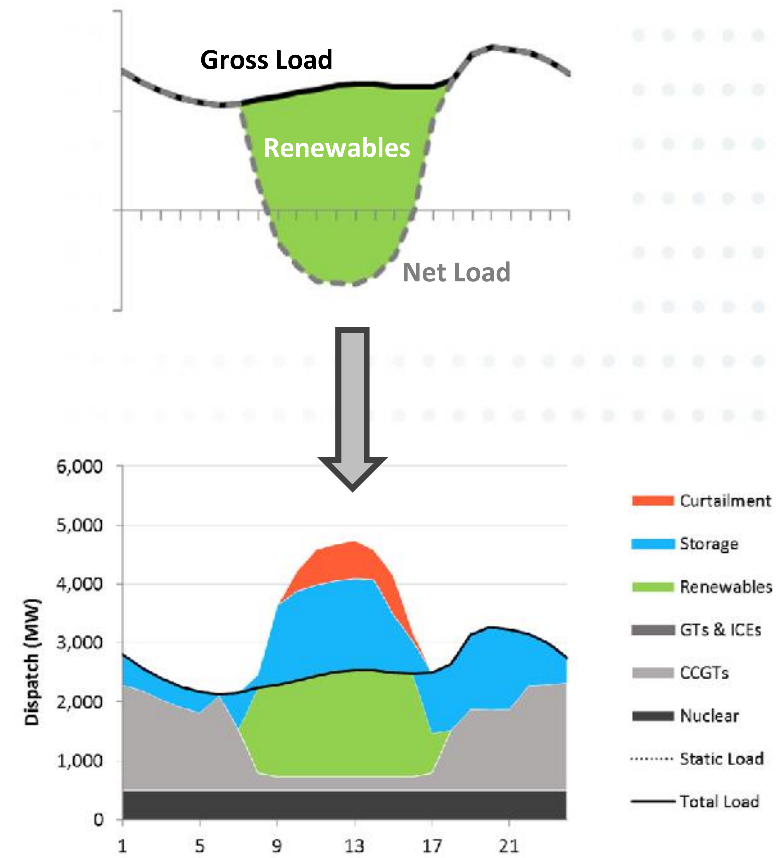
Technology	2015 Annualized Cost Components ($/kW-yr; $/kWh-yr)	2030 Annualized Cost Components ($/kW-yr; $/kWh-yr)
Lithium Ion Battery	69; 85	46; 40
Flow Battery	58; 118	39; 53
Pumped Hydro	146; 12	146; 12

Note: The first number indicates the annualized cost of the power conversion system ($/kW-yr) of the device and the second number indicates the annualized cost of the energy storage capacity or reservoir size ($/kWh-yr). Both numbers are additive.

Hourly Model Brings Operational Challenges into Investment Decisions

+ For each year in the simulation, a subset of days are selected and weighted to reflect long-run distributions of:
    - Daily load, wind, and solar
    - Monthly hydro availability
+ Operations modeled using linear dispatch formulation
    - Upward and downward operating reserve constraints
    - Parameterization of subhourly renewable curtailment due to downward reserve shortfalls

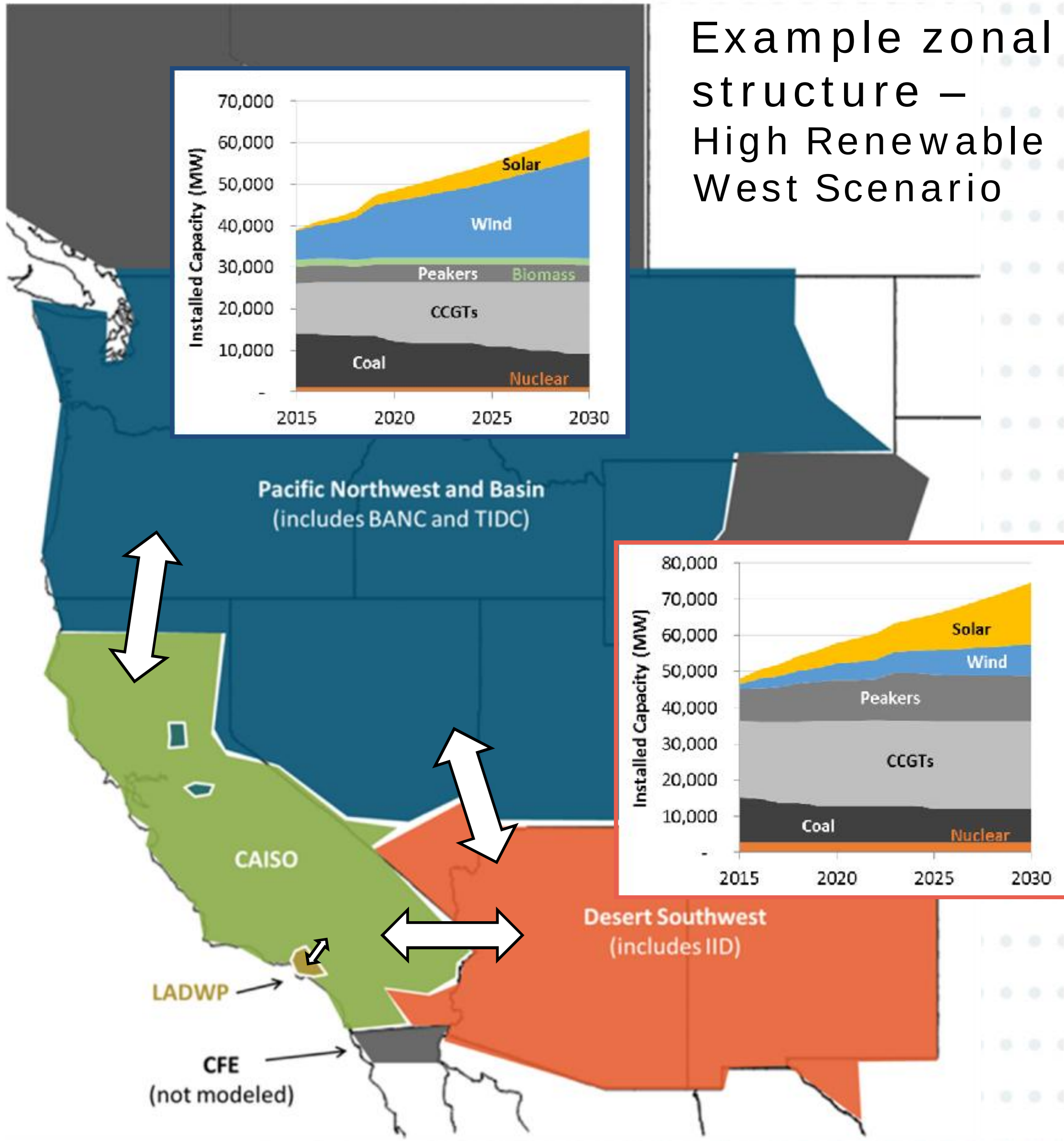
Captures operational impacts of renewable integration challenges



Limits on Exports of Surplus Power Vary by Scenario

+ Under current system of bilateral trading, the ability of other Balancing Authorities to absorb surplus power from California during periods of high renewable output is limited
    - BAAs maintain obligation to balance their systems subject to NERC performance standards
    - Other bilateral "friction" may prevent some California renewable energy from finding a market
+ Exports under the Current Practice Scenario are limited to 2,000 MW
    - Significant reduction from 4,000 MW of imports today
+ 8,000 MW of exports allowed under regional markets
    - Also tested as a sensitivity to Current Practice scenario

Example zonal structure – High Renewable West Scenario



Energy+Environmental Economics

SB350 CAISO REGIONALIZATION STUDY : RESULTS

Summary of RESOLVE Outputs

- RESOLVE produces a variety of outputs that may inform planning decisions
  - Incremental resource portfolio (MW)
  - Fixed costs of new investments ($)
  - System-wide operational cost ($)
  - Renewable curtailment (GWh)
  - CAISO GHG emissions (MMTCO2e)
  - CAISO natural gas burn (MMBtu)
  - Shadow prices of key constraints ($ per unit)

Used directly in Regionalization Study

Total Incremental Resources for California (in GWh)

- **Model selects a diverse portfolio of in-state solar and out-of-state wind across all cases**

	Scenario 1a	Sensitivity 1b	Scenario 2	Scenario 3
CAISO simultaneous export limit	2,000	8,000	8,000	8,000
Procurement	Current practice	Current practice	Current practice	WECC-wide
Operations	CAISO	CAISO	WECC-wide	WECC-wide
Portfolio Composition (GWh)				
California Solar	21,482	23,483	22,147	9,827
California Wind	8,480	8,480	5,596	5,596
California Geothermal	3,942	3,942	3,942	3,942
Northwest Wind, Existing Transmission	4,056	1,253	1,574	891
Northwest Wind RECs	2,803	0	2,803	0
Utah Wind, Existing Transmission	1,693	1,693	1,693	1,177
Wyoming Wind, Existing Transmission	1,708	1,708	1,708	1,708
Wyoming Wind, New Transmission	0	0	0	8,037
Southwest Solar, Existing Transmission	0	809	1,489	1,489
Southwest Solar RECs	2,978	2,978	2,978	2,978
New Mexico Wind, Existing Transmission	3,416	3,416	3,416	3,416
New Mexico Wind, New Transmission	0	0	0	7,905
Total CA Resources	33,904	35,905	31,685	19,365
Total Out-of-State Resources	16,654	11,857	15,661	27,601
Total Renewable Resources	**50,558**	**47,762**	**47,346**	**46,966**
Curtailment (IOUs only, GWh)	4,818	2,022	1,606	1,226
Curtailment (% of available RPS energy)	4.5%	2.0%	1.6%	1.2%

- **Curtailment is significantly reduced under regional operations**

Scenario 1: Incremental Resources for California

	Scenario 1a	Sensitivity 1b	Scenario 2	Scenario 3
CAISO simultaneous export limit	2,000	8,000	8,000	8,000
Procurement	Current practice	Current practice	Current practice	WECC-wide
Operations	CAISO	CAISO	WECC-wide	WECC-wide
Portfolio Composition (MW)				
California Solar	**7,601**	**8,279**	7,804	3,440
California Wind	**3,000**	**3,000**	1,000	1,000
California Geothermal	**500**	**500**	[illegible]	[illegible]
Northwest Wind, Existing Transmission	**1,447**	**447**	[illegible]	[illegible]
Northwest Wind RECs	**1,000**	**0**	[illegible]	[illegible]
Utah Wind, Existing Transmission	**604**	**604**	[illegible]	[illegible]
Wyoming Wind, Existing Transmission	**500**	**500**	[illegible]	[illegible]
Wyoming Wind, New Transmission	**0**	**0**	0	1,995
Southwest Solar, Existing Transmission	0	272	500	500
Southwest Solar RECs	1,000	1,000	1,000	1,000
New Mexico Wind, Existing Transmission	1,000	1,000	1,000	1,000
New Mexico Wind, New Transmission	0	0	0	1,962
Total CA Resources	11,101	11,779	10,204	5,840
Total Out-of-State Resources	5,551	3,823	5,166	7,694
Total Renewable Resources	**16,652**	**15,602**	**15,370**	**13,534**
Energy Storage (MW)	**972**	**500**	500	500

- **Under higher export capability, in-state solar displaces out-of-state wind due to reduced curtailment**

- **Additional battery storage selected in Scenario 1a**

Scenario 2: Incremental Resources for California

- **Ability to export reduces curtailment; procurement of both in-state and out-of-state wind is reduced**

	Scenario 1a	Sensitivity 1b	Scenario 2	Scenario 3
CAISO simultaneous export limit	2,000	8,000	8,000	8,000
Procurement	Current practice	Current practice	Current practice	WECC-wide
Operations	CAISO	CAISO	WECC-wide	WECC-wide
Portfolio Composition (MW)				
California Solar	**7,601**	8,279	**7,804**	3,440
California Wind	**3,000**	3,000	**1,900**	1,900
California Geothermal	**500**	500	**500**	500
Northwest Wind, Existing Transmission	**1,447**	447	**562**	318
Northwest Wind RECs	**1,000**	0	**1,000**	0
Utah Wind, Existing Transmission	604	604	604	420
Wyoming Wind, Existing Transmission	500	500	500	500
Wyoming Wind, New Transmission	0	0	0	1,995
Southwest Solar, Existing Transmission	0	272	500	500
Southwest Solar RECs	1,000	1,000	1,000	1,000
New Mexico Wind, Existing Transmission	1,000	1,000	1,000	1,000
New Mexico Wind, New Transmission	0	0	0	1,962
Total CA Resources	11,101	11,779	10,204	5,840
Total Out-of-State Resources	5,551	3,823	5,166	7,694
Total Renewable Resources	16,652	15,602	15,370	13,534
Energy Storage (MW)	972	500	500	500

Scenario 3: Incremental Resources for California

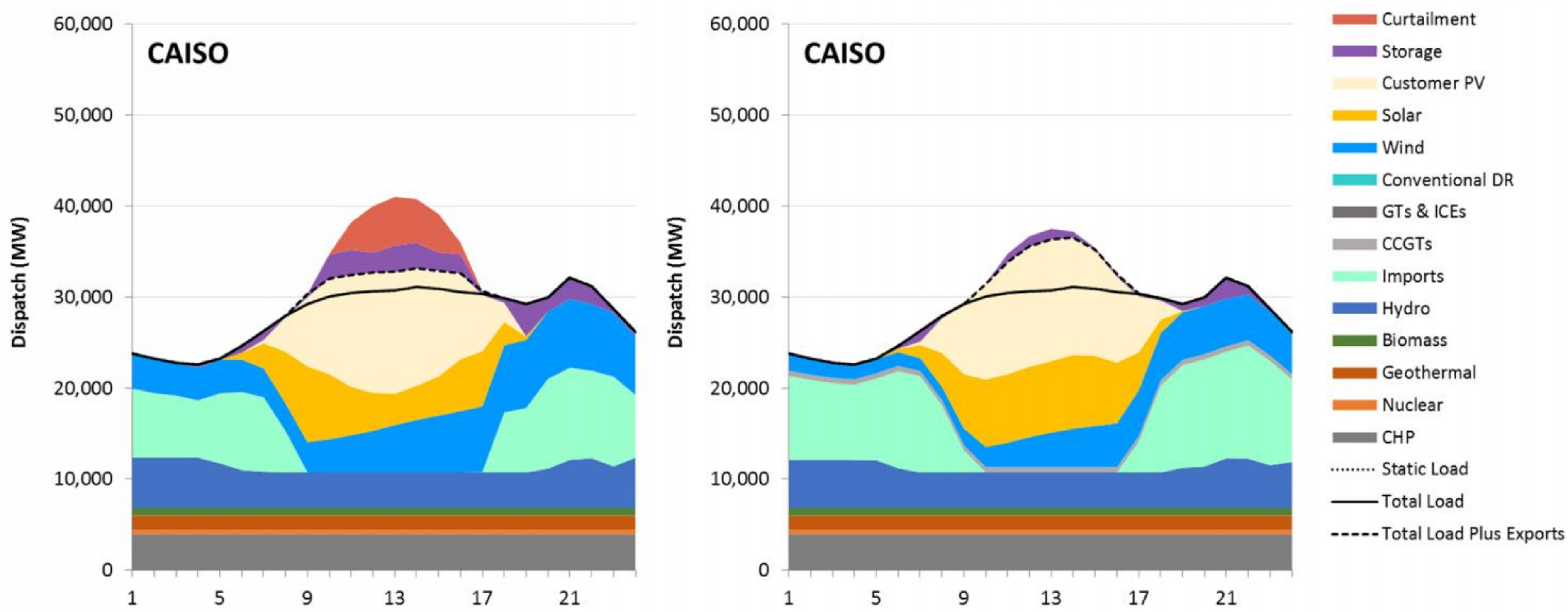
	Scenario 1a	Sensitivity 1b	Scenario 2	Scenario 3
CAISO simultaneous export limit	2,000	8,000	8,000	8,000
Procurement	Current practice	Current practice	Current practice	WECC-wide
Operations	CAISO	CAISO	WECC-wide	WECC-wide
Portfolio Composition (MW)				
California Solar	**7,601**	8,279	7,804	**3,440**
California Wind	**3,000**	3,000	1,900	**1,900**
California Geothermal	**500**			**500**
Northwest Wind, Existing Transmission	**1,447**			**318**
Northwest Wind RECs	**1,000**			**0**
Utah Wind, Existing Transmission	**604**			**420**
Wyoming Wind, Existing Transmission	**500**			**500**
Wyoming Wind, New Transmission	**0**	0	0	**1,995**
Southwest Solar, Existing Transmission	**0**	272	500	**500**
Southwest Solar RECs	**1,000**	1,000	1,000	**1,000**
New Mexico Wind, Existing Transmission	**1,000**	1,000	1,000	**1,000**
New Mexico Wind, New Transmission	**0**	0	0	**1,962**
Total CA Resources	11,101	11,779	10,204	5,840
Total Out-of-State Resources	5,551	3,823	5,166	7,694
Total Renewable Resources	16,652	15,602	15,370	13,534
Energy Storage (MW)	972	500	500	500

WY and NM wind displace California solar and lower-quality NW wind

Snapshots of Operations

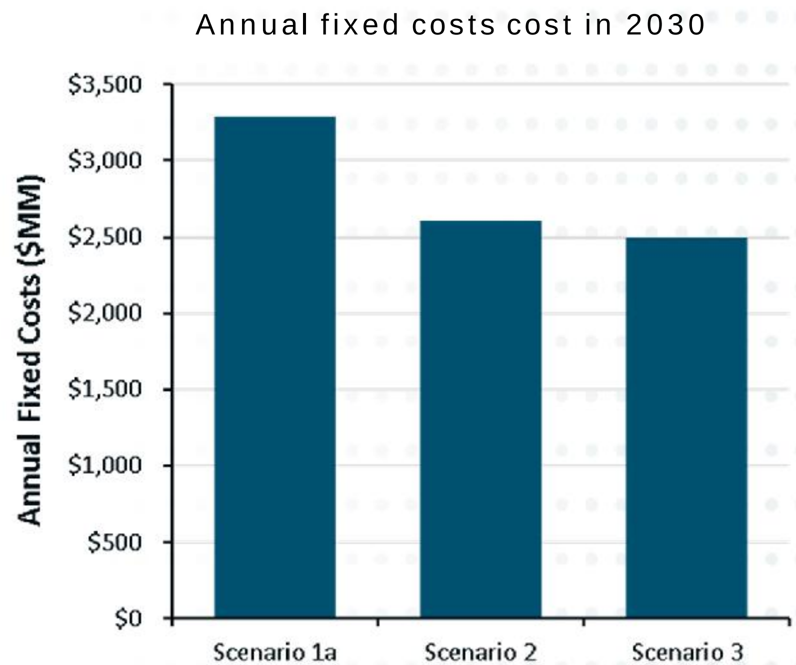
+ RESOLVE's internal production cost model simulates operations of each portfolio, quantifying the total operational cost across the year

Scenario 1A → Scenario 3



Fixed Cost Results

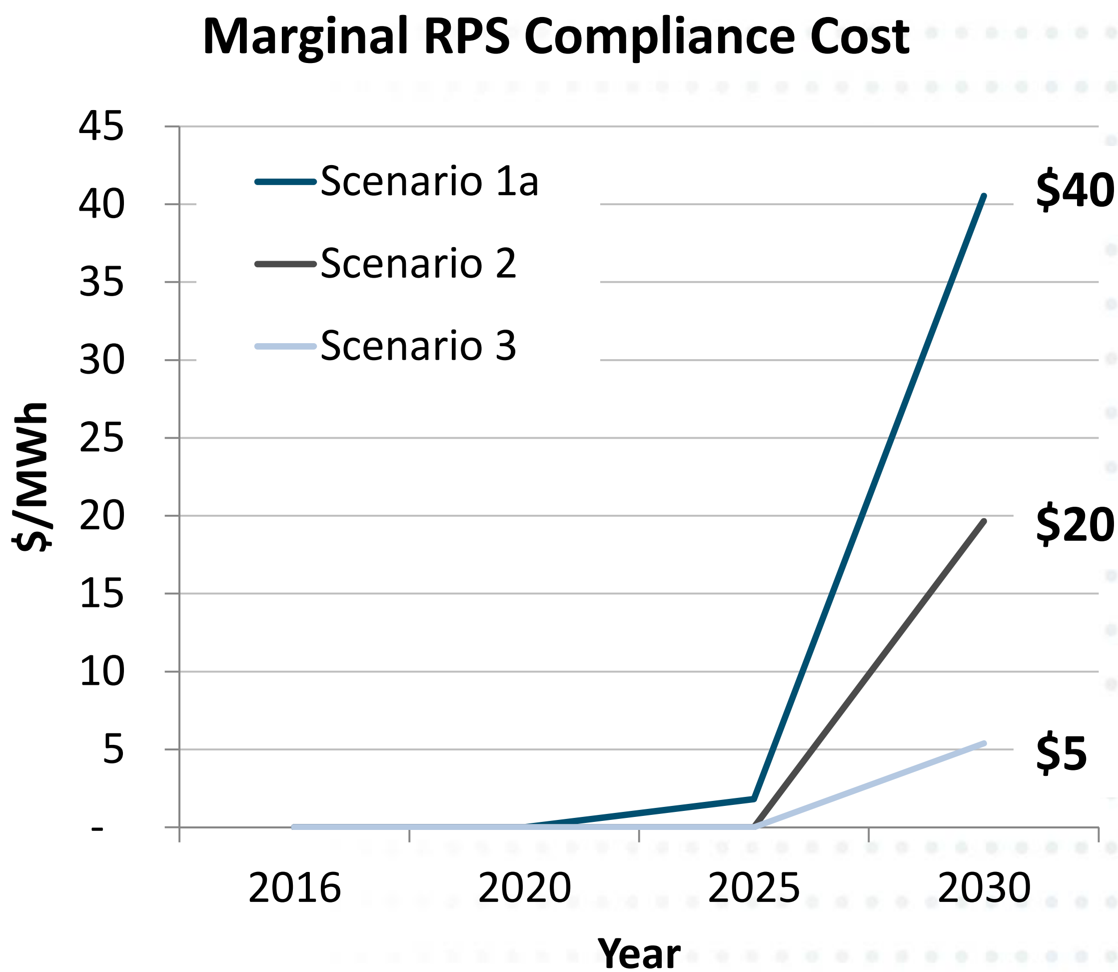
+ In 2030, total fixed costs vary from $2.5 to $3.3 billion
  - Fixed costs only; variable cost differences accounted for in PSO analysis
  - Modest savings assumed for non-CAISO BAs



	Scenario 1a	Scenario 2	Scenario 3
Fixed Costs ($MM) - CAISO	$2,578	$1,934	$1,840
Fixed Costs ($MM) - non-CAISO Bas	$714	$678	$652
Total California Fixed Costs ($MM)	**$3,292**	**$2,612**	**$2,492**

Shadow Prices on Key Constraints

- RESOLVE can produce shadow prices on key model constraints to inform planning decisions
- Marginal cost of RPS compliance varies by scenario
  - Reflects the marginal cost of procuring an additional MWh of renewable generation
  - Also represents the marginal cost of renewable curtailment to ratepayers



Summary of Results with Sensitivity Analysis

+ Annual savings from regional integration range from $391 million to $1 billion per year under 50% RPS
    - High flexible loads and high energy efficiency reduce savings
    - Low Portfolio diversity, high rooftop PV, and higher RPS increase savings
    - High out-of-state availability has limited effect on savings

Fixed Costs ($MM)	Scenario 1a	Scenario 2	Scenario 3
Base assumptions	$3,292	$2,612	$2,492
A. High coordination under bilateral markets	$3,003	$2,612	$2,492
B. High energy efficiency	$2,790	$2,214	$2,098
C. High flexible loads	$3,138	$2,643	$2,522
D. Low portfolio diversity	$3,196	$2,301	$2,192
E. High rooftop PV	$3,256	$2,418	$2,312
F. High out-of-state resource availability	$3,104	$2,526	$2,443
G. Low cost solar	$3,137	$2,627	$2,490
H. 55% RPS	$4,385	$3,221	$3,044

Energy+Environmental Economics

Thank You!

Energy and Environmental Economics, Inc. (E3)
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
Tel 415-391-5100
http://www.ethree.com