Renewable Energy Transmission Initiative v2.0

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Western Regional Partnership

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Agenda

1. RETI 2.0 Background
2. Planning Goals summary
3. Resource Values summary
4. Focus Areas summary
5. Current Activities

RETI 2.0 Background

Renewable Energy Transmission Initiative
v2.0

- Cooperative project of four state and one federal agency
- Statewide, non-regulatory planning effort to help meet statewide GHG and renewable energy goals.
- Explore combinations of renewable generation resources in California and throughout the West that can best meet goals
- Build understanding of transmission implications of renewable scenarios, and identify common transmission elements
- Identify land use and environmental opportunities and constraints to accessing these resources
- Accelerated, agency-driven, high-level assessment to inform future planning and regulatory proceedings

RETI 2.0 Policy Context

Executive Order B-30-15

- Established 40% GHG reduction goal by 2030
- Mandates state agencies to pursue with all statutory authority
- New California **Air Resources Board Scoping Plan**

SB 350

- CPUC and CEC increase **Renewable Requirements** from 33% by 2020 to **50% by 2030**
- Require **resource optimization** and an **Integrated Resource Planning (IRP) process**
- Expresses intent for **regional expansion of the CAISO**
- Encourages **widespread Transportation Electrification**

California Independent System Operator

- Regional expansion planning
- Transmission Planning complete for 33%; “considerable work” necessary to plan for 50%

Western developments

- Clean Power Plan
- OR, WA, NV policy developments
- Mexico electricity sector reform

RETI 1.0 and 2.0

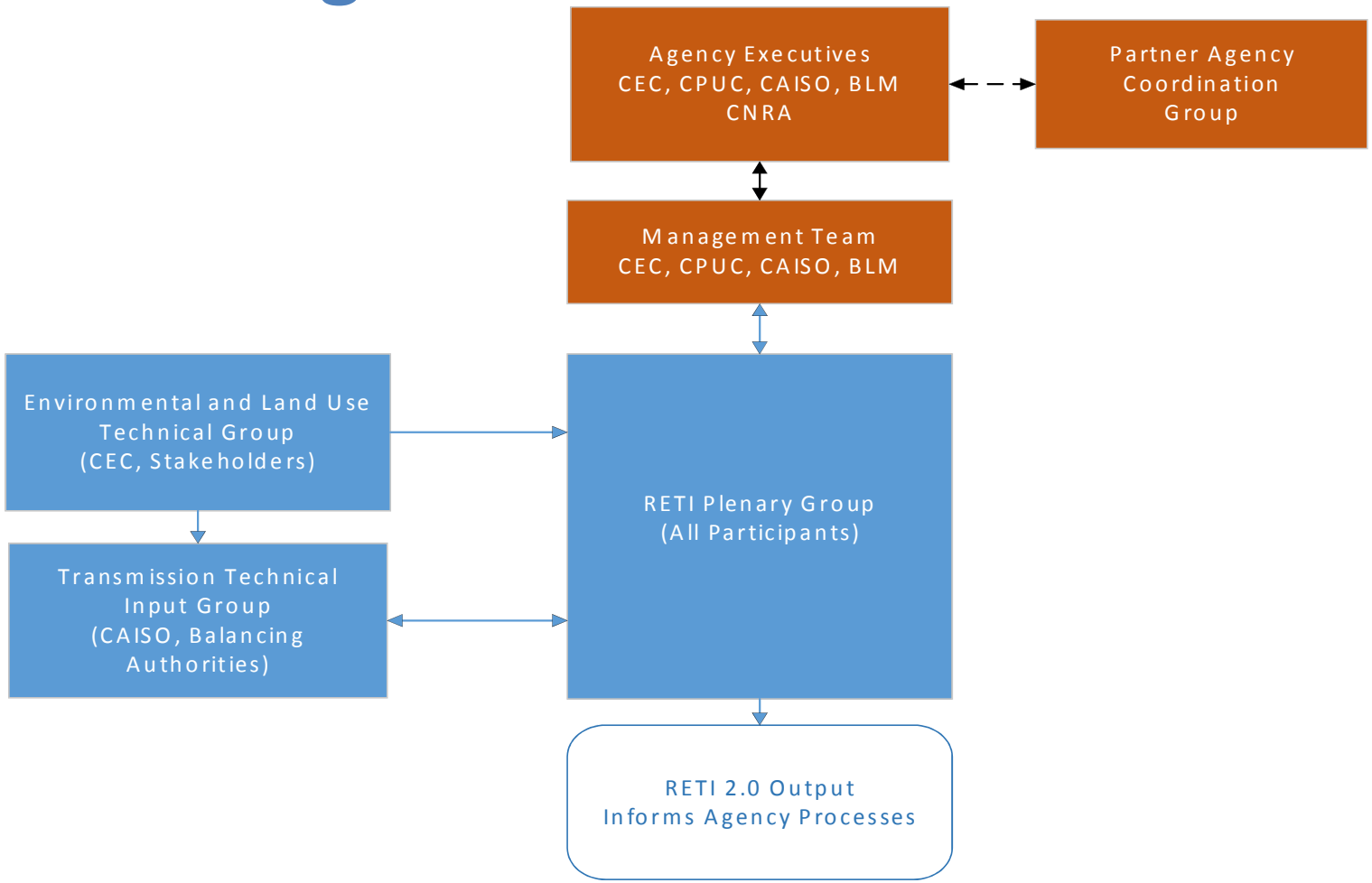
RETI 1

- 2008-2010 Stakeholder-driven process when CA RPS going from 20% to 33%
- Built exhaustive renewable resource potential and cost GIS and economic model; identified numerous potential transmission options
- Institutionalized in CPUC RPS Calculator and CAISO Policy-driven Transmission Planning

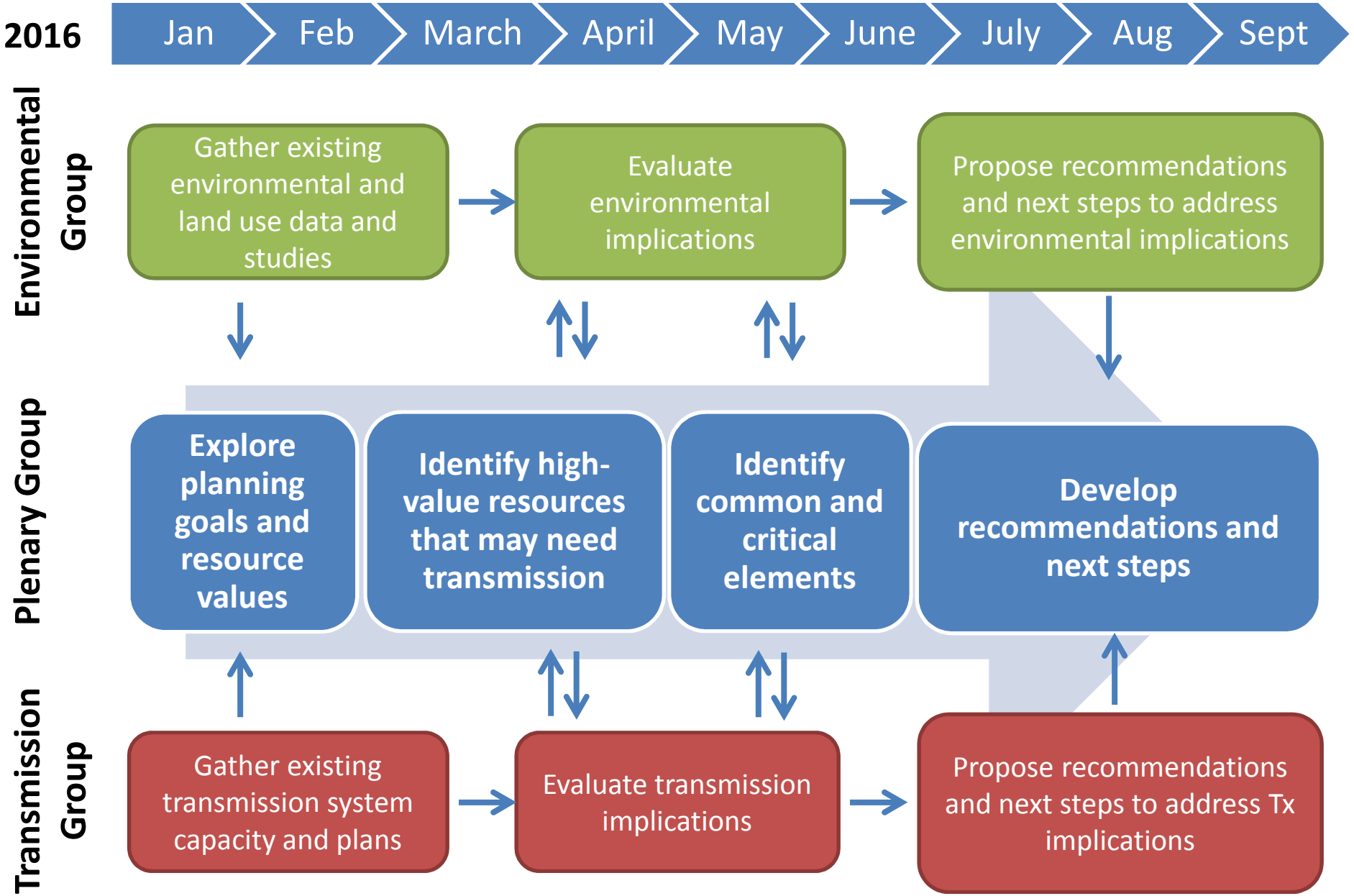
RETI 2

- Accelerated, agency-driven, RETI reprise
  - Final report by October 2016
  - Inform 2017 CPUC IRP and ISO TPP
- Leverage existing studies – no new models
- Emphasis on long-term resource portfolio optimization and GHG reduction in Western context

Organizational structure



RETI 2.0 Process and Timeline



Planning Goals Summary

Planning Goals Background

- Goal is to characterize (ballpark) the scale of renewable energy that may be needed to reach 2030 energy and GHG goals, in the context of Western renewables demand
- No regulatory weight or status
- Used to guide the scale of demand for renewable resources from specific geographic areas
- Create hypothetical range* based on:
  - Minimum needs to reach 50% RPS by 2030
  - Maximum need to reach 40% economy-wide GHG reduction by 2030, on track to 80% by 2050
- Data Sources:
  - California Energy Commission
    - California Energy Demand Forecast
  - California Public Utilities Commission
    - Renewable Portfolio Standard proceedings
  - L.A. Department of Water and Power
    - 2015 Integrated Resource Plan
  - Energy and Environmental Economics (E3)
    - California PATHWAYS State Agencies' project
  - Western Electricity Coordinating Council
    - 2026 Common Case

RPS-based renewables demand

2030 RPS-eligible sales and 50% RPS estimates by CEC*

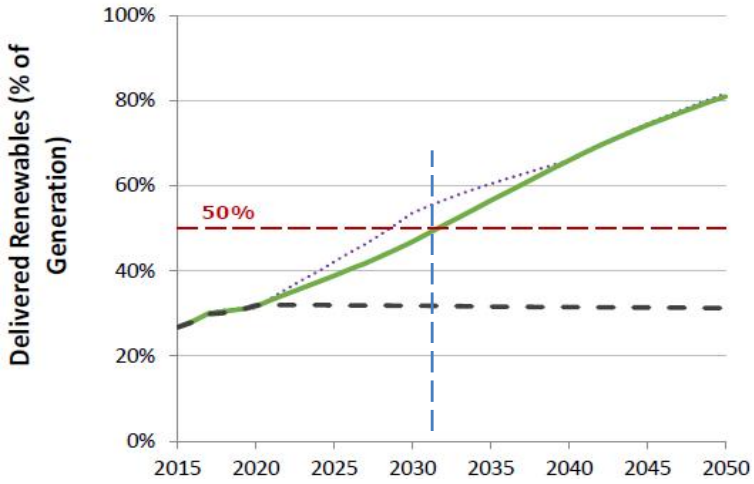
RPS Eligible Retail Sales w/AAEE (GWh)			
Year	High Demand, Low AAEE	Mid Demand, Mid AAEE	Low Demand, High AAEE
2020	257,061	**247,441**	236,893
2030	276,454	**243,081**	205,519
33% RPS 2020	84,830	**81,655**	78,175
50% RPS 2030	138,227	**121,541**	102,760
(2020)-(2030)	53,397	**39,866**	24,585

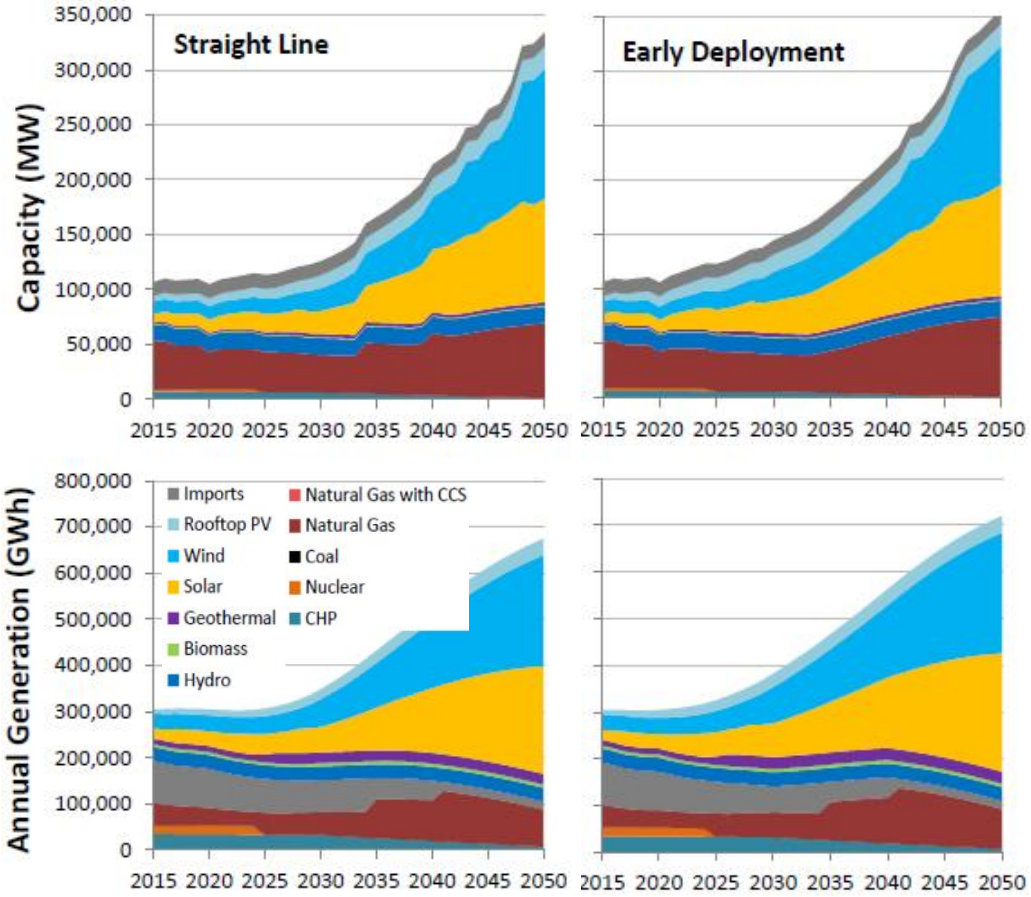
*Estimates only; no regulatory weight

GHG-based Renewables Demand

California PATHWAYS State Agencies' Project

- Large-scale electrification could entail more than doubling total generation and more than tripling total capacity by 2050
- Renewables capacity could quintuple
- By 2030, scenarios suggest 50-60% RPS





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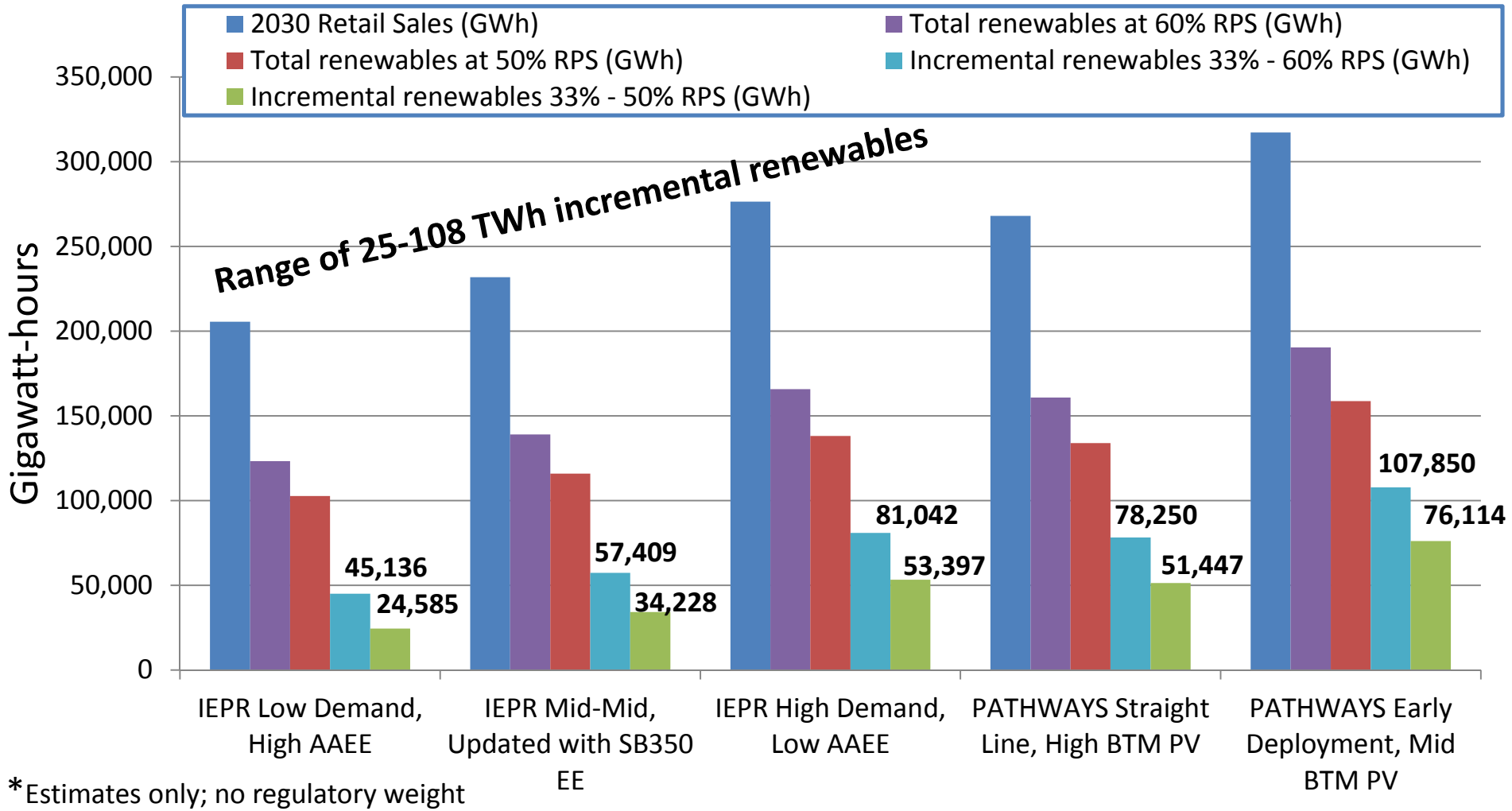
Potential 2030 Renewables under different scenarios



*Estimates only; no regulatory weight

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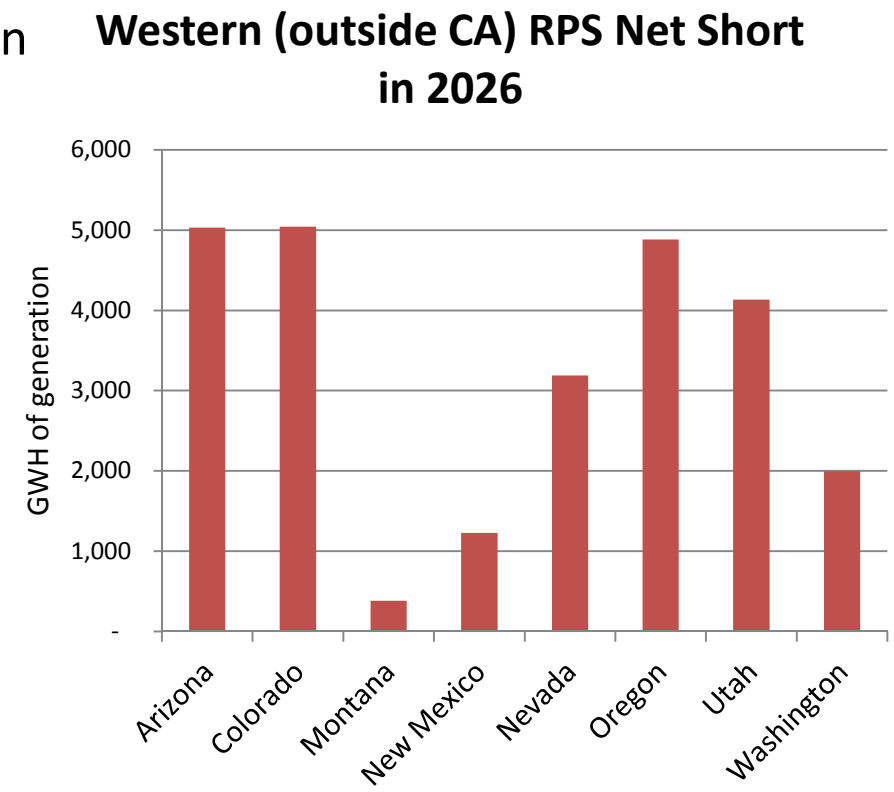
West-wide renewables demand

- Western Electricity Coordinating Council prepares 10-year forecasts (the "Common Case") of west-wide demand and generation, including RPS, based on bottom-up balancing authorities' data
- Preliminary 2026 Common Case RPS projections estimate a "net short" of ~25,000 GWh in other RPS states
  - Equivalent to ~9 GW of solar or ~3 GW of geothermal
- WECC projects total Western RPS renewables at 168,000 GWH in 2026
  - This projected level of total western electric sales and renewables would be equivalent to an 18% west-wide RPS



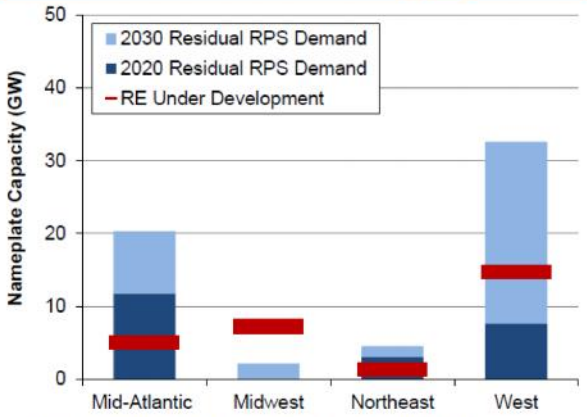
West-wide renewables demand

- LBNL's April 2016 Annual RPS Status report projects ~32 GW of additional capacity needed in the West (including CA) by 2030, roughly half of which is already in development

RE Capacity Needed for RPS Demand Growth

60 GW of additional RE capacity needed by 2030

Residual RPS Demand Relative to Available RPS Supply



Notes: Residual RPS demand is measured relative to RPS-Contracted/Delivered capacity through 2015, as shown on slide 12. See Supplemental Notes for additional details and for information on how this approach could over- or under-estimate residual RPS capacity needs. RE Under Development consists of plants permitted or under construction as of Jan. 2016, based on data from ABB-Ventyx Velocity Database.

Given existing RE capacity available for RPS compliance, RPS demand growth will require an additional 22 GW of RE capacity by 2020 and 60 GW by 2030

- Represents roughly a doubling of total RPS-builds to-date (56 GW)
- More than a 50% increase from current non-hydro RE capacity (114 GW)
- Current build-rates are on pace to meet residual needs (6 GW of RPS capacity added in 2015, per slide 15)

Much of the near-term residual RPS demand may be met with RE capacity under development (28 GW currently)

- Though not all will be built, and not all will be available for RPS compliance or fungible within regions

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Conclusions

- Reaching 50% RPS under low demand conditions could entail modest renewables expansion by 2030
- However, reaching 2030 GHG goals, on track to 2050 goals, raises important cross-sector effects that could increase both total electricity sector demand and de-carbonization needs substantially
- The range of renewable need by 2030 could range from 25,000 GWh (for low load and 50% RPS) to over 100,000 GWh (for high load and 60% renewables).
- In capacity terms, this equates to a range of:
  - 7 to 31 GW of capacity if assuming an average 40% capacity factor
  - 9.4 to 41 GW of capacity at a 30% average capacity factor
- Western RPS renewables demand and supply add an additional ~25,000 MWh of need, but market forces, new RPS targets, Clean Power Plan, and other forces may increase this demand

Resource Values Summary

Resource Values Background

- Goal is to identify locations of potential large-scale renewable resource development that helps meet 2030 need.
- Involves two basic questions:
  - Latest and greatest on costs and value of different renewable technologies in different areas
  - Insights on the portfolio of different resources that may be necessary to operate a majority-renewables grid at lowest cost

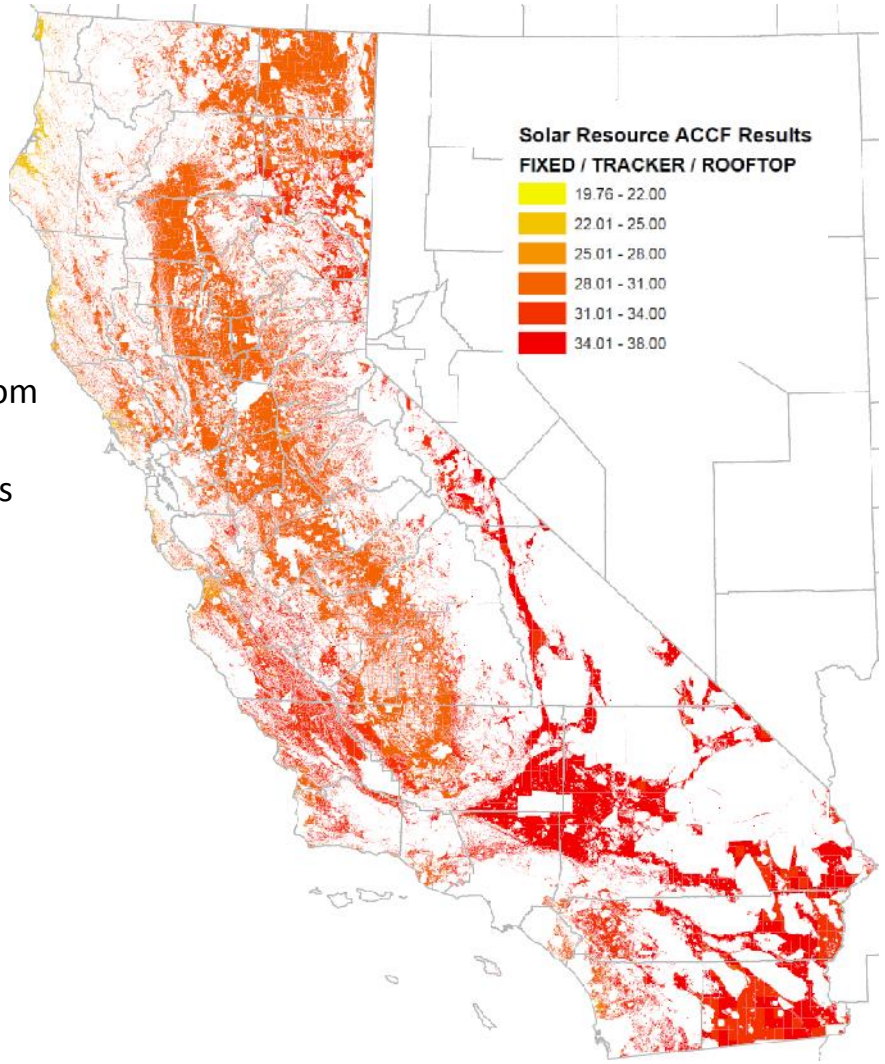
In-state Solar Resources

Solar Photovoltaic

- Widespread and generally good quality throughout California
- Cost reduction of 82% in last six years ; LCOE range from $35/MWh to $57/MWh (*Lazard's 2015)
- The worst current RPS Calculator PV resource now less expensive than the best RETI 1.0
- Substantial improvement in PV capabilities, barriers appear more institutional than technological
  - Voltage / VAR control and/or Power Factor regulation
  - Fault ride-through
  - Real power control, ramping, and curtailment
  - Primary frequency regulation
  - Frequency droop response
  - With storage, potential for black start capability

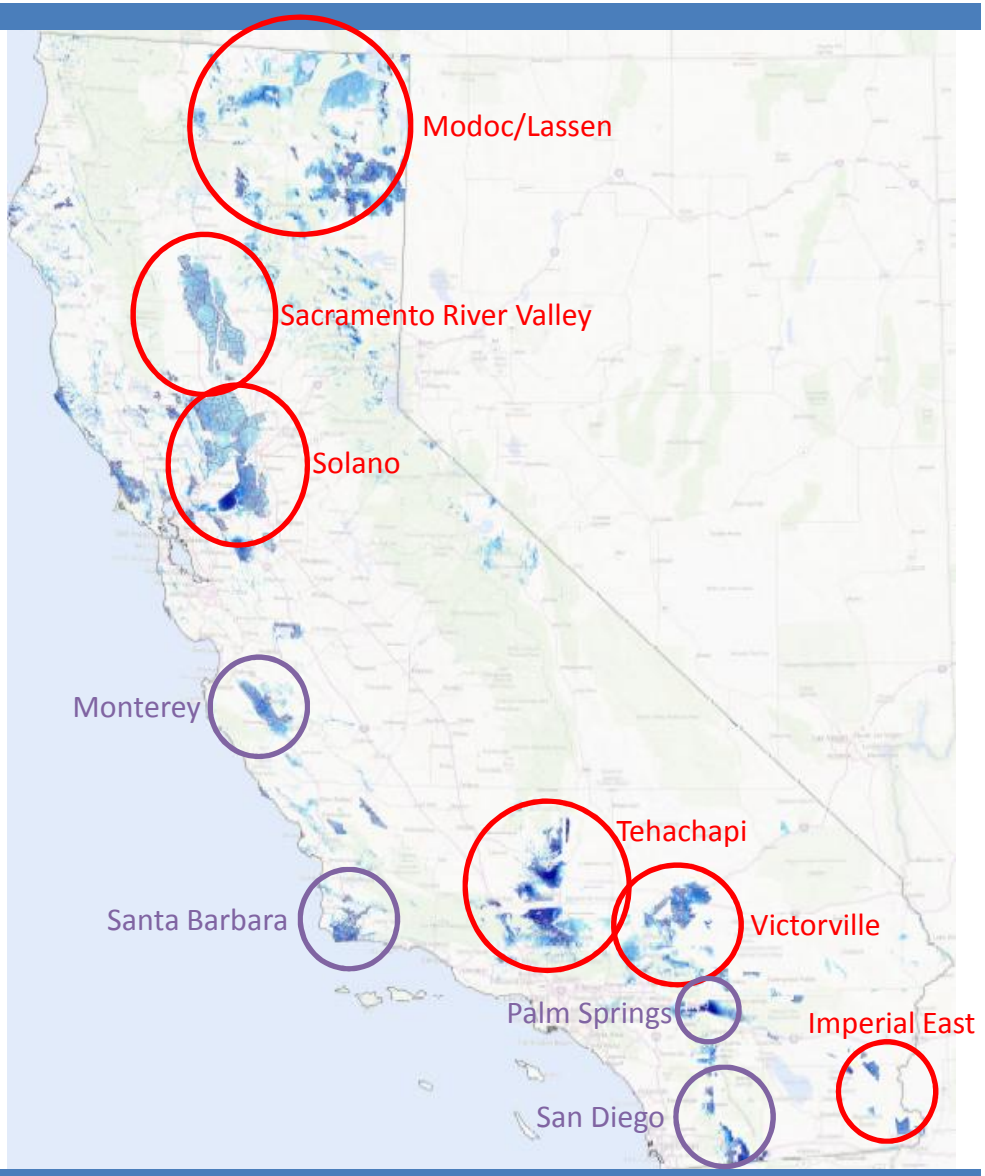
Solar Thermal technologies

- Stakeholders advised not competitive



In-state Wind Resources

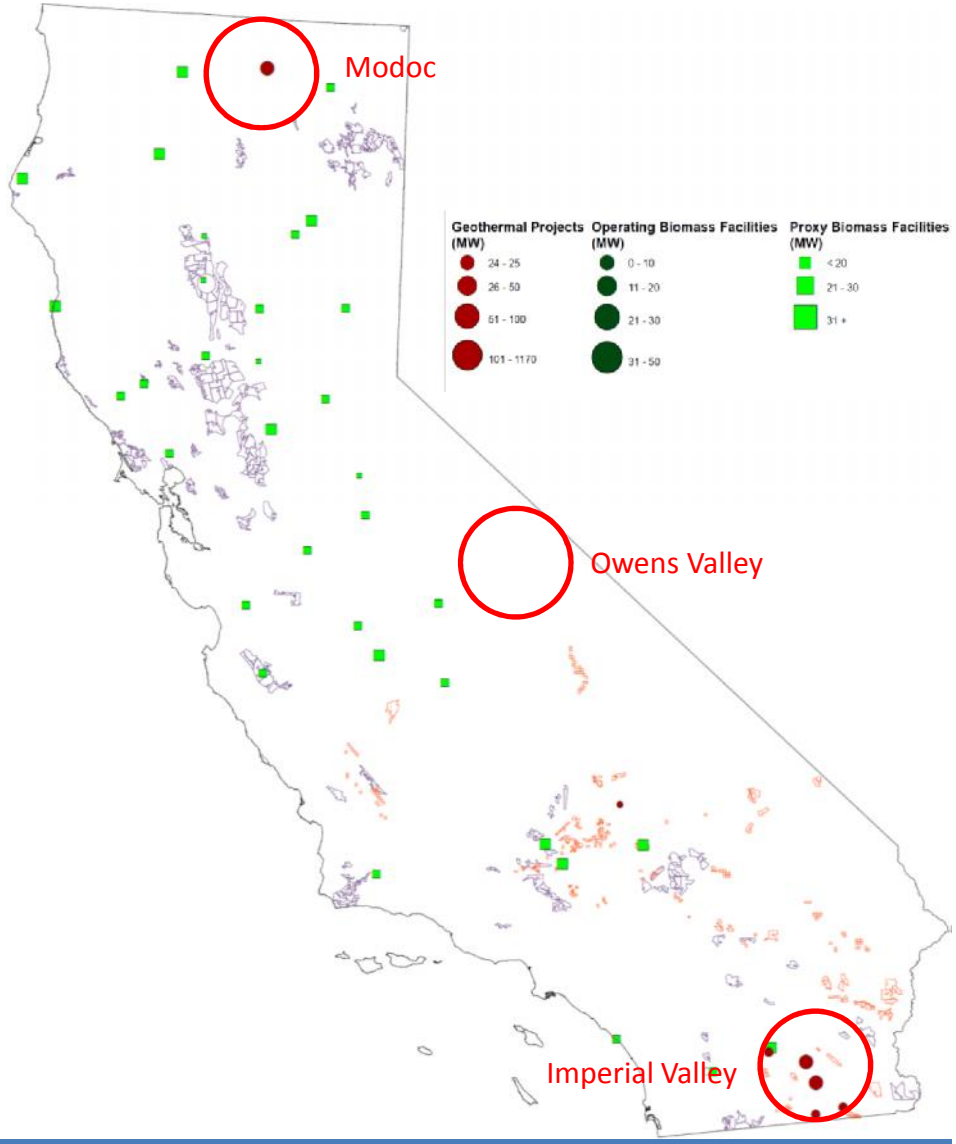
- High technical potential wind resources concentrated in a few areas
- Most highest potential sites already developed
  - Repowering existing sites
- Skepticism about many remaining undeveloped areas
  - CalWEA estimates a maximum potential undeveloped resource of 1,000-2,000 MW



In-State Geothermal and Biomass

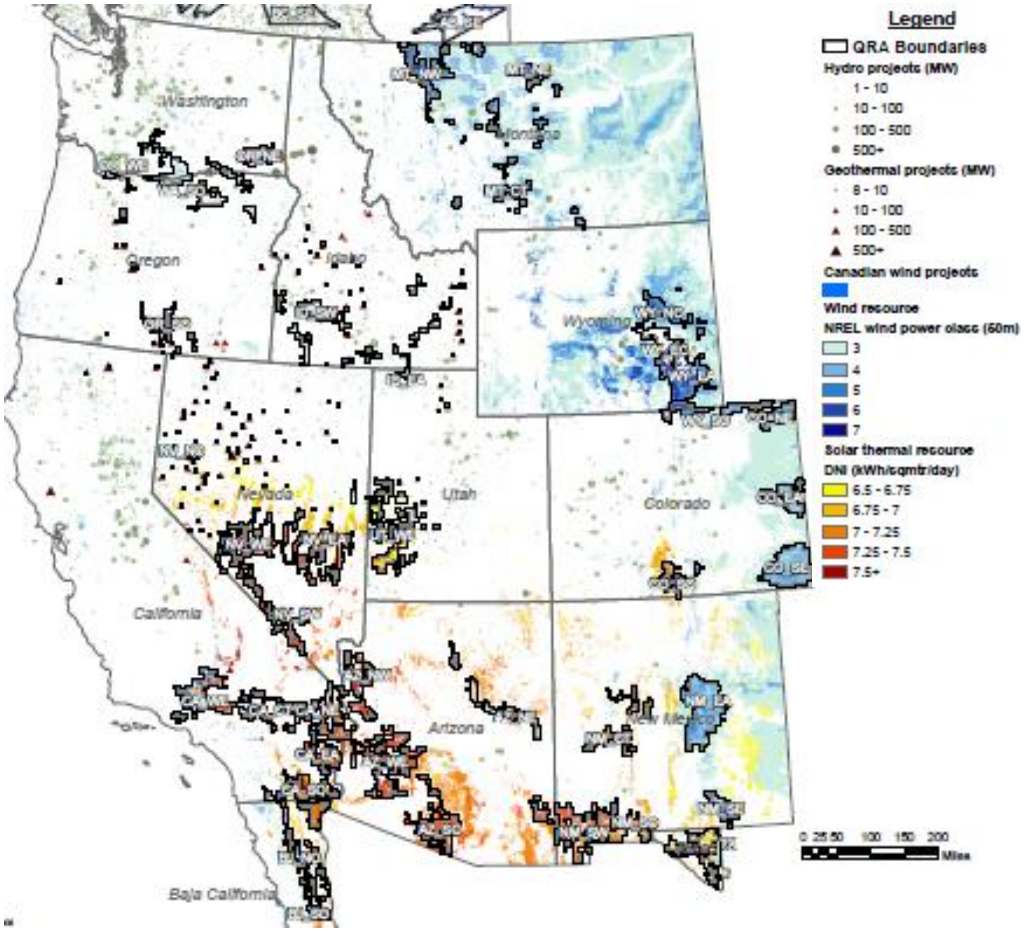
- Geothermal concentrated in very few areas
- Costs are very site-specific, and subject to considerable dispute
- High capacity factor and potential flexibility

- Biomass very dispersed across state
- Current tree mortality planning does not suggest new large facilities

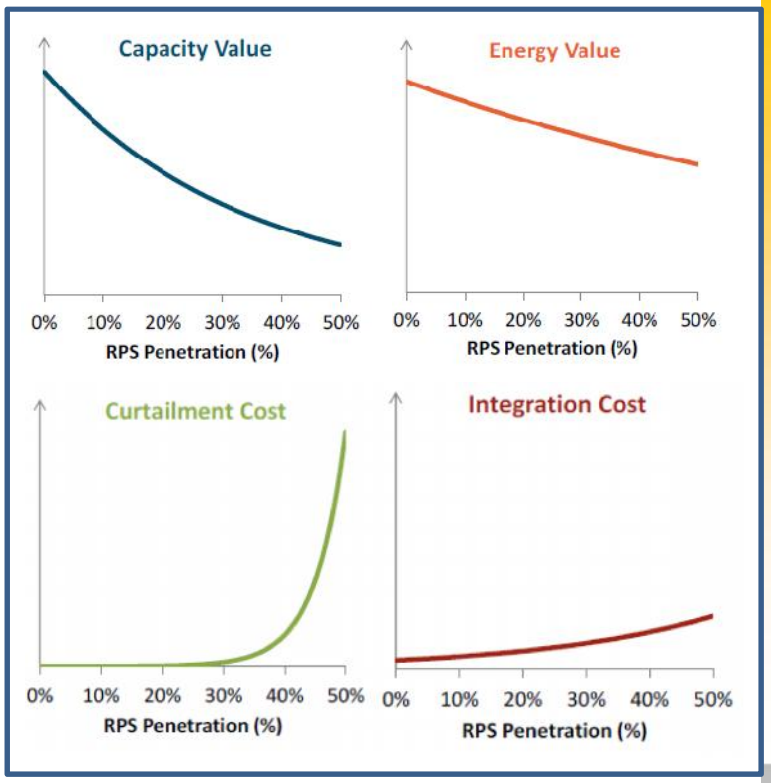


Western renewable energy potential

- Solar
  - Active development in AZ and NV
  - Advance solar land use planning, including BLM
- Wind
  - Best resources for CA in Wyoming, New Mexico
  - Colorado and Montana also good resource, but more remote
- Geothermal
  - Northern Nevada
  - SE Oregon



Utility resource valuation



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RPS Valuation and Selection: LCBF Methodology Overview

- **"Least-Cost" –** Proposals are evaluated and ranked by Net Market Value ($/MWh)

Costs	Benefits
Contract Payments	***Energy Value***
• Based on the capacity prices, expected generation and contract term	• Captures market value of the energy including a forecast for GHG while taking into account generation profile of offers
Transmission Cost	***Capacity Value***
• Cost adders for required network upgrades based on the best information	• The value of the countable Resource Adequacy capacity. (zero for energy only projects)
Debt Equivalence Cost	***Ancillary Services and Real Time Flexibility Value*** (if applicable)
• Cost of contract commitments on SCE's balance sheet	• Attributed to dispatchable, supply-side projects offering AS capability
GHG Cost (if applicable)	
• There is usually no GHG cost to the majority of renewable offers	
Renewable Integration Cost Adder (RICA)	
• Adopted interim methodology	
Congestion	
• This can be a negative or a positive number for projects based on the location	
Energy Only Cost Adder	

All costs and benefits are valued using SCE's latest forecasts

- **"Best-Fit"** – After the quantitative valuation process, SCE evaluates each proposal's qualitative characteristics
  - Contribution to other SCE programs and goals (e.g. Energy Storage, portfolio diversity, LCR, WMDVBE, TRTP, viability, safety, environmental impacts, etc.)

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California Low Carbon Grid Study

Low Carbon Grid Study
Principal Conclusions

I. Climate & Clean Energy Goals are Technically Feasible without significant rate impacts

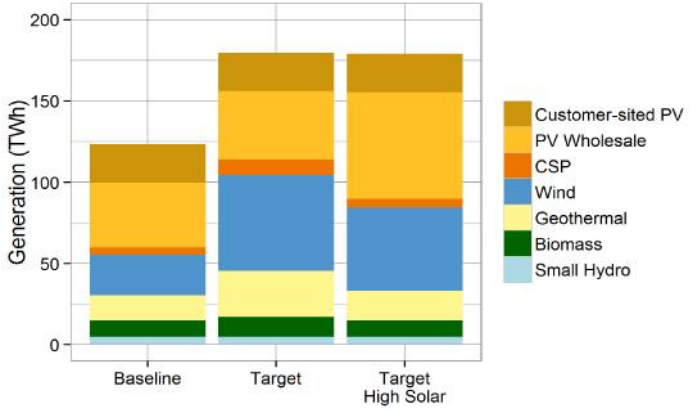
- The California electric sector can reduce 40-50MM Tons/CO2 annually by 2030, a significant contribution to executive order B-30-15, for 40% below 1990 GHG levels. On the trajectory to meet long term goal of 80% reduction.
- Meets or exceeds a 50-60% RPS
- Accommodates a 50% reduction in commercial and industrial energy use in buildings
- Absorbs the increased energy load from a projected 3.3 MM electric vehicles

II. Multiple Paths with Significantly Different Costs

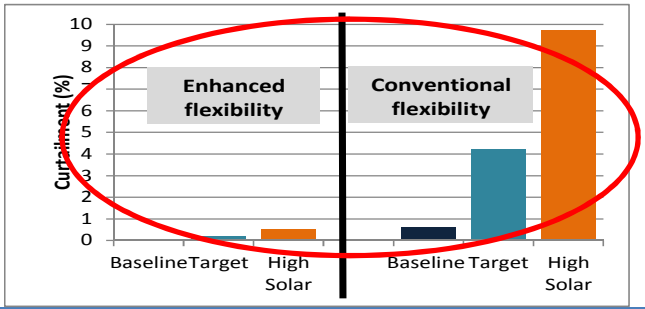
- Conventional Flexibility measures present significant cost barriers to effective GHG reduction
- Enhanced Flexibility measures present low cost means to 2030 GHG reduction target as well as pathway to deeper reductions

III. Critical Components of Enhanced Flexibility

1) Real-time carbon accounting for dispatch, unit commitment as well as procurement and planning
2) Technologically and geographically diverse renewable energy portfolio including: grid-scale PV solar, rooftop solar, regional wind, geothermal, biomass, and concentrating solar power with thermal storage
3) Bulk storage benefits shared across multiple balancing authorities and utilities, including both new projects and an optimized, statewide use of existing non-IOU pumped hydro
4) Essential reliability services provided by non-thermal resources including CSP w/ TES and the entire state hydro fleet
5) Strategic dispatch of natural gas resources, staggered quick starts to prevent idling, ramping
6) Increased flexibility in unbundled REC accounting, enabling optimal sub-hourly dispatch



Case	Net Cost (% of RevReq)	CA Carbon (MMT/yr)	RE Curtailment (%)
Diverse/Enhanced	0.6%	41.1	0.2%
High Solar/Enhanced	2.2%	42.2	0.5%
Diverse/Conventional	2.3%	45.0	4.2%
High Solar/Conventional	4.1%	46.8	9.7%



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CPUC RPS Calculator v6.2

2016 Portfolio Sensitivity Analyses

- March 2016 CPUC Staff Paper studied LTPP scenarios and additional "sensitivities" to 2030
- Not "optimized" portfolios, but do yield insights into potential trade-offs

Portfolio Balance:
Declining capacity value of solar PV + increasing curtailment of solar PV drives selection of complementary resources, especially wind, starting in mid 2020s

Land Use:
More restrictive land use assumptions may increase curtailment by eliminating high quality in-state wind

In-State Wind:
In-state wind connecting as energy-only resources may reduce overall portfolio costs if prioritized for available transmission capacity

Geothermal:
Assuming a significantly lower geothermal costs, including in the Salton Sea area, reduces the amount of PV on the system by 2026

Electric Vehicles:
Battery electric vehicle adoption tends to increase solar PV selection and reduce curtailment

Exports:
Exports can greatly reduce solar PV curtailment

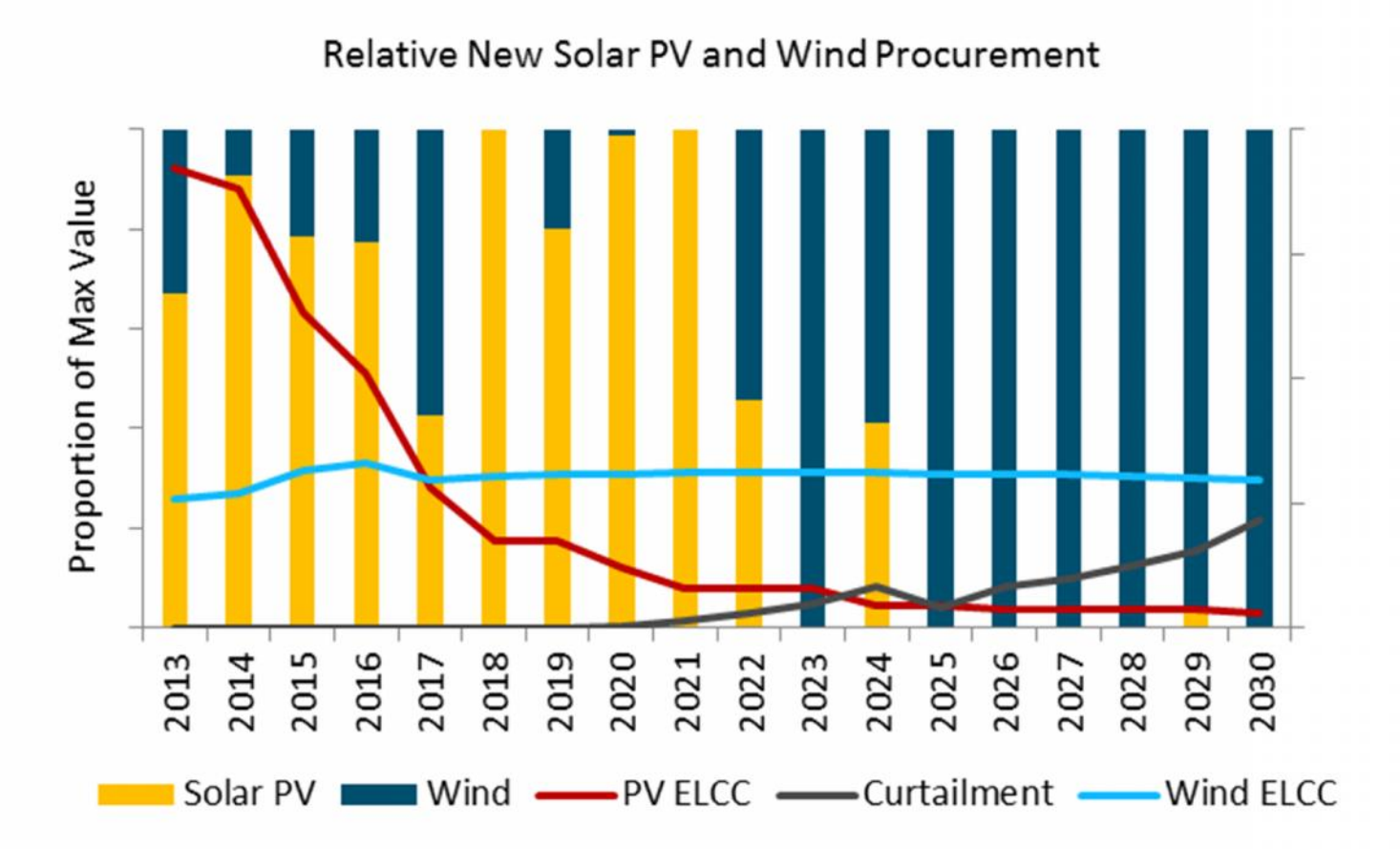
Storage:
Storage can greatly reduce solar PV curtailment, but at a higher cost than exports

Sensitivity	Total Generic Buildout (MW)	Total DNU (MW)	PV Ratio (PV GWh/ RN GWh)	Curtailmt (% RPS energy)	Rev Reqmt ($MM)	Avg Rate (¢/kWh)
Default	5,495	3,260	0.49	7.9%	37,530	30.8
Env Baseline	5,689	4,000	0.50	8.9%	37,686	30.9
DRECP/SJVP	5,580	4,500	0.49	8.2%	37,745	31.0
Energy Only	5,054	0	0.44	5.6%	37,410	30.7
EO & WECC	4,284	0	0.44	5.4%	37,242	30.5
In-State Wind	4,348	1,500	0.47	6.1%	37,469*	30.6*
Geotherm. 2	2,785	7,500	0.40	5.4%	37,303*†	30.7*†
High BEV	6,952	4,260	0.52	5.9%	37,693	28.7
Exports	3,521	1,500	0.48	0.5%	37,402	30.7
Storage	4,151	2,500	0.48	2.6%	38,788	31.8

*costs are not comparable with other portfolios because of forced-in resources
†without assuming lower geothermal capital costs, rev. req. is $37,632 MM, avg. rate is 30.9¢/kWh

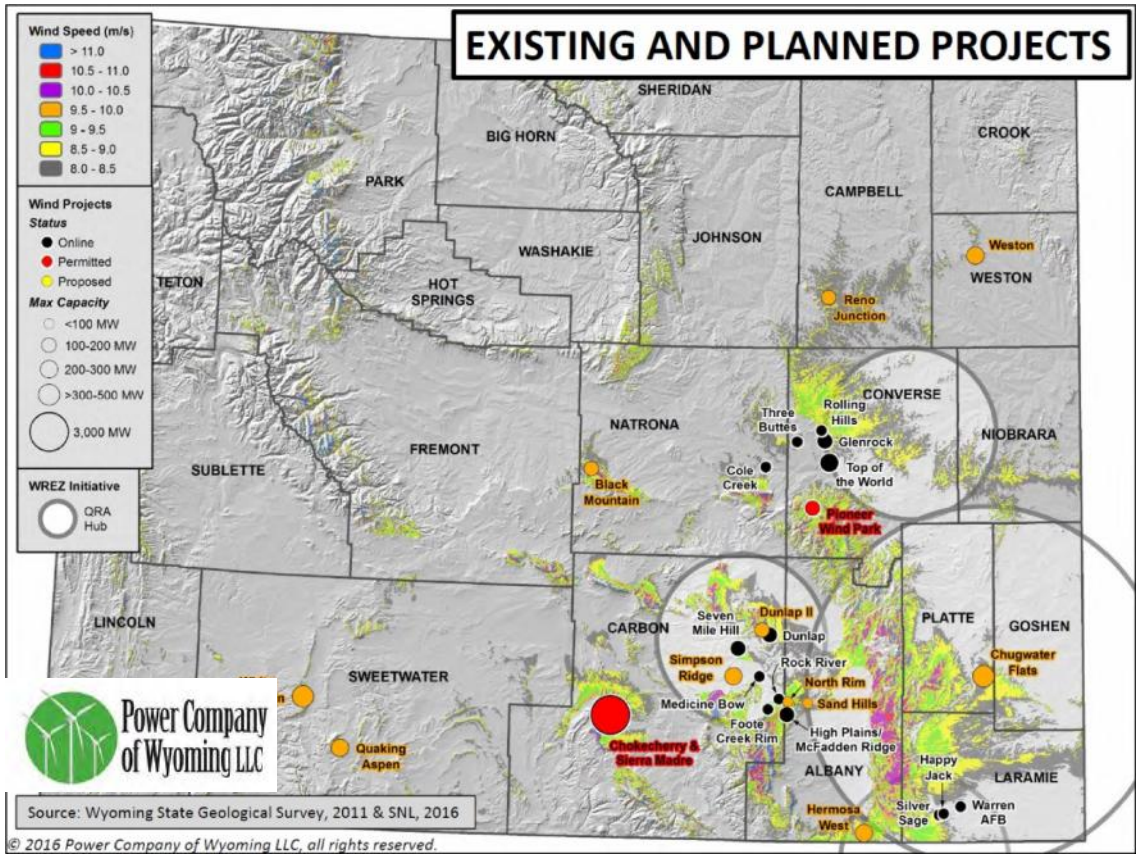
2016 Portfolio Sensitivity Conclusions

WECC-wide, energy-only portfolio



Out-of-state interest

- CA utilities signing contracts with AZ and NV solar, NM wind
- Multiple projects in advanced permitting in WY and NM
- Proposals evolving to phase development, access multiple markets, utilize existing transmission
- Less current data regarding development interest and activity in other states
- Further outreach necessary



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Out-of-state interest

need to consider some level of full-deliverable procurement. DATC encourages procurement from multiple geographic regions that have thus far been eliminated from California's energy planning processes, including the San Joaquin Valley, the Lassen North area and other states, like Wyoming and northern Nevada. A flexible transmission plan that provides early signals

…fort with RETI 2.0 in considering …eatment of out-of-state alternatives.

Interestingly though, focusing effort on out-of-state information gathering and sharing may be the most needed task of the agencies at this time – even despite our collective disadvantage at tackling such challenges - with SB350 focusing the agencies on regional expansion and with many takers seemingly independently interested in joining with the CAISO. Getting ahead of planning with regional opportunities outside of California will require that the RETI 2.0 group put extra effort into continuing its focus on equally-informed choices both inside and outside of California. SWPG is not suggesting that the

Conclusions

- Low cost solar is ubiquitous, but does raise long-term integration challenges
  - Many integration options, but resource and technology diversity and exports are among the cheapest
- Determining environmental feasibility and transmission access for remaining in-state wind may be a priority
- Geothermal may offer important benefits by 2030 but costs and benefits need further work
  - Transmission access one important component
- Environmental and land use constraints tend to favor in-state solar and out-of-state wind
- Broad support for further assessment of Out-of-state resources
  - High-quality, low-cost resources with complementary profiles
  - Quality and timeliness of data does not match in-state
  - Options for access by existing transmission largely un-assessed
  - Export options very important

Focus Areas Summary

Transmission Assessment Focus Area: Approach

Explore planning goals and resource values

1. How much renewables *might* we need?
   - Bookend scale of renewable need by 2030
   - Sources include IEPR, Pathways
2. Which resources *might* be important by 2030?
   - Review resource costs and values in 2030 context to identify resources and zones of potential value for 2030
   - Sources include industry and stakeholder comments, academic and government studies

Identify high-value resources that may need transmission

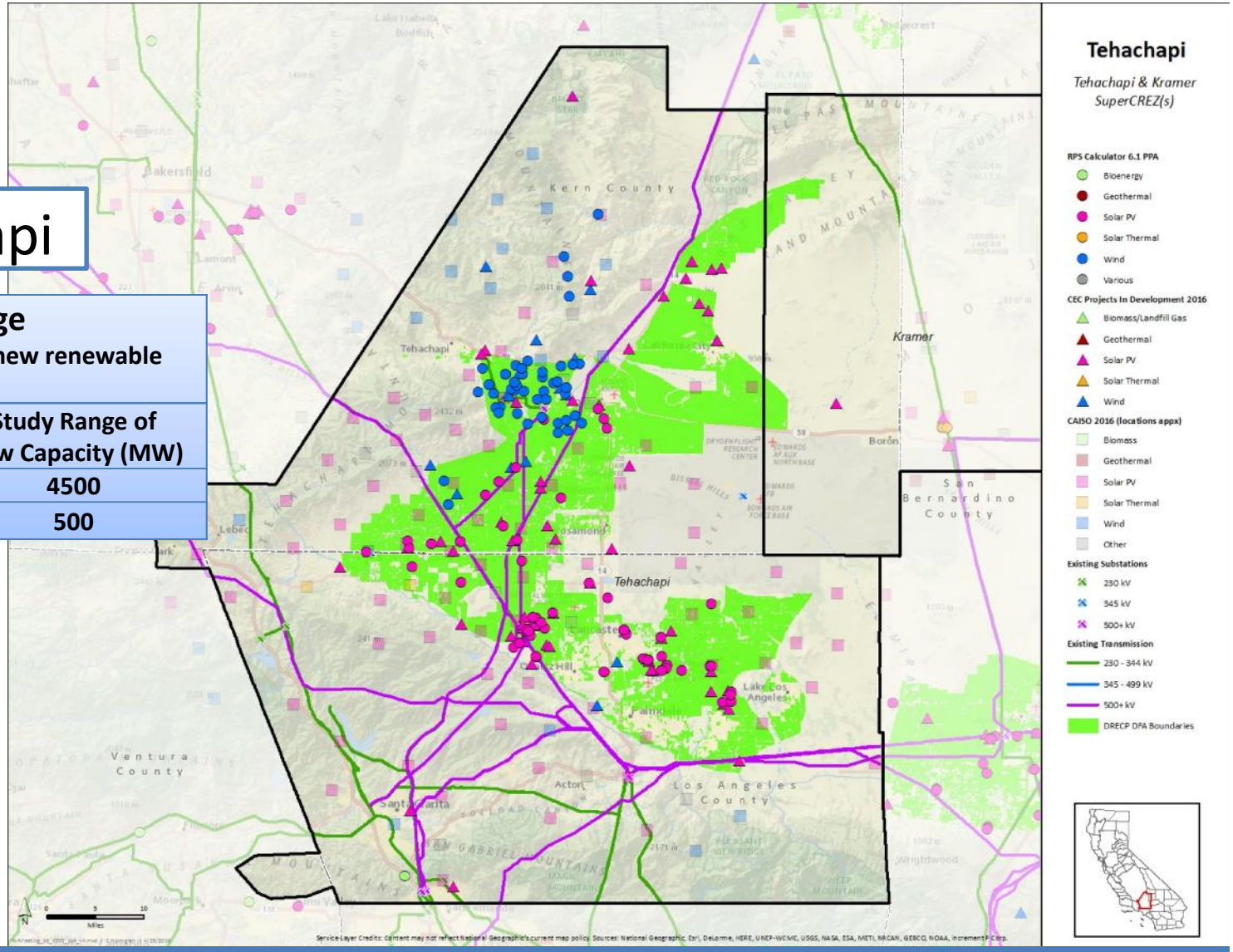
3. How much renewables *might* come from different areas?
   - Bookend range of renewable resources from specific areas that may be developed by 2030
   - Sources include comments, studies
4. *Might* this level of renewables require new transmission?
   - Match resource ranges to existing transmission capacity and identify where resource range exceeds transmission capacity
   - Sources include TPP and WECC studies, stakeholder comment

Proposed Focus Area List

1. In-state resources
   - California Desert
     - Tehachapi
     - Victorville/Barstow
     - Riverside East
     - Imperial Valley
   - San Joaquin Valley
     - Modesto to Bakersfield
   - Northern California
     - Solano and East Bay
     - Sacramento River Valley
     - Lassen & Modoc
2. Import/Export Paths
   - Eldorado/Mead/Marketplace
   - Palo Verde/Delaney
   - California-Oregon Intertie
   - Central and Northern Sierra
3. Out-of-State Projects
   - WY and NM wind
   - NV and AZ solar
   - NV geothermal
   - NW wind and geothermal
   - OOS “Delivery” projects
   - OOS “Network” projects

Tehachapi

Study Range Hypothetical additions of new renewable resources	
Resource	**Study Range of New Capacity (MW)**
Solar	**4500**
Wind	**500**



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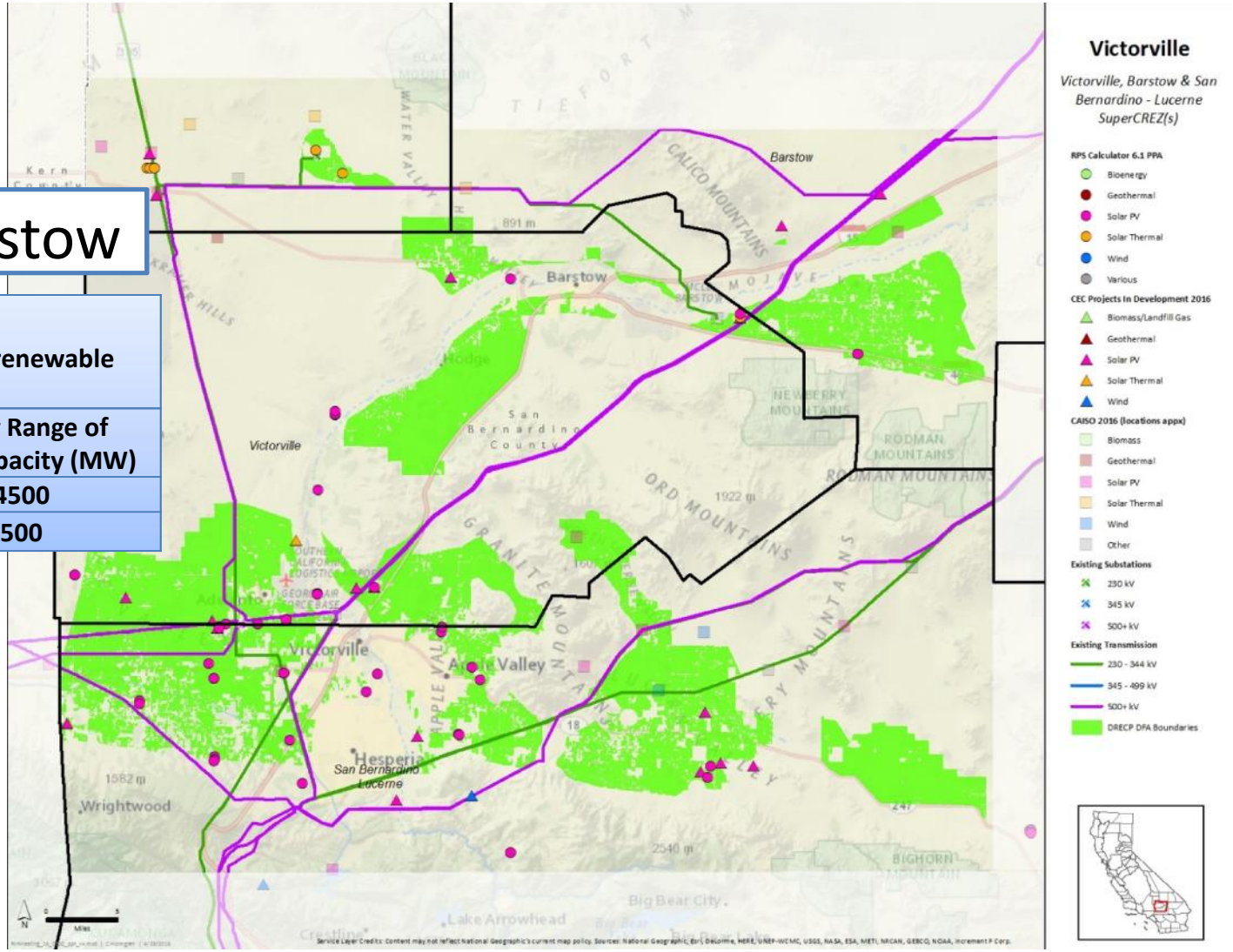
Victorville/Barstow

Study Range Hypothetical additions of new renewable resources	
Resource	**Study Range of New Capacity (MW)**
Solar	**4500**
Wind	**500**



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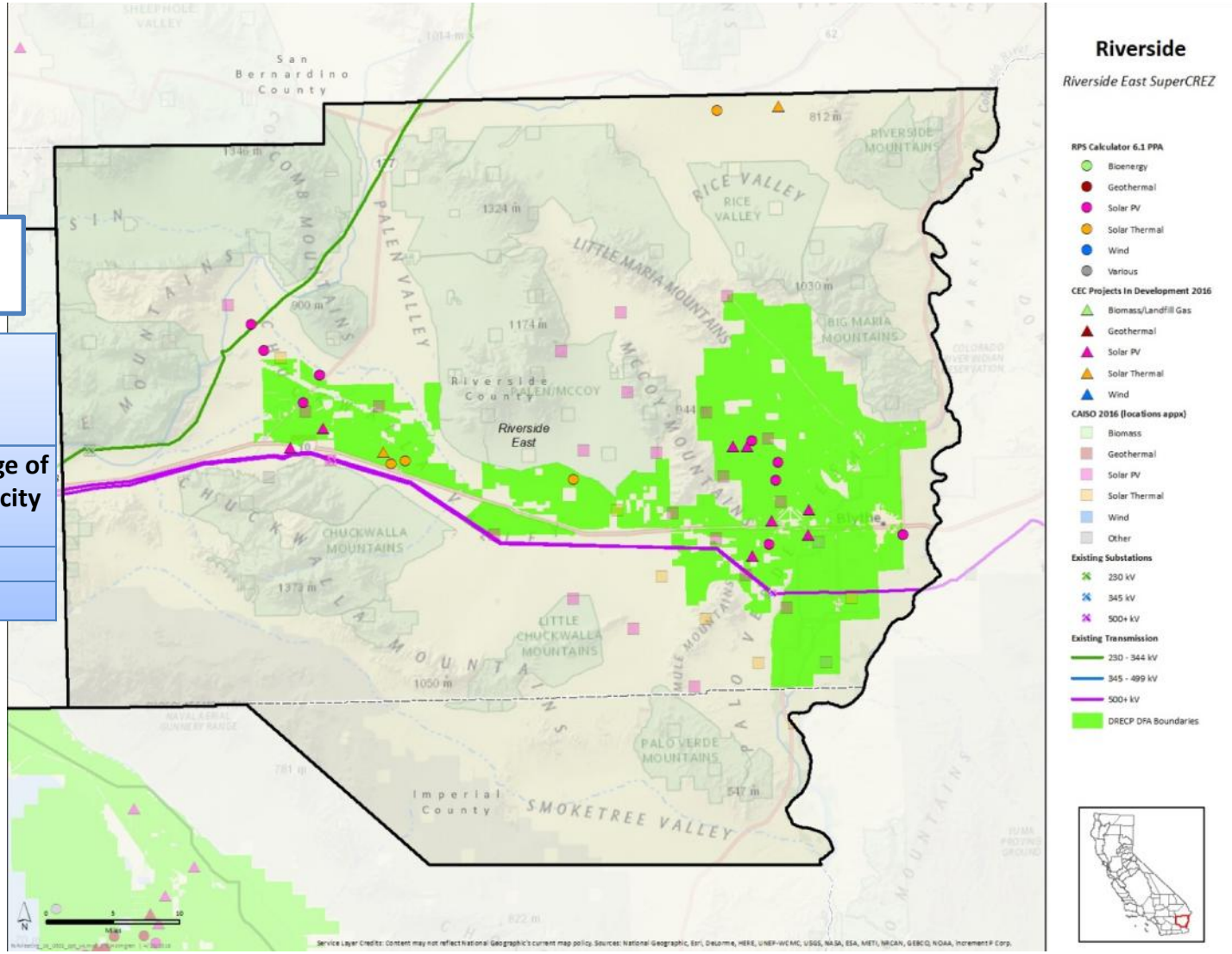
Riverside East

Study Range Hypothetical additions of new renewable resources	
Resource	**Study Range of New Capacity (MW)**
Solar	**4,000**
Wind	**1000**



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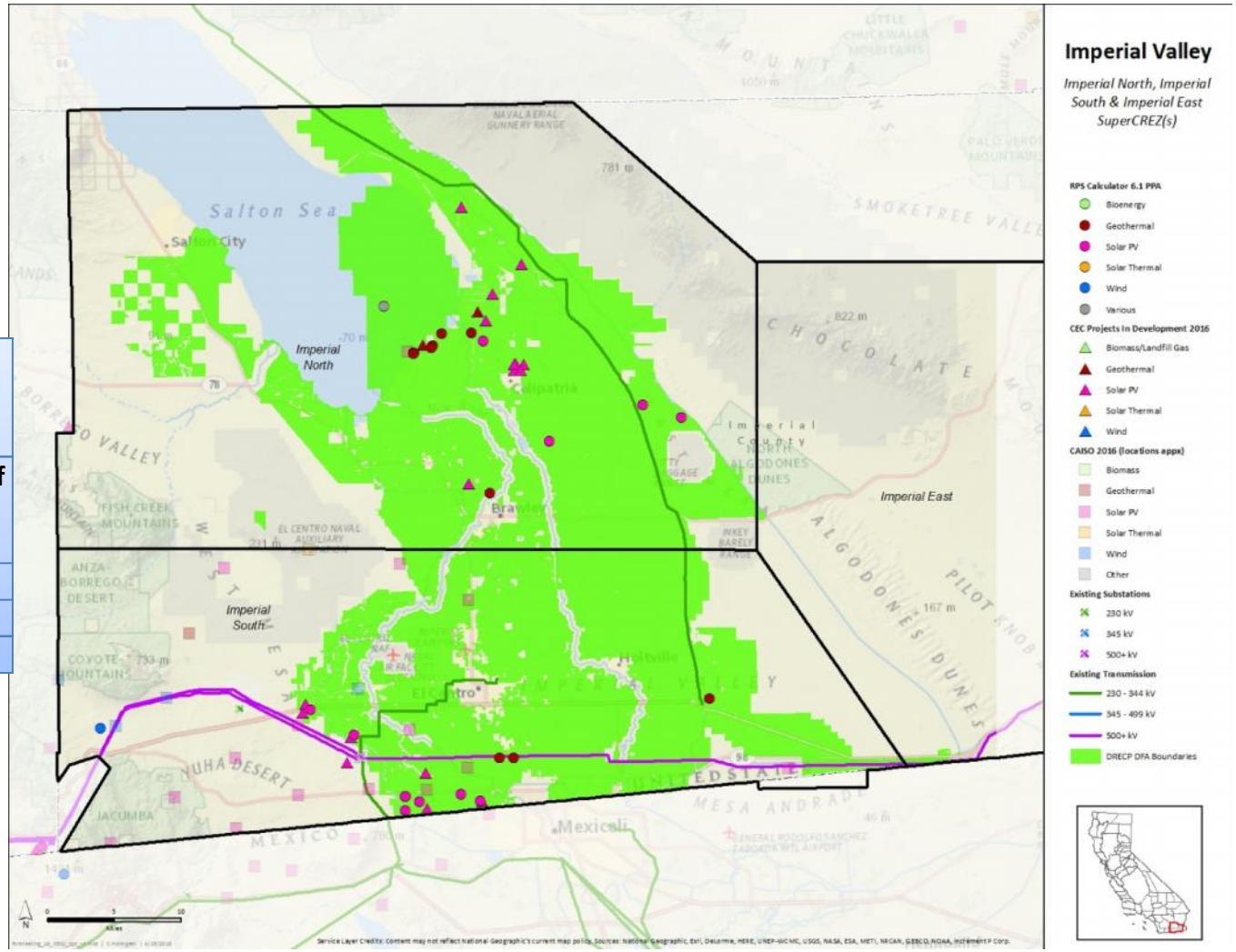
Imperial Valley

Study Range Hypothetical additions of new renewable resources	
Resource	**Study Range of New Capacity (MW)**
Solar	**3500**
Wind	**500**
Geothermal	**1000**



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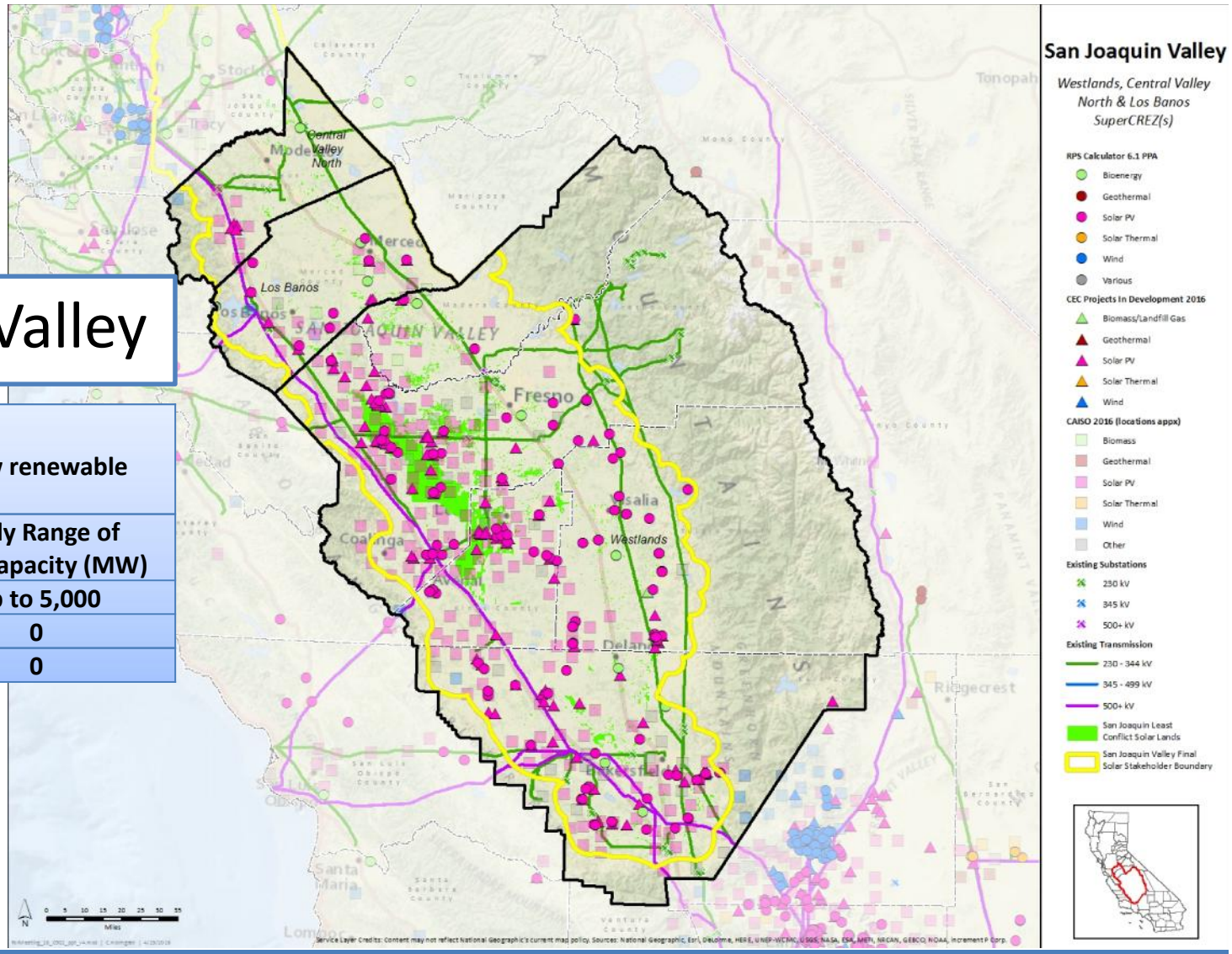
San Joaquin Valley

Study Range Hypothetical additions of new renewable resources	
Resource	**Study Range of New Capacity (MW)**
Solar	**Up to 5,000**
Wind	**0**
Geothermal	**0**



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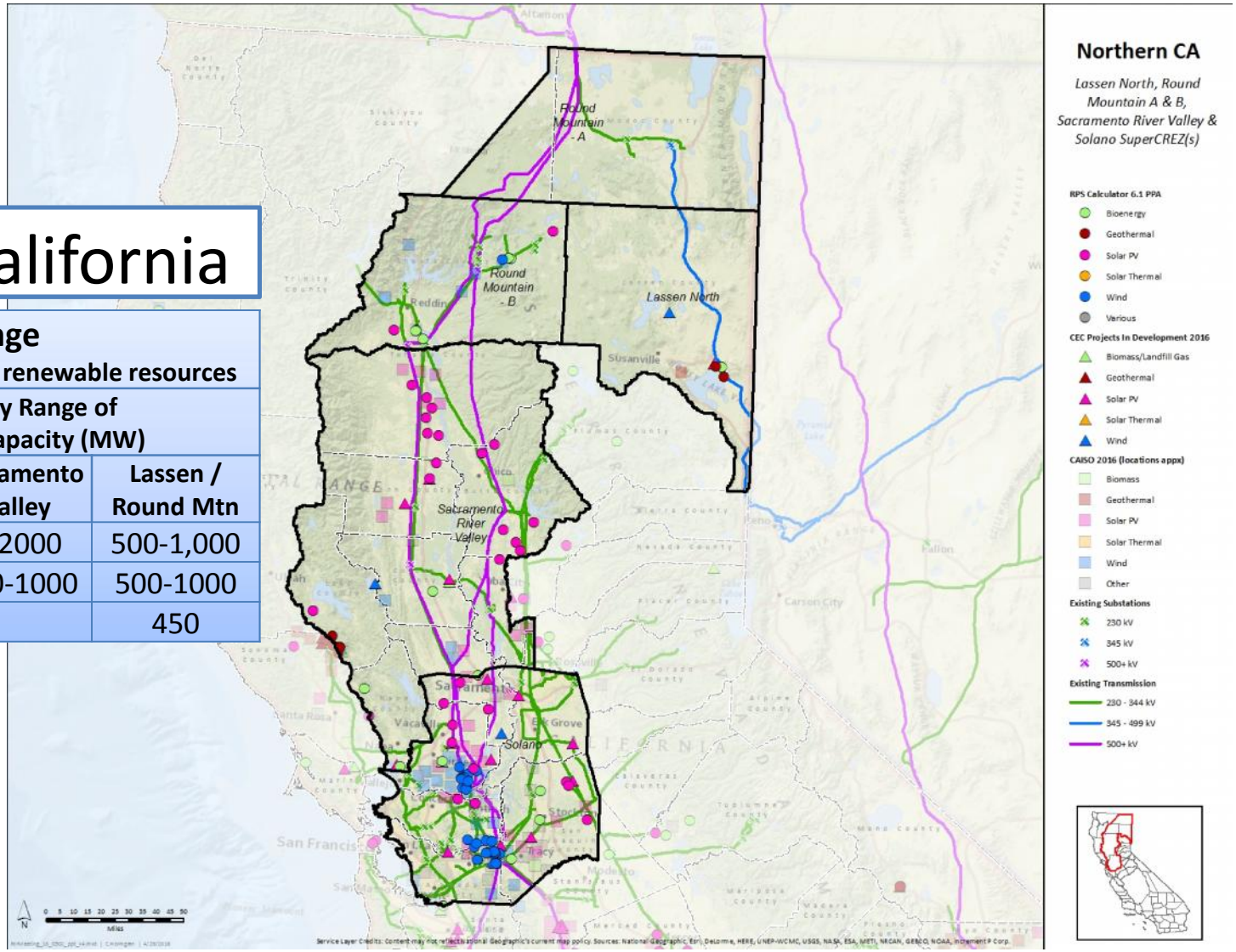
Northern California

Study Range Hypothetical additions of new renewable resources			
Resource	**Study Range of New Capacity (MW)**		
	Solano	**Sacramento Valley**	**Lassen / Round Mtn**
Solar	1-2,000	1-2000	500-1,000
Wind	500-1000	500-1000	500-1000
Geo			450



STATE OF CALIFORNIA resources AGENCY

California Public Utilities Commission

California Energy Commission

California ISO

Import / Export Paths

Study Ranges Hypothetical additions of new renewable resources	
Delivery point or path	**Study Range of New Capacity (MW)**
Eldorado/Mead/Marketplace	3000
Palo Verde/Delaney	3000
California-Oregon Intertie / Path 66	2000
Central/Northern Sierra (Path 76; Path 24; Path 52)	500

Transmission Assessment Focus Areas

Study Ranges **Hypothetical additions of new renewable resources**	
Delivery point or path	**Study Range of New Capacity (MW)**
Imperial Valley	Up to 5000
Riverside East	Up to 5000
Victorville/Barstow	Up to 5000
Tehachapi	Up to 5000
San Joaquin Valley	Up to 5000
Solano	1500-3000
Sacramento River Valley	1500-3000
Lassen / Round Mountain	1500-3000
Path 46 / Palo Verde / Delaney	Up to 3000
Path 46 / Eldorado / Marketplace	Up to 3000
Path 66 / California-Oregon Intertie	Up to 3000
Central/Northern Sierra (Path 76; Path 24; Path 52)	Up to 500

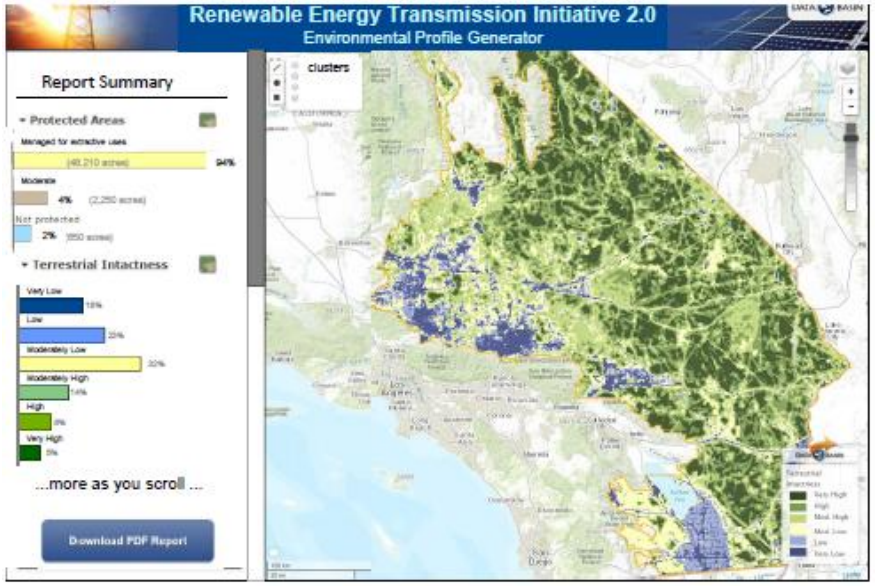
Out of State Resources
Delivery and Network Transmission

- Developments elsewhere in the West could have substantial effect on accessibility of other resources
  - Out-of-State (OOS) renewables development proposals and projects
    - WY and NM wind; AZ and NV solar; NW wind and geothermal
  - "Delivery" transmission projects that deliver of WY and NM wind to California interconnections points - E.g. Transwest Express; Zephyr; Sunzia; Southline
  - "Network" transmission that may increase access to a variety of renewables and export markets - Gateway projects; SWIP North
  - Resource changes in other states (coal plant retirements; reduced hydro export)
  - Markets for California solar exports
- Limited in-state knowledge or coordinated west-wide view; Broader assessment approach planned

Current Activities Summary

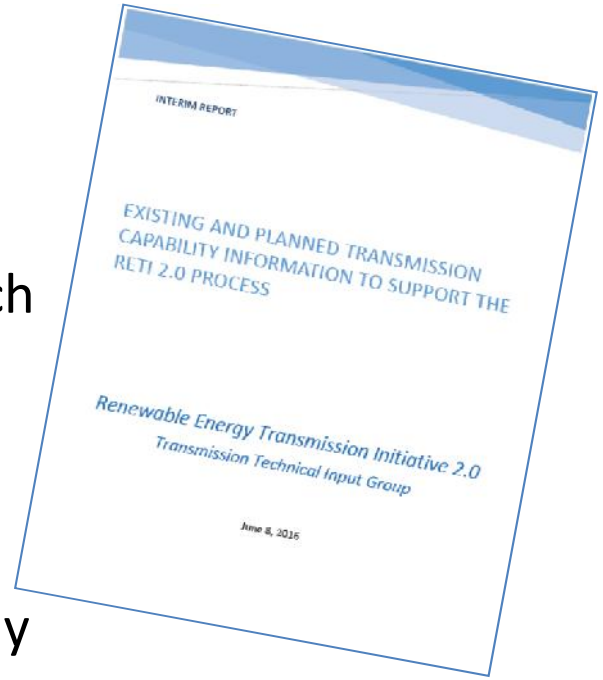
Environmental and Land Use Technical Group

- ELUTG is collecting a database of available datasets and studies in a publicly-accessible online tool DataBasin: https://reti.databasin.org/
- ELUTG is preparing a standard Environmental Profile Report to summarize available data and data gaps
- Working iteratively with the Plenary Group and TTIG, ELUTG will utilize these tools to evaluate the environmental and land use implications of each Focus Area study range, and to make recommendations for further work where necessary
- Provide initial draft reports to Plenary Group in July



Transmission Technical Input Group

- TTIG has published an initial report “Existing and Planned Transmission Capability Information to Support the RETI 2.0 Process”
- TTIG is gathering existing studies and data to use to assess in-state resources and import-export paths
  - Generation interconnection studies
  - Transmission planning studies and
  - Any specific 33% RPS or 50% renewable studies
- Use to evaluate “transmission implications” of each Focus Area study range
  - “Tinker toy” infrastructure requirements
  - Identify path-level corridor options
  - Cost and permitting
- Provide initial draft reports to Plenary Group in July



Regional Consultation

- Summarize the existing, planned, and potential capability of the out-of-state transmission network to deliver renewable energy to California, to deliver California excess renewables to western load centers, and to support more renewable energy trade across the west generally.
- RETI 2.0 has requested that Western Interstate Energy Board convene a short "regional consultation"
- RETI 2.0 and WIEB staff will develop a set of questions on expected renewable supply and demand patterns and transmission implications. Example questions:
  - Where is large-scale renewable development (grid storage) likely to occur?
  - Where are markets/load centers for renewable energy around West?
  - How much expansion can be accommodated by existing transmission?
  - What resource/operations changes on existing transmission?
  - What kinds of new transmission might best increase options for access to generation and markets and regional trade?
- Target audience/participants are state officials, utilities, renewables and transmission developers, environmental and other advocates
- Process will take place in July and involve webinar(s), in-person workshop(s), and written comments. WIEB will write report summarizing input for presentation to RETI 2.0 in August

Plenary Group

- RETI 2.0 staff will conduct outreach to stakeholders, including local communities, military, and tribes, to further refine understanding of the Focus Areas and to make sure appropriate issues and perspectives are captured in the Focus Area study ranges and the ELUTG and TTIG assessments.
- Will gather Technical Groups' and Regional Consultation input in early August
- Next RETI 2.0 Executives' workshop, to present groups' input, being scheduled for mid-August

Questions, comments, suggestions?

http://www.energy.ca.gov/reti/

and click on the “Submit eComment” link

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