NREL National Renewable Energy Laboratory
Innovation for Our Energy Future

Renewable Resources and Transmission: Needs and Gaps

Southwest Renewable Energy Transmission Conference

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Organization of this talk

- What is each state’s future renewable energy need (benchmarked to 2025), and where will it come from?
- What are the key value propositions for interstate commerce in renewable energy?
- What transmission planning are states doing individually?
- Does current planning enable or forego any of the key value propositions?

Projecting demand for renewables

- Assumed a state's future electricity demand growth would be half of what it was from 2000 to 2008
  - Accounts for DSM, energy efficiency measures
- Projected demand growth from 2008 rather than 2009
  - 2009 data were generally lower than 2008, much of it attributable to the recession
  - 2008 data have been verified by EIA

Annual growth in total demand, 2000-2008	
California	1.2%
Arizona	2.8%
Nevada	3.0%
New Mexico	2.0%
Colorado	2.4%

Projecting demand for renewables

- Assumes 2008 retail market shares for IOUs, munis, co-ops, and utility districts
- Projected demand to 2025, even though some state RPS goals are benchmarked earlier
  - Assumes renewable capacity in place to meet a 2015 or 2020 goal will still be operating in 2025
  - Consistent with “and each year thereafter” statutory language

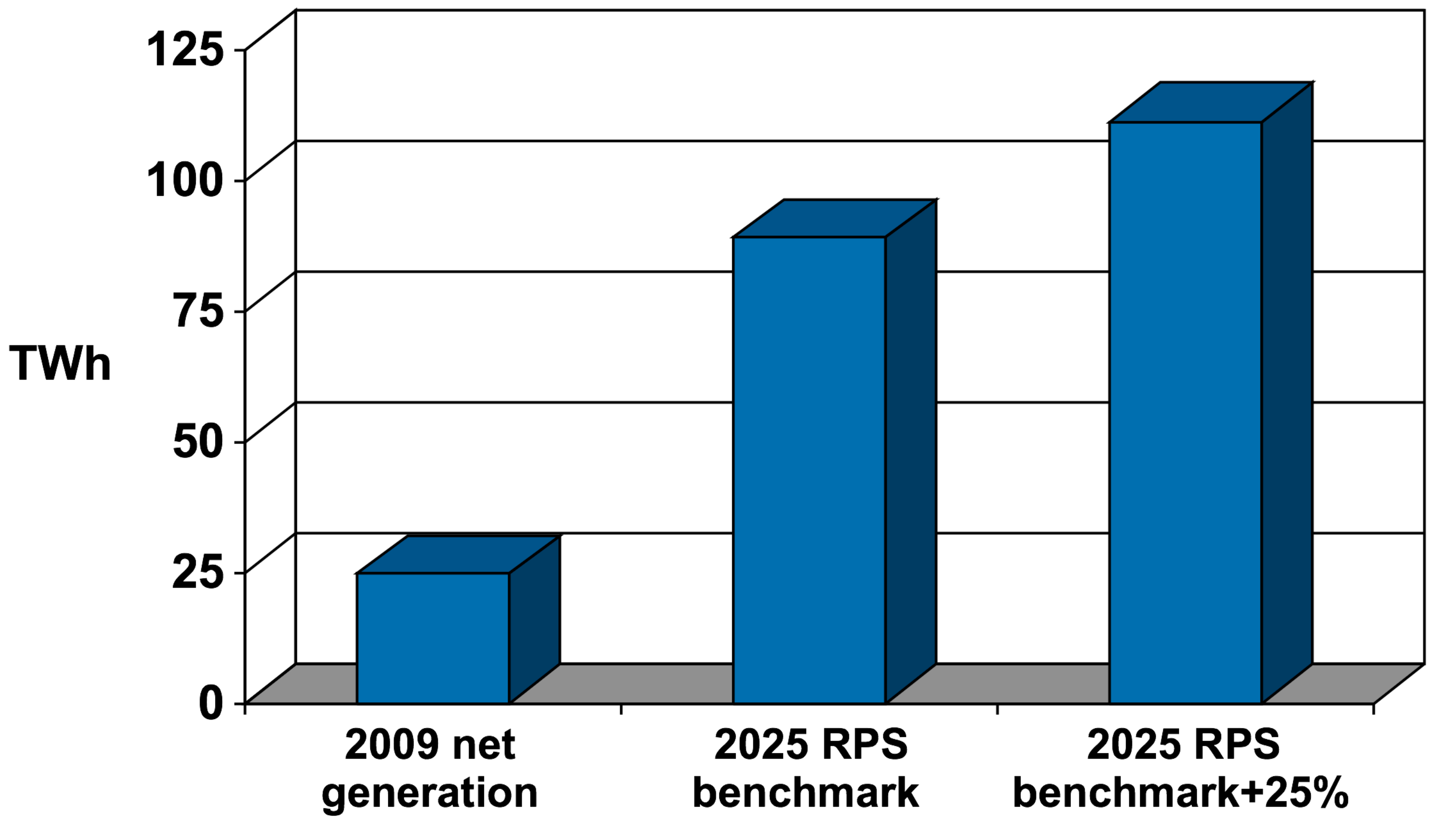
Projecting demand for renewables

- Included benchmarks 25% above RPS targets
  - Assumes that the RPS is a minimum, rather than a ceiling on renewable procurement
  - Allows for voluntary consumer demand that would be additional to RPS mandates
  - Assumes some spillover resulting from competition among renewable energy developers
  - Adds some flexibility in the event a state decides to increase its RPS from what is currently in law

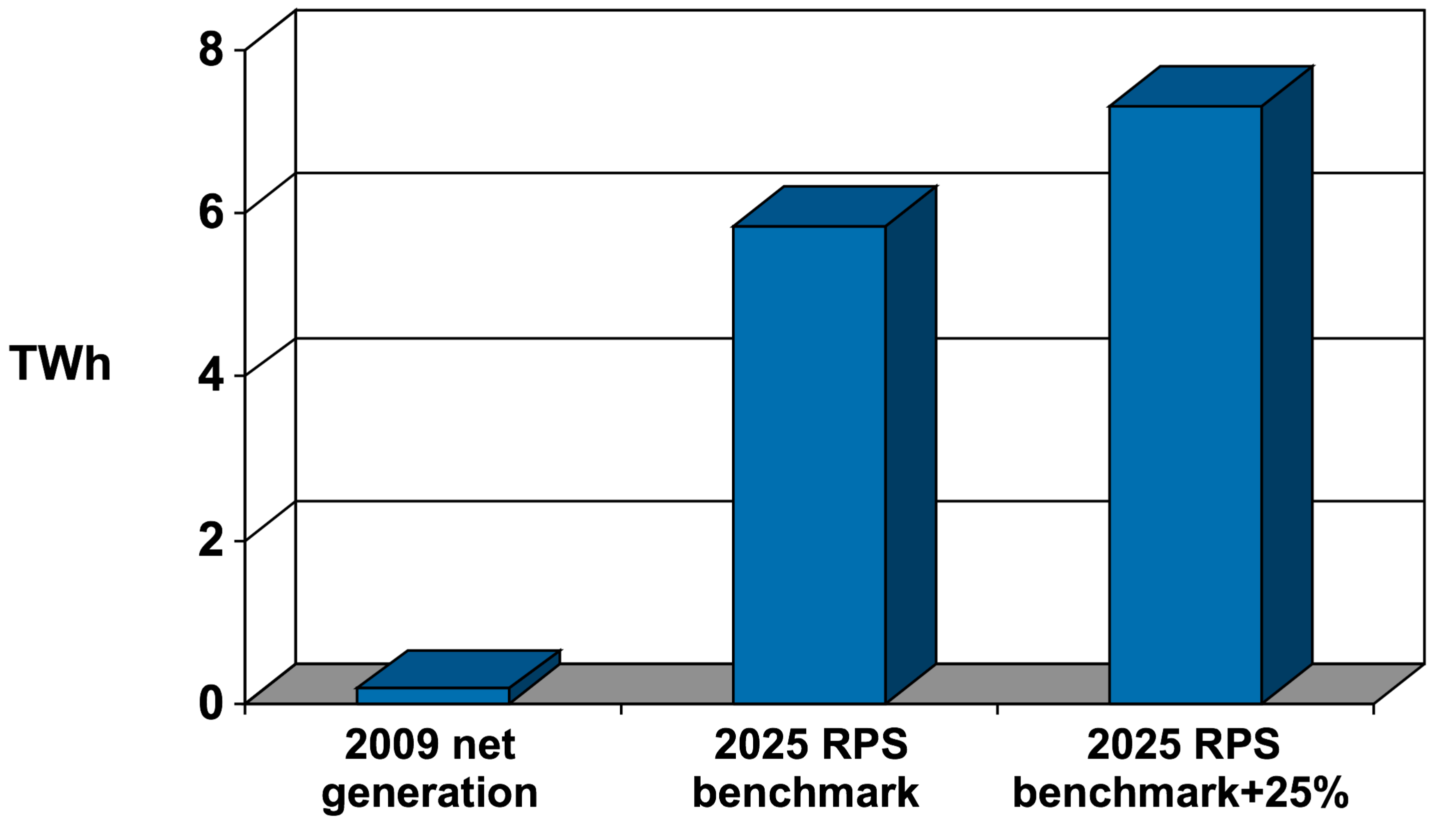
Projecting demand for renewables

	RPS benchmark	RPS benchmark plus 25%
	(TWh in 2025)	
California	89.0	111.3
Arizona	5.8	7.3
Nevada	10.0	12.5
New Mexico	3.9	4.9
Colorado	10.7	13.4

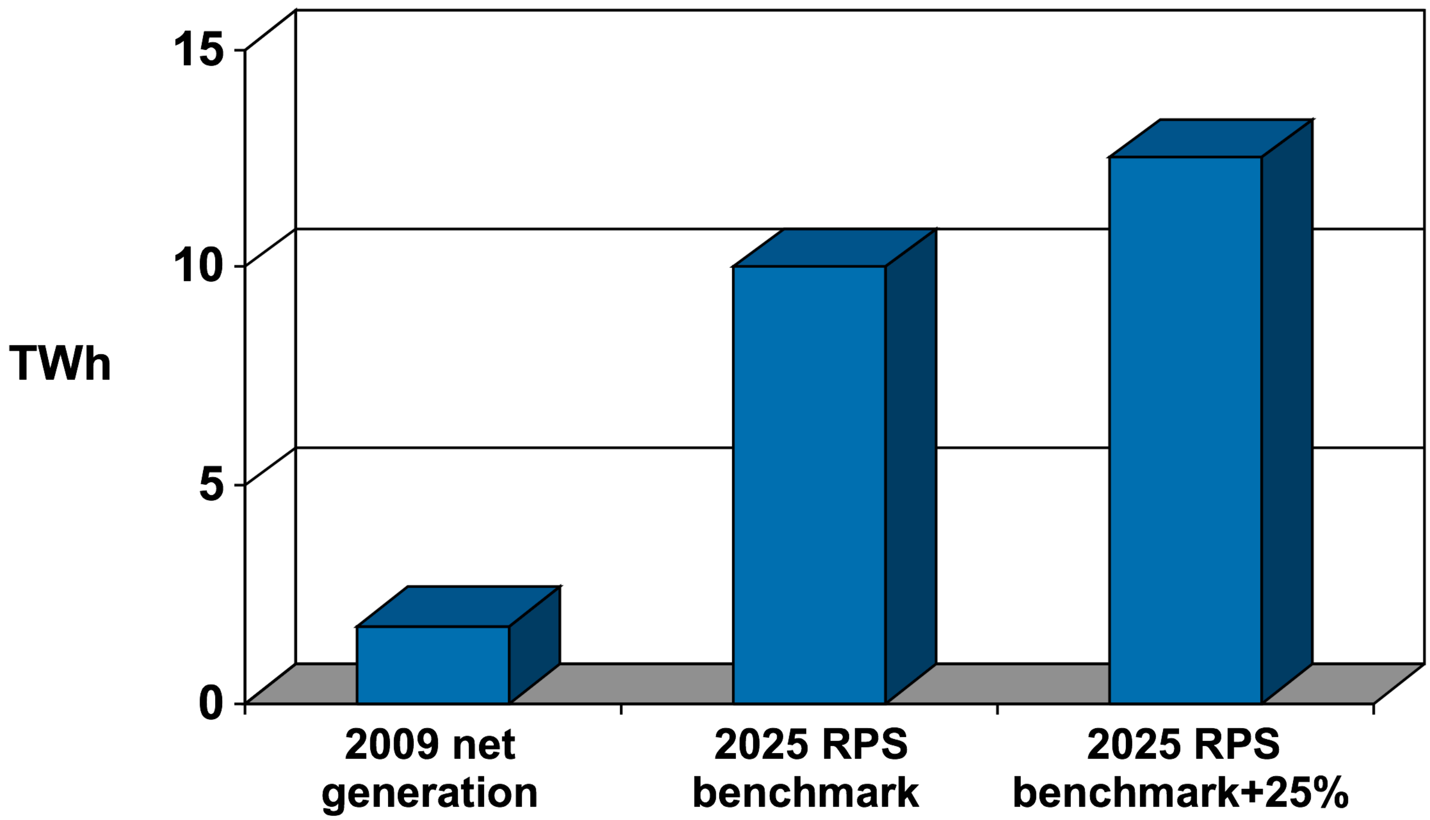
Progress to date: California



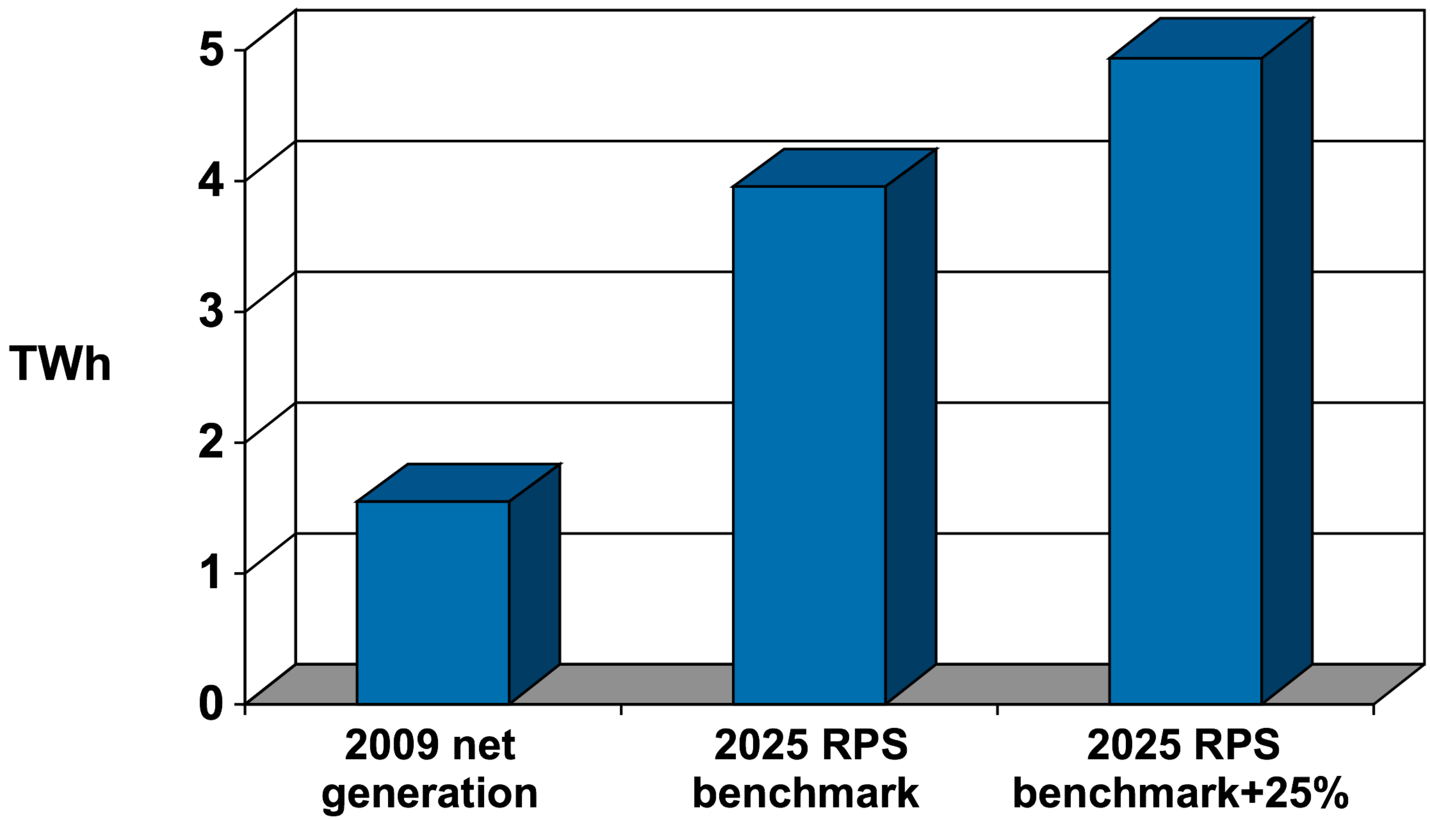
Progress to date: Arizona



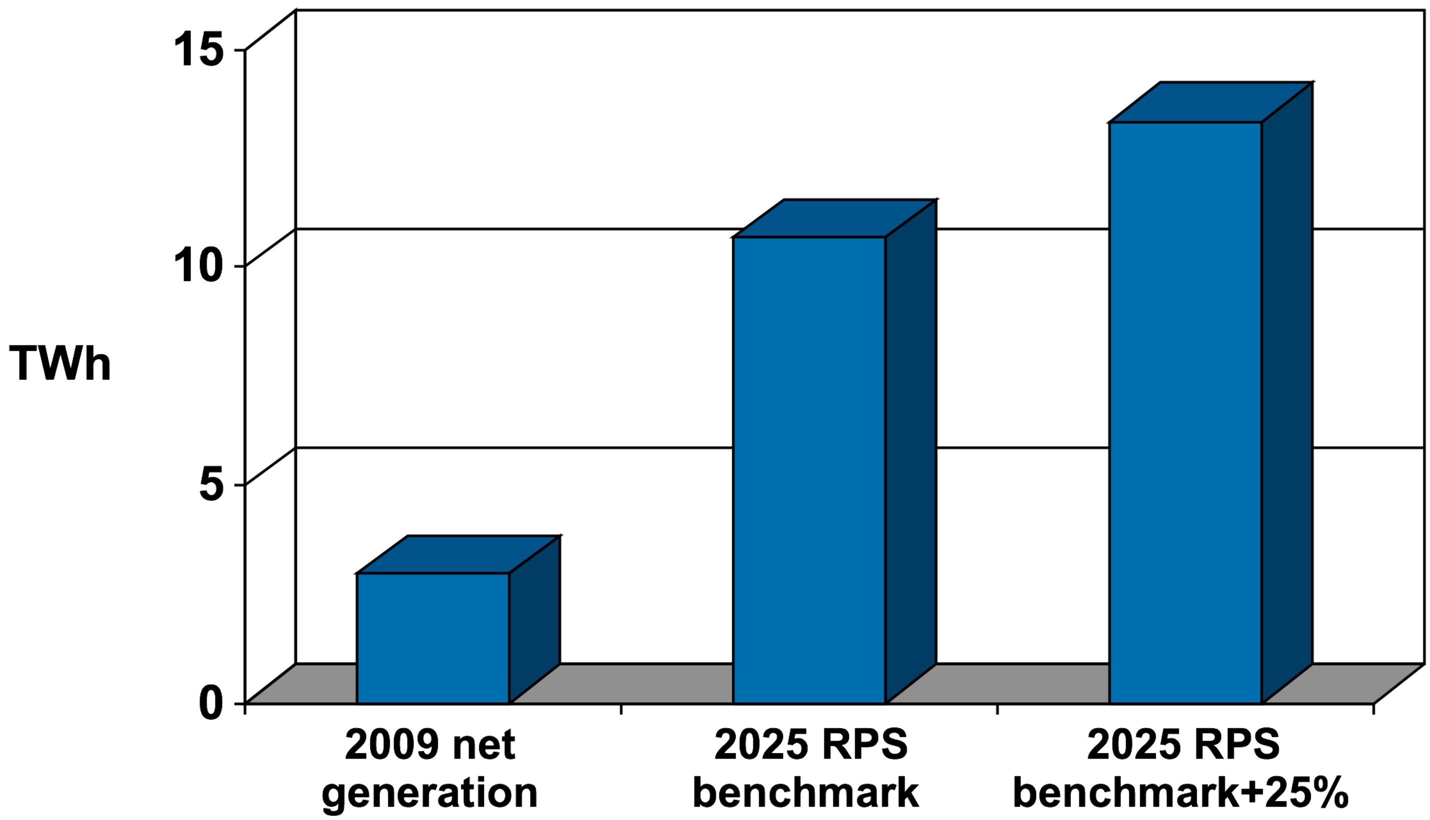
Progress to date: Nevada



Progress to date: New Mexico



Progress to date: Colorado



2025 need minus 2009 generation

	RPS benchmark	RPS benchmark + 25%
	(TWh in 2025)	
California	64.2	86.5
Arizona	5.7	7.1
Nevada	8.2	10.7
New Mexico	2.4	3.4
Colorado	7.7	10.4

In-state Supply-Demand Balances

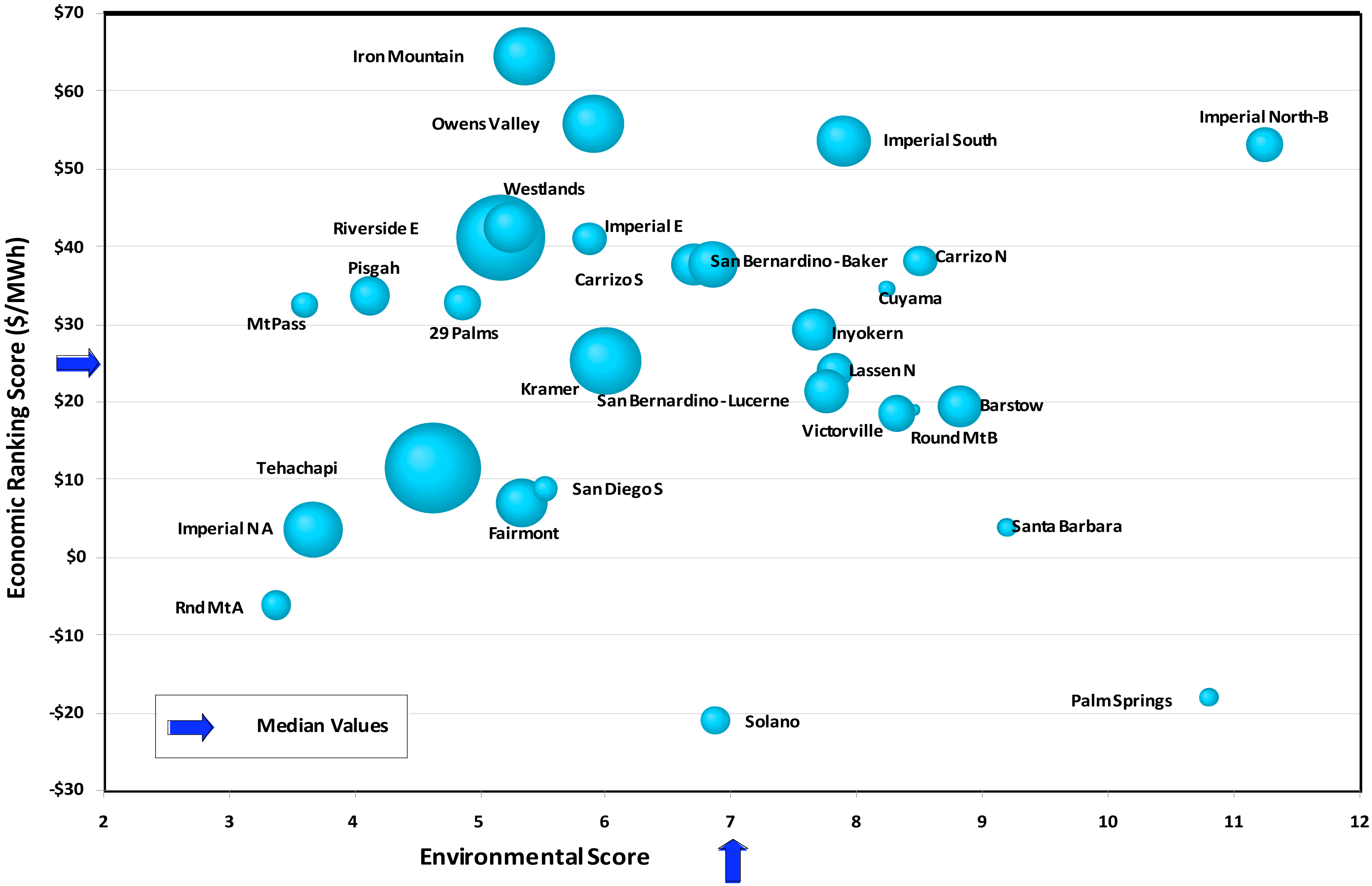
Key definition and assumptions

- Most data taken from Western Renewable Energy Zone (WREZ) Initiative
- "Prime resources"
  - Wind: Class 5 or better
  - Solar: Direct normal insolation (DNI) 7.5 kw/m^2/day or better
  - Geothermal: Known sites included in a WREZ hub
- A state's likely export will consist of prime resources in excess of its own internal need
- Prime resources will dominate good resources in interstate commerce for renewable power

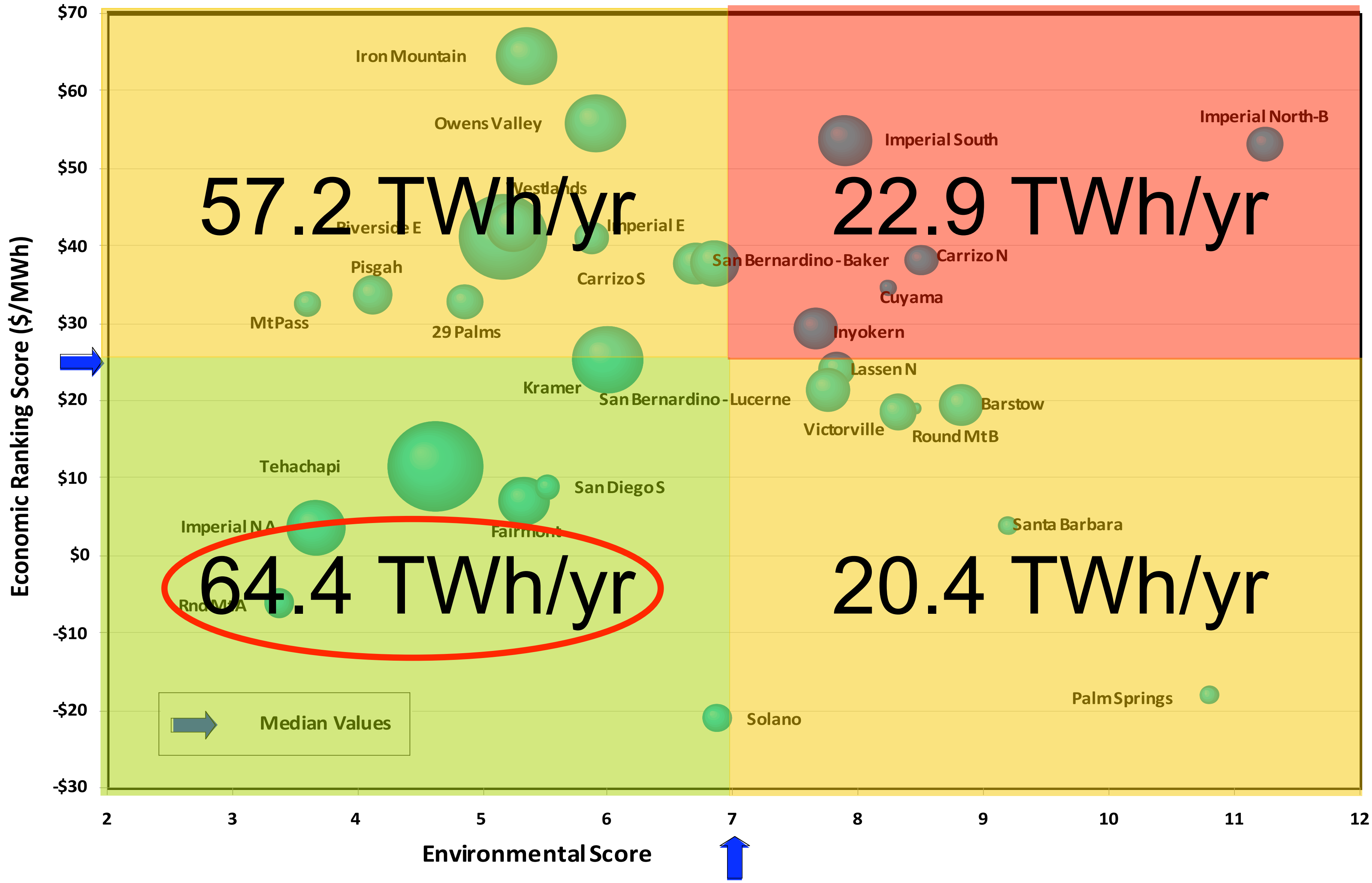
California: RETI

- Estimates of future in-state resources were based on RETI Phase 2B report
- This analysis focuses on renewable energy zones with above-median economic scores and above-median environment scores
- Includes Kramer zone, which RETI stakeholders kept even though its economic score was on the margin
- Analysis counts all of the resources in a RETI zone, although 100% development is unlikely
- Some double-counting: existing RE projects that are in a RETI zone

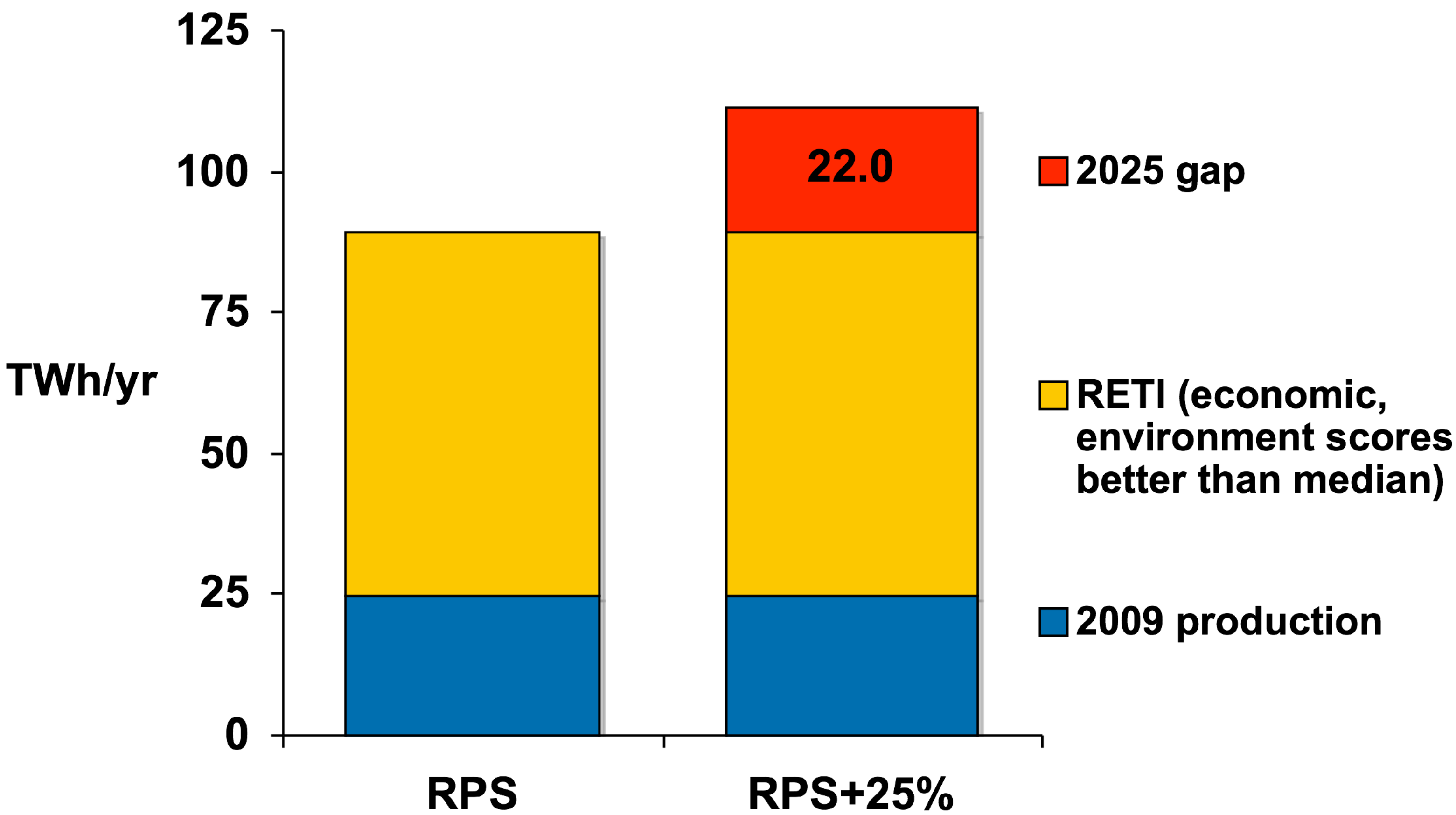
California: RETI



California: RETI



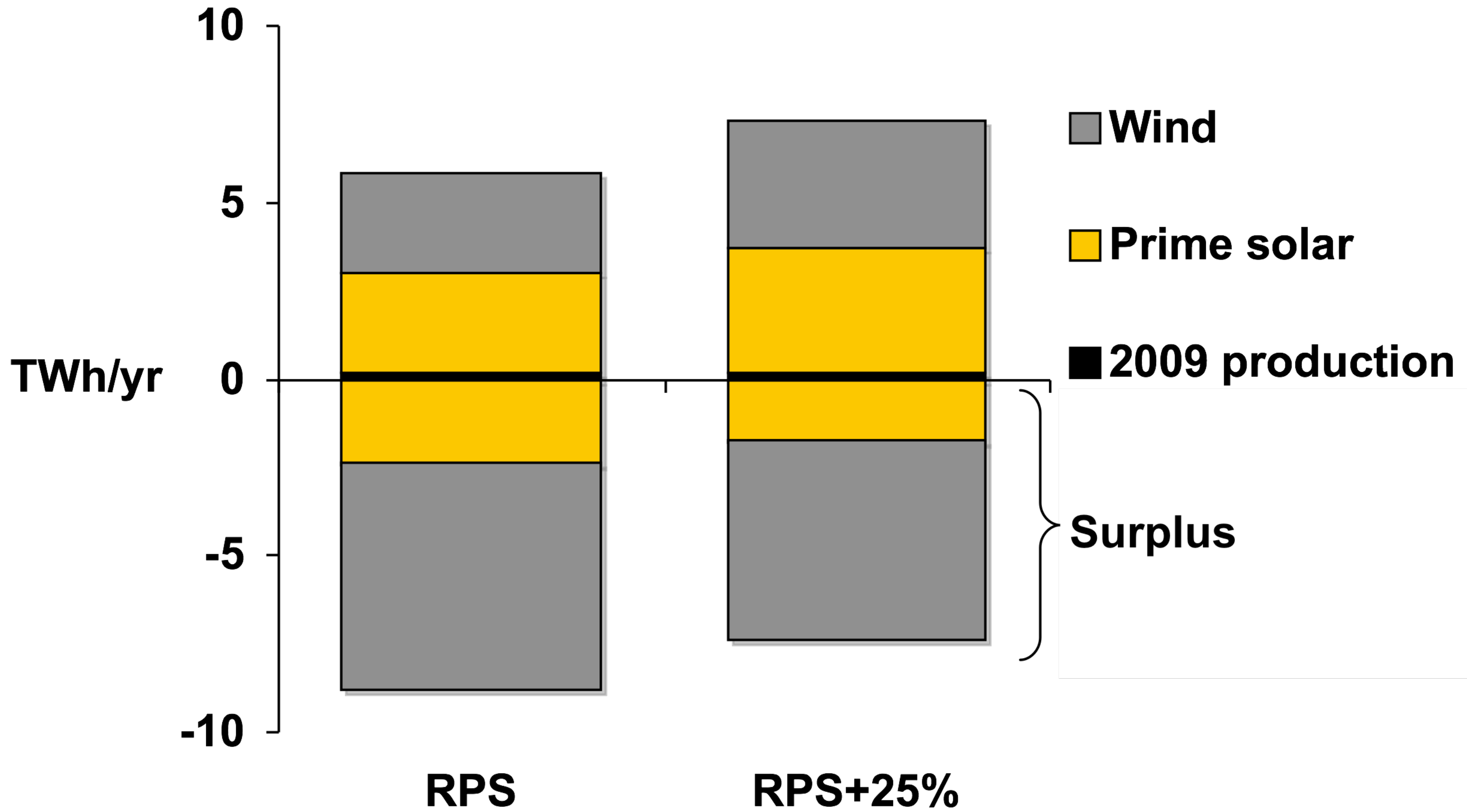
California 2025 RE supply gap



Arizona supply

- Arizona Renewable Transmission Task Force screened renewable energy development areas, in support of ACC's Biennial Transmission Assessment order
- Options were generally near WREZ hubs
  - WREZ estimates used to quantify likely potential
  - Prime solar is mostly in AZ_WE (west of Phoenix)
- Simplifying assumption: Half of Arizona's RE need met by solar, half by in-state wind
  - Substitution is likely, but no attempt to model for this exercise

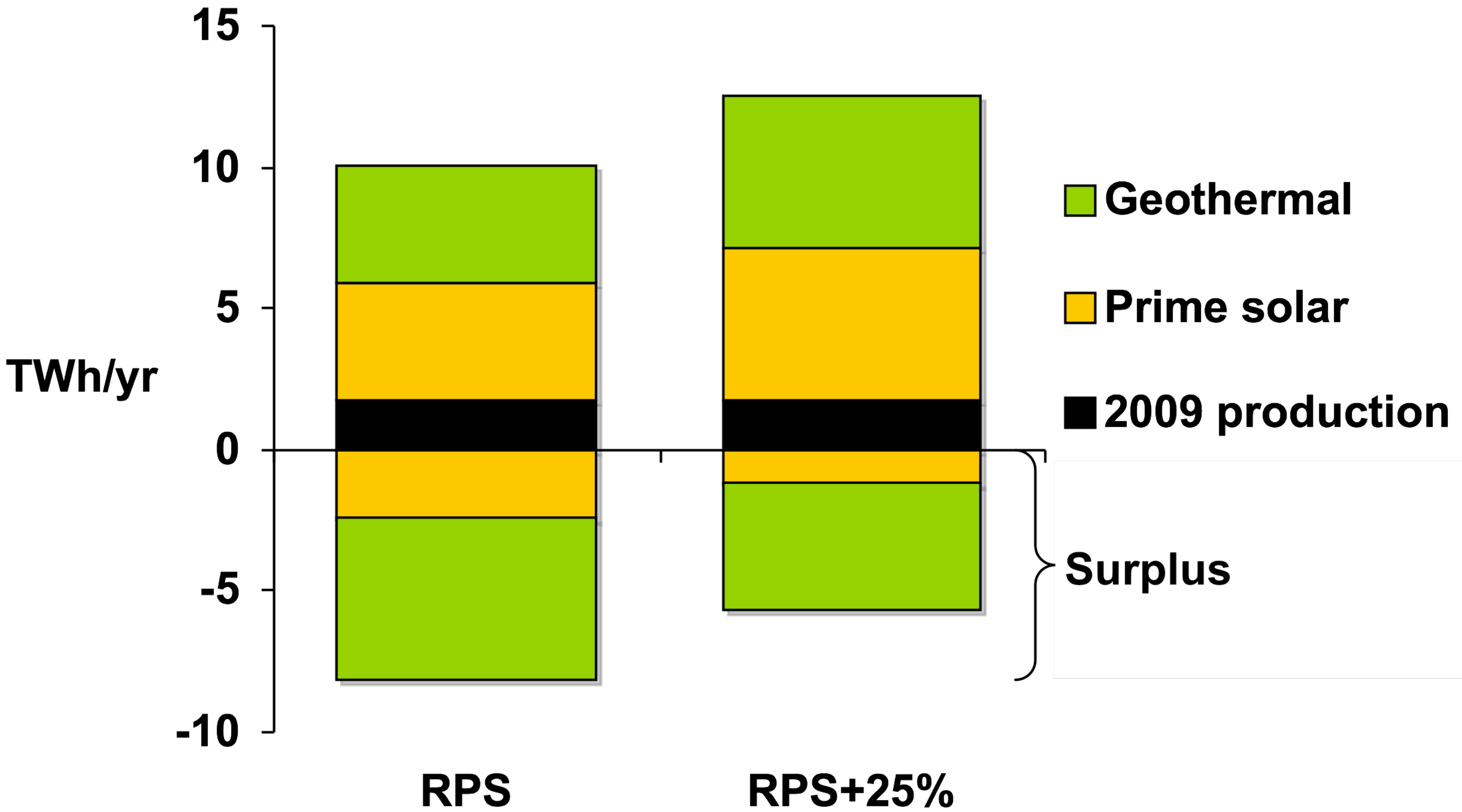
Arizona 2025 RE supply surplus



Nevada supply

- NPUC has adopted renewable energy zones identified by Renewable Energy Transmission Access Advisory Committee (RETAAC)
- Limited overlap between RETAAC zones and WREZ
  - WREZ did not intend to capture all resources, just those suitable for interstate commerce
  - RETAAC wind zone near Reno failed WREZ screening, but is a good local resource
  - Significant overlap in prime resources (geothermal, solar); WREZ estimates were used to quantify potential
- Simplifying assumption: Half of Nevada's RE need met by solar, half by geothermal
  - Some substitution with other good local resources is likely

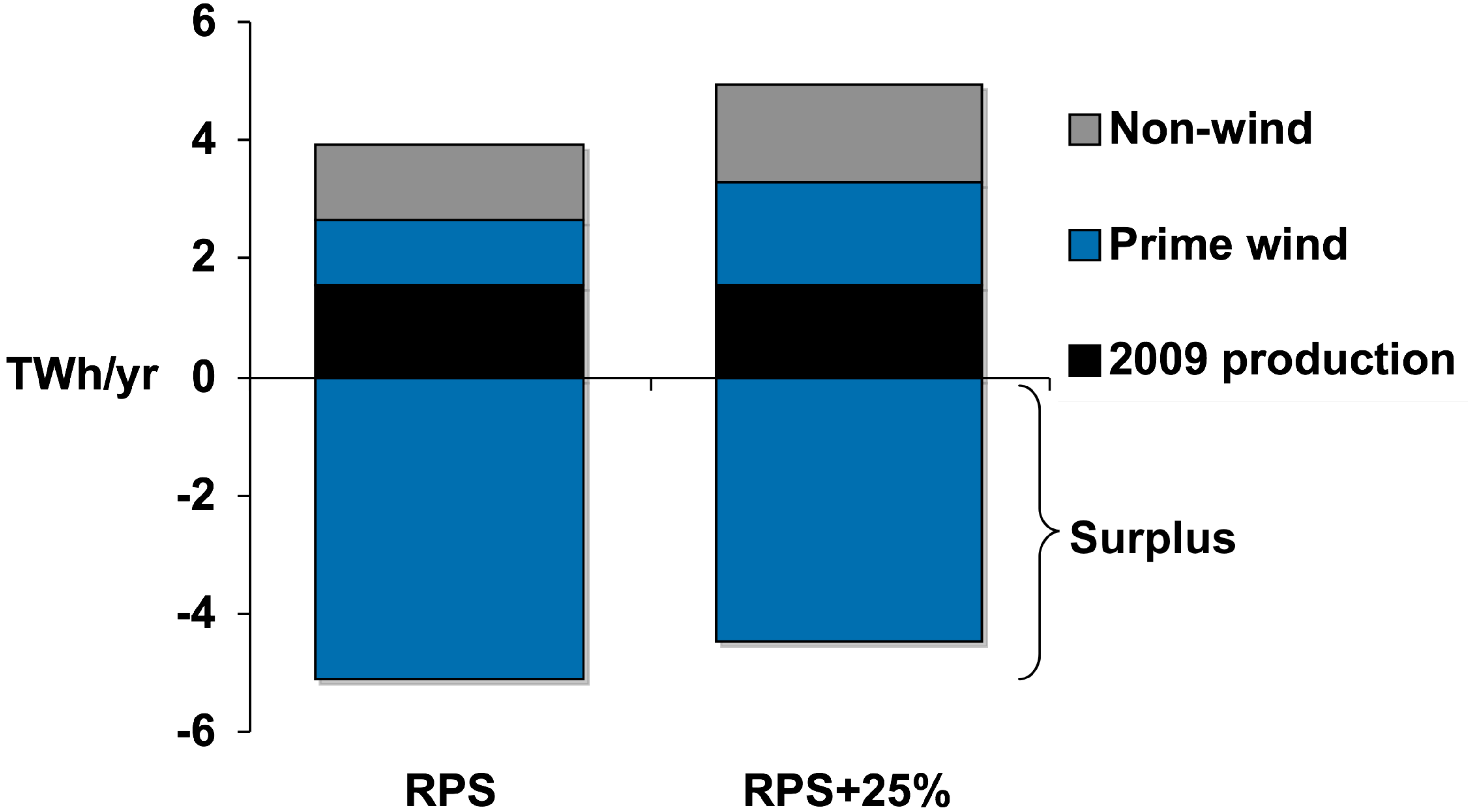
Nevada 2025 RE supply surplus



New Mexico supply

- 33% of RPS has to come from something other than wind
- Most of New Mexico’s non-wind RE potential is solar, but none is of prime quality (DNI above 7.5 kw/m^2/day)
- Nearly all of New Mexico’s 2009 renewable energy generation came from wind

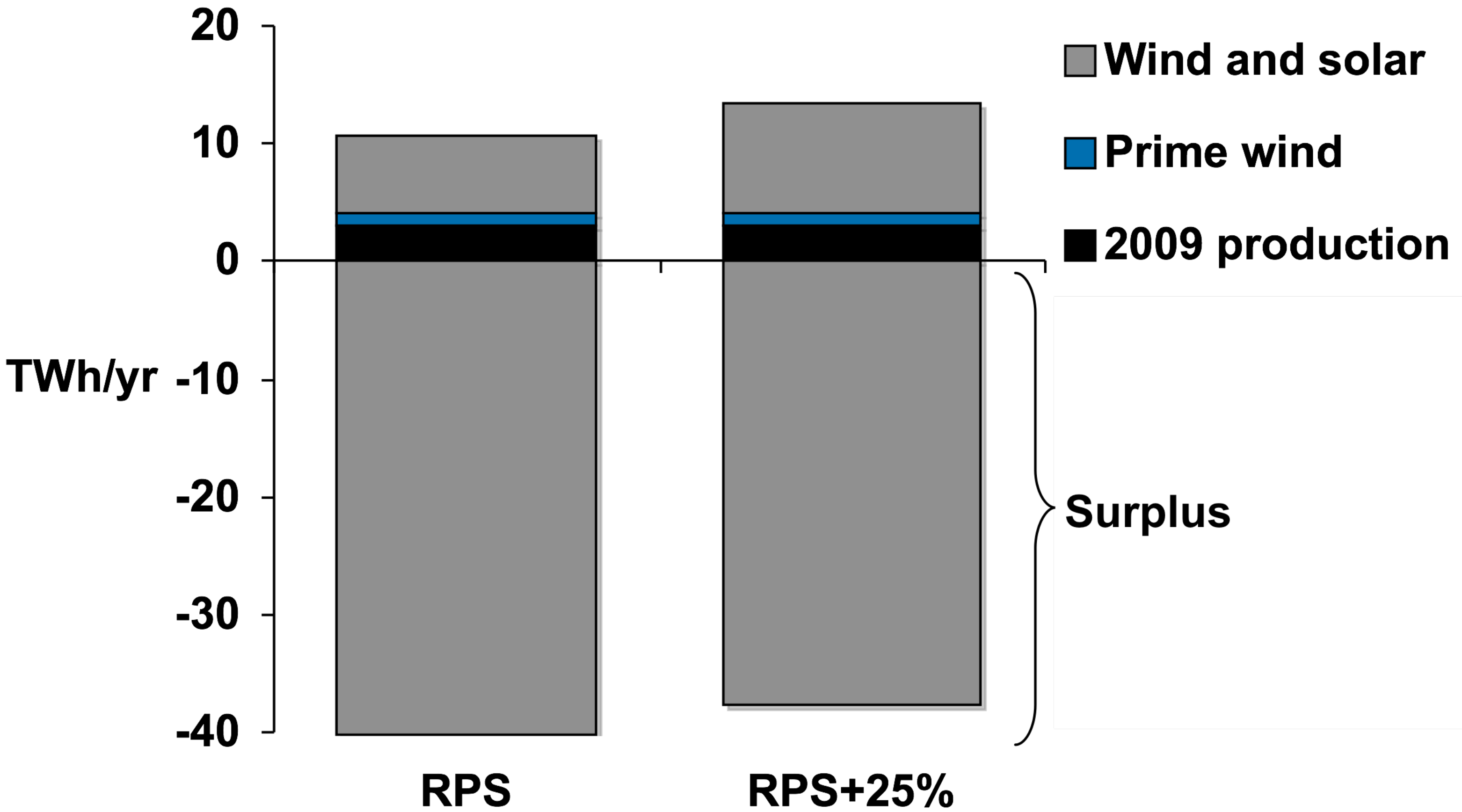
New Mexico 2025 supply surplus



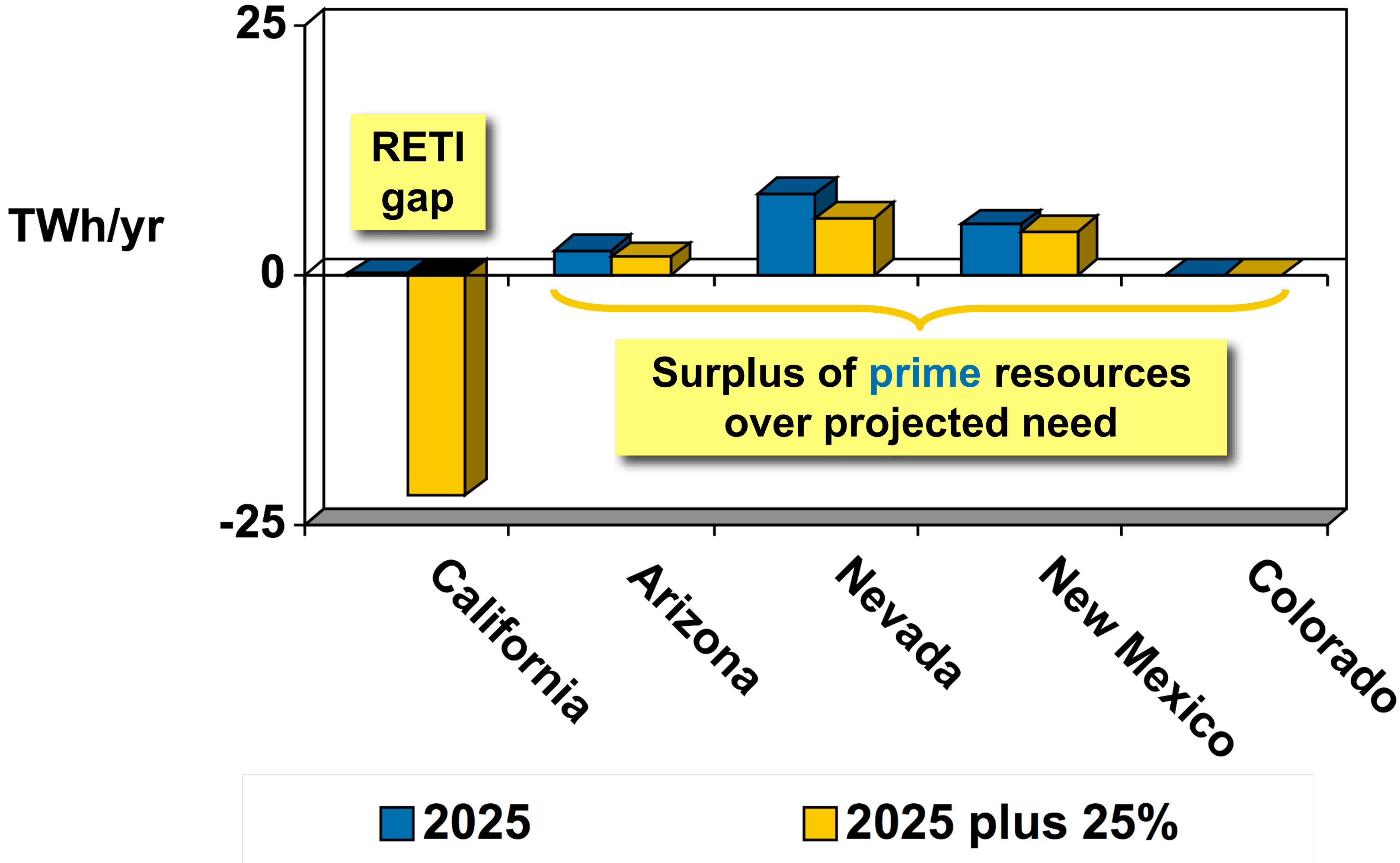
Colorado supply

- Colorado State Assembly directed a task force in 2007 to identify renewable resource generation development areas (GDAs)
- GDAs largely coincided with WREZ hubs; WREZ estimates used to quantify potential
- GDAs and Colorado REZs had the same screening threshold for wind (class 4 or better)

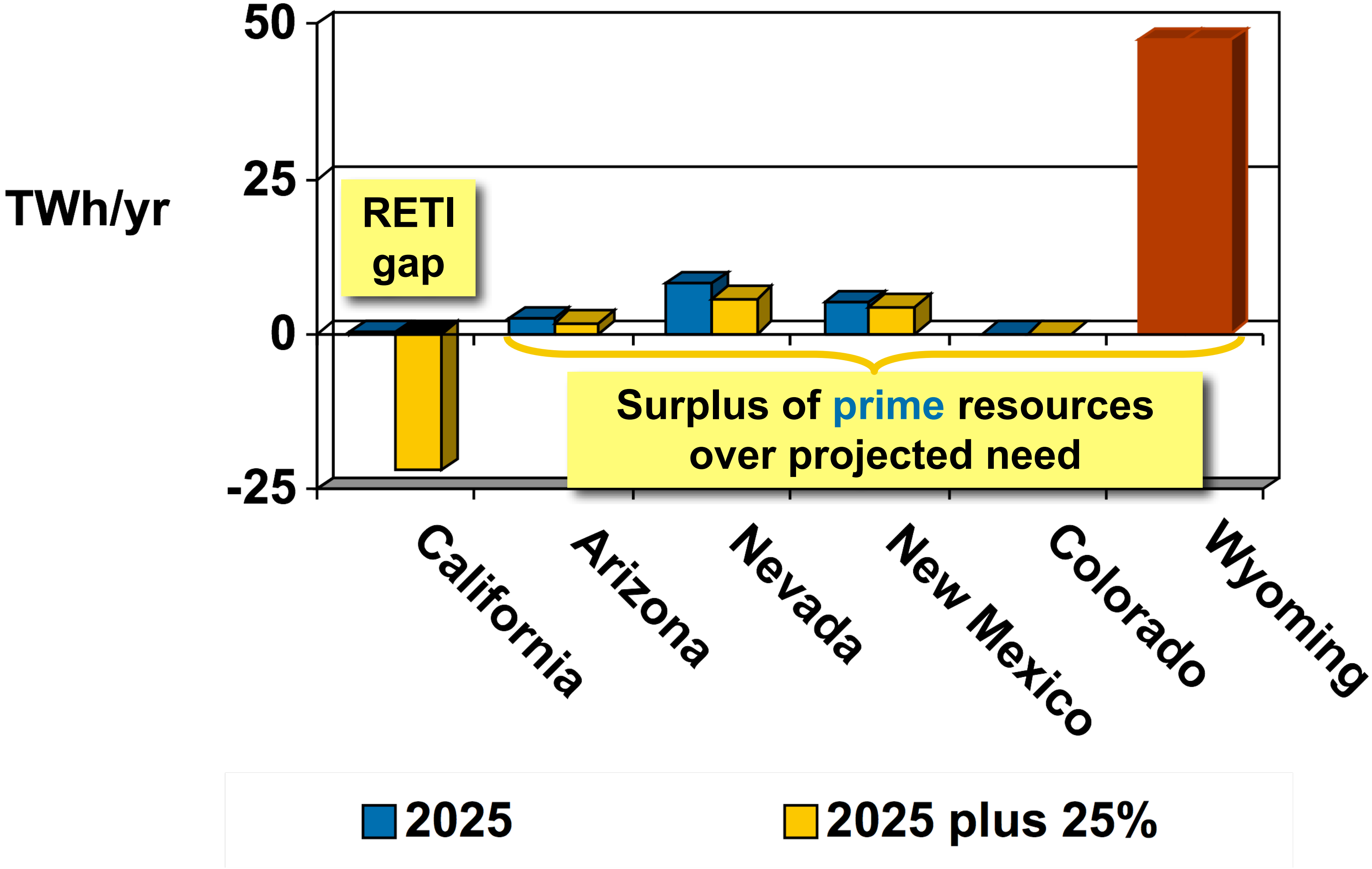
Colorado 2025 RE supply surplus



Renewable energy balances



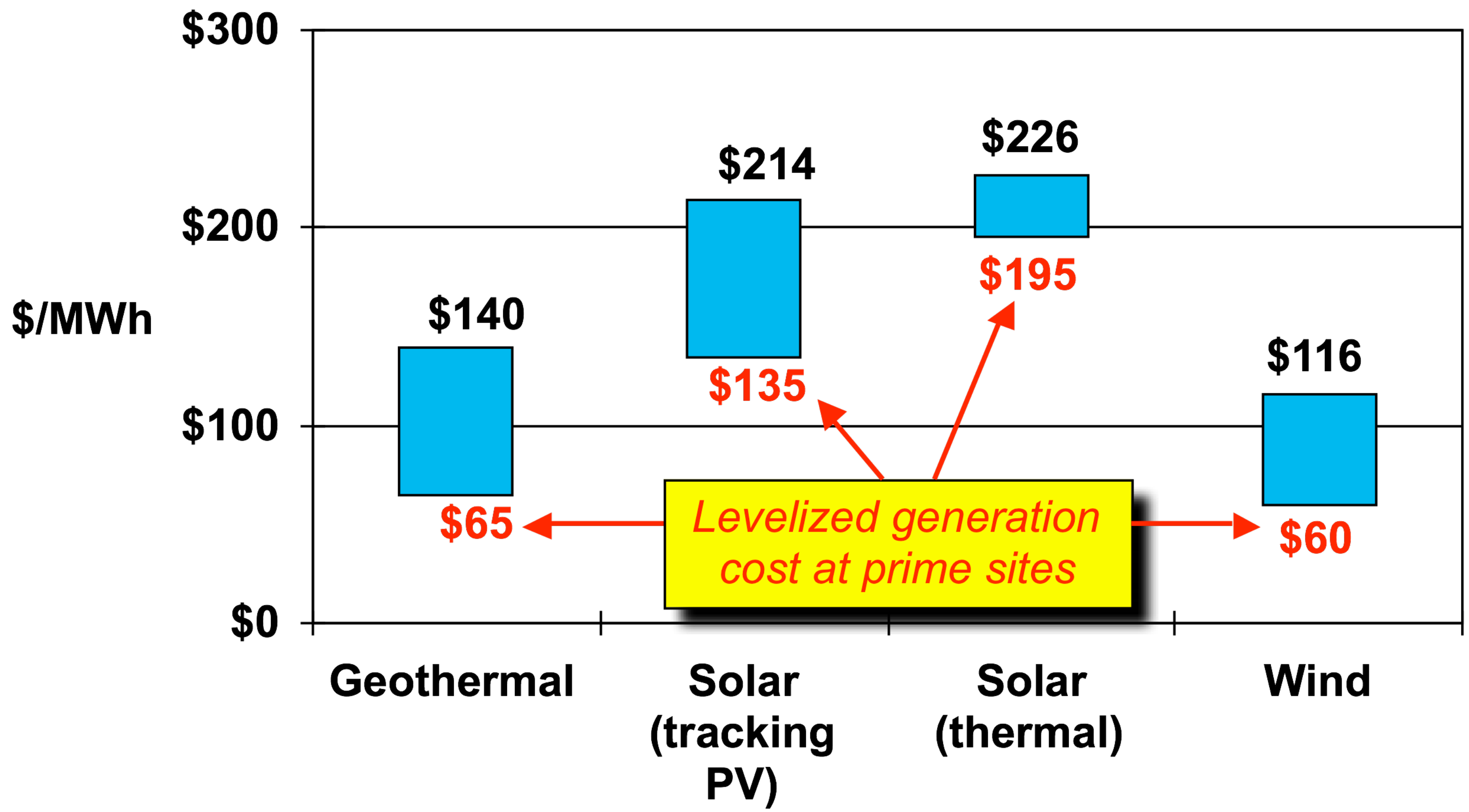
Renewable energy balances



Is there room for a deal?

- As California moves through the RETI stack, additional in-state resources will be less productive and more expensive on a $/MWh basis
- Prime resources in other states will have busbar cost similar to prime RETI resources
  - Similar equipment, similar capacity factors
  - Excluding transmission cost
- If the spread in busbar generation cost is larger than the cost of transmission, then meeting RE needs with prime resources from another state may be reasonable economically

RETI range of generation costs



Interstate value propositions

State transmission planning

California: RETPP

- Renewable Energy Transmission Planning Process represents collaboration between California ISO and the California Transmission Planning Group
- Builds on RETI
- Implement new criterion for evaluating new lines: accessing renewable resources to meet state RPS and environmental goals
- Shift from a project proposal approach to a comprehensive plan approach
- Early identification of “least regrets” projects

How ‘comprehensive’?

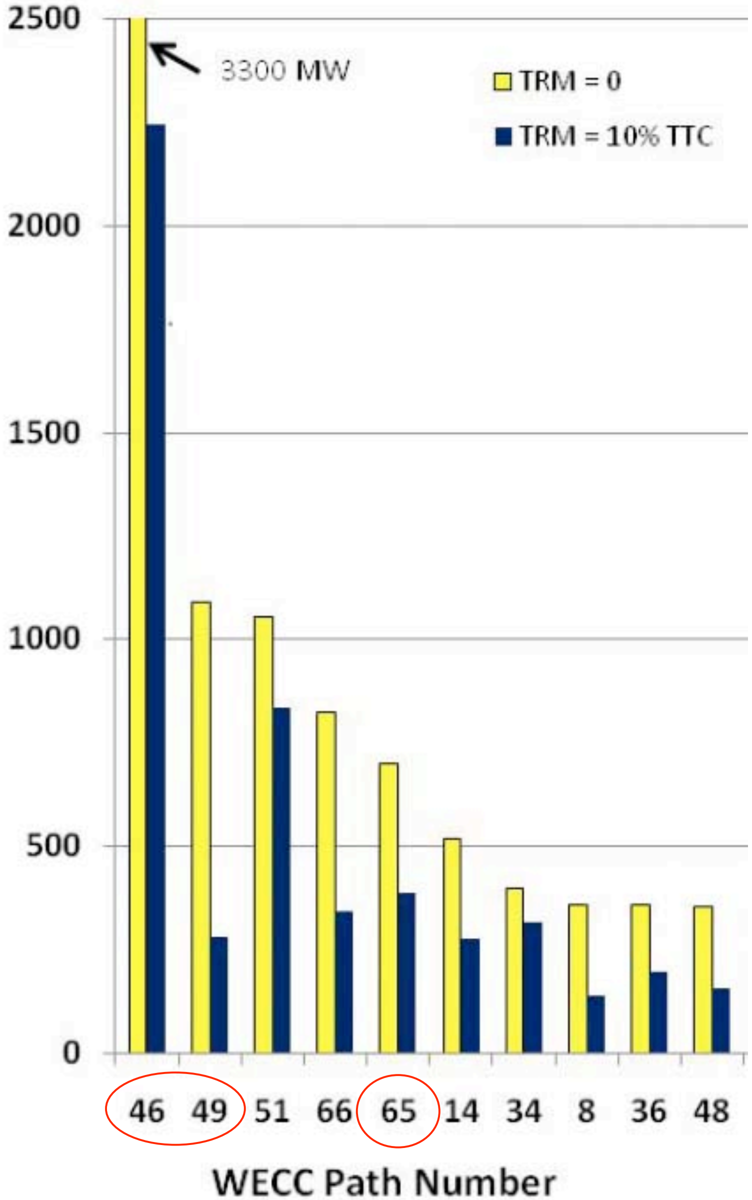
- RETI evaluated out-of-state resources, identified “gateway” zones
- Comprehensive plan that includes out-of-state resources would need to study network upgrades in gateway zones, and evaluate available transmission capability coming into the zone
- But are other states planning lines that will get their renewable power to the gateway?

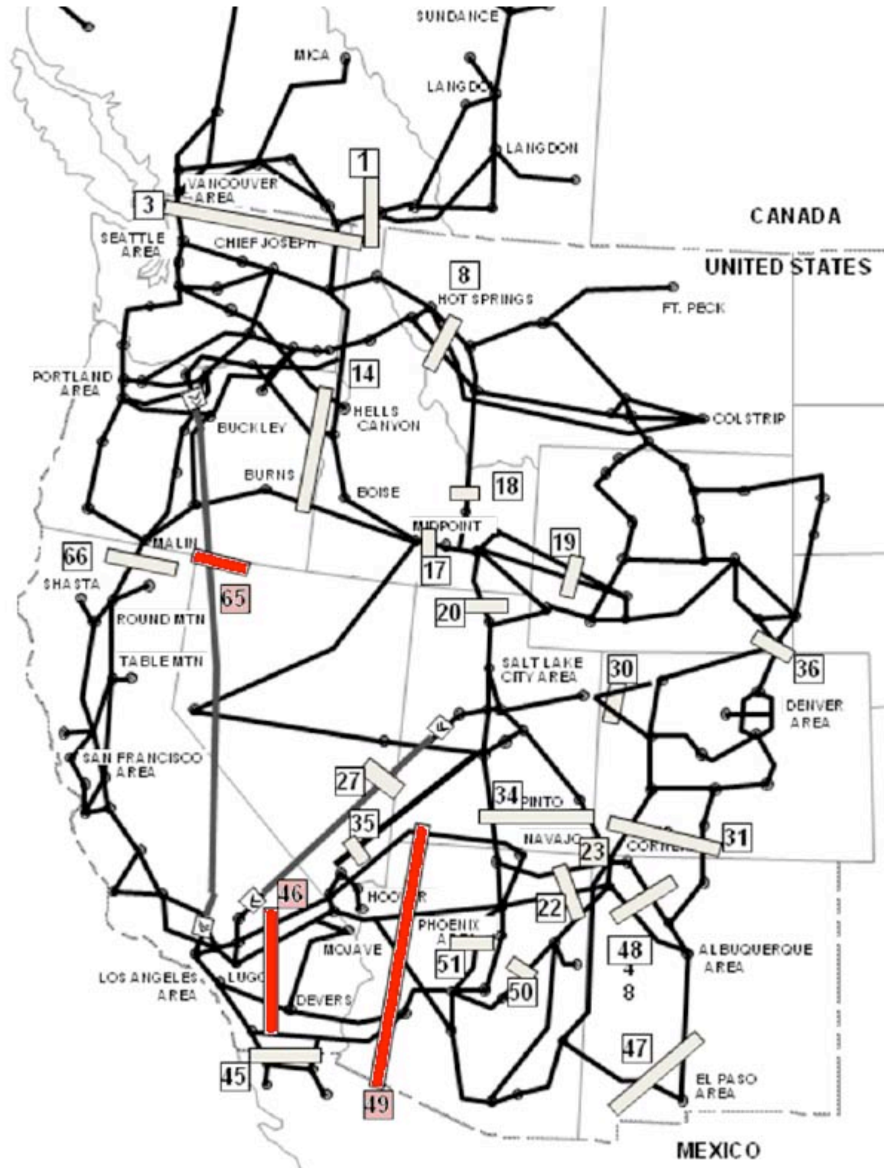
Existing paths into California

- Some transmission solutions may already be there
- Two major paths into California have large amounts of unused capacity
  - Paths 46 and 49: Arizona and S. Nevada to California
  - Path 65: NW Nevada to S. California
- May provide some capability quickly, if local network can get power from RE zone to the “on-ramp” of major line

Unscheduled path capacity

MW not used 90% of the time

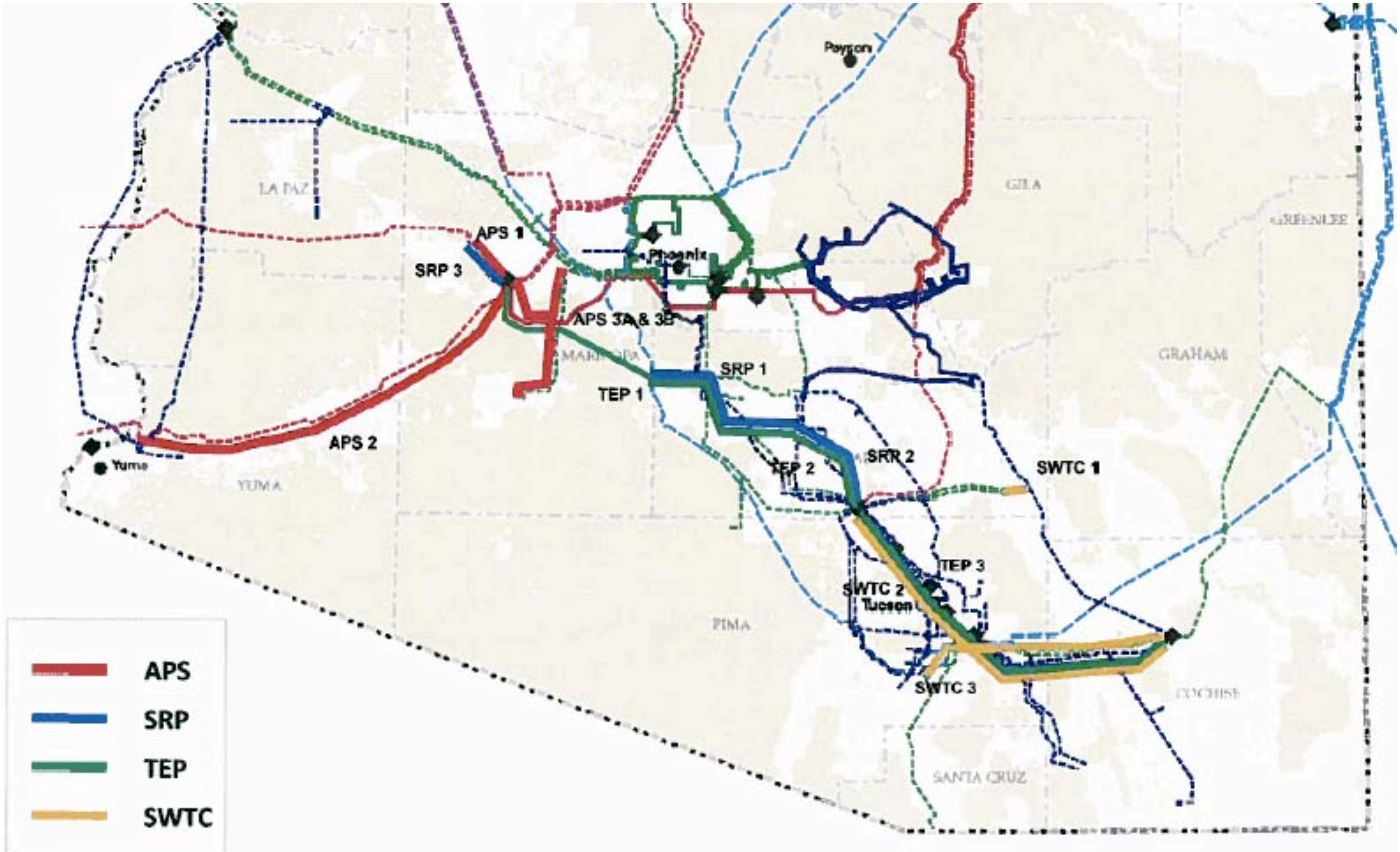




Arizona: BTA

- Biennial Transmission Assessment (BTA) directs utilities to identify top 3 transmission projects for enabling RE
- Utilities and stakeholders collaborated on identifying zones and lines with most value and least environmental impact
- High degree of coordination between APS, TEC, SRP, and SWTC plans
- Most projects would enable solar resources
- In filings, utilities anticipate possible flows to California (solar), from New Mexico (wind)

Lines proposed by utilities



Lines proposed by APS

- Palo Verde to Delaney solar zone
  - Would enable up to 1,500 MW of solar resources
  - 1,500 MW of solar power in Delaney zone could produce 6 TWh per year, equal to Arizona's 2025 RPS benchmark
- Palo Verde to Hyder solar zone (North Gila)
  - Would enable up to 1,500 MW of solar resources
  - 1,500 MW of solar power in Hyder zone could produce 6 TWh per year, equal to Arizona's 2025 RPS benchmark
  - Interface at North Gila connects to Imperial Valley, with potential to accommodate geothermal to Arizona

TEC, SRP, SWTC proposed lines

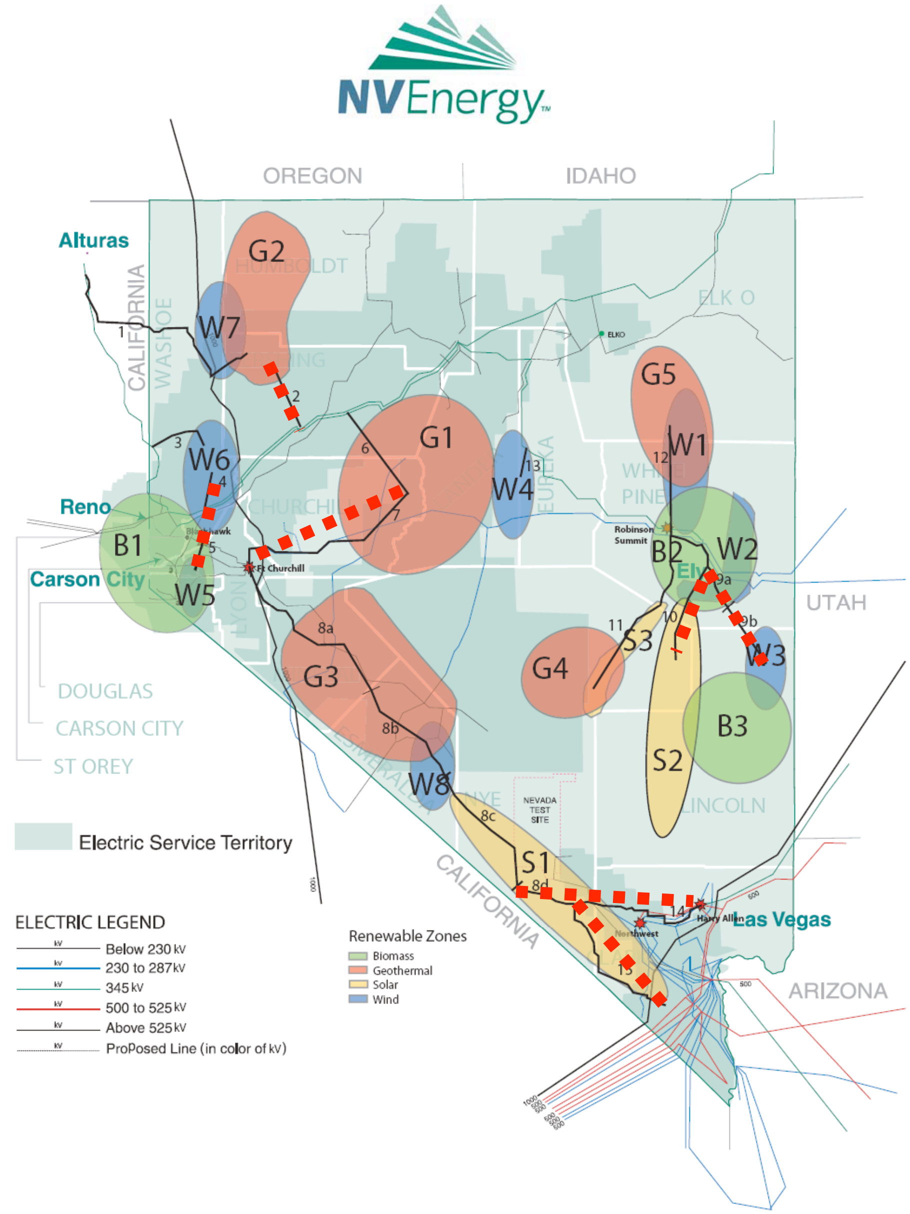
- Would provide connection to resources from New Mexico (SunZia)
- Would provide additional transmission capacity to accommodate good solar resources in south central Arizona

Nevada: RETAAC

- Identified renewable energy zones for solar, geothermal, wind, biomass
- Phase 2 identified conceptual transmission segments that would connect zones to load
- Assigned prioritization scores to segments based on RE potential, environment/land use, transmission cost, and reliability effects

Highest-ranked line segments

- NV Energy activity
  - Completing 500 kV line from eastern zones to Las Vegas
  - Conducting 345kV routing studies in and near geothermal zone G1
- WECC path utilization study shows about 2,000 MW of unused line capacity west from retired Mojave plant



Status

- Nevada statute requires NV Energy to prepare a plan for construction or expansion of transmission facilities to serve RE zones and to facilitate the utility in meeting its RPS
- NV Energy recently executed PPA with 150 MW wind plant in eastern wind zone that is expected to be on-line in 2011
- NV interconnection queue (as of January)
  – Geothermal: 819 MW
  – Solar: 2,622 MW
  – Wind: 3,722 MW
  – Biomass/biogas: 25 MW

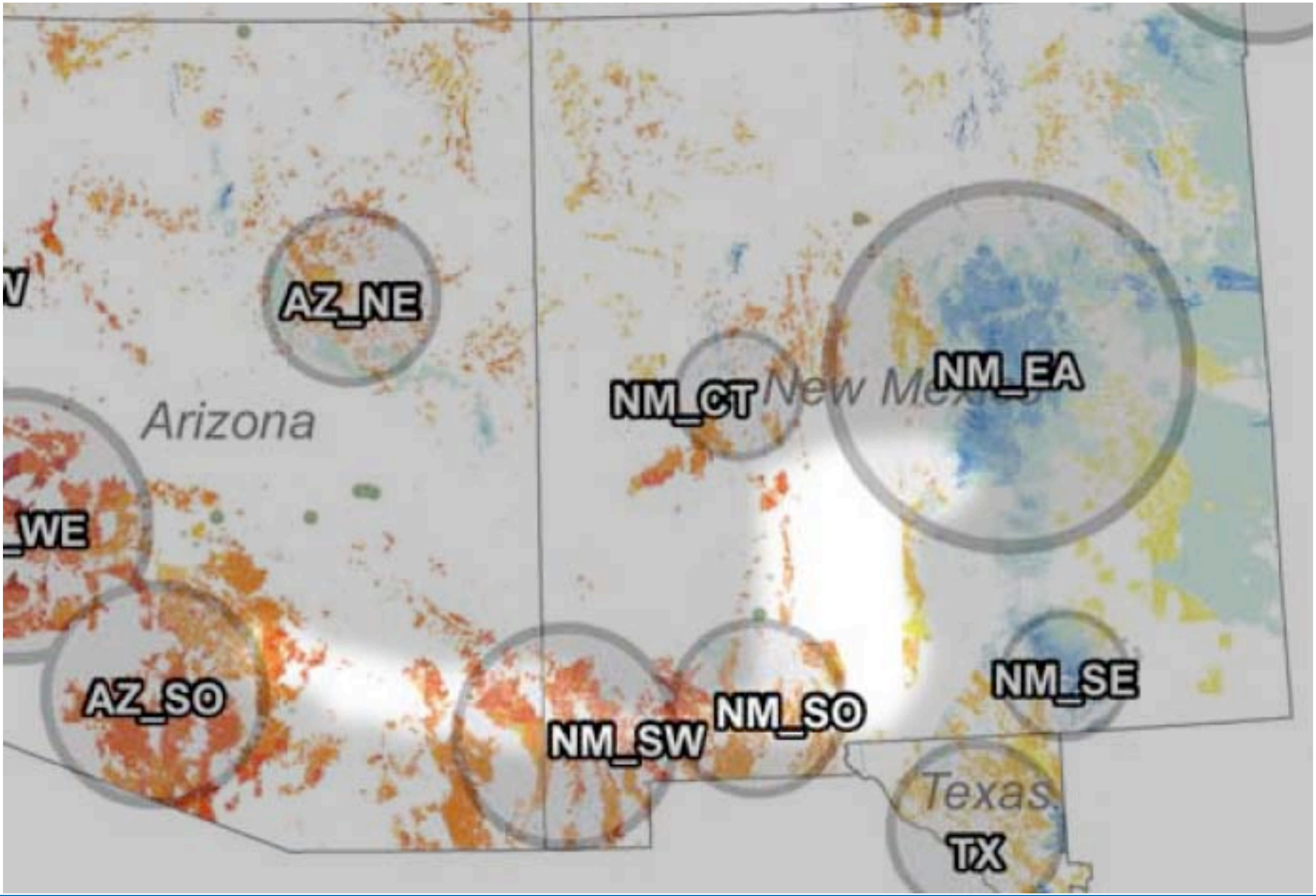
New Mexico: RETA

- New Mexico Renewable Transmission Authority created in 2007 to plan, finance build and operate new transmission
  - At least 30% of power must come from renewable sources
  - Specific authority to facilitate renewable energy exports from New Mexico
- Has mapped wind, solar, geothermal resource areas in the state
- No comprehensive transmission development plan

New Mexico: SunZia

- SunZia project currently undergoing environmental review and planning
  - Begins near prime wind resource zone in New Mexico, terminates in Arizona
  - Expected power transfer capability of more than 3,000 MW (annual energy equivalent of about 10 TWh)
  - More than 80% of route is on public land
  - Expected operation in 2014

SunZia planning area, WREZ hubs



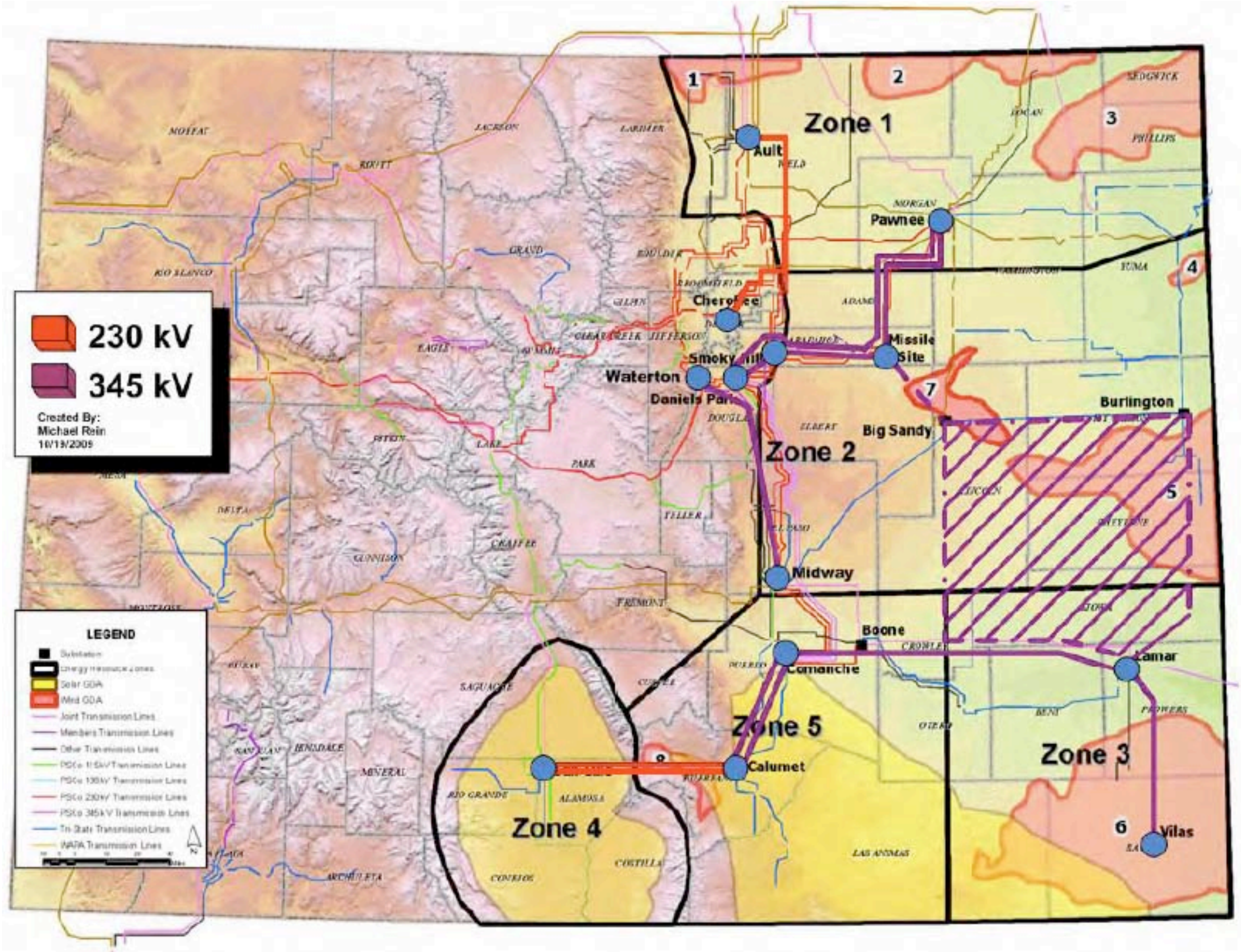
Colorado: SB 100

- Colorado has the largest demand for renewable power in the West outside of California
- Statute gives in-state resources 125% credit toward RPS, making in-state class 4 wind economically equivalent to class 5 wind elsewhere — *but only in Colorado*

Colorado: SB 100

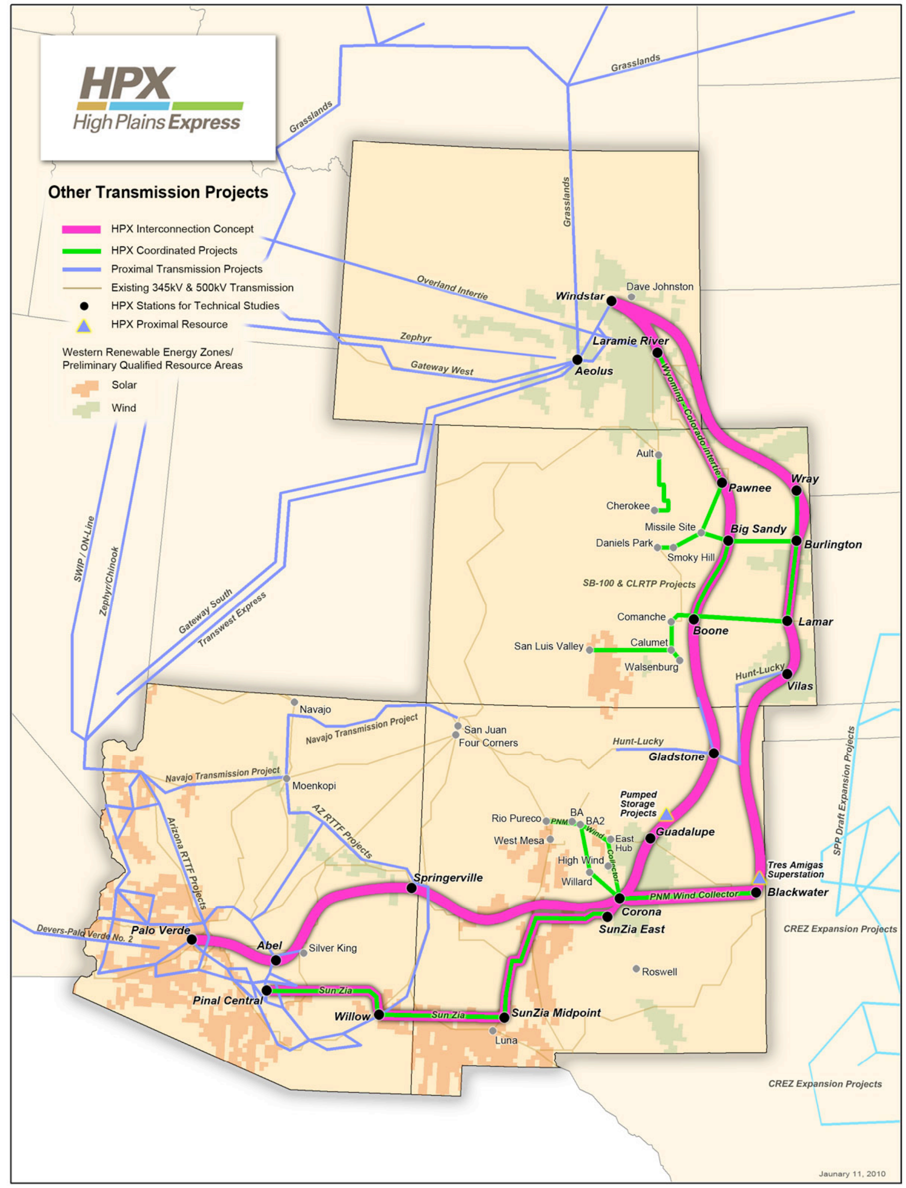
- Most transmission planning by the state's major IOU (Xcel) and G&T co-op (Tri-State) focuses on meeting internal demand
- Lackluster responses from Wyoming wind power in recent Xcel RFP
- SB 100 projects under way or in regulatory review would enable renewable resources equivalent to about 60% of Colorado's outstanding need, using its RPS benchmark

CO SB 100 lines



Colorado: High Plains Express

- Two 500kV lines from Wyoming to New Mexico
- Up to 4,000 MW of transfer capability, equivalent to about 14 TWh/year of power from prime wind resources
- Potential to connect with SunZia in New Mexico



How well do separate state planning efforts support the value propositions?

Nevada to California

- Short-term opportunities on underutilized path from Mojave to California
  - Mostly benefit Nevada's prime solar resources
  - Some prime solar nearby in Arizona
  - Even these resources still need to get to Mojave substation; RETAAC priority segments will be crucial
- Transmission for geothermal remains problematic
  - Current development has been limited to smaller plants (10-30 MW)
  - Filling a 345kV line (or larger) would require wide-area transmission collector system in geothermal zones
  - Subject of NREL study in 2010

Arizona to California

- Coordinated utility planning for BTA order may enable Arizona to meet its own RE needs, with sufficient prime solar resources left over to provide California with relatively low-cost solar power
- Prime solar power available for California will increase to the extent Arizona:
  - Uses its own wind and biomass resources, and
  - Uses prime wind power from New Mexico

California to Arizona

- Delivery of geothermal power from Imperial Valley to Arizona may be accomplished with the same lines used to deliver prime solar power to California
- Will depend on network upgrades

New Mexico to Arizona, California

- New Mexico only needs 1 TWh/yr more wind power to reach its RPS benchmark (excluding non-wind requirements)
- SunZia would be able to move up to ten times that amount to Arizona

Wyoming/Colorado to Southwest

- Transmission planning by Colorado utilities is foregoing the value proposition for wind power to Arizona and California
- Wyoming wind can bypass Colorado to get to destination markets
- Economic case with respect to supply and demand is not compelling for Colorado; few prime resources
- Economic case with respect to manufacturing is compelling
  - Vestas, SunEdison, other renewable energy equipment makers have manufacturing facilities in Colorado that would serve development in Wyoming or New Mexico

Interstate value propositions

Manifesting the value propositions

- Some pieces of the transmission puzzle are in place or are progressing
  - Utility planning in Arizona; independent projects in New Mexico, Colorado, Wyoming
  - Key uncertainty will be procurement: Will LSEs in California be in the market for non-California renewables?
- Some gaps remain
  - Nevada needs a plan to bring its geothermal resources to the interstate market
  - Is it within regulators' implied authority to determine need for a line based wholly or in part on the economic benefit to the state of exploiting its comparative advantage in interstate commerce?

Questions?