



Future RETI Phase 2 Work by Black & Veatch

Black & Veatch

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Working Group Meeting

September 9, 2009

Agenda

- Review of potential work areas
 - CREZ and Technology Updates
 - Economic Model Update
 - Extended Analysis of WECC Resources
- Discussion of economic model update
- Introduction of out-of-state issues

CREZ and Technology Updates

- Solar
 - Update site-specific solar project characteristics for large solar projects that have been moved
 - Re-evaluate the assumptions for wet/dry cooling at solar thermal projects
 - Update solar profiles to correct truncation issue. Likely to reduce solar thermal CFs by ~8% (e.g. from 24% to 22%)
 - Revisit solar technology assumptions (storage for solar thermal, thin film for PV)
 - Re-evaluate cost assumptions for solar thermal and solar PV projects

CREZ and Technology Updates

- Geothermal
 - Consider dry-cooling impacts on geothermal output profiles (current assumption is flat)
 - Update geothermal project cost
- Wind
 - Reassess Palm Springs wind resources
 - Reassess Fairmount wind resources
 - Review 12x24 typical output profiles against WREZ and new data
- Reassess need / definitions for sub-CREZs
- Update pre-ID project information



Economic Model Update

Economic Model Update

- Consider incentives from the American Recovery and Reinvestment Act of 2009
 - Update Canadian/Mexican incentives
- Recalculate base economic rankings
- Re-perform uncertainty analysis
- Reformat overall model to be user friendly similar to the WREZ model (probably long-term)

Cost of Generation Calculator Improvements

- Modeled ITC as a capital cost reduction, not a year 1 windfall
 - More appropriate to reflect ARRA “ITC Grant”
- Allowed for a mix of depreciation schedules
 - Can better reflect tax code and better mimic foreign depr rules
- Included additional revenue streams
 - Allows for more flexibility in modeling incentives
- Modeled performance degradation
 - Previous RETI work included degradation, but now it is modeled explicitly

Cost of Generation Calculator

All inputs are in blue.

Technology Assumptions	
Project Capacity (MW)	1
Capital Cost (\$/kW)	\$2,400
Fixed O&M (\$/kW)	\$50
Fixed O&M Escalation	2.5%
Variable O&M (\$/MWh)	\$0
Variable O&M Escalation	2.5%
Fuel Cost (\$/MBtu)	\$0
Fuel Cost Escalation	2.5%
Heat Rate (Btu/kWh)	0
Capacity Factor	35%
Misc Revenue (\$/MWh)	\$0
Misc Escalation	2.5%
Degradation	0%

Financial/Economic Assumptions	
Debt Percentage	60%
Debt Rate	7.50%
Debt Term (years)	15
Economic Life (years)	20
Percent 5-year MACRS	100%
Percent 7-year MACRS	0%
Percent 15-year MACRS	0%
Percent 20-year MACRS	0%
Energy Price Escalation	2.5%
Tax Rate	40%
Cost of Equity	15.00%
Discount Rate	9.000%

Incentives	
PTC (\$/MWh)	\$20
PTC Escalation	2.5%
PTC Term (years)	10
ITC	0%
ITC Depr Basis	100%

Outputs	
NPV Equity Return	\$0
LCOE	\$84.24

Calculation	
Cap Cost	\$2,400,000
	0
	0 -813493.6209
	5 -755913.816
slope	11515.96099

84.24405168

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	
Annual Generation (MWh)	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	
Power Price	\$70.64	\$72.41	\$74.22	\$76.07	\$77.97	\$79.92	\$81.92	\$83.97	\$86.07	\$88.22	\$90.43	\$92.69	\$95.00	
Misc Revenue	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
Total Operating Rever	\$216,584	\$221,998	\$227,548	\$233,237	\$239,068	\$245,045	\$251,171	\$257,450	\$263,886	\$270,484	\$277,246	\$284,177	\$291,281	
Fixed O&M	\$50,000	\$51,250	\$52,531	\$53,845	\$55,191	\$56,570	\$57,985	\$59,434	\$60,920	\$62,443	\$64,004	\$65,604	\$67,244	
Variable O&M	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Fuel Cost	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Operating Expenses	\$50,000	\$51,250	\$52,531	\$53,845	\$55,191	\$56,570	\$57,985	\$59,434	\$60,920	\$62,443	\$64,004	\$65,604	\$67,244	
Interest Payment	\$108,000	\$103,865	\$99,420	\$94,641	\$89,504	\$83,982	\$78,046	\$71,664	\$64,804	\$57,429	\$49,501	\$40,979	\$31,817	
Principal Payment	\$55,134	\$59,269	\$63,714	\$68,492	\$73,629	\$79,151	\$85,088	\$91,469	\$98,330	\$105,704	\$113,632	\$122,155	\$131,316	
Debt Service	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	\$163,134	
Tax Depreciation - 5	\$480,000	\$768,000	\$460,800	\$276,480	\$276,480	\$138,240	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Tax Depreciation - 7	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Tax Depreciation - 15	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Tax Depreciation - 20	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Taxable Income	(\$421,416)	(\$701,117)	(\$385,203)	(\$191,729)	(\$182,107)	(\$33,748)	\$115,140	\$126,352	\$138,162	\$150,611	\$163,740	\$177,593	\$192,219	
PTC	\$61,320	\$64,386	\$64,386	\$67,452	\$67,452	\$70,518	\$70,518	\$73,584	\$73,584	\$76,650	\$0	\$0	\$0	
Taxes	(\$229,886)	(\$344,833)	(\$218,467)	(\$144,143)	(\$140,295)	(\$84,017)	(\$24,462)	(\$23,043)	(\$18,319)	(\$16,406)	\$65,496	\$71,037	\$76,888	
Total	(\$560,886)	233,337	352,447	236,351	160,462	161,635	169,358	54,514	57,326	58,152	61,312	(15,388)	(15,553)	(15,585)

MACRS Depreciation Schedules													
5	0.2	0.32	0.192	0.1152	0.1152	0.0576	0	0	0	0	0	0	0
7	0.1429	0.2449	0.1749	0.1249	0.0893	0.0892	0.0893	0.0446	0	0	0	0	0
15	0.05	0.095	0.0855	0.077	0.0693	0.0623	0.059	0.059	0.0591	0.059	0.0591	0.059	0.0591
20	0.0375	0.07219	0.06677	0.06177	0.05713	0.05285	0.04888	0.04522	0.04462	0.04461	0.04462	0.04461	0.04462



OOS Resources in RETI

Western Renewable Energy Zones (WREZ)

- High-level WECC-wide analysis of renewable energy zones
- Analyzes cost of transmitting renewables from zones to load centers
- Could augment or substitute RETI out of state resource analysis

WREZ Initiative Hub Map

"Hubs" are graphical representations of regional renewable resource potential in the Western Interconnection, identified for purposes of evaluating interstate transmission lines in future phases of the initiative. Hubs are sized in proportion to the total amount of electricity (in terawatt-hours) that could be produced over the course of one year using the resources within Qualified Resource Areas under the assumptions used in the WREZ initiative. These estimates exclude a number of areas for environmental and technical reasons, and they discount the remaining resource potential to account for unknown development constraints. In some instances, the energy generating potential of a QRA is also reduced to account for certain environmental sensitivities identified by state wildlife agencies. There has been little consideration of construction logistics or costs, permitting or cultural or other land use concerns related to the specific sites.

These hubs are not intended to suggest that renewable resources inside a QRA should be developed first, or that those areas outside of a QRA either should or cannot be developed. Hubs do not represent physical boundaries. Hubs do not indicate actual planned transmission service to these areas or the location of planned transmission interconnection points, and renewable development is not precluded in other areas where no hub is shown.

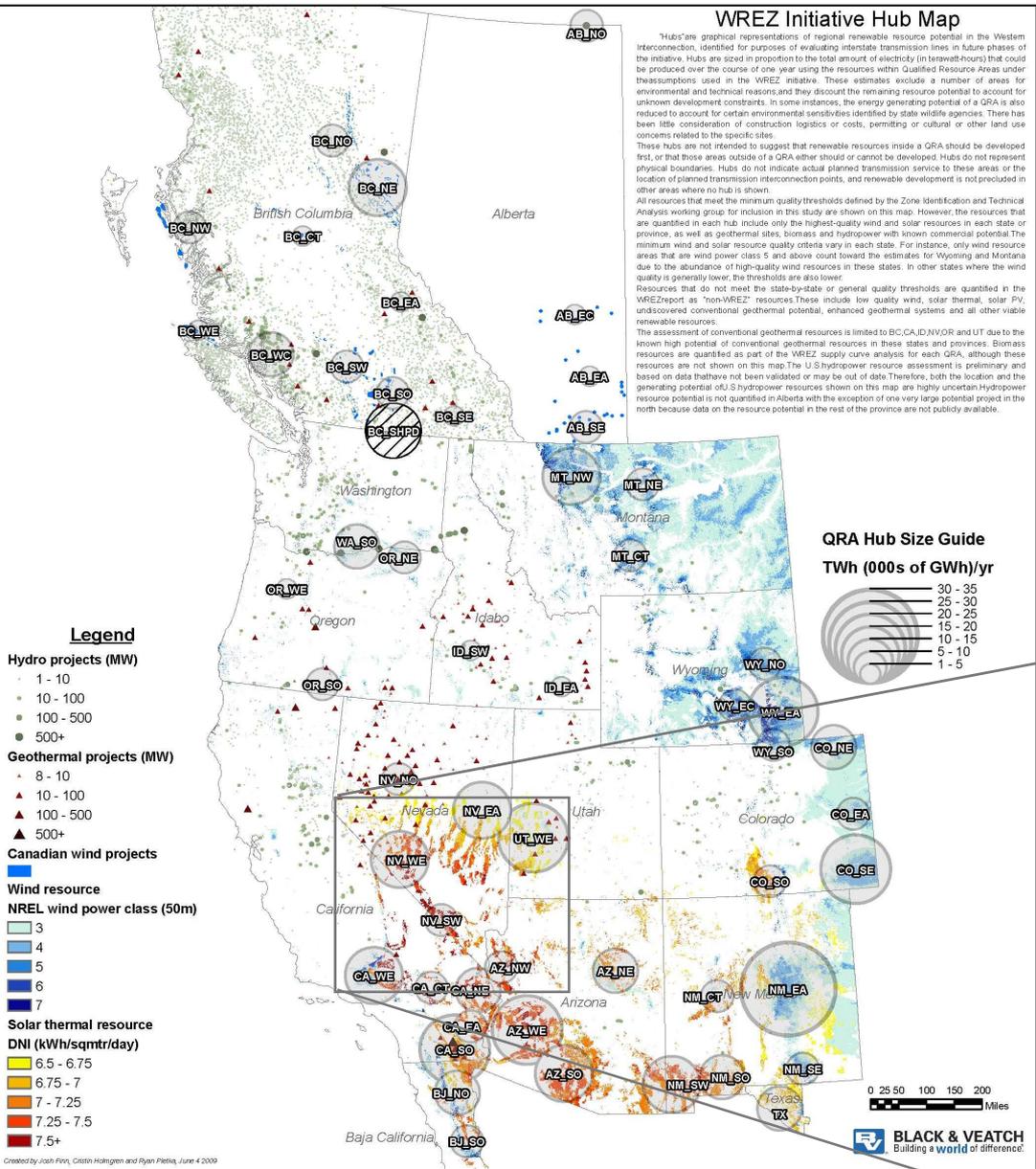
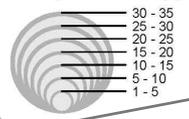
All resources that meet the minimum quality thresholds defined by the Zone Identification and Technical Analysis working group for inclusion in this study are shown on this map. However, the resources that are quantified in each hub include only the highest-quality wind and solar resources in each state or province, as well as geothermal sites, biomass and hydropower with known commercial potential. The minimum wind and solar resource quality criteria vary in each state. For instance, only wind resource areas that are wind power class 5 and above count toward the estimates for Wyoming and Montana due to the abundance of high-quality wind resources in these states. In other states where the wind quality is generally lower, the thresholds are also lower.

Resources that do not meet the state-by-state or general quality thresholds are quantified in the WREZ report as "non-WREZ" resources. These include low quality wind, solar thermal, solar PV, undiscovered conventional geothermal potential, enhanced geothermal systems and all other viable renewable resources.

The assessment of conventional geothermal resources is limited to BC, CA, ID, NV, OR and UT due to the known high potential of conventional geothermal resources in these states and provinces. Biomass resources are quantified as part of the WREZ supply curve analysis for each QRA, although these resources are not shown on this map. The U.S. hydropower resource assessment is preliminary and based on data that have not been validated or may be out of date. Therefore, both the location and the generating potential of U.S. hydropower resources shown on this map are highly uncertain. Hydropower resource potential is not quantified in Alberta with the exception of one very large potential project in the north because data on the resource potential in the rest of the province are not publicly available.

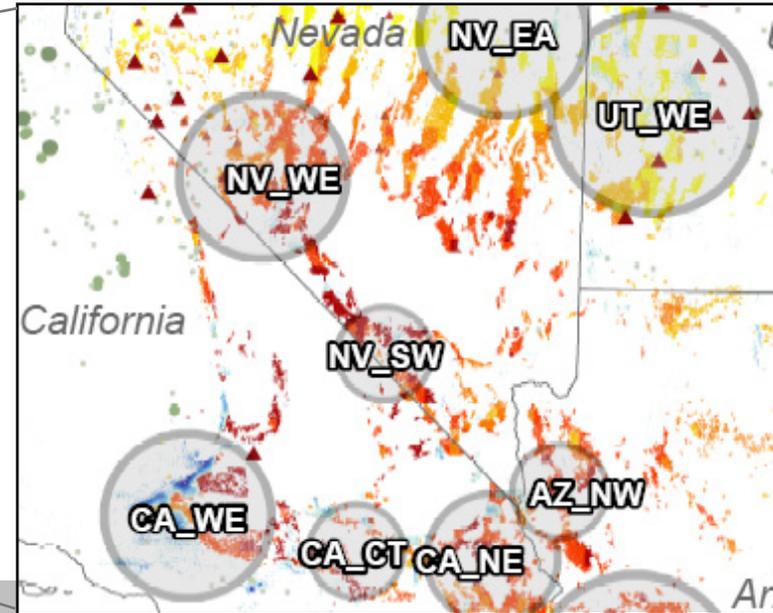
QRA Hub Size Guide

TWh (000s of GWh)/yr

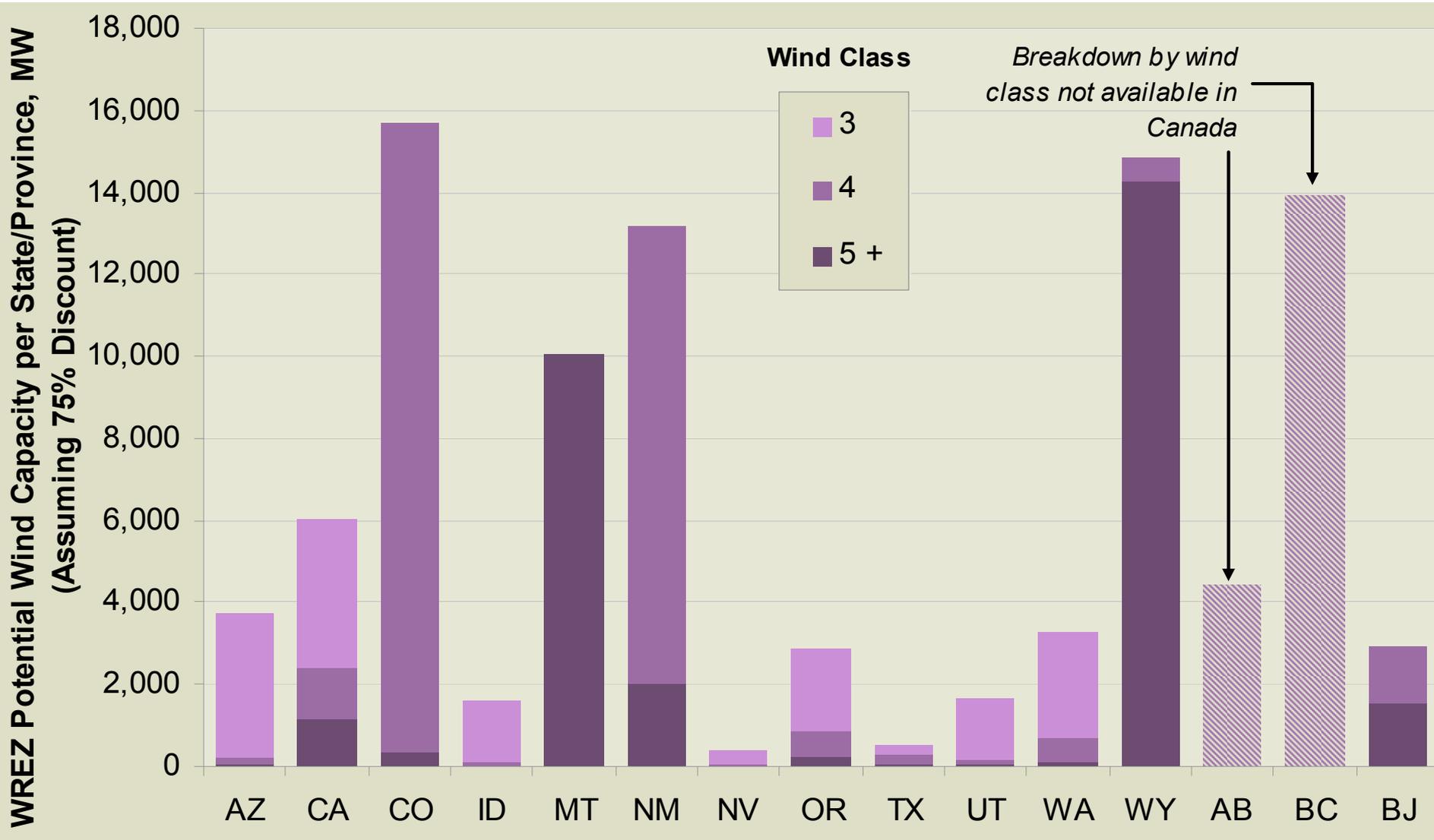


WREZ Resource Assessment

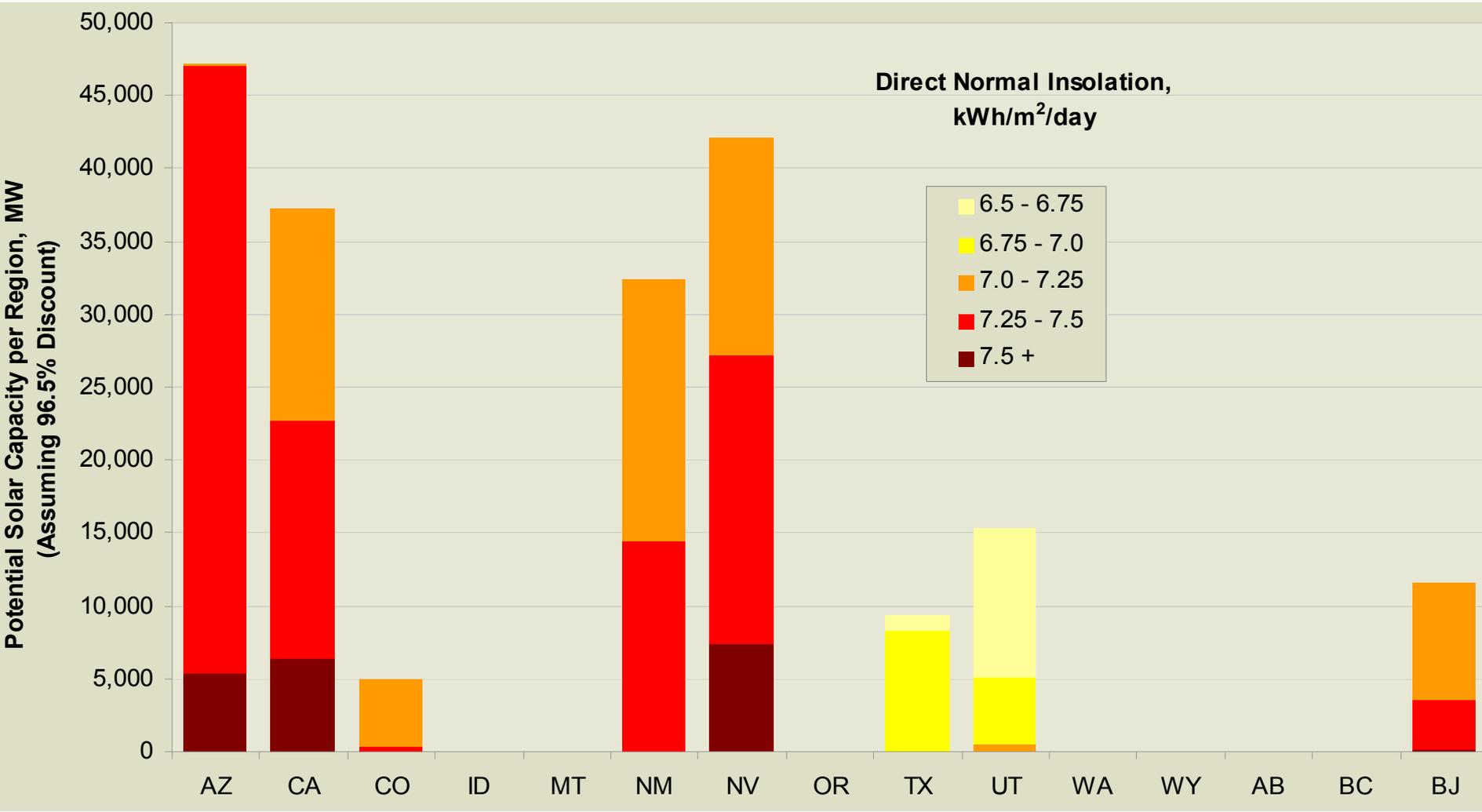
- Estimates resource potential at a particular price point in each "hub"



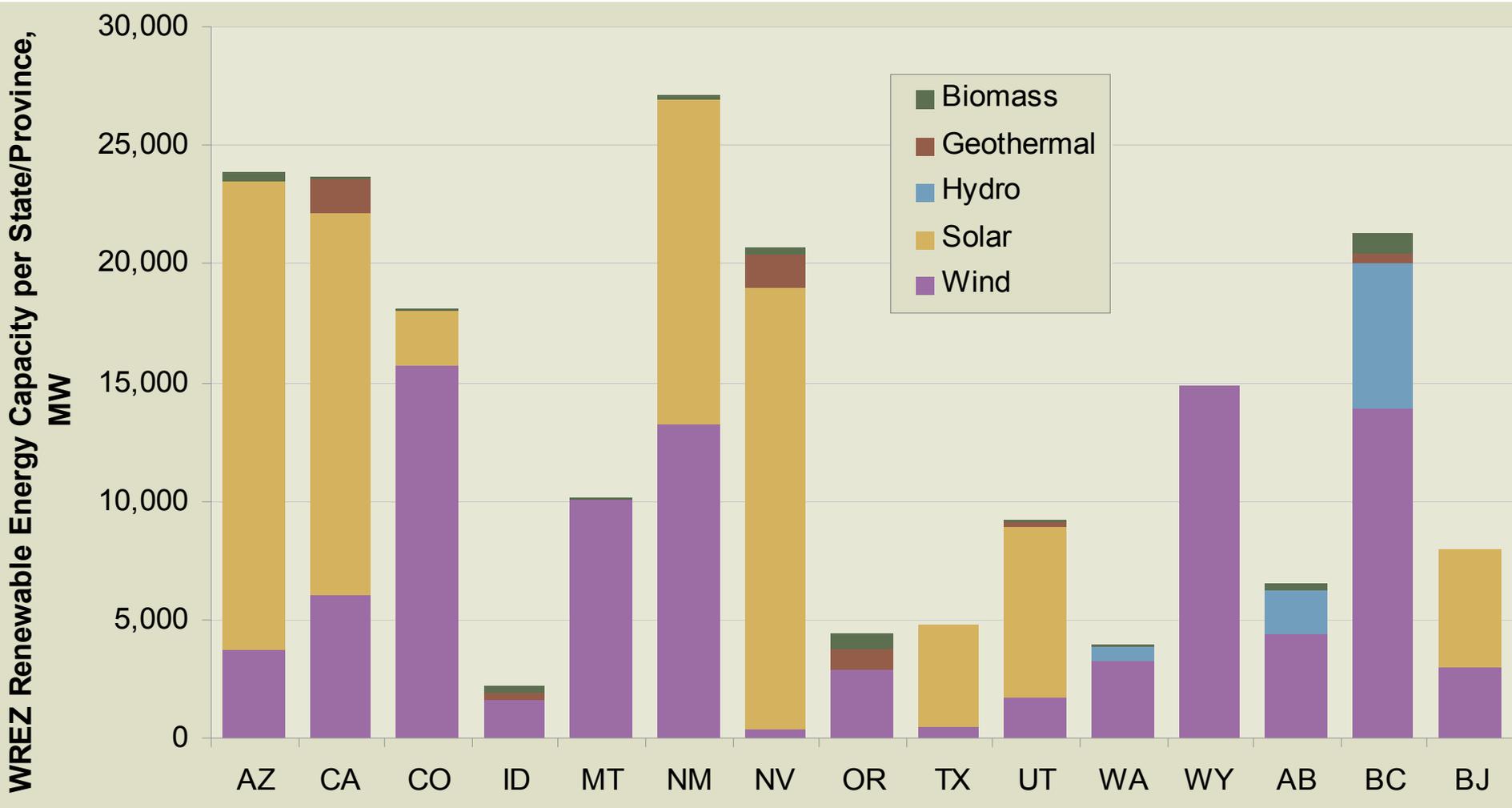
Wind Resources in Hubs (MW)



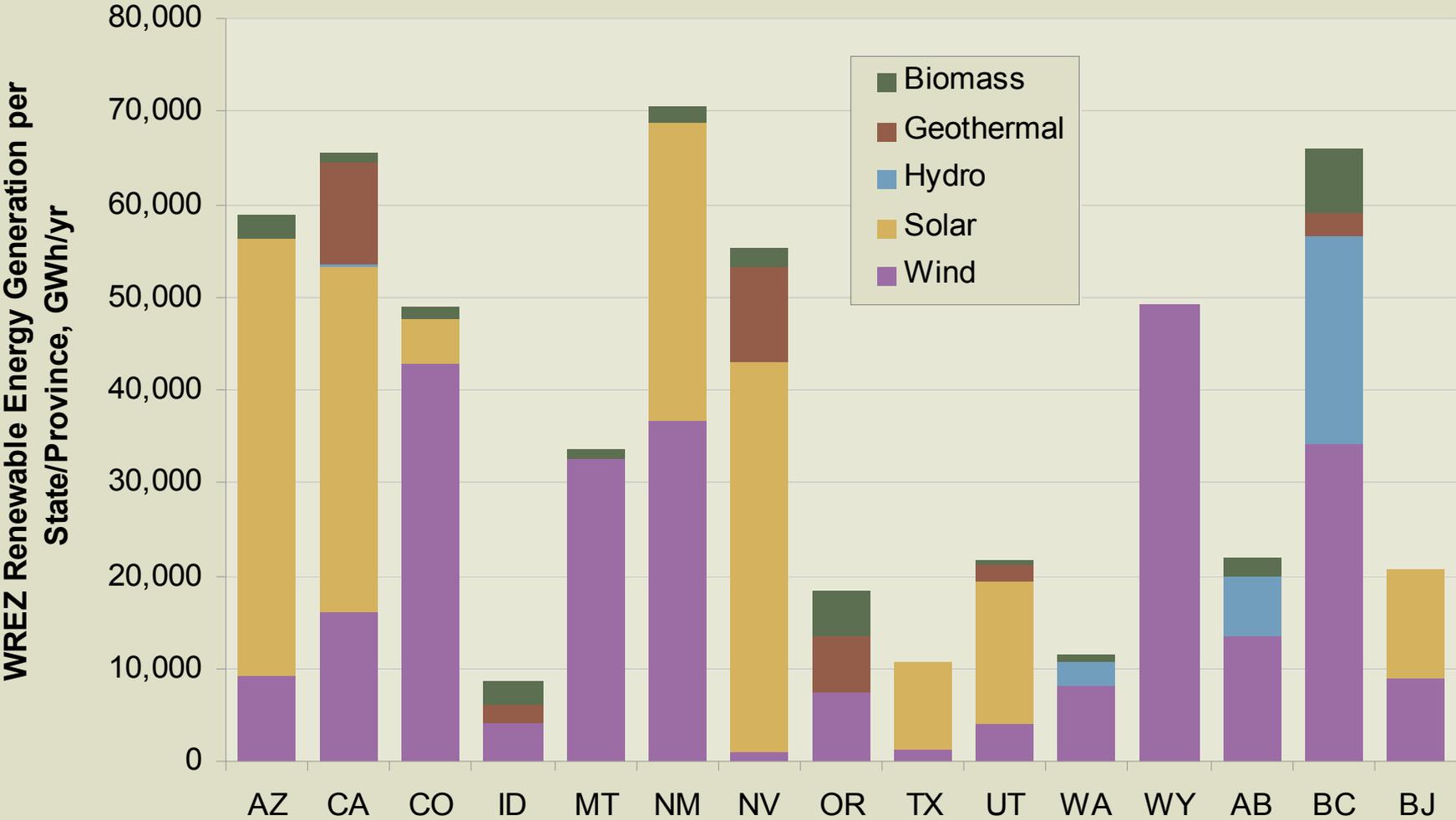
Solar Resources in Hubs (MW)



MW – All Resources (within hubs)



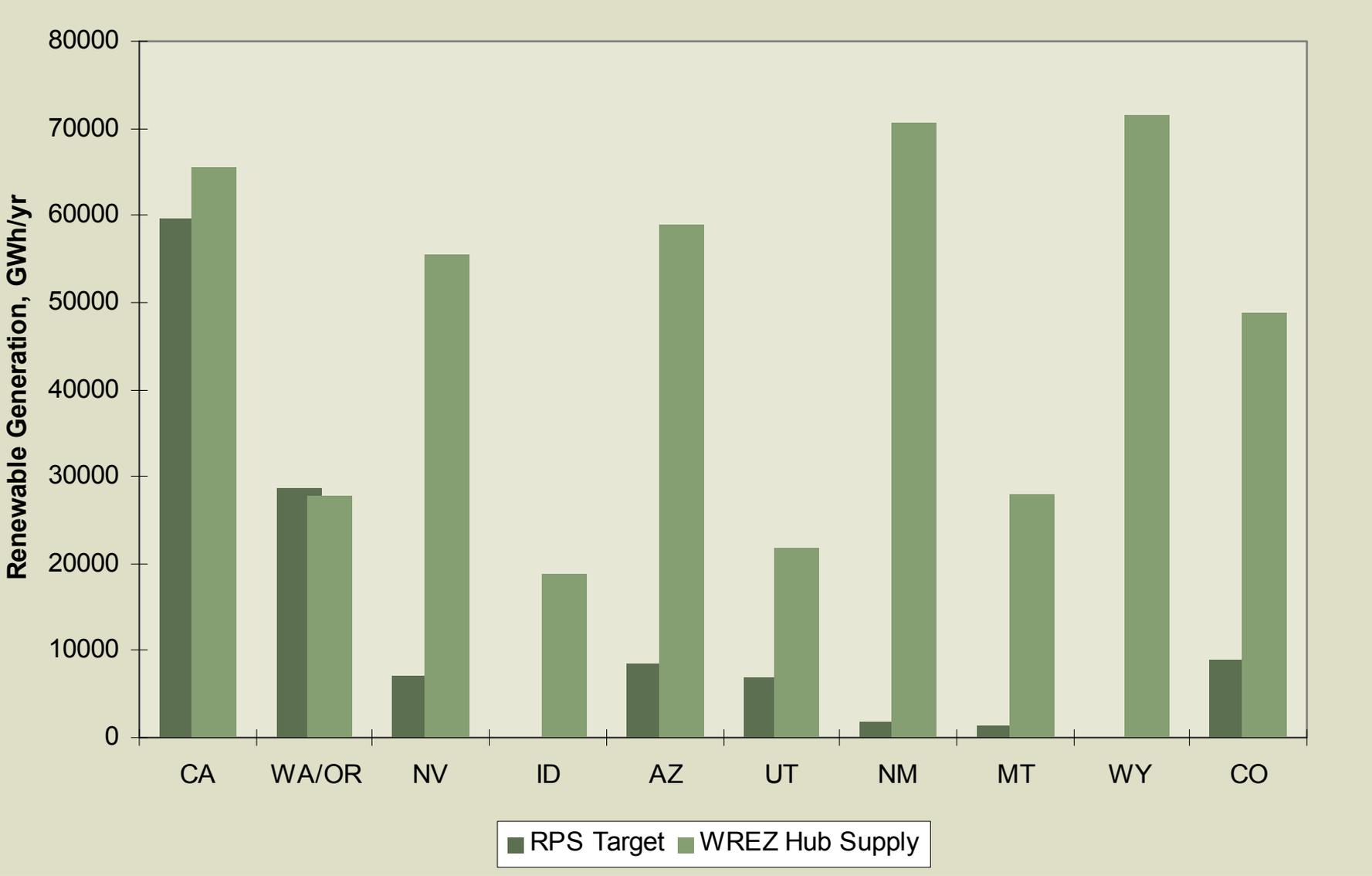
GWh/yr – All Resources (within hubs)



WREZ Resource Assessment Conclusions for RETI

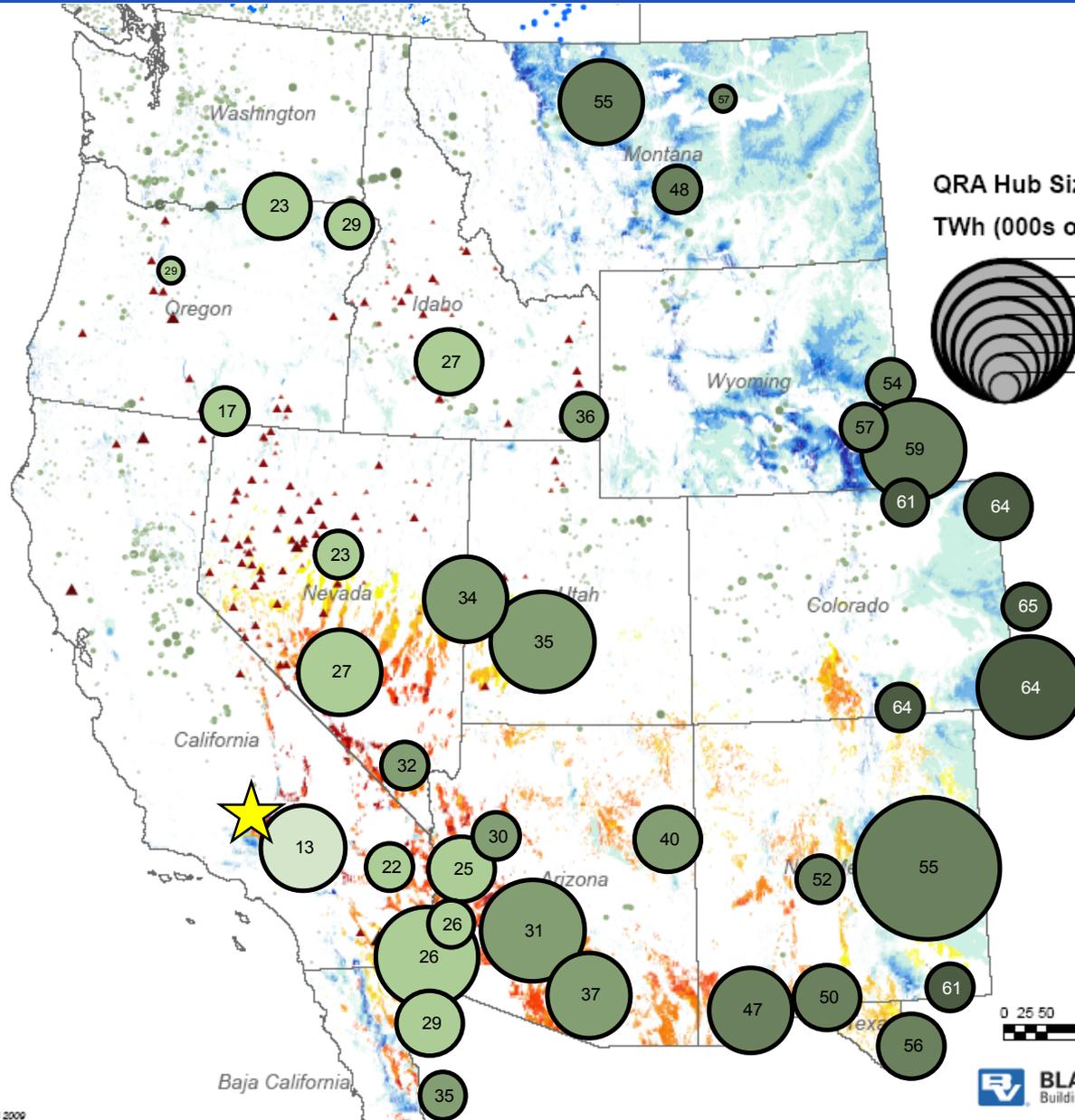
- There is significantly more developable renewable energy across the WECC than there is RPS demand
- Throughout the WECC there is a large amount of high quality developable renewable energy resources
- WREZ has quantified and estimated the cost of these resources

Comparison of WREZ resources and RPS Targets



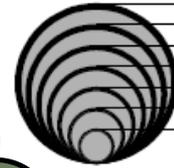
WREZ Trans- mission Costs (\$/MWh) from QRAs to California

- Legend**
- Hydro projects (MW)**
 - 1 - 10
 - 10 - 100
 - 100 - 500
 - 500+
 - Geothermal projects (MW)**
 - 8 - 10
 - 10 - 100
 - 100 - 500
 - 500+
 - Canadian wind projects**
 - Wind resource**
NREL wind power class (50m)
 - 3
 - 4
 - 5
 - 6
 - 7
 - Solar thermal resource**
DNI (kWh/sqmr/day)
 - 6.5 - 6.75
 - 6.75 - 7
 - 7 - 7.25
 - 7.25 - 7.5
 - 7.5+

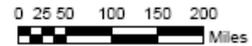


Transmission Cost, \$/MWh

QRA Hub Size
TWh (000s of



- 60+
- 45-60
- 30-45
- 15-30
- 0-15



Created by Josh Finn, Orstin Holmgren and Ryan Pietka, June 4 2009

RETI Out of State Analysis vs. WREZ

	RETI 1B Out of State Analysis	WGA WREZ Analysis
Geographic scope	OR, WA, parts of AZ, BJ, BC, NV	Entire WECC
Resource assessment	Pre-id'ed projects or high-level resource assessment (no resource locations)	Screening level assessment with general resource locations
Transmission access methodology	Piecemeal, assumes resources utilize existing OR planned infrastructure	Standardized, assumes all new lines
Transmission economics	Piecemeal, assessed by location or proposed line	Standardized, applies standard assumptions across the WECC

Putting WREZ to Work for RETI – Potential Options

- Consider substitution of WREZ OOS results for RETI in Oregon, Washington, Arizona, Nevada, and British Columbia
- Consider additional states in RETI using WREZ data set (e.g. include Wyoming and Montana)
- Evaluate possibility to merge some OOS resource areas into adjacent CA CREZs (e.g., southern NV into Mountain Pass)
- Update transmission costs for out of state resources

Baja Resource Assessment

- Conduct more detailed assessment of Baja wind to determine capacity
- Split wind resource to deliver at Imperial and ECO substations
- Develop transmission assumptions to interconnect to CA grid