

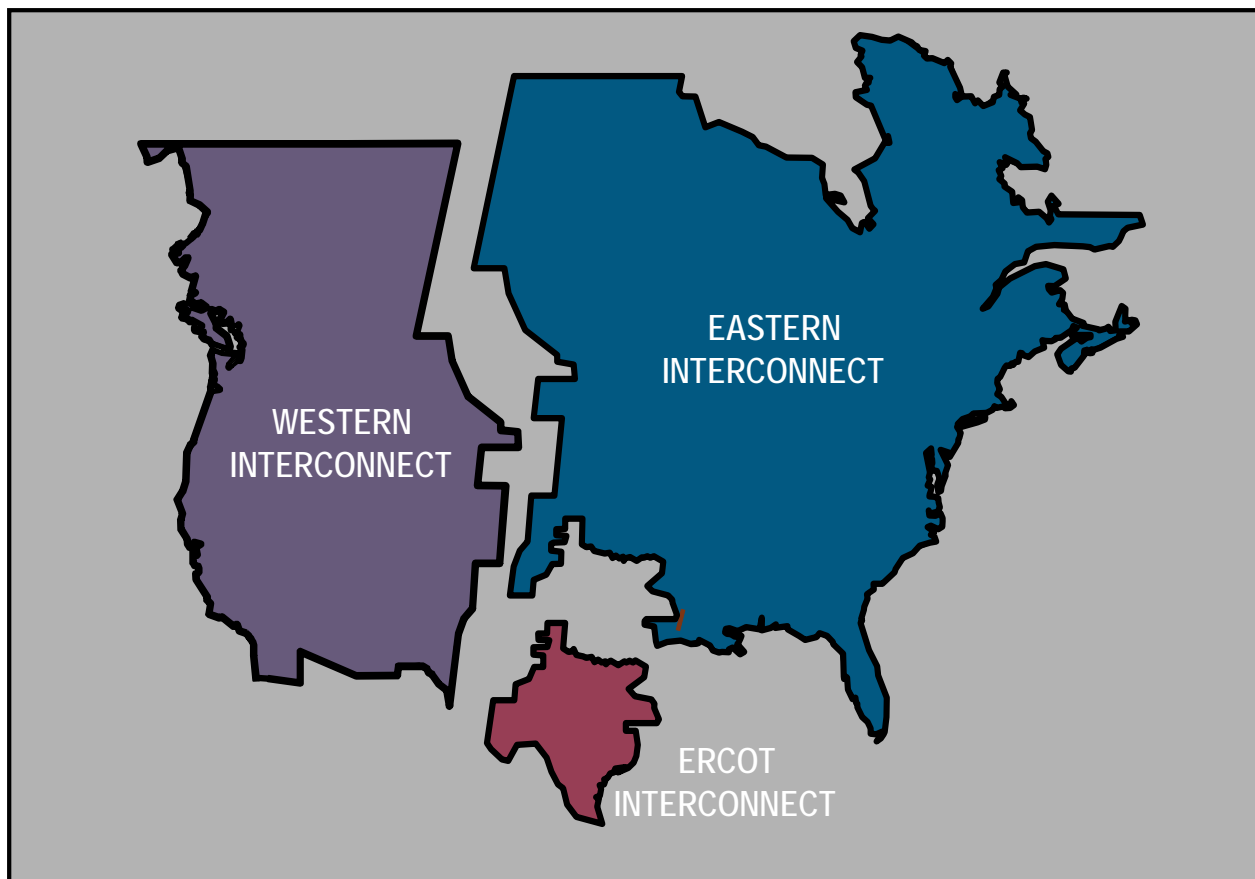


# Need for Renewables and Gas Fired Generation in WECC

*Wyoming Infrastructure Authority Board Meeting  
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Teton Mountain Lodge*

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## The Three Interconnects



## Overview: WECC Area Loads and Resources in 2010

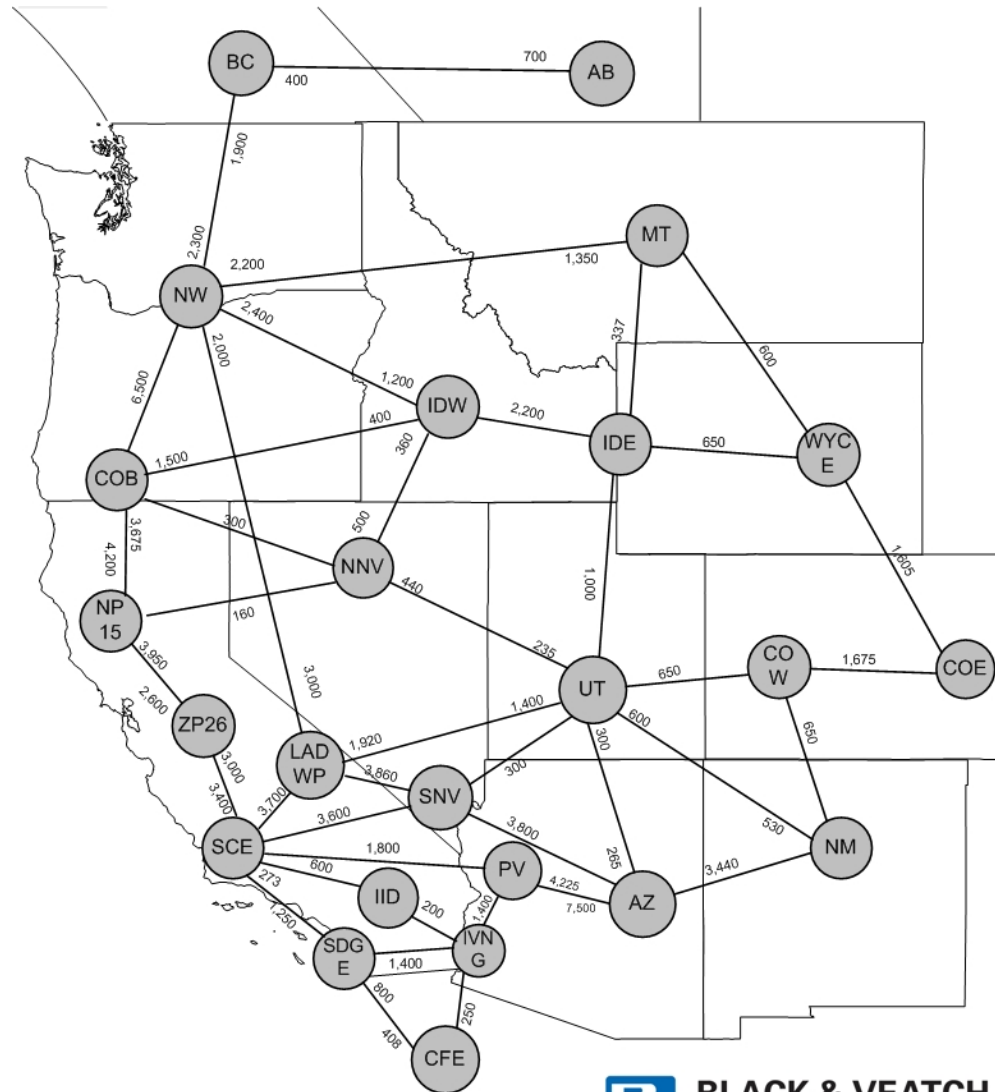
- Forecast Coincident Summer Peak = 158,375 MW
- Forecast Non-Coincident Summer Peak = 163,091 MW
- Forecast Winter Coincident Peak = 137,071 MW
- Forecast Coincident Minimum Load = 73,050 MW
- Forecast 2010 Ave Energy Load = 102,901 MW

Capacity (MW)	2010
Hydro RPS	2,407
Hydro	62,556
Biomass	1,452
Combined Cycle	47,781
CT Gas	16,399
CT Oil	962
Geothermal	3,442
Interruptible	2,667
Nuclear	9,552
Pumped Storage	4,516
Renewable (Nameplate)	18,610
Renewable (Dependable)	1,861
ST Coal	36,446
ST Gas	18,845
<b>Total WECC Capacity</b>	<b>208,886</b>
<b>Peak Load</b>	<b>163,091</b>
<b>Reserve Margin</b>	<b>28%</b>

Source: Black & Veatch

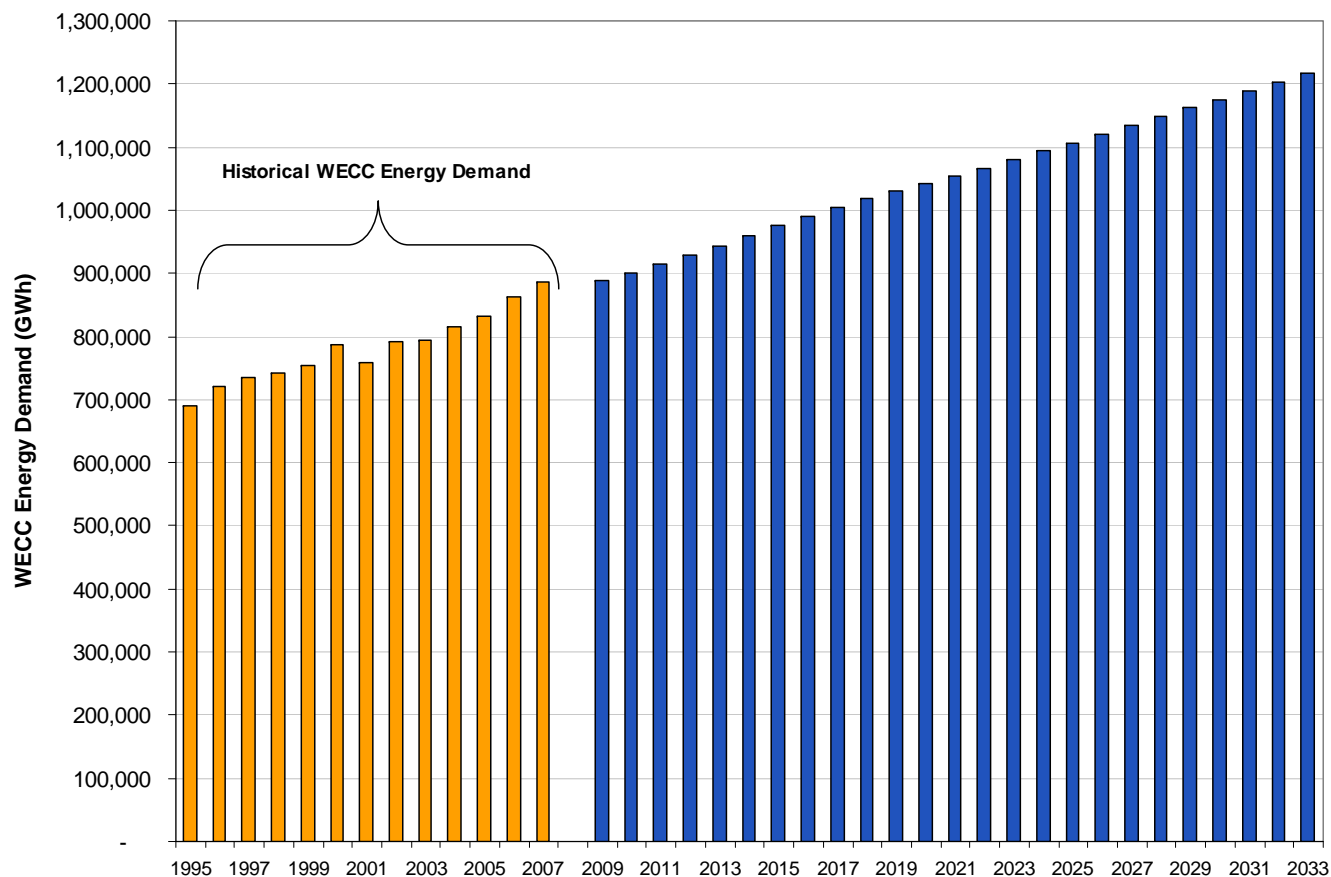


# Overview: Black & Veatch WECC Modeling Topology



## Load: WECC Historical Actual and Forecast Annual Energy Load

- Between 1995 and 2007 energy loads grew at an average of 2.1% per year
- The forecast from 2010-2033 is growing at 1.3% per year



Source: WECC and Black & Veatch

## Renewables: Expected 2009 and 2010 GWh U.S. WECC

- Only three states have RPS goals for 2009 (Colorado, Montana, Nevada)
- Total RPS goal for 2009 is 6,405 GWh
- In 2010 Arizona and California RPS goals begin
- Total RPS goal for 2010 is 59,514 GWh
- **California RPS goal for 2010 is 51,383 GWh...The bulk of WECC RPS goal!**
- In total, there is sufficient Renewable in 2010 to meet combined RPS goals in U.S. WECC states.
- There is not enough renewable in California in 2010 for it to meet its RPS goal.
- It is possible that California utilities will purchase excess renewable from others in WECC to meet its goal.

State	2009	2010
Arizona	218	353
California	36,982	38,103
Colorado	3,876	3,867
Montana	1,055	1,055
Nevada	3,107	3,668
New Mexico	1,164	1,431
Oregon	5,359	5,948
Utah	1,835	2,146
Washington	8,038	8,922
Idaho	3,206	3,211
Wyoming	1,692	2,965
<b>WECC total</b>	<b>66,532</b>	<b>71,668</b>
<b>aMW</b>	<b>7,595</b>	<b>8,181</b>

## RPS Targets by State (% of eligible billed sales)

- Some states such as Oregon and Washington have low RPS targets and have excess renewables
- Deliverability requirements eliminate the ability of many renewables outside of California to count towards the California RPS requirement

RPS %	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
California		20%	20%	20%	20%	23%	23%	26%	26%	30%	30%	33%	33%	33%	33%	33%	33%
Colorado	5%	5%	10%	10%	10%	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%
Montana	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Nevada	12%	12%	15%	15%	18%	18%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
New Mexico			10%	10%	10%	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%
Oregon			5%	5%	5%	5%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	25%
Washington				3%	3%	3%	3%	9%	9%	9%	9%	15%	15%	15%	15%	15%	15%

Source: Black & Veatch

## Renewables: How much more is needed to meet RPS goals?

- As state loads grow and RPS targets increase, there will be a need for additional amounts of renewables
- The table below shows the amount of additional renewable energy needed to meet state RPS goals, relative to the existing base of renewable energy generation plus that amount under construction and planned for completion by 2010. This provides an indication of the additional amount of renewable energy needed to meet state goals.
- This chart assumes that California's goal is 20% 2010-2013; 23% 2014-2015; 26% 2016-2017; 30% 2018-2019; 33% 2020 and beyond

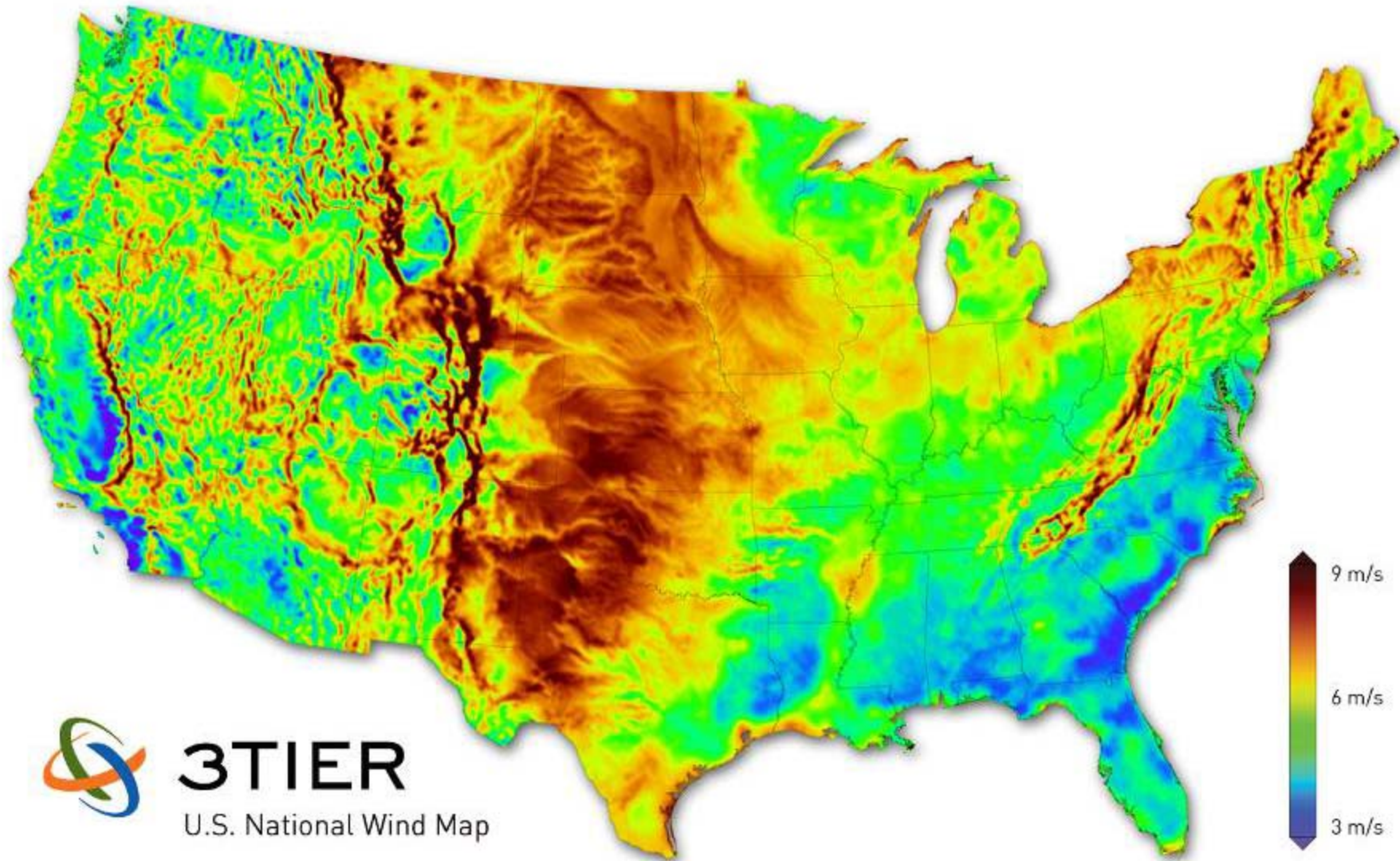
**Additional Renewable Energy Needed to Meet RPS Goal (GWh)**  
 (Relative to 2010 assets. Positive value indicates a short fall, negative value is a surplus.)

State	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arizona	(218)	920	1,193	1,478	1,789	2,126	2,471	3,133	3,824	4,472	5,168	5,888
California	(36,982)	13,281	13,797	14,474	15,027	23,591	24,191	32,969	33,593	45,395	45,957	54,985
Colorado	(1,480)	(1,504)	958	859	925	977	3,507	3,623	3,728	3,864	3,941	6,648
Montana	(631)	(199)	(199)	(203)	(204)	(200)	229	236	236	238	240	242
Nevada	478	(30)	981	1,121	2,192	2,282	3,075	3,228	3,345	3,470	3,562	3,656
New Mexico	(1,164)	(1,431)	785	840	894	948	2,204	2,273	2,340	2,410	2,467	3,845
Oregon	(5,359)	(5,948)	(3,090)	(3,090)	(3,065)	(3,022)	2,936	3,070	3,169	3,271	3,348	6,551
Utah	(1,835)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)	(2,146)
Washington	(8,038)	(8,922)	(8,922)	(6,510)	(6,496)	(6,471)	(6,454)	(1,432)	(1,392)	(1,324)	(1,281)	3,886
Idaho	(3,206)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)	(3,211)
Wyoming	(1,692)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)	(2,965)
<b>WECC total</b>	<b>-60,127</b>	<b>-12,154</b>	<b>-2,819</b>	<b>648</b>	<b>2,742</b>	<b>11,908</b>	<b>23,839</b>	<b>38,779</b>	<b>40,522</b>	<b>53,475</b>	<b>55,082</b>	<b>77,380</b>

## Primary Renewable Technologies

- Wind
- Solar

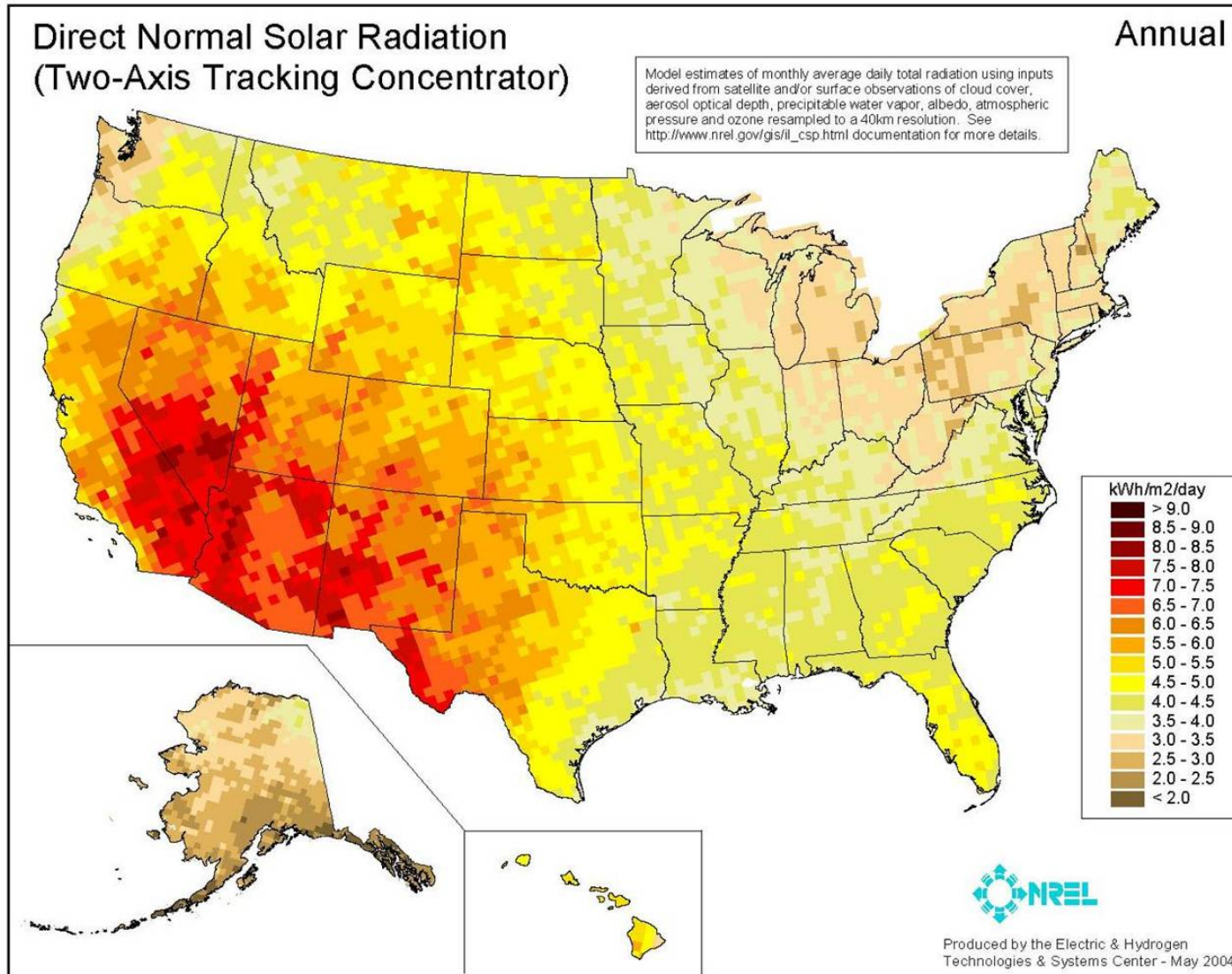
# U.S. Wind Resource



**3TIER**

U.S. National Wind Map

# Direct Normal Insolation (Used by Concentrating Solar Systems)



# Central Station Solar Photovoltaic Assumptions

(Large Systems: 20 MW +)

- **Single-Axis Tracking Crystalline**

<b>Performance</b>	<b>Current</b>
Capacity Factor (percent)	23 to 30
Degradation	0.75%/year
<b>Economics (2010\$)</b>	
Total Project Cost (\$/kWe)	4,000 to 5,000
Consolidated O&M (\$/MWh)	20 to 27

- **Fixed-tilt Thin Film**

<b>Performance</b>	<b>Current</b>
Capacity Factor (percent)	20 to 27
Degradation	1%/year
<b>Economics (2010\$)</b>	
Total Project Cost (\$/kWe)	3,600 to 4,000
Consolidated O&M (\$/MWh)	17 to 25

## Your Central Station Solar Competition

- \$150/MWh (approximate)
  - Assumes 27% CF
  - Assumes 30% ITC
- Generates its energy during the day, including most peak hours
- Located closer to load, therefore needing less transmission

## Challenge to Developers of Rocky Mountain Wind

- Demonstrate that delivered cost of wind is less than delivered cost of solar
  - Taking into account difference in transmission needs
  - Taking into account difference in daily shapes of wind vs. solar
- Convince utilities that the transmission needed to deliver the wind will be built and in a timely fashion

## Gas Fired Generation Needs in the Future in WECC

- Significant new generation will be needed in WECC in the next 25 years
- Much of that new generation will likely be gas fired
- Quick start gas units will be needed to integrated wind and solar
- Pros and Cons for locating gas fired generation in the Rockies
  - Pros...lower cost gas, gas near production, may be easier to permit
  - Cons...Higher elevation causing lower heat rate and output, transmission losses to load.

## Other Resource Changes in the Forecast

- Total Renewables (including BC and Alberta) grows by 40,000 MW over the period
  - Counts 4,000 MW toward RA
- 17,000 MW of retirements of Steamers
- Added a mixture of gas CC, Frame GTs and Aero GTs to provide some base load and flexibilities to deal with large amounts of wind
- Can't fill in the balance of all need with gas fired generation because of the large demand this would put on gas markets if this is done across North America
- With the understanding that WECC is rich in coal supplies, assumed that IGCC with 90% CO2 capture and sequestration would be developed beyond 2020. If this does not pan out, this niche may be filled by nuclear generation.

Capacity (MW)	2010	2033	Delta
Hydro RPS	2,407	2,407	0
Hydro	62,556	63,240	684
Biomass	1,452	1,452	0
Combined Cycle	47,781	49,504	1,724
CT Gas	16,399	16,690	291
CT Oil	962	736	-226
GenAero GT		20,400	20,400
GenCC		23,000	23,000
GenGeothermal		2,359	2,359
GenGT		28,650	28,650
GenIGCC		14,850	14,850
Geothermal	3,442	3,442	0
Interruptible	2,667	3,194	527
Nuclear	9,552	9,552	0
Pumped Storage	4,516	4,636	120
Renewable (Nameplate)	18,610	57,368	38,758
Renewable (Dependable)	1,861	5,737	3,876
ST Coal	36,446	36,211	-235
ST Gas	18,845	1,260	-17,585
<b>Total WECC Capacity</b>	<b>208,886</b>	<b>287,321</b>	<b>78,435</b>
<b>Peak Load</b>	<b>163,091</b>	<b>227,629</b>	<b>64,538</b>
<b>Reserve Margin</b>	<b>28%</b>	<b>26%</b>	

Source: Black & Veatch

## Going Forward

- You have Opportunities and Challenges
- Who could ask for more?