28 February 2012

Mr. Stuart Drown
Executive Director
Little Hoover Commission
925 L Street, Suite 805
Sacramento, CA 95814

Re: Testimony on Analysis and Cost Comparison of Renewable Power in California

Dear Mr. Drown:

Thank you for the opportunity to present to the Little Hoover Commission (the Commission) on the costs of alternative sources of renewable power that are available to serve California. I appreciate the opportunity to present on a topic which is so important to the economic future of California, its power markets, and the renewable power industry.

FTI Consulting is a global business advisory firm with 3,800 professionals worldwide who provide multidisciplinary solutions to complex challenges and opportunities. Our motto, "Critical Thinking at the Critical Time" is particularly apt given the issues the Commission is examining today.

I am a managing director and co-founder of FTI's Electricity Consulting Group where I lead the industry analytics capabilities for the power sector. That said, I am not representing any position held by FTI or testifying on behalf of any clients. The views expressed herein are those of the author and not necessarily the views of FTI Consulting, Inc. or its other professionals. My testimony today is a reflection of my own opinions and expertise garnered from my role as an energy consultant, nearly 20 years of experience in assessing the economics of the power sector, and my analysis of the costs of renewable resources available to California.

I look forward to assisting the Commission think through the opportunities and challenges facing California as it implements its energy and environmental policy.

Sincerely,

Tanya Bodell

Tanya Bodell
Managing Director, FTI Consulting

cc: Members of the Little Hoover Commission

Analysis and Cost Comparison of Renewable Power in California

by

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28 February 2012

Testimony to the Little Hoover Commission
Sacramento, CA

1. Introduction

I am a Managing Director of FTI Consulting ("FTI") and co-founder of FTI's Electricity Consulting Group. For nearly 20 years, I have provided economic and business advice to assist clients in their investment and asset management decisions. I advise clients on business strategy and investment decisions, primarily in the electricity sector. My assignments include advising on mergers and acquisitions, restructuring, divestiture decisions, regulatory strategy, market assessments, and asset valuation, including merchant generation, regulated assets and contractual assets such as power purchase and sales agreements. I write a r

Within the Electricity Consulting Group, I am the business leader of Industry Analytics, responsible for developing and maintaining our power market models and overseeing the analyses of industry data to enable clients to make informed decisions. We maintain and operate locational marginal pricing models for the Western Electricity Coordinating Council, of which California is a member, the Eastern Interconnect, and ERCOT. We use these detailed electricity industry models to

answer questions concerning investment decisions, projected power prices, transmission project benefits, economic retirements, regulatory impacts, market power concerns and asset valuation. Each model includes nearly all operating and planned generating units and transmission lines. Our WECC model also has a representation of hydroelectric generation for each of the seventy water conditions in the Pacific Northwest. We make extensive use of industry data for these models in order to understand key industry issues. Exhibits with additional detail in support of my conclusions are attached at the end of this report.

2. Overview

The opinions I intend to discuss today are as follows:

- Superior renewable resources are plentiful outside of California in states that are electrically connected with the high voltage transmission grid that services California.
- Long distance resources with more efficient production cost structures can off-set higher transmission costs required to deliver such power to market, resulting in lower cost renewable resources than in-state alternatives.
- California's Renewable Portfolio Standard (RPS) legislation limits the share of renewable resources that can come from out-of-state, potentially resulting in California-based renewable resources composing 75 percent to 90 percent of the total renewable portfolio.
- A recent ruling by the Administrative Law Judge concerning definitions required to interpret and implement the RPS requirements advances the discussion, but does not provide sufficient clarity on what is required for out-of-state resources to become RPS-eligible.
- Limiting imports of renewable resources will cost California ratepayers in two ways:
    1) Utilities and load-serving entities subject to the RPS will not have the ability to access potentially more cost-effective resources.
    2) Limitations on potential imports limits the flexibility required to integrate a diverse portfolio of renewable resources.
- Limiting the imports of more cost-effective renewable resources could result in additional costs in excess of hundreds of million of dollars per year, costing ratepayers billions of dollars over the life of the RPS program.

3. Location of Renewable Resources

For nearly all land-based renewable resources, superior locations exist outside of California. These alternative locations offer the following:

- Higher capacity factors due to better renewable resource availability and intensity
- Lower construction costs due to regional economic conditions
- More expansive land area for purposes of siting large, utility-scale renewable resources

Although new transmission lines may be required to bring those renewable resources to market, the additional cost of transmitting power over longer distances are offset by the cost-effectiveness of the superior renewable resource options.

Exhibits 1 through 5 provide the standard renewable resource maps generated by the National Renewable Energy Laboratory (NREL) for wind, photovoltaic solar, concentrated thermal solar and geothermal energy. As can be seen by these maps superior renewable resources are plentiful outside of California in states that are electrically connected with California's high voltage transmission grid.

4. California's RPS Requirements

Demand for renewable resources is largely driven by the federal and state policy preferences for renewable energy. State-administered RPS programs, found in 29 states, including California, mandate that retail providers of electricity satisfy a certain percentage of their load with qualified renewable resources.

Under SB2X, California electric utilities must increase their retail sales from approved renewable resources to meet the following minimum requirements:

- 20% of retail sales by 2013
- 25% of retail sales by 2016
- 33% of retail sales by 2020

When signing the California bill, Governor Brown expressed a desire for a program requiring 40% of retail sales to be met by renewable resources.

California's RPS program includes special carve-outs for renewable resources that have certain characteristics. As indicated in Exhibit 6, there are three "buckets" or means by which a renewable project may become RPS-eligible. Bucket 1 must be at least 75 percent of the total RPS requirement; Bucket 2 and 3 can total no more than 25 percent of the total RPS requirement; and Bucket 3 can be no more than 10 percent of the total requirement.

4. 1 Bucket 1

The legislative wording was sufficiently unclear that an Administrative Law Judge was appointed to clarify California's RPS eligibility requirements. On December 15, 2011, the ruling clarified legislative wording required to delineate what renewable resources would be RPS-eligible for Bucket 1. Although imports into California may be RPS-eligible under Bucket 1, such eligibility is constrained as follows:[1]

- **Import Schedule.** Energy scheduled into California may include a transmission schedule from an RPS-eligible generator into a California balancing authority on an hourly or intra-hourly basis, allowing for electricity generated outside the metered boundaries of a California balancing authority to be eligible for Bucket 1.
- **Substituting Electricity from Another Source.** The import schedule must be from the RPS-eligible generator and does not allow other energy from renewable or otherwise to be used in place of the RPS-eligible generator's output to meet the schedule.
- **Dynamic Transfer.** An RPS-eligible generation facility providing the electricity must have "an agreement to dynamically transfer electricity to a California balancing authority".
    - A dynamic transfer arrangement is made between balancing authorities, not the generator and the buyer.
    - The term "dynamic transfer" refers to a range of methods by which a balancing authority receiving electricity generated in another balancing authority area may provide some or all of the functions and services typically provided by the balancing authority in which the generation facility is interconnected.
    - Renewable generation claiming RPS-compliance under Bucket 1 must be covered by an agreement executed by a California balancing authority, before the electricity is generated, to dynamically transfer electricity from the external RPS-eligible generator into the California balancing area during the time period in which the RPS-eligible electricity is generated.

Because the techniques and protocols for dynamic transfer are evolving, the ruling deferred to those arrangements accepted by a California balancing authority providing for dynamic transfer, stopping

[1] Before the Public Utilities Commission of the State of California, Order Instituting Rulemaking to Continue Implementation and Administration of California Renewables Portfolio Standard Program. Rulemaking 11-05-005 (Filed May 5, 2011), Decision Implementing Portfolio Content Categories for the Renewables Portfolio Standard Program, Decision 11-12-052, December 15, 2011, http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/156060.pdf

short of explicitly clarifying what Dynamic Transfer really means for purposes of imports of renewable energy into California for purposes of meeting the Bucket 1 criteria.

4. 2 Bucket 2

In addition, the ruling addressed the requirements for Bucket 2. Recognizing that the legislation provided a stricter definition of deliverability for purposes of imports that could be RPS-eligible under Bucket 2, the definitions still create ongoing challenges for an external renewable resource to meet the criteria for Bucket 2 that are not similarly imposed on in-state renewables, including the following:

- **Firming Resources.** Required to find cost-effective firming resources.
- **Shaping Resources.** Required to find cost-effective shaping resources.
- **Incremental Resources.** Limitations on the entity from whom a renewable generator can purchase firm and shaping resources (i.e., the buyer is not allowed to sell the RPS-eligible resource such services).
- **Cross-border Transmission Capacity.** Need to schedule cross-border transfer capability for purposes of "scheduling into a California balancing authority".

The net result is that renewable resources outside of California will have to overcome more significant legislated challenges to meet the RPS-eligibility requirements than in-state resources.

4.3 Bucket 3

Whereas Buckets 1 and 2 require the energy and renewable energy credit to be bundled, Bucket 3 allows for the load-serving entity to meet its renewable resource obligations through simply purchase of the separate renewable energy credit. This requirement is much easier to fulfill with imports as it does not require "physical" delivery through scheduling into the California balancing authority's area. The portion of the renewable resource requirement that can be RPS-eligible under Bucket 3 is only 10 percent.

4. 4 Calculating the Unmet Need for Renewable Resources

The RPS program in California will create a need for renewable resources that currently is not met by existing or planned developments. I estimated the size of the Northern and Southern California markets for renewable power under each bucket using the methodology and inputs described in Exhibit 7.

The results of the analysis of the unmet need for renewable resources for Bucket 1 and for Bucket 1 and 2 are summarized in Exhibits 8 and 9. In general, Northern California appears to be further along than Southern California in meeting its renewable requirements. Given the proposed grandfathering of existing renewable resources and approved projects, Bucket 1and 2 requirements are likely to be met through 2015. Depending on the success rates of approved projects, the unmet need for renewable resources by 2020 ranges from 4,500 gigawatt-hours (GWh) to 13,500 GWh for Bucket 1 alone. Combining Bucket 1 and 2, the unmet need for renewable resources by 2020 is 18,000 GWh to 27,500 GWh.

5. Cost of Renewables

Renewable resources generally have low marginal costs of production combined with higher up-front capital costs. A conversion is required to translate capital costs incurred during development and construction into a levelized cost of electricity in dollars per megawatt-hour necessary to recover the capital investment over each hour of production. Exhibit 10 presents estimates of the levelized cost of energy from different technologies for 2016 as calculated by the US Department of Energy (DOE).

The DOE's estimates are an average across the country. As already mentioned, such costs can vary by region according to the availability of the renewable resources (i.e., capacity factors), site availability, construction costs, and transmission required to deliver those renewable to market. In order to understand the potential economic cost of limiting renewable imports into California, I estimated the region-specific costs for wind and solar, added an estimate of transmission cost to deliver to the designated markets of Northern California or Southern California, and then compared the delivered costs to the in-state costs. Exhibit 11describes the methodology I deployed.

Exhibit 12 presents the relative costs of renewable from alternative sources assuming the existing transmission is sufficient to deliver the power subject to payment of the regulated Open Access Transmission Tariff (OATT) for each transmission line between the source and the market. The analysis indicates that Southern California generally has more cost-effective renewable resources than Northern California. However, both are more costly than renewable resources delivered into California.

On average, Montana, Wyoming and New Mexico wind are much more cost-effective than the California counterparts by about $3/MWh. Montana wind is nearly $10/MWh less expensive than Northern California wind. Arizona solar is more cost-effective than Southern California solar, with

both Arizona and New Mexico more cost-effective than Northern California solar by around $10 / MWh to $30/MWh.

6. Cost of Limiting Renewable Imports

Combining the cost savings and the unmet need provides an estimate of the potential costs to California ratepayers of limiting cost-effective imports of renewable resources. Exhibit 13 is a matrix of incremental cost ($/MWh) and unmet need (GWh). Multiplying the two together provides the annual incremental cost.

At the extreme low end of the range, Bucket 2 is filled with imports and the remaining unmet need of Bucket 1 is exclusively in-state resources, requiring only 5,000 GWh per year (see Exhibit). Multiplied by a $5/MWh incremental cost, results in increased costs of $25 million per year. Over a 20 year period, the limitation on imports would aggregate to half a million dollars.

In reality, however, the unmet need is much greater and the potential incremental costs of in-state resources over external renewable resources is likely to be closer to $10 / MWh when superior sites and solar is taken into account. The estimated range of the incremental cost of limiting renewable resources to California resources under a 33 percent RPS requirement would be closer to $100 million to $300 million per year. Increasing the RPS requirement (and therefore the unmet need) without the corresponding relaxation of import requirements would more than triple costs to around $450 million to $700 million per year.

In addition to costing more, limiting imports of renewable resources will require additional costs to integrate a constrained portfolio of renewable resources. Furthermore, utilities will have less flexibility to keep costs below the threshold levels currently under consideration. These impacts are more difficult to quantify, but are real costs associated with limiting the option of accessing out-of-state renewable for purposes of meeting the RPS requirement in California.

In closing, the incremental costs of limiting renewable resources to in-state could cost ratepayers billions of dollars over the life of the RPS regulations.

EXHIBIT 1: Wind Locations with Capacity Factors above 30 Percent at 80-m Height

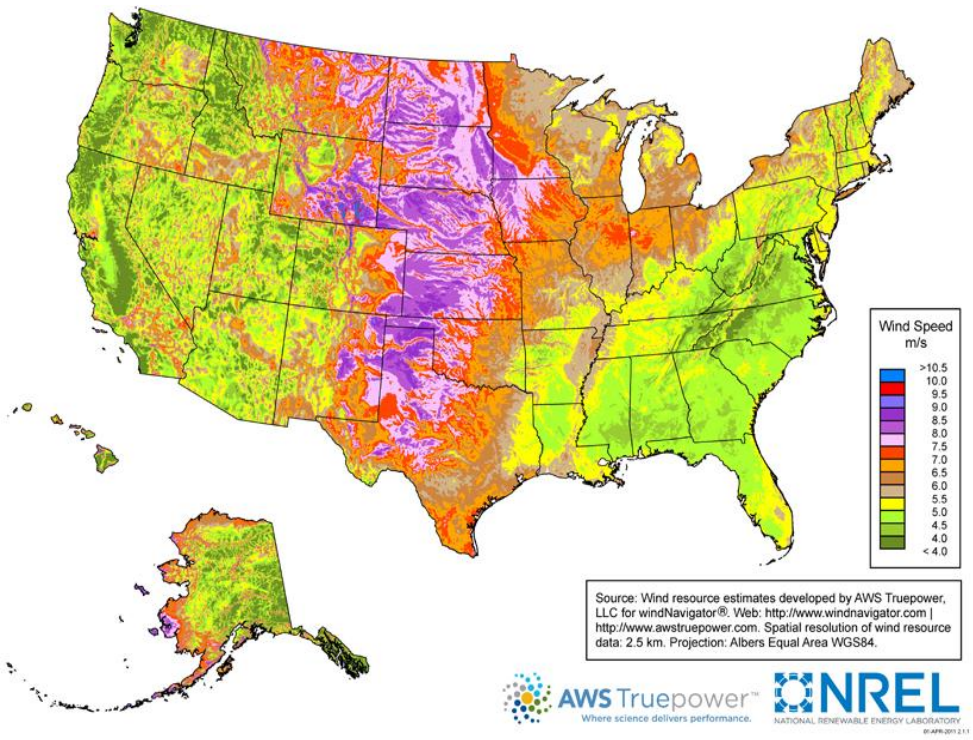
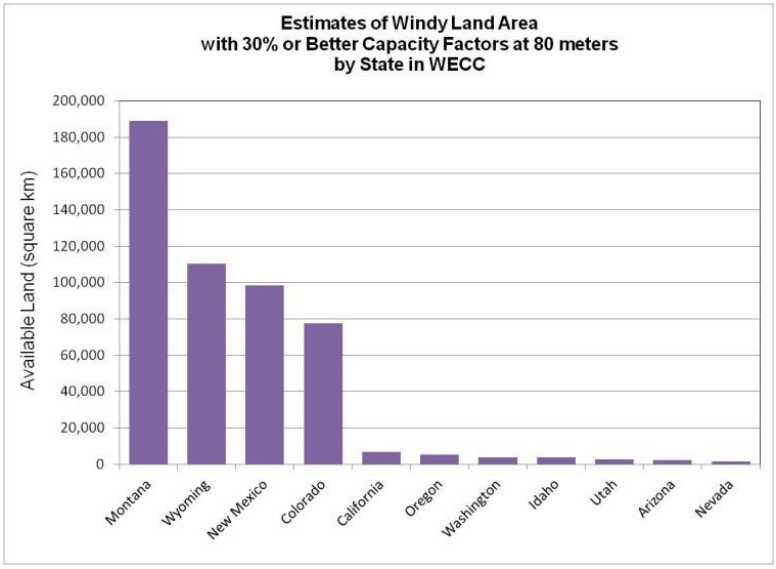


EXHIBIT 2: Estimates of Wind Land Areas by State in WECC



Source: FTI Analysis, DOE National Renewable Energy Laboratory (NREL)

EXHIBIT 3: Estimated Photovoltaic Solar Resources by State

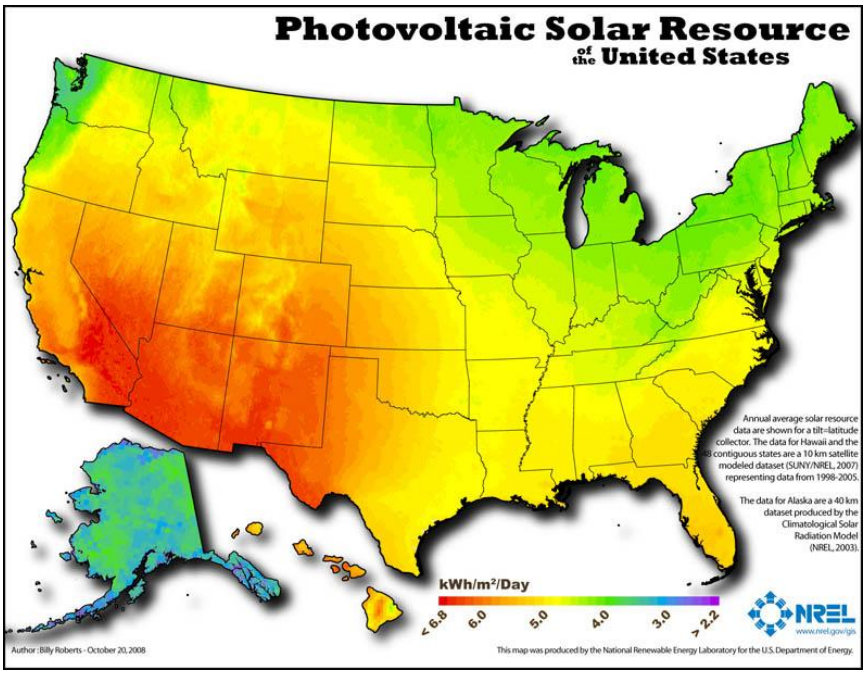
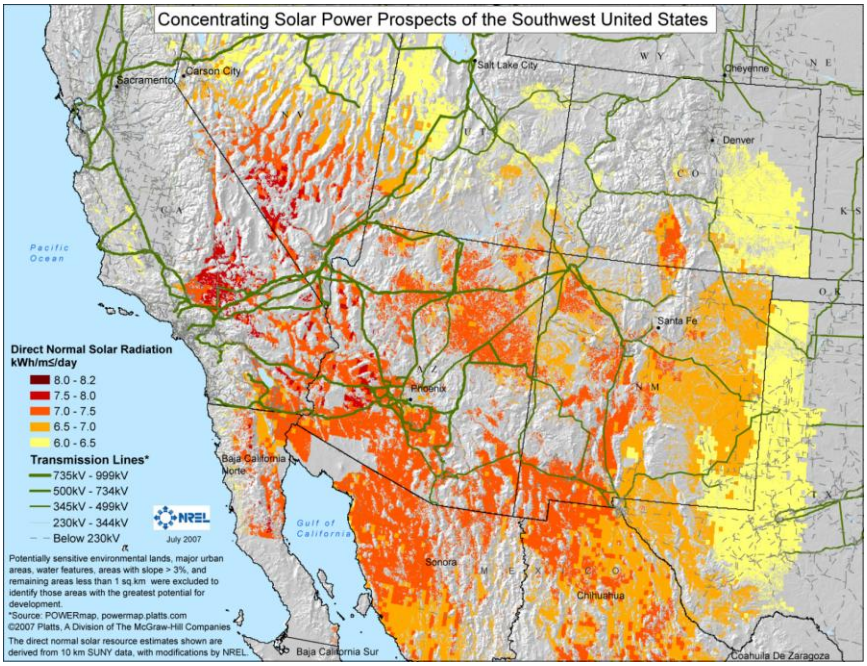
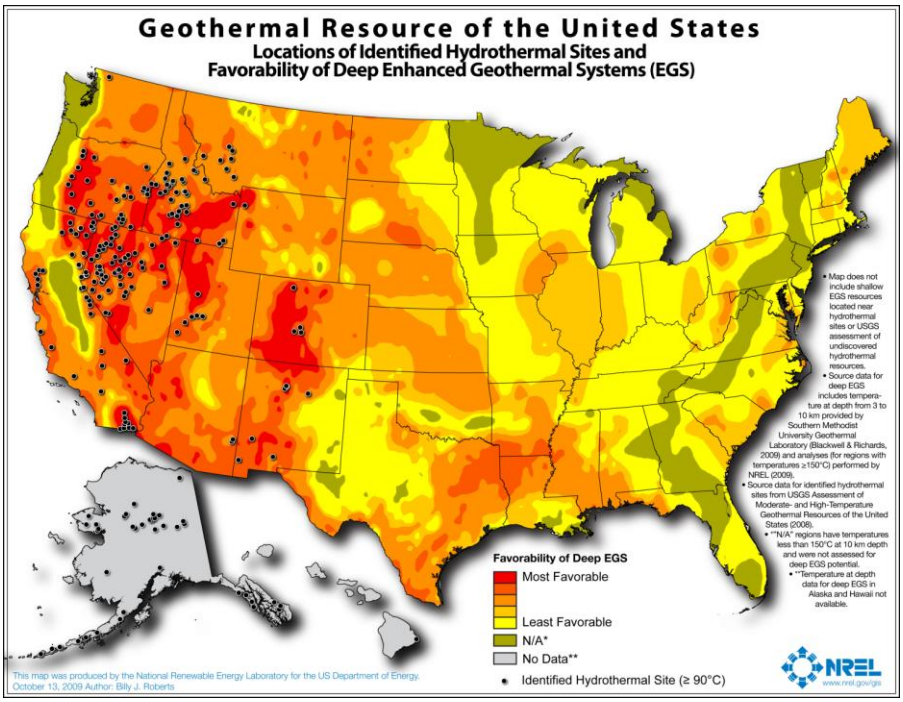


EXHIBIT 4: Estimated Concentrated Solar Power Prospects by State



Source: DOE National Renewable Energy Laboratory (NREL)

EXHIBIT 5: Estimated Geothermal Resources by State



Source: DOE National Renewable Energy Laboratory (NREL)

EXHIBIT6: Requirements for RPS-Eligible Resources

Bucket	Eligible Resources	Restrictions from 2017
#1	a) first point of interconnection with CA balancing authority or distribution system to serve CA end users b) energy scheduled into a CA balancing authority *without* substituting from another source c) energy deliverd to CA balancing authority under a dynamic transfer	>= 75% of total requirement
#2	a) firmed and shaped resources providing incremental electricity into a California balancing authority	Sum of #2 and #3 can never exceed 25%
#3	a) products not fitting buckets 1 or 2, including unbundled RECs that do not deliver energy into California	Can never exceed 10%

Source: California Energy Commission

EXHIBIT 7: Methodology and Inputs to Estimate Unmet RPS Need

Methodology:

1) **Project Future Load:** Project load for each of the major utilities and service areas
2) **Calculated Renewable Requirements:** Multiply projected load by the state RPS goal times the eligibility adjustment for each bucket
3) **Net Off Existing Renewable Resources:** Determine the level of existing renewable resources eligible for the requirement
4) **Net Off Approved Projects:** Adjusted the total approved projects by an assumed project success rate of 50 percent or 90 percent, and subtract off the net requirements

$$\textbf{Market Size} = (L \times R \times A) - ES - (AP \times S)$$

Where: L = Projected load R = State RPS goal A = Eligibility Adjustor
ES = Existing supply AP = Approved projects S = Approved project success rate

Inputs:

Bucket 1 Calculation

Target Market	L	R	A	ES	AP	S
Northern California	2020 load projection	33% of load	75% (Minimum Bucket 1 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%
Southern California	2020 load projection	33% of load	75% (Minimum Bucket 1 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%

Bucket 1 and 2 Calculation

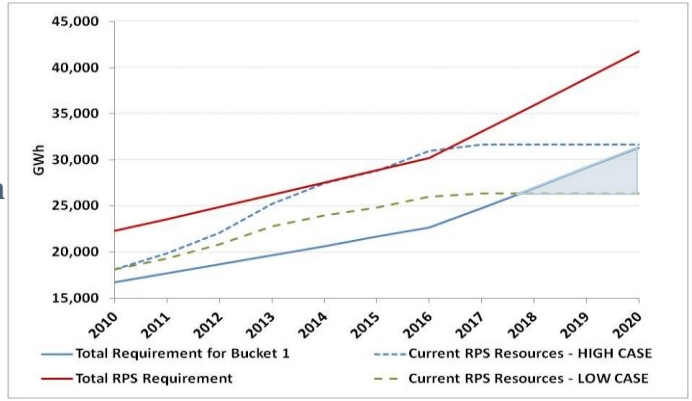
Target Market	L	R	A	ES	AP	S
Northern California	2020 load projection	33% of load	90% (Minimum Bucket 1 & 2 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%
Southern California	2020 load projection	33% of load	90% (Minimum Bucket 1 & 2 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%

Source: FTI Analysis

EXHIBIT 8: Unmet Need in Bucket 1

RPS Projections – Bucket 1

Northern California



Bucket 1 Projections (GWh)

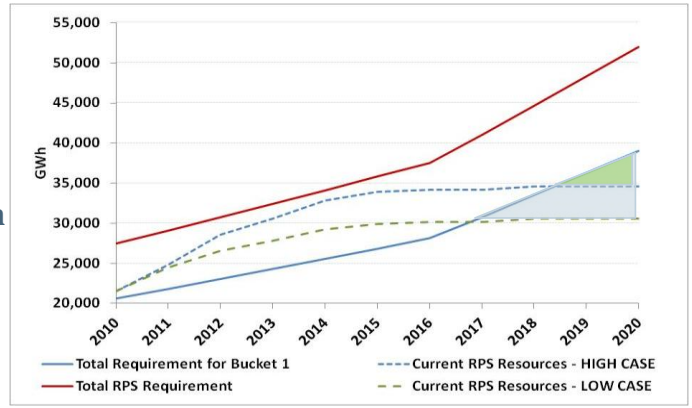
Low Demand*

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Bucket 1	22,672	31,335
Current Bucket 1	30,992	31,636
Unmet Need	**(8,320)**	**(302)**

High Demand**

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Bucket 1	22,672	31,335
Current Bucket 1	26,028	26,386
Unmet Need	**(3,356)**	**4,949**

Southern California



Low Demand*

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Bucket 1	28,130	38,999
Current Bucket 1	34,182	34,576
Unmet Need	**(6,052)**	**4,423**

High Demand**

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Bucket 1	28,130	38,999
Current Bucket 1	30,140	30,534
Unmet Need	**(2,010)**	**8,465**

* Low Demand represents RPS requirements assuming an approved project high success rate of 90%

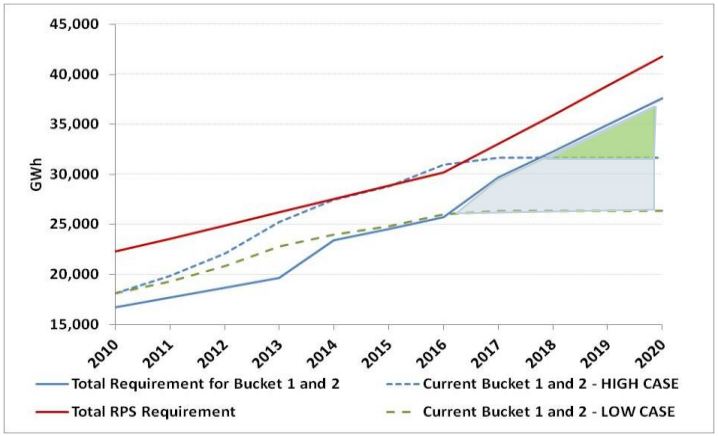
** High Demand represents RPS requirements assuming an approved project low success rate of 50%

Source: FTI Analysis

EXHIBIT 9: Unmet Need in Bucket 1 and 2

RPS Projections – Bucket 1 and 2

Northern California



Bucket 1 and 2 Projections (GWh)

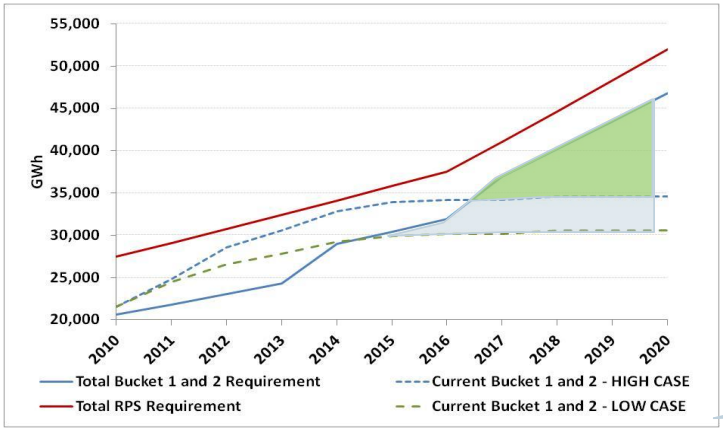
Low Demand*

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Buckets 1 and 2	25,695	37,602
Current Buckets 1 and 2	30,992	31,636
Unmet Need	**(5,297)**	**5,965**

High Demand**

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Buckets 1 and 2	25,695	37,602
Current Buckets 1 and 2	26,028	26,386
Unmet Need	**(333)**	**11,216**

Southern California



Low Demand*

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Buckets 1 and 2	31,881	46,799
Current Buckets 1 and 2	34,182	34,576
Unmet Need	**(2,301)**	**12,223**

High Demand**

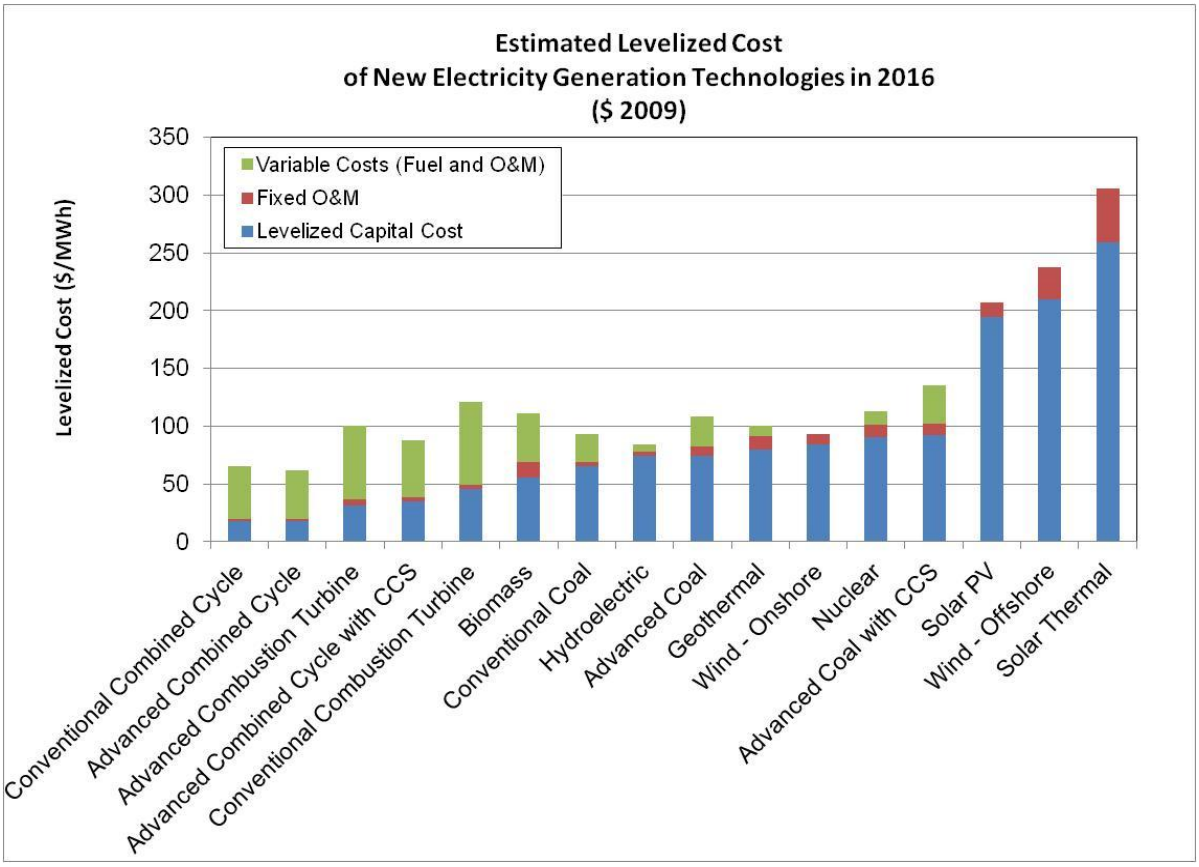
	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Buckets 1 and 2	31,881	46,799
Current Buckets 1 and 2	30,140	30,534
Unmet Need	**1,741**	**16,265**

* Low Demand represents RPS requirements assuming an approved project high success rate of 90%

** High Demand represents RPS requirements assuming an approved project low success rate of 50%

Source: FTI Analysis

EXHIBIT 10: Levelized Cost of Energy from New Electricity Generation Technologies



Source: FTI Analysis of Energy Information Administration, Annual Energy Outlook 2011, http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html Does not include environmental cost of emissions

EXHIBIT 11: Methodology to Calculate Levelized Costs of Renewables from Different Regions

FTI calculated and ranked the long-run marginal cost of different renewable resources for target markets incorporating renewable resource efficiency and distance from source to sink using the following formula:

$$\mathbf{LRMC = \underbrace{G \times (1 - FG)}_{\text{Production Cost}} + \underbrace{Tr}_{\text{Delivery Cost}}}$$

Where:

LRMC = Long Run Marginal Cost of Production
G = Levelized capital cost of generation, adjusted for local resource capacity factors ($/MWh)
Tr = Transmission Cost ($/MWh)

Variable	Long-run Marginal Cost Component	Source
G =	Local Cost of Technology Adjusted for Capacity Factor	EIA levelized capital cost estimates ($/MWh)
	Capacity Factor of Resource	NREL wind and solar resource data
FG =	30% Federal Grants / Tax Credits	Assumed to be zero
Tr =	Cost of Transmission	Existing tariffs

EXHIBIT 12: Methodology to Calculate Levelized Costs of Renewables from Different Regions

Incremental Cost of Renewables to Northern California

OATTS — Existing Tariffs

Rank	Resource	Levelized Cost (2010 $/MWh)	Incremental Cost to NoCal (2010 $/MWh)
1	Montana Wind	$ 94.75	$ (9.58)
2	Wyoming Wind	$ 101.70	$ (2.62)
3	New Mexico Wind	$ 104.32	$ (0.01)
4	No Cal Wind	$ 104.33	$ -
5	So Cal Wind	$ 111.87	$ 7.54
6	Pac Northwest Wind	$ 113.11	$ 8.78
7	Arizona Wind	$ 113.58	$ 9.25
8	Arizona Solar - PV	$ 180.45	$ (30.68)
9	So Cal Solar - PV	$ 191.03	$ (20.10)
10	New Mexico Solar - PV	$ 202.80	$ (8.33)
11	No Cal Solar - PV	$ 211.13	$ -
12	Arizona Solar - TH	$ 280.81	$ (74.33)
13	New Mexico Solar - TH	$ 316.72	$ (38.41)
14	So Cal Solar - TH	$ 320.93	$ (34.21)
15	No Cal Solar - TH	$ 355.14	$ -

Incremental Cost of Renewables to Southern California

OATTS — Existing Tariffs

Rank	Resource	Levelized Cost (2010 $/MWh)	Incremental Cost to SoCal (2010 $/MWh)
1	Wyoming Wind	$ 99.48	$ (3.85)
2	New Mexico Wind	$ 100.25	$ (3.09)
3	Montana Wind	$ 100.81	$ (2.52)
4	So Cal Wind	$ 103.33	$ -
5	Arizona Wind	$ 109.51	$ 6.17
6	No Cal Wind	$ 112.86	$ 9.53
7	Pac Northwest Wind	$ 115.11	$ 11.77
8	Arizona Solar - PV	$ 176.37	$ (6.12)
9	So Cal Solar - PV	$ 182.49	$ -
10	New Mexico Solar - PV	$ 198.73	$ 16.23
11	No Cal Solar - PV	$ 219.66	$ 37.17
12	Arizona Solar - TH	$ 276.74	$ (35.66)
13	So Cal Solar - TH	$ 312.39	$ -
14	New Mexico Solar - TH	$ 312.65	$ 0.26
15	No Cal Solar - TH	$ 363.67	$ 51.28

Source: FTI Analysis, does not include subsidies, grants or tax credits

EXHIBIT 13: Estimated Impact of Limiting RPS-eligibility of Imports into California

		Incremental Cost of California Renewables ($/MWh)					
		5	10	15	20	25	30
Unmet Need (GWh) 33% RPS	5,000	$ 25,000,000	$ 50,000,000	$ 75,000,000	$ 100,000,000	$ 125,000,000	$ 150,000,000
	10,000	$ 50,000,000	$ 100,000,000	$ 150,000,000	$ 200,000,000	$ 250,000,000	$ 300,000,000
	15,000	$ 75,000,000	$ 150,000,000	$ 225,000,000	$ 300,000,000	$ 375,000,000	$ 450,000,000
	20,000	$ 100,000,000	$ 200,000,000	$ 300,000,000	$ 400,000,000	$ 500,000,000	$ 600,000,000
	25,000	$ 125,000,000	$ 250,000,000	$ 375,000,000	$ 500,000,000	$ 625,000,000	$ 750,000,000
40% RPS	30,000	$ 150,000,000	$ 300,000,000	$ 450,000,000	$ 600,000,000	$ 750,000,000	$ 900,000,000
	35,000	$ 175,000,000	$ 350,000,000	$ 525,000,000	$ 700,000,000	$ 875,000,000	$ 1,050,000,000
	40,000	$ 200,000,000	$ 400,000,000	$ 600,000,000	$ 800,000,000	$ 1,000,000,000	$ 1,200,000,000
	45,000	$ 225,000,000	$ 450,000,000	$ 675,000,000	$ 900,000,000	$ 1,125,000,000	$ 1,350,000,000
	50,000	$ 250,000,000	$ 500,000,000	$ 750,000,000	$ 1,000,000,000	$ 1,250,000,000	$ 1,500,000,000

Source: FTI Analysis

CORPORATE FINANCE/RESTRUCTURING

FORENSIC AND LITIGATION CONSULTING

ECONOMIC CONSULTING

STRATEGIC COMMUNICATIONS

TECHNOLOGY

Analysis and Cost Comparison of Renewable Power in California

Presented to the Little Hoover Commission

by Tanya L. Bodell

28 February 2012

FTI CONSULTING™

CRITICAL THINKING AT THE CRITICAL TIME™

Overview

- **Objective:** Review the relative costs of renewable resource generation, including transmission, for delivery into California from the surrounding states

- **Contents:**
  - Executive Summary
  - Location of Renewable Resources
  - California's RPS Requirements
  - Cost of Limiting Renewable Imports

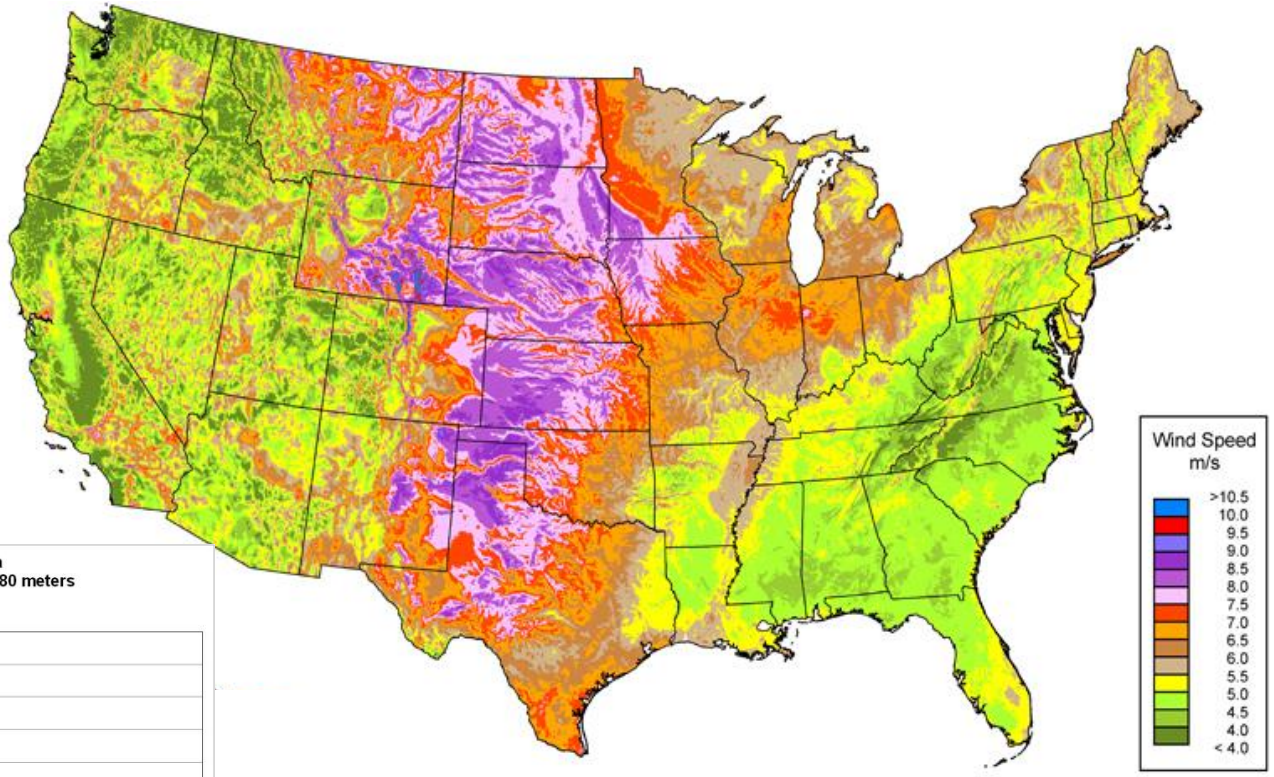
Executive Summary

- **Superior renewable resources exist outside of California**
  - Higher capacity factors
  - Lower construction costs
  - Greater geographical options
- **Long distance resources with more efficient production cost structures can off-set higher transmission costs required to deliver such power to market**
- **California's RPS legislation limits the share of renewable resources that can come from out-of-state**
  - Explicit limits for three separate "buckets"
  - Recent ruling does not provide sufficient clarity on what is required for out-of-state resources to be dynamically scheduled and delivered into California
  - As a result, California-based renewable resources could be 75 percent to 90 percent of the total portfolio
- **Limiting imports of renewable resources will cost California ratepayers**
  - Inability to access the most cost-effective resources
  - Lack of flexibility to integrate a diverse portfolio of renewable resources
- **The incremental costs of limiting renewable imports could exceed hundreds of million of dollars per year, costing ratepayers billions of dollars over the life of the RPS program**

Location of Renewable Resources

Renewable Resources | Wind Potential by State

Utility-Scale Wind Maps
For each of the 50 states and the total U.S., these estimates show windy land area with a gross capacity factor (without losses) of 30% and greater at 80-m height above ground development of the "available" windy land area after exclusions. Excluded lands include protected lands (national parks, wilderness, etc.), incompatible land use (urban, airports, wetland, and water features), and other areas unlikely to be developed for wind. The map illustrates wind energy potential by state.



Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: http://www.windnavigator.com | http://www.awstruepower.com. Spatial resolution of wind resource data: 2.5 km. Projection: Albers Equal Area WGS84.

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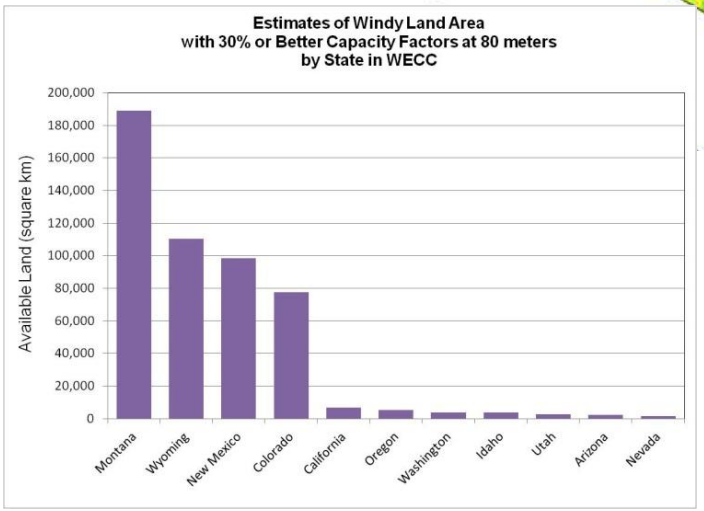
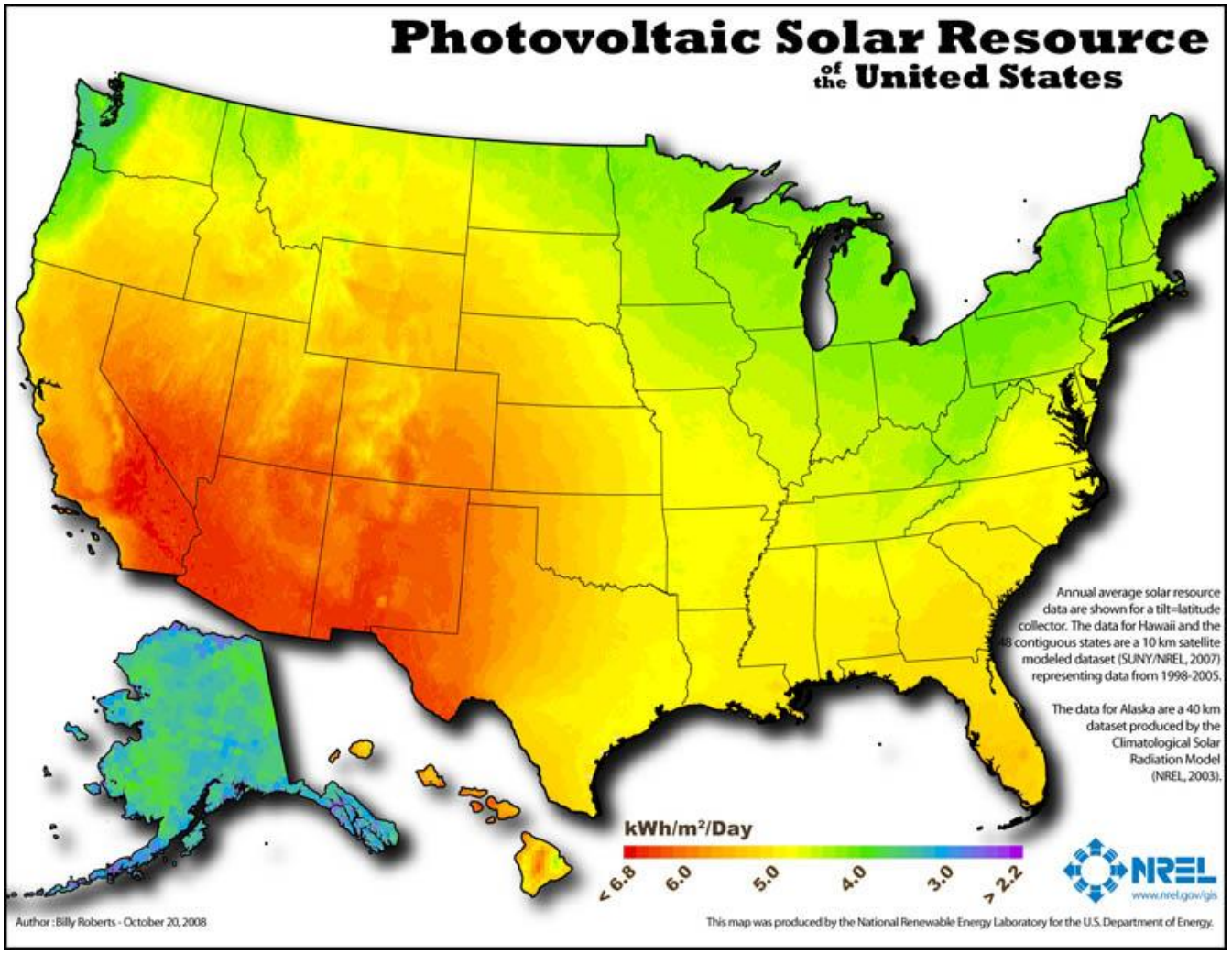


Substantially larger regions of superior wind sources exist outside of California

Source: FTI Analysis, DOE National Renewable Energy Laboratory (NREL) http://www.windpoweringamerica.gov/wind_maps.asp,

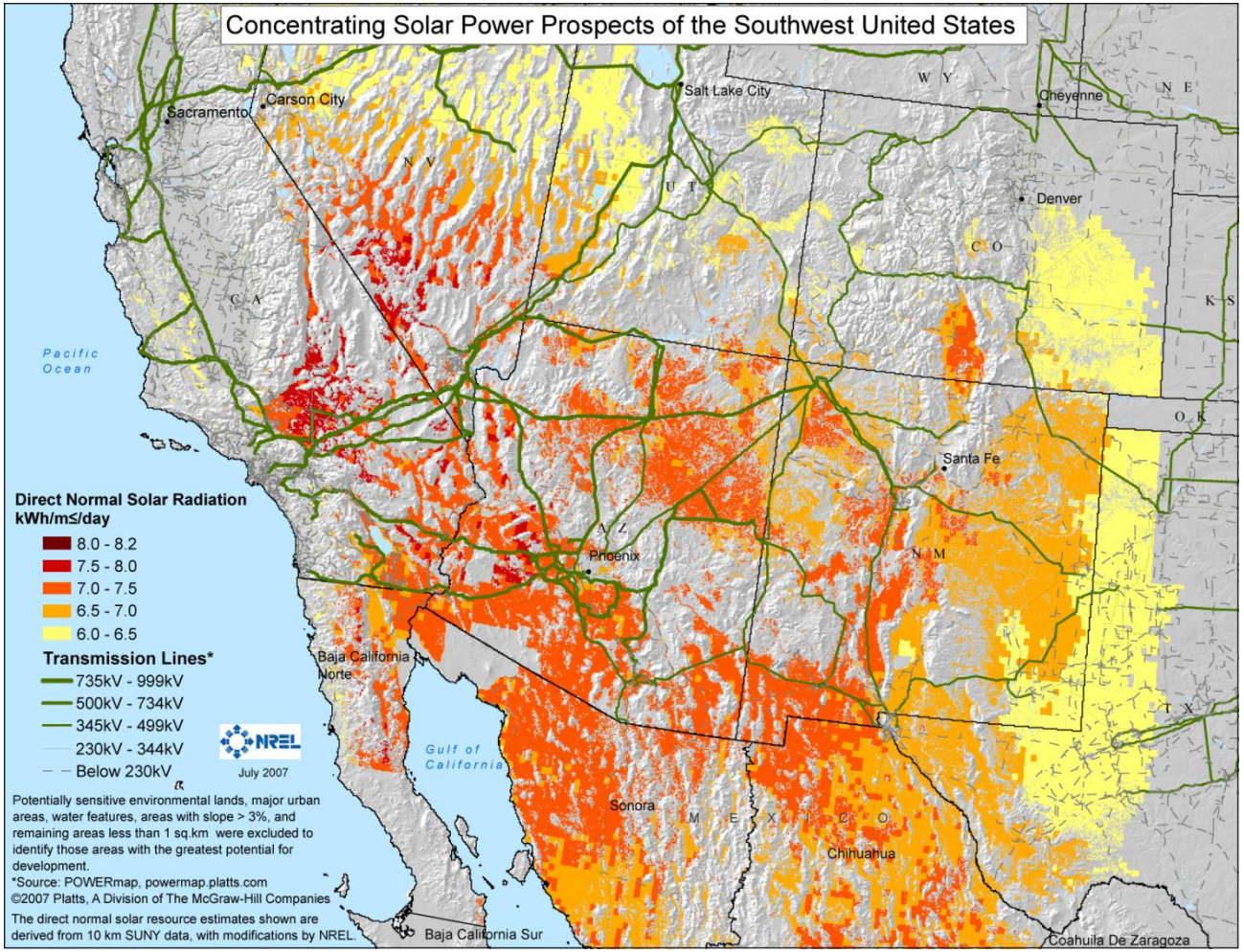
Renewable Resources | Photovoltaic Potential by State



Photovoltaic opportunities are plentiful in Southern California and surrounding states

Source: DOE National Renewable Energy Laboratory (NREL) http://www.nrel.gov/csp/maps.html

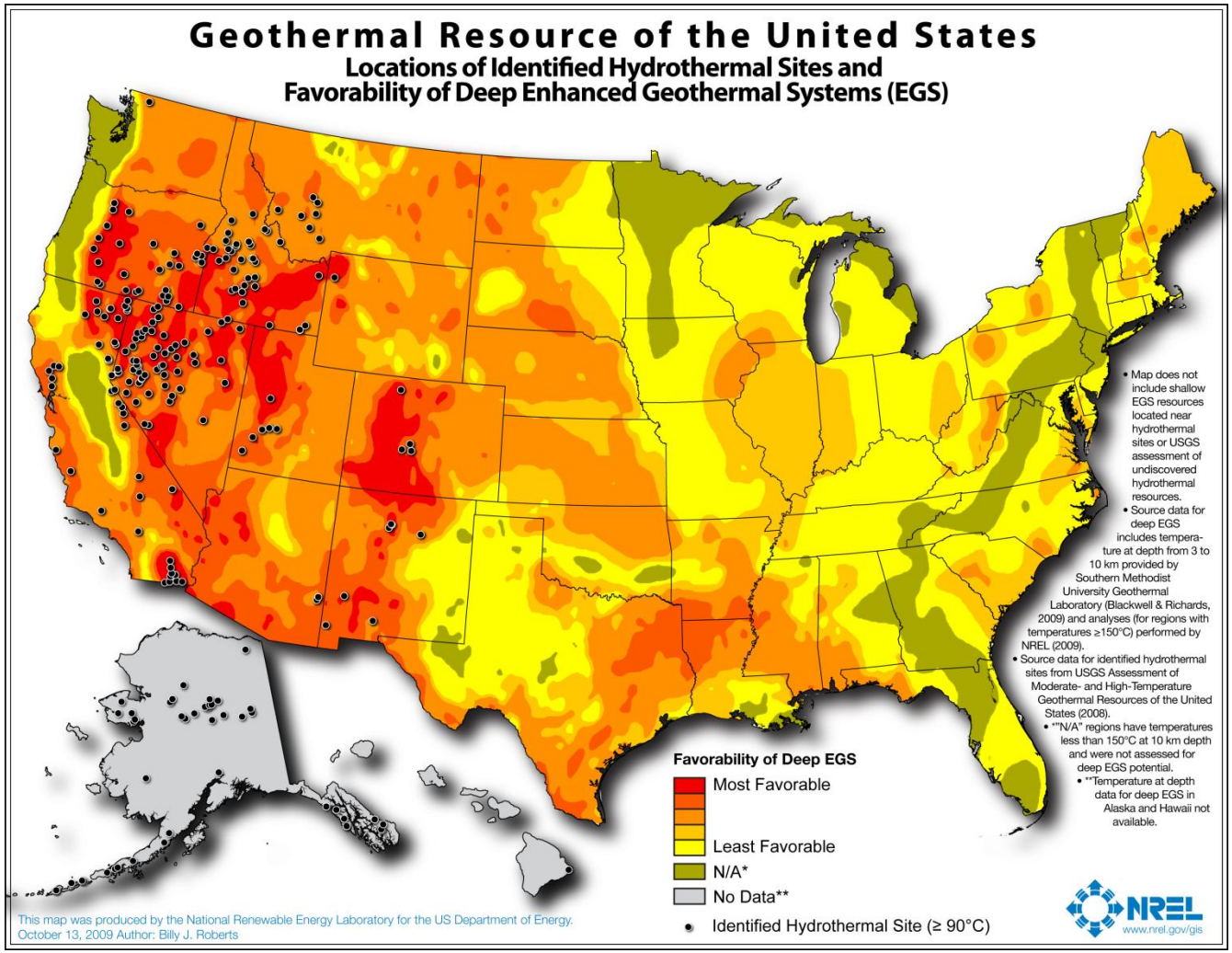
Renewable Resources | Solar Thermal Potential by State



Wider expanses of solar thermal sites with accessible transmission occur outside of California

Source: DOE National Renewable Energy Laboratory (NREL) http://www.nrel.gov/csp/maps.html

Renewable Resources | Geothermal Potential by State



A significant number of identified geothermal sites are outside of California

Source: DOE National Renewable Energy Laboratory (NREL) http://www.nrel.gov/gis/images/geothermal_resource2009-final.jpg

California’s RPS Requirements

RPS Requirements | Requirements and Restrictions

California Renewable Portfolio Requirements -- SB 2 (1X)

- California electric utilities must increase their retail sales from approved renewable resources according to the following timeline:
  - 20% of retail sales by 2013
  - 25% of retail sales by 2016
  - 33% of retail sales by 2020

Resource Restrictions:

- Utilities can fulfill their obligations from the following three types of renewable resources:

Bucket	Eligible Resources	Restrictions from 2017
#1	a) first point of interconnection with CA balancing authority or distribution system to serve CA end users b) energy scheduled into a CA balancing authority *without* substituting from another source c) energy deliverd to CA balancing authority under a dynamic transfer	>= 75% of total requirement
#2	a) firmed and shaped resources providing incremental electricity into a California balancing authority	Sum of #2 and #3 can never exceed 25%
#3	a) products not fitting buckets 1 or 2, including unbundled RECs that do not deliver energy into California	Can never exceed 10%

- Utilities and other market participants have expressed concern with these restrictions

When signing the bill, California Governor Brown expressed a desire for a 40 percent RPS target

Source: FTI Analysis, California Energy Commission

RPS Requirements | External Resources Face More Challenges than In-state

Bucket 1: Definition of Dynamic transfer is left to the balancing authority

- **Dynamic Transfer.** The term "dynamic transfer" refers to a range of methods by which a balancing authority receiving electricity generated in another balancing authority area may provide some or all of the functions and services typically provided by the balancing authority in which the generation facility is interconnected.
  - A dynamic transfer arrangement is made between balancing authorities, not the generator and the buyer.
  - Renewable generation claiming RPS-compliance under Bucket #1 must be covered by an agreement executed by a California balancing authority, before the electricity is generated, to dynamically transfer electricity from the external RPS-eligible generator into the California balancing area during the time period in which the RPS-eligible electricity is generated.

Bucket 2: Ongoing challenges remain for an external renewable resource to be eligible:

- **Firming Resources.** Ability to find cost-effective firming resources.
- **Shaping Resources.** Ability to find cost-effective shaping resources.
- **Incremental Resources.** Limitations on the entity from whom a renewable generator can purchase firm and shaping resources.
- **Cross-border Transmission Capacity.** Ability to schedule cross-border transfer capability for purposes of "scheduling into a California balancing authority".

RPS eligibility requirements are significantly greater for out-of-state resources versus in-state

Source: Ibid., http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/156060.pdf, December 15, 2011

RPS Requirements | Methodology to Calculate Unmet Need

❖ **FTI Methodology:** Estimate the size of each market for renewable power using the following formula:

$$\text{Market Size} = (L \times R \times A) - ES - (AP \times S)$$

Where: L = Projected load R = State RPS goal A = Eligibility Adjustor ES = Existing supply
AP = Approved projects S = Approved project success rate

Bucket 1 Calculation

Target Market	L	R	A	ES	AP	S
Northern California	2020 load projection	33% of load	75% (Minimum Bucket 1 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%
Southern California	2020 load projection	33% of load	75% (Minimum Bucket 1 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%

Bucket 1 and 2 Calculation

Target Market	L	R	A	ES	AP	S
Northern California	2020 load projection	33% of load	90% (Minimum Bucket 1 & 2 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%
Southern California	2020 load projection	33% of load	90% (Minimum Bucket 1 & 2 requirement)	Current RPS-compliant projects filed by IOUs, POUs and ESPs	Projects currently under development approved by IOUs and POUs	Low Case: 50% High Case: 90%

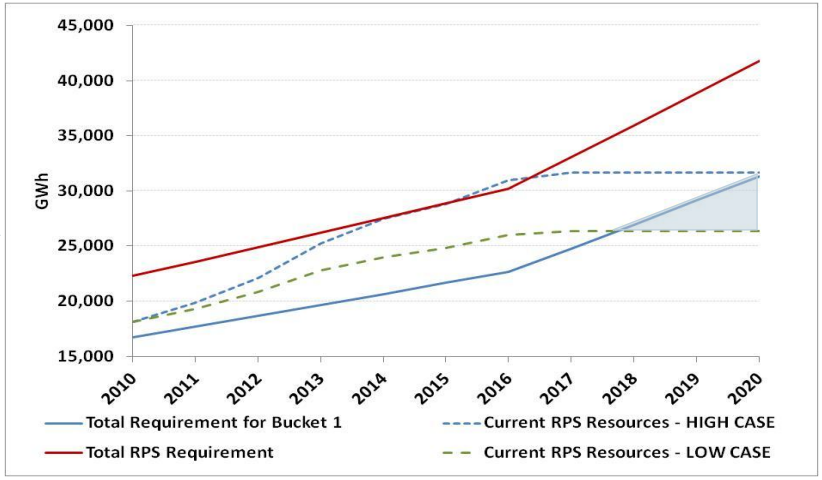
Source: FTI Analysis, Energy Information Administration, California Energy Commission, California Public Utility Comission, North America Electric Reliability Corporation

RPS Requirements | Unmet Need for Bucket 1 (33% RPS)

RPS Projections – Bucket 1

Bucket 1 Projections (GWh)

Northern California



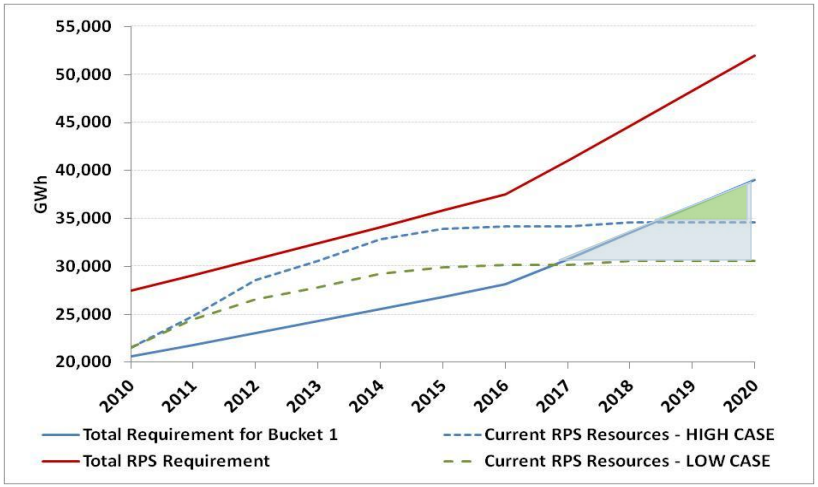
Low Demand*

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Bucket 1	22,672	31,335
Current Bucket 1	30,992	31,636
Unmet Need	**(8,320)**	**(302)**

High Demand**

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Bucket 1	22,672	31,335
Current Bucket 1	26,028	26,386
Unmet Need	**(3,356)**	**4,949**

Southern California



Low Demand*

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Bucket 1	28,130	38,999
Current Bucket 1	34,182	34,576
Unmet Need	**(6,052)**	**4,423**

High Demand**

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Bucket 1	28,130	38,999
Current Bucket 1	30,140	30,534
Unmet Need	**(2,010)**	**8,465**

Demand for renewable resources is met through existing and planned projects through 2017

* Low Demand represents RPS requirements assuming an approved project high success rate of 90%

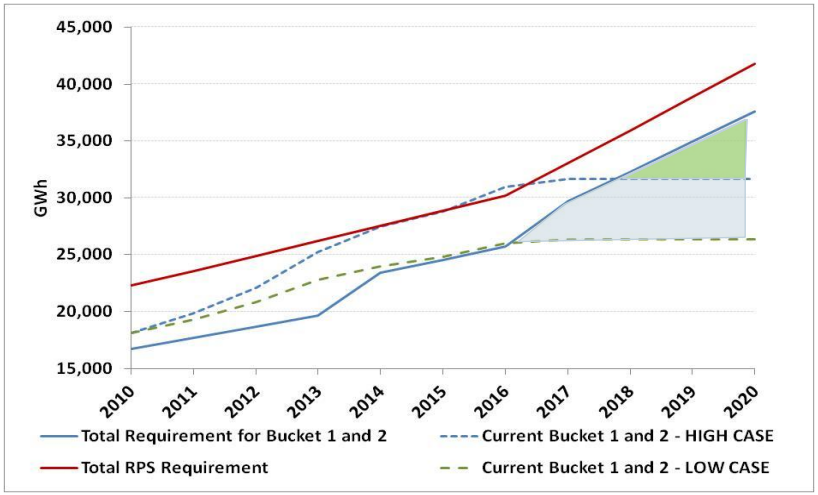
** High Demand represents RPS requirements assuming an approved project low success rate of 50%

RPS Requirements | Unmet Need for Bucket 1 and 2 (33% RPS)

RPS Projections – Bucket 1 and 2

Bucket 1 and 2 Projections (GWh)

Northern California



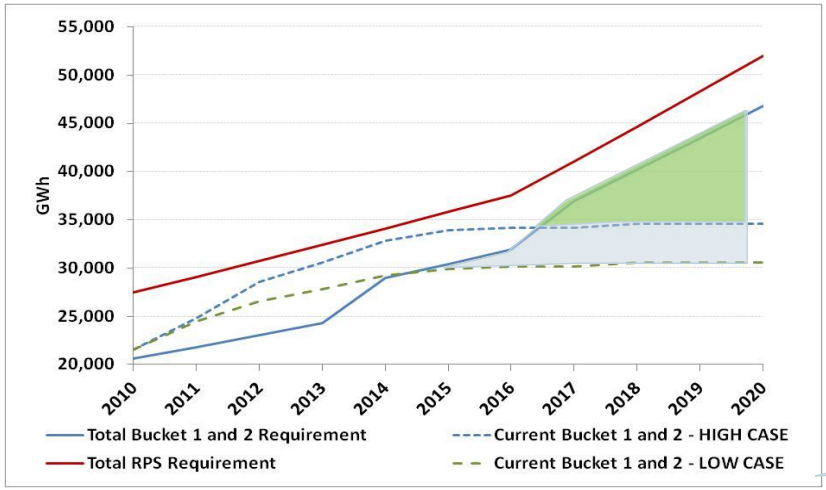
Low Demand*

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Buckets 1 and 2	25,695	37,602
Current Buckets 1 and 2	30,992	31,636
Unmet Need	**(5,297)**	**5,965**

High Demand**

	2016	2020
Load	120,916	126,605
Total RPS	30,229	41,780
Total Buckets 1 and 2	25,695	37,602
Current Buckets 1 and 2	26,028	26,386
Unmet Need	**(333)**	**11,216**

Southern California



Low Demand*

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Buckets 1 and 2	31,881	46,799
Current Buckets 1 and 2	34,182	34,576
Unmet Need	**(2,301)**	**12,223**

High Demand**

	2016	2020
Load	150,027	157,571
Total RPS	37,507	51,999
Total Buckets 1 and 2	31,881	46,799
Current Buckets 1 and 2	30,140	30,534
Unmet Need	**1,741**	**16,265**

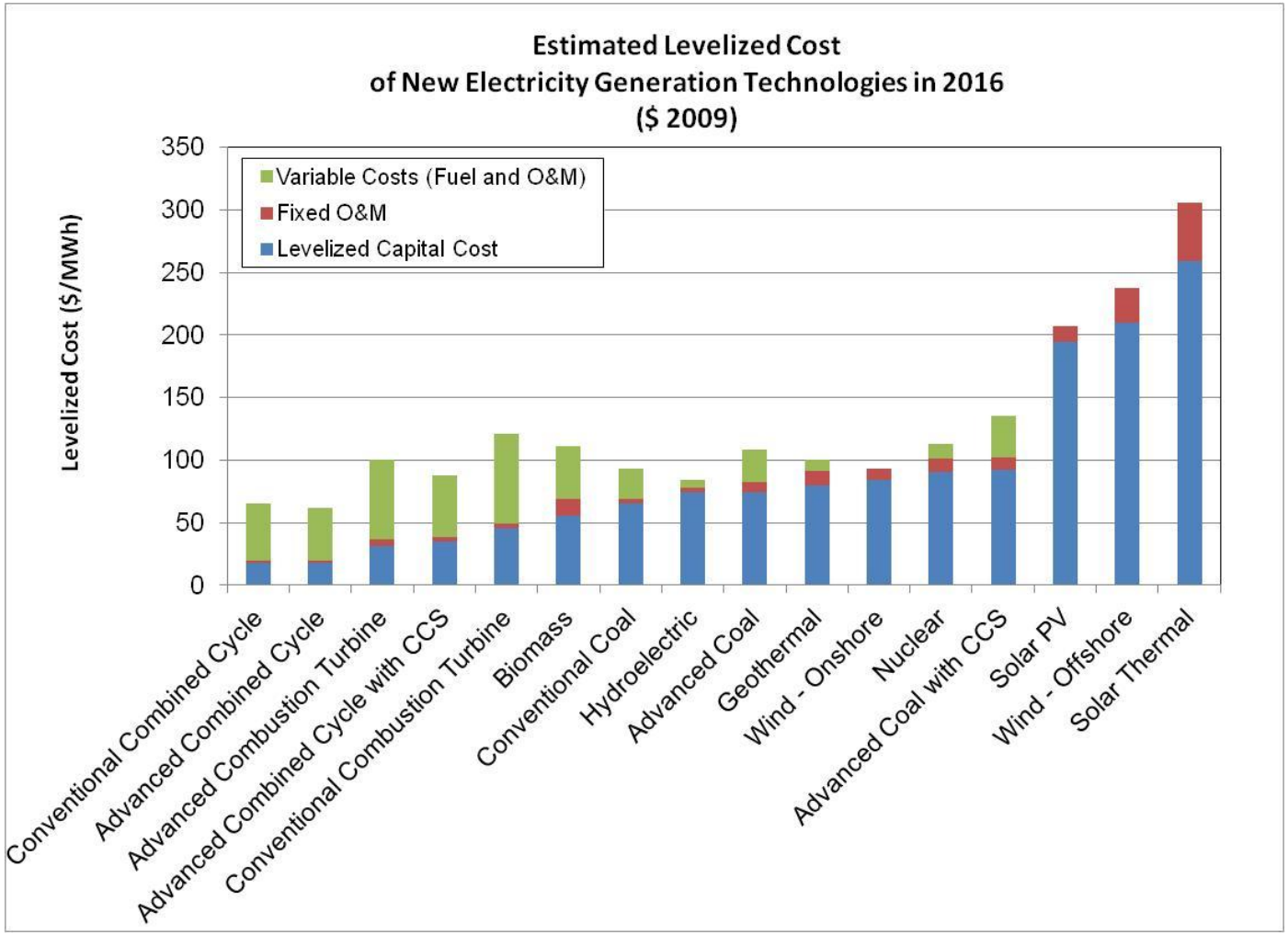
Demand for renewable resources is met through existing and planned projects through 2015

* Low Demand represents RPS requirements assuming an approved project high success rate of 90%

** High Demand represents RPS requirements assuming an approved project low success rate of 50%

Cost of Renewable Resources

Cost of Renewables | Levelized Cost by Generation Technology



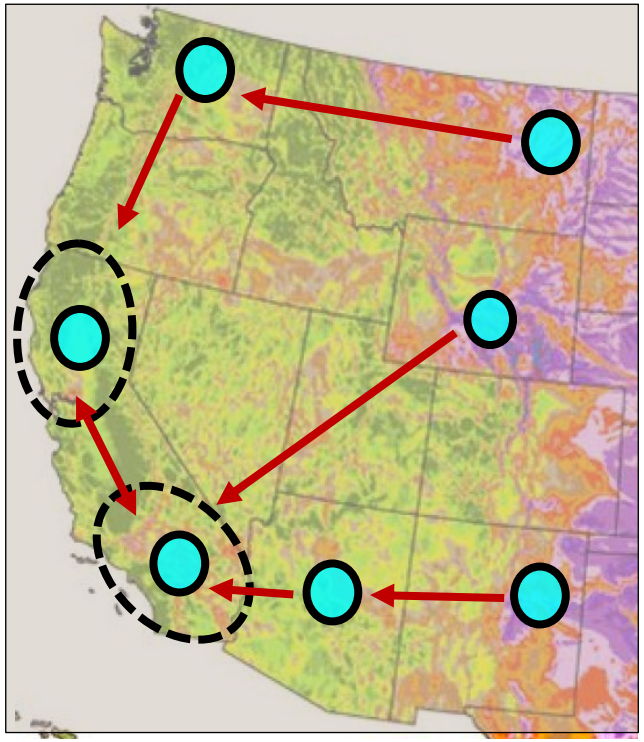
The cost to build and operate generation plants varies by technology

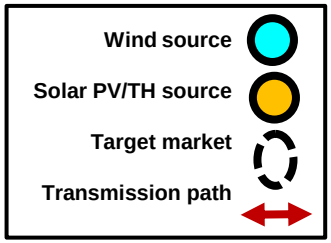
Source: FTI Analysis of Energy Information Administration, Annual Energy Outlook 2011, http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html
Does not include environmental cost of emissions

Cost of Renewables | Supply Sources and Transmission Paths

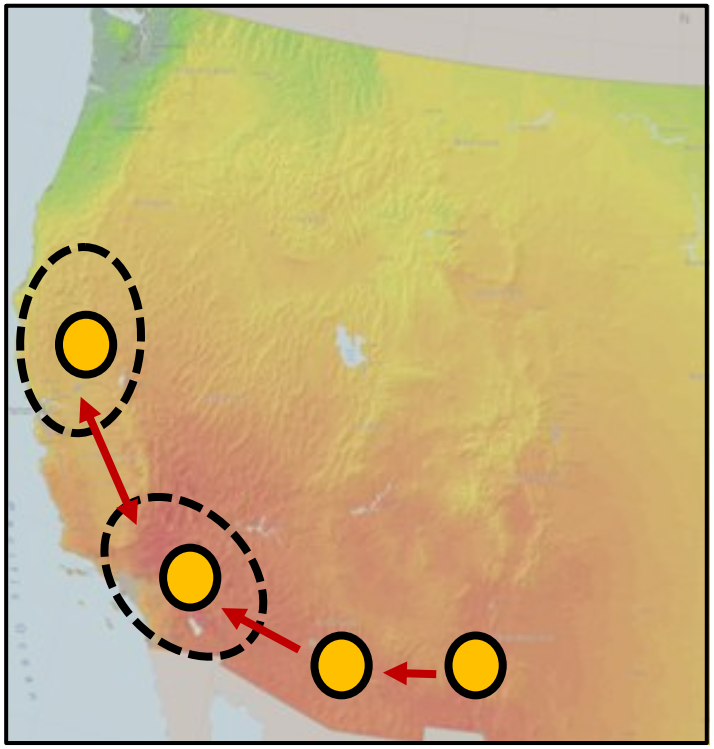
- Renewable resource supply may be sourced from different geographic regions
- Existing and planned transmission lines can be used to deliver renewable resources from optimal locations to California

Wind Supply Sources





Solar Supply Sources



Superior capacity factors allow longer distance renewable resources to be competitive

Source: FTI Analysis, Energy Information Administration, FERC, NREL

Cost of Renewables | Long-run Marginal Cost of Delivered Renewables

- **Approach:** FTI calculated and ranked the long-run marginal cost of different renewable resources for target markets incorporating renewable resource efficiency and distance from source to sink
- **Methodology:** Estimate the relative position of renewable resources using the following formula:

$$\text{LRMC} = \overbrace{G \times (1 - FG)}^{\text{Production Cost}} + \overbrace{Tr}^{\text{Delivery Cost}}$$

Where: LRMC = Long Run Marginal Cost of Production

G = Levelized capital cost of generation, adjusted for local resource capacity factors ($/MWh)

Tr = Transmission Cost ($/MWh)

Drivers of Long-run Marginal Cost

Variable	Long-run Marginal Cost Component	Source
G =	Local Cost of Technology Adjusted for Capacity Factor	EIA levelized capital cost estimates ($/MWh)
	Capacity Factor of Resource	NREL wind and solar resource data
FG =	30% Federal Grants / Tax Credits	Assumed to be zero
Tr =	Cost of Transmission	Existing tariffs

Total delivered costs include options for transporting renewable energy from other states

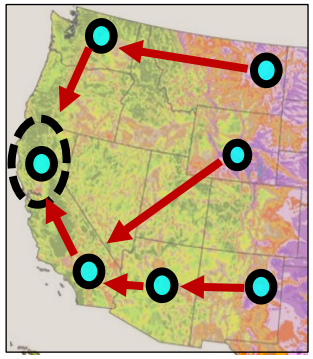
Cost of Renewables | Comparative Renewable Costs – Existing Tariffs

Incremental Cost of Renewables to Northern California

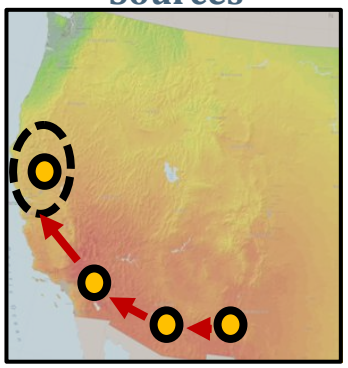
OATTS Existing Tariffs

Rank	Resource	Levelized Cost (2010 $/MWh)	Incremental Cost to NoCal (2010 $/MWh)
1	Montana Wind	$ 94.75	$ (9.58)
2	Wyoming Wind	$ 101.70	$ (2.62)
3	New Mexico Wind	$ 104.32	$ (0.01)
4	No Cal Wind	$ 104.33	$ -
5	So Cal Wind	$ 111.87	$ 7.54
6	Pac Northwest Wind	$ 113.11	$ 8.78
7	Arizona Wind	$ 113.58	$ 9.25
8	Arizona Solar - PV	$ 180.45	$ (30.68)
9	So Cal Solar - PV	$ 191.03	$ (20.10)
10	New Mexico Solar - PV	$ 202.80	$ (8.33)
11	No Cal Solar - PV	$ 211.13	$ -
12	Arizona Solar - TH	$ 280.81	$ (74.33)
13	New Mexico Solar - TH	$ 316.72	$ (38.41)
14	So Cal Solar - TH	$ 320.93	$ (34.21)
15	No Cal Solar - TH	$ 355.14	$ -

Wind Supply Sources

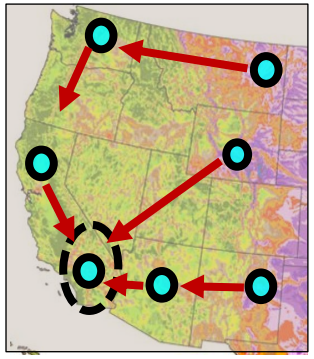


Solar Supply Sources

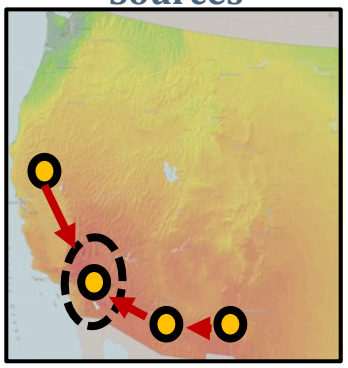


Incremental Cost of Renewables to Southern California

Wind Supply Sources



Solar Supply Sources



OATTS Existing Tariffs

Rank	Resource	Levelized Cost (2010 $/MWh)	Incremental Cost to SoCal (2010 $/MWh)
1	Wyoming Wind	$ 99.48	$ (3.85)
2	New Mexico Wind	$ 100.25	$ (3.09)
3	Montana Wind	$ 100.81	$ (2.52)
4	So Cal Wind	$ 103.33	$ -
5	Arizona Wind	$ 109.51	$ 6.17
6	No Cal Wind	$ 112.86	$ 9.53
7	Pac Northwest Wind	$ 115.11	$ 11.77
8	Arizona Solar - PV	$ 176.37	$ (6.12)
9	So Cal Solar - PV	$ 182.49	$ -
10	New Mexico Solar - PV	$ 198.73	$ 16.23
11	No Cal Solar - PV	$ 219.66	$ 37.17
12	Arizona Solar - TH	$ 276.74	$ (35.66)
13	So Cal Solar - TH	$ 312.39	$ -
14	New Mexico Solar - TH	$ 312.65	$ 0.26
15	No Cal Solar - TH	$ 363.67	$ 51.28

Source: FTI Analysis, does not include subsidies, grants or tax credits

Cost of Renewables | Incremental Cost of Restricting Imports

- **Approach:** Multiply the incremental cost of California-based renewable resources vs. out-of-state options and by the unmet need for renewable resources in California
- **Conclusion:** Estimated range of the incremental cost of limiting renewable resources to California resources is:
  - Under a 33% RPS Requirement: $100 million to $300 million per year
  - Under a 40% RPS Requirement: $450 million to $700 million per year
  - Incremental costs of limiting renewable resources to in-state could cost ratepayers billions of dollars over the life of the RPS regulations

		Incremental Cost of California Renewables ($/MWh)					
		5	10	15	20	25	30
Unmet Need (GWh) – 33% RPS	5,000	$ 25,000,000	$ 50,000,000	$ 75,000,000	$ 100,000,000	$ 125,000,000	$ 150,000,000
	10,000	$ 50,000,000	$ 100,000,000	$ 150,000,000	$ 200,000,000	$ 250,000,000	$ 300,000,000
	15,000	$ 75,000,000	$ 150,000,000	$ 225,000,000	$ 300,000,000	$ 375,000,000	$ 450,000,000
	20,000	$ 100,000,000	$ 200,000,000	$ 300,000,000	$ 400,000,000	$ 500,000,000	$ 600,000,000
	25,000	$ 125,000,000	$ 250,000,000	$ 375,000,000	$ 500,000,000	$ 625,000,000	$ 750,000,000
Unmet Need (GWh) – 40% RPS	30,000	$ 150,000,000	$ 300,000,000	$ 450,000,000	$ 600,000,000	$ 750,000,000	$ 900,000,000
	35,000	$ 175,000,000	$ 350,000,000	$ 525,000,000	$ 700,000,000	$ 875,000,000	$ 1,050,000,000
	40,000	$ 200,000,000	$ 400,000,000	$ 600,000,000	$ 800,000,000	$ 1,000,000,000	$ 1,200,000,000
	45,000	$ 225,000,000	$ 450,000,000	$ 675,000,000	$ 900,000,000	$ 1,125,000,000	$ 1,350,000,000
	50,000	$ 250,000,000	$ 500,000,000	$ 750,000,000	$ 1,000,000,000	$ 1,250,000,000	$ 1,500,000,000

- Additional costs also include higher integration costs associated with a limited subset of resources

Actual costs depend on resource constraints, cost of those resources and foregone cost savings