ICF QUICK TAKE

Drought Puts California Transmission in Dire Straits:

Option Value of Thermal Generation Increases

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Executive Summary

The severe drought in California has led to a drop in hydroelectric generation that could create ongoing price spikes in hydro-heavy transmission-limited load pockets. Stakeholders should now consider the increased option value that thermal generation in those areas will now carry, because the revenue effects for affected thermal generators are significant.

One way to view price spikes is as a form of supplemental capacity revenue for thermal generators located in hydro-dependent areas. For example, the Fresno local capacity area price spikes corresponded to an equivalent of $20-45/kW-yr[1] *capacity pricing in 2014 and 2015. Combined with the more formal Resource Adequacy (RA) capacity payments (around $35/kW-yr currently), dispatchable generators in Fresno earned up to a substantial $55-$80/kW-yr or higher capacity revenue in 2014 and 2015.*

Moreover, this type of drought-driven dynamic could be both persistent and widespread within the state, and other transmission-limited pockets with hydroelectric generation would likely see the same pattern under the ongoing drought conditions. And while it is impossible to predict how long the California drought will last, California is particularly vulnerable due to weaknesses in the transmission system that create a large number of sub zones, some of which rely heavily on hydro. There are strong indications that we may see added value for thermal generators in these areas for quite some time.

If the impacts of drought are factored into the Local Capacity Requirement (LCR) calculations, we expect that the Sierra, Fresno and Big Creek–Ventura Local Capacity Areas (LCAs) would have higher resource adequacy payments than current levels. The prices in these zones could be in the range of the Capacity Procurement Mechanism (CPM) price of $75.68/kW-yr to as high as the net cost of new entry of a small peaker, incentivizing new builds that are clearly needed in some of these zones.

The California Drought and Its Impacts on Local Capacity Areas and Sub-Zones

After four consecutive years of below-normal rainfall, California is currently facing its most severe drought emergency in decades. According to data published by the U.S. Drought Monitor, about 95 percent of California is currently facing severe to exceptional drought conditions (see Exhibit 1). As a result, current capacities in all reservoirs are lower than the historical average at this time of year. While hydro has historically accounted for up to 20 percent of California's total annual generation, in recent years the proportion has fallen to around 10 percent, as seen in Exhibit 2. Moreover, snowpack (an indicator of how much water will be available to fill reservoirs and power hydroelectric generators throughout the year) in the Sierra Nevadas has hit the lowest levels seen in the natural record for over 500 years,[2] indicating that low-hydro conditions will be prolonged even if the upcoming El Niño weather pattern temporarily brings increased precipitation. The Sierra snowpack provides 30 percent of the state's water supply.

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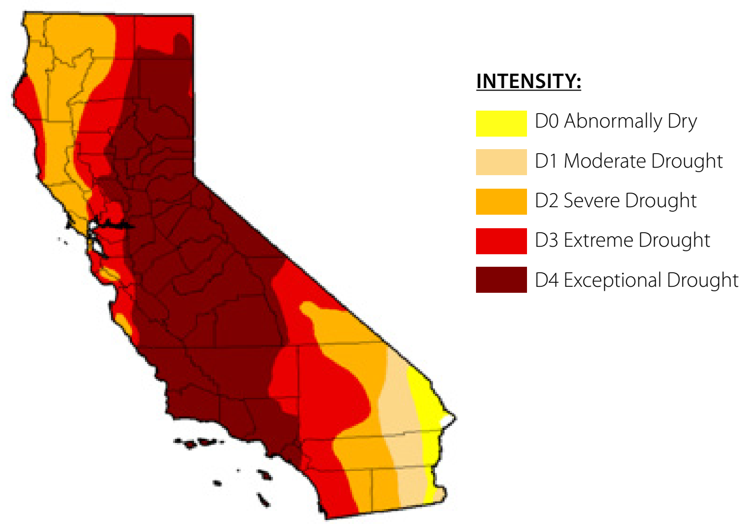
[1] Using scarcity pricing cutoffs of 15,000-18,000 market implied Btu/kWh

[2] Belmecheri, Soumaya et al. Mid-century evaluation of the Sierra Nevada snowpack. Nature Climate Change (2015). Also reported at http://www.usatoday.com/story/weather/2015/09/12/california-snowpack-lowest-level-500-years/72097844/

The situation has not yet created an imminent concern for statewide resource adequacy. California ISO (CAISO) has 13,975 MW of nameplate hydroelectric capacity in its footprint, representing 18 percent of total nameplate capacity in the system. According to CAISO's 2015 Summer Assessment report, Net Qualifying Capacity (NQC) of hydro generation for resource adequacy purposes is currently 7,428 MW (53 percent reserve margin contribution),[3] or 13.7 percent of total generating resources as counted towards resource adequacy. In calculating the expected operating reserve margin for 2015 (which accounts for generator outages and derates), CAISO estimated an additional hydro derate of between 1,511 MW (Base Case) and 2,733 MW (Extreme Case) due to drought. In the base case, including the additional loss of 1,511 MW of hydro, CAISO's overall expected actual reserve margin for summer 2015 is 25.3 percent, exceeding the target of 15 percent. Even with the extreme case derate, the reserve margin would be 23 percent, still not enough to threaten system-wide supply margins.

Exhibit 1: Drought information for California as of October 20, 2015



Source: U.S. Drought Monitor

The more pressing issue relates to transmission. Weaknesses in the transmission system leave a significant number of zones with limited import capabilities compared to their demand level, and these zones must therefore rely on local resources. CAISO demarcates 10 transmission-limited Local Capacity Areas (LCAs), and, within these areas, 51 individual sub-zones.[4] These LCAs and sub-zones are determined by CAISO based on transmission security analysis (TSA).[5] CAISO requires that each LCA and sub-zone individually show adequate local resources under contract to satisfy transmission security requirements. These requirements are known as Local Capacity Requirements (LCRs).

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[3] The 2015 NQC calculates the derate for 2015 as the average of the actual derates over 2011-2013, and this is already accounted for in the NQC capacity of 7,428 MW.

[4] The very existence of 51 local sub zones indicates the general weakness in the transmission grid that remains even after significant recent investments in transmission — in most cases to support renewables.

[5] In very simple terms, TSA is a contingency analysis where models assess different combinations of transmission contingencies (unplanned disconnections), and calculate how much local capacity is required to meet reliability criteria set by the North American Electric Reliability Corporation (NERC). Two standards are applied in this analysis: NERC Category B (the single most critical system loss, or N-1) and Category C (loss of the two most critical system elements, or N-1-1). While long-term procurement planning (LTPP) is organized around Category B, CAISO uses Category C for planning local resource adequacy.

Some of these LCAs and sub-zones are very dependent on hydro resources to fulfill their LCRs. Among the 10 LCAs, three rely on more than 1 GW of local hydro capacity: Fresno, Sierra and Big Creek-Ventura, as seen in Exhibit 2.

Exhibit 2: Hydro Resources of CAISO LCAs

LCA	NQC of hydro resources (MW)	Hydro % of total capacity
NCNB	21	2%
Kern	0	0%
Fresno	1,936	69%
LA Basin	299	3%
Big Creek-Ventura	1,221	23%
Bay Area	0	0%
Humboldt	0	0%
Sierra	1,473	68%
San Diego	44	1%
Stockton	210	35%

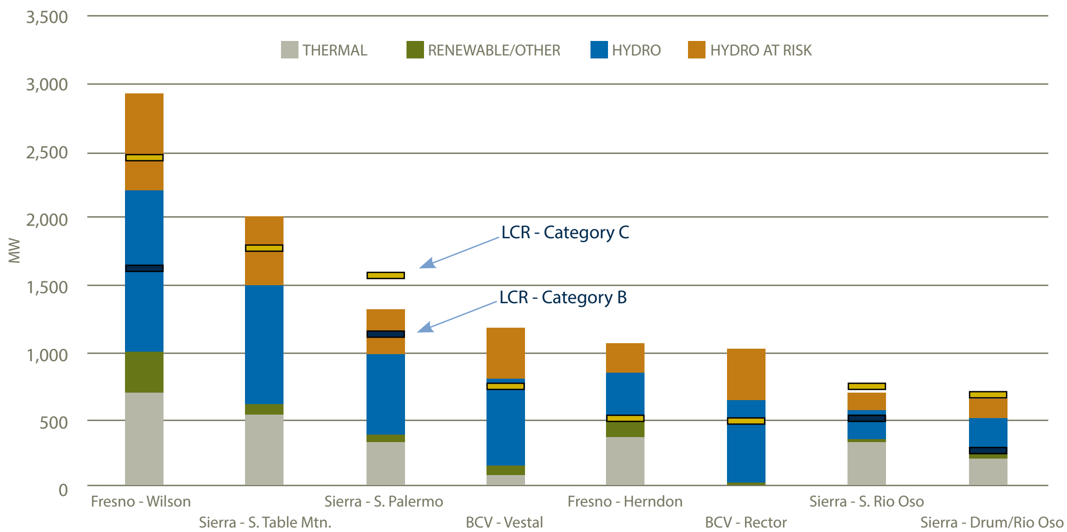
Source: CAISO 2016 Final Local Capacity Technical Analysis and 2015 NQC List

In the 2016 CAISO transmission security analysis, the Fresno, Sierra, and Big Creek[6] LCAs contain 7 sub-zones that will be capacity-deficient, and several other sub-zones which barely clear the requirements, **even assuming hydro-normal conditions**. As noted, these deficiencies factor into the determination of local sourcing requirements and long term procurement objectives. Siting, permitting and procurement of capacity can be challenging in California, especially if units over 50 MW are required (which face greater restrictions than smaller units). Transmission improvements also face extensive lead times and permitting processes, often several years from first identification. Therefore, even after a determination of need, the system may remain stressed for extended time periods before improvements can be realized.

Exhibit 3 plots generation resources in critical sub-zones with the potential for hydro derate of up to 37 percent. As seen below, if hydro resources are unavailable due to the persistence of drought, these areas could experience a serious shortage of capacity.

[6] Big Creek and Ventura are aggregated into one LCA but are distinct areas; Ventura has no hydro capacity.

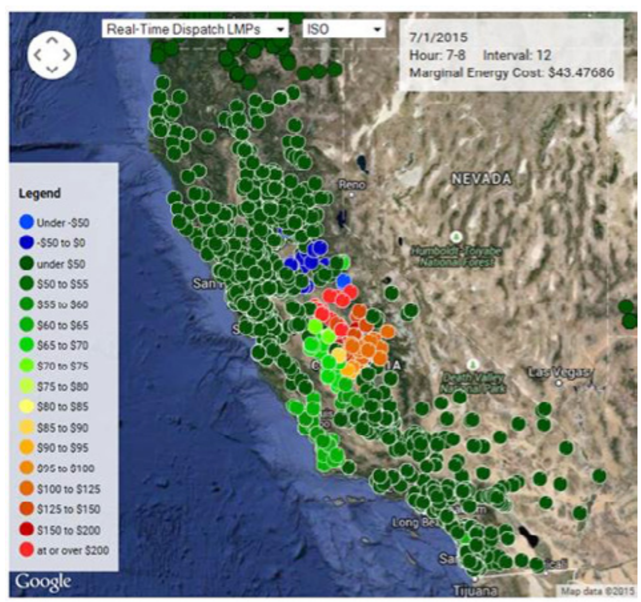
Exhibit 3: Generating Capacity and LCA Requirements in 2016 in Hydro-dependent Sub-zones



CAISO: 2016 Final Local Capacity Technical Analysis

The effects of drought on hydro-dependent transmission-limited areas have already been seen in the past couple of years, most sharply in the Fresno LCA, which has experienced summer prices spiking above the surrounding NP-15 zone. In 2014 and into 2015[7] so far, the annual around-the-clock (ATC) day-ahead energy price in some Fresno nodes was roughly \$10-11/MWh higher than the NP-15 price, with more frequent spikes into the hundreds of dollars per MWh, as shown at right.

Exhibit 4: Example of Premium Pricing in Fresno Area, 7/1/2015



Source: CAISO

[7] Through October 2015.

Such price spikes above the highest peaking plant bids can be thought of as additional capacity revenues. Peaking-dispatchable generators in Fresno have therefore captured implied premiums of $20-45/kW-yr over the past two years, as seen in Exhibit 5.[8] Combined with RA payments, the total translates into $55-$80/kW-yr capacity prices for merchant thermal generators located in this area, close to the CPM floor price of $75.68/kW-yr.

Exhibit 5: Implied Scarcity Premium Ranges, Based on 15,000-18,000 Btu/kWh Scarcity Cut-offs

Scarcity Premium Range ($/kW-yr.)	2010	2011	2012	2013	2014	2015 YTD
Fresno LCA	0.0 – 1.0	0.1 - 0.5	3.6 – 7.0	1.9 - 8.1	20.3 - 43.1	19.9 - 37.1
Sierra LCA	0.5 – 1.0	0.1 - 0.9	5.4 - 9.2	2.2 - 4.5	8.2 - 13.1	15.0 - 22.5
NP-15	0.4 - 0.8	0.0 - 0.3	3.9 - 6.6	1.5 - 3.0	0.7 - 3.6	3.1 - 8.6

Source: ICF, SNL

Potential Winners

Owners of thermal generators in these transmission-limited areas are presented with additional option value against a possible generation shortage due to drought. Exhibit 6 shows operating thermal plants over 20 MW NQC within the Sierra, Fresno and Big Creek LCAs. There is roughly 2,685 MW of thermal generation in these zones. Calpine owns roughly 800 MW NQC, followed by Chevron (592 MW) and Carlyle (255 MW). While these assets are notable, other assets and zones may also face upside pricing potential.

A significant portion (73 percent of MW) of the plants in Exhibit 6 are currently under contract. Following the expiration of these contracts, utilities will need to find new ways to engage these plants and keep them in the market. Faced with merchant energy and capacity payments, many of these plants may opt to mothball or retire, putting local transmission systems under further stress. In the absence of a broader market reform such as the adoption of a centralized capacity market or the institution of a scarcity pricing mechanism with higher price caps, we believe that the only viable near-term generation option for utilities would be re-contracting of these assets.[9]

[8] Scarcity premiums presented are for a cut-off heat range of 15,000-18,000Btu/kWh. Power plants in California typically do not see a heat rate higher than 11,000Btu/kWh. Some peakers have a heat rate of around 18,000 Btu/kWh, the highest in the state.

[9] Alternatives include transmission, which can have its own challenges in California, or demand side programs, which can also be challenging to implement for specified areas.

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Exhibit 6: List of Thermal Plants in Hydro Heavy Sub-LCAs

Plant Name	NQC	LCA	Prime Mover	Owner
Pastoria	715	Big Creek	CC / Gas	Calpine
Kern River 1-4	309	Big Creek	CT / Gas	Chevron
Sycamore	283	Big Creek	CT / Gas	Chevron
Berry Cogen 42	36	Big Creek	CT / Gas	Linn Energy LLC
Wellhead Power Delano	49	Big Creek	CT / Gas	W Power LLC
Rio Bravo Jasmin	32	Big Creek	Steam / Coal-Petcoke	North American Power Group, IHI Corp
Feather River	45	Sierra	CT / Gas	Calpine
Greenleaf 1-2 (Aggregate)	89	Sierra	CC + CT / Gas	Union Bank
Lodi Energy Center (Aggregated Units)	330	Sierra	CC / Gas	NCPA
Yuba City Cogen	24	Sierra	CT / Gas	General Electric, Yuba City Cogen Partners
Yuba City Energy Center (Calpine)	46	Sierra	CT / Gas	Calpine
Fresno Cogen	41	Fresno	CC / Gas	Fresno Cogen Partners
Chow 2 Peaker Plant (Chowchilla)	48	Fresno	IC / Gas	Korean East-West Power
Coalinga Cogeneration (Aggregated)	37	Fresno	CT / Gas	Shell, Exxon
Hanford Peaker Plant	84	Fresno	CT / Gas	Oaktree Capital, Star West Generation
GWF Henrietta Peaker, 1-2	91	Fresno	CT / Gas	Oaktree Capital, Star West Generation
Kingsburg Cogen	24	Fresno	CT / Gas	Fortress
Kings River CT	96	Fresno	CT / Gas	Carlyle Group LP
Starwood Power - Midway	111	Fresno	CT / Gas	Carlyle Group LP
Panoche Peaker	50	Fresno	CT / Gas	Hal Dittmer & Fresno Power
CalPeak Power Panoche 1	48	Fresno	CT / Gas	Carlyle Group LP
Sanger (Dynamis Cogen)	31	Fresno	CC / Gas	Algonquin Power
Total	**2,619**			

Sources: CAISO Final Local Capacity Technical Study 2016, SNL

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