California Statewide Non-Residential Critical Peak Pricing 2010 Impact Evaluation

Josh Bode, M.P.P.

DRMEC Load Impact Workshop
San Francisco, CA
April 26, 2010

FSC
FREEMAN, SULLIVAN & CO.
A MEMBER OF THE FSC GROUP

Presentation Overview

- **Introduction and comparison of rates**
- **Evaluation methodology and validation**
- **Ex post results**
- **Ex ante results**
- **Recommendations**

Introduction and Comparison of Rates

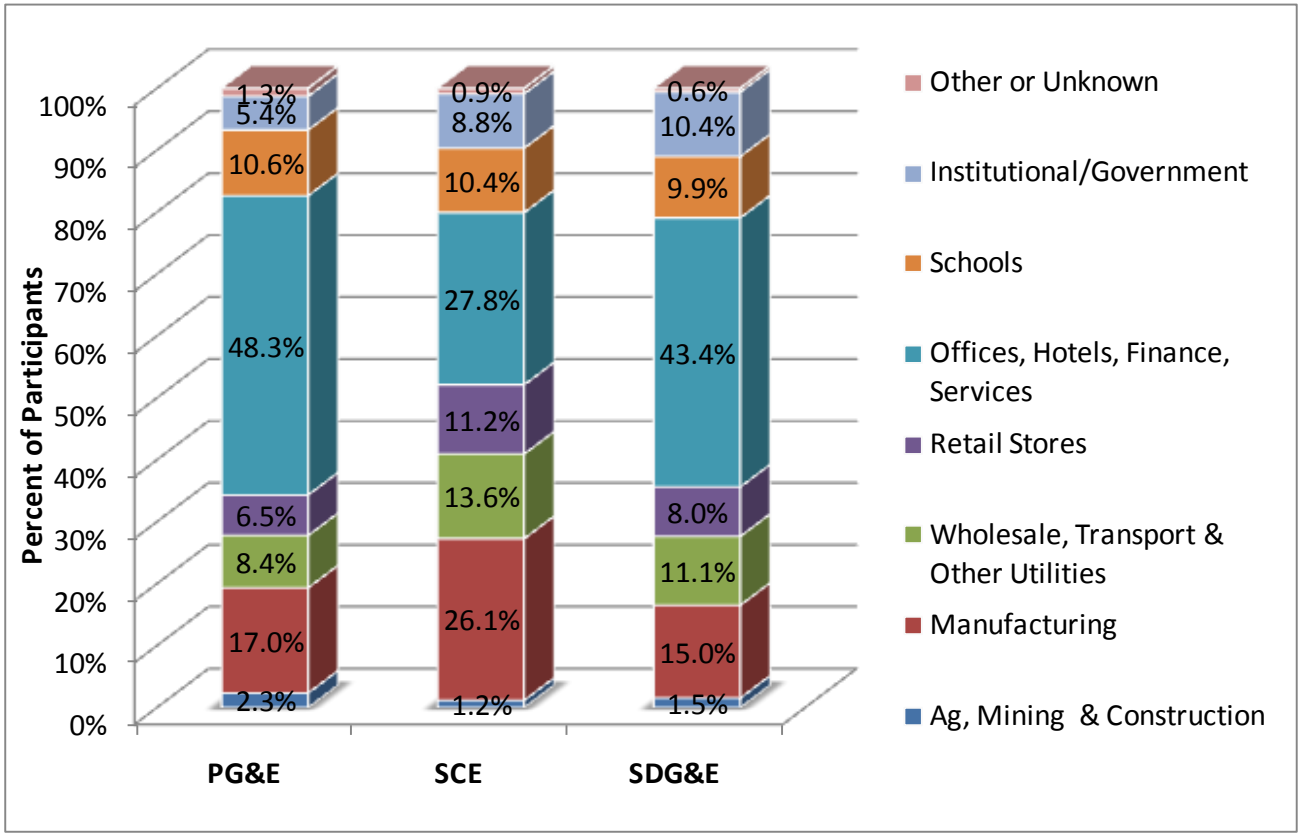
FREEMAN, SULLIVAN & CO.

A MEMBER OF THE FSC GROUP

By the summer of 2010, PG&E, SCE and SDG&E had defaulted approximately 15,000 non-residential accounts onto default CPP

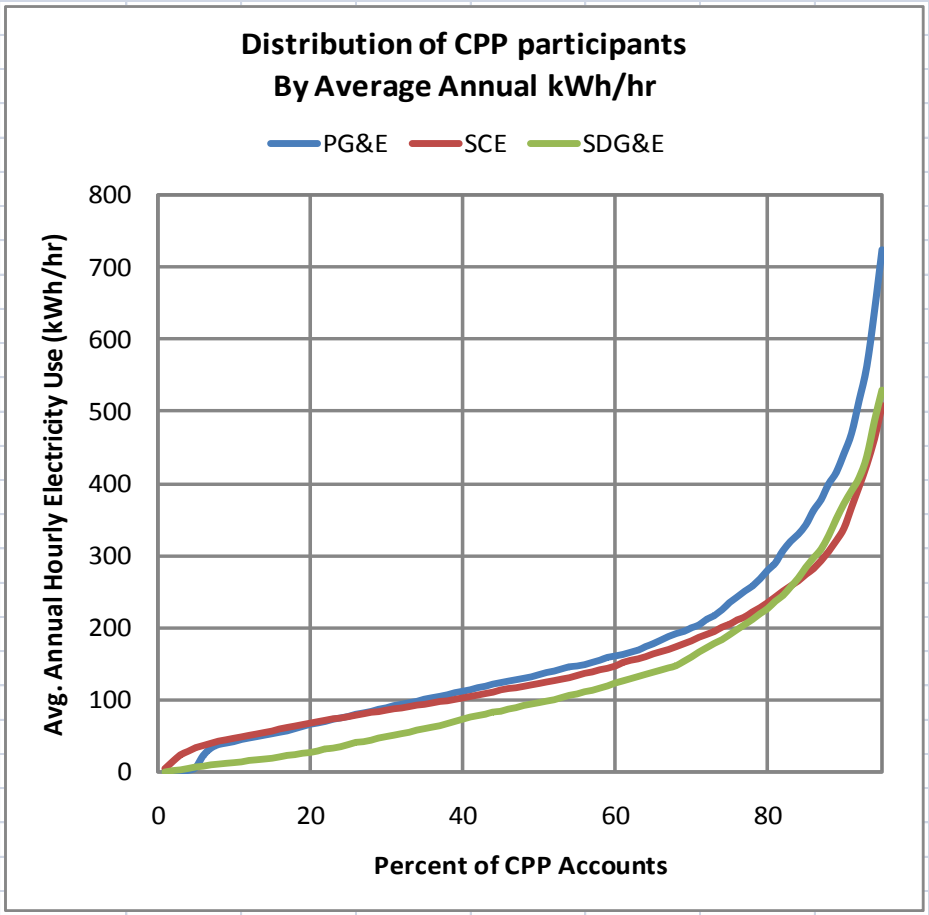
- To date, the 2010 California experience provides the largest body of evidence regarding non-residential customer choice and price response for default dynamic pricing.
- Across all three utilities, 7,100 accounts with roughly 2,200 MW of coincident peak load remained enrolled on default CPP through the summer of 2010.
- Within the next three years, approximately 220,000 medium and 1,000,000 small non-residential accounts are scheduled to be defaulted onto CPP in California. Combined, they account for roughly 8,500 MW during peaking conditions.

The 2010 CPP load by industry varied across the three utilities



- **SCE's CPP load included more Manufacturing and Wholesale and Transport than SDG&E's or PG&E's**
- **PG&E's and SDG&E's program participation had a higher share of load in the Offices & Hotels business category**

Average customer electricity use varied widely across participants in all three utilities



*Graph excludes the top 5% of largest accounts

- **Across all 3 utilitie,s many participants use less than 100 kWh/hr**
  - 670 PG&E accounts
  - 1,570 SCE accounts
  - 663 SDG&E accounts
- **CPP participant load is highly concentrated among larger accounts. The share of peak load in the top 10% of accounts equals:**
  - 44% for PG&E
  - 36% for SCE
  - 41% for SDG&E

Although conceptually similar, many rate & deployment details vary across the 3 utilities

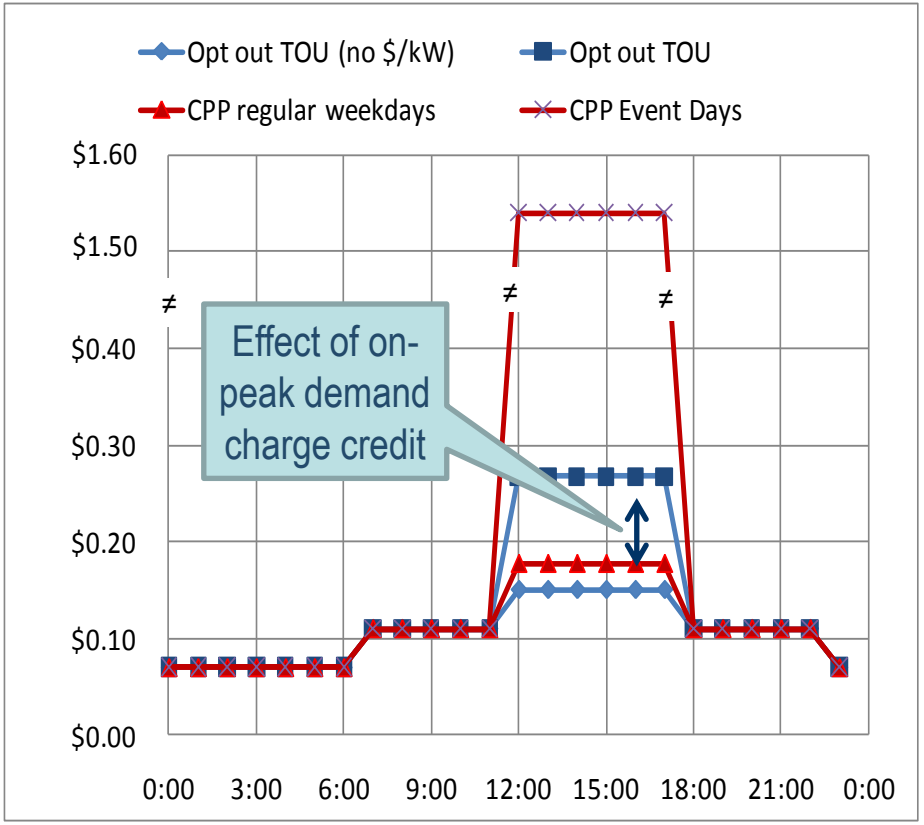
CPP Characteristic	Utility		
	PG&E	SDG&E	SCE
Date of First CPP Default	May-10	May-08	Oct-09
Demand Criterion for CPP Default	>200 kW	>20 kW	>200 kW
Number of Months Demand Must Exceed Threshold	3 out of 12	12 out of 12	NA
Opt-Out Period	Rolling	Once Annually	Rolling
Event Period Hours	2 pm-6 pm	11 am-6 pm	2 pm-6 pm
Event Season	Year-round	Year-round	Summer M-F
Number of Events	9 (Min) -15 (Max)	Maximum 18	9 (Min) -15 (Max)
Summer TOU Peak Hours	12 pm-6 pm, M-F	11 am-6 pm, M-F	12 pm-6 pm, M-F
Winter TOU Part-Peak Hours	NA	5pm-8pm, M-F	NA
Summer Season Definition	May-Oct	May-Sep	Jun-Sep
Winter Season Definition	Nov-Apr	Oct-Apr	Oct-May
Capacity Reservation Default Level	50%*	50%*	NA
First Year Bill stabilization	Yes	Yes	Yes

*Capacity reservation default level of 50% refers to 50% of the customer's peak demand during the previous summer

CPP discounts were mainly applied through reductions to demand charges

Illustrative CPP rates for Summer Months				
Type of Charge	Period	PG& E's E-19	SCE's GS-3	SDG&E's AL-TOU
Energy Rates ($/kWh)	CPP Event Period	$1.20	$1.36	$1.03
	On-Peak	$0.15	$0.15	$0.11
	Semi-Peak	$0.11	$0.11	$0.09
	Off-Peak	$0.09	$0.07	$0.06
Summer CPP Energy Credits ($/kWh)	On-Peak	($0.00)	NA	NA
	Semi-Peak	($0.00)	NA	NA
Summer CPP Demand Credit ($/kW)	On-Peak	($6.10)	($11.62)	($7.06)
	Semi-Peak	($1.30)	NA	NA
CR Charge ($/kW)	Summer	$13.05	NA	$6.25
Summer Season Time Related Demand Charge	On-Peak	$13.05	$15.09	$7.06
	Semi-Peak	$2.99	$3.59	NA
($ per kW)	Maximum Demand	$8.58	NA	NA

The impact of CPP tariffs depends on the rates in place before default CPP - SCE example



- All customers were already on TOU tariffs
- SCE and SDG&E have on-peak demand charges that provide an incentive to shift away from peak periods – in the graph, these have been converted to effective kWh charges
- The TOU rates already provide strong incentives to shift or reduce electricity use during peak periods over summer months
- Much of what customers could easily shift to off-peak periods already had been shifted in response to strong TOU prices, leaving less load reduction potential for CPP

Evaluation Methodology and Validation

FREEMAN, SULLIVAN & CO.

A MEMBER OF THE FSC GROUP

To estimate CPP impacts, load patterns in the absence of program participation—the counterfactual or reference load—must be estimated

Randomized Assignment Strategies	Methods that rely on random assignment to recruitment blocks	Other methods that use pre-enrollment data or control groups	Statistical Methods
• Recruit and deny • Random assignment to start times • Random assignment of dosage • Random assignment to alternating treatment groups	• Intention to treat analysis • Randomized encouragement design (RED) • Selection of control group via propensity score matching combined with random assignment to recruitment blocks	• Difference-in-differences with or without regression • Propensity score matching combined with panel regressions • Regression discontinuity designs (assignment based on cut-off threshold) • Interrupted time series analysis • Panel regressions with an unmatched control group	• Panel regressions without control groups • Regression with heckman selection models • ANCOVA

CONTROL OVER DESIGN AND QUALITY OF RESULTS

- The best available method is a function of program characteristics, available data, the ability to influence, implementation, and statistical methods.
- The goal is to systematically eliminate alternative explanations for change in energy use – the only plausible explanation is CPP

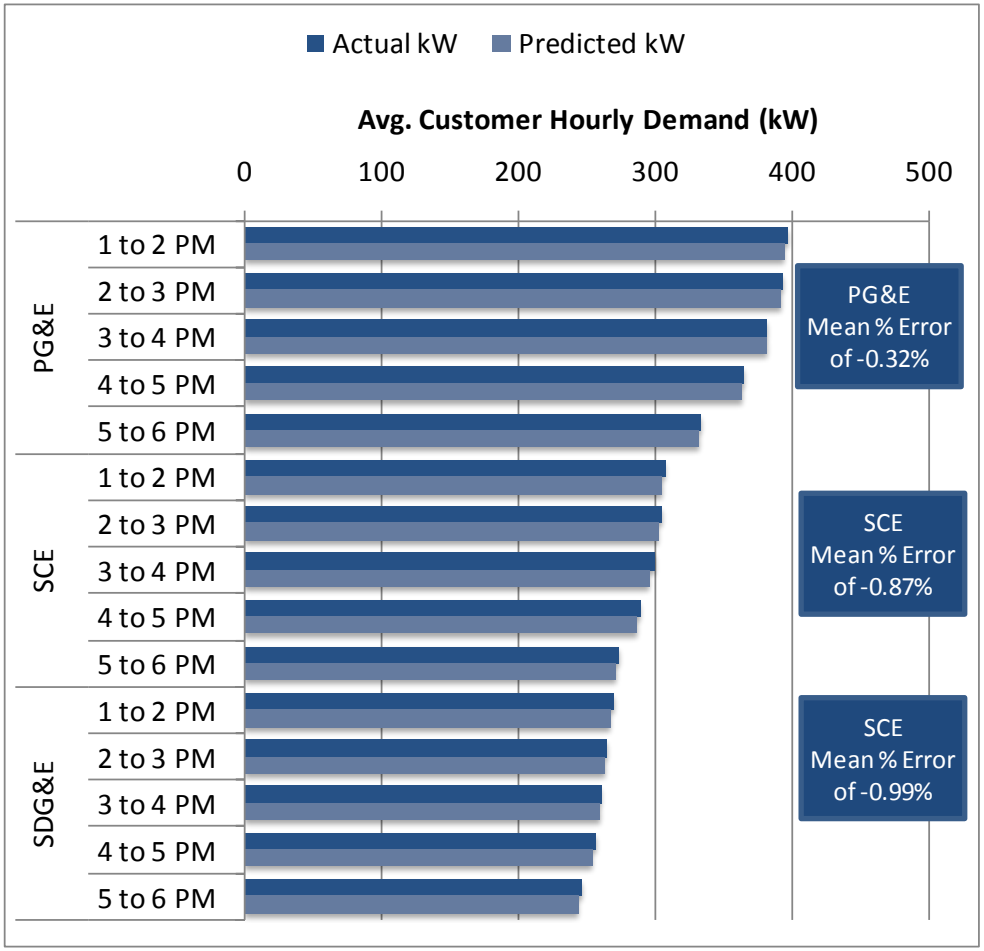
The primary method for CPP used individual customer regressions based on a year of pre-CPP data and 2010 interval data

- **CPP naturally produces an alternating or repeated treatment design**
  - Event days with higher critical peak prices are introduced on some days and not on others, making it possible to observe behavior with and without events under similar conditions.
  - We can observe if demand rises or falls with the presence or absence of a critical peak pricing event.
  - The entire event day is evaluated to estimate both load reductions during event hours and load shifting to non-event hours.
- **Pre-default CPP data helps quantify the effect of CPP tariffs**
  - CPP tariffs also include rate credits on non-event days that can affect energy use. Pre-enrollment data provides information on electricity use in the absence of the rate credits.
  - CPP event days tend to coincide with hot temperatures and can be confounded with them. Pre-enrollment data provides information to disentangle impacts from high prices and hot weather.

Several tests were conducted to ensure impacts were accurate

- How well do the regressions predict out-of-sample on event like days?
- Do the regressions confound event conditions with other factors?
- Do we get similar results if we apply an altogether different analysis approach - panel regressions with a non-equivalent control group?
- Do we get similar results if we change the regression model?
- How accurate are the regressions across temperature conditions?
- Are there particular accounts for whom it is difficult to predict well during event like hours?

Predictive accuracy during event-like days was high for all three utilities



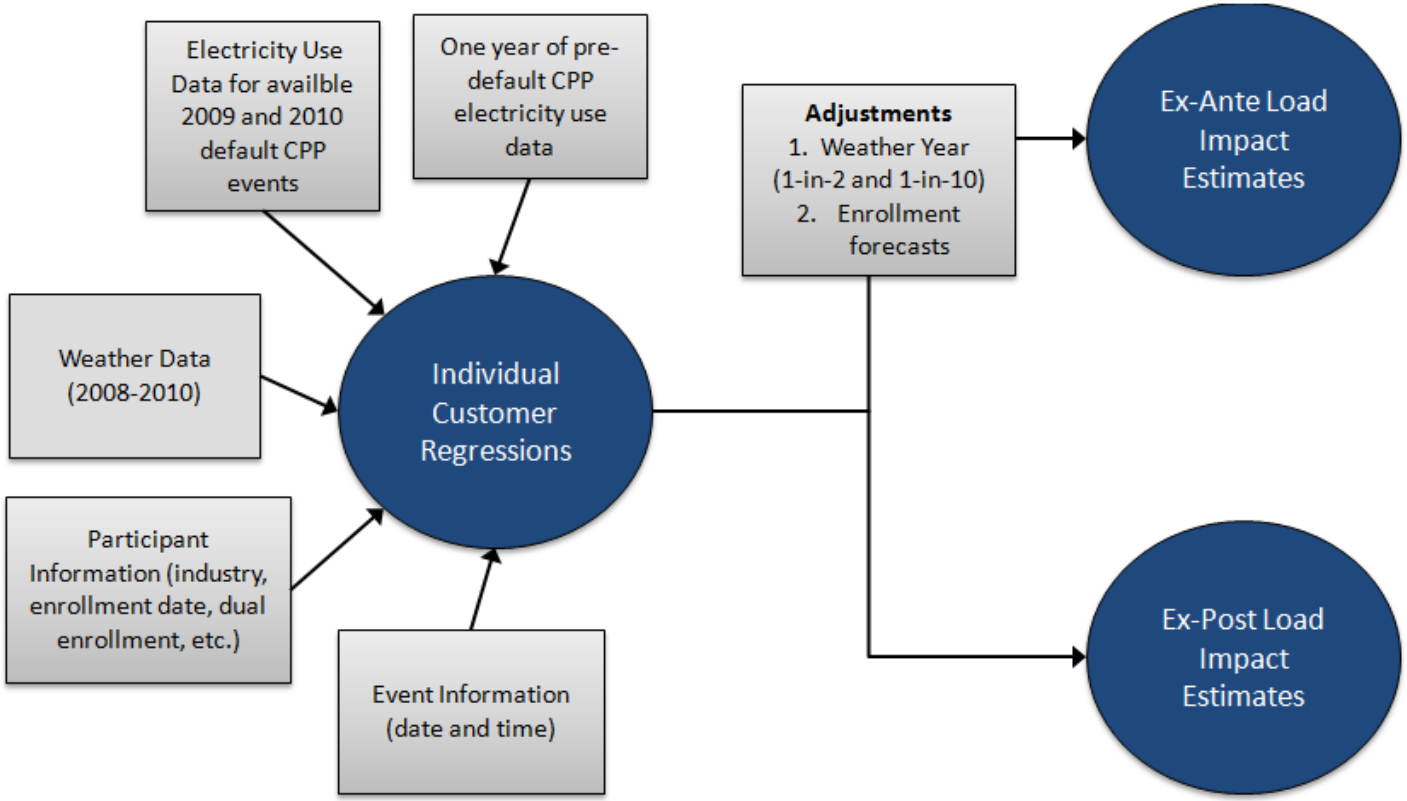
- **The better the electricity use pattern during event conditions is explained, the less likely it is that other factors will be confounded with impacts**
- **Steps in assessment**
  1) Identify event-like days based on highest system load (mostly from pre-CPP period)
  2) Exclude those days from regression models
  3) Predict load for excluded event-like days
  4) Assess how well predicted values match up with actual values

The regressions are unlikely to confound other factors with impacts

Event hour	PG&E	SCE	SDG&E
	% Bias	% Bias	% Bias
11 AM to 12 PM	-	-	0.06%
12 PM to 1 PM	-	-	-0.04%
1 PM to 2 PM	-	-	0.27%
2 PM to 3 PM	2.43%	0.18%	0.14%
3 PM to 4 PM	2.52%	0.08%	0.32%
4PM to 5 PM	2.42%	-0.15%	0.38%
5 PM to 6 PM	1.86%	-0.30%	0.73%
TOTAL	2.32%	-0.04%	0.26%

- **We used a "false experiment" to assess the potential for confounding impacts**
  - Identify event-like days, mostly in pre-CPP period
  - Introduce "fake event" variables
  - The impacts are in fact zero since no event was called. Does the regression get it right or does it pick up impacts when there are none?

For large customers, ex ante impacts are based on historical data and performance



Ex-ante impacts reflect the load reduction capability under a standard set of weather conditions that align with those that drive system planning

2010 Ex-post Results

FSC

FREEMAN, SULLIVAN & CO.

A MEMBER OF THE FSC GROUP

Event days are different across the three utilities

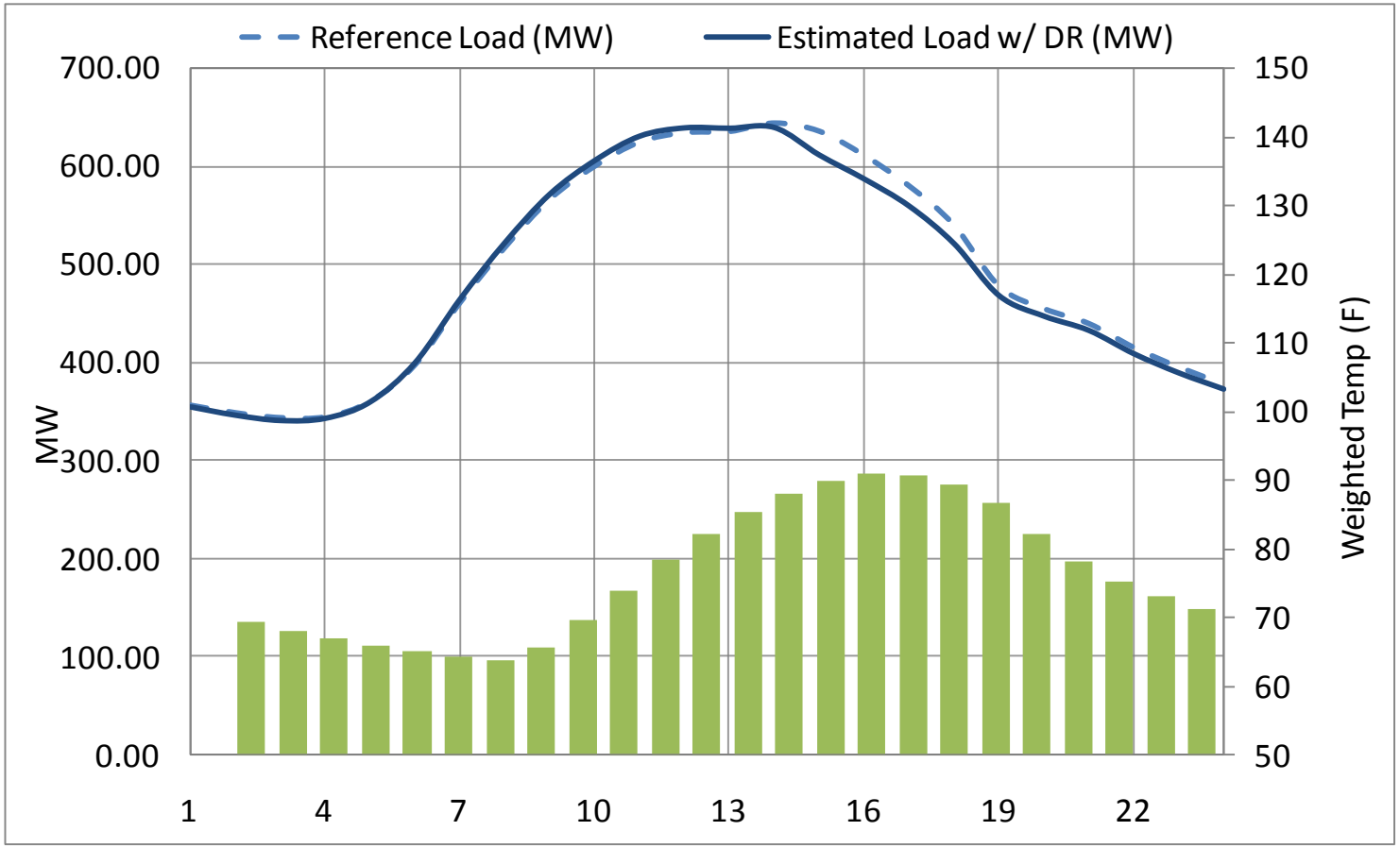
- **PG&E called 9 events**
- **SCE called 12 events**
- **SDG&E called 4 events**
- **Each utility calls event days based on the conditions on their system**
- **SDG&E's event hours last from 11 am to 6 pm and are different than PG&E's and SCE's, which last from 2 to 6 PM**
- **Caution is recommended in comparing ex post results**

- **System load patterns across utilities are not always coincident, particularly for Northern and Southern California**
  - PG&E's system peaked on August 25th
  - SCE and SDG&E's peaked on September 27th
- **August 25th is the only common event across all three utilities**

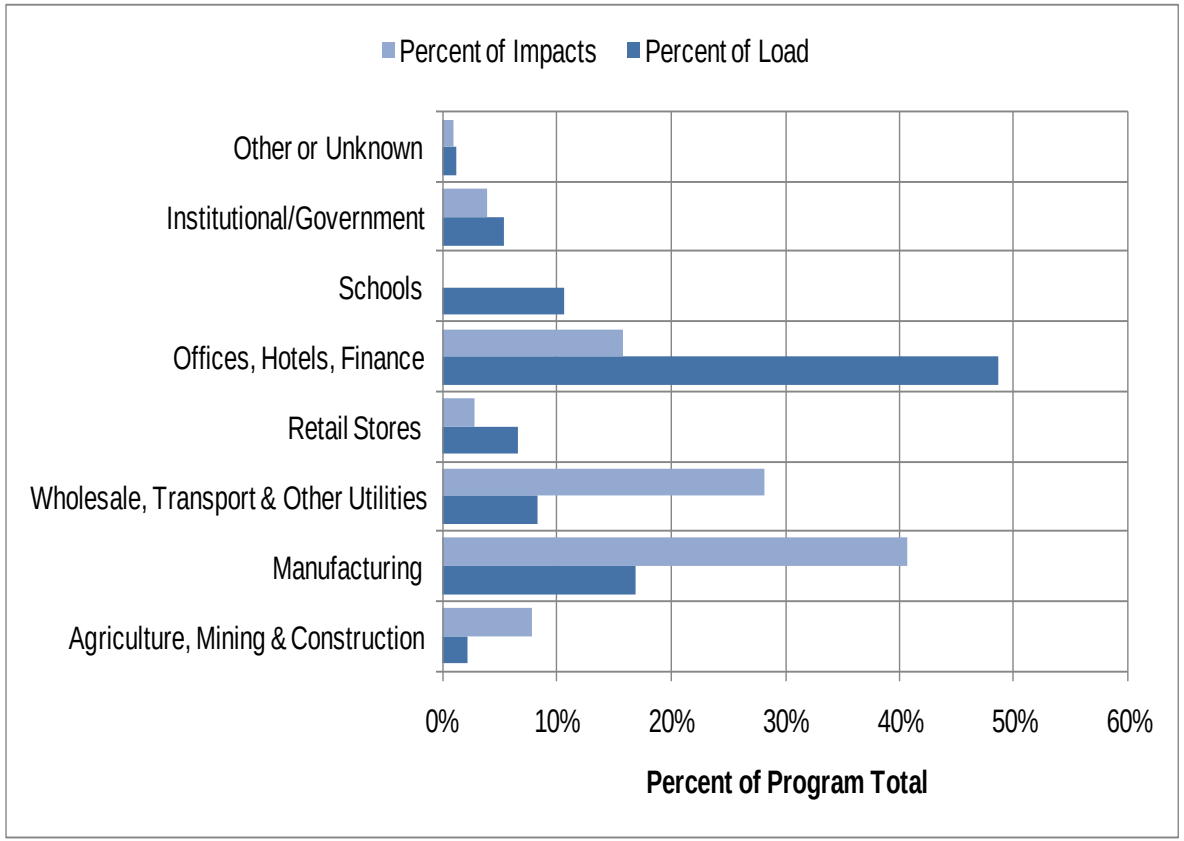
PG&E's average load reduction was 3.9%, or 23 MW, across the 9 events in 2010

Event Date	Accounts	Avg. Reference Load (kW)	Avg. Load with DR (kW)	Avg. Load Impact (kW)	% Load Impact	Aggregate Load Impact (MW)	Average Temp During Event (°F)
7/16/2010	1651	310.4	294.1	16.3	5.3%	26.9	85.0
8/16/2010	1646	324.5	307.4	17.1	5.3%	28.1	80.2
8/23/2010	1643	360.8	348.1	12.7	3.5%	20.9	91.8
8/24/2010	1643	377.0	367.2	9.9	2.6%	16.2	98.7
8/25/2010	1645	373.7	360.4	13.3	3.6%	21.9	92.5
9/1/2010	1659	366.8	353.6	13.3	3.6%	22.0	90.5
9/2/2010	1657	375.4	361.9	13.5	3.6%	22.3	91.6
9/3/2010	1656	340.5	324.0	16.5	4.8%	27.3	86.2
9/28/2010	1817	364.1	352.2	11.9	3.3%	21.6	95.3
Average Event	**1,669**	**354.9**	**341.1**	**13.8**	**3.9%**	**23.0**	**90.2**

The load impact on PG&E's peak day, August 25th, was 21.9 MW or 3.6%



Customers in PG&E's Manufacturing and Wholesale & Transport sectors provided the majority of program load reductions

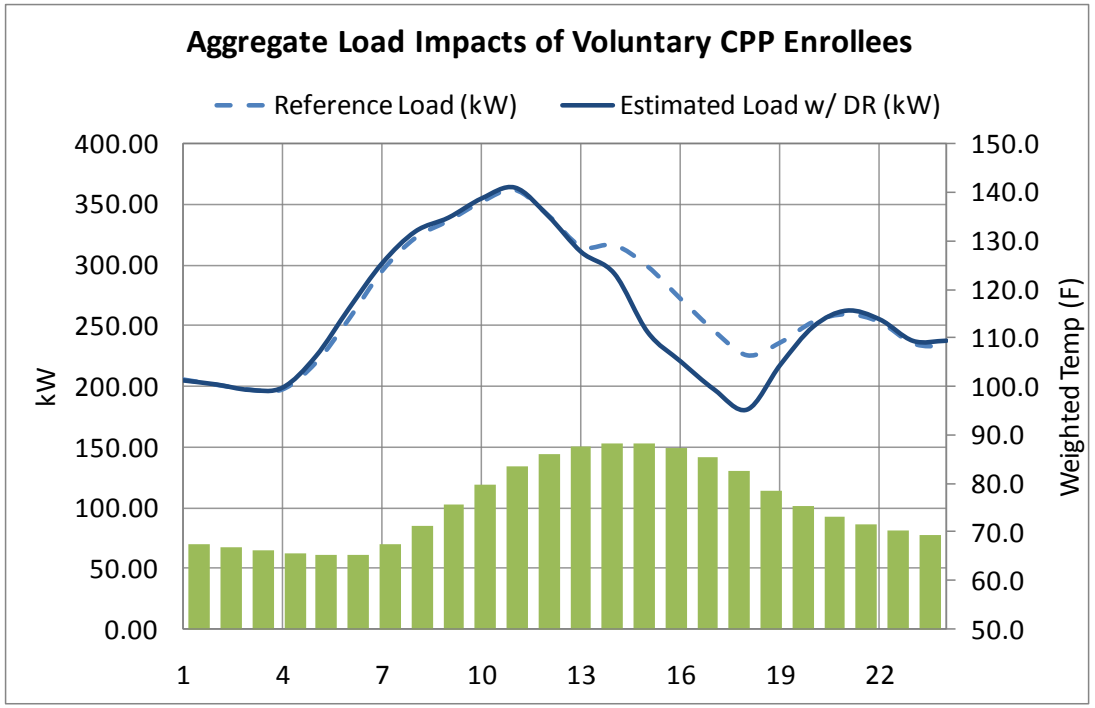


- **Combined they accounted for 26% percent of the load and 70% percent of impacts**
- **While the Offices, Hotel & Finance sector had the most load, 48%, it accounted for only 15% of program impacts**

SCE's average load reduction was 2.8%, or 30.7 MW, across the 12 event days in 2010

Event Date	Number of Participants	Average Reference Load (kW)	Average Load with DR (kW)	Average Load Impact (kW)	% Load Impact	Aggregate Load Impact (MW)	Avg. Temp During Event (°F)
6/30/2010	4198	249.1	241.0	8.2	3.3%	34.3	77.4
7/16/2010	4117	258.3	251.3	7.0	2.7%	29.0	89.4
8/6/2010	4085	233.4	225.2	8.3	3.5%	33.8	76.5
8/12/2010	4085	246.2	238.0	8.2	3.3%	33.7	76.7
8/16/2010	4081	258.5	250.7	7.8	3.0%	31.9	81.7
8/18/2010	4076	275.1	268.1	7.0	2.6%	28.6	87.9
8/23/2010	4076	272.0	264.7	7.3	2.7%	29.6	89.5
8/24/2010	4076	279.6	272.6	7.0	2.5%	28.7	91.1
8/25/2010	4076	277.1	269.7	7.4	2.7%	30.1	88.5
9/2/2010	4076	266.2	258.3	7.9	3.0%	32.2	82.6
9/20/2010	4075	253.2	244.9	8.3	3.3%	33.8	74.9
9/27/2010	4075	293.5	287.9	5.6	1.9%	22.9	100.1
Average Event	**4091**	**263.5**	**256.0**	**7.5**	**2.8%**	**30.7**	**84.7**

Customers that voluntarily enrolled in CPP prior to the default accounted for 65% of aggregate impacts

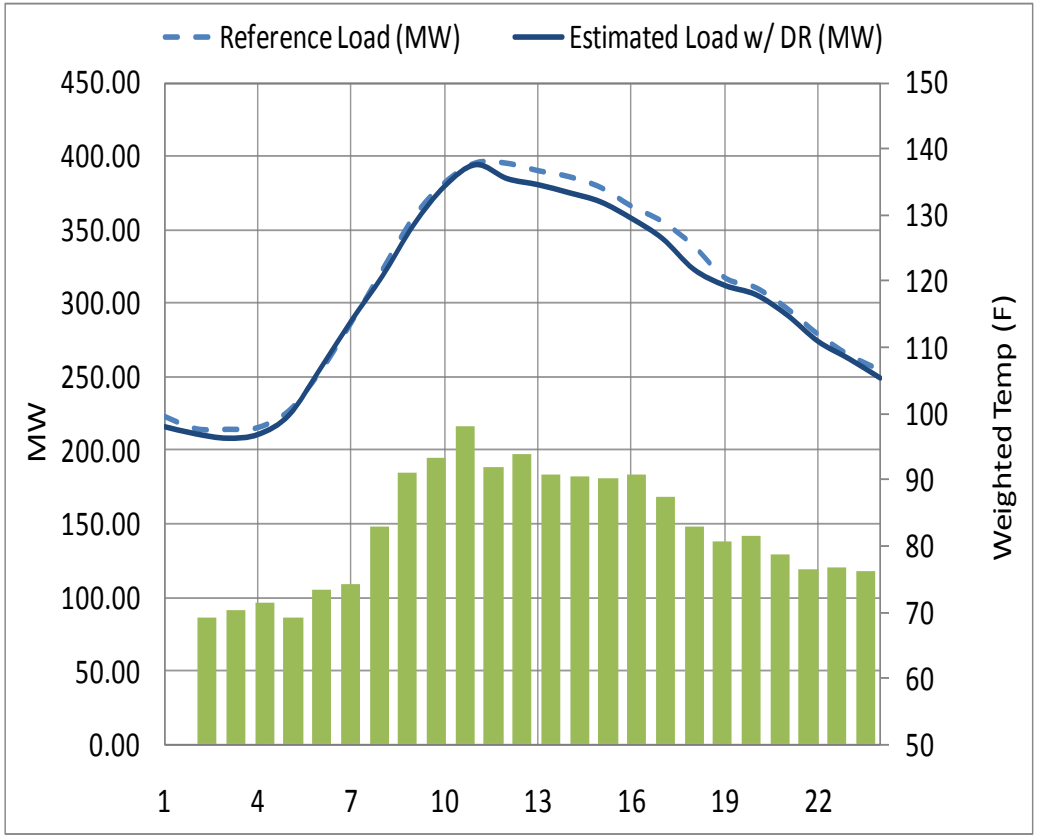


- **Overall, 395 of the roughly 4,100 participants (10%) volunteered onto CPP prior to its implementation as the default rate**
- **Their peak load is almost identical to customers defaulted onto CPP (260 kW per account)**

SDG&E's average load reduction equaled 5.3%, or 18.8 MW across the four event days in 2010

Event Date	Number of Participants	Average Reference Load (kW)	Average Load with DR (kW)	Average Load Impact (kW)	% Load Impact	Aggregate Load Impact (MW)	Avg. Temp During Event (°F)
8/25/2010	1,368	254.3	238.6	15.8	6.2%	21.6	78.8
8/26/2010	1,368	248.7	230.7	18.0	7.2%	24.6	76.0
9/27/2010	1,368	272.8	264.5	8.3	3.0%	11.3	89.5
9/28/2010	1,368	267.2	254.5	12.7	4.7%	17.3	81.2
Average Event	**1,368**	**260.6**	**246.9**	**13.7**	**5.3%**	**18.8**	**81.3**

The lowest impact, 8.3 MW, occurred on September 27, 2010, the hottest event day and the all-time system peak



- **The raw data affirms that the percent impact was low that day rather than simply an artifact of downward bias in the regression**
- **The event occurred late in the summer and was the only Monday SDG&E event in 2010**
- **When 2009 events are included in the analysis, hotter weather conditions correlate with larger percent impacts**

For the first time, SDG&E provides empirical data on multi-year persistence and on the effect of first year bill protection

- **Neither bill protection or multi-year participation had a statistically significant effect**
  - Percent impacts did not increase with the expiration of bill protection, which in theory mutes price signals
  - Percent impacts did not change with multi-year participation
- **Disentangling the two can be difficult because they are closely related**
- **The CPUC extension of bill protection allowed us to disentangle the two**
  - Halfway through the 2009 summer, the CPUC retroactively extended bill protection for an additional year for customers that were defaulted on the rate in 2008
  - For the first half of 2009, those customers provided price response as if bill protection had expired since the extension of bill protection was not known at the time. For the latter half of the 2009 summer, they provided price response with bill protection.

The SDG&E evaluation also produced several notable findings

- **CPP price insurance, known as the capacity reservation level, dampens impacts**
  - The smaller the share of load exposed to CPP prices, the smaller the percent impacts
  - The share of load exposed to CPP prices varied from event to event for individual customers
- **Structural winners provided larger load reductions**
- **Customers with annual average hourly consumption of 100 kW or less were more price responsive than larger ones**
- **Dually enrolled customers were 6% of accounts but provided 35% of impacts. Percent impacts from BIP and CBP customers were larger even after accounting for differences in customer mix.**

Ex-ante Results

FREEMAN, SULLIVAN & CO.

A MEMBER OF THE FSC GROUP

Uncertainty for large customer ex ante load impacts has narrowed substantially because they have already been defaulted

- **We now know:**
  - how many of these customers tried out default CPP;
  - how much load reduction they provide during events;
  - what type of customers are more responsive; and
  - how many remained on CPP at the end of the summer.
- **We also have a good idea about second and third year opt-out rates and persistence of impacts.**
- **While some attrition will occur as customers in the first and second year determine if CPP is the right rate for them, the customer mix for these customers is expected to remain relatively stable.**

There is less certainty for medium customers and no relevant empirical data for Small accounts

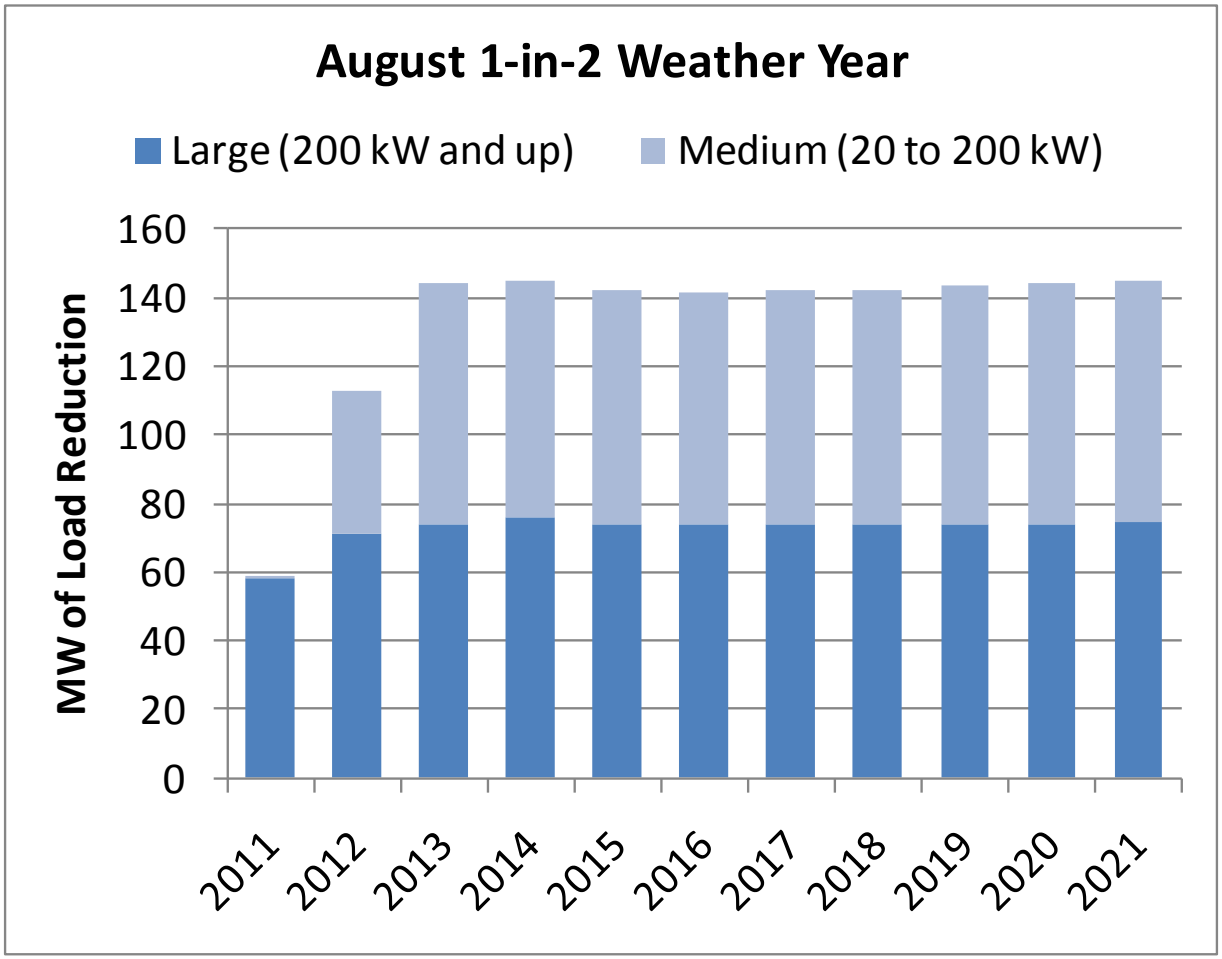
MEDIUM C&I

- SDG&E and SCE medium customer rates are nearly identical to those of 200 to 500 kW customers
- Some information can be inferred from customers with under 100 kW of annual average hourly consumption, but needs to be scaled and adjusted for differences in customer mix

SMALL C&I

- Default CPP opt rates are unknown
- Default CPP rates are unknown
- Default CPP can potentially affect a lot of customers – about 1 million – but they only account for 15% of total C&I demand

Ex Ante Impacts are projected to grow with the scheduled introduction of default CPP



Recommendations and Concluding Remarks

FSC

FREEMAN, SULLIVAN & CO.

A MEMBER OF THE FSC GROUP

Recommendations

- **Conduct research on how to improve percent load reductions among large customers**
- **Reduce the uncertainty in enrollment and impacts among small C&I customers by using a staged deployment approach (if feasible)**
  - To date, there is very limited factual data on what works and what doesn't in helping SMB customers migrate to default dynamic pricing
  - There is no empirical data on the share of customers that will try out CPP if defaulted, how customers will react and the extent to which they will reduce load under default CPP or opt out TOU.
- **Develop CPP impact estimates for agricultural customers**
  - Adequate empirical data was not available for the 2010 evaluation. Neither PG&E nor SCE had defaulted large customers on agricultural rates onto CPP. While SDG&E did default about 100 accounts, they were almost exclusively golf courses and water districts.

For any questions, feel free to contact

Josh Bode, M.P.P.

Freeman, Sullivan & Co.
101 Montgomery Street 15th Floor, San Francisco, CA 94104
joshbode@fscgroup.com
415.777.0707