



DRAFT - T&D Assessment Distribution Line Transformer / Secondary

Pacific Gas and Electric Company
November 15, 2010



Analysis of Transmission, Distribution Substation & Primary, Transformer & Secondary Impacts

- Key Points of Analysis Completed

- Not all cars need full charge when plugged in
- Not all cars plug in at peak as not everyone is home at peak
- Car peak demand varies based upon car battery charger size: 1.4 kW, 3.6 kW, 7.2 kW
- Distribution primary system per car load range = 0.68 kW to 1.1 kW
- Charging impacts are highest at the house service, then secondary, then transformer and decrease as the voltage increases
- Analysis completed matched current processes on evaluating new residential loads

Transformer & Secondary Impacts

- Immediate impacts once PEV's are sold and start charging
- Full impact of charging, 1.4 to 7.2 kW per PEV
- Approximately 50% of the time an upgrade is required if charging at peak time period
- Approximately 10% of the time an upgrade is required if charging at non peak time period (non air conditioning area)
- The more PEV's connected the higher the likelihood an upgrade is needed
- Underground systems needing upgrades take more time and are more costly
- Upgrade costs depend on penetration rates, the time of day when charging, and time of the year
- Costs could reach the \$100's of millions in 5-10 years

Distribution Substation, Primary and Transmission Impacts

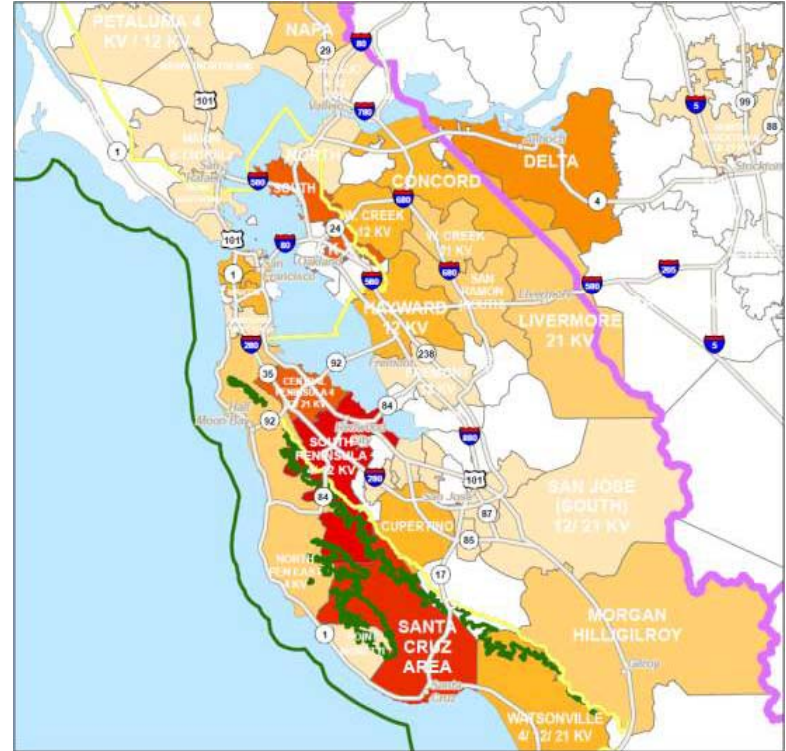
- No impacts expected for the foreseeable future
- Diversified impact of charging, approximately .7 kW per PEV
- Future impacts depend on penetration rates



Clustered PEV Adoption, Load Impacts



Nissan Leaf Reservations

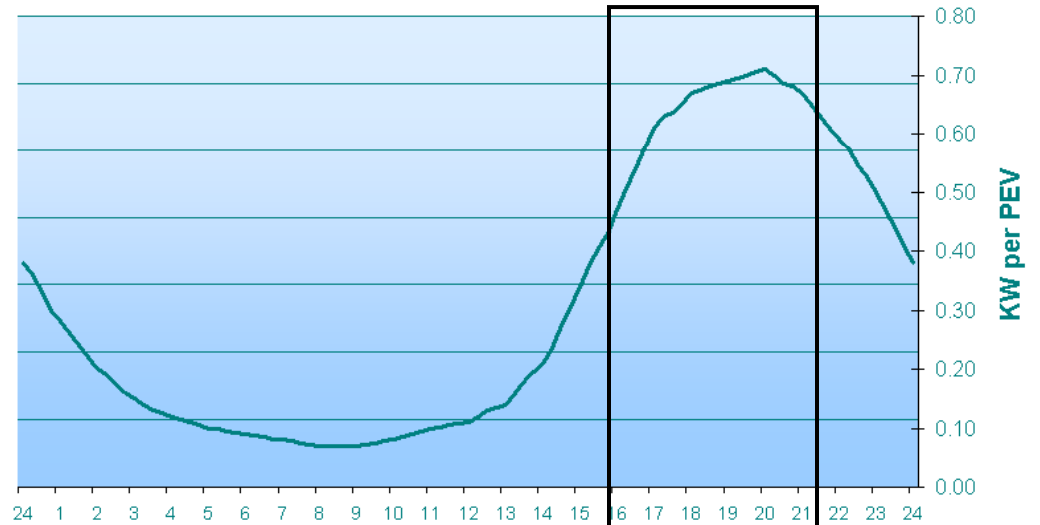


Load Impacts



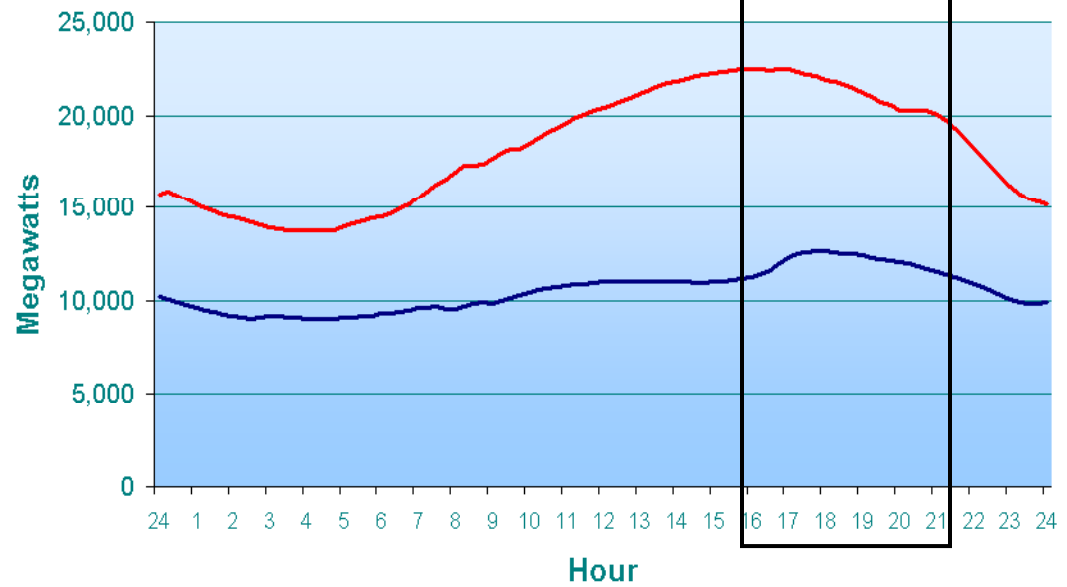
Uncontrolled Charging Adds to Peak

PEV Charging Load



Peak Summer Load

Minimum Load Day





Real life distribution line transformer & secondary study leads to two distinct conclusions

Background:

- Study analyzed what happens when a customer purchases an electric vehicle
- Analyzed impacts on transformer and secondary system at peak and off peak
- One EV added, then a 2nd EV and a 3rd EV at each charging level
- Analysis looked at 3.6 kW and 7.2 kW cars at 240V
- Berkeley analysis was on overhead and underground system (non-AC area)
- Fresno analysis was an overhead system (AC area)
- San Ramon analysis was on underground system (AC area)

Conclusions:

- Non-AC areas will need upgrades at peak and off peak
- AC areas will need upgrades at peak only

Percent of time upgrade is needed (first 1 - 5 years)

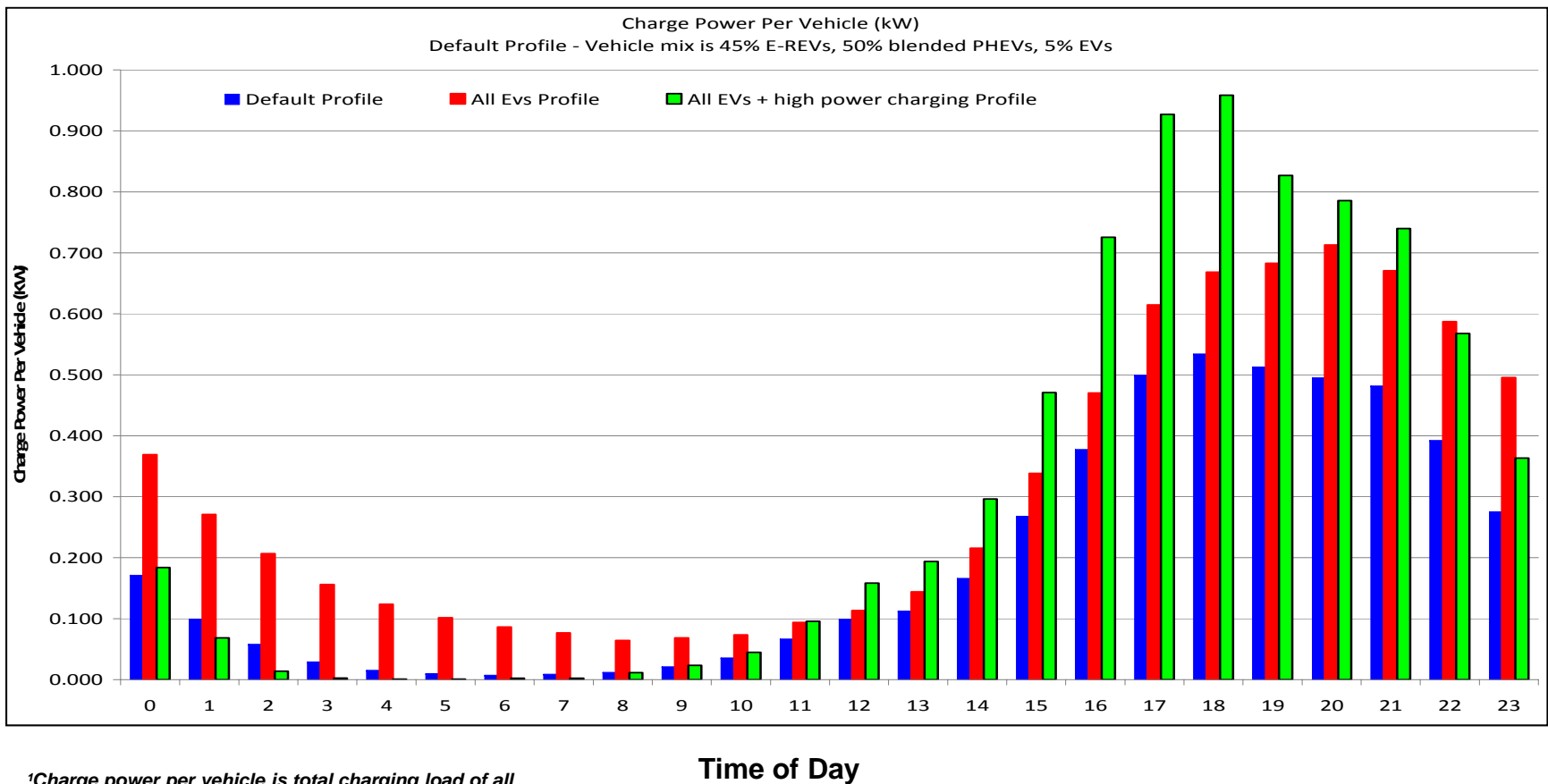
	Berkeley	Fresno	San Ramon	Average
Transformer Off Peak	11%	0%	0%	4%
Secondary Off Peak	11%	0%	0%	4%
Transformer On Peak	54%	57%	8%	39%
Secondary On Peak	25%	8%	25%	19%



Power demand for uncontrolled charging

- The peak load (~500W / EV) occurs between 5 PM and 7PM and lasts into the evening
- If all the vehicles are BEV, the peak load still occurs at between 5PM and 7PM, but increases to ~700W / BEV

1



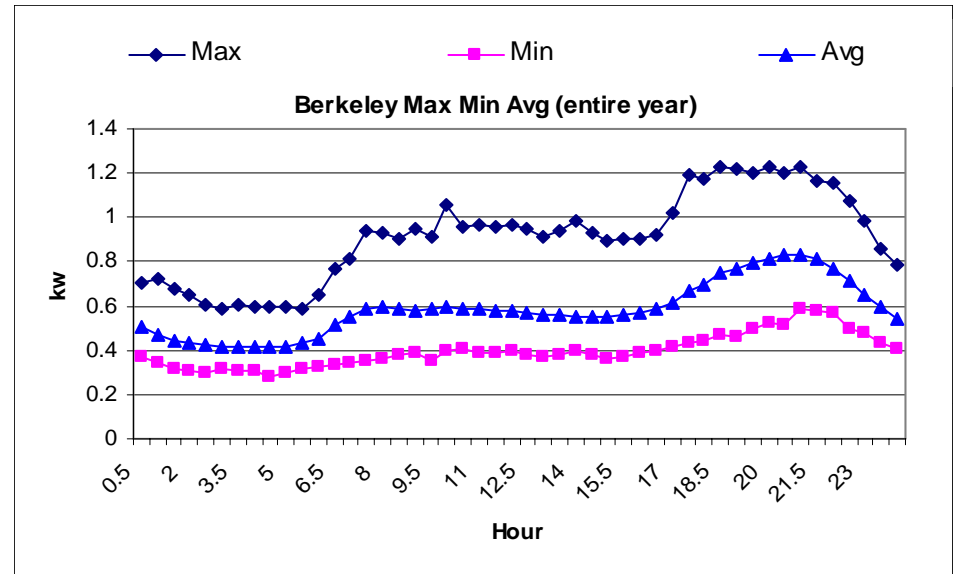
¹Charge power per vehicle is total charging load of all PEVs at specific time of day / total # of PEVs



Residential Load Pattern Berkeley vs Fresno

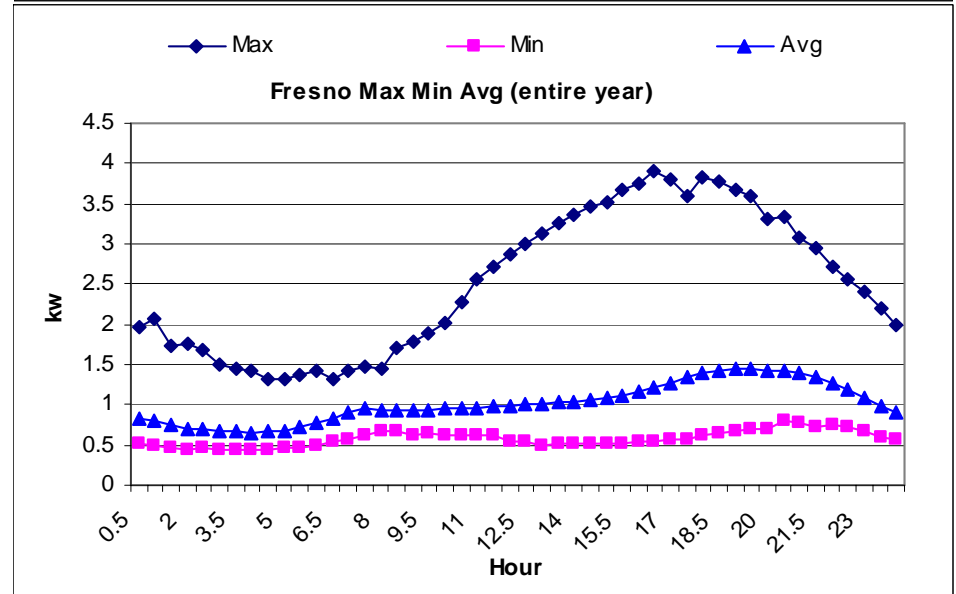
Berkeley

- Residential winter peaking
- Early morning and evening peaks
- Summer load is generally lower and constant



Fresno

- Residential summer peaking
- Noon to 11 pm peak
- Winter load is generally lower

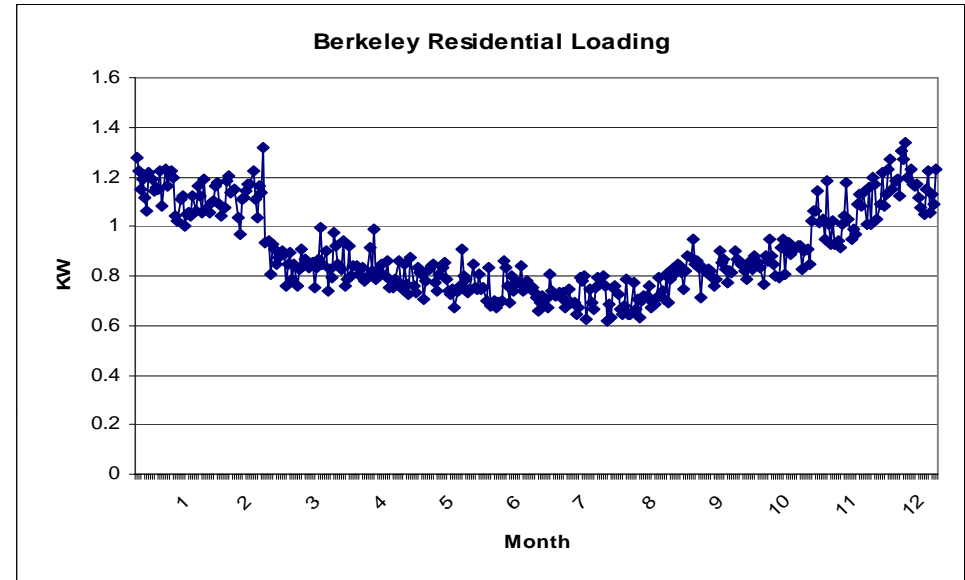




Residential Load Pattern Berkeley vs Fresno

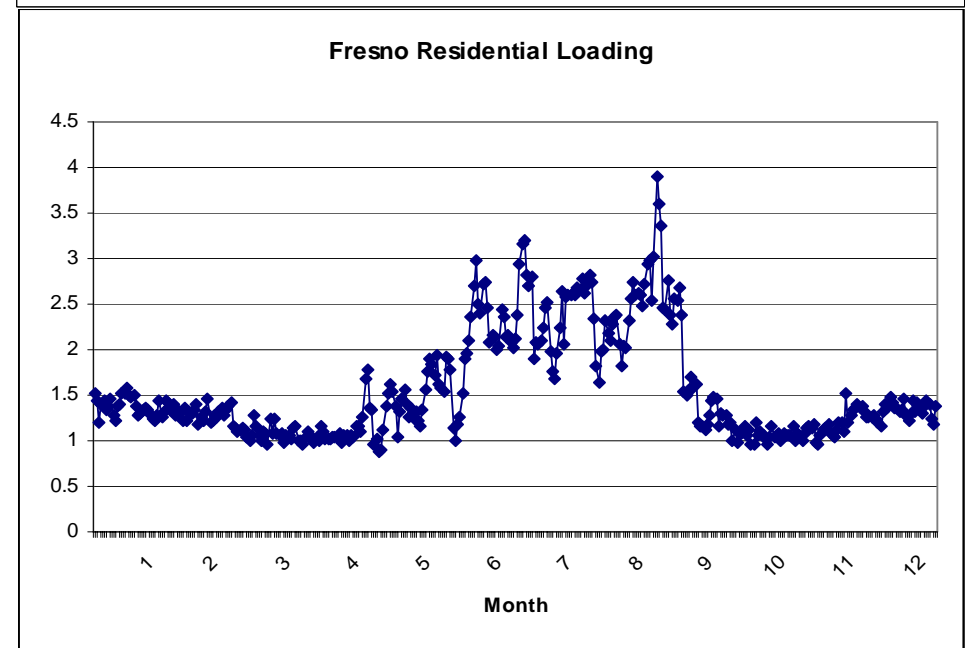
Berkeley

- Residential winter peaking
- Early morning and evening peaks
- Summer load is generally lower and constant



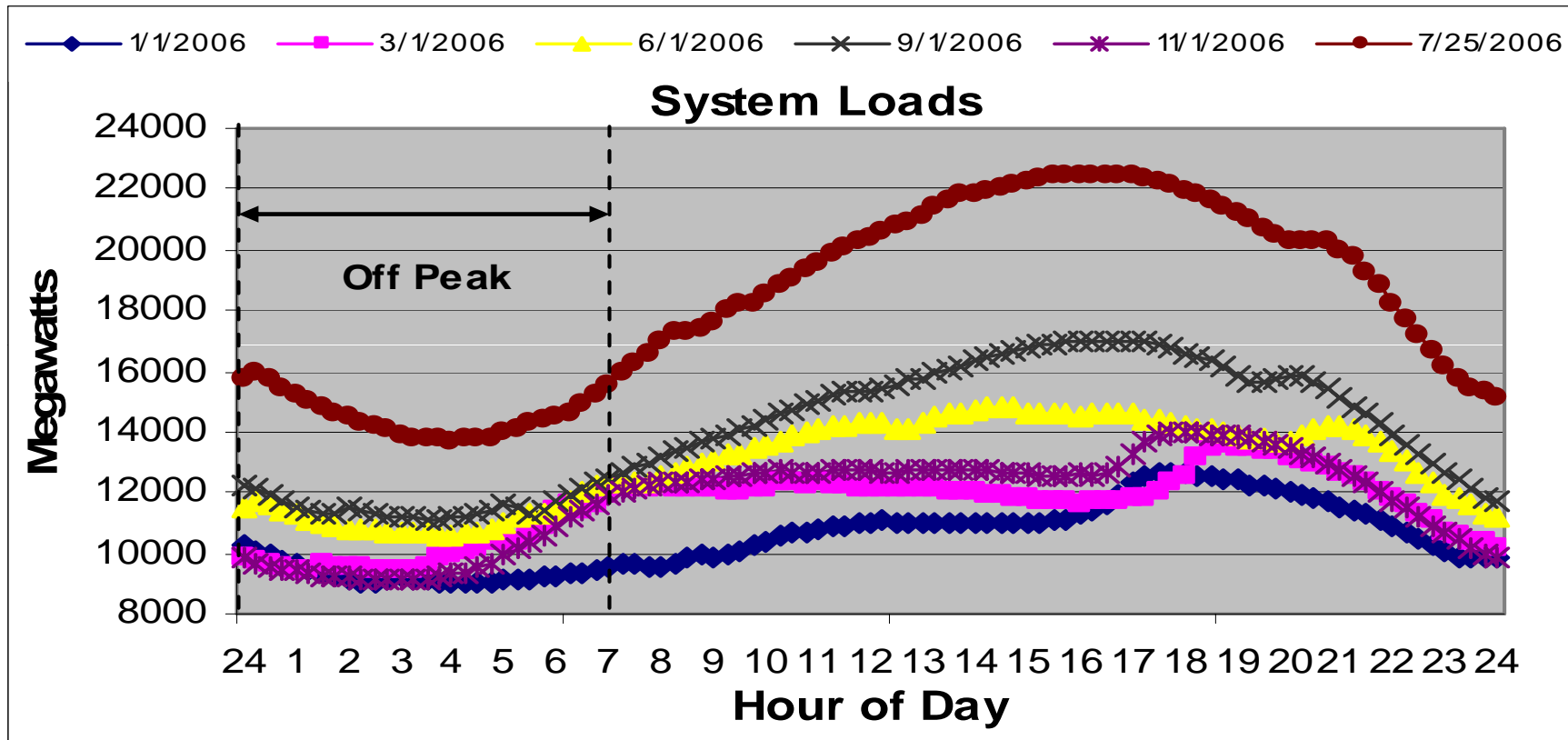
Fresno

- Residential summer peaking
- Noon to 11 pm peak
- Winter load is generally lower





System Peak Loads



System Peak Loads

- Summer is the dominate peak period – AC driven load
- In 2006, 80-100% of peak occurred in ~170 hours over multiple days (170 hrs = 7 days)
- In 2006, 90-100% of peak occurred in ~50 hours over multiple days (50 hrs – 2 days)

Winter Peak Loads

- System loads in the winter are significantly lower than summers

DRAFT



1) Allowing Customers to Charge Before Upgrade

Customers choice:

- Can charge at any time of day

System Peak Load:

- 80-100% of peak is less than 170 hrs per year
- Transmission, substation, primary, dsbn transformer, secondary are generally designed for peak load
- Dsbn transformer, secondary are the most impacted equipment and provide power for 1 to 20 customers

Future Corrective Work:

- Analysis and upgrade planned to be completed in approximately 4 days
- Analysis completed prior to or soon after customer notifies PG&E

Overall Impact of Allowing Charging Prior to Upgrade:

- Could load the transformer above its capability
- Could create low voltage condition at the EV owner or adjacent customer
- Could cause an outage to all customers fed from dsbn transformer (fuse blows, transformer failure)

Impact Mitigation Plan:

- Reduce dsbn transformer and secondary wire failures
- Reduce significant voltage drop
- During initial corrective work analysis add in an additional step that reviews:
 - Time of year and is system designed already for AC (is charging prior to upgrade during peak load period)
 - Have overload and voltage ok thresholds above corrective work requirements temporarily (i.e. allow transformers to be loaded to 125% normal limit, allow voltage drop to 8.5 volts)
 - If analysis is outside of thresholds expedite the corrective work (move to top of list)



Tariff vs Upgrade

Will the Electric Vehicle Tariff defer system upgrades?

- Short term the answer is one of impact to the dsbn transformer / secondary / service. *Will customers adjust charging to take advantage of rate schedules?*
- Long term the risk is the same as transformer, secondary & service but the primary system will potentially be impacted
- As more electric vehicles are added to the dsbn transformer / secondary / service an upgrade becomes inevitable
- In the non-AC areas even charging at night would require upgrades in 10% of cases initially and grow over time.
- In the AC areas air conditioners can run at night
- We don't know yet how customers will respond to electric vehicles and the tariff
- How will the utility know who will follow the tariff and who wont

Recommendation

- For purposes of evaluating the benefits of the tariff perform upgrades at appropriate time and revisit this approach in 6 months to a year after more information is received



Update Distribution System Design

Subdivision / New Residential Service

- Current design - 6.5 volt drop, 25, 50 or 100 kVA transformer (depends on number of customers to be served / loading)
- Future design – 5 volt drop, minimum 100 kVA transformer (subdivision), 25 kVA single customer *(note 5 volt drop matches adding two 7.5 kw chargers on the transformer resulting in 6.5 volt drop, analysis was ran to compare the two).*
- Cost impact of going to 100 kVA minimum ~\$2 million per year (PG&E only construction, does not include applicant installed)

New or existing overhead serving multiple customers

- Current design – 6.5 volt drop, 15, 25, 50, 100 kVA transformers (depends on number of customers to be served / loading)
- Future design – 5 volt drop, upgrade transformer / secondary / service to minimize pole replacement, if replace pole upgrade transformer size and replace secondary / service as needed

Reason for change

- Increases new capability to serve 2-3 electric vehicles initially
- Need to revisit design yearly once we have better information on penetration rates
- Proactive design change that is pragmatic
- System design personnel need consistent guidance to reduce confusion and meet customer needs