Electric Vehicle Opportunities

Intermediate Training

Electric Vehicle Charging

Electric vehicle use is growing in North America

Over 1 million EV’s have been sold in the U.S. since 2010
- Over 50,000 per month
- One of every 200 cars in U.S is an EV
- One of evert 50 cars in California is an EV
- About half of all EV’s are in California

There are approximately 25,000 public charging stations currently in service in 2020, up from 15,000 in 2017
- 18,000 are in California, 15% are fast chargers

Electric Vehicle Charging

How Electric Vehicles Could Sink the Texas Grid

“Simultaneous charging of just 60,000 next-generation electric vehicles could one day threaten the Texas grid”, an analysis has shown.

“Based on a 100-kilowatt EV battery with a 5-minute charge time, which could potentially be the standard for EV’s in three or four years, demand from 60,000 cars charging at once would equate to 70 gigawatts”, said analysts from GTM’s parent company, Wood Mackenzie.[1]

[1]JASON DEIGN DECEMBER 19, 2017
https://www.greentechmedia.com/articles/read/how-electric-cars-could-sink-the-texas-grid#gs.AzaZgsk

Electric Vehicle Charging

"California Wants More Than 4.2 Million Electric Vehicles By 2030; *A New Plan Charts The Road Ahead*".

"Electrification is key to driving these emissions down, the state has aggressive electric vehicle targets, aiming to have 1.5 million EV's on the road by 2025 and more than 4.2 million EVs deployed by 2030".

https://www.forbes.com/sites/energyinnovation/2017/12/14/california-wants-4-2-million-electric-vehicles-by-2030-a-new-state-plan-charts-the-road-ahead/#693405564b44

Electric Vehicle Charging

IMPACTS OF PEV CHARGING RATE, PENETRATION AND CHARGING PERIOD ON THE POWER QUALITY OF SMART GRIDS

Charging Rates	Charging Periods	Low PEV Penetration (20%)				High PEV Penetration (80%)			
		$P_{LOSS}^{MAX}/P_{TOTAL}^{PEAK}$	Max. voltage deviation** [%]	Trans. I^{max} [pu]	THD_V [%]	$P_{LOSS}^{MAX}/P_{TOTAL}^{PEAK}$	Max. voltage deviation** [%]	Trans. I^{max} [pu]	THD_V [%]
Normal Charge 6 Hr @ $P_{chg,max} \approx$ 2.4 kW	5pm-8am	2.146	12.700	0.812	3.385	2.304	17.246	0.946	13.704
	5pm-2am	2.232	12.945	0.861	2.875	2.760	18.249	1.102	15.830
	5pm-11pm (peak)	2.275	12.986	0.884	2.837	3.239	18.826	1.181	15.830
Medium Charge 4 Hr @ $P_{chg,max} \approx$ 3.6 kW	5pm-8am	2.217	12.936	0.896	3.800	2.464	18.736	0.987	15.919
	5pm-2am	2.188	12.875	0.893	4.089	2.769	19.627	1.179	22.446
	5pm-11pm (peak)	2.305	13.132	0.933	4.073	3.712	21.422	1.343	24.430
	5pm-9pm (peak)	2.357	13.139	0.933	4.073	4.057	21.518	1.395	24.430
Quick Charge (to 80% Capacity) 1 Hr @ $P_{chg,max} \approx$ 11.4 kW	5pm-8am	2.185	12.665	0.912	8.627	3.672	35.524	1.343	45.935
	5pm-2am	2.411	13.879	1.031	10.371	3.270	35.452	1.343	45.935
	5pm-11pm (peak)	2.337	13.579	1.063	10.491	3.495	33.022	1.696	52.584
	5pm-6pm (peak)	3.126	13.920	1.267	13.266	----	----	----	----

Chart From: Power Quality of Smart Grids with Plug-in Electric Vehicles Considering Battery Charging Profile

- The more EV chargers, the worse the power quality
- The faster the charger, the worse the power quality
- As the battery charge gets closer to 100%, the load decreases while the overall THD increases

Electric Vehicle Charging Issues

The conclusion of a technical paper *Smart Grids with Plug-in Electric Vehicles Considering Battery Charging Profile* paper was:

- With low EV penetration levels, normal EV charging rates, irrespective of time-zone, simulation results show acceptably low harmonic levels and voltage deviations with the least amount of losses[1]

- Quick charging rate will cause significant voltage harmonics and losses, as well as transformer overloading if charging is concentrated at peak times[2]

- For high penetrations, EV's will cause unacceptable and severe voltage harmonics, deviations, power losses and transformer overloading. While the HV system may be able to cope with the extra EV charging load, it is clear that the LV infrastructure will be significantly stressed and affect the reliability of network assets (e.g., transformers)[3]

1, 2, & 3: Power Quality of Smart Grids with Plug-in Electric Vehicles Considering Battery Charging Profile

Electric Vehicle Charging Issues

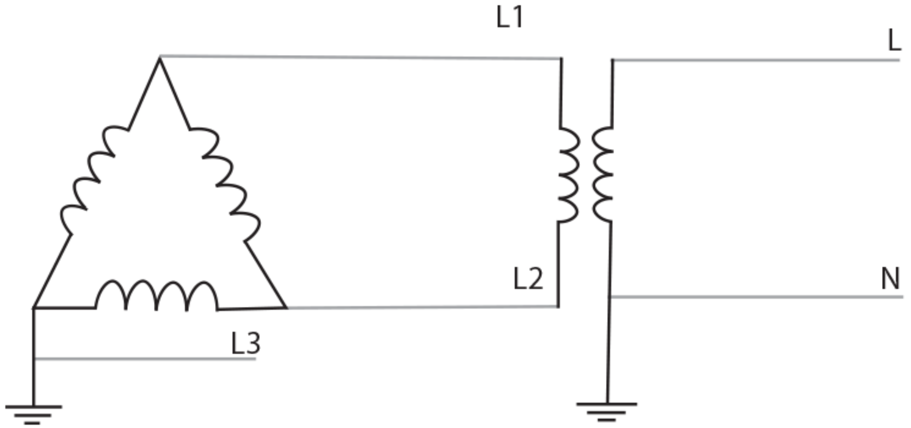
In another study, *The Impact of Electric Vehicles on Voltage Profile and Harmonics in a Distribution Network*:

- Simulations were done at EV loads of 45%, 65% and 95% with multiple charging points
- Current total harmonic distortion (THD's) of up to 17.4% were calculated, well above established limits of 8%
- Voltage THD can become as high as 14.2%
- **"Thus, it could be readily established that EV's could significantly contaminate the distribution system with high amounts of harmonic injection"**

Grounding Concerns

Level 1 and 2 Chargers – Public

- Some chargers may have problems if fed from a 240V phase to phase system without a true neutral



- In this example, a single phase transformer is placed between the three phase delta source
  - The single phase secondary is grounded to avoid charger problems

Charging

Types of Electric Vehicle Chargers

	Level 1	Level 2	Level 3
Typical Load Per Unit	1 to 2 kVA	3 to 8 kVA	200 to 500 kVA
Typical Feed Voltage	120 to 240	208, 240 to 480, 600	480, 600 or medium voltage
Phase	Single	Single or Three	Three

Charging

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EV Transformer Specification Consideration

This chart provides recommendations for a transformer's k-factor to overcome the extra heating from the EV charger's harmonic distortion. In addition, consider low temperature rise transformers if the ambient temperature regularly exceeds a 30°C average during a 24 hour period.

	Level 1 & 2	Level 2	Level 3
Chargers per Transformer	1 to 2	3+	1 or more
Transformer	Single Phase	Three Phase	Three Phase
Allowance for Harmonic Distortion	kVA increased for harmonic heating	K = 4 Minimum K = 9 Better Harmonic Mitigating Best	K = 9 Consider Harmonic Mitigating if 2 or more
Voltage Transient Damage	Consider snubber protection		
Inside Location	150°C temperature rise		
Outside Location	150°C temperature rise if avg. <30°C Otherwise consider 130°C or 115°C Tamperproof Type 3RE Enclosure		

Access Concerns

Access and environmental concerns when installing transformers with EV Chargers:

- Avoid installing ventilated units in areas accessible by the general public
  - Use non-ventilated, ventilation baffles, tamper resistant hardware, hinged locked doors, etc.
  - Secure transformer access
- Bollards should protect transformer from vehicles

Access Concerns

Access and environmental concerns when installing transformers with EV Chargers:

- Do not install below gutters, pipes or other water sources
  - Avoid irrigation areas
- Protect bottom ventilation points from collecting debris and limiting airflow
- Road salt and other factors can create corrosion

HPS Magnetic Products

HPS Fortress

HPS PowerPlus

HPS Titan

HPS Sentinel Series

HPS Millennium Series

HPS EnduraCoil Series

Conclusion

Thank you for completing this presentation and we hope that you found it informative. Please complete the quiz for this presentation which is required in order to receive a “passing” grade.

To exit from this presentation, please click on the red X (close button) located in the top right corner and/or close the course page.

Thank you

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