

Regional opportunities and impacts from electric vehicles



June 6, 2017 Andrew Levitt Senior Market Strategist, Emerging Markets Department



PJM as Regional Transmission Organization (RTO)





Electric Vehicles: Opportunity for Customers



Carbon emissions in PJM down 25% since 2005

Source: http://www.pjm.com/~/media/documents/reports/20160318-2015-emissions-report.ashx

- Reduced combustion emissions in high-density population centers.
- Reduced energy costs and consumption. (Reduced maintenance as well).
- Possible solution for low-carbon transport.
- International Energy Agency:

"The wide global deployment of EVs across all modes is necessary to meet sustainability targets."



Opportunity for the grid



"The Central Station's Opportunity for increased business—business that means a big income and that is nearly all profit since the load comes on after the peak—is in the Electric Vehicle."

Electrical Review, 1910

Higher utilization of power industry assets → win/win



Opportunity for the grid

- 84% of EV charging is at home (7% at work).
- EV are plugged in at home for 12 hours/day.
- Typical charge time with home charging equipment: 1-3 hours.
- Result: load can be shifted up to 10 hours → remarkable controllable load resource.

- Opportunities in PJM?
- Load Serving Entities: reduce wholesale costs by incentivizing charging off-peak. E.g.: time varying rates, critical peak pricing.
- Revenue opportunity: aggregators work with EV owners to modulate charge rate and sell ancillary services in PJM via Demand Response.

Source: Idaho Nat'l Lab, 2015, Plugged In: How Americans Charge Their Electric Vehicles. https://avt.inl.gov/sites/default/files/pdf/arra/SummaryReport.pdf

University of Delaware/NRG Vehicle-to-Grid Resource

Example of electric vehicles generating ancillary services revenue

Balance of Power

The numbers behind the University of Delaware program using cars as a money-making reserve for the electric grid

Cars used	23 (19 all-electric Mini E's, 3 modified Scion xB's, 1 experimental Honda Accord plug-in hybrid)
What they do	Store or discharge electricity according to grid needs
Special equipment needed	Control board, \$200-\$300 per car
Power of car batteries	12 kilowatts per vehicle*
Minimum capacity needed for a grid "bank"	100 kilowatts/9 cars
Time connected to grid	24/7 except when being driven
Average daily driving time	About an hour per car
Monthly revenue per car from grid operator	About \$150
Monthly electricity cost/car	About \$40
Monthly profit	About \$110 per car/\$2,500 total
*For Minis and Scions. Honda power not disclosed. Source: University of Delaware The Wall Street Journal	



EVAN KRAPE/UNIVERSITY OF DELAWARE

https://www.wsj.com/articles/electric-vehicles-sell-power-back-to-the-grid-1411937796



Preliminary results of peak load impact from EV charging

Enough EV load by 2032 to warrant inclusion in peak load forecast?

Refine inputs for:

- Vehicle retirement rate: current inputs are rough estimates; pursue a survival rate approach.
- Prevalence of Level 1 vs Level 2 PEV charging.
- Prevalence of PEV charging at 5PM: this is the most sensitive input.
- Allocate load to transmission zones.





- Home charging prevalent.
- Charging power up to 19 kVA per car (Tesla Model S), though 6.6 kVA more common.
- With uncoordinated charging, clustering of electric vehicles on a single distribution transformer could cause overload.
 - 18 kVA is much higher than typical assumed average on-peak power draw per house after application of a "diversity factor".
 - 240V residential pole-mount transformers and other "last-mile" infrastructure often serve a handful of homes. Hence: possible clustering issue.
 - Case study of typical 25 kVA distribution transformer serving 5 homes with just 2 5.8 kVA EVs found potential issues*.
- In practice in CA, very little upgrade needed despite high EV deployment**.

^{*} Shao, S., Pipattanasomporn, M, & Rahman, S., 2009. "Challenges of PHEV Penetration to the Residential Distribution Network". <u>http://www.ari.vt.edu/wp-content/uploads/2015/01/PHEV-7.28.09.pdf</u> ** SCE, 2013. <u>"</u>Southern California Edison's Key Learnings about Electric Vehicles, Customers and Grid Reliability". http://newsroom.edison.com/internal_redirect/cms.ipressroom.com.s3.amazonaws.com/166/files/20136/SCE-EVWhitePaper2013.pdf



Electric transport: foundation for the electric power industry?

Andrew Levitt <u>andrew.levitt@pjm.com</u> 610-666-2256 215-554-5260



Photo 1892: <u>http://digitallibrary.hsp.org/index.php/Detail/Object/Show/object_id/513</u>