Effects of transportation electrification on the electricity grid

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There are two levels that have to be dealt with separately

Transmission / Generation

Distribution
Transmission level is primarily influenced by driving patterns

- This is data derived from the National Household Travel Survey
- Maximum home arrival is 12% at 5 PM
Power demand for uncontrolled charging

- This is the demand for 2 million simulated vehicles versus the demand for July 7, 2009; average load is 700W per vehicle
Controlled charging can reduce load increases

- The same 2 million vehicles can be charged overnight with no increase in peak load
Potential impacts of *badly* controlled charging

- By 8 PM, 70% of drivers have arrived home
Power demand from *badly* controlled charging

- 2 million badly controlled vehicles can create a new peak
- This would be a serious disruption
The distribution level is different

- Vehicles can be concentrated in particular neighborhoods
- Problems will be highly localized and difficult to predict
- The discussion below is specific to one Dominion circuit

8% Penetration
Assets are already stressed

- 25 kVA transformers are operating with narrow margin today
- These transformers typically serve 5-7 households
Transformer aging can increase quickly

- An average of one vehicle per household could be problematic
Conclusions

• At the generation and transmission level, Smart Charging will help spread out load and prevent bad control

• At the distribution level, the Smart Grid can help identify “hotspots” before they become problems and help to protect transformers

• **PHEVs and EVs do not need to be feared, but they need to be understood**

• **Smart Grid technologies will be a valuable tool in understanding the impact of electrification and mitigating any problems**
Power demand for uncontrolled charging

- Vehicle mix is 30% E-REVs, 50% blended PHEVs, 20% EVs
- Average charge power is about 700W per vehicle
Power demand from *badly* controlled charging

- What if all of the vehicles waited until 8 PM to charge?
- Maximum power requirements are about **4 times higher**
Power demand for uncontrolled charging

- Vehicle mix is 30% E-REV, 50% blended PHEV, 20% EV
- Average charge power is about 700W per vehicle
Asset overloading can increase quickly

- With medium rate charging, it takes less than one PHEV per household to significantly increase overloading