ES Reliability & Safety Forum
EV adoption on DTE Energy distribution circuits

Hawk Asgeirsson
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ES Reliability & Safety Forum talking points

• Distribution circuit electric vehicle adoption studies (2010)
• Worst case scenario i.e. most heavily loaded circuits @ 4.8 kV & 13.2 kV - 93 circuits studied
• 4.8 kV ckt impact is greater than 13.2 kV. Greater number of 25 kVA trf on 4.8 kV circuits
• Concern with overloading transformers (especially 25 kVA vs 50 kVA) & low voltage
• Higher loading increases the likelihood of outages contributing to SAIDI & SAIFI
• Distribution circuit peak loading usually extends into the evening hours while system peak is mid to late afternoon
• Also studied distribution transformer loading and aging due to temperature rise
• Based on distribution loading pattern and transformer aging, we designed a rate experiment to evaluate EV charging behavior effect of loading distribution circuits
• Time of use rate to start at 11 PM to 9 AM & flat rate allowing people to charge anytime
• Flat rate allowed us to evaluate uncontrolled charging behavior vs TOU rate
• Every EV was on a separate AMI meter allowing us to evaluate charging behavior
• TOU rate works well for initial rollout of EVs. Higher penetration needs smarter charging behavior.
What gaps can ES R&D address to lower barriers to future aggressive EV targets? – Some initial thoughts.

• Residential home charging
  • Initial growth can be managed by utilities as part of normal business.
  • ES will play a role for residents in apartment and condos. Both to manage demand and electrical infrastructure upgrade

• Workplace charging
  • ES can manage electrical infrastructure upgrades and demand

• DC fast charging
  • ES can manage electrical infrastructure upgrades and demand.
  • At DTE just installed ES for DC chargers without the need to upgrade electrical infrastructure.

• DC in the home with ES
  • V2G with vehicle DC export as backup for outages and home fast charging. Incorporate PV to manage extended outage.
**PEV Impact on the Distribution System**

**Understanding PEV Charging Behavior**

Worst case – heavily loaded 4.8 kV residential circuit in Ann Arbor. Shows that if we use TOU rate starting at 11 PM we will not have issues until we are at 25% EV adoption of Volts (3.3 kW charger). At higher charge rates the effect would be observed sooner.

**PEV Impacts on the Distribution System**

On-Peak vs. Off-Peak Charging

Increased loading can also cause low voltage on the circuit starting at 15% adoption.

*There are 125 distribution transformers with 1,339 customers. Peak load is 4.1 MVA*
Is the DTE Grid Ready? – Level 2 at 3.3 kW

- Number of circuits studied = 93
- 4.8 kV circuit have more overloaded transformers than 13.2 kV circuits
- 4.8 kV circuits are dominated by 25 kVA transformers

![Graph showing PEV Adoption Rate and Uncontrolled Charging: 4.8 kV vs. 13.2 kV](image)
Distribution Circuit Load Graph
Summer 2012 high temperature day

<table>
<thead>
<tr>
<th>Day</th>
<th>High Temp</th>
<th>Low Temp</th>
<th>Avg. Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>102</td>
<td>76</td>
<td>89</td>
</tr>
</tbody>
</table>
EV Rate Adoption and Charging Behavior

Flat Rate

- Off-Peak: 22%
- On-Peak: 78%

Flat rate: Charge anytime.
Average Monthly Charge was $41.60/month

Time of Use

- Off-Peak: 62%
- On-Peak: 38%

Time of use rate:
- On-peak 9AM-11PM
- Off-peak 11PM-9AM

Average Monthly Charge was $30/month
Average Weekday Charging Profile of DTE Energy PEV customers

Time of Use vs Charge any Time

Through August 2013
AMI data showing a distribution transformer loading from a 50 kVA transformer with 8 homes and one Volt charging on a TOU rate

Three Day Transformer Loading Data – AMI Smart Grid

50 kVA Transformer
Eight residential homes
- TOU PEV Rate

With EV
without EV