THE IMPACT OF PLUG-IN ELECTRIC VEHICLES ON LONG RANGE DEMAND FORECASTS OF DISTRIBUTION NETWORKS – ETHEKWINI CASE STUDY

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Introduction

• Market adoption of PEVs
• Market Drivers
  – Operating & maintenance cost
  – Source to consumption delivery cost
  – Air pollution and perceived greenhouse gas reduction
  – Imported oil dependency
  – Government incentives
  – Improvements in power electronics
Study Objective

- Develop a PEV forecast model
- Utilise existing long range forecast
- Superimpose PEV load contribution on existing forecast
- Assess impact on existing + planned network
PEV Forecast Model

- PEV market penetration
- Vehicle efficiency
- Current and future battery charge capacity
- Distance travelled
- Consumer charging behaviour
- Charger & battery efficiencies
- Charger PF
- Charging tempo
Comparison of energy densities for various battery chemistries.

- Lead-Acid
- Ni-Cd
- LFP
- Ni-MH
- Li-Titanate
- Li-ion
- Li-Polymer
- Li-Metal
- Li-P, Li-ion (New Systems)
- Zn/Air

Source: ICCNexergy
Battery Energy Density

Whr/kg

PEV Utilisation Behaviour

Travel distance distribution density 2010

Travel distance distribution density 2030
Uncontrolled Charging
Forecast Results: Uncontrolled Charging

20 Year Load Forecast (total network load)

2029 Load Profile (total network load)
Forecast Results: Time of Use Charging

20 Year Load Forecast (total network load)

2029 Load Profile (total network load)
## Impact on Distribution Substations

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Number of substations</th>
<th>EPRI Medium</th>
<th>EPRI High</th>
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<tbody>
<tr>
<td>275kV</td>
<td>8</td>
<td>1</td>
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<tr>
<td>132kV</td>
<td>100</td>
<td>7</td>
<td>22</td>
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<td>33kV</td>
<td>45</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Total</td>
<td>153</td>
<td>8</td>
<td>23</td>
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</tbody>
</table>
Impact on MV Network: Uncontrolled Charging

20 Year Load Forecast (total network load)

2029 Load Profile (total network load)
Controlled Charging
Impact on MV Network: ToU Charging

- ToU charging has insignificant effect on total network load
- ToU charging at MV level can be devastating

20 Year Load Forecast (total network load)
Other things to worry about

- Clustering
- Market penetration saturation
- Filling stations -> charging stations
- Workplace charging
- Regeneration
Conclusion (based on this case study)

• Total distribution network level
  – No cause for concern over the next 10 years
  – ToU charging appears to restrain capacity requirements at total distribution load level

• Substations
  – PEV impact over 20 years seems negotiable at substation level
  – Provided that the utility has a master plan in place (and executes it)
Conclusion (based on this case study)

- MV Feeders
  - MV feeders will run into trouble long before substations
  - ToU charging is not suitable to mitigate MV demand increases
  - Significant opportunity exists with controlled charging, but requires:
    - Smart meters
    - Smart tariffs
    - Smart customer offerings
Conclusion (based on this case study)

- Importance of having a long range master plan (and executing it)
- Long range load forecasts
  - must model PEV scenario(s)
  - new stakeholders
    - PEV industry
    - PEV consumers
Thanks to eThekwini Electricity for sharing their long range forecast and data in support of this case study.