Infrastructure and Operational Considerations for BEV Electric Rate Structures

10 September 2018

Michele Chait
E3 was engaged by California Transit Association (CTA) to conduct an analysis of electric rate structures that are most economic for electrified transit

- Focus on operations and economics of electric buses

Key learnings from this study deal with the impact of infrastructure and operations in determining optimal BEV electric rate structures

- Current and future technology, operations and electricity grid conditions
Key Questions

+ Which electric rate structures are best for today’s and tomorrow’s e-buses?

+ Does un-managed versus Smart charging impact this outcome?

+ What is the impact of increased bus battery size?

+ What is the impact of increased EVSE size?
Analysis Steps

1. Develop “Charging Profiles”
   - Hourly annual bus operations: determines how buses charge

2. Create candidate rate designs for evaluation
   - Range of energy and demand charge structures
   - ~4 pm to ~9 pm on-peak, ~ 9 am to ~ 3 pm off-peak
   - Each rate structure is “revenue neutral”

3. Calculate annual electricity bills for each Charging Profile and candidate rate design

4. Rank electricity bills for each Charging Profile
Current & Future e-buses

+ **Today’s e-bus**
  - 500 kWh battery with 60 kW EVSE
  - BYD’s current best-in-class is 500 kWh, New Flyer is 545 kWh, Proterra is 660 kWh

+ **Tomorrow’s e-bus**
  - 1,000 kWh battery with 500 kW EVSE

+ **Both**
  - 30% minimum SOC at all times
Charging Profiles

+ **Non-commuter**
  - 150 and 230 miles per day

+ **Commuter**
  - 150 miles per day

+ **Both**
  - Single depot and two-depot charging locations
  - 5- and 7-day schedules
  - Unmanaged charging: each bus charges immediately upon depot arrival and charges as quickly as possible
  - Smart charging: bus charging can be staggered, delayed and throttled to minimize monthly bills
For today’s and tomorrow’s bus under un-managed charging:

- No demand charge
- Flatter TOU ratios (lower on-peak, higher off-peak)
  - A fully flat rate structure would yield the most economic results, however this is unlikely from a regulatory perspective
For today’s and tomorrow’s bus with Smart charging:

- More volatile “peakier” TOU rates or real-time price signal for energy charges
- “Peakier” time-differentiated demand charges
  - For smaller customers, a non-time differentiated demand charge at roughly today’s levels
Smart Charging Reduces Bills

Example: Today’s e-Bus 2-Depot Commuter, 5 Days per Week

- Bill under Optimal Un-managed Charging Rate: $20,017
- Bill under Optimal Smart Charging Rate: $16,465

Energy + Environmental Economics
Impact of Increased EVSE capacity

- Under **un-managed** charging, if rates have a demand charge then adding charging capacity will increase electricity bills.

- Under **Smart** charging, increasing EVSE capacity can decrease bills by increasing the charging flexibility.
We estimate value of up to about $5 per kWh of additional e-bus battery storage.

The more charging-constrained the facility is, the more beneficial a larger e-bus battery is.

In cases where charging is already flexible, benefit of a larger battery is negligible.
Thank you!

Energy and Environmental Economics, Inc. (E3)
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
Tel 415-391-5100
michele@ethree.com
Web http://www.ethree.com