DC Fast Charging and Demand Charges

Oregon Utility Engagement Work Group Meeting
Sep 7, 2016

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• Testing and evaluation results from advanced charging systems supports:
  – Support codes and standards development and harmonization
  – Grid modernization initiative

• Measurement evaluation metrics
  • System efficiency
  • EM-field emissions
  • Power quality
  • Response to dynamic grid events
  • Cyber security vulnerability assessment

• Wide range of grid input power
  o from 120 VAC to 480 VAC 3φ
  o 400 kVA total capability

• Sub-system and full vehicle testing capabilities
Current Technology: DC Fast Charging

CHAdeMO and SAE CCS

- 50 kW power transfer
  - 480 VAC 3φ
  - 75 A circuit

SAE J1772 / CCS
Current Technology: DC Fast Charging

Tesla Super Charger Network

- 120 kW power transfer to each vehicle
- Charging complex
  (up to 8 Super Chargers at one site location)
  - 500 kVA from 12.5 kV utility electric grid feed
  - Stepped down at site to 480 VAC 3φ (600 A)
**DC Fast Charging Profile**

ABB Terra 53 CJ charging a 2015 Nissan Leaf

Constant Current Mode
- 92.3% AC to DC efficiency
- -0.98 Power Factor
- 11.0% input current THD
- 6.1% Phase current unbalance
Real-world Usage of DCFCs in Aggregate

100 Blink DCFCs nationwide, Jul-Sep 2013  (trends stay the same in 2014 – 2015)

Percent of DCFCs connected to a vehicle

Weekday avg = 19.6 min
Weekend avg = 19.3 min

Weekday avg = 8.8 kWh
Weekend avg = 9.0 kWh

Full report: avt.inl.gov/project-type/quarterly-and-annual-reports-and-maps
Real-world Usage of DCFCs in Aggregate

12 Blink DCFCs and 56 AeroVironment DCFCs in Washington and Oregon, 2015

Time of Day When Charging Session Started

Blink avg = 19.8 min
AV avg = 30.3 min

Blink avg = 8.2 kWh
AV avg = 10.1 kWh
Geographic Variation in Charging Frequency

12 Blink DCFCs and 45 AeroVironment DCFCs in Washington and Oregon, Jan – Dec 2014

- DCFCs in/near cities and along I-5 were used significantly more frequently than outerlying DCFCs
- Overall average events per week was 11.3
- Max average events per week was 53.6
Charging Frequency Over Time

12 Blink DCFCs and 56 AeroVironment DCFCs in Washington and Oregon, Jan 2013 – Dec 2015

- Blink fees implemented - $5.00 per session
- AV fees implemented - $7.50 per session or monthly membership fee
Anatomy of a Non-residential Electric Bill

- Electric utility rates for non-residential customers are complex and based on multiple factors

- Customer will be on different rate schedule depending on how much power they demand and/or energy they consume
  - Examples: 0 – 30 kW; 30 – 200 kW; >200 kW
  - 0 – 15,000 kWh; >15,000 kWh

- Everything about the rate can change based on schedule

- Generally 3 components:
  - **Customer charge** (aka service charge or meter charge) as a flat rate for month
  - **Energy charge** in $ / kWh consumed in monthly billing cycle
  - **Demand charge** in $ / kW…
More on Demand Charges

• The demand charge is based on the peak power demanded during a monthly billing cycle and/or during the past 12 months.

• Peak power demand is calculated as the highest average power over specific time interval
  – 15 min interval is most common
  – 30 min and 60 min are also used

• Demand charge rate ($ / kW) varies dramatically between schedules and between utilities
  – $X/kW for first Z kW, plus $Y/kW for demand over Z kW
  – X and Y vary from $0 to $30/kW, with most between $4 to $12/kW
  – Z is typically 0, 10, 15, 20, 30, or 50 kW

• Demand charge rate may vary based on time of day (on peak vs. off peak) and/or time of year (summer vs. winter)
Check the Fine Print

- Additional per-kW or per-kWh service charge(s) may apply
- “In the event of loads with large short-period fluctuations, [the utility] reserves the right to employ special demand determinations”
- One utility rate schedule cited an EV mileage credit of $0.0138 per mile – not sure how this was implemented
Why Demand Charges

• A demand charge is not an “add-on” so the utility can make more money
• It is part of the rate design and balanced against energy and service charges
• For high-power customers, the utility must install, maintain, and/or upgrade expensive equipment to reliably serve the load
• This cost would not be recouped for high-power, low-energy customers without a demand-based rate component
Case Study

- Estimate monthly electric bill for a small office building with DC fast charger Portland, OR

- Portland General Electric (PGE) provides rate schedules for
  - small non-residential (0 to 30 kW) [Schedule 32]
  - medium and large non-residential (31 to 200 kW) [Schedules 38 and 83]
  - large non-residential (31 to 200 kW)

- For a hypothetical business day, the facility peak demand (sans DCFC) was 11.4 kW
- 179 kWh consumed on this work day.
- Assuming 21 work days per month, the monthly energy consumed was 3,764 kWh
- Without DCFC, building fits in Schedule 32
- Without DCFC, monthly electricity cost is $411
Case Study

- If building’s existing service has capacity to support the addition of DCFC, assuming a 49 kW peak power demand during billing period

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Case Study

- If a new service is needed for the DCFC
- Schedule 38 has no demand charge so it is selected, with the only added cost from the energy consumed by the DCFC

![Table 1](image1.png)

- Cost for similar building in Phoenix, AZ using Arizona Public Service rates

![Table 2](image2.png)
Managing Demand Charges

Site host

- Talk with their utility to choose the best rate schedule
- For facility with large load, consider using TOU pricing or charge scheduling to prevent charging to occur coincident with facility peak

DCFC service provider

- Implement options for TOU pricing or charge scheduling/demand response
- Consider options for automatically reducing charge rate to allow “not-quite-as” fast charging to stay below facility peak, demand charge threshold (if any), or otherwise minimize demand charge
- Add an energy storage system that charges off peak and discharges to provide or supplement on-peak charging

Utility

- Consider alternate rate designs that minimize demand charges to encourage EV adoption
References


Smart Boys Like EV Charging Infrastructure

(Now if only Dad would only buy them an EV…)

![Children standing by an EV charging station.](image)