DC Fast Charging and Demand Charges

Oregon Utility Engagement Work Group Meeting
Sep 7, 2016

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Energy Storage & Advanced Vehicles

INL/MIS-16-39824

INL's Electric Vehicle Infrastructure (EVI) Lab

- 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
  - from 120 VAC to 480 VAC 3ϕ
  - 400 kVA total capability

- Sub-system and full vehicle testing capabilities

https://avt.inl.gov/panos/EVLTour/?startscene=pano5141

Current Technology: DC Fast Charging

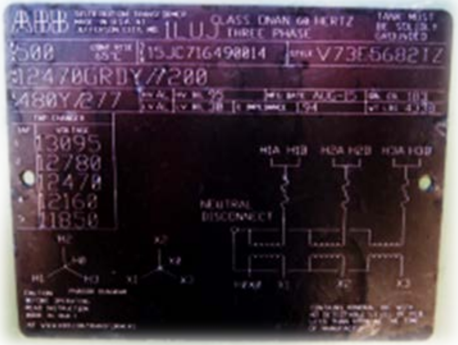
CHAdeMO and SAE CCS

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

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)



ABB

CLASS ONAN 60 HERTZ
THREE PHASE

TANK MUST BE SOLIDLY GROUNDED

500

15JC716490014

V73E56821Z

12470GRDY/7200

480Y/277

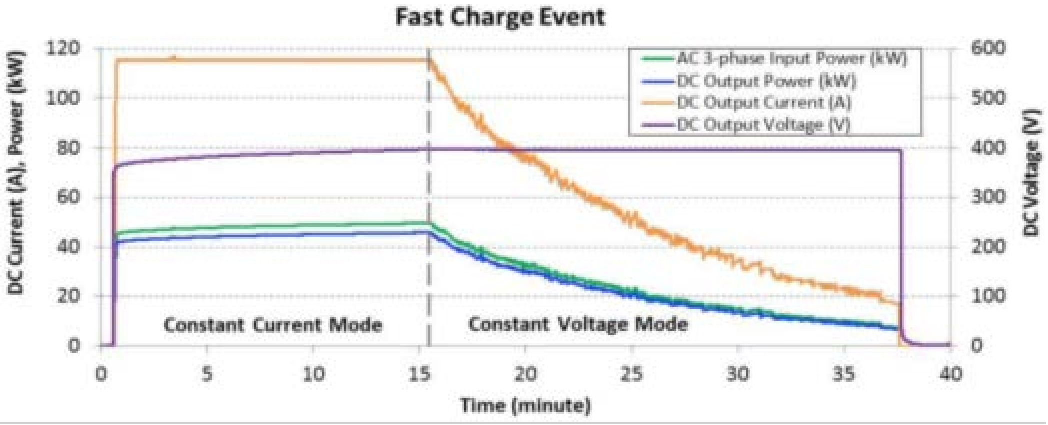
13095
12780
12470
12160
11850

NEUTRAL DISCONNECT

Pocatello, ID

DC Fast Charging Profile

ABB Terra 53 CJ charging a 2015 Nissan Leaf



Constant Current Mode

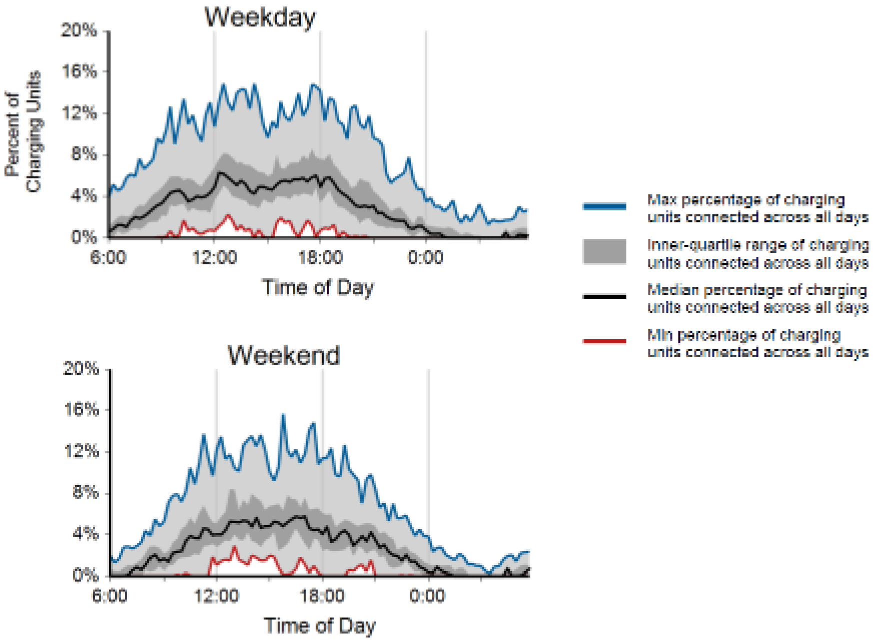
- 92.3% AC to DC efficiency
- -0.98 Power Factor
- 11.0% input current THD
- 6.1% Phase current unbalance

Idaho National Laboratory

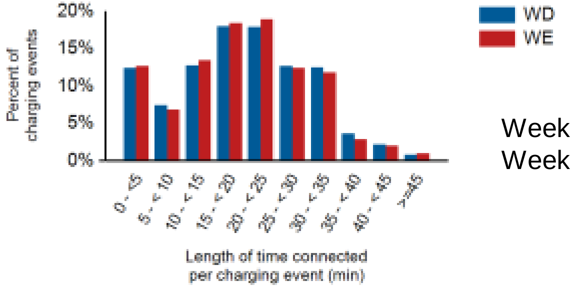
Real-world Usage of DCFCs in Aggregate

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

Percent of DCFCs connected to a vehicle

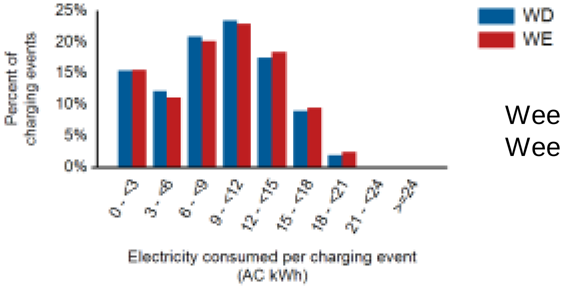


Distribution of Length of Time with a Vehicle Connected per Charging Event



Weekday avg = 19.6 min
Weekend avg = 19.3 min

Distribution of Electricity Consumed per Charging Event

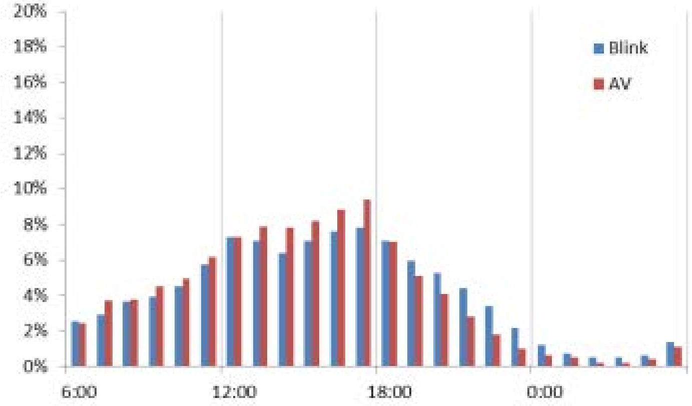


Weekday avg = 8.8 kWh
Weekend avg = 9.0 kWh

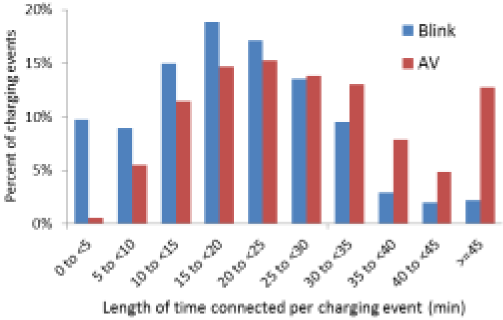
Full report: avt.inl.gov/project-type/quarterly-and-annual-reports-and-maps

Real-world Usage of DCFCs in Aggregate

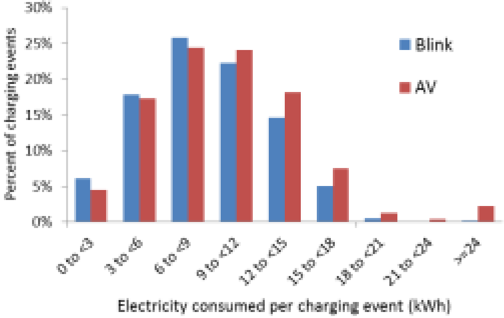
12 Blink DCFCs and 56 AeroVironment DCFCs in Washington and Oregon, 2015



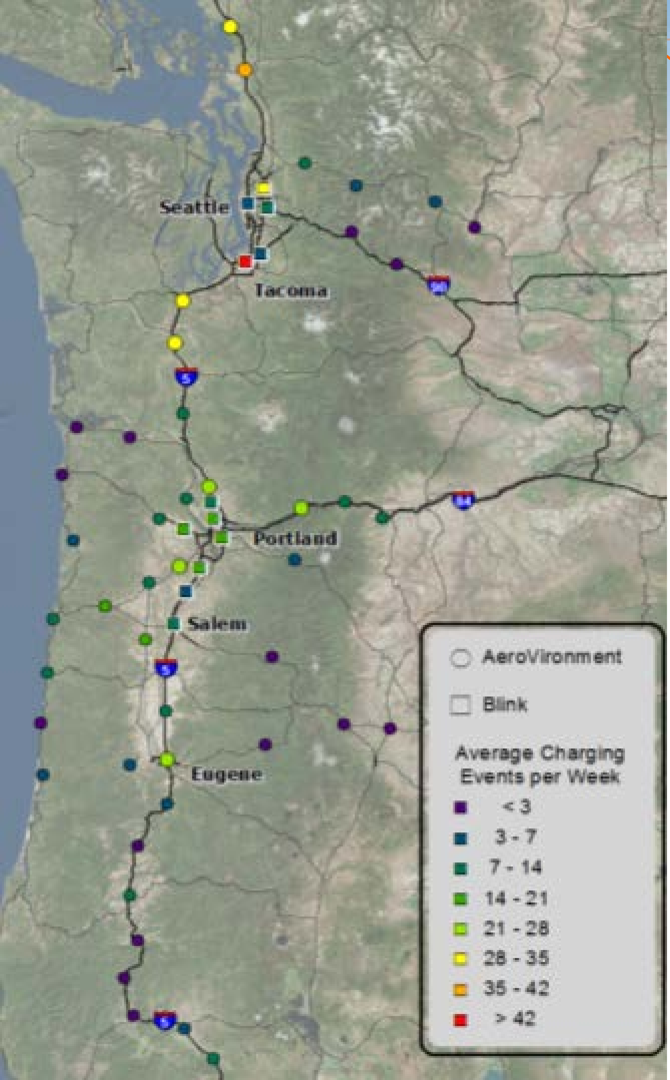
Time of Day When Charging Session Started



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

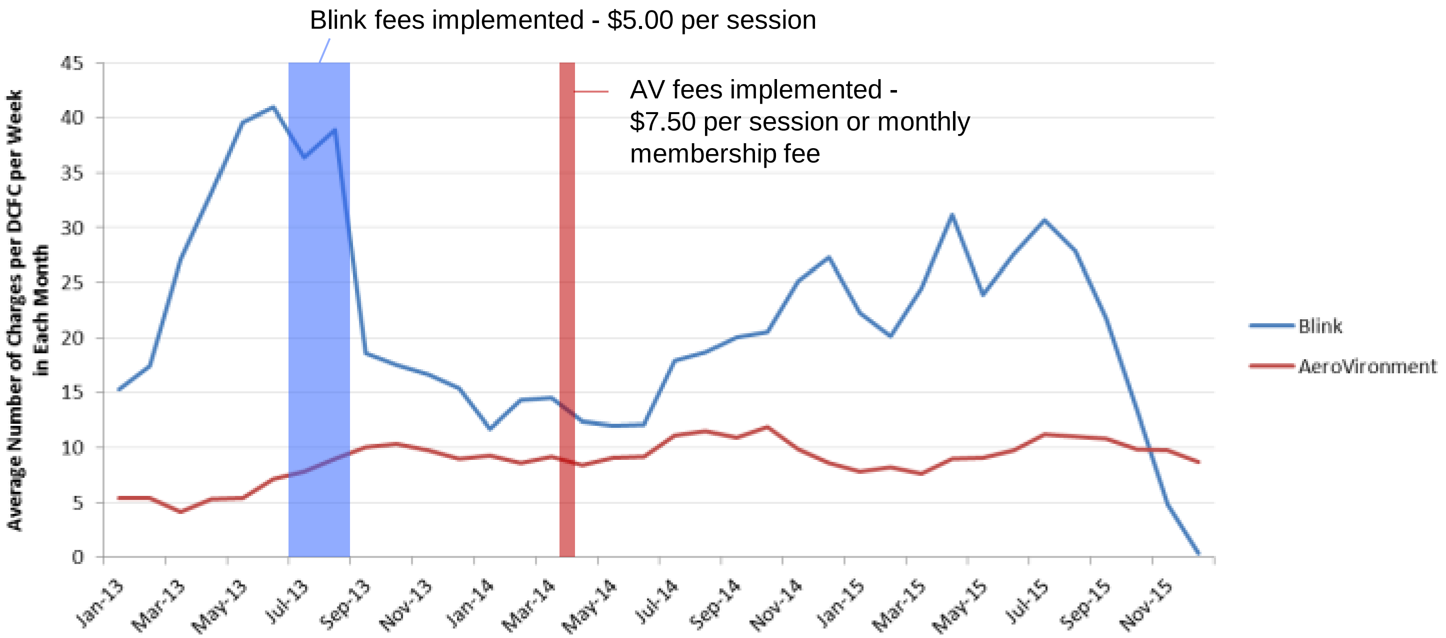
- DCFCs in/near cities and along I-5 were used significantly more frequently than outerlying DCFCs
- Overall average events per week was 11.3
- Max average events per week was 53.6

AeroVironment DCFCs part of

WEST COAST ELECTRIC HIGHWAY

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

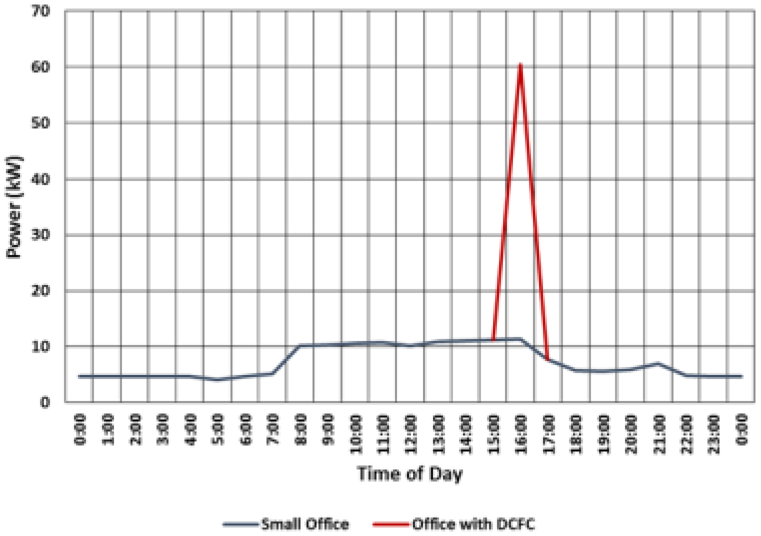
Why Demand Charges

- 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)

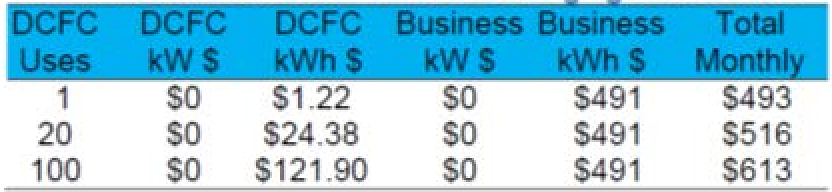
- For a hypothetical business day, the facility peak demand (sans DCFC) was 11.4 kW
- 179 kWh consumed on this work day.
- Assuming 21 work days per month, the monthly energy consumed was 3,764 kWh
- Without DCFC, building fits in Schedule 32
- Without DCFC, monthly electricity cost is $411



Case Study

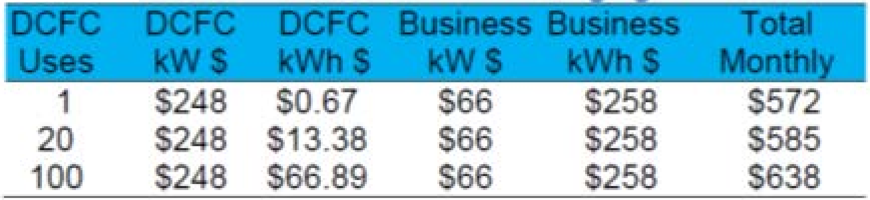
- If building’s existing service has capacity to support the addition of DCFC, assuming a 49 kW peak power demand during billing period

Small business with DCFC charging Schedule 38.



DCFC Uses	DCFC kW $	DCFC kWh $	Business kW $	Business kWh $	Total Monthly
1	$0	$1.22	$0	$491	$493
20	$0	$24.38	$0	$491	$516
100	$0	$121.90	$0	$491	$613

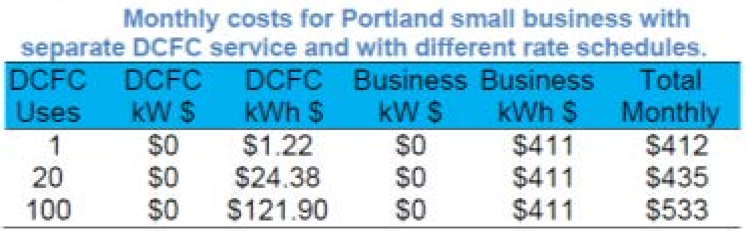
Small business with DCFC charging Schedule 83.



DCFC Uses	DCFC kW $	DCFC kWh $	Business kW $	Business kWh $	Total Monthly
1	$248	$0.67	$66	$258	$572
20	$248	$13.38	$66	$258	$585
100	$248	$66.89	$66	$258	$638

Case Study

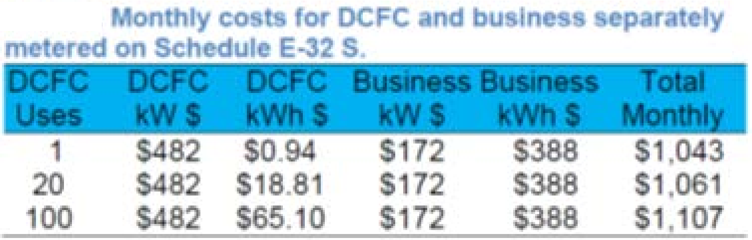
- If a new service is needed for the DCFC
- Schedule 38 has no demand charge so it is selected, with the only added cost from the energy consumed by the DCFC



Monthly costs for Portland small business with separate DCFC service and with different rate schedules.

DCFC Uses	DCFC kW $	DCFC kWh $	Business kW $	Business kWh $	Total Monthly
1	$0	$1.22	$0	$411	$412
20	$0	$24.38	$0	$411	$435
100	$0	$121.90	$0	$411	$533

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



Monthly costs for DCFC and business separately metered on Schedule E-32 S.

DCFC Uses	DCFC kW $	DCFC kWh $	Business kW $	Business kWh $	Total Monthly
1	$482	$0.94	$172	$388	$1,043
20	$482	$18.81	$172	$388	$1,061
100	$482	$65.10	$172	$388	$1,107

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

Slide 5 – DC Fast Charger Fact Sheet: ABB Terra 53 CJ charging a 2015 Nissan Leaf, avt.inl.gov/sites/default/files/pdf/evse/ABBDCFCFactSheetJune2016.pdf

Slide 7 – Electric Vehicle Charging Infrastructure Summary Report: July - September 2013, avt.inl.gov/project-type/quarterly-and-annual-reports-and-maps

Slide 9 – Direct Current Fast Charger Usage in the Pacific Northwest During 2014, avt.inl.gov/sites/default/files/pdf/evse/INL_WCEH_DCFC_Usage_2014.pdf

Slides 11-13 – DC Fast Charge-Demand Charge Reduction, May 2012, avt.inl.gov/sites/default/files/pdf/EVProj/DCFastCharge-DemandChargeReductionV1.0.pdf

Slides 15 -17 – What is the Impact of Utility Demand Charges on a DCFC Host? June 2015, avt.inl.gov/sites/default/files/pdf/EVProj/EffectOfDemandChargesOnDCFCHosts.pdf

Smart Boys Like EV Charging Infrastructure

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