



EV Charging Infrastructure



What's happening in the charging world?





Agenda

Session Topics

- **Charging Overview**
- **How people charge their EVs** (home/ workplace/ public)
- **Charging Rates** of EVs and PHEVs
- **2019 Buildout** in the Midwest and the U.S.
- **Deployment + Driver Costs**
- **Call to action!**





ZEF Introduction

ZEF owns and operates 23 DC Fast Charging Locations in MN/WI, has Level 2 Smart Charger product: ZEFNET

ZEF has built over 30 DCFC projects with various clients:

Nissan, Moorhead Public Service, Connexus Energy, Wright Hennepin Electric Co-op, Lake Country Power, GRE, MPCA, University of MN, WCROC Morris, 36 Lyndale BP Gas Station, Arrowhead Electric Cooperative, Goodwill Easter Seals, EVgo, Outpost Natural Foods





Products & Services

Turn-key DC Fast Charging Development

Secure funding, design, build, commission & test chargers

ZEFNET: Controlled & Metered L2 Smart Charging

- Made in MN (Montevideo)
- Charge data logging
- Load Control
- Revenue Grade Metering
- Demand Reduction (run multiple chargers off a single circuit)
- Renewables dispatch (Solar & Wind Sync)
- WiFi/Cellular

MAKE MANAGING EV CHARGING A BREEZE.

Whether you are a multi-unit housing manager or a utility, the requirement for managing multiple EV chargers in your portfolio is now a reality. We provide a full, turnkey EV charging solution allowing for revenue grade metering, billing & reporting, demand charge management and fault reporting platform.

PLATFORM FEATURES	MULTI-UNIT HOUSING FEATURES	SAFETY FEATURES
<ul style="list-style-type: none"> • Secure management • System software (charging, charge history) • Demand management capabilities (revenue grade, smart charging, time-based charging) • WiFi/Cellular connectivity 	<ul style="list-style-type: none"> • Report on individual or groups of chargers for billing & metering usage • Customizing alert for max charger levels, loadshed, remaining energy • System-recommended rates, loadshed energy usage across all chargers • Demand load control to address chargers at billing or maintenance 	<ul style="list-style-type: none"> • Inhibit or reverse power transfer to the grid for safety when needed • Cellular open alert in emergency situations - no extra labor or equipment required by customer • Full, true capacity, allowing participation utility demand response programs • Remote reboot management (manual, secondary grade) to prevent enter the hot state

ELECTRICAL SPECIFICATIONS	
Electrification:	ETL, UL1194, UL1474
Service:	208V to 240V, 480 to 600, single phase, 3 wire w/ground
Charge Current (Output Power):	320A to 240A/300A to 480V systems (7.5kW to 7.5kW)
Service Circuit Breaker:	Classified, suitable for protection of ground safety circuit
Substation Circuit Breaker:	After main panel/Module
Charge Circuit Interconnect Device:	Ground fault protection with fully adjustable set point, adjustable ground cable faulting

www.zefenergy.com | 612.600.0000



Battery Charging Primer

How do you charge a battery?

When you recharge your AA's or your traditional Lead Acid car battery, you need a CHARGER.

BATTERIES NEED DC POWER!

A charger typically plugs into mains AC power, converts it to DC, then pushes DC into the battery, controlling the rate of charger to ensure safety of the charging battery.

An EV IS NO DIFFERENT!





EVSE Primer Pt.1

How do you charge an EV?

You typically use something called an EVSE.

What is an EVSE?

Electric Vehicle Supply Equipment. It is technically not a charger. Provides a VERY SAFE way of getting AC power from the wall into a vehicle. It has an internal GFI, with a rugged cord and vehicle plug.

How do I use an EVSE?

Plug one end into either 120v or 240v outlet, or hardwire into 240v. Plug the other into the car. Easy!



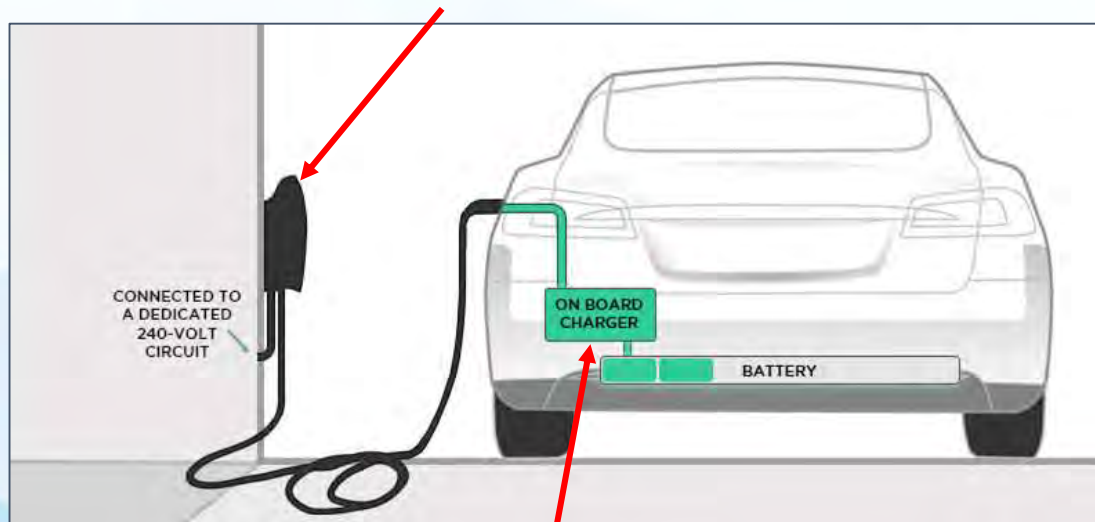


EVSE Primer Pt.2

EVSE - Passes AC through contactor, then cord, acts as a GFI

How does the battery charge, if the EVSE is just a glorified safety cord?

The on-board charger! It converts AC to DC, then passes DC electricity into the battery, just like any other battery.



On-Board Charger - AC to DC



EVSE: Level 1 vs Level 2

120v <= 12 Amps



Nissan Level 1 EVSE
Comes FREE with vehicle

How fast do they charge?

Chevy Bolt:

Level 1: 42 hours
Level 2: 8 hours

Tesla Model S:

Level 1: 100 hours
Level 2: 6 hours

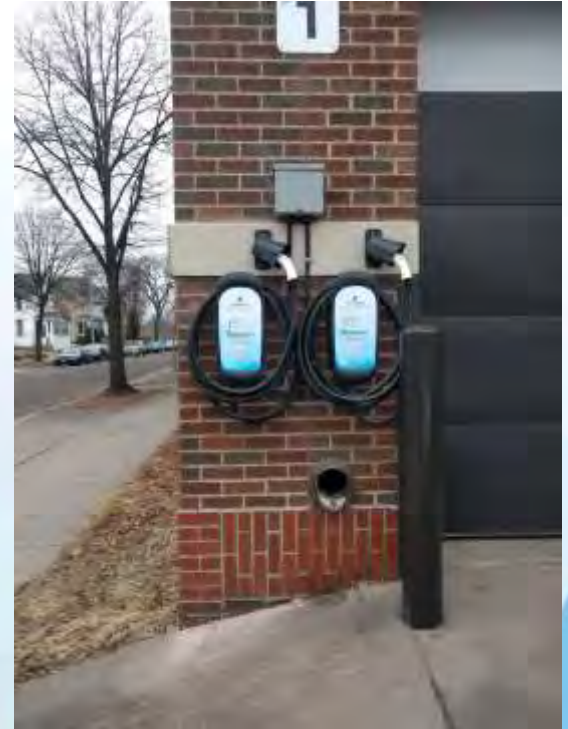
240v 6 - 80 Amps



ZEF Residential Level 2 EVSE
Cost range: ~\$400 - ~\$1,000



Level 2 Install Examples





FAST Charging Primer Pt. 1

A Level 1 or Level 2 EVSE looks good for my home, or my workplace. What about when I'm on the road?

DC Fast Charging! Charge 35x faster than Level 1, charge 7 times faster than Level 2.

You can get 100 miles of range in 30 minutes on a 50kW charger.



ZEF DC 50kW Fast Charger
Cost range: \$60k - \$150k installed (range for 50kW-150kW chargers)



FAST Charging Primer

Pt.2

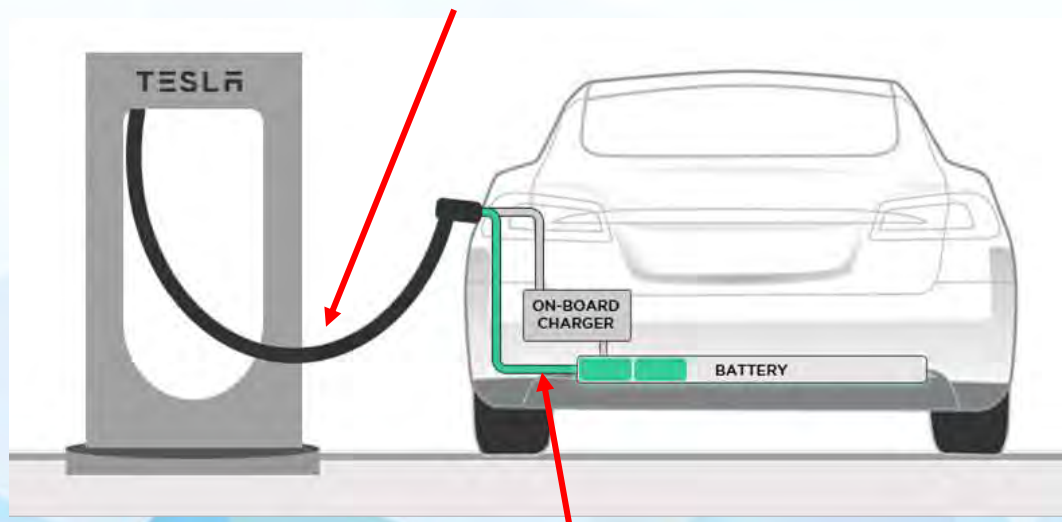
How does the battery charge?

The DC Power coming from the Fast Charger is ready to go STRAIGHT INTO the battery. The on-board charger can be bypassed.

How quickly can I charge?

Anything from 100 miles to 250 miles every 30 minutes. Perfect for a rest stop!

Fast Charger - Converts AC to DC, Passes DC power through the cord



DC power bypasses the charger, because it doesn't need converting from AC!



What did we learn?

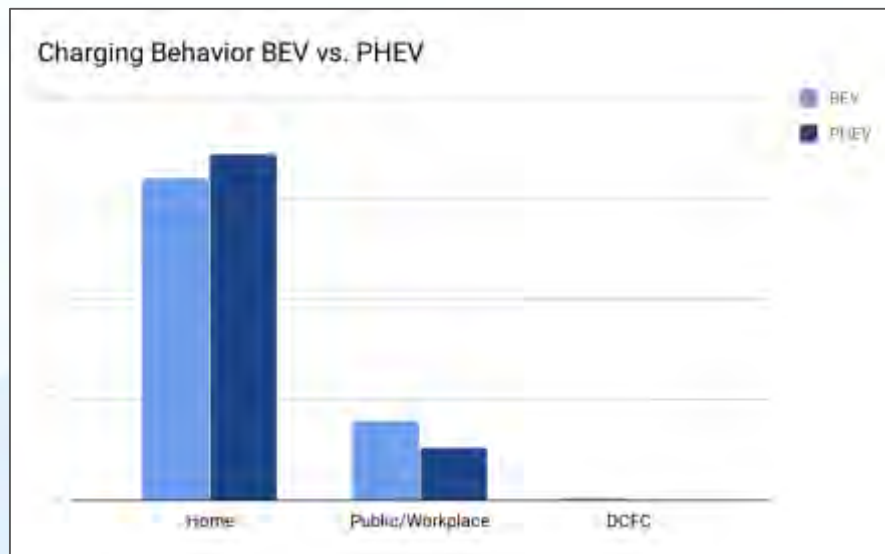
	Charging power (typical)	Time to fully charge	Range per half hour of charging	Maximum traffic in 24 hours
Level 1	1.4 kW	21 hours	3 miles	1
Level 2	7 kW	4 hours	12 miles	6
DC Fast Charger	50 kW+	30 mins (80%)*	100 miles	36

Note: These figures are based on Nissan Leaf 24kWh model

*Under ideal conditions, final 20% takes 45 mins



How Do People Charge?

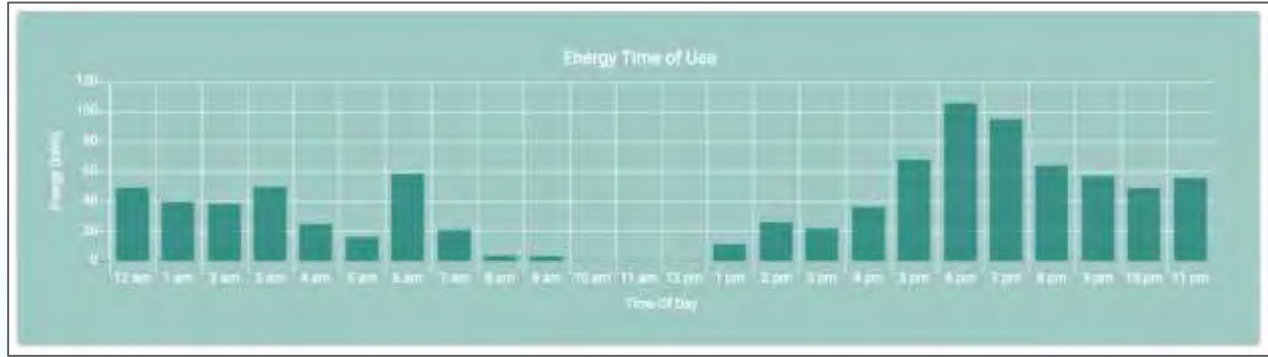


Note: These figures are based on Nissan Leaf 24kWh model vs. Chevy Volt

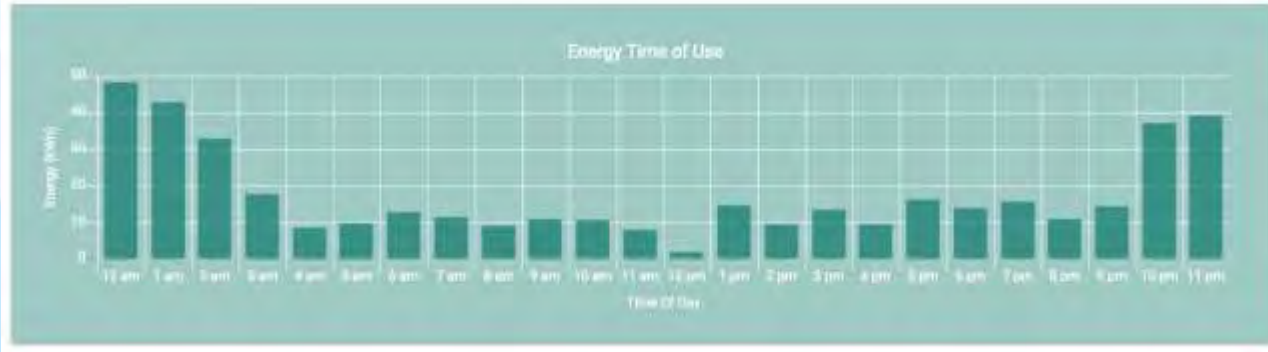


Home Charging

M-F



S-S

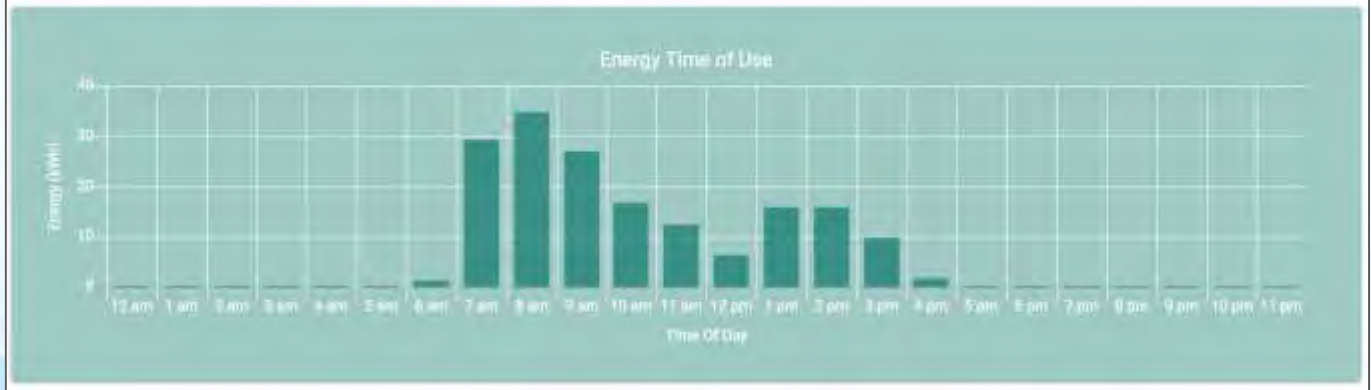




Workplace Charging

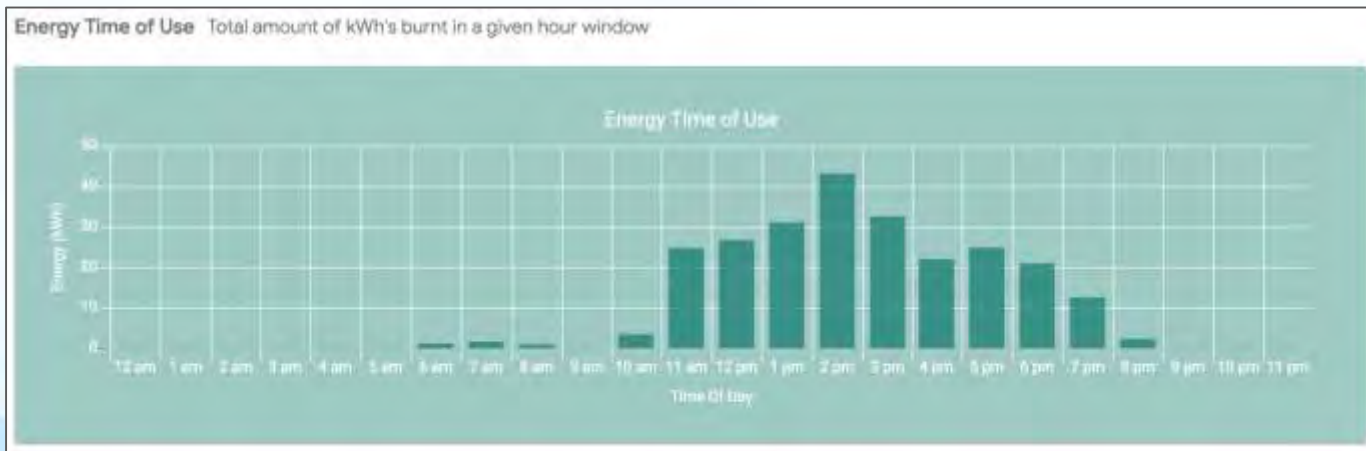


Energy Time of Use Total amount of kWh's burnt in a given hour window





Public L2 Charging





Charging Rates

L2

DCFC

Tesla Model S



17kW

120kW

300 Miles/Hr



Chevy Bolt

7.7kW

50kW

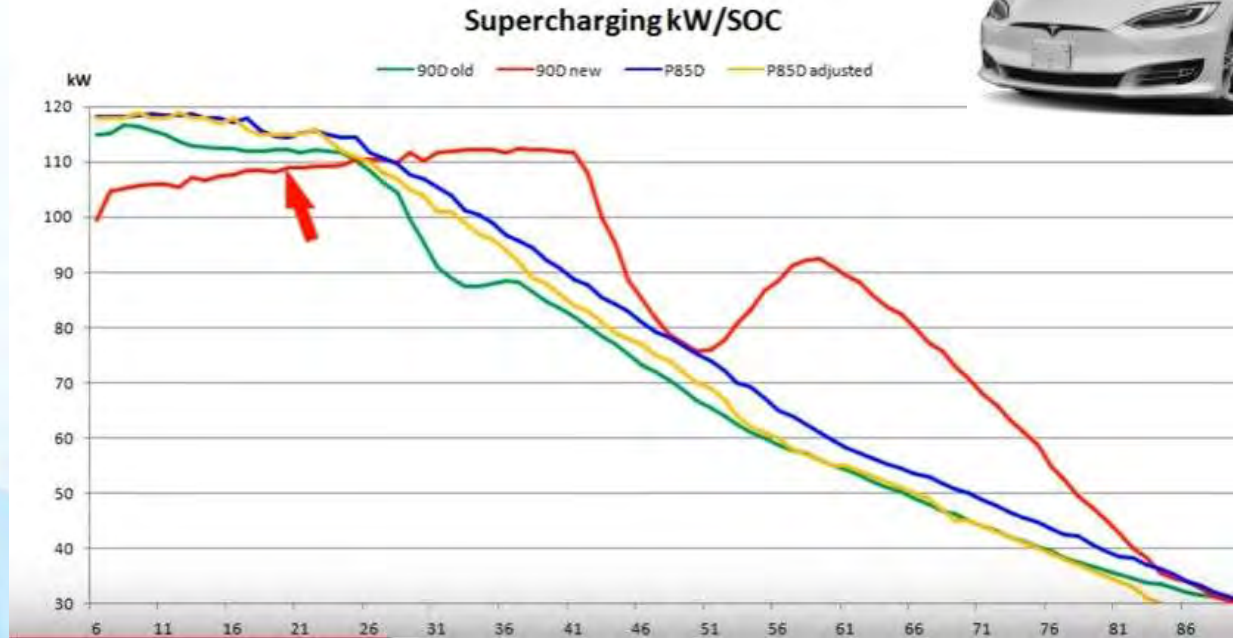
150 Miles/Hr

**Mitsubishi
Outlander
PHEV**



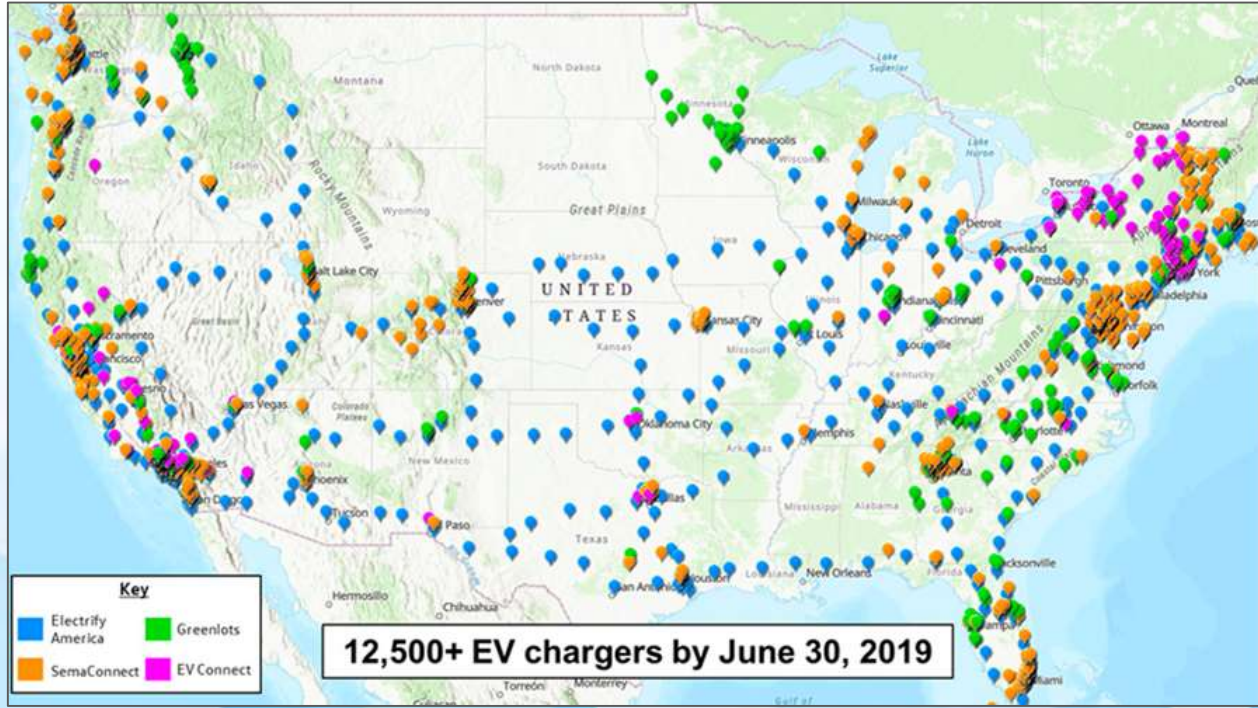


Charging Profiles





Deployment



Key	
Blue	Electrify America
Green	Greenlots
Orange	SemaConnect
Pink	EV Connect

12,500+ EV chargers by June 30, 2019



Deployment Costs



Power Level	Costs
Level 2 - Residential	\$1k - \$3k
Level 2 - Public	\$6k - \$15k
DC Fast Charger	\$60k - \$250k



Driver Costs



Power Level	Charging power (typical)	Costs
Level 1	1.4 kW	Usually free (120v outlet)
Level 2	7 kW	Free - \$4.00/hr
DC Fast Charger	50 kW+	\$0.20 - \$0.40 /min



DCFC Subscriptions



POWERED BY greenlots

ZEF 30

- \$29.99/month
- DC fast charger
- no connection fee
- no contract, cancel anytime
- first 30 min. of each charge are free, then \$0.20/min. after that

[SIGN UP NOW >](#)

ZEF Energy

MEMBERSHIP

Unlock Our Lowest Rates

[BECOME A MEMBER >](#)

DC Fast Charging
\$0.27/minute

60-Minute Session Length 8pm-6am
45-Minute Session Length 6am-8pm

\$7.99/month
Cancel Anytime
29 minutes of fast charging included

EVgo



Call To Action

What can you do in your community to bring charging options?



- Many cities/utilities/private companies are willing to work together to provide chargers
- Think about incentives to part pay for chargers (people love a deal!)
- Level 2 charging is a great start - marketing opportunity is very strong at a good price
- Consider: people need to see charging as “normal”, so they need to see chargers everywhere.
- Collect data! The best decisions are driven by data.



Shameless “Plug”!



ZEF Manufactures ZEFNET Chargers in Montevideo, MN

Turnkey DCFC Project Execution

Provide both Commercial and Utility Program solutions

Provides “Retrofit Smarts” to pre-existing chargers

Now has leasing options from \$21/month



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