EV Charging Strategies

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PlugInConnect
Explore the electric future

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Department of Energy and Minnesota Pollution Control Agency

What do I do:

- Plug-in vehicle market and business development
  www.PlugInConnect.com
- Charging information for condos and apartment buildings
  www.MultiHousingCharging.com
- Charging information for workplaces
  www.WorkplaceCharging.com
- MN Plug-in Vehicle Owners' Circle
  www.pluginconnect.com/mnpevowners.html
- EV market expert at Fresh Energy
  www.Fresh-Energy.org

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Explore the electric future

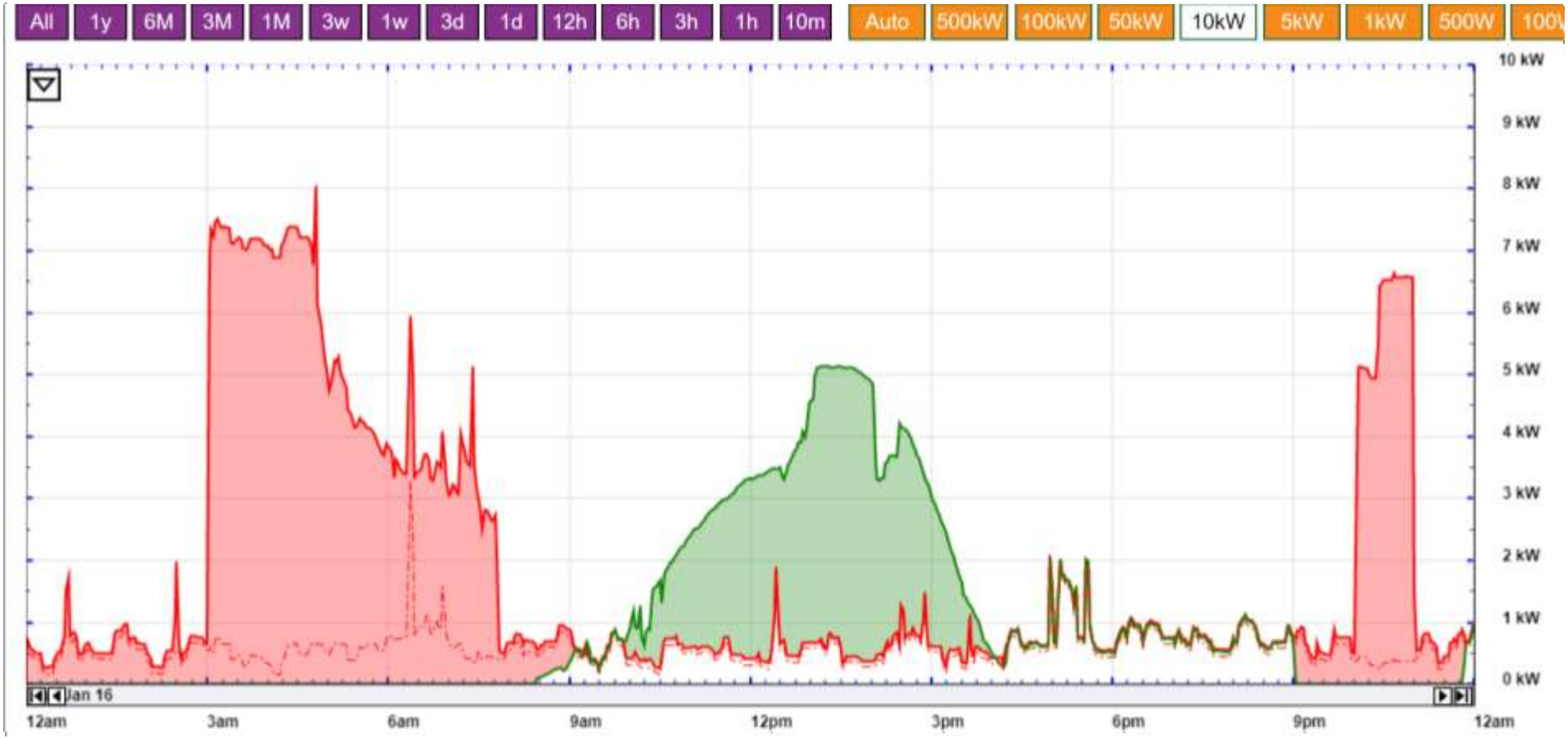
MN PLUG-IN VEHICLE OWNERS' CIRCLE

Fresh Energy

New for Fall 2018!

- **Electric Vehicle Market and Technologies,** ETLS 699-01, CRN: 43150
- A one semester introductory graduate course exploring the key areas of electric vehicle market and technologies. This course will provide an understanding of the present state of electric vehicle market and technologies, perspectives on the dynamics of the market and plenty of ideas on future opportunities. This course will provide a solid foundation for anyone considering future career or business options with EVs and related technologies in this fast-growing field.

Residential household



Graph:
Jukka Kukkonen

Electric era in transportation is coming.

- Over 1,000,000 plug-in vehicles on US roads.
- Over 7000 PEVs in MN. Over 50 million gas free miles in 2017.

- Very high satisfaction: Over 90% of owners say their next vehicle will be a PEV too.
- People are hesitant to try new things but we are approaching the tipping point.

Photo: Chevrolet

"20 percent of Americans (50 million people) saying they are likely to buy an EV for their next car."

Sales forecasts

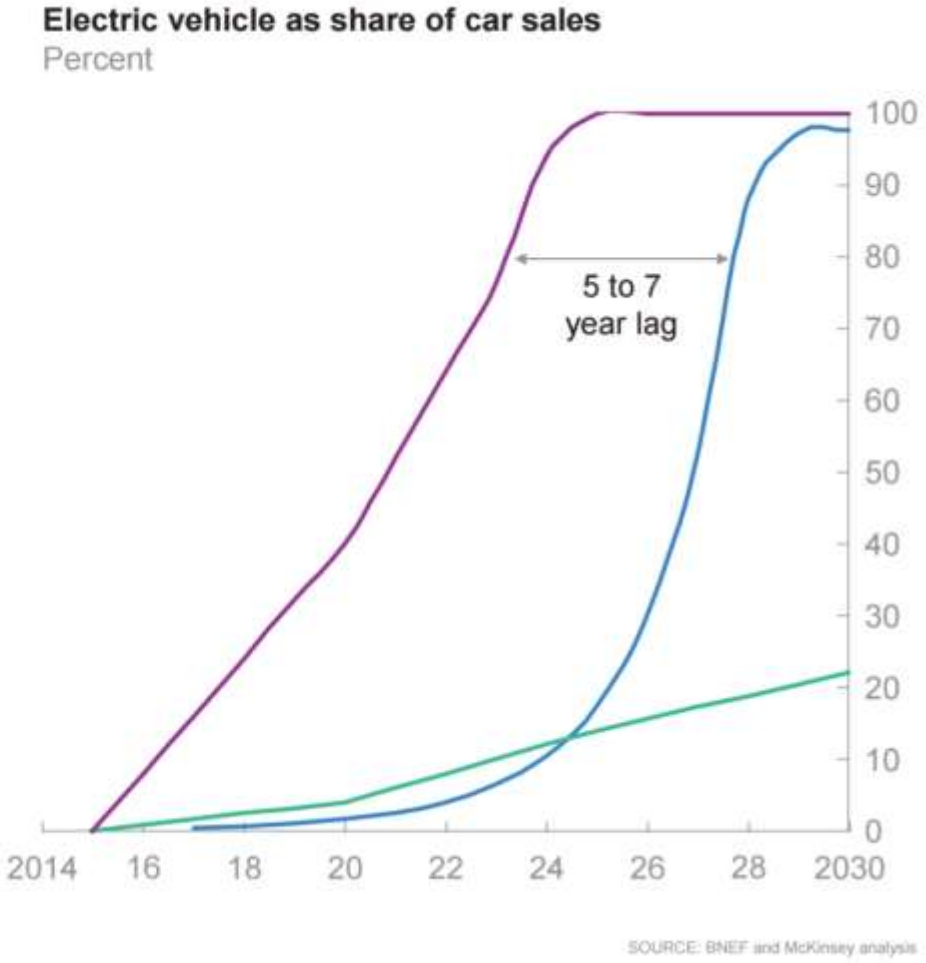
November /
2016

Different possible adoption curves

Base case curve
- Meets general fleet emission targets

Regulatory-driven curve
- 100% of light vehicle sales to be electric by 2025 (e.g., Seamless Mobility)
- Based on Norway's intentions

Innovation and imitation curve
- Assuming early adopter and imitation effect
- Speed of adoption and imitation based on historic sales, and the relative cost of ICE versus EV's



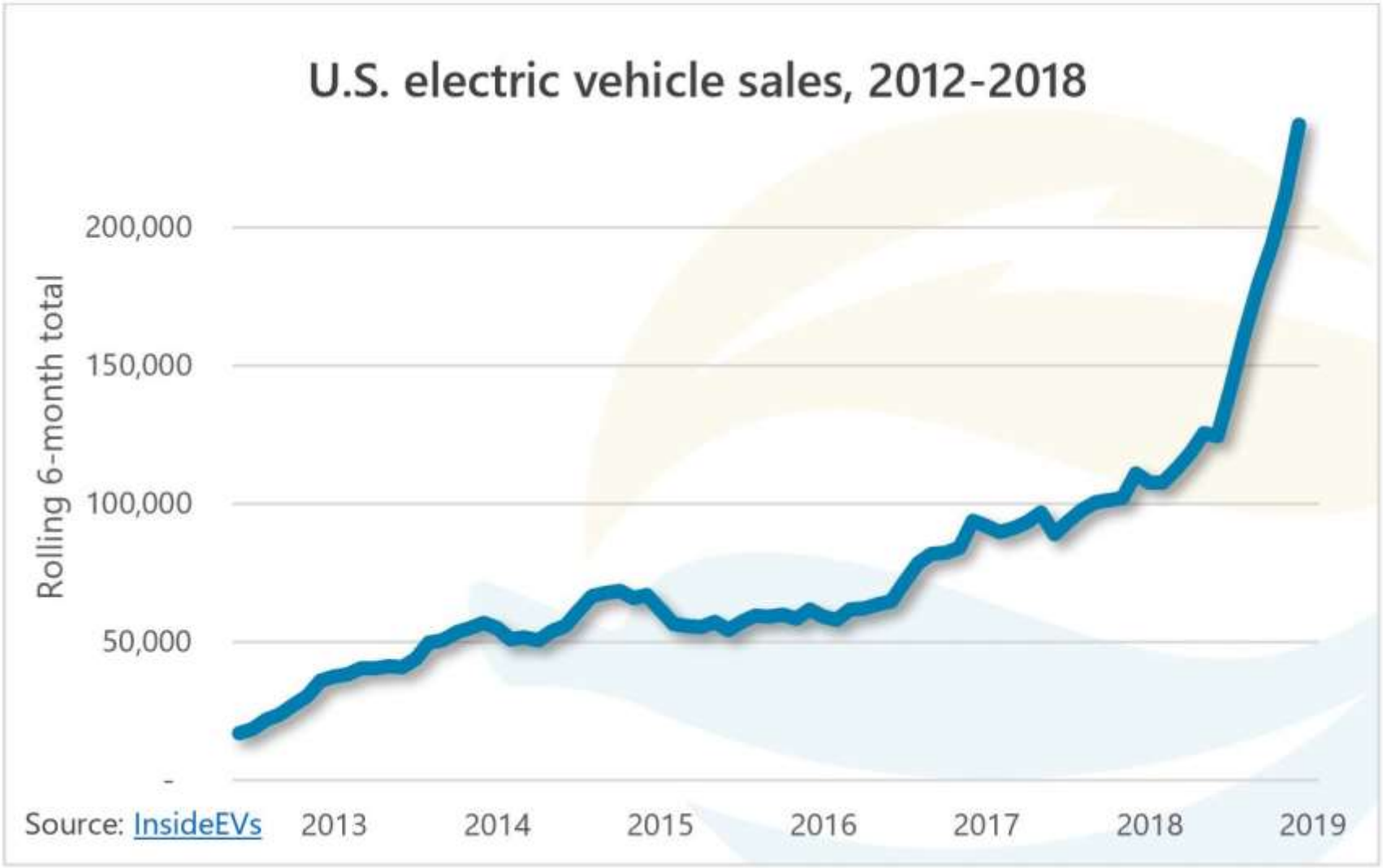
Graphs:
BNEF and McKinsey

S-Curve of Consumer Adoption

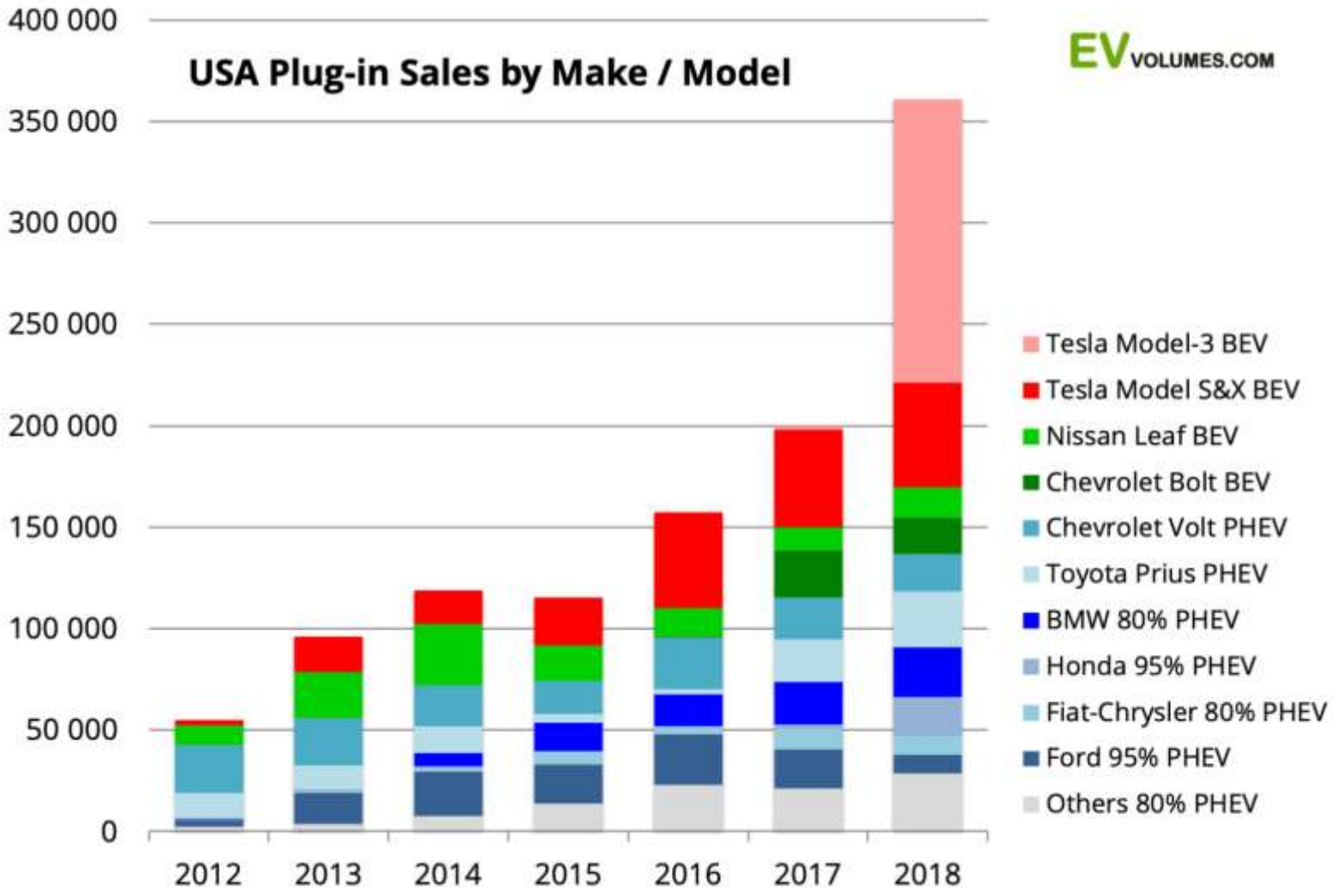
Electric Car Adoption Overlay, via CleanTechnica / Zach Shahan

Source: Dent Research

www.dentresearch.com



Graph:
Andrew Twite, Fresh Energy


USA Plug-in Sales by Make / Model
EVVOLUMES.COM
400 000
350 000
300 000
250 000
200 000
150 000
100 000
50 000
0
2012
2013
2014
2015
2016
2017
2018
Tesla Model-3 BEV
Tesla Model S&X BEV
Nissan Leaf BEV
Chevrolet Bolt BEV
Chevrolet Volt PHEV
Toyota Prius PHEV
BMW 80% PHEV
Honda 95% PHEV
Fiat-Chrysler 80% PHEV
Ford 95% PHEV
Others 80% PHEV

Volkswagen says last generation of combustion engines to be launched in 2026

Photo:
Jukka Kukkonen

Choose your ride!

BMW 330e, Mitsubishi Outlander, Toyota Prius Prime, Volvo XC 90, Ford Fusion Energi, etc

Chrysler Pacifica PHEV

Chevrolet Volt 2017 and Honda Clarity PHEV

Chevrolet Volt 2012

Tesla Model S and X

Tesla Model 3

Chevrolet Bolt

Nissan Leaf 2018

Nissan Leaf 2012

miles

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340

Photos:
Vehicle manufacturers

Models available in Midwest

Photos: Vehicle manufacturers

Plug-in vehicles available in Minnesota (December 2016)

Manufacturer									Range			Charging speed (miles/hr)			Performance			
Name	Model	Photo	Seating	PEV Type	Battery size (kWh)	Base MSRP	Federal tax credit	Price after federal tax credit	Electric Range (miles)	Total Range (miles)	Level 2 Charging Rate (kW)	Level 1 120v	Level 2 240v	DCFC 400+v	MPGe/MPG	Top Spd (mph)	Accel. 0-60 mph (sec)	Crash Rating
Audi	A3 E-Tron		5	PHEV	9	$38,900	$4,168	$34,732	17	430	3.3	4	8	N/A	86/39	130	7.6	NR
BMW	i3		4	BEV	33	$43,600	$7,500	$36,100	114	114 (180)	7.4	5	27	166	124 (39)	93	7.0	4 star
BMW	i8		4	PHEV	7.2	$141,000	$3,793	$137,207	15	330	3.3	3	7	N/A	76/28	155	4.2	NR
BMW	X5 xDrive40e		5	PHEV	9	$62,100	$4,700	$57,400	14	540	3.3	2	5	N/A	56/24	130	6.5	NR
BMW	330E		5	PHEV	7.6	$43,700	$4,000	$39,700	14	350	3.7	3	8	N/A	72/31	130	5.9	NR

www.PlugInConnect.com/mnpevmodels.html

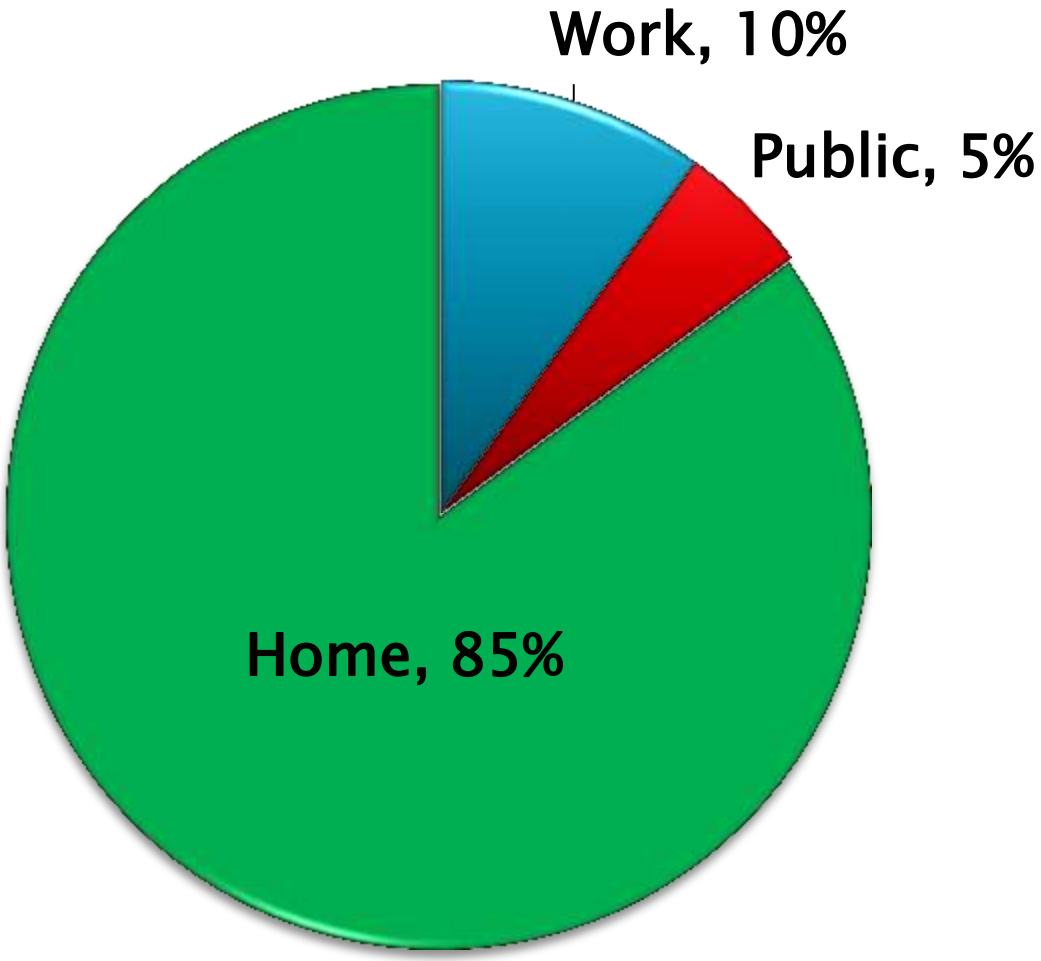
Nissan	Leaf		5	BEV	30	$30,680	$7,500	$23,180	107	107	3.3 or 6.6	5	11 or 22	152	114	90	10.1	5 star
Porsche	Panamera S E-hybrid		2	PHEV	9.4	$77,000	$4,752	$72,248	16	540	3	3	6	N/A	65/25	167	5.2	NR
Porsche	Cayenne S E-hybrid		5	PHEV	10.8	$93,000	$5,300	$87,700	14	480	3	3	6	N/A	65/25	151	5.4	NR
Tesla Motors	Model S		5	BEV	60 - 100	$68,000	$7,500	$60,500	210-315	210-315	10 or 20	4	60	375	101	155	2.8	5 star
Tesla Motors	Model X		7	BEV	75 - 100	$90,000	$7,500	$82,500	238-289	238-289	10 or 20	4	55	341	92	155	3.2	5 star
Toyota	Prius Prime		4	PHEV	8.8	$27,100	$4,500	$22,600	25	640	3.3	6	13	N/A	133/54	155	3.2	NR
Volvo	XC90 T8		7	PHEV	9	$69,000	$4,600	$64,400	14	350	3.3	2	5	N/A	53/25	125	5.9	NR

This table was updated in December 2016 by Jukka Kukkonen, PlugInConnect.

Photos and information sources: Manufacturers' websites and www.fueleconomy.gov

More info: www.pluginconnect.com/MNpevmodels.html

Where does the energy flow?



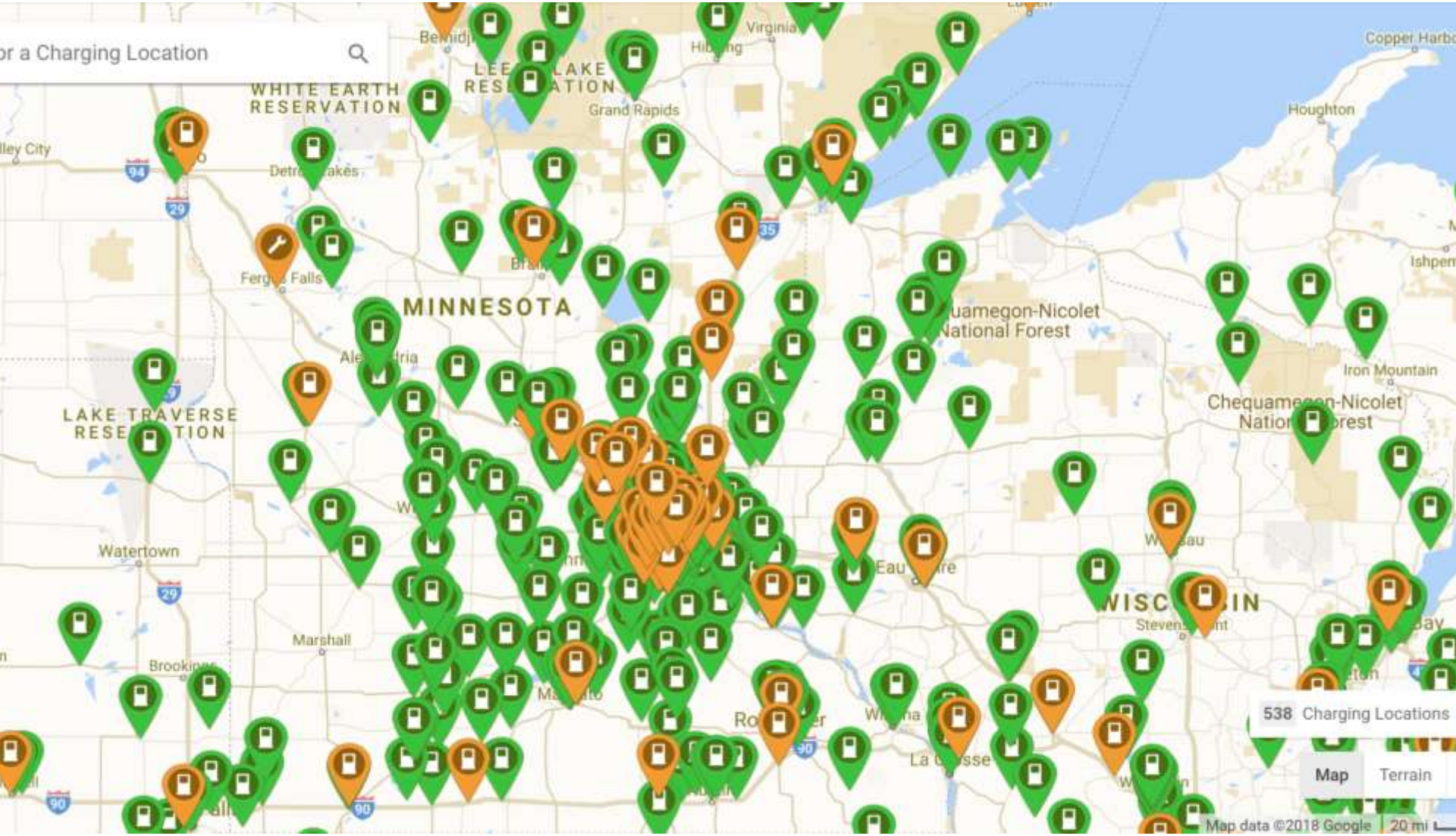
How to charge an EV?

Level 1
120 Volt

Level 2
240 Volt

DC fast charge

Pictures: Bosch, Clipper Creek, ChargePoint, ABB

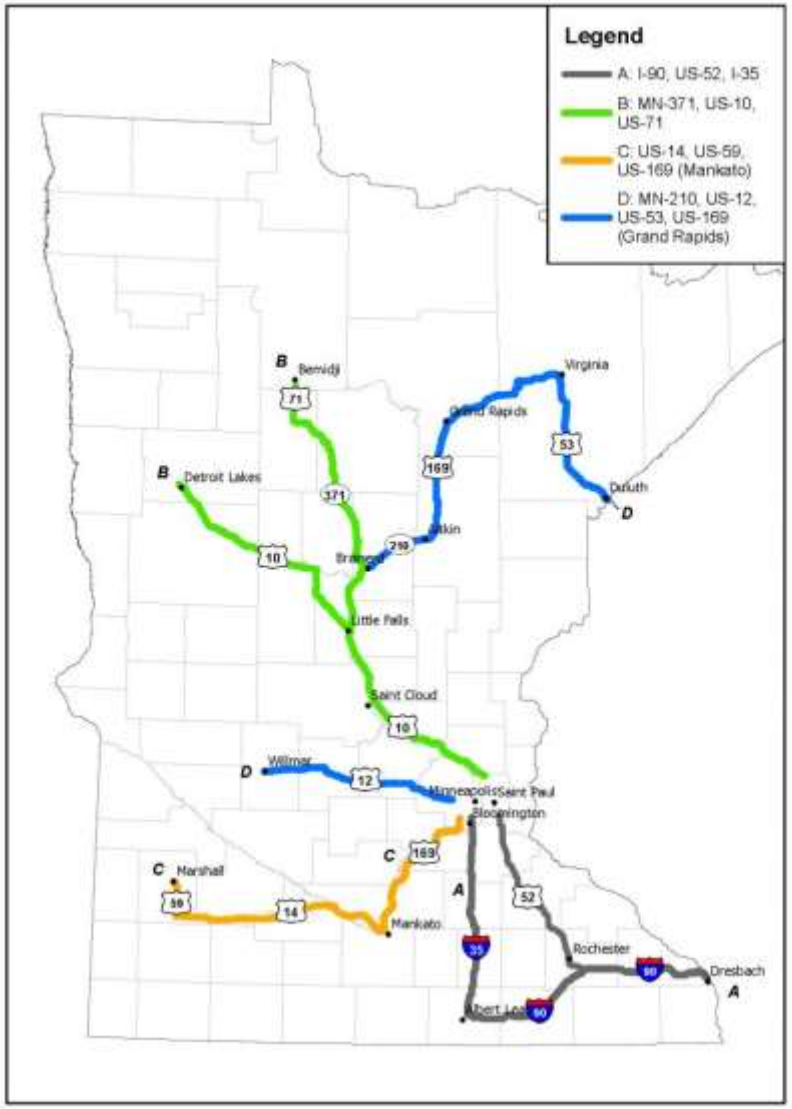


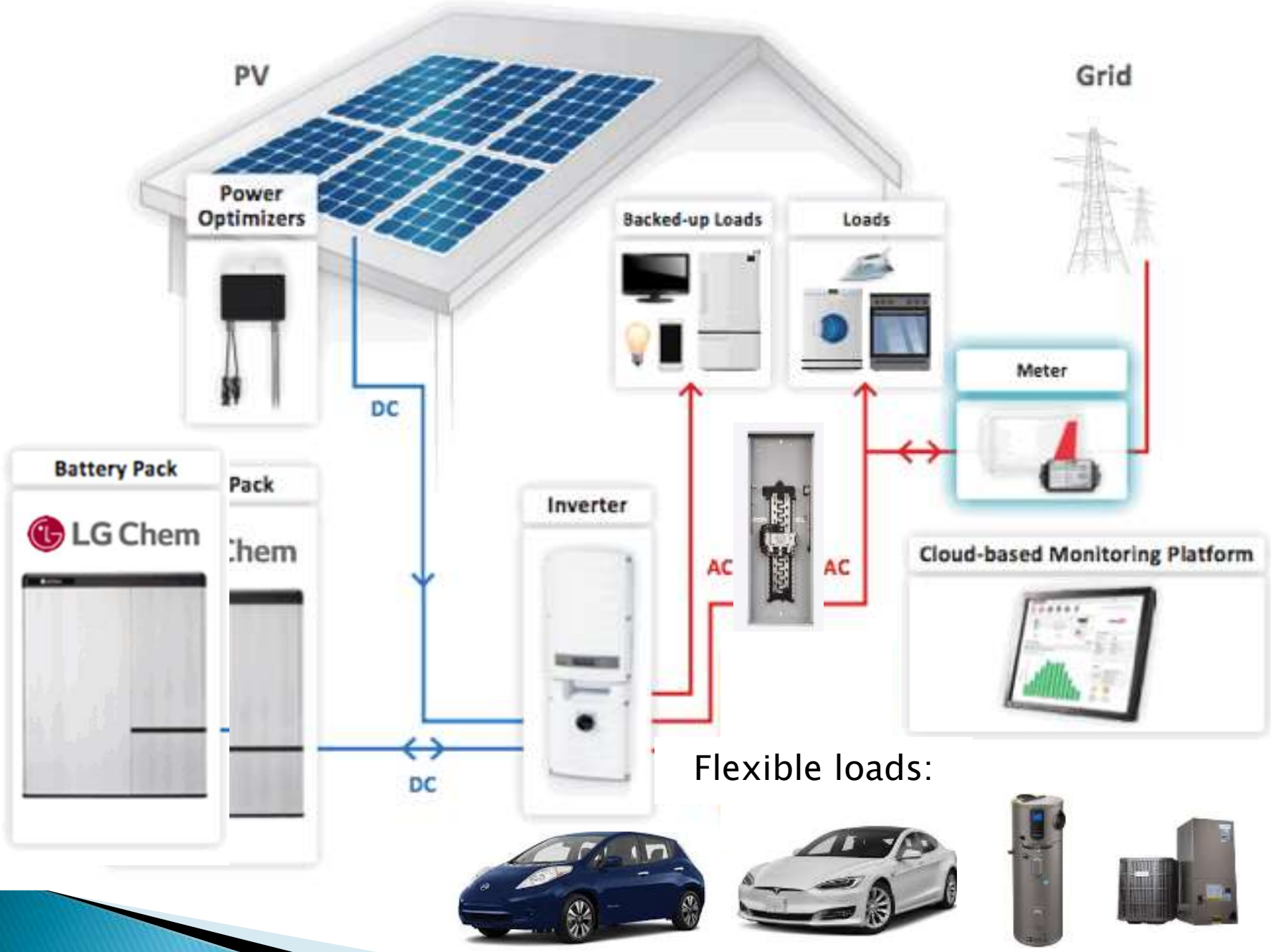
Map: PlugShare.com

MPCA VW settlement DCFC corridors

Phase 1(2018-2019)

- DCFC stations at 30- to 70-mile increments along identified highways
- Minimum 50 kW
- Adequate conduit size at each station for future upgrades as well as space for extending the parking pad.
- Encourage renewable energy (wind and solar) (Utility program or energy credits)




PV
Grid
Power Optimizers
Backed-up Loads
Loads
Meter
DC
Battery Pack
LG Chem
Inverter
AC
AC
Cloud-based Monitoring Platform
DC
Flexible loads:

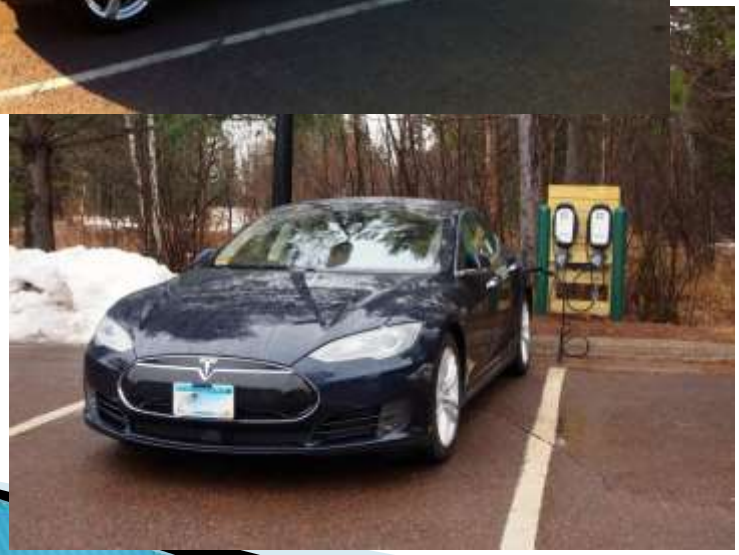
ICE vs. EV household calculation

- Average American drives 13,500 miles/year
- Average household has 1.8 drivers
- Average household driving 24,000 miles/year

	ICE	EV
Efficiency	25MPG = 0.74miles/kWh	>100MPGe = 3miles/kWh
Annual fuel consumption	970 gallons	0
Annual energy consumption	33,000kWh	8100kWh
Cost	$2.5/gallon	$0.07/kWh
Annual energy cost	$2,425	$570
Annual saving		$1.855

- For comparison average American household consumes 11,000 kWh of electricity annually

EV Charging for Multi-Housing and Commercial Properties



BENEFITS FOR BUILDING OWNERS / MANAGERS

- New service product
- Client attraction and retention
- Future proofing the property
- LEED points
- Property value increase
- Green credentials and publicity

How to future proof your property?

California Green Building Standards Code 2016

- Both residential and non-residential
  - 3 % of parking spots (residential)
  - 6 % of parking spots (non-residential)
  - 208/240V 40A circuit breaker
  - Conduit size minimum 1 inch

- Cost estimates:
  - $53 for single family homes
  - $110 for multi housing buildings

LEED v4 Credit 8, Green Vehicles

1 Point for Green Parking and Electric Vehicle Charging

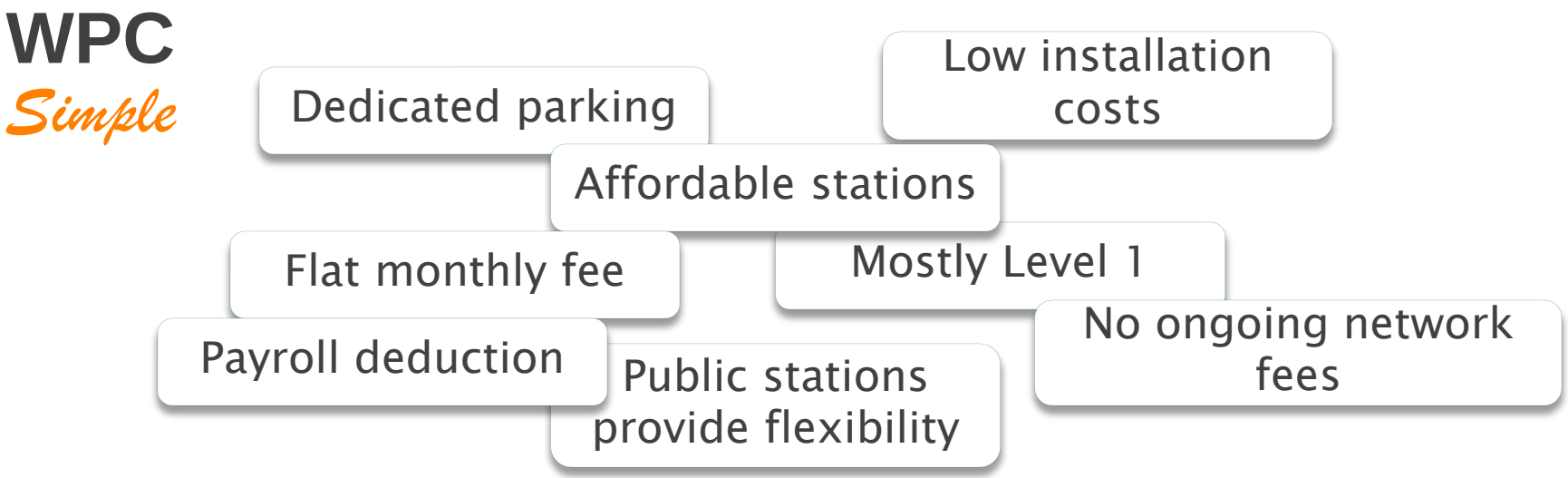
- Designate 5% of all parking spaces for green vehicles
- Install Electric vehicle Supply Equipment (EVSE) in 2% of all parking spaces used by the project.
- The EVSE must:
  - Be Level 2 (208/240V) or higher
  - Use standardized connector (J1772)
  - Be networked and be capable of participating in a demand-response program or time-of-use pricing to encourage off-peak charging.

Source:
LEED Reference Guide

Considerations

- Electrical service
- Breaker panel capacity
- Future expansion
- Proximity to the electrical service
- Safety
- Cord management
- Connectivity
- Lighting
- Signage

Workplace Charging Simple concept



Resources


MultiHousingCharging.com
HOME PAGE
EV OWNERS
HOAS
BLDG OWNERS/MGRS
UTILITIES
TOOLS AND RESOURCES
ABOUT US
Practical processes
to PEV charging.
AN INCREASING NUMBER OF PROPERTIES ARE ADDING EV CHARGING AS A NEW AMENITY
A growing number of people are choosing to drive electric vehicles and plug-in hybrids. These vehicles need to be charged at home rather than filled up at the gas station. In single family homes, EV charging systems are very straightforward to choose and install. Multi housing charging (MHC) can


WorkplaceCharging.com
HOME
EV OWNERS
EMPLOYERS
BLDG OWNERS/MGRS
UTILITIES
RESOURCES
ABOUT US
Workplace EV charging provides value to all stakeholders

Multi Housing Charging worksheet

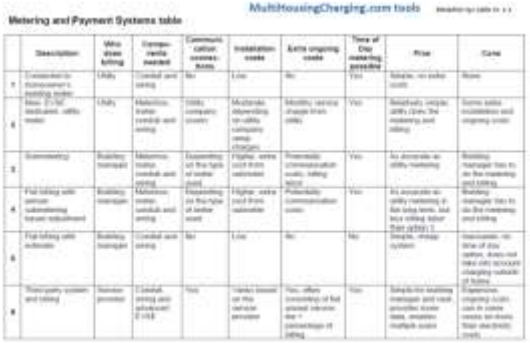

MultiHousingCharging.com tools

Multi Housing Charging worksheet


MultiHousingCharging.com tools


MultiHousingCharging.com tools

Metering and Payment Systems Table


MultiHousingCharging.com tools

Metering and Payment Systems table

Power and Energy Calculator tool


MultiHousingCharging.com tools

Power and Energy Calculator tool


MultiHousingCharging.com tools

Metering and Payment Systems table

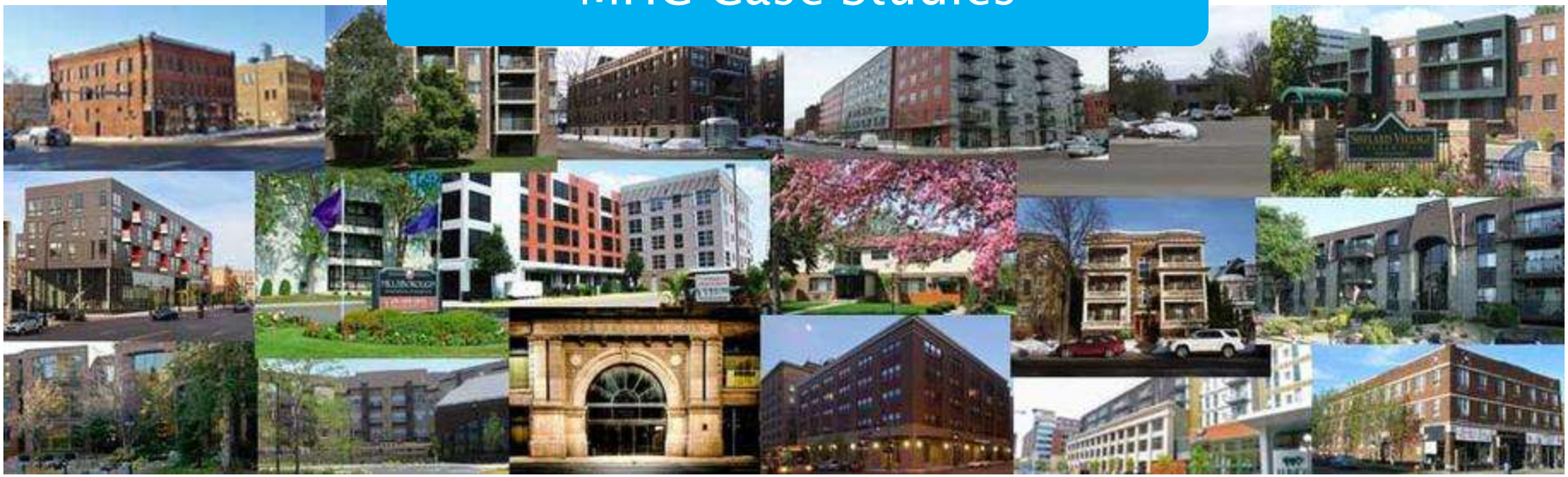
	Description	Who does billing	Compo-nents needed	Communi-cation connec-tions	Installation costs	Extra ongoing costs	Time of Day metering possible	Pros	Cons
1	Connected to homeowner's existing meter	Utility	Conduit and wiring	No	Low	No	Yes	Simple, no extra costs	None
2	New, EVSE dedicated, utility meter	Utility	Meterbox, meter, conduit and wiring	Utility company covers	Moderate, depending on utility company setup charges	Monthly service charge from utility	Yes	Relatively simple, utility does the metering and billing	Some extra installation and ongoing costs
3	Submetering	Building manager	Meterbox, meter, conduit and wiring	Depending on the type of meter used	Higher, extra cost from submeter	Potentially communication costs, billing labor	Yes	As accurate as utility metering	Building manager has to do the metering and billing
4	Flat billing with annual submetering based adjustment	Building manager	Meterbox, meter, conduit and wiring	Depending on the type of meter used	Higher, extra cost from submeter	Potentially communication costs	Yes	As accurate as utility metering in the long term, but less billing labor than option 3	Building manager has to do the metering and billing
5	Flat billing with estimate	Building manager	Conduit and wiring	No	Low	No	No	Simple, cheap system	Inaccurate, no time of day option, does not take into account charging outside of home
6	Third party system and billing	Service provider	Conduit, wiring and advanced EVSE	Yes	Varies based on the service provider	Yes, often consisting of flat annual service fee + percentage of billing	Yes	Simple for building manager and user, provides more data, enables multiple users	Expensive, ongoing costs can in some cases be more than electricity costs

This worksheet was developed as part of the Advancing Alternatives for Minnesota Drivers Initiative funded by the U.S Department of Energy.
Author Jukka Kukkonen, PlugInConnect. For more information visit www.MultiHousingCharging.com .

Sharing experiences

- Over 20 case studies from the Twin Cities

MHC Case Studies



www.multihousingcharging.com/case-studies.html

Q&A+O

For more information visit:

PlugInConnect.com

MultiHousingCharging.com

WorkplaceCharging.com

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