
ELECTRIC VEHICLE CHARGING
EV
AVAILABLE HERE

EV Charging Strategies

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PlugInConnect
Explore the electric future

Portion of the work presented here was funded by
Department of Energy and Minnesota Pollution Control Agency

www.PlugInConnect.com

What do I do:

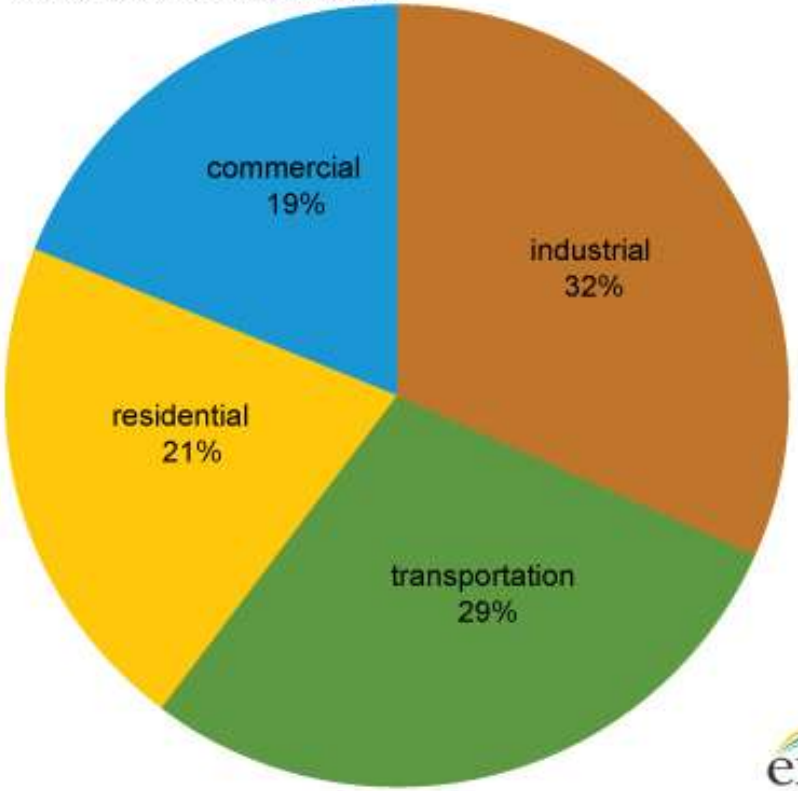
- Plug-in vehicle market and business development
  www.PlugInConnect.com
- Charging information for condos and apartment buildings
  www.MultiHousingCharging.com
- Charging information for workplaces
  www.WorkplaceCharging.com
- MN Plug-in Vehicle Owners' Circle
  www.pluginconnect.com/mnpevowners.html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

PlugInConnect
Explore the electric future

Fresh Energy

Share of total U.S. energy consumed by end-use sector in the United States, 2016

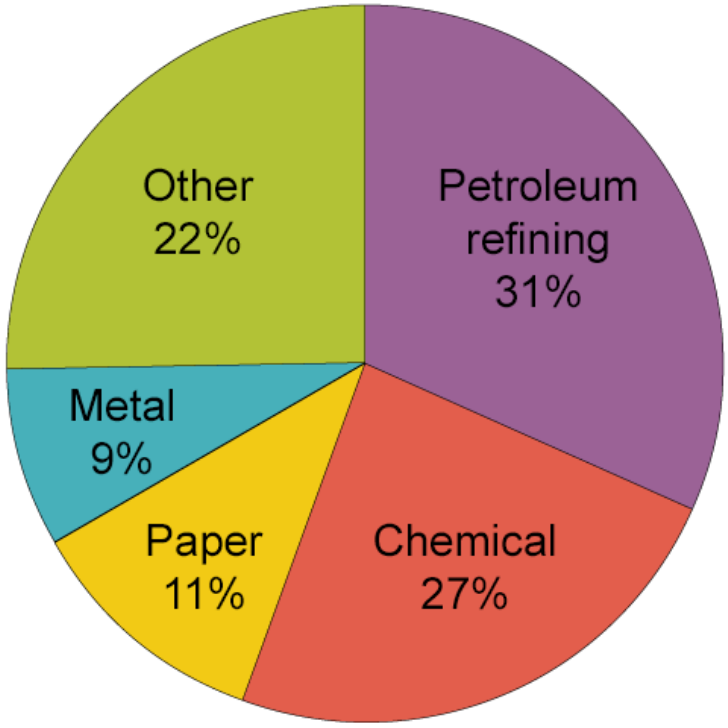
Total = 97.4 quadrillion British thermal units



Note: Sum of individual percentages may not equal 100 because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 2.1, April 2017, preliminary data

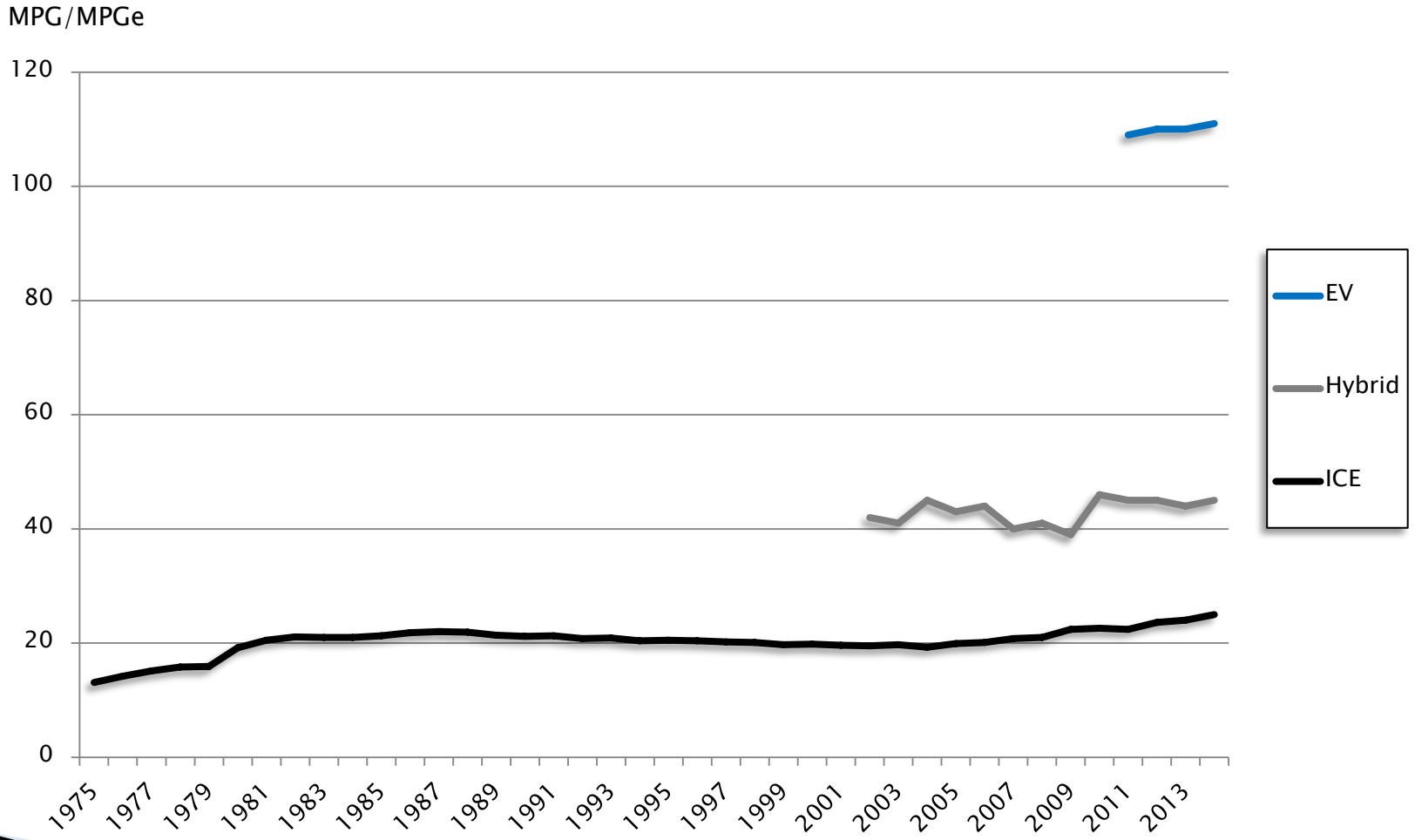
Energy use by type of industry, 2010[1]



Source: U.S. Energy Information Administration, *Manufacturing Energy Consumption Survey 2010*, Table 1.2 (March 2013)

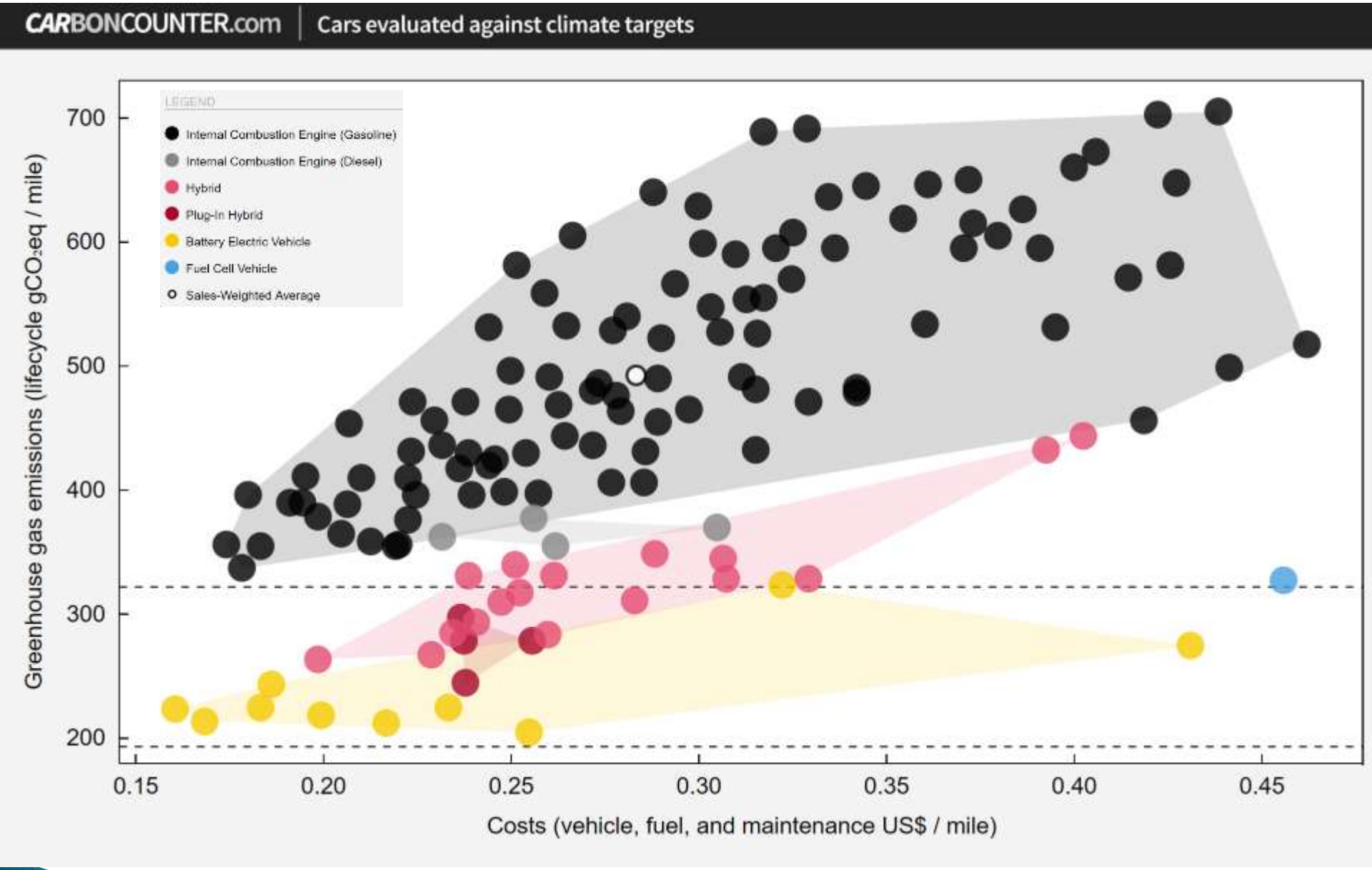
[1]Includes all use of energy and fuels; excludes shipments of energy sources produced onsite.

Average fuel economy for new vehicles sold.



Data:
www.fueleconomy.gov

www.PlugInConnect.com



Data and Graph:
MIT 09/2016

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Electric era in transportation is coming.

- Over 650,000 plug-in vehicles on US roads.
- About 5500 PEVs in MN. Over 30 million gas free miles in 2016.

- 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

Sales forecasts

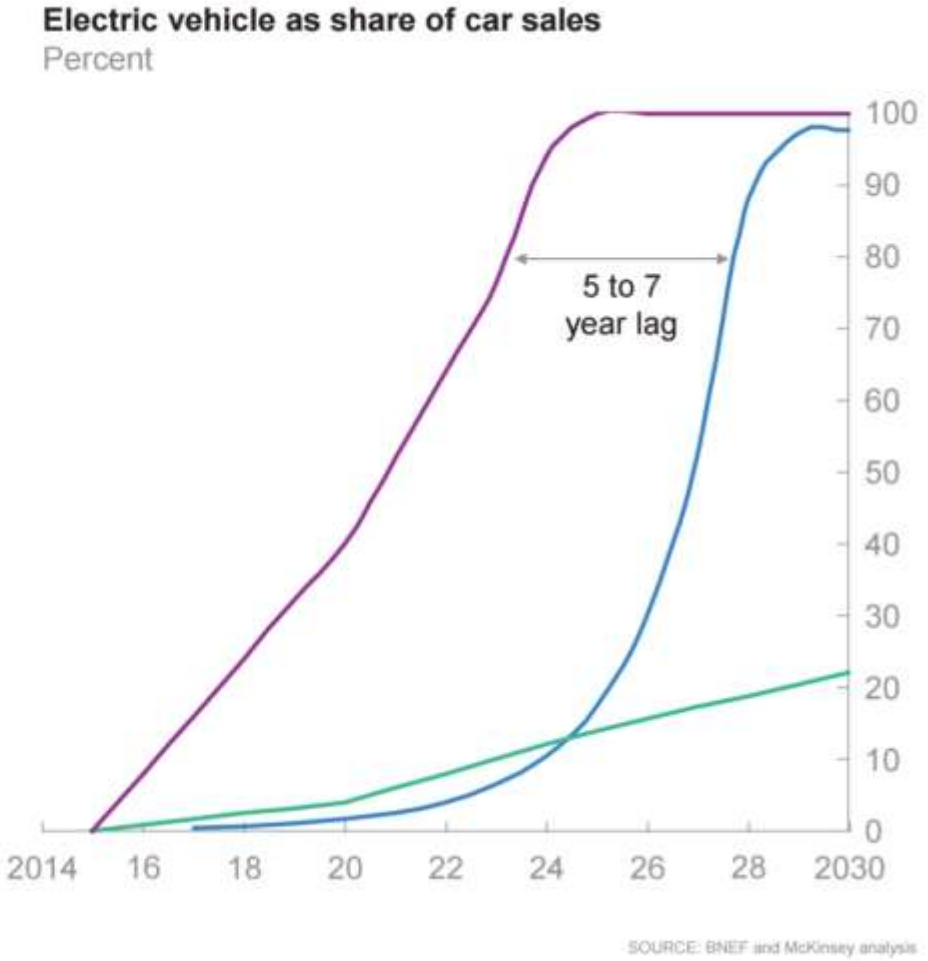
November /
2016

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

EV Technology Fun Facts

- EV drivetrain technology is four times more efficient than the traditional ICE drivetrain
- Nearly instantaneous heaters provide cozy winter driving
- Preheating offers a new level of comfort
- Electric 4WD is more efficient than 2WD
- More torque means better performance
- Whisper quiet powertrain moves the world's quickest family sedans and SUVs.
- DC Fast Charging provides quick range extension
- Zero local emissions greatly improves the air quality
- Solar and wind can power your drive
- Autonomous vehicle technology is advancing fast

EV maintenance advantage

Maintenance Schedule for your 2017 Chevrolet Bolt EV

Certified Service	7,500 miles	15,000 miles	22,500 miles	30,000 miles	37,500 miles	45,000 miles	52,500 miles	60,000 miles	67,500 miles	75,000 miles	82,500 miles	90,000 miles	97,500 miles	105,000 miles	112,500 miles	120,000 miles	127,500 miles	135,000 miles	142,500 miles	150,000 miles
Rotate tires, if recommended for the vehicle, and perform Required Services.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace passenger compartment air filter (or 2 years, whichever comes first).			✓			✓			✓			✓			✓			✓		
Drain and fill vehicle coolant circuits.																				✓

Maintenance Schedule for your 2016 Chevrolet Cruze Limited

Certified Service	7,500 miles	15,000 miles	22,500 miles	30,000 miles	37,500 miles	45,000 miles	52,500 miles	60,000 miles	67,500 miles	75,000 miles	82,500 miles	90,000 miles	97,500 miles	105,000 miles	112,500 miles	120,000 miles	127,500 miles	135,000 miles	142,500 miles	150,000 miles
Rotate tires, if recommended for the vehicle, and perform Required Services. Check engine oil level and oil life percentage. Change engine oil and filter, if needed.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace passenger compartment air filter (or 2 years, whichever comes first).			✓			✓			✓			✓			✓			✓		
Replace engine air cleaner filter (or every 4 years, whichever occurs first).						✓						✓						✓		
Replace spark plugs and inspect spark plug wires.													✓							
Replace spark plugs. Inspect ignition coils boots. (Applies to: 1.4 L.)								✓								✓				
1.8L Engine Only: Rplace timing belt, idler pulley, and timing belt tensioner (or every 3 years, whichever comes first). (Applies to: 1.8 L)													✓							
Change automatic transmission fluid, if equipped. If filter is serviceable, change filter. (Applies to: Severe)						✓						✓						✓		
Change manual transmission fluid. (Applies to: Manual, Severe)						✓						✓						✓		
Drain and fill engine cooling system (or every 5 years, whichever comes first).																				✓
Change brake fluid (or every 3 years, whichever occurs first).						✓						✓						✓		
Change clutch fluid (or every 3 years, whichever occurs first). (Applies to: Manual)						✓						✓						✓		
Inspect evaporative control system.						✓						✓						✓		
Inspect engine accessory drive belts for fraying, excessive cracks or obvious damage (or every 10 years, whichever occurs first).																				✓

Photos and data: Chevrolet

www.PlugInConnect.com

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

www.PlugInConnect.com

Plug-in vehicle types

- Plug-in Hybrid Electric Vehicle (PHEV)
  - First miles (10-50 miles) electric and then ICE turns on and takes you further (300-500 miles)
  - Examples: Chevrolet Volt, Mitsubishi Outlander PHEV, Toyota Prius Prime

- Battery Electric Vehicle (BEV)
  - All miles always electric (Range 80-335 miles)
  - Examples: Chevrolet Bolt, Nissan Leaf, BMW i3, Tesla Model S, X

Photos: Vehicle manufacturers

www.PlugInConnect.com

Models available in Midwest

Photos: Vehicle manufacturers

www.PlugInConnect.com

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

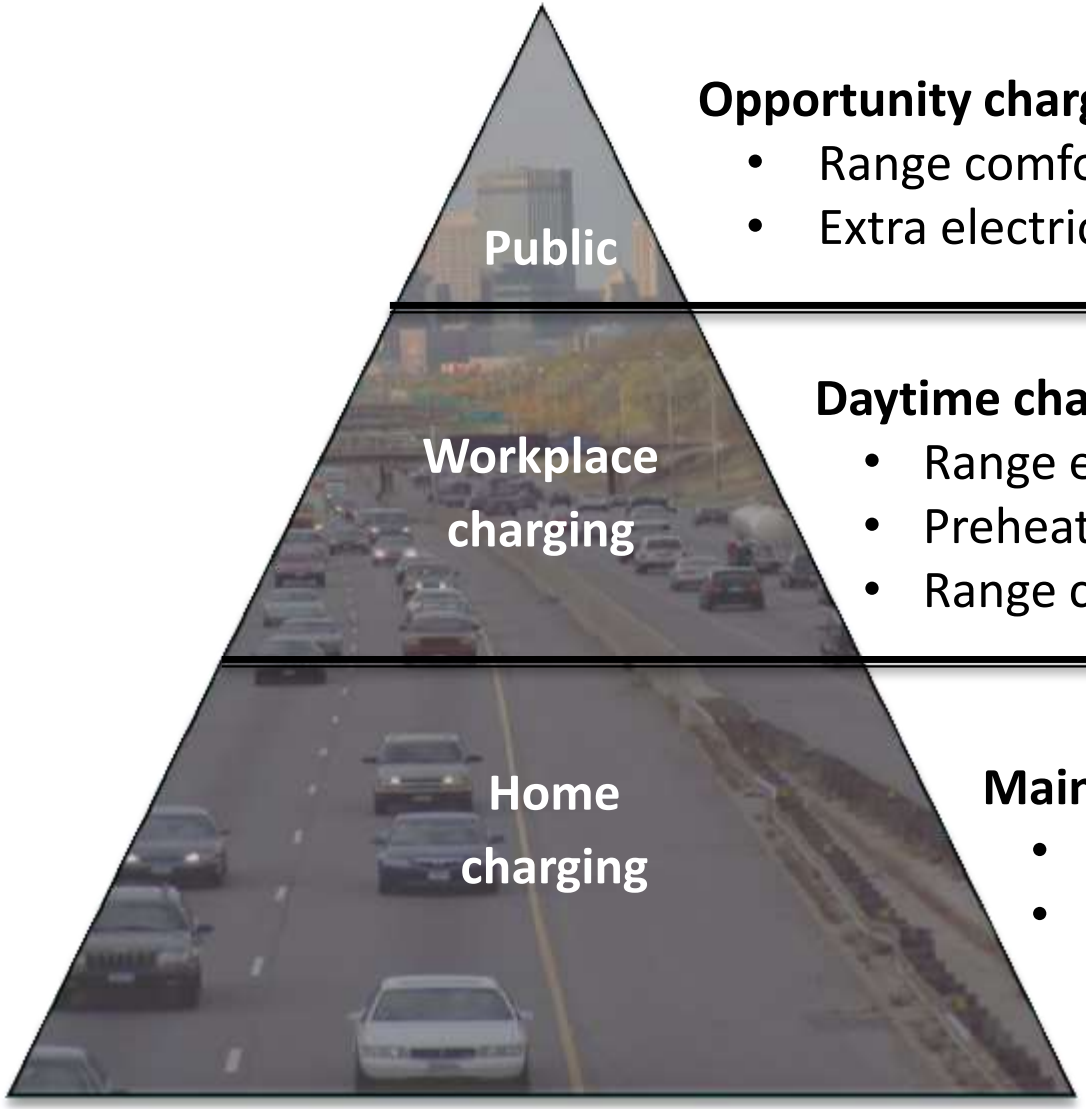
Nissan	Leaf		5	BEV	30	$30,680	$7,500	$23,180	107	107	3.3 or 6.6	5	11 or 22	152	114	90	10.1	5 star
Porsche	Panamera S E-hybrid		2	PHEV	9.4	$77,000	$4,752	$72,248	16	540	3	3	6	N/A	65/25	167	5.2	NR
Porsche	Cayenne S E-hybrid		5	PHEV	10.8	$93,000	$5,300	$87,700	14	480	3	3	6	N/A	65/25	151	5.4	NR
Tesla Motors	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

Charging patterns



Opportunity charging

- Range comfort (BEVs)
- Extra electric miles (PHEVs)

Daytime charging

- Range extension and flexibility
- Preheating and cooling
- Range comfort

Main charging

- Overnight charging
- Preheating and cooling

How to charge an EV?

Level 1
120 Volt

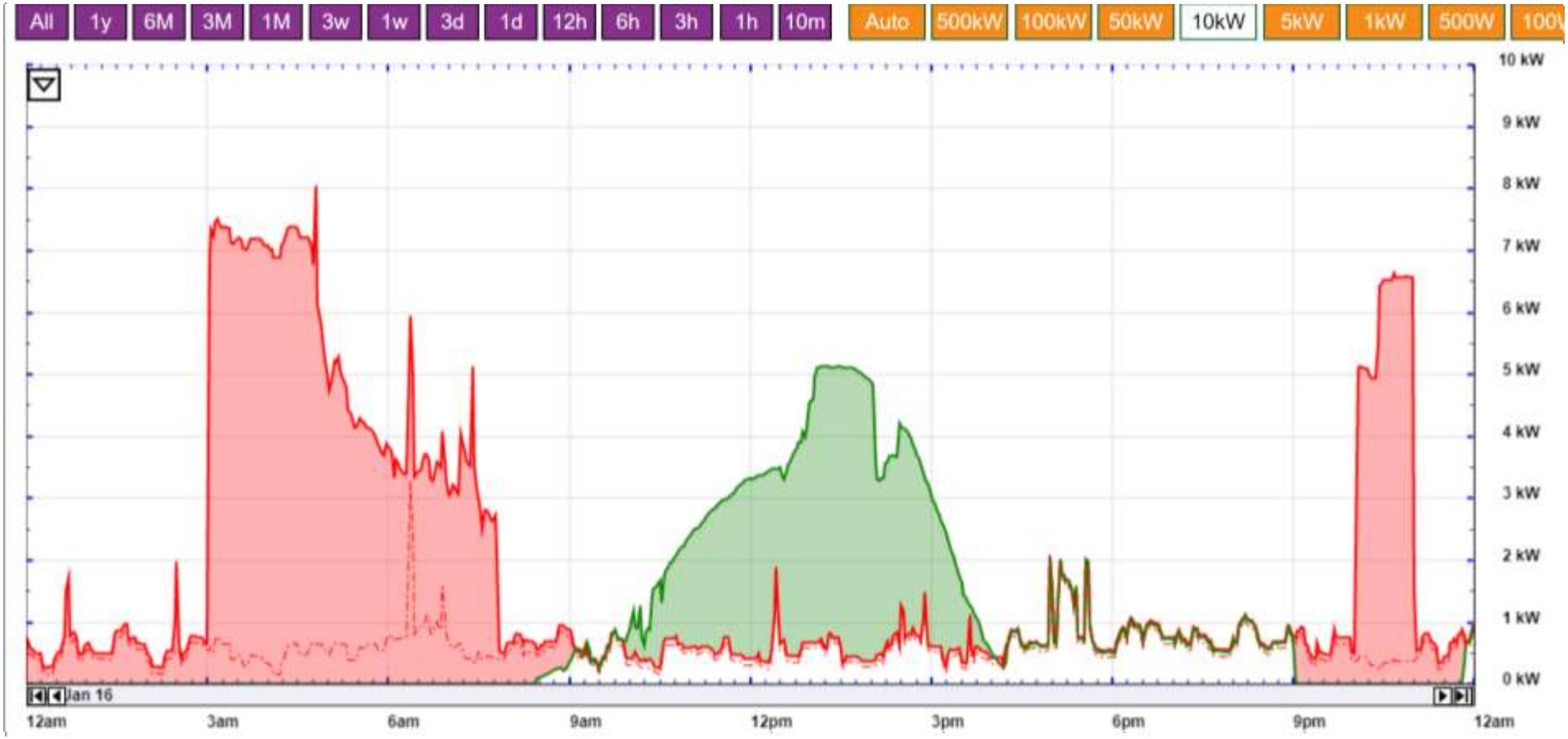
Level 2
240 Volt

DC fast charge

Pictures: Bosch, Clipper Creek, ChargePoint, ABB

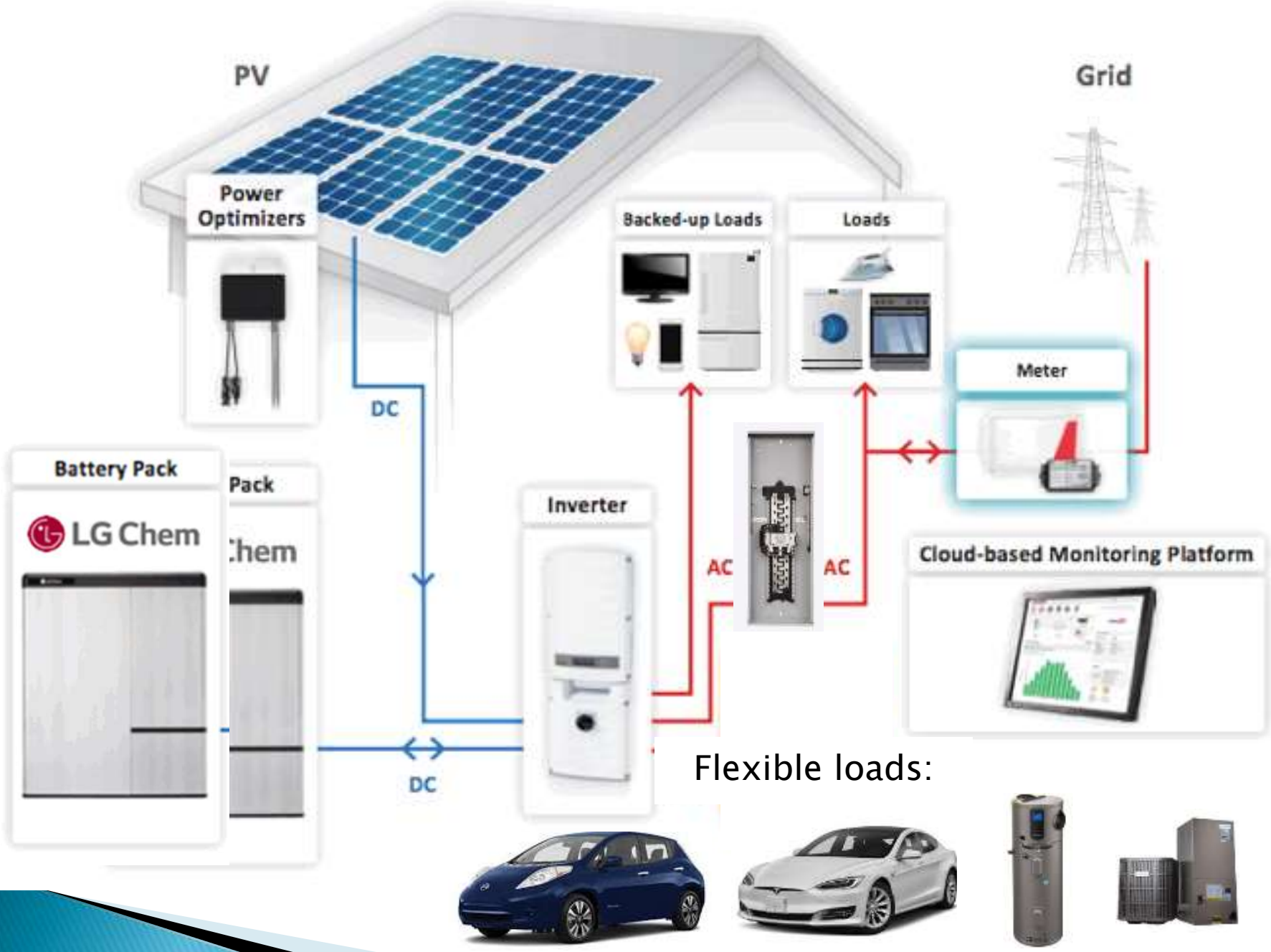
www.PlugInConnect.com

Residential household



Graph:
Jukka Kukkonen

www.PlugInConnect.com



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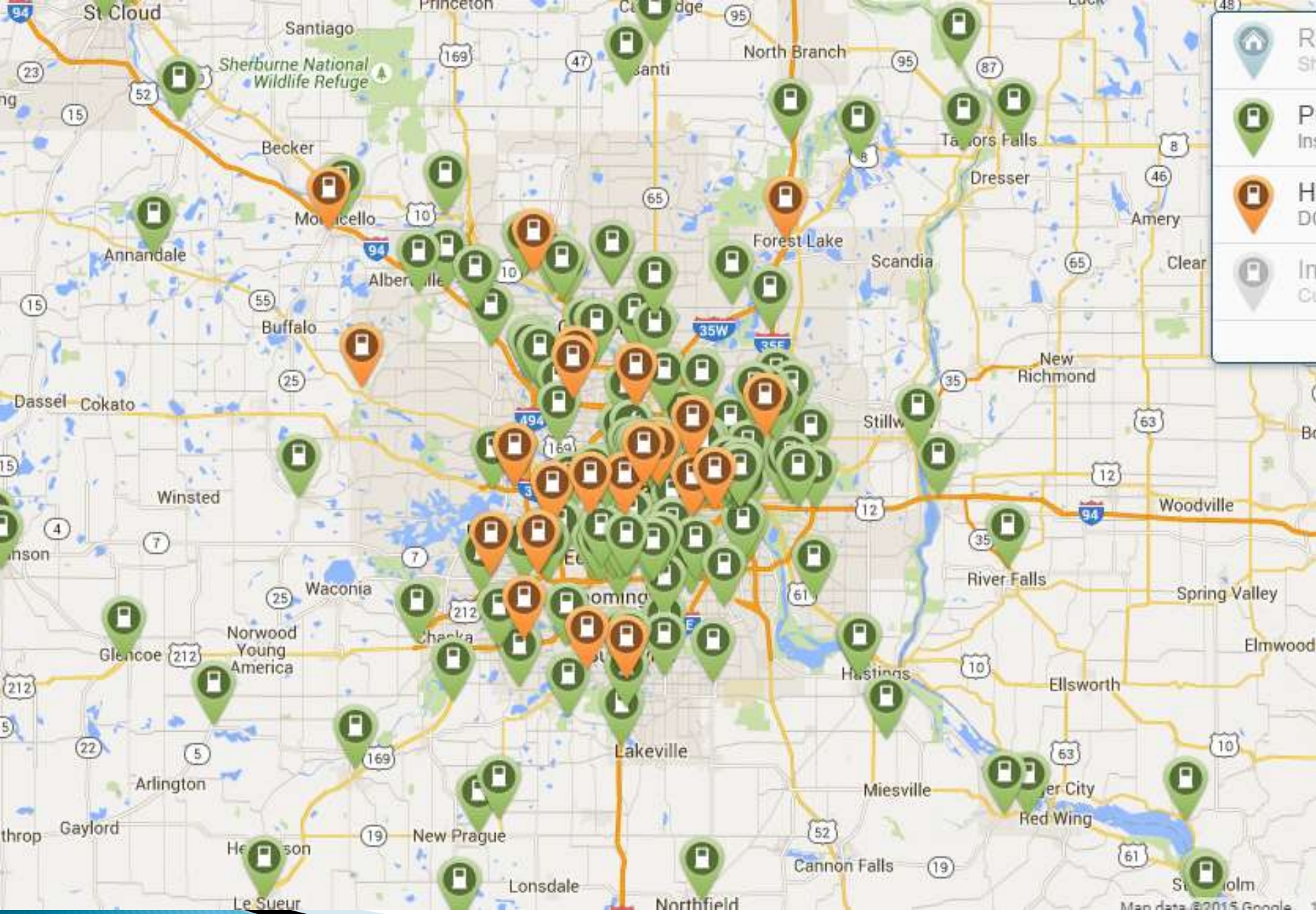
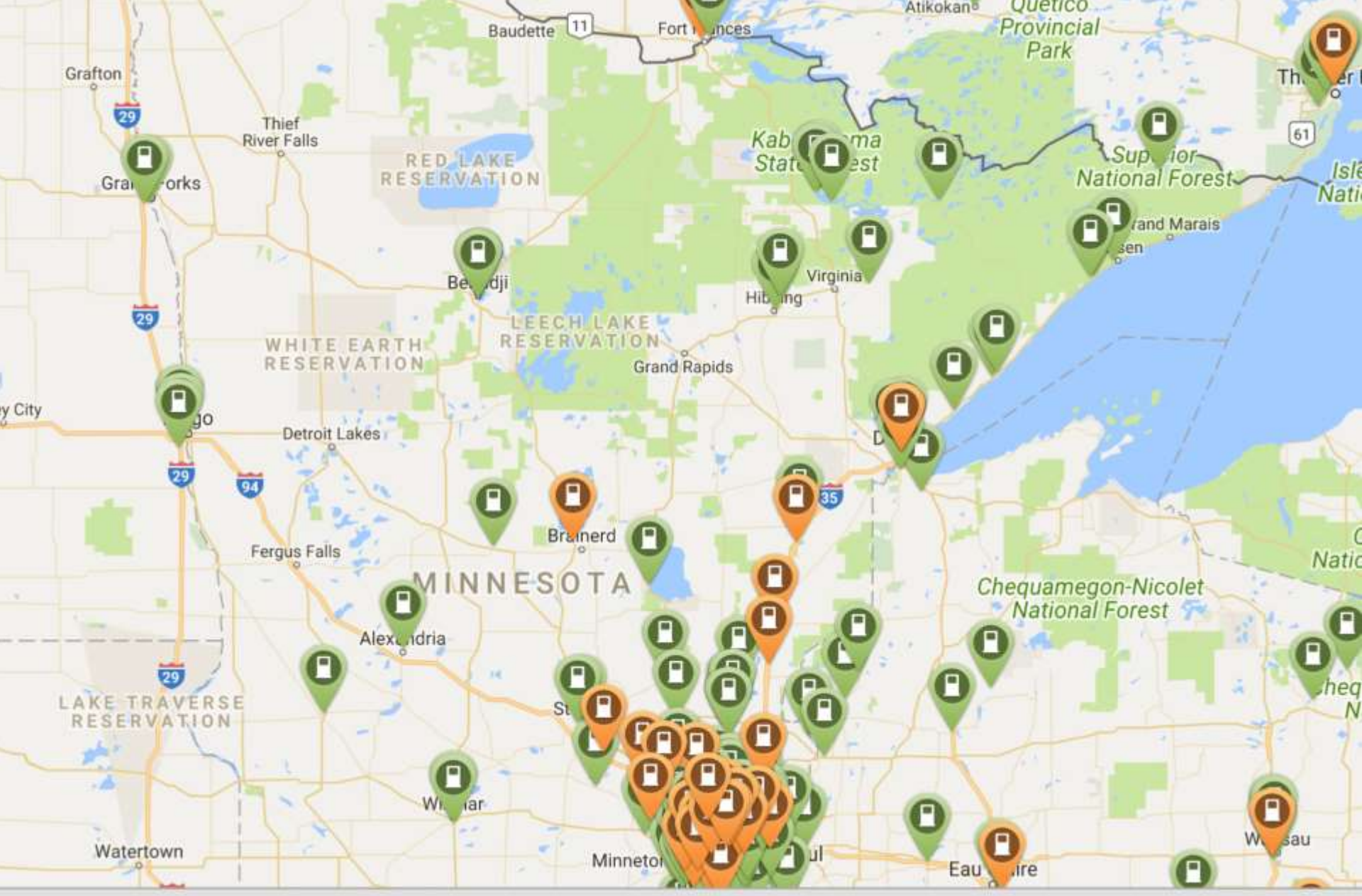


Map: PlugShare.com

www.PlugInConnect.com



Source: ZEF Energy

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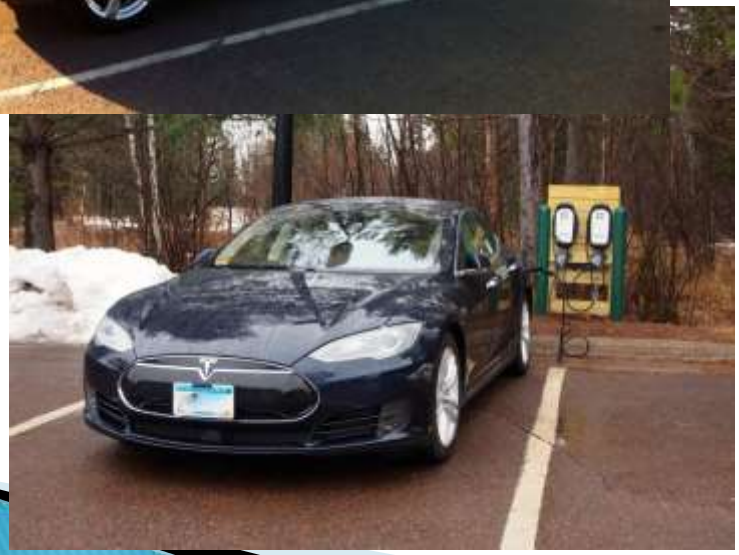
EV Charging for Multi-Housing and Commercial Properties



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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 2014

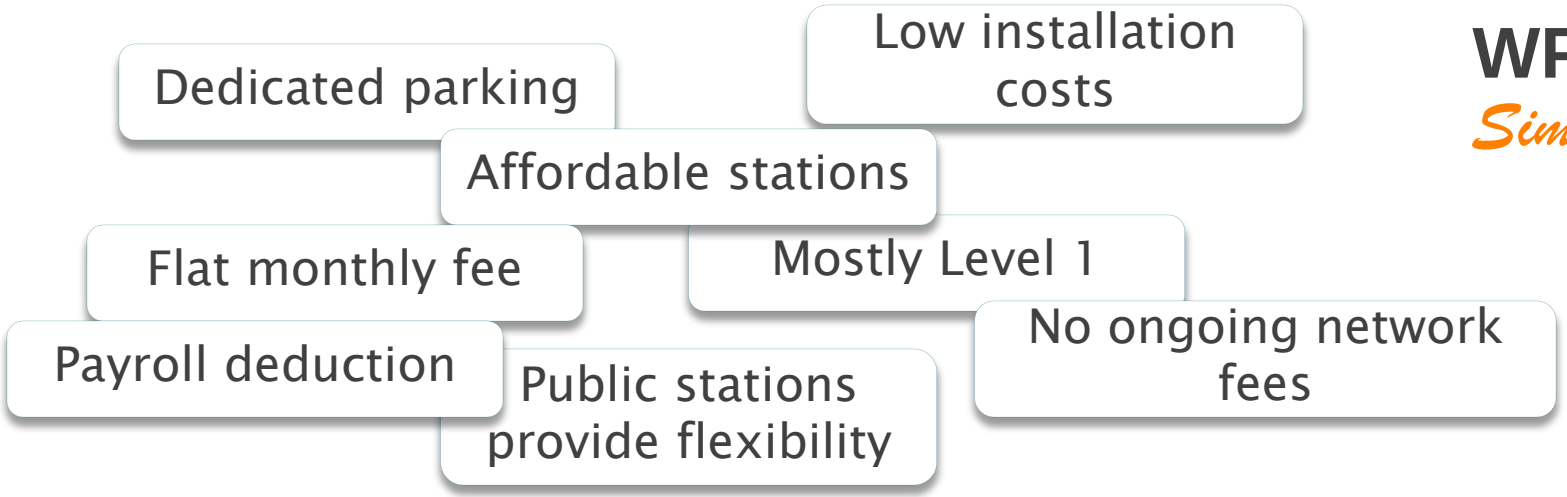
- Residential buildings
  - 3 % of parking spots
  - 208/240V 40A circuit breaker
  - Conduit that can carry 208/240V 80A wiring

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

Considerations

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

Workplace Charging Simple concept



WPC Simple

Resources

www.PlugInConnect.com

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

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Power and Energy Calculator tool


MultiHousingCharging.com tools

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MultiHousingCharging.com tools

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Metering and Payment Systems table

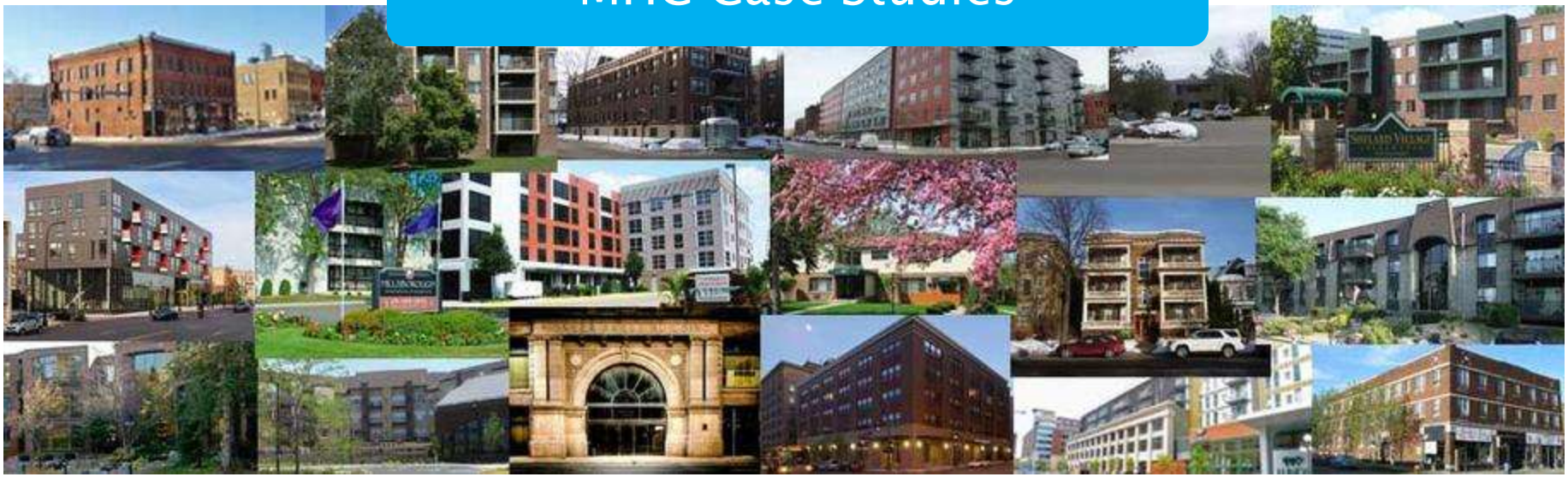
	Description	Who does billing	Compo-nents needed	Communi-cation connec-tions	Installation costs	Extra ongoing costs	Time of Day metering possible	Pros	Cons
1	Connected to homeowner's existing meter	Utility	Conduit and wiring	No	Low	No	Yes	Simple, no extra costs	None
2	New, EVSE dedicated, utility meter	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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