
ELECTRIC VEHICLE CHARGING
EV
AVAILABLE HERE

EV Charging for Multi-Housing and Commercial Properties

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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

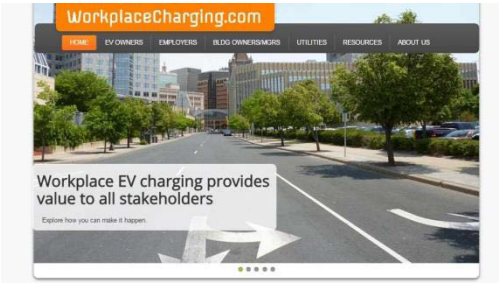
Past and present work:

- Plug-in vehicle market and business development
  www.PlugInConnect.com

PlugInConnect
Explore the electric future

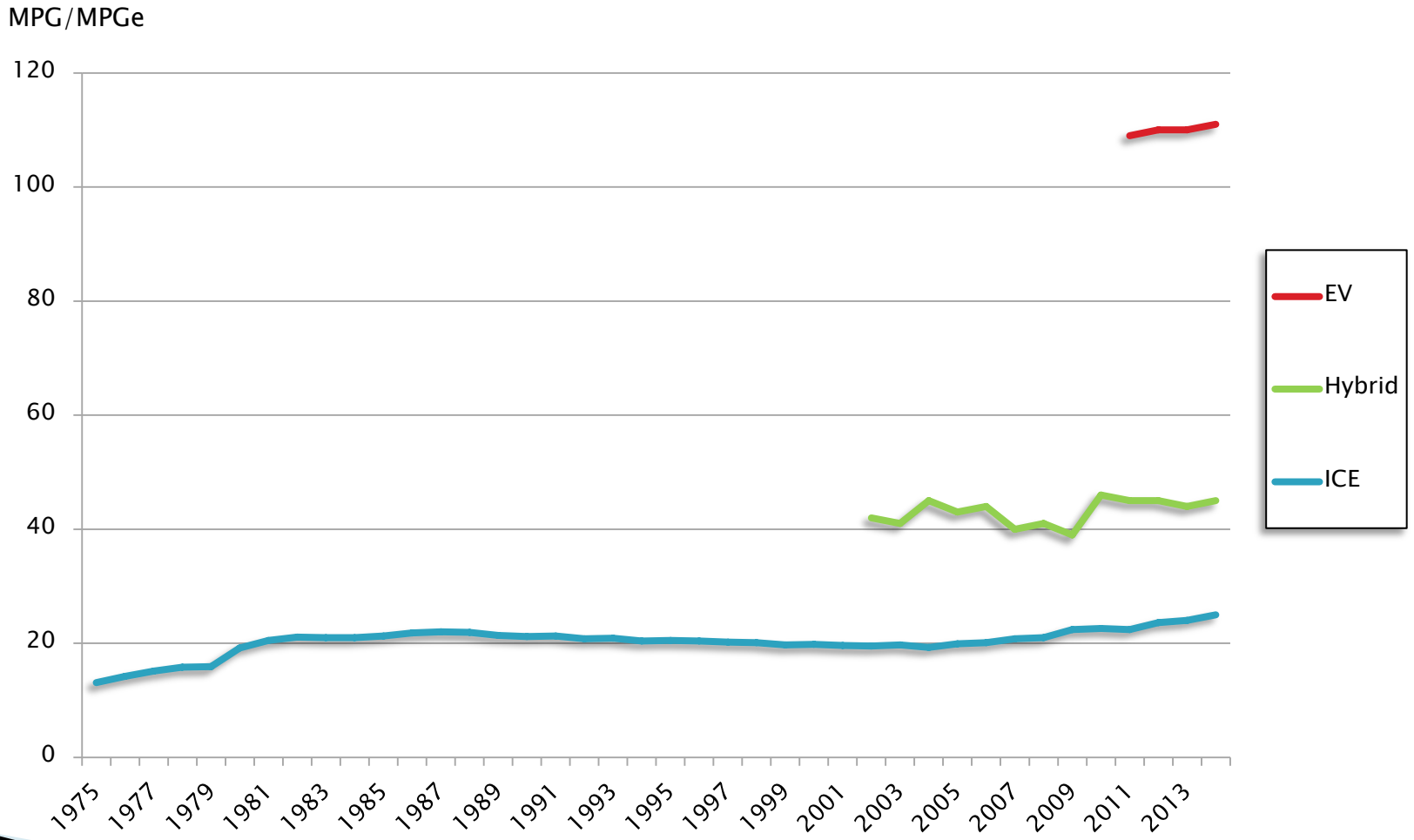
- PEV charging at condos and apartment buildings
  www.MultiHousingCharging.com

- PEV charging at workplaces
  www.WorkplaceCharging.com



- MN Plug-in Vehicle Owners' Circle
  www.pluginconnect.com/mnpevowners.html

Average fuel economy for new vehicles sold.



Data:
www.fueleconomy.gov

www.PlugInConnect.com

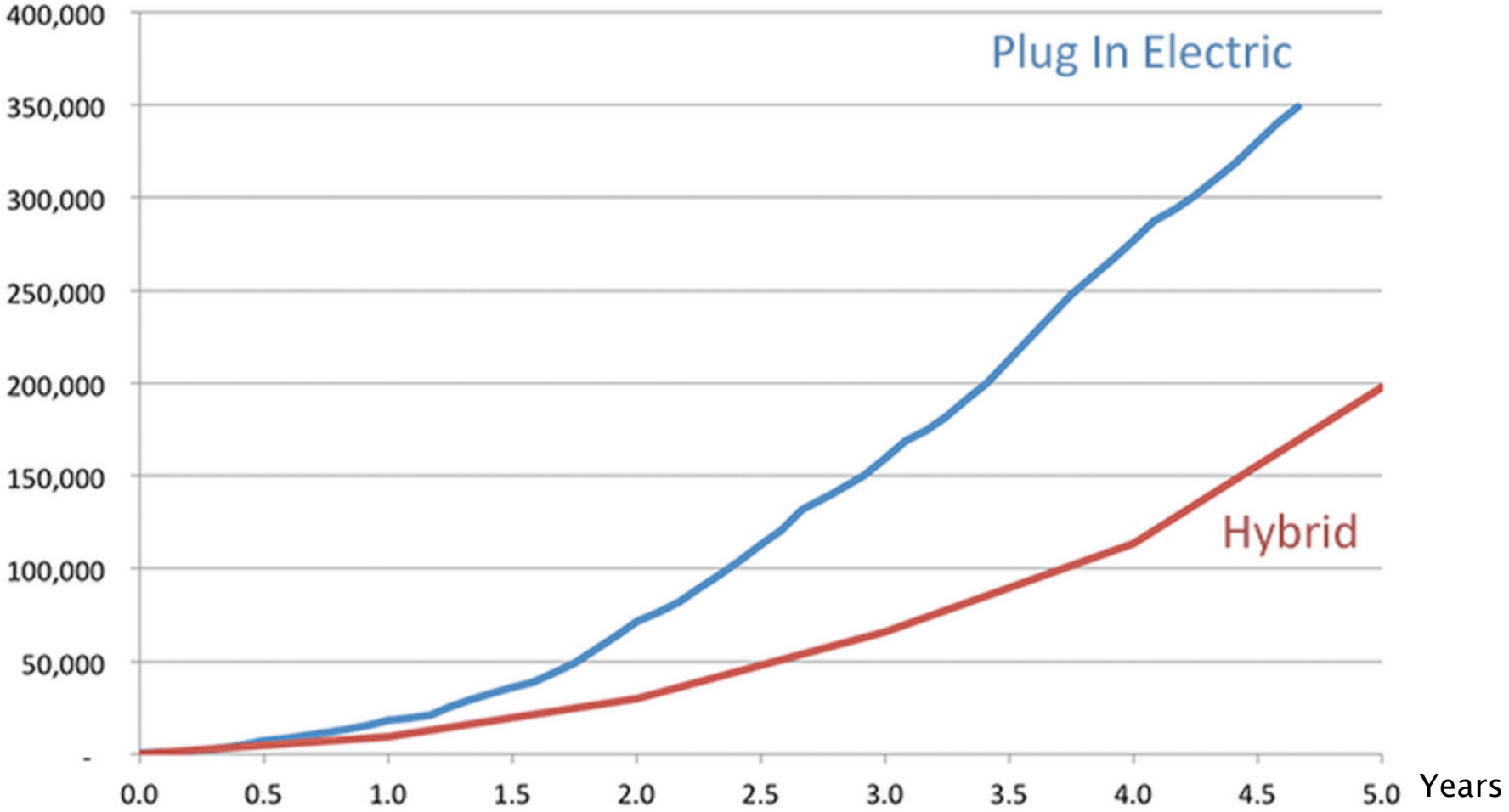
Electric era in transportation is coming.

- Over 400,000 plug-in vehicles on US roads.
- Over 3500 PEVs in MN. Over 20 million gas free miles in 2015.

- Very high satisfaction: 97% 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

Plug In Electric vs Hybrid Sales
By Years After Market Introduction



Graph: PlugInAmerica.org

www.PlugInConnect.com

What is it like to drive an EV?

Video: www.emotivebc.ca

www.PlugInConnect.com

Plug-in vehicle types

- Plug-in Hybrid Electric Vehicle (PHEV) (extended range EV)
  - First miles (10-50 miles) electric and then ICE turns on and takes you further (300-500 miles)
  - Examples of vehicles: BMW i3 Rex, Ford C-Max Energi, Chevrolet Volt

- Battery Electric Vehicle (BEV)
  - All miles always electric (Range 60-250 miles)
  - Examples of vehicles: Nissan Leaf, BMW i3, Ford Focus Electric, Tesla Model S

Photos: Vehicle manufacturers

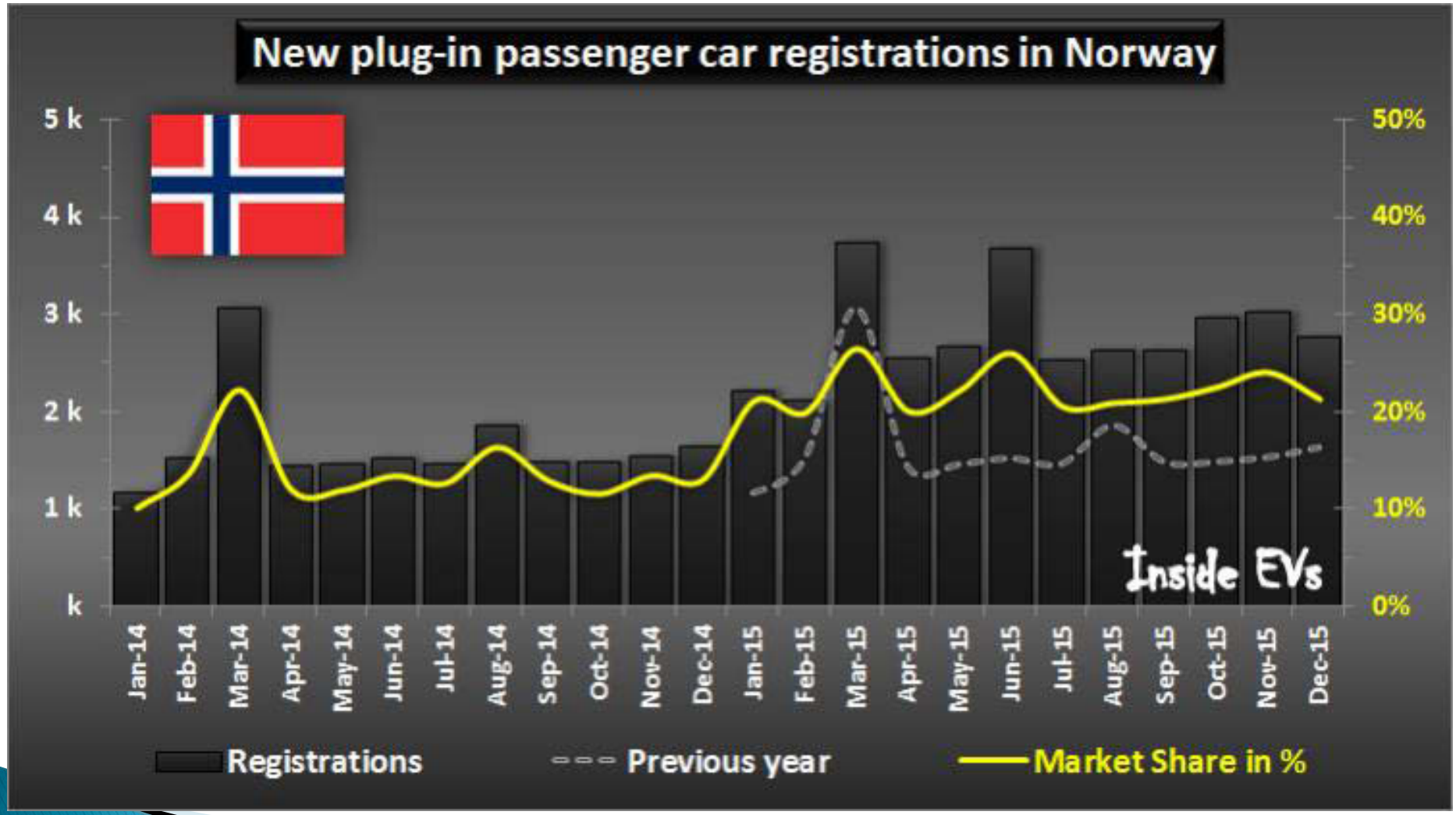
Models available in MN

Photos: Vehicle manufacturers

Upcoming models

Photos: Vehicle manufacturers

Success stories



Graph: InsideEVs

www.PlugInConnect.com

US Large Luxury Car sales

Model	2015 Sales	2014 Sales	% Change
Audi A7	7721	8133	-5.07%
Audi A8	4990	5904	-15.48%
BMW 6-Series	8146	8647	-5.79%
BMW 7-Series	9292	9744	-4.64%
Jaguar XJ	3611	4329	-16.59%
Lexus LS	7165	8559	-16.29%
Mercedes-Benz CLS-Class	6152	6981	-11.88%
Mercedes-Benz S-Class	21934	25276	-13.22%
Porsche Panamera	4985	5740	-13.15%
Tesla Model S	26566	18480	43.76%
Total	100562	101793	-1.21%

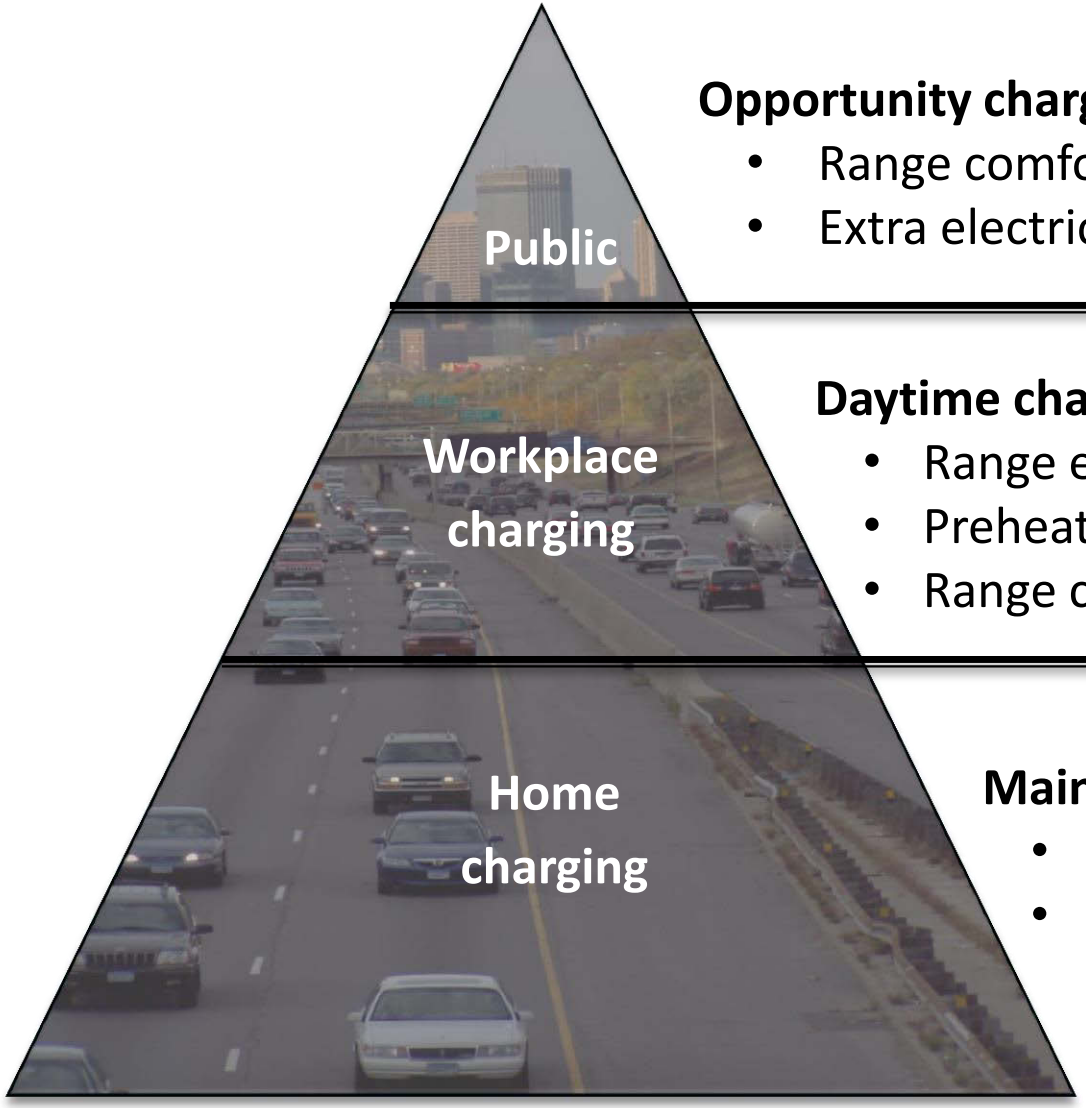
Info: EV Obsession

PHEV version sold 59% of Outlander sales in Europe

Market developments

- DC Fast Charging infrastructure
  - First DCFC installations in MN happened in 2014 and 2015. We have presently over 20 DCFC charging locations.
  - About 10 more expected in 2016
- At least 5 updated or new models in 2016
  - Chevrolet Volt 2016, Nissan Leaf 2016, Tesla Model X, etc.
- Over 200 mile EV range affordable models coming to market in 2017-2018
  - Tesla Model 3, Chevrolet Bolt, Nissan Leaf, etc.

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

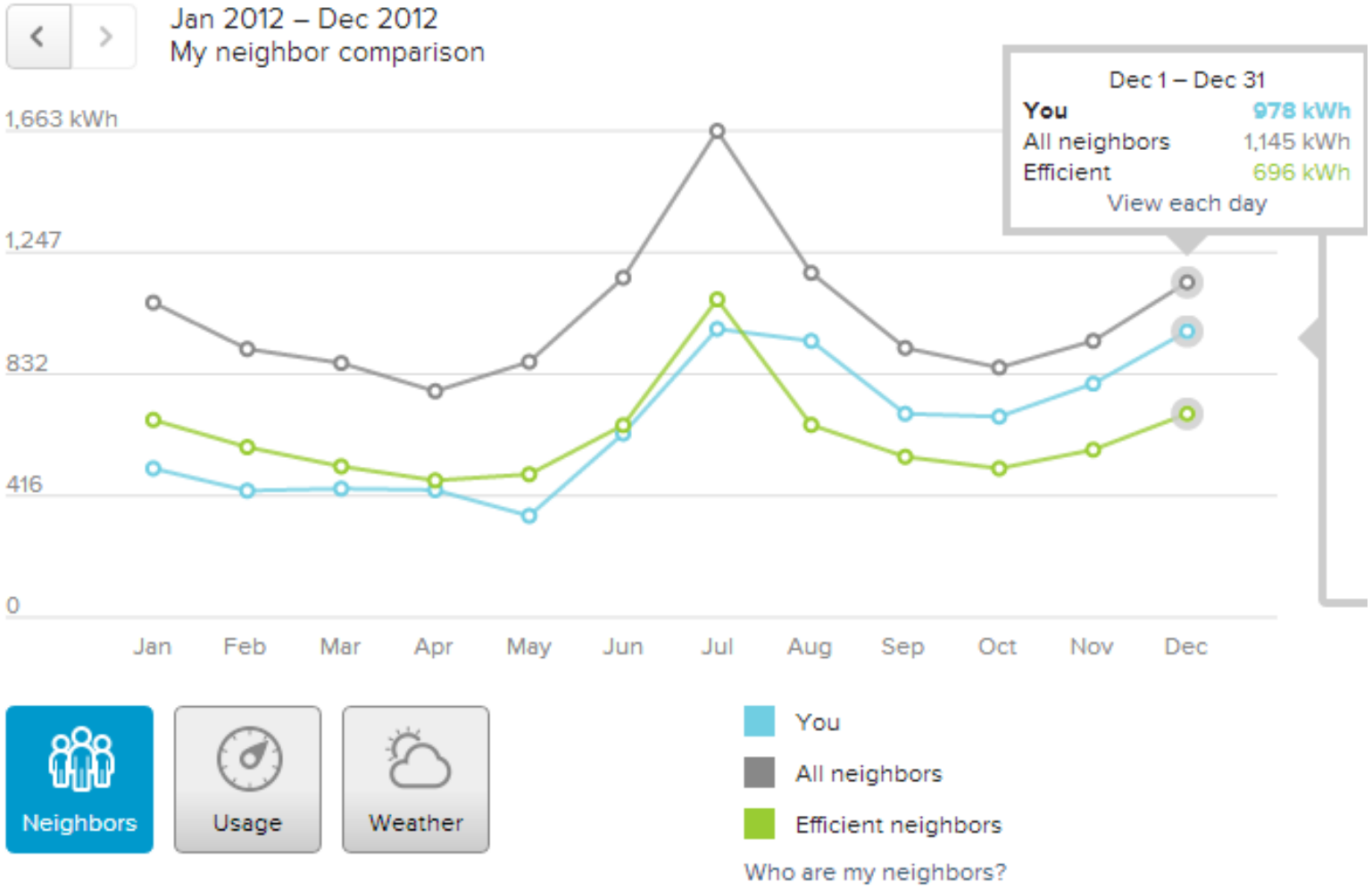
Level 2
240 Volt

DC fast charge

Pictures: Bosch, Clipper Creek, ChargePoint, ABB

www.PlugInConnect.com

Real life energy costs example



Graph: Xcel Energy

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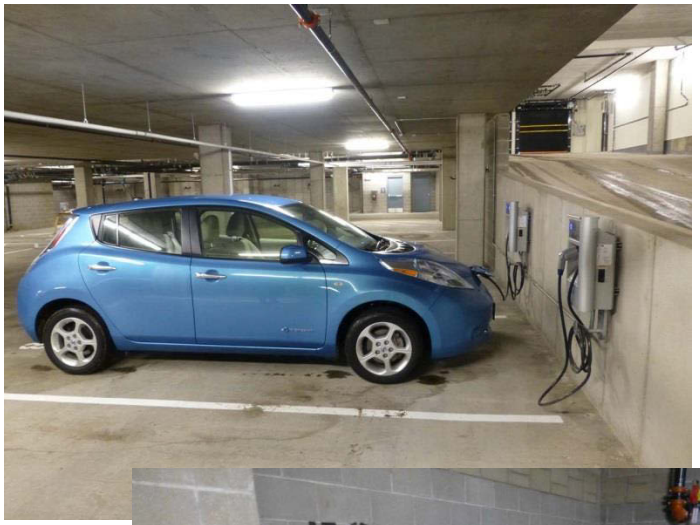
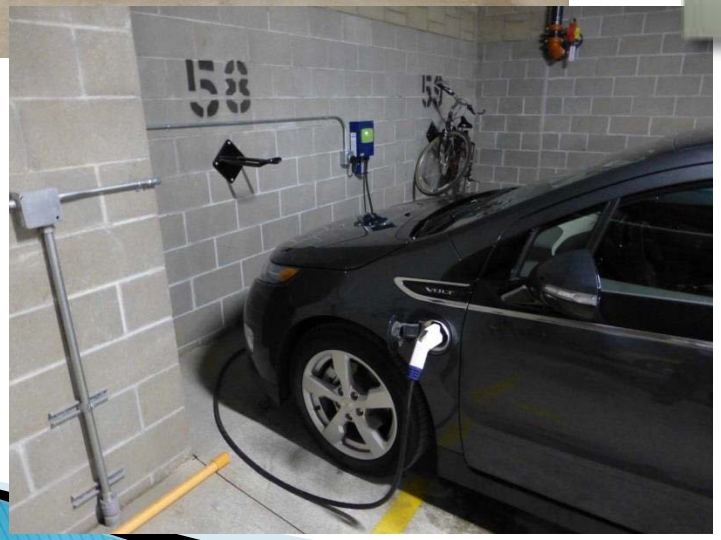
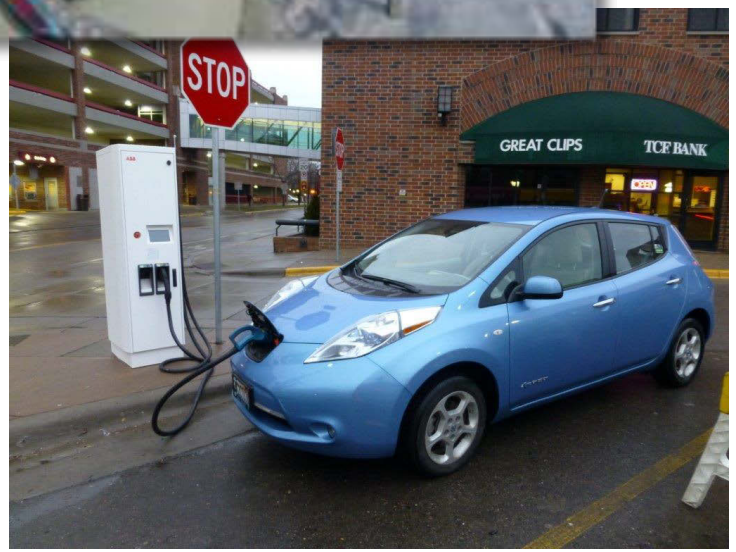
EV Charging for Multi-Housing and Commercial Properties







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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

LEED v4 Credit 8, Green Vehicles

1 Point for Green Parking and Electric Vehicle Charging

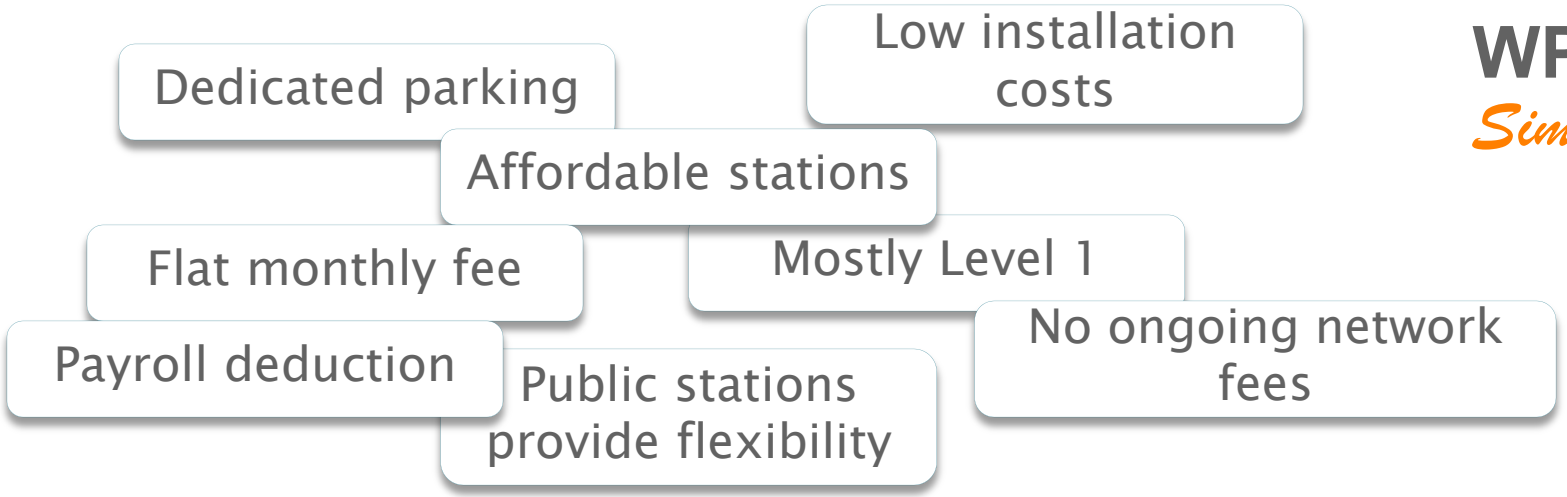
- Designate 5% of all parking spaces for green vehicles
- Install Electric vehicle Supply Equipment (EVSE) in 2% of all parking spaces used by the project.
- The EVSE must:
  - Be Level 2 (208/240V) or higher
  - Use standardized connector (J1772)
  - Be networked and be capable of participating in a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

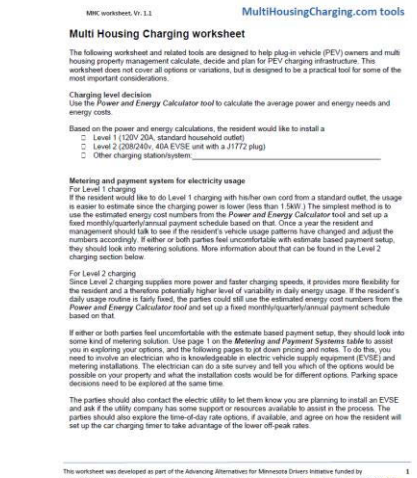


WPC Simple

Resources

www.PlugInConnect.com

Multi Housing Charging worksheet



MHC worksheet, Vr. 1.1 — MultiHousingCharging.com tools

Multi Housing Charging worksheet

The following worksheet and related tools are designed to help plug-in vehicle (PEV) owners and multi housing property management calculate, decide and plan for PEV charging infrastructure. This worksheet does not cover all options or variations, but is designed to be a practical tool for some of the most important considerations.

Charging level decision
Use the *Power and Energy Calculator tool* to calculate the average power and energy needs and energy costs.

Based on the power and energy calculations, the resident would like to install a
- ☐ Level 1 (120V 20A, standard household outlet)
- ☐ Level 2 (208/240v, 40A EVSE unit with a J1772 plug)
- ☐ Other charging station/system:_____

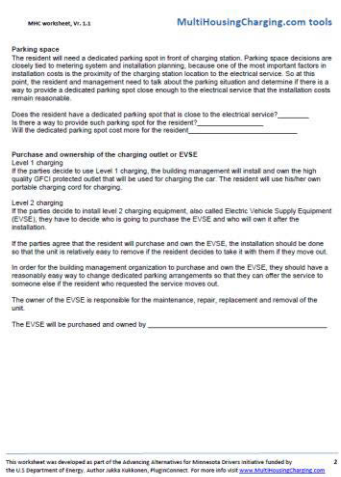
Metering and payment system for electricity usage
For Level 1 charging
If the resident would like to do Level 1 charging with his/her own cord from a standard outlet, the usage is easier to estimate since the charging power is lower (less than 1.5kW) The simplest method is to use the estimated energy cost numbers from the *Power and Energy Calculator tool* and set up a fixed monthly/quarterly/annual payment schedule based on that. Once a year the resident and management should talk to see if the resident's vehicle usage patterns have changed and adjust the numbers accordingly. If either or both parties feel uncomfortable with estimate based payment setup, they should look into metering solutions. More information about that can be found in the Level 2 charging section below.

For Level 2 charging
Since Level 2 charging supplies more power and faster charging speeds, it provides more flexibility for the resident and a therefore potentially higher level of variability in daily energy usage. If the resident's daily usage routine is fairly fixed, the parties could still use the estimated energy cost numbers from the *Power and Energy Calculator tool* and set up a fixed monthly/quarterly/annual payment schedule based on that.

If either or both parties feel uncomfortable with the estimate based payment setup, they should look into some kind of metering solution. Use page 1 on the ***Metering and Payment Systems table*** to assist you in exploring your options, and the following pages to jot down pricing and notes. To do this, you need to involve an electrician who is knowledgeable in electric vehicle supply equipment (EVSE) and metering installations. The electrician can do a site survey and tell you which of the options would be possible on your property and what the installation costs would be for different options. Parking space decisions need to be explored at the same time.

The parties should also contact the electric utility to let them know you are planning to install an EVSE and ask if the utility company has some support or resources available to assist in the process. The parties should also explore the time-of-day rate options, if available, and agree on how the resident will set up the car charging timer to take advantage of the lower off-peak rates.

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 info visit www.MultiHousingCharging.com 1



MHC worksheet, Vr. 1.1 — MultiHousingCharging.com tools

Parking space
The resident will need a dedicated parking spot in front of charging station. Parking space decisions are closely tied to metering system and installation planning, because one of the most important factors in installation costs is the proximity of the charging station location to the electrical service. So at this point, the resident and management need to talk about the parking situation and determine if there is a way to provide a dedicated parking spot close enough to the electrical service that the installation costs remain reasonable.

Does the resident have a dedicated parking spot that is close to the electrical service? _____
Is there a way to provide such parking spot for the resident?_____
Will the dedicated parking spot cost more for the resident_____

Purchase and ownership of the charging outlet or EVSE
Level 1 charging
If the parties decide to use Level 1 charging, the building management will install and own the high quality GFCI protected outlet that will be used for charging the car. The resident will use his/her own portable charging cord for charging.

Level 2 charging
If the parties decide to install level 2 charging equipment, also called Electric Vehicle Supply Equipment (EVSE), they have to decide who is going to purchase the EVSE and who will own it after the installation.

If the parties agree that the resident will purchase and own the EVSE, the installation should be done so that the unit is relatively easy to remove if the resident decides to take it with them if they move out.

In order for the building management organization to purchase and own the EVSE, they should have a reasonably easy way to charge dedicated parking arrangements so that they can offer the service to someone else if the resident who requested the service moves out.

The owner of the EVSE is responsible for the maintenance, repair, replacement and removal of the unit.

The EVSE will be purchased and owned by _____

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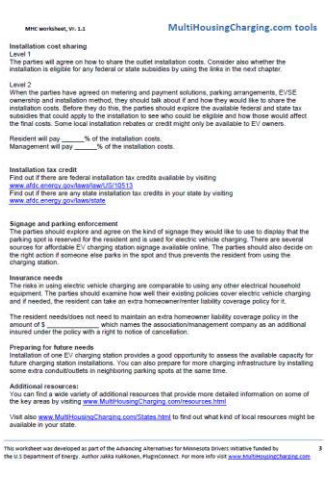

MHC worksheet, Vr. 1.1 — MultiHousingCharging.com tools

Installation cost sharing
Level 1
The parties will agree on how to share the outlet installation costs. Consider also whether the installation is eligible for any federal or state subsidies by using the links in the next chapter.

Level 2
When the parties have agreed on metering and payment solutions, parking arrangements, EVSE ownership and installation method, they should talk about if and how they would like to share the installation costs. Before they do this, the parties should explore the available federal and state tax subsidies that could apply to the installation to see who could be eligible and how those would affect the final costs. Some local installation rebates or credit might only be available to EV owners.

Resident will pay _____% of the installation costs.
Management will pay _____% of the installation costs.

Installation tax credit
Find out if there are federal installation tax credits available by visiting
www.afdc.energy.gov/laws/law/US/10513
Find out if there are any state installation tax credits in your state by visiting
www.afdc.energy.gov/laws/state

Signage and parking enforcement
The parties should explore and agree on the kind of signage they would like to use to display that the parking spot is reserved for the resident and is used for electric vehicle charging. There are several sources for affordable EV charging station signage available online. The parties should also decide on the right action if someone else parks in the spot and thus prevents the resident from using the charging station.

Insurance needs
The risks in using electric vehicle charging are comparable to using any other electrical household equipment. The parties should examine how well their existing policies cover electric vehicle charging and if needed, the resident can take an extra homeowner/renter liability coverage policy for it.

The resident needs/does not need to maintain an extra homeowner liability coverage policy in the amount of $_____ which names the association/management company as an additional insured under the policy with a right to notice of cancellation.

Preparing for future needs
Installation of one EV charging station provides a good opportunity to assess the available capacity for future charging station installations. You can also prepare for more charging infrastructure by installing some extra conduit/outlets in neighboring parking spots at the same time.

Additional resources:
You can find a wide variety of additional resources that provide more detailed information on some of the key areas by visiting www.MultiHousingCharging.com/resources.html

Visit also www.MultiHousingCharging.com/States.html to find out what kind of local resources might be available in your state.

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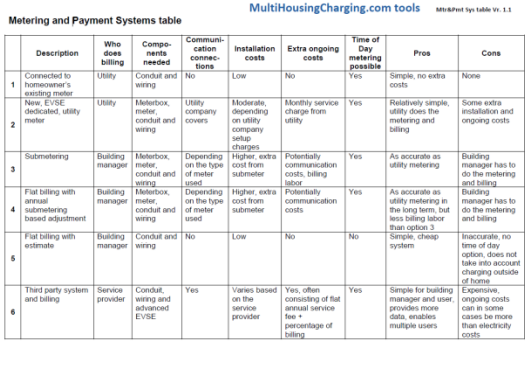
Metering and Payment Systems Table



MultiHousingCharging.com tools — Mtr&Pmt Sys table Vr. 1.1

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

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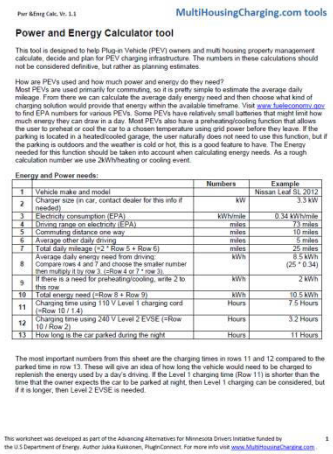
Power and Energy Calculator tool



Per &Eng Calc, Vr. 1.1 — MultiHousingCharging.com tools

Power and Energy Calculator tool

This tool is designed to help Plug-in Vehicle (PEV) owners and multi housing property management calculate, decide and plan for PEV charging infrastructure. The numbers in these calculations should not be considered definitive, but rather as planning estimates.

How are PEVs used and how much power and energy do they need?
Most PEVs are used primarily for commuting, so it is pretty simple to estimate the average daily mileage. From there we can calculate the average daily energy need and then choose what kind of charging solution would provide that energy within the available timeframe. Visit www.fueleconomy.gov to find EPA numbers for various PEVs. Some PEVs have relatively small batteries that might limit how much energy they can draw in a day. Most PEVs also have a preheating/cooling function that allows the user to preheat or cool the car to a chosen temperature using grid power before they leave. If the parking is located in a heated/cooled garage, the user naturally does not need to use this function, but if the parking is outdoors and the weather is cold or hot, this is a good feature to have. The Energy needed for this function should be taken into account when calculating energy needs. As a rough calculation number we use 2kWh/heating or cooling event.

Energy and Power needs:

		Numbers	Example
1	Vehicle make and model		Nissan Leaf SL 2012
2	Charger size (in car, contact dealer for this info if needed)	kW	3.3 kW
3	Electricity consumption (EPA)	kWh/mile	0.34 kWh/mile
4	Driving range on electricity (EPA)	miles	73 miles
5	Commuting distance one way	miles	10 miles
6	Average other daily driving	miles	5 miles
7	Total daily mileage (=2 * Row 5 + Row 6)	miles	25 miles
8	Average daily energy need from driving: Compare rows 4 and 7 and choose the smaller number then multiply it by row 3. (=Row 4 or 7 * row 3)	kWh	8.5 kWh (25 * 0.34)
9	If there is a need for preheating/cooling, write 2 to this row	kWh	2 kWh
10	Total energy need (=Row 8 + Row 9)	kWh	10.5 kWh
11	Charging time using 110 V Level 1 charging cord (=Row 10 / 14)	Hours	7.5 Hours
12	Charging time using 240 V Level 2 EVSE (=Row 10 / Row 2)	Hours	3.2 Hours
13	How long is the car parked during the night	Hours	11 Hours

The most important numbers from this sheet are the charging times in rows 11 and 12 compared to the parked time in row 13. These will give an idea of how long the vehicle would need to be charged to replenish the energy used by a day's driving. If the Level 1 charging time (Row 11) is shorter than the time that the owner expects the car to be parked at night, then Level 1 charging can be considered, but if it is longer, then Level 2 EVSE is needed.

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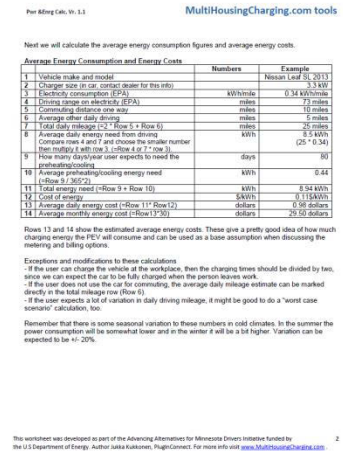

Per &Eng Calc, Vr. 1.1 — MultiHousingCharging.com tools

Next we will calculate the average energy consumption figures and average energy costs.

Average Energy Consumption and Energy Costs

		Numbers	Example
1	Vehicle make and model		Nissan Leaf SL 2013
2	Charger size (in car, contact dealer for this info)		3.3 kW
3	Electricity consumption (EPA)	kWh/mile	0.34 kWh/mile
4	Driving range on electricity (EPA)	miles	73 miles
5	Commuting distance one way	miles	10 miles
6	Average other daily driving	miles	5 miles
7	Total daily mileage (=2 * Row 5 + Row 6)	miles	25 miles
8	Average daily energy need from driving: Compare rows 4 and 7 and choose the smaller number then multiply it with row 3. (=Row 4 or 7 * row 3)	kWh	8.5 kWh (25 * 0.34)
9	How many days/year user expects to need the preheating/cooling	days	80
10	Average preheating/cooling energy need (=Row 9 / 365*2)	kWh	0.44
11	Total energy need (=Row 9 + Row 10)	kWh	8.94 kWh
12	Cost of energy	$kWh	0.115$kWh
13	Average daily energy cost (=Row 11* Row12)	dollars	0.98 dollars
14	Average monthly energy cost (=Row13*30)	dollars	29.50 dollars

Rows 13 and 14 show the estimated average energy costs. These give a pretty good idea of how much charging energy the PEV will consume and can be used as a base assumption when discussing the metering and billing options.

Exceptions and modifications to these calculations
- If the user can charge the vehicle at the workplace, then the charging times should be divided by two, since we can expect the car to be fully charged when the person leaves work.
- If the user does not use the car for commuting, the average daily mileage estimate can be marked directly in the total mileage row (Row 6)
- If the user expects a lot of variation in daily driving mileage, it might be good to do a "worst case scenario" calculation, too.

Remember that there is some seasonal variation to these numbers in cold climates. In the summer the power consumption will be somewhat lower and in the winter it will be a bit higher. Variation can be expected to be +/- 20%.

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www.PlugInConnect.com

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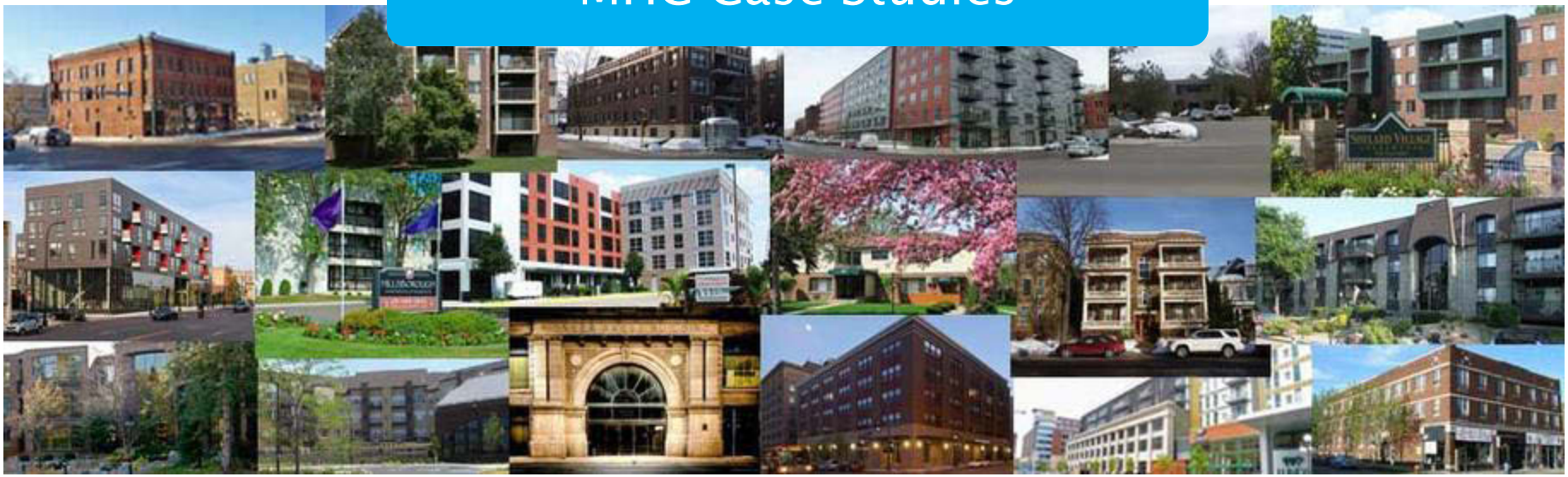
Sharing experiences

- Over 20 case studies from the Twin Cities

MHC Case Studies



www.multihousingcharging.com/case-studies.html

Societal benefits of PEVs

- Less energy produced and used
- Local energy
- Cleaner air
- Curing our oil addiction
- Renewable energy options
- Energy education

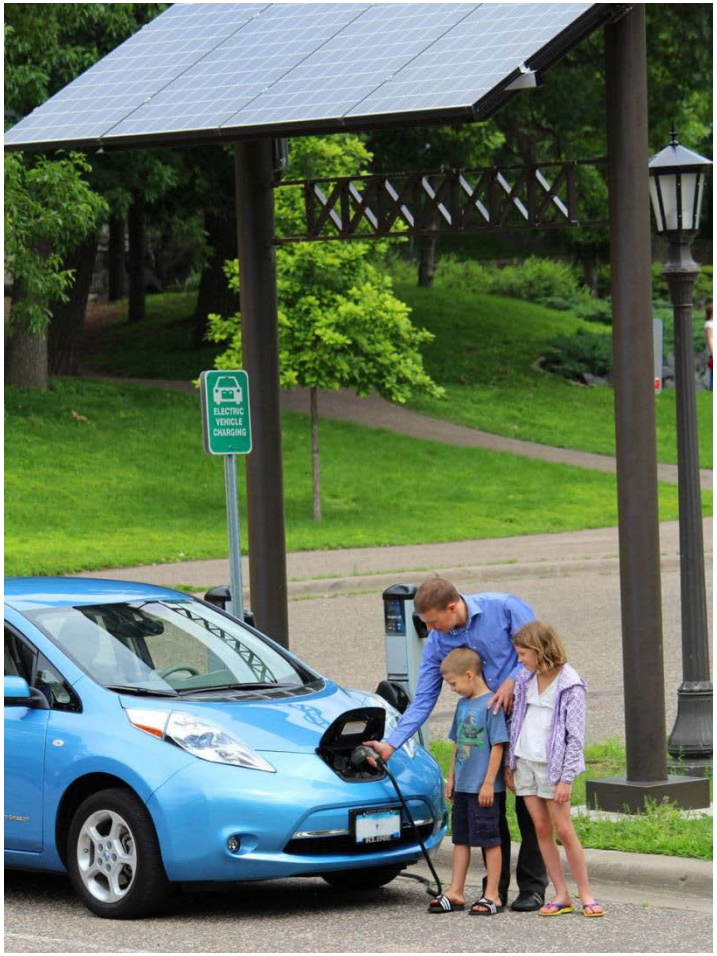


Photo:
MN Dept. of Commerce

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