

# Electric Vehicles

## The future...has arrived

### Electric vehicles...the road ahead

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Refuel Colorado



June 1<sup>st</sup>, 2016



# About us

Refuel Colorado is a project of the:



*working to:*

- address access to alternative fuels
- improve fleet and consumer adoption of alternative fuel vehicles
- reduce transportation petroleum use

*through:*

- free fleet analysis and coaching
- connecting fleets to fuels
- marketing and media outreach

**Prioritize opportunities to make smart investments**

**Maximize incentives/ grants**



# future arrived | now what?

*Fundamental Question:*

*If electric vehicles are so great why aren't there  
more on the road?*



# Agenda

future arrived  
energy fundamentals  
fundamental benefits  
driving change  
availability  
infrastructure  
incentives  
takeaways  
imperative  
question solved?  
solved?

# future arrived | energy fundamentals

Energy equation: energy in and energy out

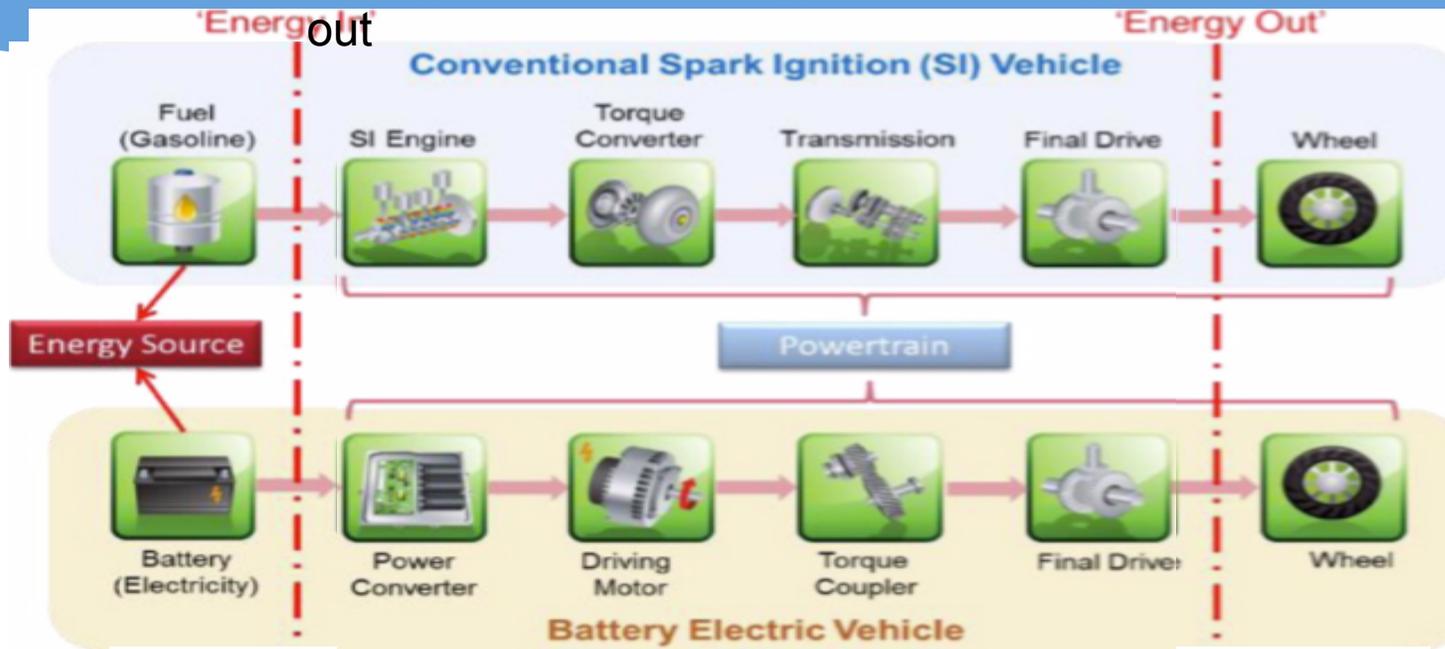
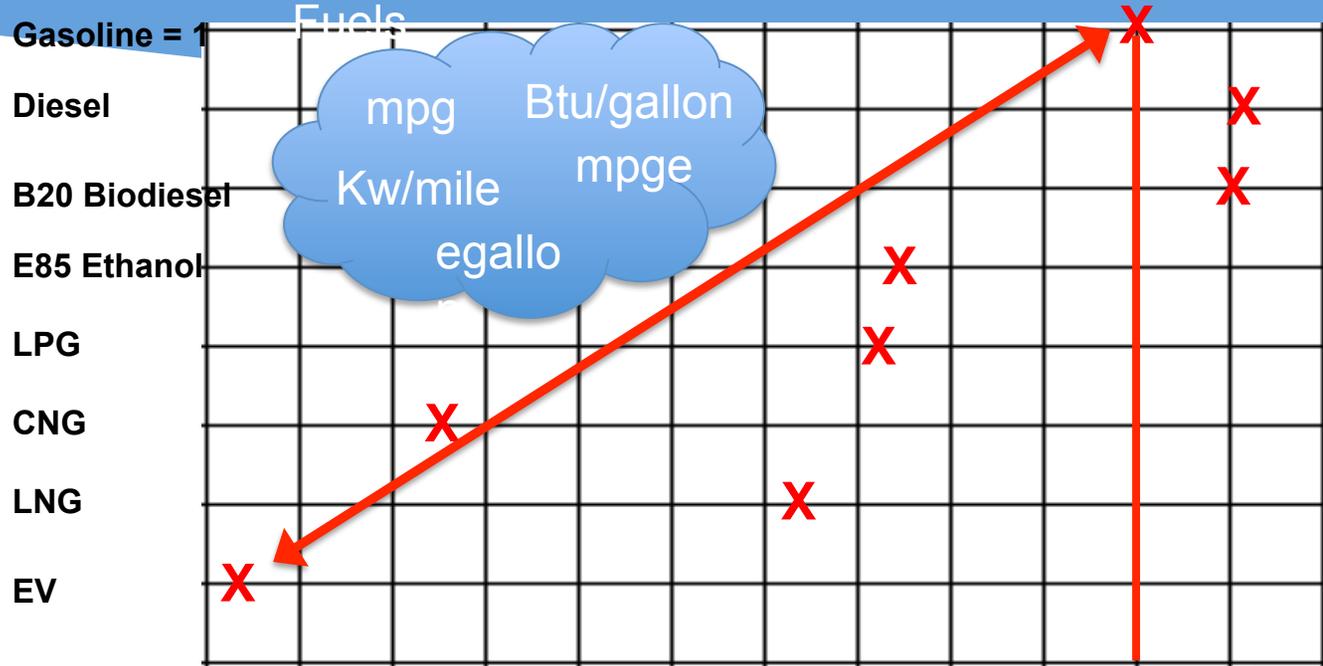


Figure 2. Powertrain components that convert stored energy to useful mechanical power output.

# future arrived | energy fundamentals

Volumetric energy density of Alternative Fuels



If I had a "gallon" of space, how much energy of each fuel would fit into that same space?

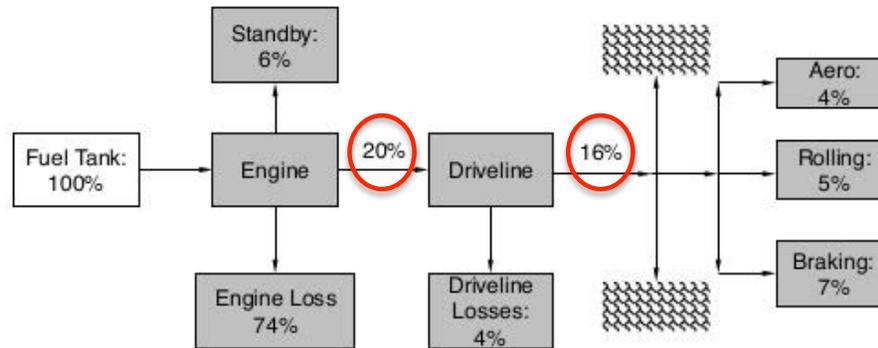


0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2  
 <-----(worse) Ratio of Alt Fuel vs Gasoline  
 (better)---->



# future arrived | energy fundamentals

## Opportunities for Vehicle Efficiency Improvements



» Matt Kromer

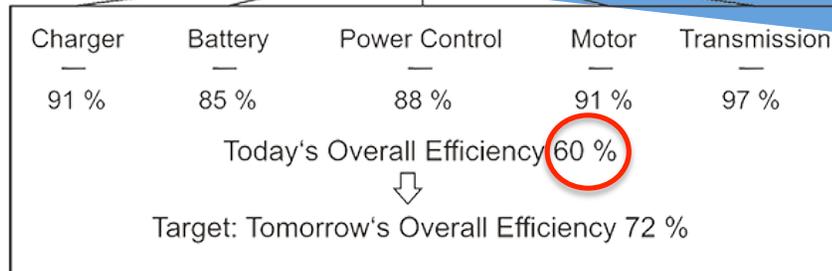


Urban Drive Cycle, 2005 2.5L Toyota Camry



# future arrived | energy fundamentals

Efficiency of  
Electric Vehicles



**Figure 1:**  
Energy efficiency of today EVs; The aim of MotorBrain is to improve the overall energy efficiency by up to 20%

Source: MotorBrain - Technical Annex

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# future arrived | benefits



EV's fuel cost is \$.03 per mile which is 60-70% less expensive than gas at \$2.50/gallon

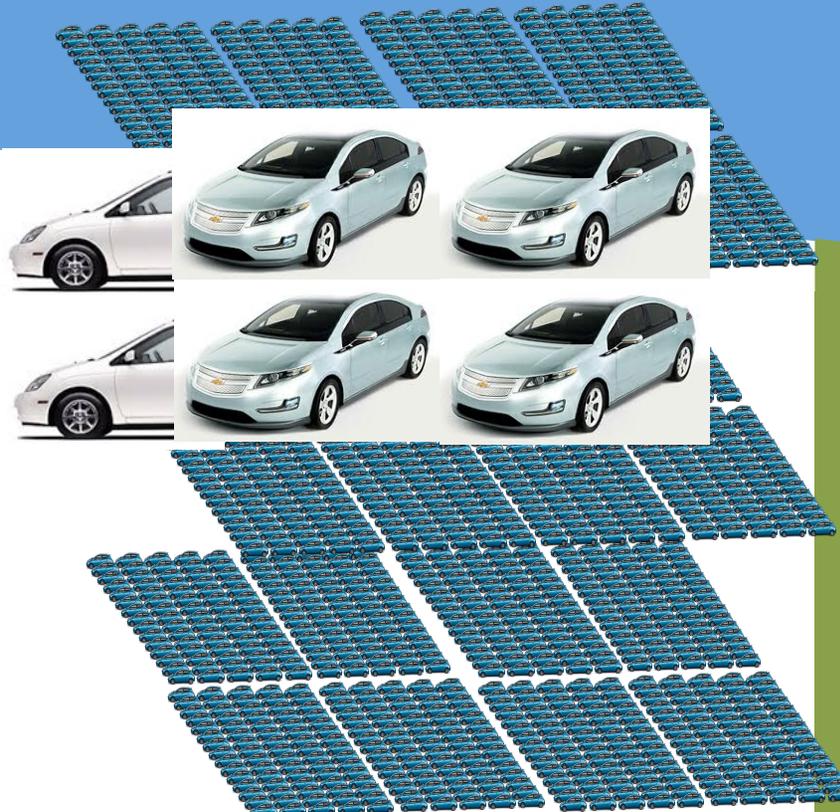
	Small Sedan †	Medium Sedan †	Large Sedan †	Average
<b>Operating Costs</b>	<b>per mile</b>	<b>per mile</b>	<b>per mile</b>	<b>per mile</b>
gas	6.88 cents	8.06 cents	10.40 cents	8.45 cents
maintenance	4.81 cents	5.39 cents	5.63 cents	5.28 cents
tires	0.70 cents	1.25 cents	1.04 cents	1.00 cents
<b>cost per mile</b>	<b>12.39 cents</b>	<b>14.70 cents</b>	<b>17.07 cents</b>	<b>14.72 cents</b>

# future arrived | benefits



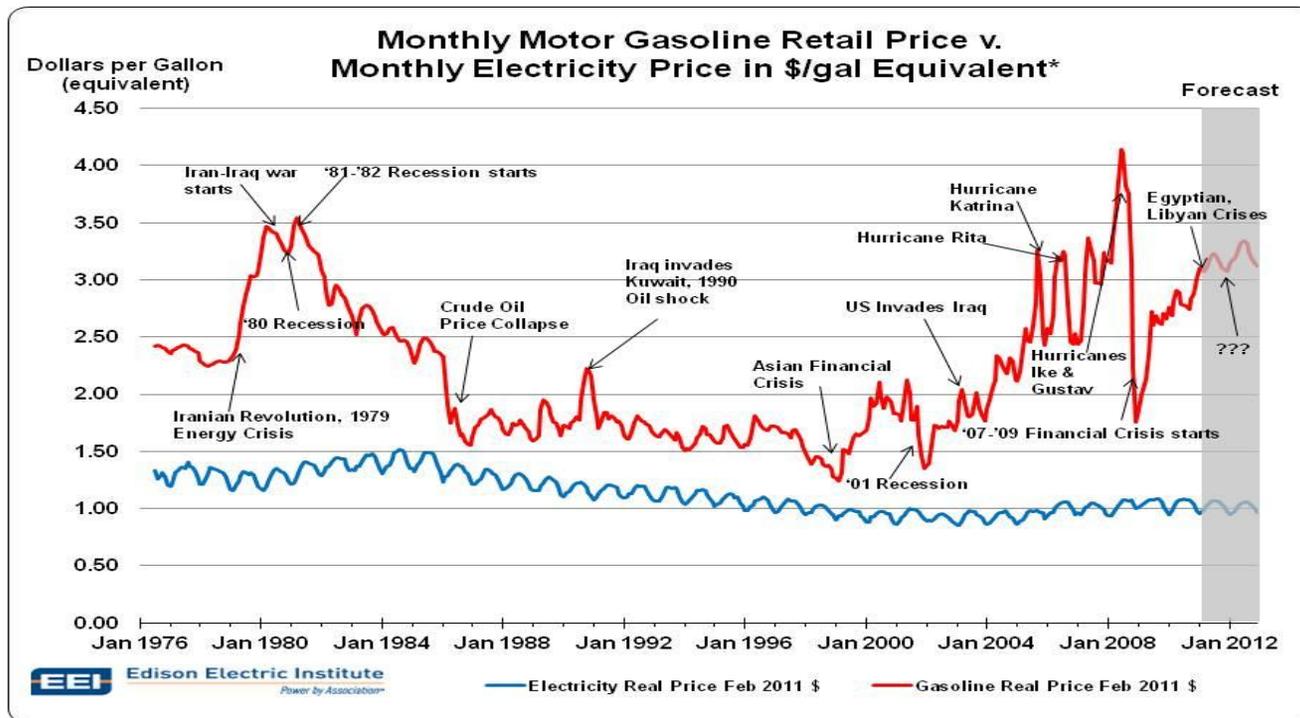
Tail pipe emissions (grams per mile)

	2015 Toyota Camry	2001 Toyota Prius	2010 Chevy Volt	2015 Nissan Leaf
Grams/mile	358	217	84	0



# future arrived | benefits

## Electricity has impressive price stability



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# driving change | availability

## Carmakers are Embracing EVs

### PHEV



### BEV



### BEV with DC Fast Charge



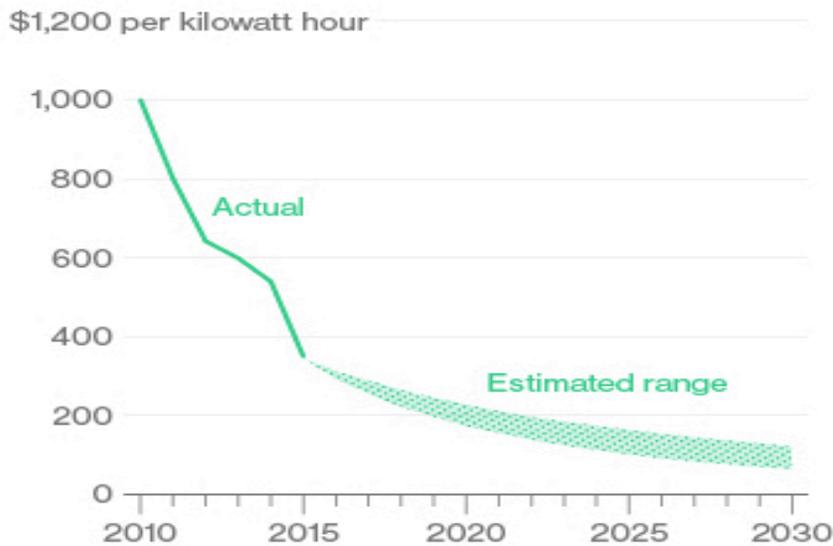
27+ Currently Available  
with many more coming in 2016

Plug-In Models

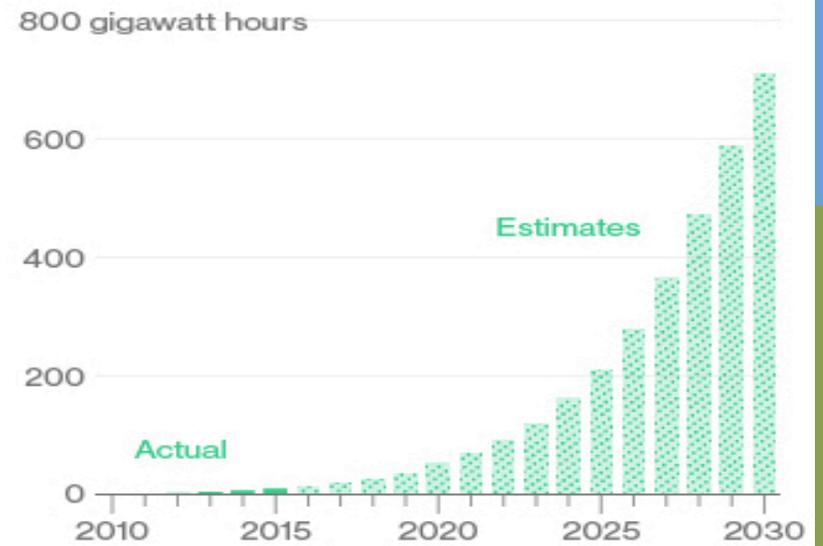


# driving change | availability

### Cost for lithium-ion battery packs



### Yearly demand for EV battery power



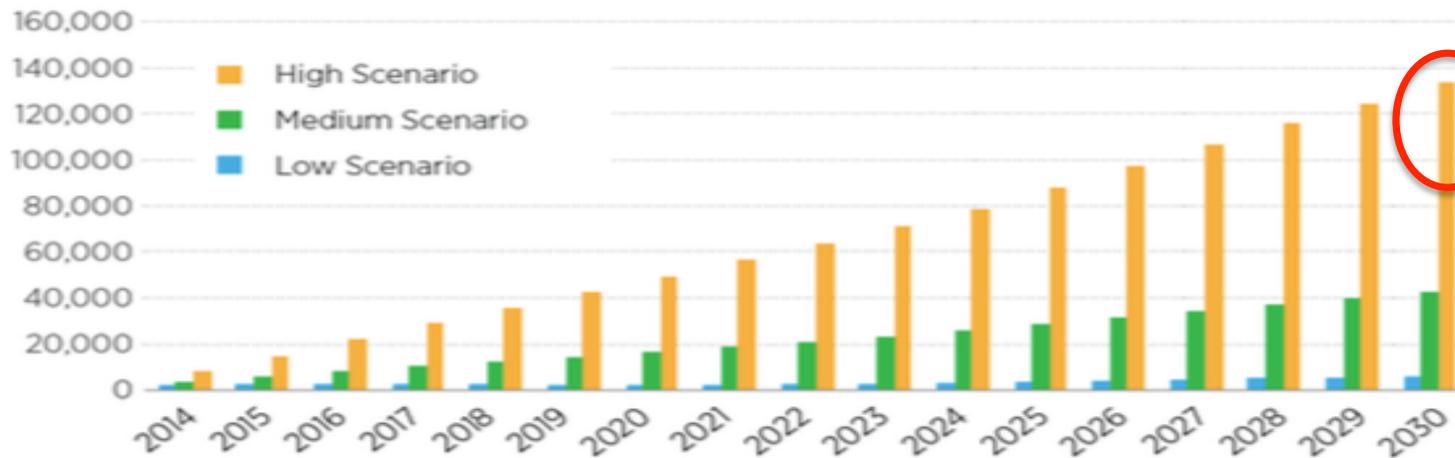
Source: Data compiled by Bloomberg New Energy Finance

Bloomberg



# driving change | availability

ANNUAL COLORADO NEW EV SALES 2014-2030 BY SCENARIO



2030 projection as many as 1 million EV's

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# driving change | infrastructure



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## EV Infrastructure is Growing Quickly

As of May 1<sup>st</sup>, 2016

### Western Slope EV Charging Locations

There are now **160+ EV charging plugs in operation** at 60 locations in Western Colorado  
DC Dual Cord 50kw Quick Charger – NOW OPEN in Aspen!

- L2 Available now
- L3 Available now
- L3 Coming soon
- L2 Coming soon



**4CORE**

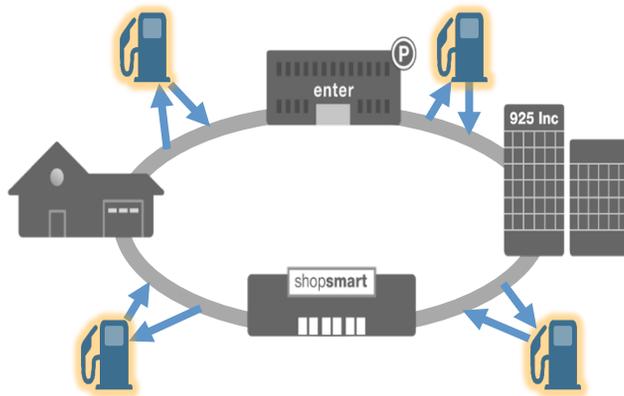
Four Corners Office For Resource Efficiency



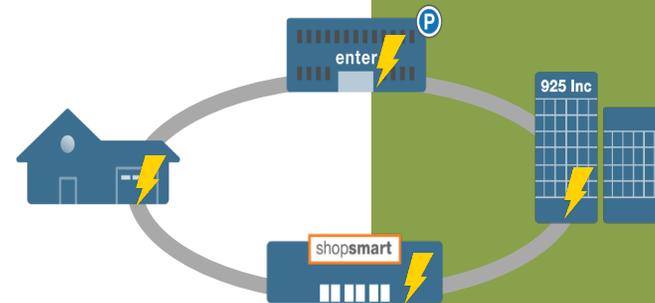
# driving change | infrastructure

## EV Drivers Don't "Fill Up," They "Top Off"

Gas car drivers **"Fill Up"** on the way to where they are going...



...electric car drivers **"Top Off"** while they are parked there.



# driving change | infrastructure

## Multi unit facilities

### Benefits of Offering EV Charging

- **Attract** residents who will pay more for EV-enabled properties
- **Retain** EV-driving residents who value EV charging as an amenity
- **Increase property value** and rents by improving green image and earning green certification credits e.g. LEED
- **Differentiate** your property from competitors
- **Comply with emerging laws** and building standards



Colorado Senate  
Bill SB13-126

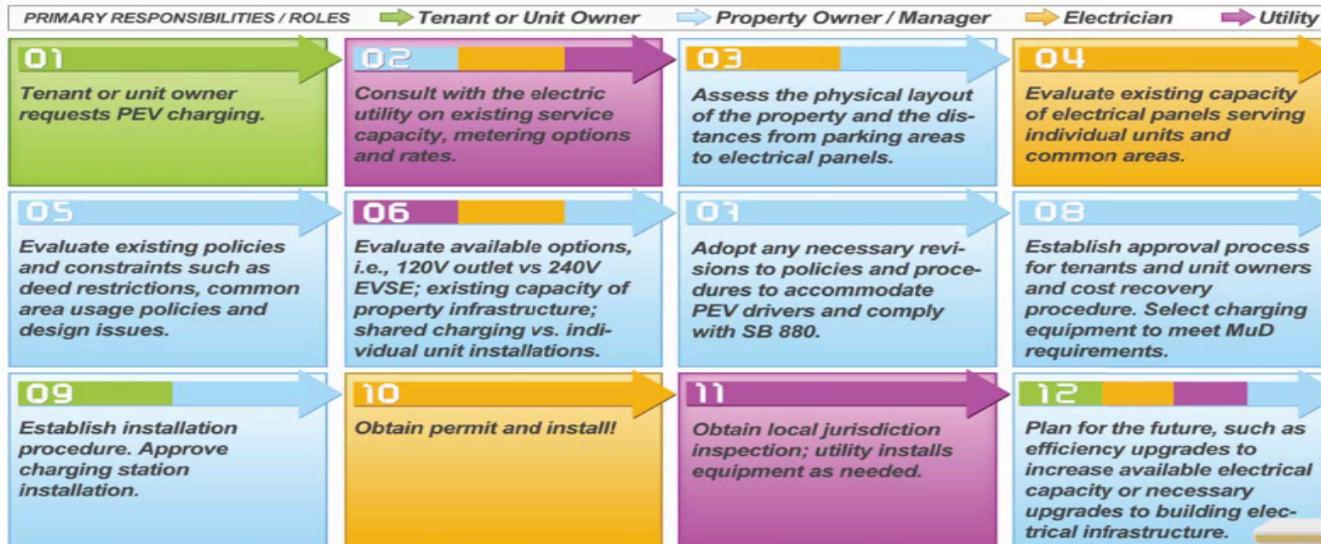


# driving change | infrastructure

## MULTI-UNIT DWELLINGS CHARGING INSTALLATION GUIDE

For Property Owners, Property Management Companies, Tenant Associations and Home Owner Associations

Property owners benefit from installing charging through environmental leadership, attracting residents and enhancing property desirability.



Source: California PEV Collaborative (GG6-5). Original source materials developed by San Diego Gas and Electric Co. and the Sacramento Municipal Utility District for the Electric Power Research Institute.

**MULTI-UNIT DWELLING PEV DRIVERS START CHARGING**



### TIPS:

1. HOA's require carefully planning – develop guidelines to help facilitate the process
2. Consider development of a permit template to allow ease of installation
3. Consider requiring on new construction to rough in a dedicated circuit

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## driving change | incentives

Colorado has the most comprehensive 'ecosystem' of incentives in the country



Colorado  
Senate Bill  
HB16-1332



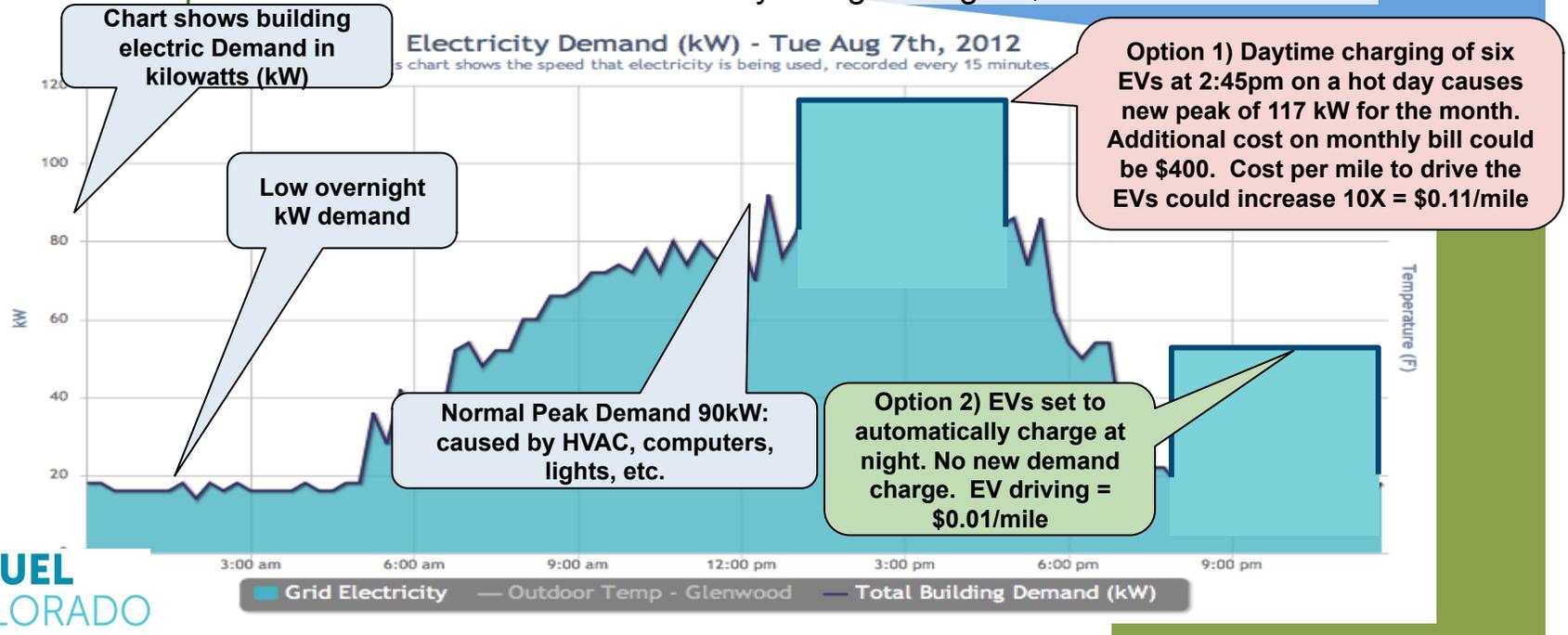
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# takeaways | imperative

Good management is critical to ensure vehicle charging costs are low at commercial buildings

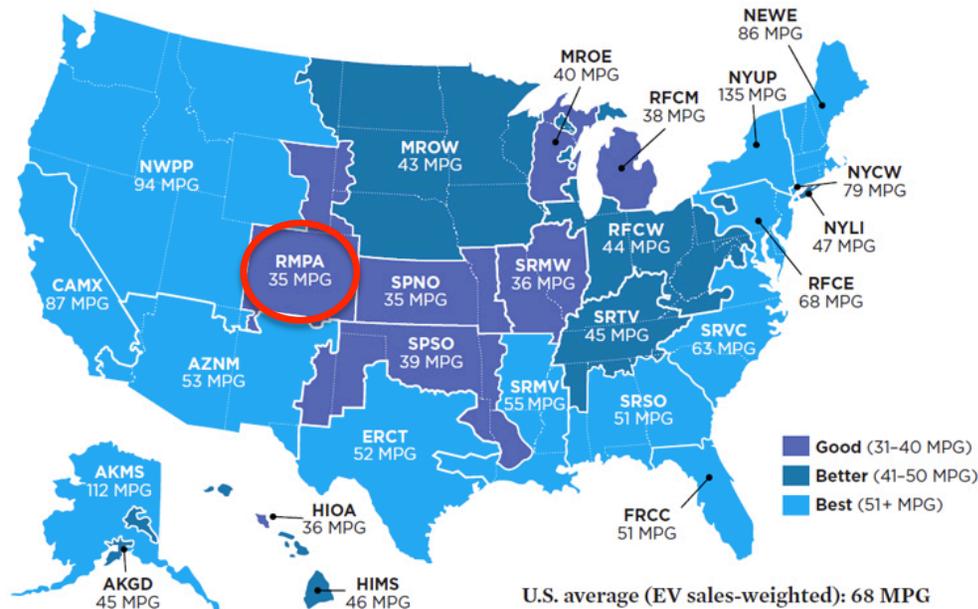
Fleet has 4 EVs, each drives 1,000 mi/month, has 4 Level 2 chargers (6.6kW each)

- **Option 1.** Charge any time. This causes a new peak, 27kW higher than usual. \$0.11/mi
- **Option 2.** Fleet sets EVs to automatically charge at night. \$0.01/mile



# takeaways | imperative

Electric Vehicle Global Warming Pollution Ratings and Gasoline Vehicle Emissions Equivalents by Region



Note: The MPG (miles per gallon) value listed for each region is the combined city/highway fuel economy rating of a gasoline vehicle that would have global warming emissions equivalent to driving an EV. Regional global warming emissions ratings are based on 2012 power plant data in the EPA's eGRID 2015 database (the most recent version). Comparisons include gasoline and electricity fuel production emissions. The 68 MPG U.S. average is a sales-weighted average based on where EVs were sold in 2014.

SOURCE: EPA 2015C.

© Union of Concerned Scientists



Do EVs really emit less CO<sub>2</sub>?  
Yes!

45% of Americans live in the "best" areas for EVs...  
...and the grid is getting cleaner every day!



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Four Corners Office For Resource Efficiency  
**CLEER**  
CLEAN ENERGY ECONOMY FOR THE REGION

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