



Exploiting the PV-EV Synergy

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Today's Agenda

- Driving to Net Zero
- Preaching to the Choir
- Open Discussion / Q&A



DRIVING TO NET 0

Stories of Hope for a Carbon-Free Future
by David Hrivnak

Steps to Sustainable Transportation

- 1) reduce demand for motorized travel**
- 2) use vehicles more productively**
- 3) electrify powertrains as feasible**
- 4) use renewable electricity**
emphasize distributed photovoltaics



+



+ FREE WILL

= 5 miles / day - OPEC



photos courtesy of Sundance Power Systems

PV System Net Present Value and EV Equivalent Gasoline Cost Calculations

annual interest rate	4.00%
loan period (yrs)	30
pv system gross cost (\$/W)	\$2.65
utility buydown (\$/W)	\$0.00
federal tax credit	30%
state tax credit	0%
pv system net cost (\$/W)	\$1.86

electricity price (\$/kWh)	\$0.10612
full sun (hr/day)	4.90
overall system efficiency derate factor	0.75

	cost	benefit	net
\$0.60 pv system net present value (\$/W)	-\$0.00886	\$0.01170	\$0.00284 (\$/W/month)

\$2.71 equivalent gasoline cost (\$/gal)
0.43 relative energy consumption - ev vs. icv
\$1.16 vehicle-adjusted equivalent gasoline cost (\$/gal)

290 ev energy consumption (Wh/mi)
50 icv fuel economy (mi/gal)
33.7 gasoline energy content (kWh/gal)

Preaching to (at?) the Choir

- Elmer isn't the only FUD
- “coal-fired” EVs need love, too
- the embodiment of efficiency

An EV charged in the given region produces emissions equivalent to a gasoline vehicle with a fuel economy rating of:

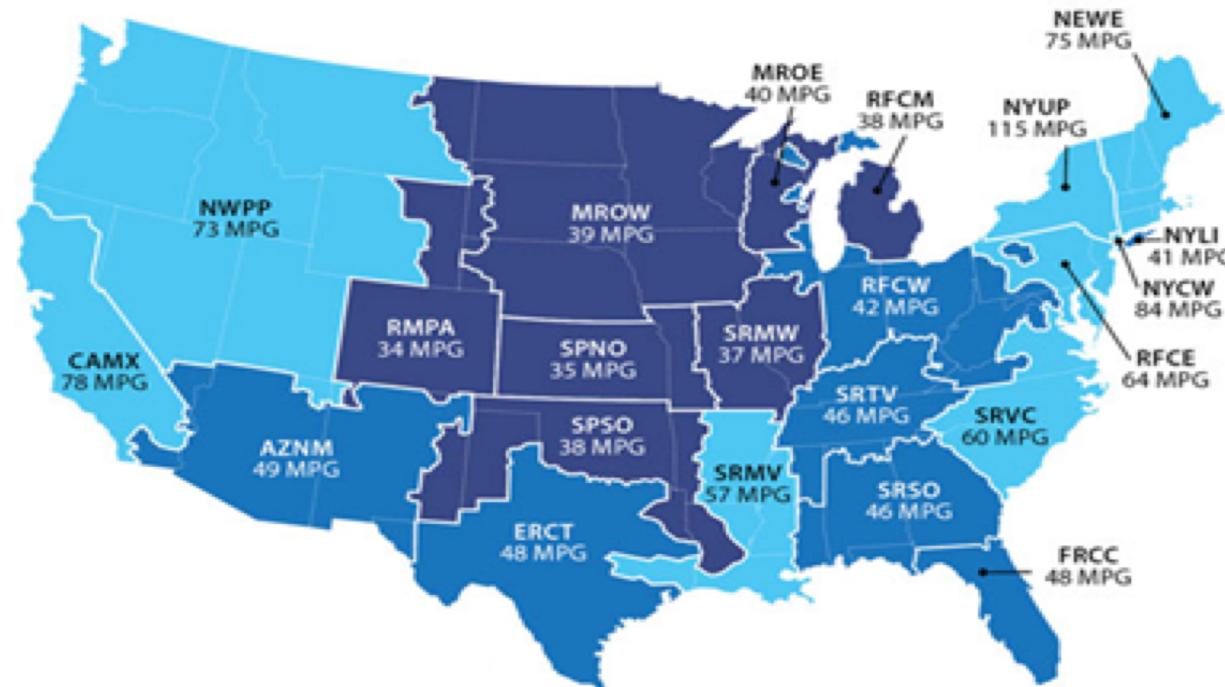
31-40 MPG

41-50 MPG

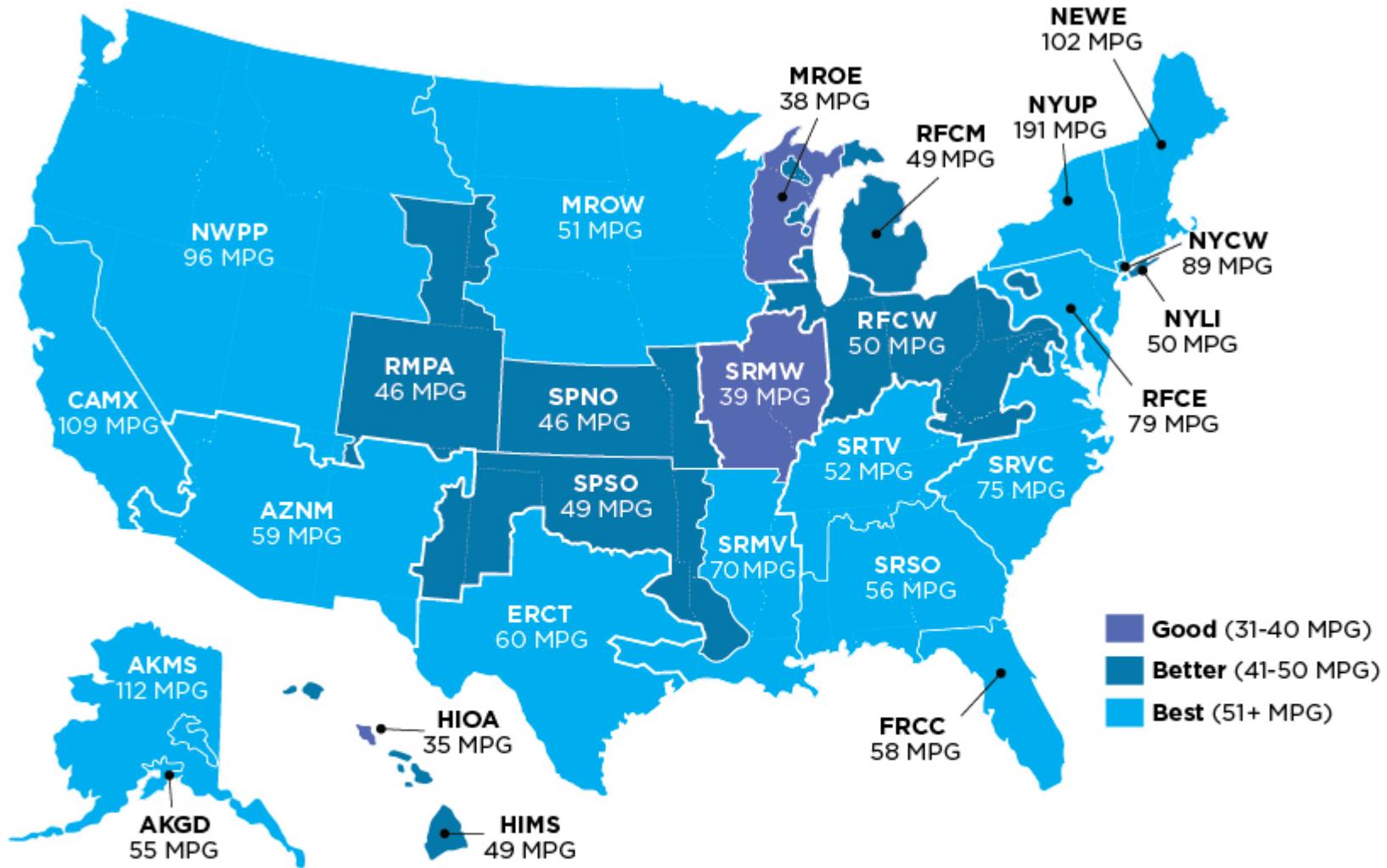
>50 MPG

The sources of electricity generation vary by region, meaning the global warming benefits of owning an electric vehicle depend on the electricity grid where it is charged.

EV Charging on the Current Electricity Grid -- 2009 Data



Source: Union of Concerned Scientists; "State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States"; 2012.



US Average (EV sales-weighted): 80 MPG

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 2016 power plant data in the EPA's eGRID 2016 database (the most recent version). Comparisons include gasoline and electricity fuel production emissions estimates using Argonne National Laboratory's GREET 2017 model. The 80 MPG US average is a sales-weighted average based on where EVs were sold in 2011-2017.

Embodied Energy (1)

- compare BMW 330i to Tesla Model 3
- mfg. energy $\sim 100 \text{ MJ/kg} = 27.8 \text{ kWh/kg}$
- RFG energy content = 33.7 kWh/gal
- typical US driving $\sim 12,000 \text{ mi/yr}$

Embodied Energy (2)

- **BMW 330i (1657 kg, 30 mpg EPA comb.)**
 - operational energy = 13,480 kWh/yr
 - embodied energy = 46,070 kWh
- **Tesla 3 (1846 kg, 290 Wh/mi EPA comb.)**
 - operational energy = 3,480 kWh/yr
 - embodied energy = 51,320 kWh
- **differences**
 - operational energy = 10,000 kWh/yr
 - embodied energy = 5,250 kWh
 - Tesla makes up difference in less than 7 months

Consumerism Can Be Good

- “Keep your car until it's dead.”
- Automotive food chain
- Auto manufacturers only make new cars.
- New car buyers dictate the vehicle mix for all drivers, rich and poor alike.

“Just Do It.”

Nike

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