Electric Vehicles, Renewable Energy and Global Warming Emissions in Michigan

A Report by The Ecology Center

Written by

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ECOLOGY CENTER

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As the nation's leader in automotive R & D, as well as producer of the best-in-class Chevy Volt, Ford Focus EV and C-Max Energi, Michigan's automotive industry has a key stake in the development of electric vehicles. A key question that arises when considering the purchase of a plug-in electric car is whether using electricity is better for reducing global warming emissions. Recent research suggests that the answer to that question depends in part on the electricity grid for the region in which the vehicle is used. As Michigan now considers policy options for the state's electricity generation post-2015, it is important to understand how those decisions not only impact emissions from power generation facilities, but also the emissions related to the future use of electric vehicles (EVs) as a mode of transportation. In this brief analysis, we provide some initial findings on potential emissions from EV's under different scenarios for the integration of renewables into Michigan's power grid.

Electric vehicles and global warming emissions

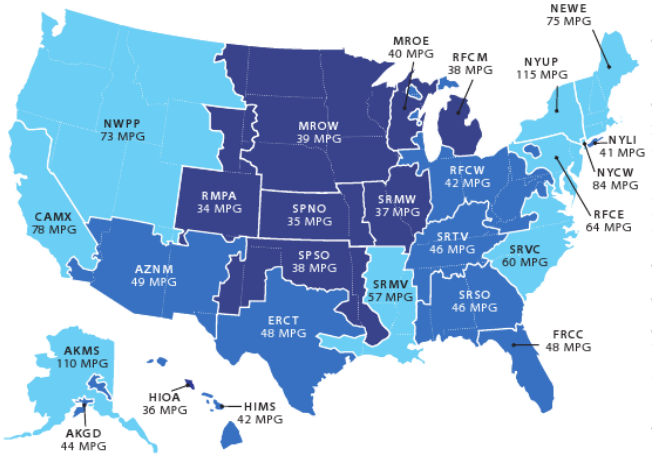
Electric vehicles (EVs) run on power from the electricity grid instead of from the gas pump. Global warming emissions from driving a gas-powered vehicle come from its tailpipe; while an EV has no tailpipe emissions, producing the electricity to charge its battery does produce global warming emissions. How much depends on the fuel used to generate the electricity. And what fuel is used varies from region to region in the United States.

The 2012 Union of Concerned Scientists report, *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States*[1], compares the global warming emissions from EVs with those from gasoline-powered vehicles in each region of the U.S. electricity grid. The report finds that:

- Nationwide, charging EVs from the electricity grid produces lower global warming emissions than the average compact gasoline-powered vehicle (with a fuel economy of 27 miles per gallon)—even with electricity produced primarily from coal in regions with the "dirtiest" electricity grids.
- In regions with the "cleanest" electricity grids, charging EVs produces lower global warming emissions than even the most fuel-efficient hybrids.
- Charging EVs entirely from renewable sources (e.g. wind, solar) produces virtually no global warming emissions.
- Driving an EV can save between $750 to $1,200 a year over gasoline fueling costs.

Electric Vehicle Emissions by Region

State of Charge evaluates the intensity of global warming emissions in each regional electricity grid (see Figure 1), and then applies those to the energy used by the most common EVs on the road today. The report then compares those global warming emissions to those from burning gasoline to arrive at the combined city/highway fuel economy rating of a gasoline vehicle that would have global warming emissions equivalent to an EV – its mile per gallon greenhouse gas equivalent, or mpg_{ghg} – in each region. The report finds that:



- Forty-five percent of Americans, in a third of the regions, live in the "best" regions where EVs produce lower global warming emissions than even the most fuel-efficient gasoline hybrids on the market today (greater than 50 mpg).
- Thirty-eight percent, in another third of the regions, live in "better" areas where EVs produce emissions comparable to the best gasoline hybrid vehicles (41 – 50 mpg).
- Just seventeen percent reside in the "good" third of the regions where emissions from EVs are comparable to the most fuel-efficient non-hybrid gasoline vehicles (31 – 40 mpg).

[1] see full report at http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-

State of Charge of Michigan

Since regional grids are defined by coverage from utilities, not geographical boundaries, *State of Charge* did not determine EV mpg_{ghg} for each state. However, because the Reliability First Corporation Michigan (RFCM) encompasses the overwhelming majority of electricity customers and electricity sold and generated in Michigan, it can be used as a good approximation for the state as a whole.

The report finds that RFCM falls within the "good" range, with EVs getting an equivalent of 38 mpg_{ghg}. While RFCM was one of the "dirtiest" regions, EVs still perform better than the most efficient 2013 conventional gasoline cars, which get an EPA estimated 37 mpg[2]. The report also finds a potential fuel-cost savings of $1,020 a year for an EV charged in Detroit, vs. a 27 mpg gasoline-powered vehicle.

Where does Michigan rank? In 2010, out of the 22 regional grids in the lower 48 states, 18 were cleaner than RFCM. The good news for Michigan is that there is plenty of room for improvement, and some improvement is already being made as the state reaches its renewable energy standard (RES) of 10% of electricity sold by 2015.

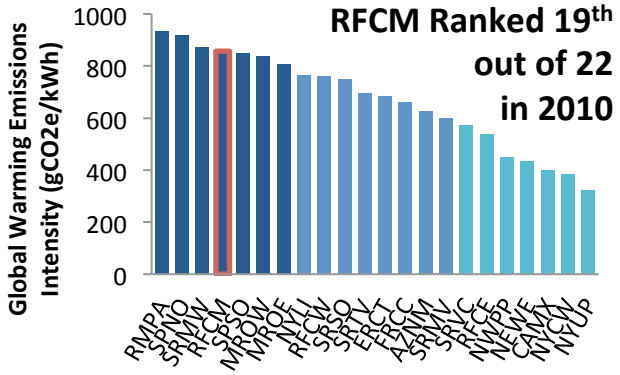


Figure 2 - Global Warming Emissions Intensity of Electricity, by Region — from *State of Charge*

Driving Ahead

But what about EV emissions going forward? While EVs already have an emissions advantage over conventional gasoline vehicles, they also have a hidden advantage: their emissions get better over time. If you keep your gasoline-powered vehicle properly maintained, the best you can hope for is to keep its fuel economy the same. However, since all electricity grids in the U.S. are expected to use less coal and more renewable energy over time, an EV you buy today will actually produce fewer and fewer emissions each year.

Two trends will decrease electricity grid emissions in coming years. First, natural gas powered electricity plants produce about half the emissions as a coal-burning plant. Use of natural gas to generate electricity is has been and is projected to increase, displacing coal, which will decrease EV charging emissions. Charging an average EV that uses 0.34 kilowatt-hours of electricity per mile (equivalent to a Chevy Volt, and the EV used in *State of Charge)* with electricity generated entirely from natural gas would get 53 mpg_{ghg}; the same EV charged with 100% coal-powered electricity would get 29 mpg_{ghg}.

Second, use of renewable energy is increasing, in general. The amount of increase will vary depending on policy decisions and market factors, and as previously stated, an EV charged with 100% renewable energy would have virtually no emissions.

Michigan is projected to see an increase in both natural gas and renewable energy use. While an average, new EV got 39 mpg_{ghg} in RFCM in 2010, that same car will achieve about 45 mpg_{ghg} in 2015 with Michigan's 10% RE grid mix. If Michigan were to achieve a 25% RE grid mix by 2025, that same 2010 EV (if still running well) would get 53 mpg_{ghg}, while a comparable gasoline vehicle would still be getting 27 mpg, the same as it was in 2010.

Using data from the U.S. Energy Information Administration (EIA)[3], we can project how the emissions of an EV might improve over time if Michigan's renewable energy (RE) grid mix is increased. And since all vehicles can be expected to improve their efficiency as technology matures, we can project the mpg_{ghg} improvements for new EV's as well. Comparing two scenarios, one in which Michigan maintains a 10% RE grid mix through 2025, and another in which Michigan achieves a 25% RE grid mix, new EVs perform as follows:

- **39 mpg_{ghg}** — what an average, new EV achieved in 2010.
- **50 mpg_{ghg}** —with Michigan's 10% RES in 2015.
- **72 mpg_{ghg}** —if Michigan holds RE at 10% through 2025 (due mostly to increasing natural gas use)
- **97 mpg_{ghg}** — if Michigan utilities can generate a 25% RE mix in 2025; two and a half times what an EV achieved in 2010.

[2] see http://www.fueleconomy.gov/

[3] forecasts from the Annual Energy Outlook at http://www.eia.gov/forecasts/aeo/er/index.cfm

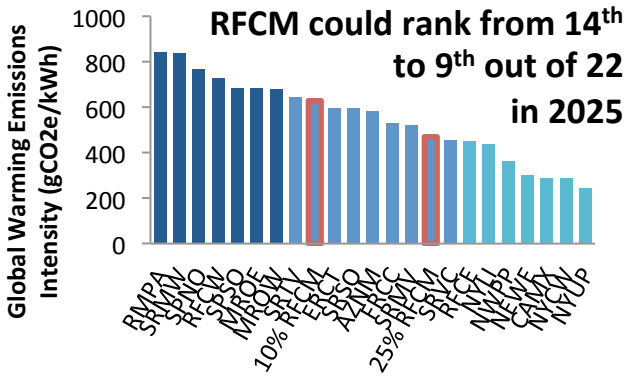


Figure 3 - Projected 2025 Global Warming Emissions Intensity of Electricity, by Region.
Note: the 10% renewable energy and 25% renewable energy scenarios for RFCM are denoted as "10% RCFM" and "25% RFCM," respectively.

How Michigan fares in the future depends on the renewable energy choices made. Assuming other regions advance as projected in EIA's Energy Outlook, RFCM could move up 3 spots to 16th out of 22 in 2015.

Holding at a 10% RE grid mix, RFCM would be expected to be 14th out of 22 in 2025; at 25% RE, RCFM could move all the way up to 9th out of 22. With more RE, RFCM could rank even higher.

Steps for Cleaner Driving

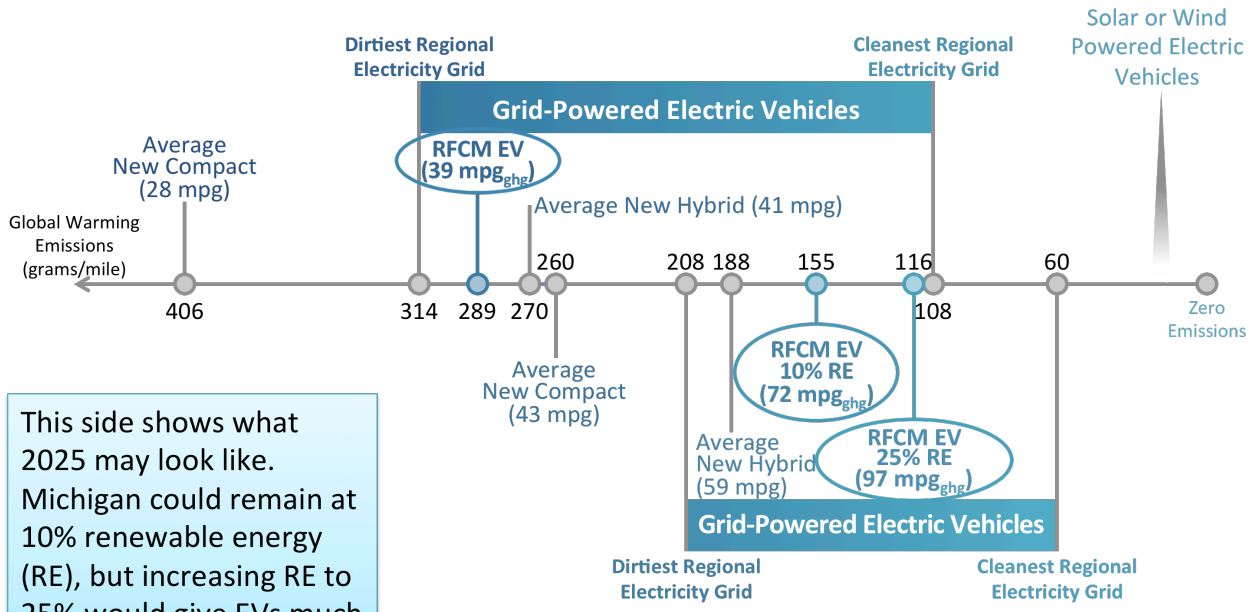
Right now, driving an electric vehicle in Michigan produces fewer global emissions than driving a comparable gasoline vehicle *despite* Michigan's heavy reliance on coal.

By increasing the amount of electricity generated from renewable sources, however, Michigan can rapidly decrease the intensity of global warming emissions from its electricity grid, and in turn, greatly boost the emissions performance of electric vehicles charged in the state. This is a winning combination for both the environment *and* the future of Michigan's electric vehicle industry.

Electric Vehicles Produce Fewer Global Warming Emissions than Gasoline Vehicles

How much lower depends on how clean the regional electricity grid is.

This side shows the range of EV charging-related emissions across the U.S. and in Michigan (RFCM) in 2010.



This side shows what 2025 may look like. Michigan could remain at 10% renewable energy (RE), but increasing RE to 25% would give EVs much better emissions.

RFCM is "Dirty" Compared to Other Grids, but is Making Some Progress

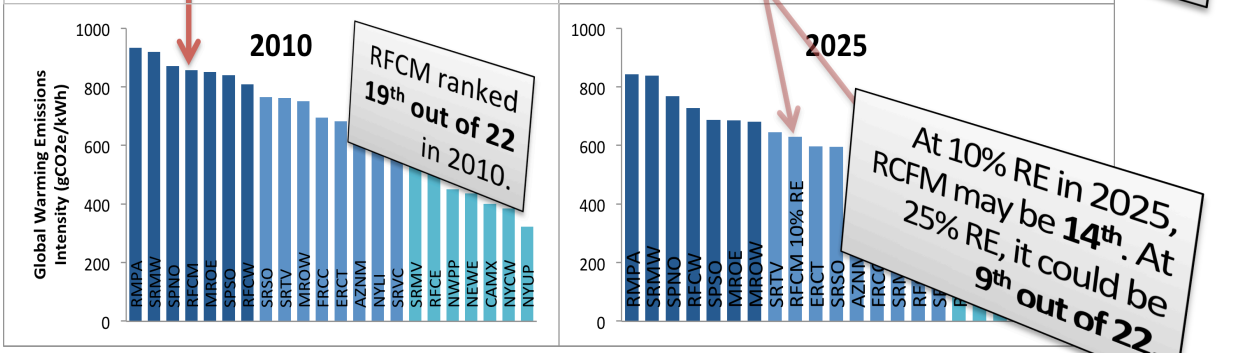
And there is great opportunity for improvement.

In *State of Charge*, each region is ranked as **Good**, **Better**, or **Best**, based on comparing EV emissions to gasoline and hybrid emissions. Michigan's main grid, RFCM, ranked **Good**, meaning an EV charged in RFCM would have fewer emissions than the best compact gasoline-vehicle available; most hybrid vehicles would have even fewer emissions.

Energy Information Administration (EIA) data ranks RFCM's grid emissions **19th** cleanest of 22 grids.

With Michigan's 10% Renewable Energy (RE) Standard in 2015, RFCM is projected to move up **3** spots to **16th**, to the top of the **Good** range.

In 2025, RFCM may move up **2** spots to **14th**, just inside the **Better** range, if RE holds at 10%. Should RFCM get to 25% RE, it could jump ahead **7** places to **9th**, just shy of making it up to **Best.**



Note: Rankings and emissions may vary from those in *State of Charge*. Projections are based on EIA forecasts, which do not include Alaska and Hawaii . *State of Charge* is based off the 2012 eGrid database, which includes Alaska and Hawaii. Data varies slightly between eGrid and EIA.

Note: *State of Charge* bases Good, Better, Best off the range of currently available vehicles. We don't know what the range of fuel economies will be for future vehicles; we only have projections for average vehicles of different classes. In this case, Good, Better, Best have been redefined as the top, middle and bottom thirds.