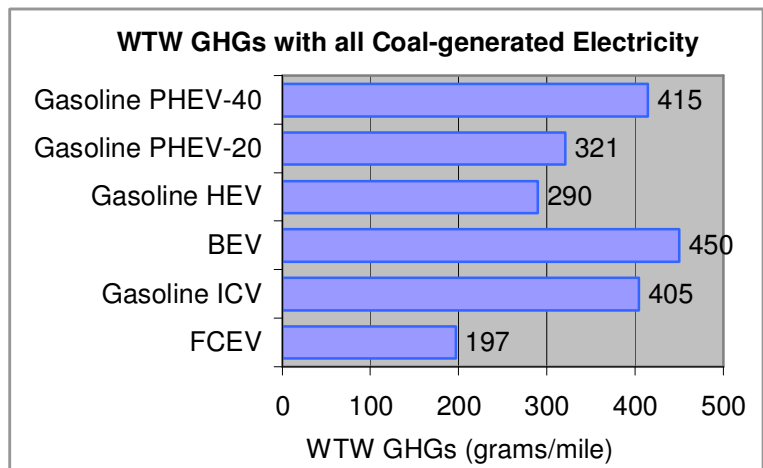


GHGs using Coal Electricity: To plug or not to plug?

There is an urban myth being circulated that BEVs and PHEVs will cut GHGs even if the electricity comes from coal plants. According to the Argonne GREET 1.8d_0 model¹, this is not true. Figure 1 shows the calculated well-to-wheels (WTW) GHGs assuming 100% coal-generated electricity. A hydrogen-powered² Fuel cell electric vehicle (FCEV) has the lowest GHGs at 197 grams/mile. A conventional (non-hybrid) gasoline ICE generates 405 g/mile, and a battery electric vehicle (BEV) produces 11% more GHGs at 450 g/mile. Similarly, a conventional Prius-like gasoline HEV has lower GHGs (290 g/mile) than a plug-in hybrid electric vehicle (PHEV) with 20 miles all-electric range (321 g/mile) or a PHEV with 40 miles AER like the proposed Chevy Volt (415 g/mile). In other words, to reduce GHG emissions, a PHEV should be operated only on gasoline; plugging in to a coal-generated electrical grid will always increase GHGs.

In fact, even for the *average* US grid mix, the cleaner (lower GHG) fuels (Hydrogen, E-85 and diesel) produce lower GHGs for the HEV mode³ than for any PHEV mode as shown in Figure 2.



EPA/Car GHG ratings sorted by total and tailpipe-only GHGs.XLS; P 66 9/21 /2010

Figure 1. Well-to-wheel greenhouse gas emissions using 100% coal-generated electricity to charge BEV and PHEV car batteries

Similarly, a conventional Prius-like gasoline HEV has lower GHGs (290 g/mile) than a plug-in hybrid electric vehicle (PHEV) with 20 miles all-electric range (321 g/mile) or a PHEV with 40 miles AER like the proposed Chevy Volt (415 g/mile). In other words, to reduce GHG emissions, a PHEV should be operated only on gasoline; plugging in to a coal-generated electrical grid will always increase GHGs.

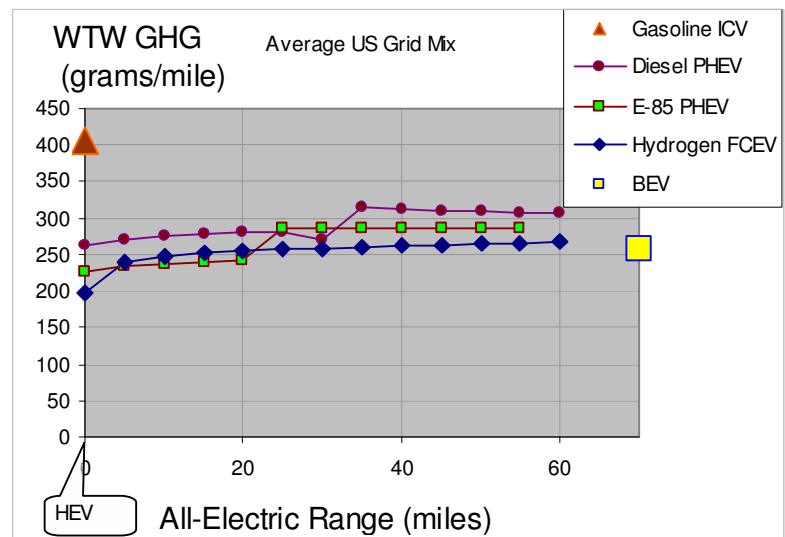


Figure 2. WTW GHG emissions in the HEV mode (AER=0) and the PHEV mode for **the average US grid mix**; GHGs increase with increasing AER for all three fuels (Hydrogen, E-85 and diesel), indicating that plugging in an HEV will increase GHGs

¹ "The Greenhouse gases, regulated emissions and energy use in transportation model", by the Argonne National laboratory, available at <http://greet.es.anl.gov/main>

² GREET assumes that hydrogen is made by reforming natural gas for this figure

³ The HEV GHGs are plotted at the all-electric range equal to zero.

GHGs from PHEVs using Coal electricity

For example, a gasoline PHEV-40 would produce lower GHGs in the HEV mode (290 g/mile) than in the PHEV-40 mode (314 g/mile), meaning that a PHEV-40 owner could cut GHGs 8.2% by never recharging the batteries from the average US Grid mix.

Amgad Elgowainy⁴ and his colleagues at the Argonne National Laboratory have extensively analyzed the impact of PHEVs in various regions of the country. As shown in their Figure ES.1, a PHEV-40 using the average Illinois electricity mix would not only have higher GHGs than an HEV, but would also have higher GHGs than a non-hybrid gasoline vehicle (GV) if the PHEV used “smart charging” (using low-cost off-peak electricity that is mostly coal-based.)

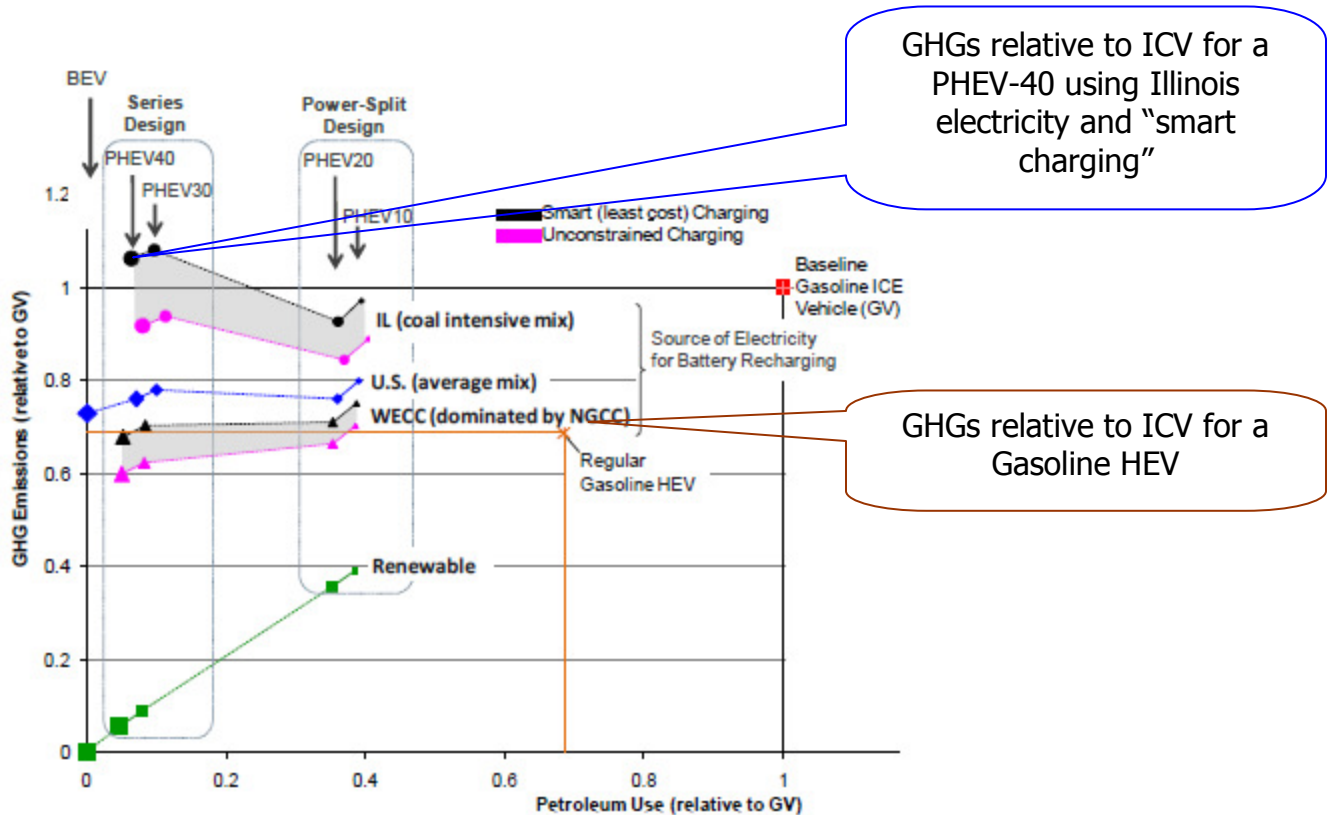


FIGURE ES.1 WTW Petroleum Use and GHG Emissions for CD Operation of Gasoline PHEVs and BEVs Compared with Baseline Gasoline ICEVs and Regular Gasoline HEVs

Similarly, their figure 6.9 (next page) shows that GHGs increase with increasing AER for electricity from Illinois. The lowest GHGs come from HEVs for each fuel, and plugging in always increases GHGs. Note also that if biofuels are used, making hydrogen for FCEVs (lower green line) always generates lower GHGs than biomass for ethanol in PHEVs.

⁴ Amgad Elgowainy, J. Han, L Poch, M. Wang, A Vyas, M. Mahalik, A. Rousseau, “Well-to-Wheel Analysis of Energy Use and Greenhouse Gas Emissions of Plug-in Hybrid electric vehicles.” Report # ANL/ESD/10-1 available at <http://www.transportation.anl.gov/pdfs/TA/629.PDF>

GHGs from PHEVs using Coal electricity

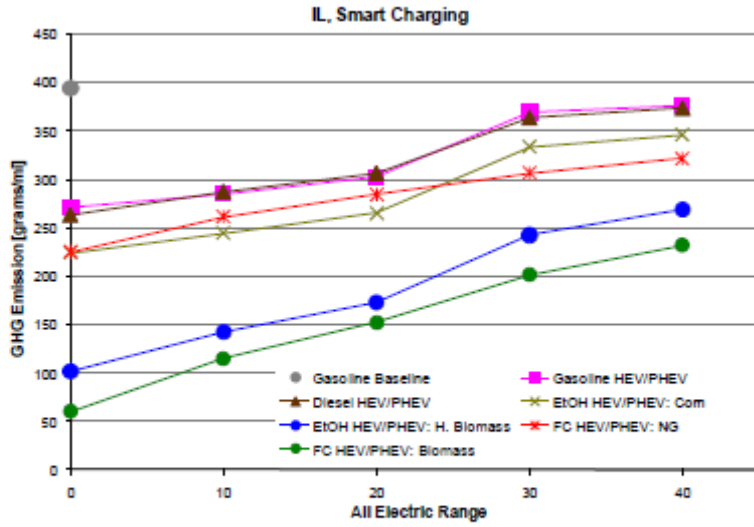


FIGURE 6.9 WTW GHG Emissions for Combined CD and CS Operations of PHEVs in IL (smart charging scenario) as a Function of Rated AER (Note: Regular HEV and conventional gasoline ICEV are represented at AER=0)