Summary of Expansions and Revisions of the GREET1.8c Version

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This release of the GREET model includes the following updates:

1. Detailed simulation capabilities of plug-in hybrid electric vehicles (PHEVs)
2. Updated fuel economies of baseline and alternative vehicle technologies from the Energy Information Administration (EIA) and U.S. Environmental Protection Agency (EPA) publications as well as simulated fuel economy results from Argonne's PSAT model
3. Updated projections of United States (US), California (CA), and northeastern (NE) US electricity generation mixes based on EIA's Annual Energy Outlook 2009
4. Adopted a new naming convention for current and future GREET releases

1. Simulation capabilities of PHEVs in GREET (for detailed WTW analysis of PHEVs, refer to ANL's recent study: Elgowainy, Amgad, Andrew Burnham, Michael Wang, John Molburg, and Aymeric Rousseau, "Well-To-Wheels Energy Use and Greenhouse Gas Emissions Analysis of Plug-in Hybrid Electric Vehicles," ANL/ESD/09-2, Center for Transportation Research, Argonne National Laboratory, Argonne, IL, February 2009, http://www.transportation.anl.gov/pdfs/TA/559.pdf)
    a. Blended charge-depleting (CD) operation mode (i.e., blending power from grid-charged battery and engine/fuel cell to operate the vehicle). Note that the electric and fuel consumption in such mode are additive for the same miles traveled under the CD operation.
    b. Simulation of all-electric range (AER) from 5 to 60 miles in the blended CD operation mode. Note that PSAT simulations indicate that the vehicle's control strategy of the on-board power unit in the blended mode CD operation can extend the rated AER by 20% (with a 10% tolerance)
    c. Several electric generation technologies and mixes for recharging PHEVs
    d. Updated electric/fuel consumption in the blended CD operation mode and fuel economy in the charge-sustaining (CS) operation mode based on PSAT simulation results
    e. Use of the utility factor (UF) to determine vehicle miles traveled (VMT) share for CD and CS operations based on AER of PHEVs. The utility factor is used

as a weighting factor to combine the energy use and emissions associated with CD and CS operations

2. Updated fuel economies (FE) in miles per gallons (MPG, gasoline equivalent) of baseline and alternative vehicle technologies
    a. GREET uses EPA's method as adopted in 2006 to adjust lab-MPG for conventional and hybrid electric vehicles (HEVs) powered with internal combustion engines to the on-road MPG for 2008 and later model year vehicles. Below are the two formulas that EPA is using to conduct MPG adjustments for both city and highway MPG.

        FE_CITY = 1/(0.003259 + 1.1805/FE_LAB_CITY)

        FE_HWY = 1/(0.001376 + 1.3466/FE_LAB_HWY)

        (Reference: Fuel Economy Labeling of Motor Vehicle Revisions to Improve Calculation of Fuel Economy Estimates, EPA Office of Transportation and Air Quality, EPA420-R-06-017, December 2006)
    b. GREET assumes a 90% degradation factor from lab-MPG to on-road MPG for fuel cell vehicles (FCVs), electric vehicles (EVs), and electric energy consumption in the CD operation of PHEVs
    c. GREET uses a 43% city/57% highway weighting factor to generate composite fuel economy values for 2008 and later model year vehicles (Reference: Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2008, EPA Office of Transportation and Air Quality, EPA420-R-08-015, September 2008). Note that EPA's Fuel Economy Guide uses a 55% city/45% highway weighting factor for estimating annual fuel costs with on-road city and highway fuel economy
    d. Historic fuel economy of the baseline conventional gasoline vehicles is calculated from the EPA fuel economy trend report (Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2008, EPA Office of Transportation and Air Quality, EPA420-R-08-015, September 2008)
    e. Estimates of future fuel economies for baseline gasoline vehicles are calculated based on the EIA's Annual Energy Outlook 2008 projections of fuel economies for automobiles and light duty trucks. Note that the EIA has already incorporated the new CAFE standard into their projections for the baseline vehicles
    f. Fuel economies for the following fuel/advanced vehicle technologies (HEVs, PHEVs, and FCVs) relative to the baseline gasoline vehicles are updated with PSAT simulation results: gasoline and diesel conventional internal combustion engine vehicles (ICEVs), HEVs and PHEVs; E85 ICEV, HEV and PHEV; hydrogen ICEV, HEV, FCV and FC-PHEV; Electric vehicles (EVs). The relative fuel economy for all other advanced fuel/vehicle

technologies are consistent with the earlier version of GREET (GREET1.8b) and are based on data drawn from broad literature search

g. Notes on fuel economy assumptions in GREET1.8c :
   - EIA's AEO 2008 projects conventional diesel vehicles' fuel economy to be 34% higher compared to the baseline conventional gasoline vehicles. PSAT projects a 10% higher fuel economy for diesel vehicles over gasoline vehicles' fuel economy. GREET adopts a value of 20% higher fuel economy for diesel vehicles relative to baseline gasoline vehicles.
   - GREET assumes 20% higher fuel economy for hydrogen ICE vehicles relative to baseline gasoline vehicles (for more details, refer to GM Study: Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems, May 2005, http://www.transportation.anl.gov/pdfs/TA/339.pdf)
   - GREET assumes 150% increase in fuel economy of FCVs for model year 2020 compared to conventional gasoline ICE vehicles based on PSAT simulation results. Note that EIA's Annual Energy Outlook 2008 projects a 33% increase in fuel economy of FCVs compared to conventional gasoline ICE vehicles

3. Updated projections of United States (US), California (CA), and northeastern (NE) US electricity generation mixes based on the EIA's Annual Energy Outlook 2009 Early Release Overview. Note that the northeastern region of the US includes the Mid-Atlantic Area Council (MAAC), Northeast Power Coordinating Council/New York (NPCC-NY), and Northeast Power Coordinating Council / New England (NPCC-NE); these are regional classifications of US electric supply and demand.

4. Adopted new naming convention for current and future GREET releases. For example, in the current release of "GREET1_8c_0.xls", the letter "c" indicates a major update from the previous version "GREET1_8b.xls", while the minor update number "0" indicates a first release of this major update. Each minor update subsequent to this "1.8c" version will increment the minor update number by one.