

Summary of Expansions and Updates in GREET™1_2014 and GREET™2_2014 Models

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I. GREET™1 2014

This release of GREET1_2014 model includes the following major updates:

1. Updated refining efficiency and GHG emission intensity of petroleum products. Detailed information on these updates are documented in the following ANL papers:

- a. <http://pubs.acs.org/doi/abs/10.1021/es5010347>
- b. <http://pubs.acs.org/doi/abs/10.1021/es501035a>

2. Expanded oil sands modeling to include the following four pathways:

- i. mining → bitumen
- ii. mining → synthetic crude oil [SCO]
- iii. in-situ → bitumen, and
- iv. in-situ → SCO)

Also added diluent pathways (naphtha and natural gas liquid) for dilbit (i.e., bitumen + diluent) transportation. Detailed information on these pathways are documented in the following reports:

- a. <https://greet.es.anl.gov/publication-lca-update-oil-sands>
- b. <https://greet.es.anl.gov/publication-luc-canadian-os>

3. Added black carbon and organic carbon emissions as additional criteria air pollutants (CAP) and GHG species throughout GREET 1 and 2. Detailed information on these updates are documented in the following ANL publications:

- a. <https://greet.es.anl.gov/publication-black-carbon-greet>
- b. <https://greet.es.anl.gov/publication-black-carbon-2014>

4. Added water consumptions as additional life-cycle analysis metric for the major pathways (petroleum, natural gas, corn ethanol, hydrogen, and electricity). Detailed information on the life-cycle water consumptions are documented in the following ANL technical memorandum, which is currently subjected to external reviews. A final report will also be posted at the end of the review process.

<https://greet.es.anl.gov/publication-water-lca>

5. Added contribution of oil and gas infrastructure to greenhouse gas emissions for crude and natural gas production and processing. Relocated oil/gas/coal/power plants infrastructure modeling from GREET2 to GREET1. Detailed information on this expansion are documented in the following report:
<https://greet.es.anl.gov/publication-oil-gas-prod-infra>
6. Added rail module as an additional transportation application. Detailed information on the rail model are documented in the following ANL report:
<https://greet.es.anl.gov/publication-rail-module>
7. Added heavy duty vehicle (HDV) module as an additional transportation application. Detailed information on the HDV model are documented in the following ANL report(will be posted by October 31):
<https://greet.es.anl.gov/publication-heavy-duty>
8. Updated stationary combustion emission factors. Detailed information on these update are documented in the following ANL report (will be posted by October 10):
<https://greet.es.anl.gov/publication-emission-factors-2014>
9. Added conventional and bio product pathways. Detailed information on the life-cycle stages for these conventional and bio product pathways are documented in the following ANL report:
<https://greet.es.anl.gov/publication-bioproducts-lca>
10. Added pretreatment pathways including dilute acid pretreatment and ammonia fiber expansion. Detailed information on these pretreatment pathways are documented in the following ANL report:
<https://greet.es.anl.gov/publication-pretreatment-module>
11. Added catalyst production pathways. Detailed information on the life-cycle stages for the catalyst pathways are documented in the following ANL report:
<https://greet.es.anl.gov/publication-catalyst-module>
12. Added a corn ethanol production process with corn oil extraction and integrated corn/corn stover ethanol production processes. Detailed information on the life-cycle stages for these pathways are documented in the following ANL report:
<https://greet.es.anl.gov/publication-update-corn-ethanol-2014>

13. Updated methane emission for natural gas pathways as well as petroleum venting, fugitive and flaring emissions. Detailed information on these updates are documented in the following two ANL technical memoranda:
 - a. <https://greet.es.anl.gov/publication-emissions-ng-2014>
 - b. <https://greet.es.anl.gov/publication-emissions-crude-oil-2014>
14. Updated global warming potential (GWP) and added global temperature potential (GTP) based on IPCC 2013 AR5 report:
http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf
15. Updated soybean and biodiesel production assumptions. Detailed information on these updates are documented in the following technical memorandum:
<https://greet.es.anl.gov/publication-soybean-biodiesel-2014>
16. Updated cellulosic ethanol production assumptions based on SOT 2013. Detailed information on the life-cycle stages for the cellulosic ethanol pathways are documented in the following report:
<https://greet.es.anl.gov/publication-scsa-2014>
17. Updated CCLUB with two new feedstocks (poplar and willow), new organic carbon emission factors for soil depth of 100 cm, and new land-use change results. Details of these updates are documented in the following CCLUB users' manual:
18. <https://greet.es.anl.gov/publication-cclub-manual>
19. Added ethanol-to-jet pathways. Detailed information on the life-cycle stages for the pathways are being documented. An ANL publication on these pathways is currently being developed.
20. Updated enzyme and yeast assumptions. These updates are described in the following short memorandum:
<https://greet.es.anl.gov/publication-enzyme-yeast-2014>
21. Added Gas/Biomass-To-Liquid (GBTL) pathways and updated Gas-To-Liquid (GTL) pathways. Detailed information on the life-cycle stages for these pathways are based on the following publications:
 - a. GBTL <http://www.sciencedirect.com/science/article/pii/S1876610211002773>
 - b. GTL http://netl.doe.gov/File%20Library/Research/Energy%20Analysis/Publications/Gas-to-Liquids_Report.pdf
22. Added a summary of the 3-season results for the algae hydrothermal liquefaction pathway described in "Integrated Evaluation of Cost, Emissions, and Resource Potential for Algal Biofuels"

at the National Scale." Environmental Science & Technology 48(10):6035-6042
(<http://pubs.acs.org/doi/abs/10.1021/es4055719>).

23. Updated the CO₂ emission factor from limestone application based on the following EPA's GHG Inventory (2014) <http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>

II. GREET™2 2014

This release of GREET2_2014 model includes the following major updates:

1. Added six new vehicles, including a midsize sedan, a crossover utility vehicle, and a pickup truck for both baseline and lightweighting models, and with different material compositions. Detailed information on the addition is documented in the following ANL memorandum:
<https://greet.es.anl.gov/publication-vehicle-additions-2014>
2. Updated carbon fiber and Magnesium production assumptions. Detailed information on the life-cycle stages for these pathways are documented in the following ANL report:
<https://greet.es.anl.gov/publication-lightweight-automotive>
3. Added additional cathode materials and composition data for Li-ion batteries including Lithium Cobalt Oxide, Lithium Nickel Manganese Cobalt Oxide, Lithium Manganese Oxide and Lithium Iron Phosphate. Detailed information on the life-cycle stages for the Li-ion battery cathode materials and their updates are documented in the following ANL reports:
 - a. <https://greet.es.anl.gov/publication-anode-cathode-liion>
 - b. <https://greet.es.anl.gov/publication-li-ion>