WORKING PAPER

OCTOBER 2015 | FUEL SUSTAINABILITY TOOL VERSION 1.0

Fuel Sustainability Tool Version 1.0: Technical References

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About This Report

This report provides technical references for the Fuel Sustainability Tool (Fuel Tool) that BSR's Ryan Schuchard, Nathan Springer, and Beth Richmond designed based on numerous sources, including a wide range of scientific studies, input from technical experts, and BSR's own experience.

The Fuel Tool is a project of BSR's Future of Fuels initiative, which is led by major fuel buyers, including PepsiCo, Inc., The Coca Cola Company, United Parcel Service, Inc. (UPS), and Wal-Mart Stores, Inc., and value chain partners, including Royal Dutch Shell, Suncor Energy, Volvo North America, and Westport Innovations. It incorporates the best available science on fuel sustainability into a decision-making tool for sustainability-focused fleet operators. It allows decision-makers to compare fuel pathways within types of fuels used in medium- and heavy-duty trucks in North America. These fuels include diesel, biofuels, and natural gas, as well as options within fuel types that decision-makers can take to engage suppliers and improve impacts.

BSR developed the tool with user input from a steering committee of fleet operators and technical input from a technical working group of experts in fuel and vehicle sustainability. Version 1.0 of the tool uses the best available carbon-intensity modeling based on Argonne National Laboratory's GREET model, with results for several fuel categories from the California Air Resources Board's California-GREET and the Oil-Climate Index (OCI), and select scenarios from EDF. Qualitative data on social, environmental, and best practices considerations are drawn from research summarized in BSR's "Future of Fuels Sustainability Briefs," supplemented with input from the technical working group.

This document references version 1.0 of the tool. We are currently developing version 1.1, which we expect to complete by the spring of 2016.

We welcome feedback to futureoffuels@bsr.org.

ABOUT BSR'S FUTURE OF FUELS INITIATIVE

BSR's Future of Fuels initiative helps companies understand the impacts of transportation fuel and how they can work together to create a system that is sustainable, resilient, and affordable. To do this, the initiative brings together critical players from the corporate, nonprofit, and public sectors in a series of facilitated dialogues supported by research.

Our work is intended to guide project participants in the development of fuel sustainability approaches, while catalyzing industry and multisector partnerships to promote the creation and adoption of leading practices, better technology, infrastructure, and policy development for fuel production, distribution, and consumption.

Future of Fuels is part of BSR's "Business in a Climate-Constrained World" strategy, which catalyzes private-sector action on climate resilience in two ways: by helping reduce greenhouse gas emissions consistent with holding global mean temperature rises to less than 2˚C above pre-industrial levels, and enhancing adaptive capacity in the face of inevitable climate impacts.

ACKNOWLEDGMENTS

The authors wish to thank the Future of Fuels member companies and fuel sustainability experts who contributed to the development of the Fuel Tool.

BSR'S FUTURE OF FUELS MEMBER ORGANIZATIONS

- PepsiCo, Inc.
- Royal Dutch Shell
- Suncor Energy
- The Coca-Cola Company
- United Parcel Service, Inc. (UPS)
- Volvo North America
- Wal-Mart Stores, Inc.
- Westport Innovations

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Working papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate discussion and critical feedback and to influence ongoing debate on emerging issues. Most working papers are eventually published in another form, and their content may be revised.

SUGGESTED CITATION

Schuchard, Ryan; Springer, Nathan; Richmond, Beth. 2015. “Fuel Sustainability Tool Version 1.0: Technical References.” Working paper, BSR.

Contents

Objectives and Design Approach

Transportation creates nearly a quarter of all energy-related carbon emissions, and because of this, a key strategy in stabilizing the climate is to greatly expand low-carbon fuels.[1] Corporate fuel buyers are important influencers because they can motivate fuel producers and vehicle original equipment manufacturers (OEMs) to invest in cost reduction, and give policymakers confidence to accelerate development. Yet there is no unified voice of influential business advocates in this sector.

Fuel Tool Objective

The purpose of the Fuel Tool is to identify and promote the sustainability and availability of emerging fuel choices for commercial trucking. **The Fuel Tool helps fleet owners and others quickly assess the impacts of fuel for trucking so they can identify low-cost, sustainable, and scalable solutions.**

Impacts related to the lifecycle of fuel use—including production, refining, distribution, and use of transportation fuel—must be addressed systemically. These include social and environmental impacts such as climate change, ecosystem conversion, community health, human rights, and labor impacts. The Fuel Tool helps commercial fleet/fuel buyers develop a clear, shared understanding of sustainability needs so that they can convey these needs to producers and policymakers, strengthening the marketplace and driving transformation.

THEORY OF CHANGE

Our vision: We envision a transportation fuel system that is sustainable, resilient, and affordable. Our mission is to identify and promote transportation fuel pathways that enhance the sustainability and availability of emerging fuel choices.

Supply, demand, and policies must reinforce each other to transform fuel markets. The Fuel Tool will help commercial fleet owners develop a clear, shared understanding of sustainability needs so that they can convey these needs to fuel producers and policymakers, strengthening the marketplace and driving transformation.

Role of the Fuel Tool: The Fuel Tool will support market transformation by driving:

» **Stronger demand signals** to enable new dialogue about aggregate purchasing

» **Understanding by policymakers** about fleet operator demand

» Clear and consistent **decisions and actions** in fuel/vehicle procurement

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[1] Intergovernmental Panel on Climate Change, 2015

» Better **identification of R&D gaps and opportunities**

USE CASE

The Fuel Tool provides insights for fleet owners when it comes to two types of decisions:

» **Fuel purchasing:** The Fuel Tool provides data on a range of carbon and other sustainability impacts, as well as the activity drivers that generate impacts of different types of fuels that fleets purchase. The tool also identifies specific “upstream” practices associated with higher or lower carbon impacts that fleet owners can use to set expectations for suppliers.

» **Fleet planning** (will be available in version 1.1)**:** Fleet owners can use the Fuel Tool to evaluate incremental environmental and social costs or benefits of two or more vehicle models with different fuel requirements. Furthermore, the Fuel Tool can be used to make projections on the environmental costs and benefits of future fleets composed of a mix of these different vehicle types.

Taken together, it can be used to plan internally and communicate with stakeholders externally.

Design Approach

DESIGN PRINCIPLES

The tool allows fleet owners and fuel buyers to understand the sustainability impacts of different fuel types on a performance basis, by providing a side-by-side comparison of quantifiable lifecycle performance and qualitative considerations on a variety of social and environmental issues.

To meet the needs of corporate fleet owners, the tool is designed to:

» Enable **decision-making**

» Provide **standardized comparison**

» Drive **improvements in fuel sustainability**

DESIGN PROCESS

The first phase of development took place in 2015, focused on quantifying climate impacts and deciding on a methodology for qualitative environmental and social considerations, best practices to improve fuel sustainability, and uncertainties. During forums at the Climate Leadership Conference in Washington, D.C., and at the ACTExpo in Dallas, more than 100 stakeholders provided input on our work. In addition, the steering committee and the technical working group met throughout the year to inform the tool’s design and technical methodology development.

The tool was developed in Excel 2010 by BSR, using the best available modeling and sources recommended by the technical working group. Early prototypes of the tool were piloted with the steering committee, the technical working group, and Future of Fuels member companies. The final version was completed and released to BSR member companies in October 2015. It is available only for members of Future of Fuels and the technical working group.

Scope, Methodology, and Data

The Fuel Tool follows the standard convention used by the U.S. Department of Energy and the U.S. Environmental Protection Agency to evaluate fuel sustainability on a lifecycle basis. Version 1.0 includes 26 well-to-pump (WTP) "pathways," with a measurement of carbon intensity and a description of social and environmental considerations, best practices, and key uncertainties for each. Pathways were selected based on the most common current and projected supply of fuel types by origin, feedstock, and production process, and those under consideration by fleet owners for short- and long-range planning.

Scope

IMPACTS COMPARISON BY FUEL TYPE

In this first version, users indicated a preference for fuels relevant to heavy-duty trucking, and so the pathways cover four fuel types. Version 1.0 provides WTP carbon-intensity values and qualitative considerations for 26 pathways of diesel and renewable diesel (ASTM D975), liquefied natural gas (LNG), compressed natural gas (CNG), and biodiesel (ASTM D6751).

Table 1: Fuel Tool Version 1.0 Scope

Scope	Version 1.0
Fuel Categories	Diesel, Natural Gas, Biofuels
Lifecycle Stages	WTP
Quantitative Results	CO_{2e}
Qualitative Results	Environmental and social considerations, best practices to improve fuel sustainability
Geographic Focus	North America users (national average)

UNCERTAINTY DEMONSTRATION

A second aspect of Version 1.0 is a scenarios-modeling function to preview the carbon-intensity impacts of various uncertainties on a full lifecycle basis. The uncertainties that vehicle efficiency and indirect land use introduce to the evaluation of fuel sustainability can best be understood on a full lifecycle basis, requiring a preview of work that will be complete in Version 1.1. Users can enter values for vehicle efficiency and toggle on/off methane leakage or indirect land use to understand how these uncertainties could impact fuel sustainability on a lifecycle basis.

Boundaries

BSR's Future of Fuels initiative focuses on trucking in North America. However, the supply chain for most fuels is global, and therefore the pathways includes full lifecycle assessments of carbon intensity and other environmental and social considerations. A description of the boundaries and assumptions for each of the 26 pathways can be found in Appendix 1.

Data Sources

STANDARD FOR INCLUSION

The sustainability impacts selected for inclusion were determined by BSR and Future of Fuels member companies based on an extensive literature review and public forums on fuel sustainability impacts using the materiality principle. They represent the sustainability impacts that scientists, businesses, nonprofit stakeholders, and regulators have identified as having the most significant social, environmental, and well-being effects on humans and ecosystems.

Data sources are given priority in the following order:

1. **Existing standards** used by federal or state governments

2. **Peer-reviewed studies** in reputable academic journals

3. **Credible stakeholder sources** supported by research and/or reflecting consensus among legitimate stakeholder groups

QUANTITATIVE

The tool includes the quantitative results of WTP carbon intensity based on Argonne National Laboratory's GREET model. Fleet- and fuel-adapted versions of the model that are used are the U.S. Department of Energy's AFLEET Tool and California Air Resources Board's California-GREET. Additional results are supplemented for diesel with BSR analysis of the OCI and EDF analysis of AFLEET as described in Table 2.

Table 2: Summary of Carbon-Intensity Models Used by Fuel Type

Fuel Type	GREET Model Version	Supplemental Data Sources
Diesel (Petroleum)	AFLEET	Oil-Climate Index (OCI)
Diesel (Renewable)	California GREET	U.S. Environmental Protection Agency
Biodiesel	California GREET	U.S. Environmental Protection Agency
Natural Gas	AFLEET	EDF GREET Analysis

QUALITATIVE

Qualitative data on social, environmental, and best practices considerations are drawn from research summarized in BSR's "Future of Fuels Sustainability Briefs," supplemented with input from the technical working group.

Assumptions and Modeling Decisions

The most relevant assumptions and decisions by the tool builders are those of the underlying carbon-intensity models themselves, along with those described in BSR's "The Sustainability Impacts of Fuels" report. We summarize several important ones, by fuel type, in Table 3.

Table 3: Summary of Assumptions and Modeling Decisions by Fuel Type

Fuel Type	Assumptions and Decisions
General	Carbon intensity is based on the energy content of fuel; 100-year global-warming potential (GWP) for all pathways; AFLEET used to determine U.S. average as a baseline for each fuel type.
Diesel	The OCI analyzes the carbon intensity of a barrel of oil from specific oil fields; Fuel Tool uses select oil fields as indicators of the average for that type of petroleum-based diesel; AFLEET's soy-based biodiesel used for Fuel Tool B5 and B20 blends are drawn from AFLEET and California GREET respectively.
Biodiesel	AFLEET's soy-based biodiesel is used for the U.S. average; iLUC is not included in comparison tables, but it is included as an option in uncertainty demonstration using CARB iLUC values; iLUC will be added more fully in version 1.1.
Natural Gas	High and low leakage are included as separate pathways; high assumes 1.5 times the rate across the value chain, based on recent studies, and low assumes a baseline 45 percent reduction in U.S. methane leakage per national 2025 goal; both use the U.S. conventional North American average for natural gas from AFLEET as the baseline.

More detail on the pathways can be found in Appendix 1.

Uncertainty

Uncertainty is a persistent challenge in evaluating fuel sustainability, and its causes are varied. As a tool designed to drive improvements in fuel sustainability, the Fuel Tool focuses on uncertainty in the underlying sustainability data to enable consistent understanding and signaling by fuel users. We identify three types of uncertainty relevant for Fuel Tool users:

» **Range of results:** Uncertainty can be caused by mixed or ambiguous results on the theoretical limits and likely scenarios of a complex system such as the fuel value chain. This may be resolved be establishing a probabilistic spectrum. An example is the range of carbon intensity of diesel fuels produced by different oil fields.

» **Data availability and consistency:** Uncertainty can be the result of missing, inconsistent, or data that are not standardized. This may be resolved with better data and research, along with standardization of research and data-reporting methods. An example is the specific rate and sources of methane leakage in the U.S. natural gas value chain.

» **Modeling uncertainties:** Uncertainties are introduced by modelers due to choices on boundaries, assumptions, data sources, and philosophical approach. This may be resolved with agreements on standard approaches. An example is the impact of fuel production on indirect land use.

Version 1.0 directly addresses the first by providing the theoretical high and low values for each fuel type, along with likely pathway scenarios in between. We will continue to improve clarity in underlying data and modeling for users in future versions of the tool.

Future Versions

Development of the Fuel Tool continues. The Fuel Tool Version 1.0 established the design objective, approach, and process, as well as results for WTP carbon intensity and various qualitative material. The priority for version 1.1 will be on the comparison of carbon intensity on a full lifecycle, well-to-wheels (WTW) basis, along with several additions summarized in Table 4.

Yet the industry must address issues at a systemic level to avoid unintended consequences and solutions that will fail to have the desired large-scale impact. Therefore, we will also begin to address criteria like pollutants, water, human and worker health, human rights, and community impacts beginning in late 2016.

Table 4: Future Fuel Tool Developments

Version 1.1 (2016)	Version 2.0 (Begin 2016)	Version 3.0 (2017 and beyond)
Addition of electrification fuel type	Inclusion of quantitative values for water or criteria pollutants	Regional averages
Comparison of full lifecycle (WTW) impacts	Supplier request for proposal/questions	Inclusion of human and worker health impacts
New detail on range and confidence of data	Comparison of availability or viability of fuel types	Inclusion of human rights
Standardize modeling across pathways		Inclusion of community impacts

The Fuel Tool will continue to evolve to meet the needs of Future of Fuels members and changing stakeholder expectations. We invite you to join us to access and develop the Fuel Tool or provide input as a fuel sustainability stakeholder. Please contact us to join BSR's Future of Fuel initiative, the Fuel Tool technical working group, or our list of stakeholders: futureoffuels@bsr.org.

Appendix 1: Description of Pathways

Table 5: Carbon Intensity References by Pathway

Pathway	Pathway Description	Data Source(s)
Biodiesel - Waste Oil (B100)	Conversion of waste oils (used cooking oil) to biodiesel (fatty acid methyl esters, or FAME) where "cooking" is required.	California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Biodiesel - Palm Oil (B100)	Malaysia or Indonesia. Transesterification. Natural gas energy. Glycerin co-product.	U.S. Environmental Protection Agency, Federal Register / Vol. 77, No. 18 / Friday, January 27, 2012 / Notices
Biodiesel - Canola (B100)	Transesterification. Natural gas energy. Glycerin co-product.	California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Typical U.S. Biodiesel - Soy (B100)	Conversion of Midwest soybeans to biodiesel (fatty acid methyl esters, or FAME).	California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
CNG (Non-North American)	Compressed natural gas extracted outside North America.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
CNG (Conventional North American High Leakage Scenario)	Max scenario (methane emissions 1.5x GREET mean to reflect scientific study).	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013) and EDF Leakage Scenario Modeling, Mean Scenario from GREET 1 2014's HDV Module
CNG (North American - Shale)	Compressed natural gas extracted from shale in North America by fracking.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
CNG Conventional North American	Compressed natural gas extracted in North America using conventional extraction.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
CNG Conventional North American (Low-Leakage Scenario)	Min scenario (Methane emissions GREET mean reduced 45 percent per national 2025 goal).	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013) and EDF Leakage Scenario Modeling, Mean Scenario from GREET 1 2014's HDV Module
CNG (Renewable Natural Gas - Landfill)	Compressed natural gas sourced from landfill methane.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)

High Flare	Nigeria Obagi.	Carnegie Endowment for International Peace; OCI Author Calculations: Deborah Gordon, Adam Brandt, Joule Bererson, and Jonathan Koomey; March 2015
Renewable Diesel - Waste Oil	Conversion of tallow to renewable diesel using higher energy use for rendering.	California Air Resources - Low Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Renewable Diesel - Palm	Malaysia or Indonesia. Hydrotreating. LPG/propane (co-product) energy. Jet fuel, naptha, LPG co-products.	U.S. Environmental Protection Agency, Federal Register / Vol. 77, No. 18 / Friday, January 27, 2012 / Notices
Extra Heavy	Venezuela Hamaca.	Carnegie Endowment for International Peace; OCI Author Calculations: Deborah Gordon, Adam Brandt, Joule Bererson, and Jonathan Koomey; March 2015
Oil Sands and Traditional Heavy	Canada Suncor Synthetic A (SCO).	Carnegie Endowment for International Peace; OCI Author Calculations: Deborah Gordon, Adam Brandt, Joule Bererson, and Jonathan Koomey; March 2015
U.S. Average Low-Sulfur Diesel	North American Average.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
Blend of US Average Low Sulfur Diesel and Soy Biodiesel (B5)	Blend of 95 Percent U.S. Average Low-Sulfur Diesel and 5 percent Soy Biodiesel.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013); and California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Blend of U.S. Average Low-Sulfur Diesel and Soy Biodiesel (B20)	Blend of 80 Percent U.S. Average Low-Sulfur Diesel and 20 Percent Soy Biodiesel - ASTM D7467.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013); and California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Renewable Diesel - Soy	Conversion of Midwest soybeans to renewable diesel.	California Air Resources – Low-Carbon Fuel Standard, LCSF Lookup Tables as of December 2012
Hydraulic Fracturing Oils	Canada Midale.	Carnegie Endowment for International Peace; OCI Author Calculations: Deborah Gordon, Adam Brandt, Joule Bererson, and Jonathan Koomey; March 2015

Light	U.S. Gulf Thunder Horse.	Carnegie Endowment for International Peace; OCI Author Calculations: Deborah Gordon, Adam Brandt, Joule Bererson, and Jonathan Koomey; March 2015
LNG Conventional North American (High Leakage Scenario)	Max scenario (Methane Emissions 1.5x GREET mean to reflect scientific study).	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013) and EDF Leakage Scenario Modeling, Mean Scenario from GREET 1 2014's HDV Module
LNG (Non-North American)	Liquified natural gas extracted from sources outside North America.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
LNG (North American Shale)	Liquified natural gas from North American shale extracted by fracking.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
LNG Conventional North American	Liquified natural gas extracted in North America by conventional techniques.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)
LNG Conventional North American (Low-Leakage Scenario)	Min scenario (Methane emissions GREET mean reduced 45 percent per national 2025 goal).	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013) and EDF Leakage Scenario Modeling, Mean Scenario from GREET 1 2014's HDV Module
LNG (Renewable Natural Gas - Landfill)	Liquified natural gas sourced from landfill methane.	AFLEET MODELING, 1. GREET1_2013 Output (10/24/2013)

References

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5. Schuchard, Ryan; Springer, Nathan. 2015. “Future of Fuels Sustainability Briefs.” BSR.

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