



**Session #13: Sustainable Fleet Analytical
Tools & Information for Fleet Decisions**

November 10, 2020



<https://www.sustainablefleetexpo.com/>

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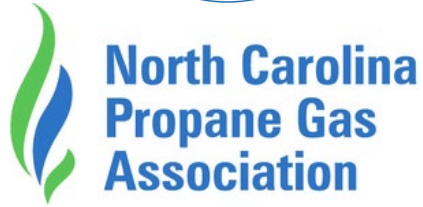
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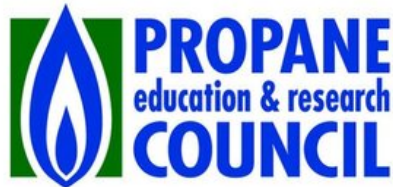
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Next Series Dates & Topics:

November 18: Potential Impacts of Connectivity/Automation Technology

December 02: Idle Reduction an Easy Win

December 09: Green Garage Contest Winners Strategies, Tools and Best Practices

December 16: Change Management to Remove Resistance & Roadblocks

Format

- Q&A at the end
- Submit questions and comments to “Panelists”
- Scheduled for 2:00p-3:30p
- Handout
- Recording



Rick Sapienza

resapienza@ncsu.edu

Phone: 919-515-2788

- **Clean Transportation Program Director NC Clean Energy Technology Center at NC State University**
- **8 years with NC State**
- **30+ years experience including General Motors, Draper Lab and Great Lakes Pulp & Fibre in both engineering and business management roles**



**Sustainable Fleet Analytical
Tools & Information for Fleet Decisions
November 10, 2020**

2:00-2:05 Rick Sapienza, NCCETC--Welcome & Introduction

2:05-2:15 Carina Soriano, Centralina Clean Fuels Coalition—Clean Cities & Overview

2:15-2:30 Stacy Davis, ORNL National Transportation Research Center—FuelEconomy.gov

2:30-2:45 Patricia Weikersheimer, Argonne National Laboratory—IdleBox Tool

2:45-3:05 Andrew Burnham, Argonne National Laboratory—AFLEET Tool

3:05-3:30 Q&A





Carina Soriano
csoriano@centralina.org
704.688.7035

- Clean Cities Co-Coordinator and Planner for Centralina Clean Fuels Coalition/Centralina Council of Governments
- Supports the goal of the Clean Cities program to advance the nation's economic, environmental, and energy security efforts to reduce petroleum consumption in transportation
- Experience includes the Regional Transit Engagement Series, the Regional Freight Mobility Plan, Centralina Clean Fuels Coalition, Planners4Health, Planning and Zoning Administrator for the Town of Marshville, NC
- Bachelor's of International Studies and Master's of Public Administration from UNC Charlotte



Clean Cities Program Overview

Carina Soriano

Co-Coordinator, Centralina Clean Fuels Coalition

Centralina Regional Council



CLEAN CITIES COALITION NETWORK

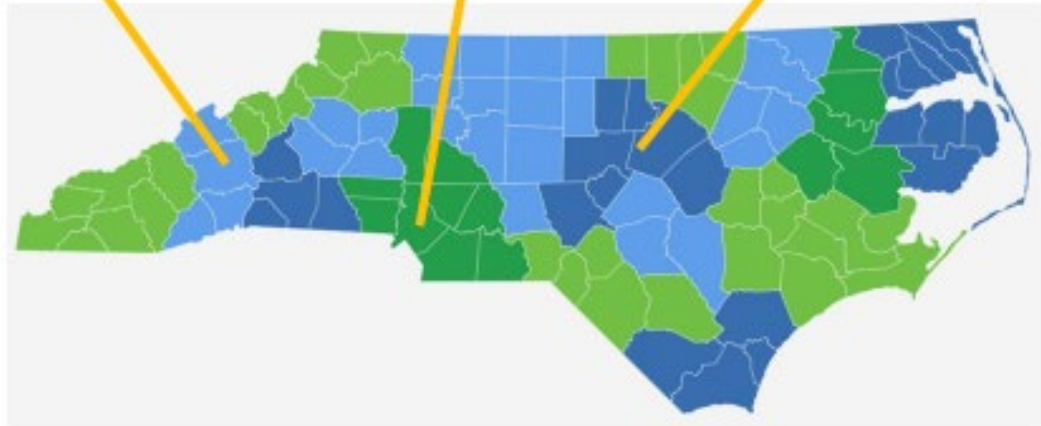


What is Clean Cities?

- National network of nearly **100 local Clean Cities coalitions** with thousands of stakeholders
- More than **80% of the U.S. population** lives within coalition boundaries
- Nearly **500,000 AFVs on the road**



NC's Clean Cities Coalitions



Centralina Clean Fuels Coalition

Fleets:

- Private companies
- Federal, state, and municipal
- School districts, universities
- Airports, transit agencies
- Taxi companies, ride share services.

Product and Service Providers:

- Vehicle and engine manufacturing
- Conversion companies
- Vehicle dealerships
- Fueling equipment suppliers, installers, and providers.

Others:

- Environmental and energy agencies
- Alternative fuel and clean air advocacy organizations
- General public.



Dominion Energy



NC CLEAN ENERGY
TECHNOLOGY CENTER



DUKE ENERGY



THE LION ELECTRIC CO.



advanced energy

Coalition Strategies



Light-, Medium-,
and Heavy-Duty
Vehicles



New Mobility
Choices and
Emerging
Transportation
Technologies

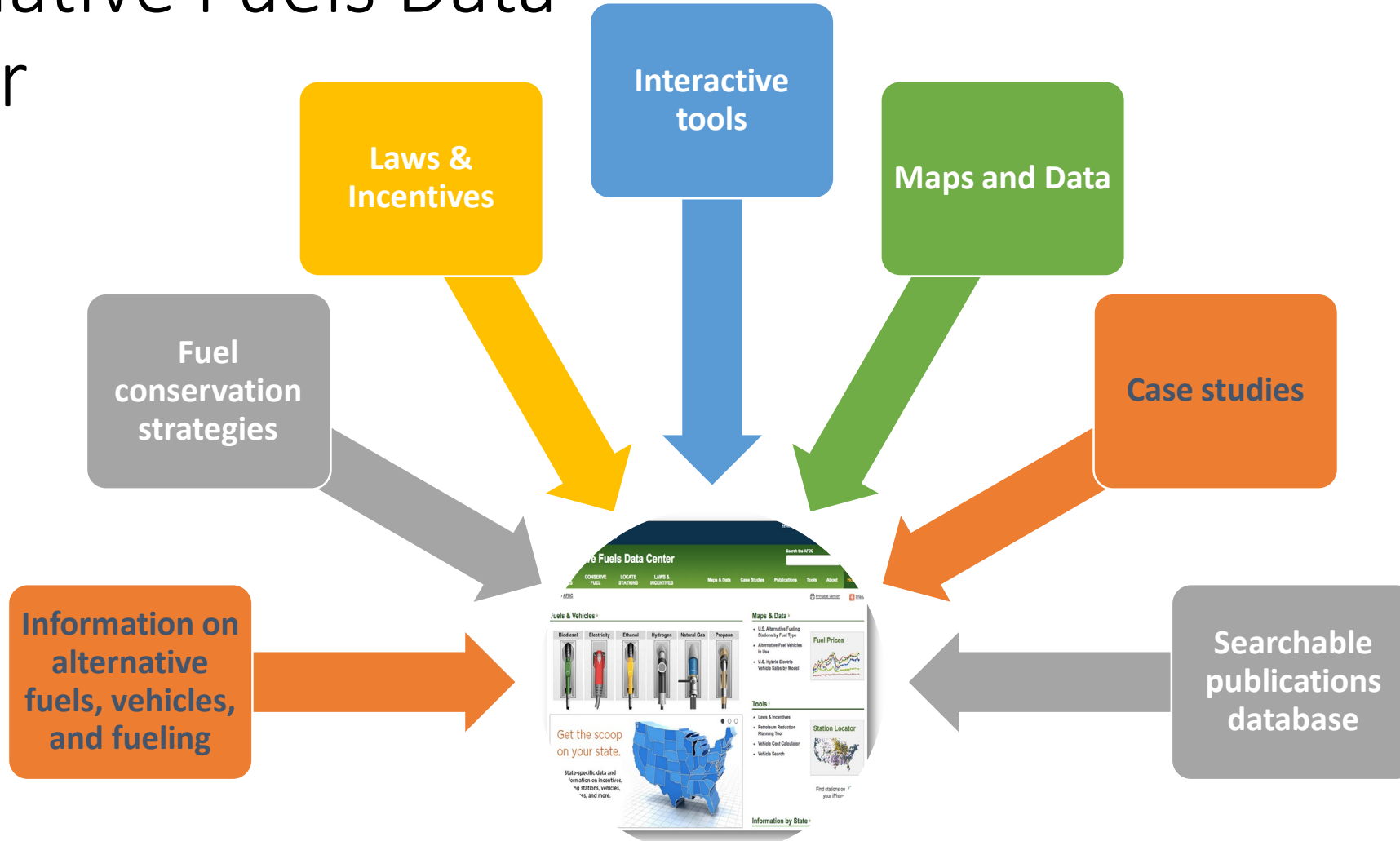


Idle Reduction
Measures and
Fuel Economy
Improvements



Alternative and
Renewable Fuels
and Infrastructure

Alternative Fuels Data Center



Resources

The screenshot shows the homepage of the Alternative Fuels Data Center (AFDC). The header includes the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy". The main title is "Alternative Fuels Data Center". Below the title are navigation tabs: "FUELS & VEHICLES", "CONSERVE FUEL", "LOCATE STATIONS", "LAWS & INCENTIVES", "Maps & Data", "Case Studies", and "Publications". A search bar is located on the right. The main content area is divided into sections: "Fuels & Vehicles" with icons for Biodiesel, Electricity, Ethanol, Hydrogen, Natural Gas, and Propane; "Information by State" with a map of the United States; "Information by Fleet" with icons for Delivery Services and Public Transit; "Maps & Data" with a list of links; and "Tools" with a list of links. A prominent banner asks "Ready for Electric Vehicles?" and provides a link to estimate charging needs. At the bottom, it states "The Information Source for Alternative Fuels and Advanced Vehicles" and describes the AFDC's mission.

afdc.energy.gov

The screenshot shows the homepage of fueleconomy.gov. The header includes the U.S. Department of Energy logo, "Office of ENERGY EFFICIENCY & RENEWABLE ENERGY", and the EPA logo. The main title is "www.fueleconomy.gov" with the subtitle "the official U.S. government source for fuel economy information". Navigation tabs include "Find a Car", "Save Money & Fuel", "Benefits", "My MPG", "Advanced Cars & Fuels", "About EPA Ratings", and "More". A search bar is on the right. The main content area features a large banner for "2020 Fuel Economy Estimates Now Available!" which includes plug-in hybrid and electric vehicles. Below the banner are four columns of featured content: "Find & Compare Cars" (Compare Side-by-Side, Power Search, Find-a-Car App), "My MPG" (Calculate or Share Your MPG, Estimates from Drivers Like You, Enter Your MPG at the Pump), "Save Money" (Gas Mileage Tips, Fuel Cost Calculator, Find the Cheapest Gas), and "Hybrids & Electrics" (Hybrids, Plug-in Hybrids, All-Electric Vehicles). At the bottom, there are sections for "Calculators and Other Tools", "New on fueleconomy.gov...", "Quick Picks", and "Related Links".

fueleconomy.gov

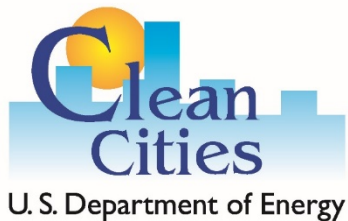


U. S. Department of Energy

Want to Connect?

Please visit <https://cleancities.energy.gov/> to find your local coalition or contact

Carina Soriano, Co-Coordinator at csoriano@centralina.org





Stacy Davis
davissc@ornl.gov
865-341-1256

- Research staff member of the Transportation Analytics and Decision Sciences Group at Oak Ridge National Laboratory's National Transportation Research Center
- More than 30 years experience working with transportation energy data
- Manages Fuel Economy Information (FEI) Project for the US DOE & EPA, prepares and updates the annual Fuel Economy Guide and the website fueleconomy.gov
- Lead author of the Transportation Energy Data Book and prepares the DOE Vehicle Technologies Office's Transportation Fact of the Week
- Transportation Research Board's Committee on Transportation Energy and the Committee on Alternative Transportation Fuels and Technologies
- Bachelor of Science in Transportation and Logistics from the University of Tennessee

Fueleconomy.gov

U.S. DEPARTMENT OF
ENERGY

Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY



United States
Environmental Protection
Agency

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

November 10, 2020

Stacy C. Davis

Current Team Members

Gina Accawi

Stacy Davis

Janet Hopson Jackie Richardson

Debbie Bain

Colby Earles

Shean Huff Scott Sluder

Robert Boundy

Robert Gibson

Jia (Lisa) Li John Thomas

Kita Cranfill

Kerry Hake

Karen Nolen W. T. Wilson

The Fuel Economy Information Program at ORNL

- ORNL has managed the DOE Fuel Economy Information Program since 1999. Our primary products:

- Annual Fuel Economy Guide (required by statute)
- Fueleconomy.gov website
- Fuel economy research

FUEL ECONOMY GUIDE 2020

www.fueleconomy.gov
the official U.S. government source for fuel economy information

2020 Fuel Economy Estimates Now Available!
Includes plug-in hybrid and electric vehicles
Fuel economy leaders for each vehicle class
More vehicles added weekly

Fuel Economy and Emissions Effects of Low Tire Pressure, Open Windows, Roof Top and Hitch-Mounted Cargo, and Trailer
John Thomas, Shean Huff, and Brian West
Oak Ridge National Laboratory

ABSTRACT
To quantify the fuel economy (FE) effect of some common vehicle accessories or alterations, a compact passenger sedan and a sport utility vehicle (SUV) were instrumented to SAE J2263 (constant) procedures. Configurations were simulated with low tire pressure, all windows open, with a roof top or hitch-mounted cargo carrier, and with the SUV pulling a 3000 pound enclosed cargo trailer. From these configurations, vehicle dynamometer coefficients were developed which simulated the execution of vehicle dynamometer experiments to determine the effect of these changes on vehicle FE and emissions over standard drive cycles and at steady highway speeds. In addition, test vehicles were subjected to duplicate vehicles to examine the similarity in derived coefficients for test duplicate vehicles of the same make.

CITATION: Thomas, J., Huff, S., and West, B. "Fuel Economy and Emissions Effects of Low Tire Pressure, Open Windows, Roof Top and Hitch-Mounted Cargo, and Trailer." SAE Int. J. Passenger Cars - Mech. Syst. 7(2):2014, doi:10.4271/2014-01-1914.

INTRODUCTION
The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy and the U.S. Environmental Protection Agency (EPA) jointly maintain a fuel economy website www.fueleconomy.gov that helps fulfill their responsibility under the Energy Policy Act of 1992 to provide accurate FE information to consumers. The site provides EPA, FE ratings for passenger cars and light trucks from 1984 to the present, information on alternative fuels, timing and vehicle maintenance tips, and other relevant information related to vehicle energy use. Additionally, the site provides consumer information and advice pertaining to methods for improving real world FE. Under the auspices of this program, the Oak Ridge National Laboratory (ORNL), Fuels, Engines, and Emissions Research Center (FEEEC) continues to update and improve this information. This paper documents a study aimed specifically at the effects of common vehicle use alterations or modifications such as trailer towing, use of rooftop cargo boxes versus hitch-mounted cargo trays, low tire pressure, and open windows. Previous studies have detailed the impact of make air filters, highway cruise speed, and air conditioning on fuel economy of light-duty vehicles [1, 2, 3, 5].

A vehicle's published EPA FE rating is determined by driving the vehicle over prescribed cycles on a chassis dynamometer. City FE is measured using the Federal Test Procedure (FTP), highway FE is measured using the Highway Fuel Economy Test (HFT). Additional tests such as the US06, SC03, and real world (RW) tests are conducted as part of certification to confirm emissions compliance during aggressive driving at very low conditions with air conditioning, and at very old temperatures, respectively. Typically FE results from these tests are not reported but EPA uses results from these tests to adjust the FTP and HFT results [2], and these adjusted FE rates are reported in the Fuel Economy Guide [3], and on the fueleconomy.gov website. Specific modifications to these tests are generally at least weight plus 300 pounds, with proper tire pressure, window up, and an conditioner of average for the SC03(C) vehicles are subjected to the SAE Standard J2263 (constant) procedure to develop target vehicle dynamometer coefficients to enable the laboratory vehicle experiments to mimic the on-road conditions [3]. Changes to the vehicle rolling resistance or aerodynamic drag can result from changes in tire design, wear

- Just over 20 million user sessions for Model Year 2020.
- Low fuel prices and COVID19 have impacted this year's traffic.

Useful Fueleconomy.gov Tools

- Find and Compare Cars
 - Power Search
 - Smartway Vehicle Search
- Trip Calculator
- Fuel Savings Calculator
- Beyond Tailpipe Calculator
- My MPG
- My Plug-in Hybrid Calculator
- Can a Hybrid Save Me Money?
- Fuel Economy vs. Highway Speed
- Developer Tools
 - Find a Car and Tips Widgets
 - Web Service Data

The screenshot shows the homepage of fueleconomy.gov. At the top, it features the U.S. Department of Energy and EPA logos. The main navigation bar includes links for Mobile, Español, Site Map, Links, FAQ, and Videos. Below this is a search bar and a secondary navigation menu with options like 'Find a Car', 'Save Money & Fuel', 'Benefits', 'My MPG', 'Advanced Cars & Fuels', 'About EPA Ratings', and 'More'. The central banner highlights the '2020-21 Fuel Economy Estimates Now Available!' and lists features like 'Includes plug-in hybrid and electric vehicles' and 'Fuel economy leaders for each vehicle class'. Below the banner are four main sections: 'Find & Compare Cars' (with sub-links for Compare Side-by-Side, Power Search, and Find-a-Car App), 'My MPG' (with sub-links for Calculate or Share Your MPG, Estimates from Drivers Like You, and Enter Your MPG at the Pump), 'Save Money' (with sub-links for Gas Mileage Tips, Fuel Cost Calculator, and Find the Cheapest Gas), and 'Hybrids & Electrics' (with sub-links for Hybrids, Plug-in Hybrids, and All-Electric Vehicles). At the bottom, there are sections for 'Calculators and Other Tools', 'New on fueleconomy.gov...', 'Quick Picks', and 'Related Links'. A footer contains contact information and a note that the site was last modified on Friday, July 10, 2020.

Finding Find a Car Searches

Click on "Find a Car" top menu

Power Search

Find a Smartway Vehicle

The screenshot shows the homepage of www.fueleconomy.gov, the official U.S. government source for fuel economy information. The page is organized into several sections:

- Navigation:** A top menu includes "Find a Car", "Save Money & Fuel", "Benefits", "My MPG", "Advanced Cars & Fuels", "About EPA Ratings", and "More".
- Searches:** A sidebar menu lists options such as "Find a Car - Home", "Compare Side by Side", "Power Search", "Search by Make", "Hybrids, Diesels, and Alternative Fuel Cars", "Find a SmartWay Vehicle", "Best and Worst Vehicles", "Fueleconomy.gov Top Ten", and "Today's Most Viewed Vehicles".
- Fuel Economy Guides:** Includes "Print the Guide" and "Help Promote Fuel Economy".
- Calculators and Other Tools:** Lists tools like "Fuel Savings Calculator", "Trip Calculator", "Can a Hybrid Save Me Money?", "My Plug-in Hybrid Calculator", "Used Car Label Tool", "Developer Tools", and "Find a Car Widget".
- New on fueleconomy.gov...:** Features recent updates like "2020-21 Fuel Economy Guide", "2020-21 Fuel Economy Data", "2020 Best and Worst Fuel Economy", "2020 Top Ten Vehicle Lists", and "Compare Old vs. New MPG for 1984-2016 Vehicles".
- Quick Picks:** Highlights "Find a Car App for Apple and Android", "Top 10 - Most Efficient Vehicles, Myths and More", "Compare Old vs. New EPA MPG", "Find a SmartWay Vehicle", "Extreme MPG", and "Motorweek Videos".
- Related Links:** Provides links to "VW, Bentley, Audi and Porsche MPG Estimates Revised", "Clean Cities", "Alternative Fuels Data Center", "Vehicle Cost Calculator", "Station Locator", and "EV Explorer".
- Advertisements:** Promotes a mobile app with the text "mobile app puts other car-buying fingertips!" and "Download on the App Store".
- Featured Content:** Includes a "Find a Car - Home" section with a photo of a couple and the text "Find a fuel efficient vehicle that meets your needs", and a "Used Car Label" for a 2011 Ford Fusion Hybrid FWD showing fuel economy ratings of 26, 39, and 41 MPG.

Power Search

<https://fueleconomy.gov/feg/powerSearch.jsp>

U.S. DEPARTMENT OF ENERGY Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

EPA United States Environmental Protection Agency

www.fueleconomy.gov
the official U.S. government source for fuel economy information

Mobile Español Site Map Links FAQ Videos

Find a Car Save Money & Fuel Benefits My MPG Advanced Cars & Fuels About EPA Ratings More Q

Power Search

Expand any feature by selecting its title. Choose as many or as few features as you like.

Model Year
From: 2020 To: 2021

Make

Market Class

MSRP

Fuel Economy

Transmission

Drive

Engine Technology

Cylinders

Fuel Type

Vehicle Type

- Supercharger
- Exclude Supercharger
- Start-Stop
- Exclude Start-Stop
- Turbocharger
- Exclude Turbocharger
- Cylinder Deactivation

- Conventional Gasoline
- Diesel
- Flex-Fuel (E85)
- Hybrid ?
- Plug-in Hybrid ?
- All Electric ?
- Dedicated CNG
- Bifuel CNG
- Bifuel LPG

Example of Results of Power Search

Search Results

Sorting is based on EPA Combined City/Hwy MPG. ⓘ

Sort ▾ Personalize View 10 ▾ |< < Page 1 > >|

MPG Energy & Environment Costs

Vehicle	EPA Fuel Economy ↓	Driver MPG	Annual Fuel Cost
<input checked="" type="checkbox"/> 2021 Hyundai Elantra 2.0 L, 4 cyl, Automatic (AV-S1), Regular Gasoline	37 MPG combined city hwy 2.7 gal/100 mi	NA	\$850
<input checked="" type="checkbox"/> 2020 Volkswagen Jetta 1.4 L, 4 cyl, Automatic (S8), Turbo, Regular Gasoline	34 MPG combined city hwy 2.9 gal/100 mi	NA	\$950
<input checked="" type="checkbox"/> 2021 Honda Accord 1.5 L, 4 cyl, Automatic (variable gear ratios), Turbo, Regular Gasoline	33 MPG combined city hwy 3 gal/100 mi	NA	\$950
<input checked="" type="checkbox"/> 2021 Volkswagen Jetta 1.4 L, 4 cyl, Automatic (S8), Turbo, Regular Gasoline	33 MPG combined city hwy 3 gal/100 mi	NA	\$950

My Selections

Years: 2020-2021
Start-Stop
Vehicle Type: Gasoline
(Showing 1 to 10 of 946 vehicles)

[Modify](#)

You are here: [Find a Car Home](#) > [Power Search](#) > Compare Side-by-Side

[Share](#)

Compare Side-by-Side

Fuel Economy Energy and Environment Safety Specs

	2021 Hyundai Elantra	2020 Volkswagen Jetta	2021 Honda Accord	2021 Volkswagen Jetta
Personalize				
Edit Vehicles				
	2.0 L, 4 cyl, Automatic (AV-S1)	1.4 L, 4 cyl, Automatic (S8), Turbo MSRP: \$18,895 - \$27,945	1.5 L, 4 cyl, Automatic (variable gear ratios), Turbo	1.4 L, 4 cyl, Automatic (S8), Turbo
EPA Fuel Economy	Regular Gasoline 37 MPG combined city highway 2.7 gal/100mi	Regular Gasoline 34 MPG combined city highway 2.9 gal/100mi	Regular Gasoline 33 MPG combined city highway 3.0 gal/100mi	Regular Gasoline 33 MPG combined city highway 3.0 gal/100mi
		 449 miles Total Range		
Unofficial MPG Estimates from Vehicle Owners	User MPG estimates are not yet available for this vehicle	User MPG estimates are not yet available for this vehicle	User MPG estimates are not yet available for this vehicle	User MPG estimates are not yet available for this vehicle
You save or spend*	You SAVE \$1,750 in fuel costs over 5 years compared to the average new vehicle	You SAVE \$1,250 in fuel costs over 5 years compared to the average new vehicle	You SAVE \$1,250 in fuel costs over 5 years compared to the average new vehicle	You SAVE \$1,250 in fuel costs over 5 years compared to the average new vehicle
Annual Fuel Cost*	\$850	\$950	\$950	\$950
Cost to Drive 25 Miles	\$1.45	\$1.57	\$1.62	\$1.62
Cost to Fill the Tank		\$28		
Tank Size		13.2 gallons		

*Based on 45% highway, 55% city driving, 15,000 annual miles and current fuel prices. [Personalize](#).
MSRP and tank size data provided by Edmunds.com, Inc.
Range on a tank and refueling costs assume 100% of fuel in tank will be used before refueling.

Find a Smartway Vehicle

Find a SmartWay Vehicle

Looking for an environmentally friendly vehicle?

Cars and trucks awarded EPA's SmartWay certification emit less greenhouse gas (GHG) and smog-forming tailpipe emissions than other vehicles.



Tell me more...

Step 1. Select State of purchase.

North Carolina Required

Step 2. Choose as many or as few features as you like.

Model Year

From: To:

Make

Miles Per Gallon

Market Class

Fuel Type

Vehicle Type

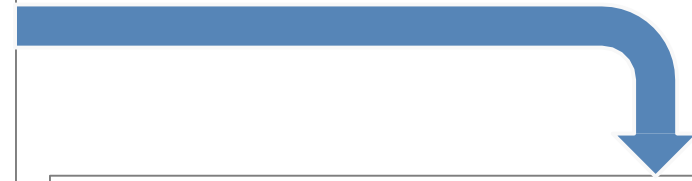
Drive

My Selections

Years: 2020 - 2021

RELATED TOPICS...

[EPA's SmartWay Page](#)
[EPA Climate Change Information](#)



Find a SmartWay Vehicle



View 10

Vehicle	EPA Fuel Economy	Greenhouse Gas Score <input type="button" value="i"/>	Smog Score <input type="button" value="i"/>	Elite <input type="button" value="i"/>
2020 Audi e-tron Sportback Automatic (A1), Electricity				
	Electricity 77 MPGe 76 city 78 hwy combined city/hwy	10 0 grams per mile	10 Federal Tier 3 Bin 0 LVGAT00.0AZE	<input checked="" type="checkbox"/>
2020 Audi Q5 2.0 L, 4 cyl, Automatic (AM-S7), Turbo, Gas and Electricity				
	Gas & Electric 65 MPGe combined city/hwy	10 165 grams per mile	7 Federal Tier 3 Bin 30 LVGAJ02.0A3P	<input checked="" type="checkbox"/>
	Prem. Gas 27 MPG combined city/hwy			
2020 BMW 530e 2.0 L, 4 cyl, Automatic (S8), Turbo, Gas and Electricity				
	Gas & Electric 69 MPGe combined city/hwy	10 170 grams per mile	7 Federal Tier 3 Bin 30 LBMXJ02.0H30	<input checked="" type="checkbox"/>
	Prem. Gas 27 MPG combined city/hwy			
2020 BMW 530e xDrive 2.0 L, 4 cyl, Automatic (S8), Turbo, Gas and Electricity				
	Gas & Electric 65 MPGe combined city/hwy	10 193 grams per mile	7 Federal Tier 3 Bin 30 LBMXJ02.0H30	<input checked="" type="checkbox"/>
	Prem. Gas 25 MPG combined city/hwy			

Your Selections

State: North Carolina
 Year: 2020
 You selected 199 vehicles

RELATED TOPICS...

[EPA's SmartWay Page](#)
[EPA Climate Change Information](#)

<https://fueleconomy.gov/feg/SmartWay.do>

Find Trip Calculator and Fuel Savings Calculator

The screenshot shows the homepage of fueleconomy.gov. At the top, it features the U.S. Department of Energy and EPA logos, along with navigation links for Mobile, Español, Site Map, Links, FAQ, and Videos. Below the header is a search bar and a main navigation menu with categories like 'Find a Car', 'Save Money & Fuel', 'Benefits', 'My MPG', 'Advanced Cars & Fuels', 'About EPA Ratings', and 'More'. The main content area has a large banner for '2020-21 Fuel Economy Estimates Now Available!' with sub-points: 'Includes plug-in hybrid and electric vehicles', 'Fuel economy leaders for each vehicle class', and 'More vehicles added weekly'. Below the banner are four columns of featured content: 'Find & Compare Cars', 'My MPG', 'Save Money', and 'Hybrids & Electrics'. At the bottom, there are four sections: 'Calculators and Other Tools', 'New on fueleconomy.gov...', 'Quick Picks', and 'Related Links'. A red arrow on the left side of the page points to the 'Calculators and Other Tools' section.

Calculators and Other Tools

- Fuel Savings Calculator
- Trip Calculator
- Can a Hybrid Save Me Money?
- My Plug-in Hybrid Calculator
- Used Car Label Tool
- Developer Tools
- Find a Car Widget

<https://fueleconomy.gov/trip/>

<https://fueleconomy.gov/feg/savemoney.jsp>

Trip Calculator

Fueleconomy.gov's interactive trip calculator uses fueleconomy.gov data and Google maps to help you plan your route, pick your car, and estimate your fuel cost for the trip.

- By default the tool uses EPA fuel economy estimates and EIA fuel prices, but these values can be personalized
- Mobile Friendly
- Users can compare fuel costs for any number of vehicles
- Supports all-electric vehicles (but not PHEVs yet)

In FY2019, users used the tool to estimate fuel costs for over 1 million trips!

The screenshot displays the fueleconomy.gov Trip Calculator interface. At the top, it features the website's logo and navigation links. The main section is titled "Trip Calculator" and includes a "Trip Vehicles" section where two vehicles are selected: a 2017 Toyota Prius (1.8 L, 4 cyl, Automatic) with a trip fuel cost of \$20.77, and a 2017 Ford F150 (2.7L 2WD GVWR>6649 LBS, 2.7 L, 6 cyl, Automatic) with a trip fuel cost of \$47.49. Below this is the "Trip Plan" section, showing the route from Knoxville, Tennessee to Washington, DC, with a 25% city driving setting. A "Calculate the Trip" button is visible. The "Directions and Map" section shows a list of 16 directions from Knoxville, TN to Washington, DC, and a map of the route. The map shows the route starting in Knoxville, TN, heading northwest on Henley St, merging onto I-40 E, taking exit 421 for I-81 N, continuing onto I-81 N, taking exit 300 for I-66 E, continuing onto I-66 E, taking the exit for I-495 N, continuing onto E St Expy, continuing onto E St NW, turning left onto 18th St NW, turning right onto H St NW, turning left onto Connecticut Ave NW, continuing onto 17th St NW, turning right onto Massachusetts Ave NW, and finally entering Scott Cir NW in Washington, DC.

Fuel Savings Calculator

Fueleconomy.gov's fuel savings calculator uses fueleconomy.gov data to help compare costs when buying a vehicle.

- Can personalize fuel prices and driving habits
- Can add purchase costs or lease costs
- Supports plug-in hybrids and all-electric vehicles


Save Money

Improved fuel economy saves you money every time you fill up!
A vehicle that gets 30 MPG will cost you \$535 less to fuel each year than one that gets 20 MPG (assuming 15,000 miles of driving annually and a fuel cost of \$2.14). Over a period of 5 years, the 30-MPG vehicle will save you \$2,675.

Calculate Fuel Costs and Savings

Vehicle A

Gasoline Vehicle




2020 Buick Regal AWD
3.6 L, 6 cyl, Automatic

Regular Gasoline

22 MPG
comb 19 27
city hwy

Vehicle B

Gasoline Vehicle



2021 Chevrolet Equinox AWD
1.5 L, 4 cyl, Automatic, Turbo

Regular Gasoline

27 MPG
comb 25 30
city hwy


Personalize Fuel Prices and Drive Habits

Fuel Costs

	Vehicle A	Vehicle B	Veh. B Saves
10 Years	\$14,590	\$11,890	\$2,700
Yearly	\$1,459	\$1,189	\$270
Monthly	\$122	\$99	\$23
Weekly	\$28	\$23	\$5
Per Mile	9.7¢	7.9¢	1.8¢

10 Years **Yearly** Monthly Weekly Per Mile

Costs

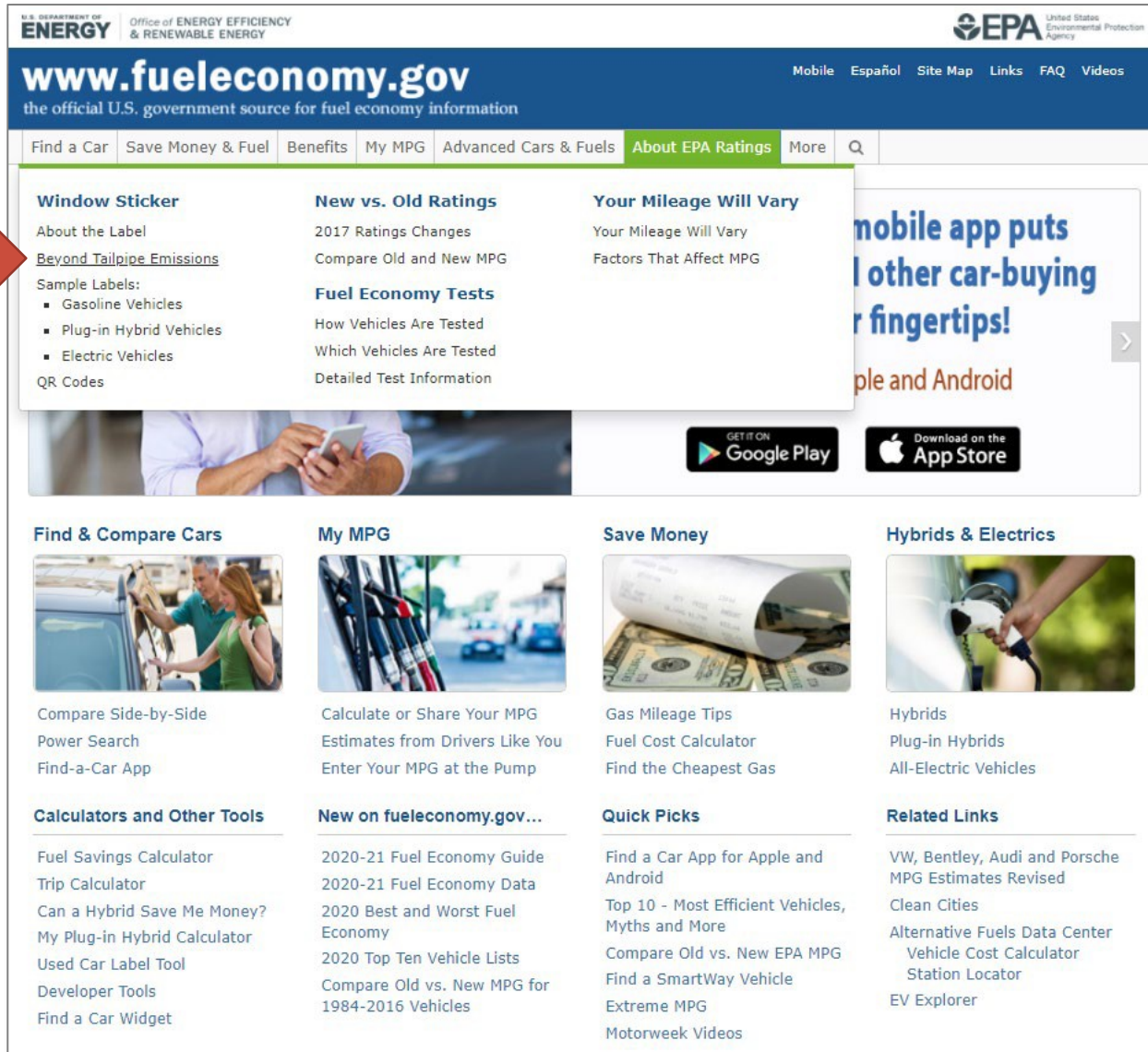


Dollars

Vehicle A Vehicle B Vehicle B Saves

Add Purchase Costs **Add Lease Costs**

Finding Beyond Tailpipe Calculator



The screenshot shows the fueleconomy.gov website. A red arrow points to the 'Beyond Tailpipe Emissions' link under the 'Window Sticker' section. The website header includes the U.S. Department of Energy and EPA logos, the URL 'www.fueleconomy.gov', and navigation links like 'Mobile', 'Español', 'Site Map', 'Links', 'FAQ', and 'Videos'. The main navigation bar has 'About EPA Ratings' highlighted. Below the navigation, there are sections for 'Window Sticker', 'New vs. Old Ratings', 'Your Mileage Will Vary', and a mobile app promotion. The 'Window Sticker' section lists 'Beyond Tailpipe Emissions', 'Sample Labels' (Gasoline, Plug-in Hybrid, Electric), and 'QR Codes'. The 'New vs. Old Ratings' section lists '2017 Ratings Changes', 'Compare Old and New MPG', 'Fuel Economy Tests', and 'Detailed Test Information'. The 'Your Mileage Will Vary' section lists 'Your Mileage Will Vary' and 'Factors That Affect MPG'. Below these are 'Find & Compare Cars', 'My MPG', 'Save Money', and 'Hybrids & Electrics' sections, each with a representative image and a list of tools or links. At the bottom, there are 'Calculators and Other Tools', 'New on fueleconomy.gov...', 'Quick Picks', and 'Related Links' sections.

<https://fueleconomy.gov/feg/Find.do?action=bt2>


Beyond Tailpipe Calculator

- Inputs are:
 - model year,
 - make & model, and
 - zip code.
- Calculator gives an estimate of:
 - upstream greenhouse gas emissions for all-electric vehicles,
 - upstream and tailpipe greenhouse gas emissions for plug-in hybrid vehicles.

Greenhouse Gas Emissions from Electric and Plug-In Hybrid Vehicles

Beyond Tailpipe Emissions Calculator

Use this calculator to estimate the total greenhouse gas (GHG) emissions associated with driving an electric vehicle (EV) or plug-in hybrid electric vehicle (PHEV), including GHG emissions from the production of electricity used to power the vehicle. Enter your ZIP Code, model year, and vehicle to calculate the tailpipe and upstream emissions.



What are the emissions from your EV or PHEV?


Vehicle:

Your Location:*

[See your results](#)


* GHG emissions depend on how electricity is generated in your area.

What is the difference between tailpipe and upstream emissions?



Tailpipe Emissions

Vehicle tailpipe emissions are the GHGs your car produces when driving.



Upstream Emissions

Upstream emissions are the GHGs associated with the production and distribution of gasoline and electricity.

Why does my ZIP Code matter?

GHG emissions vary by region, based on how the electricity is produced. For example, electricity produced from coal will result in higher GHG emissions than electricity produced from renewable sources like wind. While there may be some regional variability in upstream gasoline emissions due to factors such as differences in the distance gasoline must be transported from refineries or the source of crude oil, total CO₂ emissions for a gasoline vehicle are dominated by emissions at the tailpipe. Tailpipe emissions do not vary significantly by region.

[Learn more about electricity production in your ZIP Code.](#)

Beyond Tailpipe Results

Greenhouse Gas Emissions from Electric and Plug-In Hybrid Vehicles – Results


Beyond Tailpipe Emissions Calculator

Vehicle:
 2018
 Vehicle

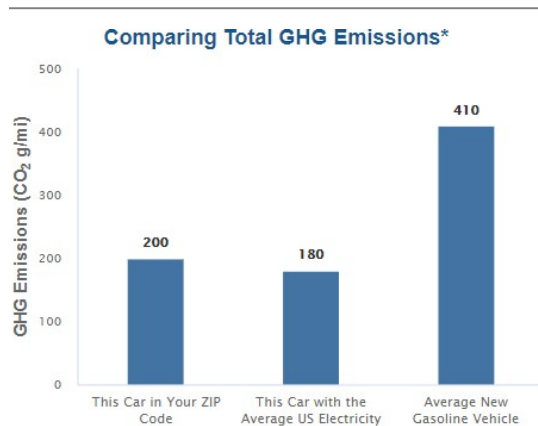
Your Location:
 37771 (Lenoir City, TN)

GHG emissions depend on how electricity is generated in your area.

Select vehicle



The Honda Clarity Plug-in Hybrid is a plug-in hybrid.



200 g/mi This Car's Total Emissions in your ZIP Code (Tailpipe + Upstream)	180 g/mi This Car's Total Emissions with the Average US Electricity Mix	410 g/mi Average New Gasoline Vehicle's Total Emissions
--	---	---

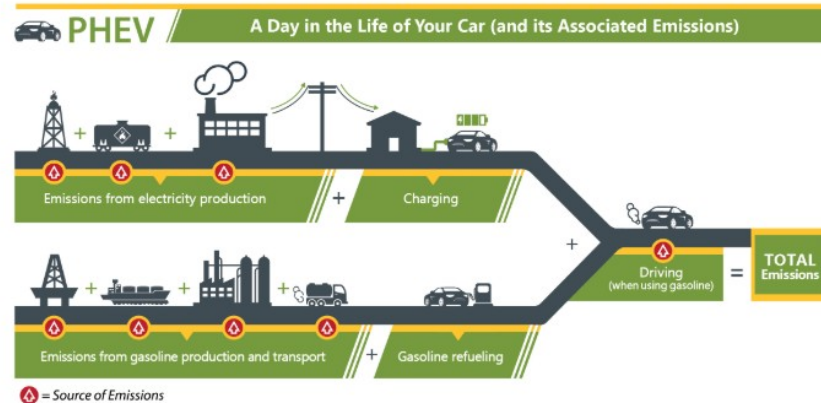
About these calculations

Tailpipe emissions for this vehicle are 57 g/mile.

Total emissions include both tailpipe and upstream emissions. The total emissions rate is affected by a vehicle's efficiency (MPG and/or MPGe), the fuel or fuels used to power the vehicle (electricity and/or gasoline), and how that fuel is produced and distributed. This car's emissions in your ZIP Code may be different than the average in the US because different fuel sources are used to produce electricity in different parts of the country. [Learn more below!](#)

How much of my car is powered by electricity vs. gasoline?

These estimates assume that 73.1% of this vehicle's operation is powered by electricity and the rest is powered by gasoline. This assumption is based on the vehicle's design and average driving habits.



What is the difference between tailpipe and upstream emissions? ▶

Why does my ZIP Code matter? ▶

* Our estimates only consider carbon dioxide (CO₂) emissions, which account for 95% to 99% of the total greenhouse gas emissions from a passenger vehicle—after accounting for the global warming potential of all GHGs. [More info.](#) CO₂ is also the predominant greenhouse gas associated with electricity production. [More info.](#)

Electricity-related emissions are estimated using the most recently available data. Due to data collection and processing time, the electricity generation data can sometimes be several years old. GHG emissions associated with the electricity grid today may be lower than indicated in many regions due to a shift to less CO₂-intensive feedstocks. Plus, purchasing green power could lower your CO₂ emissions even more.

Save Money and Fuel

The screenshot shows the website's navigation bar with the URL www.fueleconomy.gov and the tagline "the official U.S. government source for fuel economy information". The main navigation menu includes "Find a Car", "Save Money & Fuel", "Benefits", "My MPG", "Advanced Cars & Fuels", "About EPA Ratings", and "More". The "Save Money & Fuel" section is highlighted, displaying a grid of links under three main categories: "Gas Mileage Tips", "Tax Incentives", and "Cost Calculators". Below this grid are four featured sections: "Find & Compare Cars", "My MPG", "Save Money", and "Hybrids & Electrics". At the bottom, there are sections for "Calculators and Other Tools", "New on fueleconomy.gov...", "Quick Picks", and "Related Links".

Gas Mileage Tips

- Driving More Efficiently
- Keeping Your Car in Shape
- Planning and Combining Trips
- Choosing a More Efficient Vehicle
- Tips for Hybrids, Plug-in Hybrids, and Electric Vehicles
- Fuel Economy in Cold Weather
- Fuel Economy in Hot Weather
- More Information

Tax Incentives

- All-Electric and Plug-in Hybrid Vehicles
- Frequently Asked Questions
- Local Prices
- Questions About Gas Prices

Cost Calculators

- Fuel Savings Calculator
- Trip Calculator
- Can a Hybrid Save Me Money?
- My Plug-in Hybrid Calculator

Electric Vehicle Federal Tax Incentives Updated as Needed

- Tax incentive data comes from the IRS website or a manufacturer providing IRS certification letter
- Includes Tesla and GM phaseout dates
- No other manufacturers have reached their phase-out stage

The screenshot shows the website www.fueleconomy.gov, which is the official U.S. government source for fuel economy information. The page is titled "Federal Tax Credits for New All-Electric and Plug-in Hybrid Vehicles" and features a "Federal Tax Credit Up To \$7,500!" banner. Below the banner, there is a text block explaining that all-electric and plug-in hybrid cars purchased new in or after 2010 may be eligible for a federal income tax credit of up to \$7,500. The credit amount varies based on the battery capacity. A small image of a car key and a \$100 bill is shown to the right. Below the text, there are filter options for "Vehicle Type" (All-Electric, Plug-in Hybrids, All) and "Manufacturer" (Chevrolet). A table below the filters lists the tax credits for Chevrolet vehicles, including the 2017-2020 Chevrolet Bolt EV, 2011-2019 Chevrolet Volt, and 2014-2016 Chevrolet Spark EV. The table shows the full credit amount and the phase-out amounts for 50% and 25% of the full credit. A red banner at the top of the table states: "General Motors vehicles purchased after 3/31/2020 are not eligible for these tax credits."

www.fueleconomy.gov
the official U.S. government source for fuel economy information

Find a Car | Save Money & Fuel | Benefits | My MPG | Advanced Cars & Fuels | About EPA Ratings | More

Federal Tax Credits for New All-Electric and Plug-in Hybrid Vehicles

Federal Tax Credit Up To \$7,500!

All-electric and plug-in hybrid cars purchased new in or after 2010 may be eligible for a federal income tax credit of up to \$7,500. The credit amount will vary based on the capacity of the battery used to power the vehicle. State and/or local incentives may also apply.


Small neighborhood electric vehicles do not qualify for this credit, but they may qualify for another credit.

Filter table by...

Vehicle Type **OR** Manufacturer

All-Electric **EV** Plug-in Hybrids **PHEV** All

Manufacturer: Chevrolet

Vehicle Make & Model	Vehicle Type	Full Credit	Phase Out	
			50%	25%
General Motors vehicles purchased after 3/31/2020 are not eligible for these tax credits.				
Chevrolet		1/1/10 to 3/31/19	4/1/19 to 9/30/19	10/1/19 to 3/31/20
 2017-20 Chevrolet Bolt EV	EV	\$7,500	\$3,750	\$1,875
 2011-19 Chevrolet Volt	PHEV	\$7,500	\$3,750	\$1,875
 2014-16 Chevrolet Spark EV	EV	\$7,500	\$3,750	\$1,875

Research underway in 2020

- **What are the fuel savings from using the engine's auto stop-start feature?**
 - Compare fuel use with and without auto stop-start enabled.
- **Do fuel stabilizing products provide a benefit?**
 - Assess the function of three popular off-the-shelf stabilizers over extended time periods, testing for gum formation, oxidation stability, RVP, and others.
- **Use the information to update tips on FuelEconomy.Gov.**



Thank You!

Contact

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630-252-3124

- Communications writer and editor for Argonne National Laboratory
- Area of expertise is idling and idle reduction technologies
- Researched and wrote *National Idling Reduction Network News*, a monthly newsletter of the Department of Energy's Vehicle Technologies Office
- Key member of the team that developed Clean Cities IdleBox

IDLEBOX FOR IDLE REDUCTION EDUCATION AND OUTREACH



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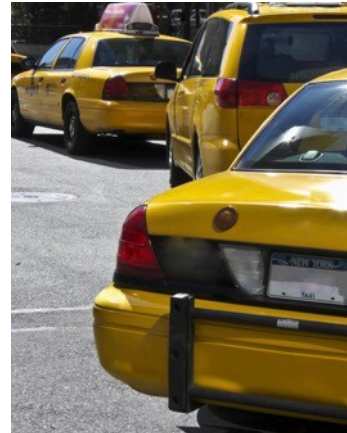
November 10, 2020



**U.S. DEPARTMENT OF
ENERGY**

Argonne National Laboratory is a
U.S. Department of Energy laboratory
managed by UChicago Argonne, LLC.

IDLING REDUCTION: THE LOW-HANGING FRUIT OF FUEL ECONOMY



- Idling may count as “engine hours”—the more idling, the shorter the maintenance intervals
 - Higher annual costs
- Any fleet can undertake idling reduction
 - Scalable: Basic to advanced

WHAT IS IDLEBOX?



IdleBox is an **electronic, modular toolkit** to help you advance the acknowledged low-hanging fruit of fuel economy—**idling reduction**.



IDLEBOX HOME PAGE

Core Resources →

Specialty Resources →

cleancities.energy.gov/idlebox

IdleBox: A Toolkit for Idling Reduction Education and Outreach

IdleBox is an electronic education and outreach toolkit on vehicle idling reduction. The low-hanging fruit of fuel economy, idling reduction is a simple way to use less fuel and minimize engine wear, reducing costs along with pollution and greenhouse gas emissions.



What Is Idling?

Idling is running a vehicle's propulsion engine when the vehicle isn't moving. Idling wastes fuel and creates harmful emissions.

Use IdleBox to:

- Learn more about the benefits of idling reduction for your organization, fleet, or community.
- Engage and educate others—including drivers, fleet managers, policymakers, sustainability managers, and others—on the value of idling reduction.
- Launch an idling reduction campaign for your organization, fleet, or community.

Core Resources

Messaging Materials	Letters & Pledge Forms	Technical Resources
Fact Card	Outreach Letter	Idle Reduction Savings Calculator: Excel or PDF
Fact Card Template	Press Release	Database of Idling Regulations
Tip Sheet	Organization Pledge Form	Compendium of Idling Reduction Equipment for Class 1-8 Vehicles
Stop Idling - Start Saving Graphic	Driver or Employee Pledge Form	
Stickers		
Sign Template		
Poster Template: 11" x 17" or 22" x 34"		
Bumper Sticker Template: Bleed or No Bleed		
tips		



College students help conduct an IdleBox campaign at New Hope Middle School in Columbus, Mississippi.

"IdleBox tools have been a tremendous support to our initiatives with area schools. We have prepared a comprehensive kit with high-quality, ready-to-use information featuring IdleBox materials and EPA lesson plans that we present to schools to encourage and support their interest in developing idling reduction and air quality [initiatives](#) and EPA lesson plans that we present to schools to encourage and support their interest in developing idling reduction and air quality [initiatives](#) for our coalition's educational outreach efforts."

Lauren Lambert-Tompkins,
Louisiana Clean Fuels

Specialty Resources

Personal Vehicles	Light- and Medium-Duty Fleet Vehicles
Idling Reduction for Personal Vehicles (Fact Sheet)	Idling Reduction Basics for Fleets (Presentation)
Which Is Greener: Idle, or Stop and Restart? Comparing Fuel Use and Emissions for Short Passenger-Car Stops (Fact Sheet)	Technology Solutions (Presentation)
Reducing Personal Vehicle Idling (Presentation)	
Stop and Restart Effects on Modern Vehicle Starting System Components—Longevity and Economic Factors (Technical Report)	

Heavy-Duty Vehicles	Emergency & Other Service Vehicles
Long-Haul Truck Idling Burns Up Profits (Fact Sheet)	Idling Reduction for Emergency and Other Service Vehicles (Fact Sheet)
Economics of Idling Reduction Options for Long-Haul Trucks (Fact Sheet)	Idling Reduction for Emergency Vehicles: A Case Study (Fact Sheet)
Idling Reduction for Long-Haul, Heavy-Duty Trucks (Presentation)	Case Study—Idling Reduction Technologies for Emergency Service Vehicles (Technical Report)
Emissions from Idling Heavy-Duty Trucks and Idling-Reduction Equipment (Technical Report)	Work Trucks
Idling Reduction for Long-Haul Trucks: An Economic Comparison on On-Board and Wayside Technologies (Technical Report)	Work Truck Idling Reduction (Fact Sheet)

Are You a Clean Cities Coordinator?

IdleBox has additional resources for Clean Cities coalitions. Go to the [Coalition IdleBox Resources](#).

IDLEBOX: CORE RESOURCES




Core Resources

Messaging Materials

Fact Card 

Fact Card Template 


Tip Sheet 

Stop Idling. Start Saving
Graphic 

Stickers 

Sign Template 

Poster Template: 11" x
17"  or 22" x 34" 

Bumper Sticker
Template: Bleed  or


No Bleed 


tips 

Letters & Pledge Forms

Outreach Letter 


Press Release 

Organization Pledge
Form 

Driver or Employee
Pledge Form 

Technical Resources


Idle Reduction Savings
Calculator: [Excel](#) or [PDF](#)

Database of Idling
Regulations 

Compendium of Idling
Reduction Equipment for
Class 1-8 Vehicles

IDLING REDUCTION SAVINGS CALCULATOR

The **Idling Reduction Savings Calculator** helps fleet managers and others estimate how much they can save with idling reduction.



Idling Reduction Savings Calculator

For an interactive Excel version of this calculator, please go to http://www.transportation.anl.gov/downloads/idling_worksheet.xls

Calculate Costs for Avoidable Idling				
1	How much fuel is used for idling? (If you don't know, see reference table on reverse.)	Realistically, how many hours each year might you use idling reduction (IR) devices instead of idling?	What is the price of fuel?	Avoidable Idling Fuel Costs
	<input type="text"/> gallons/hour	<input type="text"/> hours/year	<input type="text"/> \$ /gallon	\$ <input type="text"/> /year +
	\times	$=$ <input type="text"/> gallons/year	\times	
2			What is your average fuel economy?	
	<input type="text"/> gallons/hour	<input type="text"/> hours/year	<input type="text"/> miles/gallon	"Miles of idling" (idling is like putting miles on your engine)
	\times	$=$ <input type="text"/> miles/year		
3	How much does an oil change cost?	How many miles between oil changes?		Preventive Maintenance Cost¹
	<input type="text"/> \$ /oil change	<input type="text"/> miles/oil change	<input type="text"/> \$ /mile	\$ <input type="text"/> /year +
	\div	$=$ <input type="text"/> miles/year	\times	
4	How much does an engine overhaul or new vehicle cost?	How many miles between overhauls or vehicle replacement?		Overhaul or Replacement Cost¹
	<input type="text"/> \$ /overhaul or replacement	<input type="text"/> miles/overhaul or replacement	<input type="text"/> \$ /mile	\$ <input type="text"/> /year
	\div	$=$ <input type="text"/> miles/year	\times	
5	Add values in right-hand column			Total Avoidable Idling Costs
				\$ <input type="text"/> /year
Calculate Costs for Idling Reduction (IR) – Device and/or Electrified Parking Space (EPS)				
6	How much fuel is used by the IR device?	How many hours each year could you use IR devices instead of idling? ^{**}	Price of fuel (same as price listed in line 1)	Fuel cost for IR device
	<input type="text"/> gallons/hour	<input type="text"/> hours/year	<input type="text"/> \$ /gallon	\$ <input type="text"/> /year
	\times	$=$ <input type="text"/> gallons/year		
7			Maintenance cost for IR device	Operating Cost for On-board IR Device
			<input type="text"/> \$ /year	\$ <input type="text"/> /year
			$+$ <input type="text"/> \$ /year	
8	Cost per hour to plug into EPS	How many hours each year could you use EPSs instead of idling? ^{**}	Cost to plug in	Total Operating Costs for IR
	<input type="text"/> \$ /hour	<input type="text"/> hours/year	<input type="text"/> \$ /year	\$ <input type="text"/> /year
	\times	$=$ <input type="text"/> \$ /year	$+$ <input type="text"/> \$ /year	
Calculate Savings from IR				
9			Capital cost of on-board IR device	SAVINGS Line 5 – Line 8
			<input type="text"/> \$	\$ <input type="text"/> /year saved
			\div	Payback Time
				<input type="text"/> years
10	<input type="text"/> A	<input type="text"/> B	$=$	<input type="text"/> gallons saved/year

^{**} Total number of hours from lines 6 and 8 should equal the number of hours in line 1.
¹ TMC Recommended Practice 1106, "Analysis of Costs from Idling and Parking Devices for Heavy Duty Trucks" (2003), Technology & Maintenance Council, American Trucking Associations (TMC/ATA).

www.anl.gov/es/reference/vehicle-idle-reduction-savings-worksheet-pdf
www.anl.gov/es/reference/vehicle-idle-reduction-savings-worksheet-excel

IDLING REDUCTION TECHNOLOGY SOLUTIONS

Describes and provides links to 50+ products.

Organized by service(s) needed:

- Idle management
- Heat only
- Cooling only
- Heat, cooling, and power (auxiliary power unit)
- Power take-off
- Cargo refrigeration
- Wayside power / truck stop electrification

Argonne
NATIONAL LABORATORY

Idling Reduction Technology Solutions for Class 1–8 Vehicles^{*, †}

Services provided	Vehicle type (LD, MD, HD, trailer)	Power source	Company/Product(s)	EPA verification [†]	Notes
<i>Idle management</i>					
	LD, MD	Battery/electric	Derive Systems / Derive Efficiency	No	Idle efficiency gains are achieved by reducing idle RPM levels
	LD, MD, HD	Battery/electric	GRIP / Grip Idle Management	No	Enables use of heat and cooling and provides power for auxiliaries while maintaining battery state of charge
	LD	Battery/electric	Havis / ChargeGuard	No	Automatic idle shutoff timer
	LD, MD	Battery/electric	Havis / IdleRight2	No	Monitors the battery's voltage while the vehicle is turned off and electronics, such as emergency lighting, are on. Restarts vehicle when battery voltage drops below a preset level
	MD, HD	Battery/electric	IdleSmart / IdleSmart	No	Cycles engine on and off as needed to maintain battery state of charge and coolant heat
	LD, MD, HD	Battery/electric	InterMotive Vehicle Controls / EcoStar	No	Programmable system that automatically turns the engine off when specific customizable conditions are met
	HD	Battery/electric	Temp-a-Start / Temp-a-Start system	No	Cycles engine on or off to maintain engine block temperature, battery state of charge, and/or bunk temperature
	LD, MD, HD	Battery/electric	Vanner / IdleWatch	No	Idle management system to cycle on and off engine as needed to maintain battery state of charge and coolant heat

www.anl.gov/es/reference/idling-reduction-technology-solutions-for-class-18-vehicles

IDLEBOX: SPECIALTY RESOURCES

Specialty Resources



Personal Vehicles

[Idling Reduction for Personal Vehicles](#) (Fact Sheet)

[Which Is Greener: Idle, or Stop and Restart? Comparing Fuel Use and Emissions for Short Passenger-Car Stops](#) (Fact Sheet)

[Reducing Personal Vehicle Idling](#) (Presentation)

[Stop and Restart Effects on Modern Vehicle Starting System Components—Longevity and Economic Factors](#) (Technical Report)



Light- and Medium-Duty Fleet Vehicles

[Idling Reduction Basics for Fleets](#) (Presentation)

[Technology Solutions](#) (Presentation)



Heavy-Duty Vehicles

[Long-Haul Truck Idling Burns Up Profits](#) (Fact Sheet)

[Economics of Idling Reduction Options for Long-Haul Trucks](#) (Fact Sheet)

[Idling Reduction for Long-Haul, Heavy-Duty Trucks](#) (Presentation)

[Emissions From Idling Heavy-Duty Trucks and Idling-Reduction Equipment](#) (Technical Report)

[Idling Reduction for Long-Haul Trucks: An Economic Comparison on On-Board and Wayside Technologies](#) (Technical Report)



Emergency & Other Service Vehicles

[Idling Reduction for Emergency and Other Service Vehicles](#) (Fact Sheet)

[Idling Reduction For Emergency Vehicles: A Case Study](#) (Fact Sheet)

[Case Study – Idling Reduction Technologies for Emergency Service Vehicles](#) (Technical Report)



Work Trucks

[Work Truck Idling Reduction](#) (Fact Sheet)



OTHERS' USE OF IDLEBOX MESSAGING

ENVIRONMENTAL INITIATIVES
REDUCE OUR CARBON FOOTPRINT

**STOP Idling.
START \$aving.**

- IDLING IS EXPENSIVE**
up to a gallon or more of fuel per hour, depending on vehicle size
- IDLING POLLUTES**
a gallon of fuel creates about 20 lbs. of greenhouse gases
- IDLING THREATENS HEALTH**
breathing vehicle emissions increases risk of respiratory illness

ComEd
An Exelon Company

Idling uses more fuel than restarting your engine

- Unnecessary idling at ComEd wastes over **HALF A MILLION GALLONS** of fuel AND more than **\$2 MILLION** each year

ISO 14001 Certified
SINCE 2008

© Commonwealth Edison Company, 2011

ComEd, Illinois's largest electric utility

WE CARE ABOUT CLEAN AIR

**STOP Idling.
START \$aving.**

Bank of Utah

**STOP Idling.
START \$aving.**

SUSTAIN KANE

Kane County, Illinois

THANK YOU

Work sponsored by the U.S. Department of Energy's
Vehicle Technologies Office (VTO)



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- Principal Environmental Scientist at Argonne National Laboratory
- Research focuses on transportation energy and environmental issues specifically with the energy use and emissions analysis for advanced vehicle technologies and transportation fuels
- Developer the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool
- Estimates petroleum use, greenhouse gas emissions, air pollutant emissions, and cost of ownership of light-duty and heavy-duty alternative fuel and advanced vehicles

**“AFLEET TOOL” TO ANALYZE
THE COSTS AND BENEFITS
OF ALTERNATIVE FUEL
VEHICLES**



ANDY BURNHAM
Principal Environmental Scientist
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November 10, 2020

AFLEET Suite of Tools



AFLEET Spreadsheet

Detailed energy, emission, and cost data for light- and heavy-duty AFVs



AFLEET Online

User-friendly interface analyzes petroleum use, emissions, simple payback



Heavy Duty Vehicle Emissions Calculator

Compares NOx, PM, GHGs and cost-effectiveness

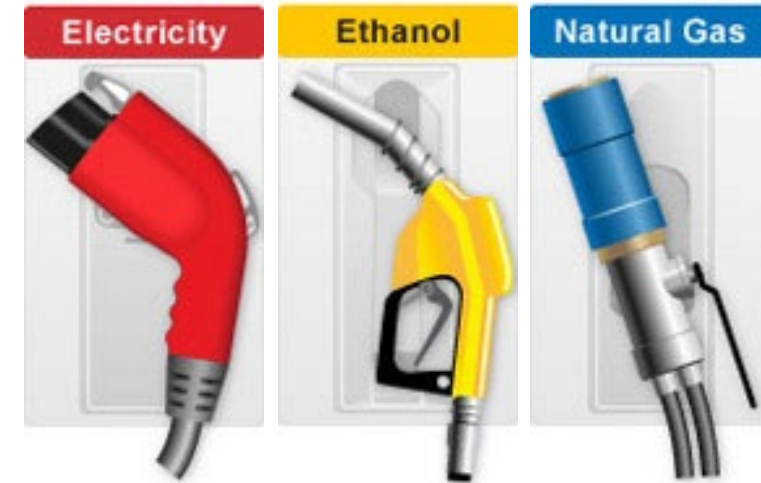
afleet-web.es.anl.gov

AFLEET SPREADSHEET AND ONLINE



AFLEET SPREADSHEET

- **Examines light-duty & heavy-duty vehicle:**
 - Petroleum use
 - GHGs
 - Air pollutants
 - Cost of ownership
- **Contains 18 fuel/vehicle technologies**
 - Conventional
 - Hybrids
 - Plug-in electrics
 - Alternative fuels: CNG, LNG, LPG, H₂, ethanol, biodiesel, renewable diesel
- **New features in AFLEET 2019 Spreadsheet**
 - Off-Road Footprint calculator
 - Public EV Charging calculator
 - Low-NOx LPG engines
- **AFLEET Spreadsheet and Online; HDVEC: afleet-web.es.anl.gov**
 - Updates will be released later this year



AFLEET TOOL'S CALCULATION METHODS

1. Simple Payback Calculator

- Annual emissions & simple payback: new AFV vs. conventional

2. Total Cost of Ownership Calculator

- Lifetime emissions & NPV of costs: new AFV vs. conventional

3. Idle Reduction Calculator

- Annual emissions & simple payback: IR equipment vs. idling

4. On-Road Fleet Footprint Calculator

- Annual & remaining lifetime emissions of existing & new vehicles

5. Off-Road Fleet Footprint Calculator

- Annual & remaining lifetime emissions of existing & new off-road equipment

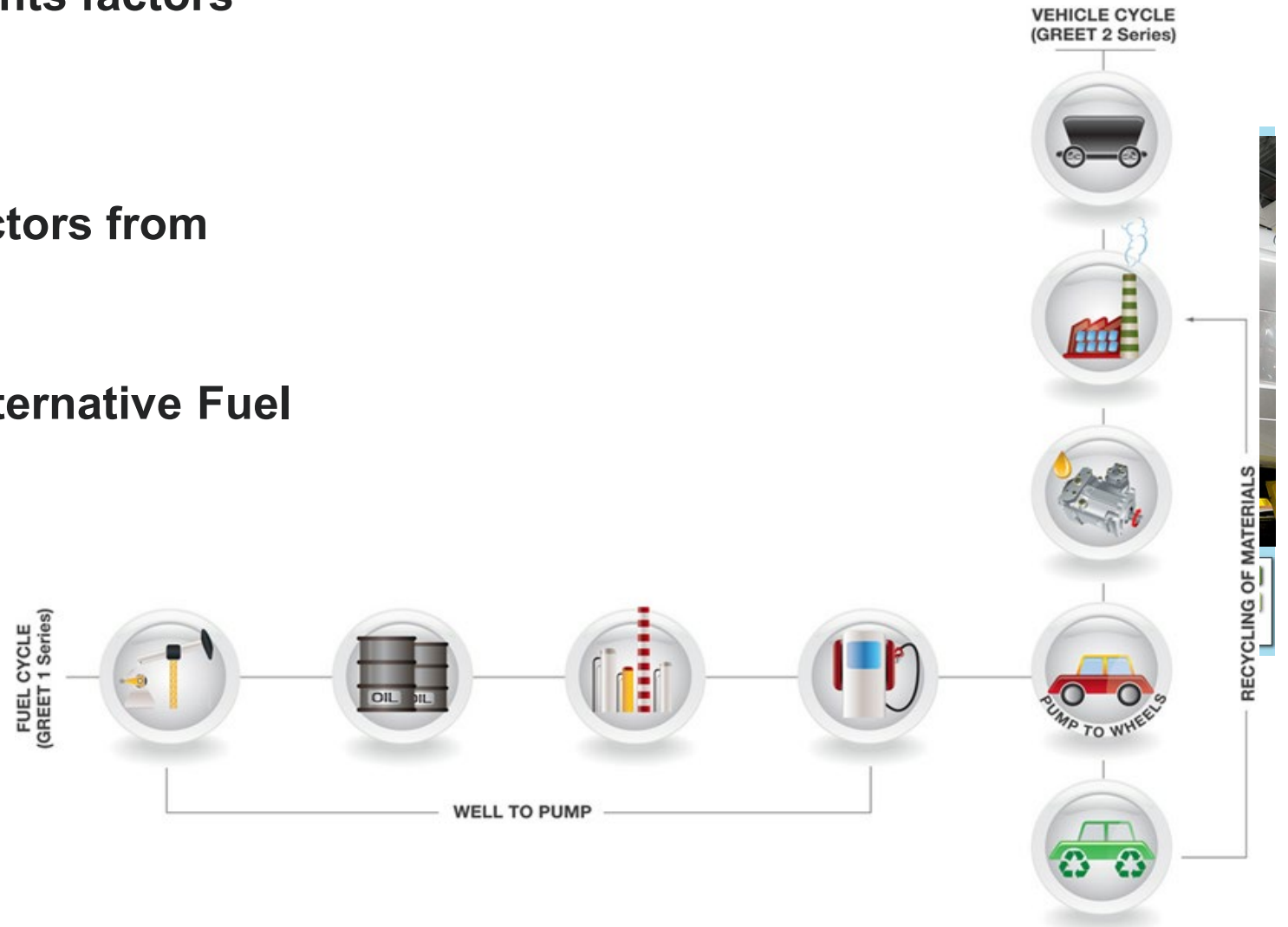
6. EV Charging Calculator

- Annual emissions benefit of utilizing public charging infrastructure



KEY DATA SOURCES

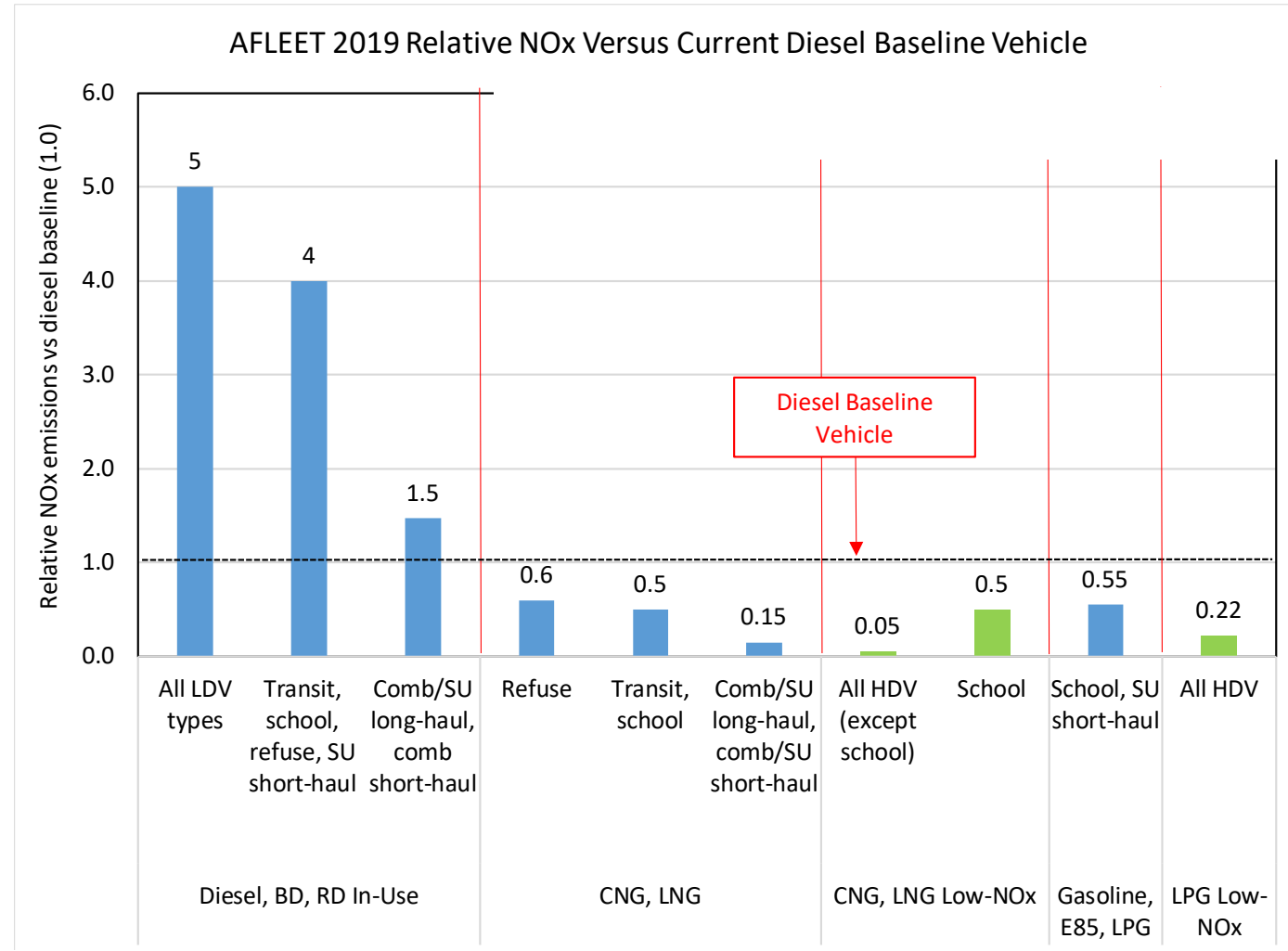
- **Petroleum use, GHGs, air pollutants factors from Argonne's GREET 1 2019**
 - Updated fuel economy data
- **Vehicle air pollutant emission factors from EPA's MOVES 2014b**
- **Fuel prices using Clean Cities Alternative Fuel Price Reports**



AFLEET TOOL 2019 – DIESEL IN-USE & LOW-NO_x EMISSIONS

- **Diesel in-use NO_x feature**
 - EPA’s MOVES (& DEQ) needs to revise diesel NO_x

- **Heavy-duty low-NO_x feature**
 - Added LPG low-NO_x in AFLEET 2019



Anenberg, 2017, Impacts and mitigation of excess diesel-related NO_x emissions in 11 major vehicle markets

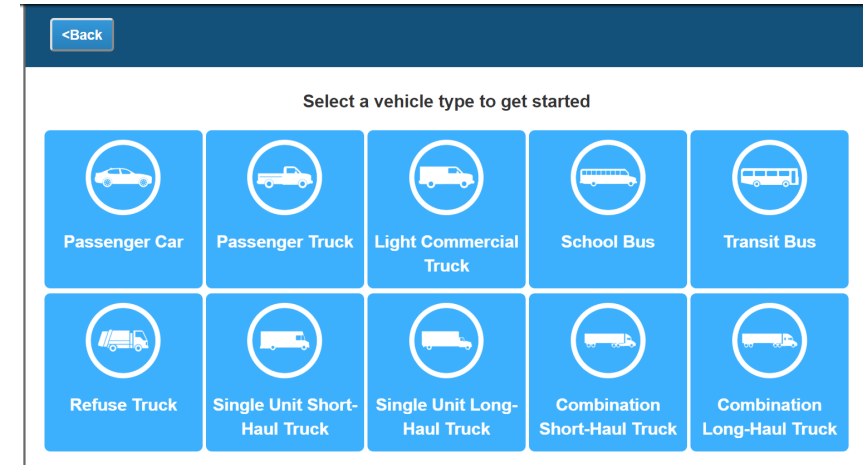
Cai, 2017, Wells to Wheels: Environmental Implications of Natural Gas As A Transportation Fuel

Sandhu, 2017, In-Use Emission Rates for MY 2010+ Heavy-Duty Diesel Vehicles

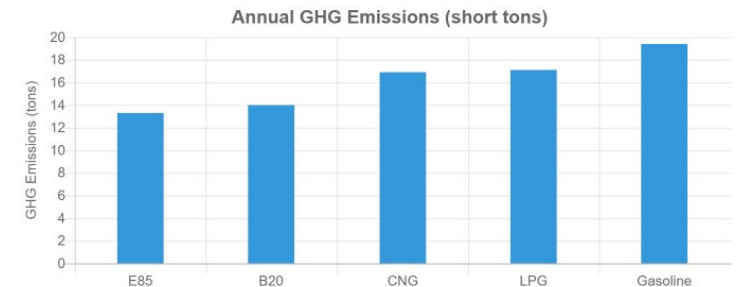
Ryskamp, 2020, Chassis Dynamometer Evaluation of Propane Powered MD to HD Vehicles

AFLEET ONLINE

- **User friendly, web-based version**
 - Replicates Simple Payback Calculator
- **Examines light-duty & heavy-duty vehicle:**
 - Petroleum use
 - GHG emissions
 - Air pollutant emissions
 - Simple payback
- **Contains 18 fuel/vehicle technologies**
 - Conventional: 2
 - Hybrids: 3
 - Plug-in electrics: 3
 - Alternative fuels: 10
- **AFLEET Online:** afleet-web.es.anl.gov/afleet/



Light Commercial Truck

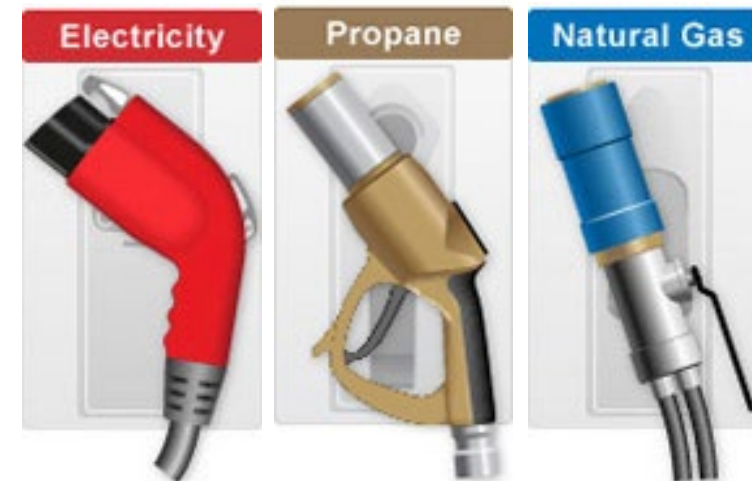


HDVEC Introduction



HEAVY-DUTY VEHICLE EMISSIONS CALCULATOR

- Simple online tool based on AFLEET to help analyze AFVs for funding opportunities
- Examines medium-duty & heavy-duty vehicle:
 - Vehicle operation NO_x & $\text{PM}_{2.5}$
 - WTW GHGs
 - Emission reduction cost effectiveness
- Contains 4 fuel/vehicle technologies:
 - Diesel
 - Electric vehicle
 - Propane
 - Natural gas
- HDVEC available at:
afleet-web.es.anl.gov/hdv-emissions-calculator/



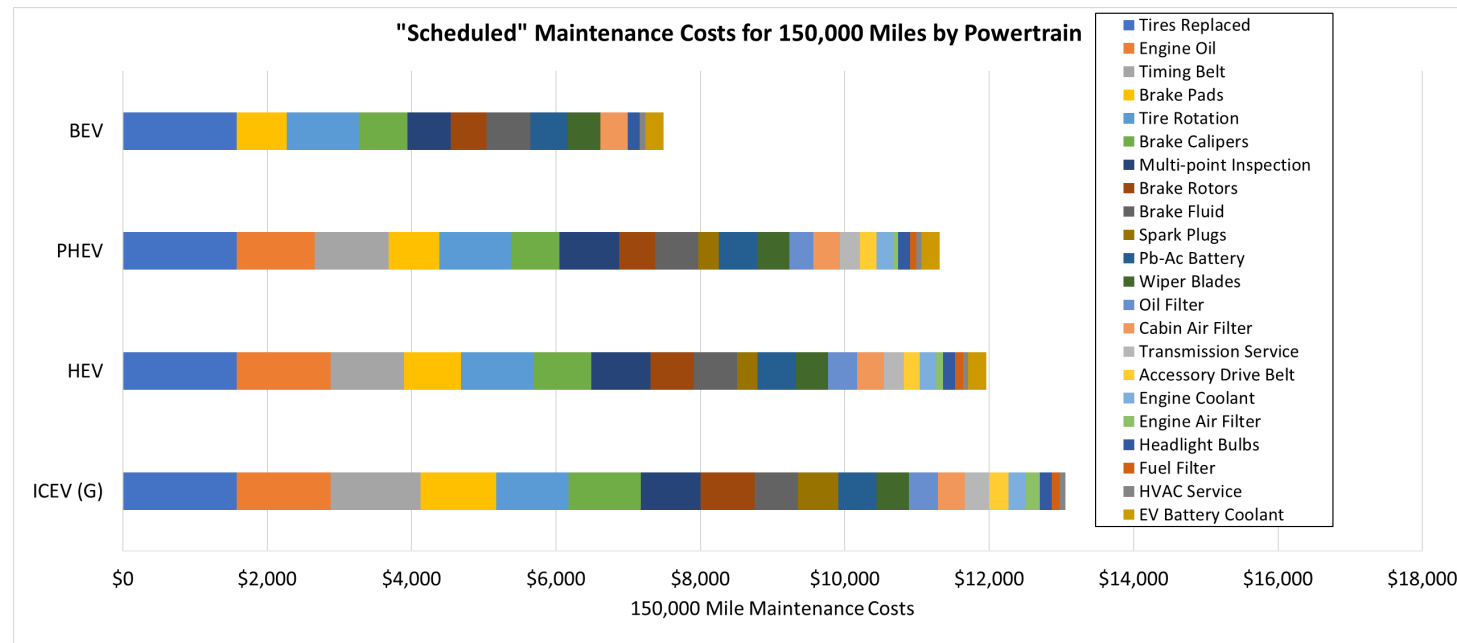
HDVEC'S CALCULATION METHODS

- **Environmental Mitigation w/ Scrappage**
 - New AFV vs. new diesel, plus additional benefit from early retirement of scrapped vehicle
- **Environmental Mitigation w/ Repower**
 - Vehicle after repower vs. diesel vehicle before repower
- **Clean Vehicle Replacement**
 - New AFV vs. new diesel



AFLEET TOOL 2020 PLANNED UPDATES

- **Forthcoming update of MOVES emissions data**
 - Should address diesel in-use NOx
- **New off-road fuel use/emissions data from ports analysis**
 - Cargo handling equipment
 - Harbor craft
 - Ocean-going vessels
 - Rail
- **Update vehicle maintenance, insurance, depreciation and fee data**



THANK YOU!!!

Argonne National Laboratory's work is supported by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

This work has been supported and assisted by:

Linda Bluestein: U.S. DOE

Dennis Smith: U.S. DOE

Marcy Rood: Argonne

Joann Zhou: Argonne

Shannon O'Donnell, Maddy Seveska, Sandra Marquez

AFLEET TUTORIAL – DEMO #1

Using the Fleet Footprint Calculator to Examine Existing Fleet



AFLEET TUTORIAL – FLEET FOOTPRINT CALCULATOR

- 1st step: enter location on “Inputs” sheet

Primary Vehicle Location	
State	CALIFORNIA
County	LOS ANGELES

- 2nd step: adjust fuel production & energy/emission assumptions on “Inputs” sheet

Fuel Production Assumptions

Biodiesel Feedstock Source	1 - Soy	1
	2 - Canola	
	3 - Corn	
	4 - Tallow	
Ethanol Feedstock Source	1 - Corn	1
	2 - Switchgrass	
	3 - Sugarcane	
	4 - Grain Sorghum	
CNG Feedstock Source	1 - North American NG	1
	2 - Landfill Gas	
	3 - AD Gas of Animal Waste	
	4 - AD Gas of Wastewater Sludge	
	5 - AD Gas of MSW	
North American NG Feedstock Source	Conventional	Shale
	66%	34%
LPG Feedstock Source	NG	Petroleum
	69%	31%
Source of Electricity for PHEVs, EVs, and FCVs (Electrolysis)	7	
	1 - Average U.S. Mix	
	2 to 11 - EIA Region Mix (see map)	
	12 - User Defined (go to 'Background Data' sheet)	
G.H2 Production Process	1 - Refueling Station SMR (On-site)	1
	2 - Central Plant SMR (Off-site)	
	3 - Refueling Station Electrolysis (On-site)	

Petroleum Use, GHGs & Air Pollutant Options

Petroleum Use, GHGs & Air Pollutant Calculation Type	1	
1 - WTW Petroleum Use and GHGs & Tailpipe Air Pollutants		
2 - WTW Petroleum Use, GHGs, and Air Pollutants		
3 - WTW & Vehicle Production* Petroleum Use, GHGs, Air Pollutants (*LDVs only)		
Diesel In-Use Emissions Multiplier	yes/no	No
Low NOx Engines - CNG and LNG HDVs	yes/no	Yes

Note: Several fuels are not shown for clarity in this presentation

AFLEET TUTORIAL – FLEET FOOTPRINT CALCULATOR

- **4th step: copy and paste fleet data into “Footprint” sheet**
 - Model year
 - Annual mileage
 - Fuel use

- **5th step: adjust vehicle type via drop-down**

Vehicle Type	Model Year	Annual Vehicle Mileage	Fuel Use			Petroleum Use (barrels)	GHG (short tons)	Vehicle Operation Air Pollutant Emissions (lb)							
			Gasoline (gal)	Diesel (gal)	Gasoline HEV (gal)			CO	NOx	PM10	PM10 (TBW)	PM2.5	PM2.5 (TBW)	VOC	VOC (Evap)
Passenger Car	2005	10,255	513			10.7	6.0	92.4	7.0	0.1	0.7	0.1	0.1	3.9	2.6
Passenger Car	2005	10,312	516			10.8	6.1	92.9	7.0	0.1	0.7	0.1	0.1	3.9	2.7
Passenger Car	2005	10,369	518			10.8	6.1	93.4	7.0	0.1	0.7	0.1	0.1	3.9	2.7
Passenger Car	2005	10,426	521			10.9	6.1	93.9	7.1	0.1	0.7	0.1	0.1	4.0	2.7
Passenger Car	2005	10,483	524			10.9	6.2	94.4	7.1	0.1	0.7	0.1	0.1	4.0	2.7
Passenger Car	2005	10,540	527			11.0	6.2	94.9	7.2	0.1	0.7	0.1	0.1	4.0	2.7
Passenger Car	2005	10,597	530			11.1	6.2	95.5	7.2	0.1	0.7	0.1	0.1	4.0	2.7
Passenger Car	2005	10,654	533			11.1	6.3	96.0	7.2	0.1	0.7	0.1	0.1	4.0	2.7
Passenger Car	2005	10,711	536			11.2	6.3	96.5	7.3	0.1	0.7	0.1	0.1	4.1	2.8
Passenger Car	2005	10,768	538			11.2	6.3	97.0	7.3	0.1	0.7	0.1	0.1	4.1	2.8
Passenger Car	2005	10,825	541			11.3	6.4	97.5	7.4	0.1	0.7	0.1	0.1	4.1	2.8
Passenger Car	2005	10,882	544			11.4	6.4	98.0	7.4	0.1	0.7	0.1	0.1	4.1	2.8
Passenger Car	2007	10,939	497			10.4	5.9	67.6	3.9	0.1	0.7	0.1	0.1	2.7	1.8
Passenger Car	2007	10,996	500			10.4	5.9	68.0	3.9	0.1	0.7	0.1	0.1	2.7	1.8
Passenger Car	2007	11,053	502			10.5	5.9	68.3	3.9	0.1	0.7	0.1	0.1	2.7	1.8
Passenger Car	2007	11,110	505			10.5	5.9	68.7	4.0	0.1	0.7	0.1	0.1	2.7	1.8
Passenger Car	2007	11,167	508			10.6	6.0	69.0	4.0	0.1	0.7	0.1	0.1	2.8	1.8
Passenger Car	2007	11,224	510			10.7	6.0	69.4	4.0	0.1	0.7	0.1	0.1	2.8	1.9
Passenger Car	2007	11,281	513			10.7	6.0	69.7	4.0	0.1	0.7	0.1	0.1	2.8	1.9
Passenger Car	2007	11,338	515			10.8	6.1	70.1	4.0	0.1	0.7	0.1	0.1	2.8	1.9
Passenger Car	2007	11,395	518			10.8	6.1	70.4	4.1	0.1	0.8	0.1	0.1	2.8	1.9
Passenger Car	2007	11,452	521			10.9	6.1	70.8	4.1	0.1	0.8	0.1	0.1	2.8	1.9
Passenger Car	2007	11,509	523			10.9	6.2	71.1	4.1	0.1	0.8	0.1	0.1	2.8	1.9
Passenger Car	2007	11,566	526			11.0	6.2	71.5	4.1	0.1	0.8	0.1	0.1	2.9	1.9
Passenger Car	2007	11,623	528			11.0	6.2	71.8	4.2	0.1	0.8	0.1	0.1	2.9	1.9

Note: Several fuels are not shown for clarity in this presentation

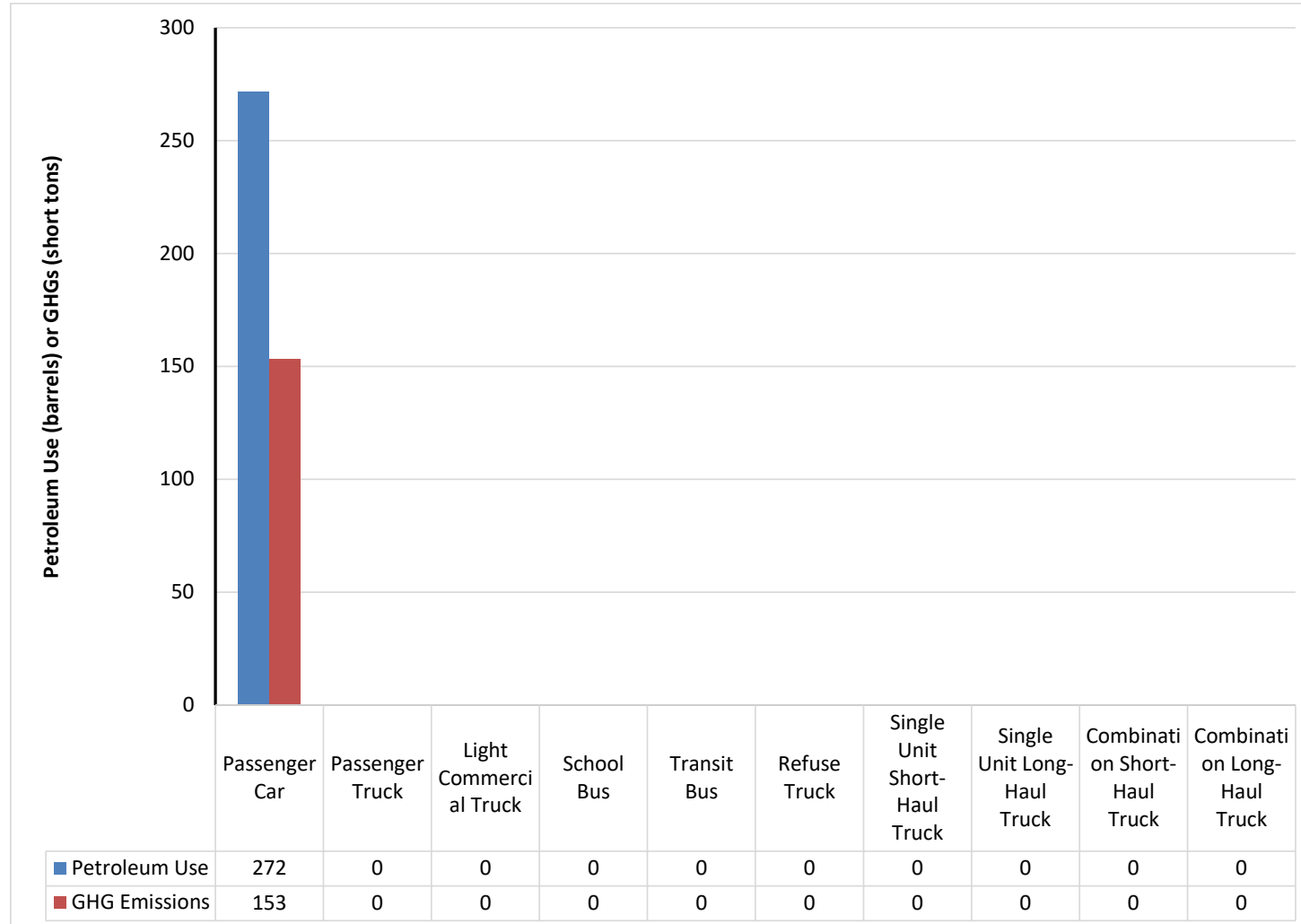
AFLEET TUTORIAL – FLEET FOOTPRINT CALCULATOR

- View existing fleet results on “Footprint Outputs” sheet

Vehicle Type	Petroleum Use (barrels)	GHG Emissions (short tons)	CO (lb)	NOx (lb)	PM10 (lb)	PM2.5 (lb)	VOC (lb)
Passenger Car	272	153	2,049	138	21	5	141
Passenger Truck	0	0	0	0	0	0	0
Light Commercial Truck	0	0	0	0	0	0	0
School Bus	0	0	0	0	0	0	0
Transit Bus	0	0	0	0	0	0	0
Refuse Truck	0	0	0	0	0	0	0
Single Unit Short-Haul Truck	0	0	0	0	0	0	0
Single Unit Long-Haul Truck	0	0	0	0	0	0	0
Combination Short-Haul Truck	0	0	0	0	0	0	0
Combination Long-Haul Truck	0	0	0	0	0	0	0
Total	272	153	2,049	138	21	5	141

AFLEET TUTORIAL – FLEET FOOTPRINT CALCULATOR

- View existing fleet results on “Footprint Outputs” sheet



AFLEET TUTORIAL – DEMO #2

Using Simple Payback and TCO Calculators to Compare Potential Acquisitions



AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- **1st step: enter key inputs on “Inputs” sheet**
 - State, County (for externalities) & vehicle type (via drop-down)
 - # of vehicles, VMT, MPGGE, and purchase price
 - Default and MPDGE reference values available (to the side of below tables)
 - Can simulate both an LDV and HDV

Primary Vehicle Location				
State	CALIFORNIA			
County	LOS ANGELES			
Heavy-Duty Vehicle Information				
Vehicle Type	Transit Bus			
Heavy-Duty Fuel Type	Number of Heavy-Duty Vehicles	Annual Vehicle Mileage	Fuel Economy (MPDGE)	Purchase Price (\$/Vehicle)
Gasoline	0	0	3.4	\$0
Diesel	0	35,000	4.1	\$300,000
All-Electric Vehicle (EV)	0	35,000	11.3	\$750,000
Gaseous Hydrogen (G.H2) Fuel Cell Vehicle (FCV)	0	35,000	6.8	\$1,800,000
Diesel Hybrid Electric Vehicle (HEV)	0	35,000	5.7	\$510,000
Diesel Hydraulic Hybrid (HHV)	0	0	5.3	\$0
Biodiesel (B20)	0	35,000	4.1	\$300,000
Biodiesel (B100)	0	35,000	4.1	\$300,000
Ethanol (E85)	0	0	3.4	\$0
Propane (LPG)	0	0	3.4	\$0
Compressed Natural Gas (CNG)	0	35,000	3.5	\$360,000
Liquefied Natural Gas (LNG)	0	35,000	3.5	\$350,000
LNG / Diesel Pilot Ignition	0	0	3.9	\$0

Note: Red cells show values changed for demo, cell color doesn't change in AFLEET

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- **2nd step: enter key fuel price inputs on “Inputs” sheet**
 - Choose either public or private station fuel pricing (via drop-down)
 - Results based on state level AFPR data
 - Choose if you want to look at fuel price sensitivity for simple payback (via drop-down)
 - Enter fuel price data (in respective fuel unit)

Refueling Information			
Fueling Type	Private Station	For infrastructure costs, go to 'Payback' sheet	
Fuel Price Sensitivity	No	To enter fuel price range, go to 'Payback' sheet	
Fuel and DEF Price			
		Public Station	Private Station
	Fuel Unit	(\$/Fuel Unit)	
Gasoline	gasoline gallon	\$3.01	\$2.84
Diesel	diesel gallon	\$3.04	\$3.03
Electricity	kWh	\$0.16	\$0.16
G.H2	hydrogen kg	\$20.29	\$6.99
B20	B20 gallon	\$2.92	\$2.70
B100	B100 gallon	\$3.94	\$4.41
E85	E85 gallon	\$2.59	\$2.56
Propane	LPG gallon	\$3.01	\$2.63
CNG	CNG GGE	\$2.43	\$1.96
LNG	LNG gallon	\$2.86	\$2.11
Diesel Exhaust Fluid (DEF)	DEF gallon	\$2.80	\$2.80

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- 3rd step: enter TCO inputs on “Inputs” sheet

Total Cost of Ownership Inputs

Light-Duty Vehicle Information			
Years of Planned Ownership	years	15	
Heavy-Duty Vehicle Information			
Years of Planned Ownership	years	15	
Infrastructure Information			
Years of Planned Ownership	years	15	
Financial Assumptions			
		Vehicles	Infrastructure
Loan	yes/no	No	No
Loan Term	years	5	5
Interest Rate	%	3.37%	3.37%
Percent Down Payment	%	0.00%	0.00%
Discount Factor	%	0.83%	

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- 4th step: adjust fuel production & energy/emission assumptions on “Inputs” sheet

Fuel Production Assumptions

Biodiesel Feedstock Source	1 - Soy	1	
	2 - Canola		
	3 - Corn		
	4 - Tallow		
Ethanol Feedstock Source	1 - Corn	1	
	2 - Switchgrass		
	3 - Sugarcane		
	4 - Grain Sorghum		
CNG Feedstock Source	1 - North American NG	1	
	2 - Landfill Gas		
	3 - AD Gas of Animal Waste		
	4 - AD Gas of Wastewater Sludge		
	5 - AD Gas of MSW		
North American NG Feedstock Source	Conventional	Shale	
	66%	34%	
LPG Feedstock Source	NG	Petroleum	
	69%	31%	
Source of Electricity for PHEVs, EVs, and FCVs (Electrolysis)	7		
	1 - Average U.S. Mix		
	2 to 11 - EIA Region Mix (see map)		
	12 - User Defined (go to 'Background Data' sheet)		
G.H2 Production Process	1 - Refueling Station SMR (On-site)	1	
	2 - Central Plant SMR (Off-site)		
	3 - Refueling Station Electrolysis (On-site)		

Petroleum Use, GHGs & Air Pollutant Options

Petroleum Use, GHGs & Air Pollutant Calculation Type		1
1 - WTW Petroleum Use and GHGs & Tailpipe Air Pollutants		
2 - WTW Petroleum Use, GHGs, and Air Pollutants		
3 - WTW & Vehicle Production* Petroleum Use, GHGs, Air Pollutants (*LDVs only)		
Diesel In-Use Emissions Multiplier	yes/no	No
Low NOx Engines - CNG and LNG HDVs	yes/no	Yes

Note: Several fuels are not shown for clarity in this presentation

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- **5th step: if examining PHEV or EREV, enter additional data on “Payback” sheet**
 - CD “EV mode” fuel consumption & range
 - Charges per day & days driven per week
 - Other secondary assumptions are on this sheet as well

	Gasoline	Diesel	Gasoline HEV	Gasoline PHEV	Gasoline EREV	EV	G.H2 FCV
<u>Light-Duty Vehicle Inputs</u>							
Vehicle Type	<u>Passenger Car</u>						
Number of LDVs	25	25	25	25	25	25	25
Annual Mileage	11,000	11,000	11,000	11,000	11,000	11,000	11,000
Fuel Economy (MPGGE)	28.8	34.6	40.3	42.9	41.2	95.0	57.3
CD Electricity Use (kWh/100mi)				23.0	31.4	34.6	
CD Electricity Use (GGE/100mi)				0.7	1.0		
CD Gasoline Use (GGE/100mi)				0.7	0.0		
PHEV CD Range (miles)				19.6	34.0		
Charges/day				1.0	1.0		
Days driven/week				5	5		
Share of CD miles				46%	81%		
Share of Alternative Fuel Use in Dual-Fuel or PHEV (Energy %)				17%	62%		
DEF Use (% of fuel consumption)	0%	2%	0%	0%	0%	0%	0%
Purchase Price (\$/vehicle)	\$20,000	\$22,500	\$23,000	\$32,500	\$34,000	\$30,000	\$58,500
Incentive (\$/vehicle)	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Maintenance & Repair (\$/mile)	\$0.142	\$0.192	\$0.137	\$0.135	\$0.135	\$0.125	\$0.125

Note: Several fuels are not shown for clarity in this presentation

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- **6th step: if examining fuel price sensitivity, enter additional data on “Payback” sheet**
 - Enter high and low fuel prices for either public or private station
 - Can either enter values or % relative to default price
 - Do not have to enter multiple times for vehicles using same fuel

	Gasoline	Diesel	Gasoline HEV	Gasoline PHEV	Gasoline EREV	EV	G.H2 FCV
Fuel Price Sensitivity							
Public Fuel Price Sensitivity Case							
	No						
High Fuel Price (% increase vs default)	17%	19%	17%	17%	17%	0%	0%
High Primary Fuel Price (\$/GGE)	\$3.51	\$3.13	\$3.51	\$3.51	\$3.51	\$5.34	\$20.29
High Secondary Fuel Price (\$/GGE)				\$5.34	\$5.34		
Low Primary Fuel Price (% decrease vs default)	17%	19%	17%	17%	17%	0%	0%
Low Primary Fuel Price (\$/GGE)	\$2.51	\$2.13	\$2.51	\$2.51	\$2.51	\$5.34	\$20.29
Low Secondary Fuel Price (\$/GGE)				\$5.34	\$5.34		
Private Fuel Price Sensitivity Case							
	No						
High Fuel Price (% increase vs default)	18%	19%	17%	17%	17%	0%	0%
High Primary Fuel Price (\$/GGE)	\$3.34	\$3.13	\$3.31	\$3.31	\$3.31	\$5.34	\$6.99
High Secondary Fuel Price (\$/GGE)				\$5.34	\$5.34		
Low Primary Fuel Price (% decrease vs default)	18%	19%	17%	17%	17%	0%	0%
Low Primary Fuel Price (\$/GGE)	\$2.34	\$2.13	\$2.37	\$2.37	\$2.37	\$5.34	\$6.99
Low Secondary Fuel Price (\$/GGE)				\$5.34	\$5.34		

Note: Several fuels are not shown for clarity in this presentation

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

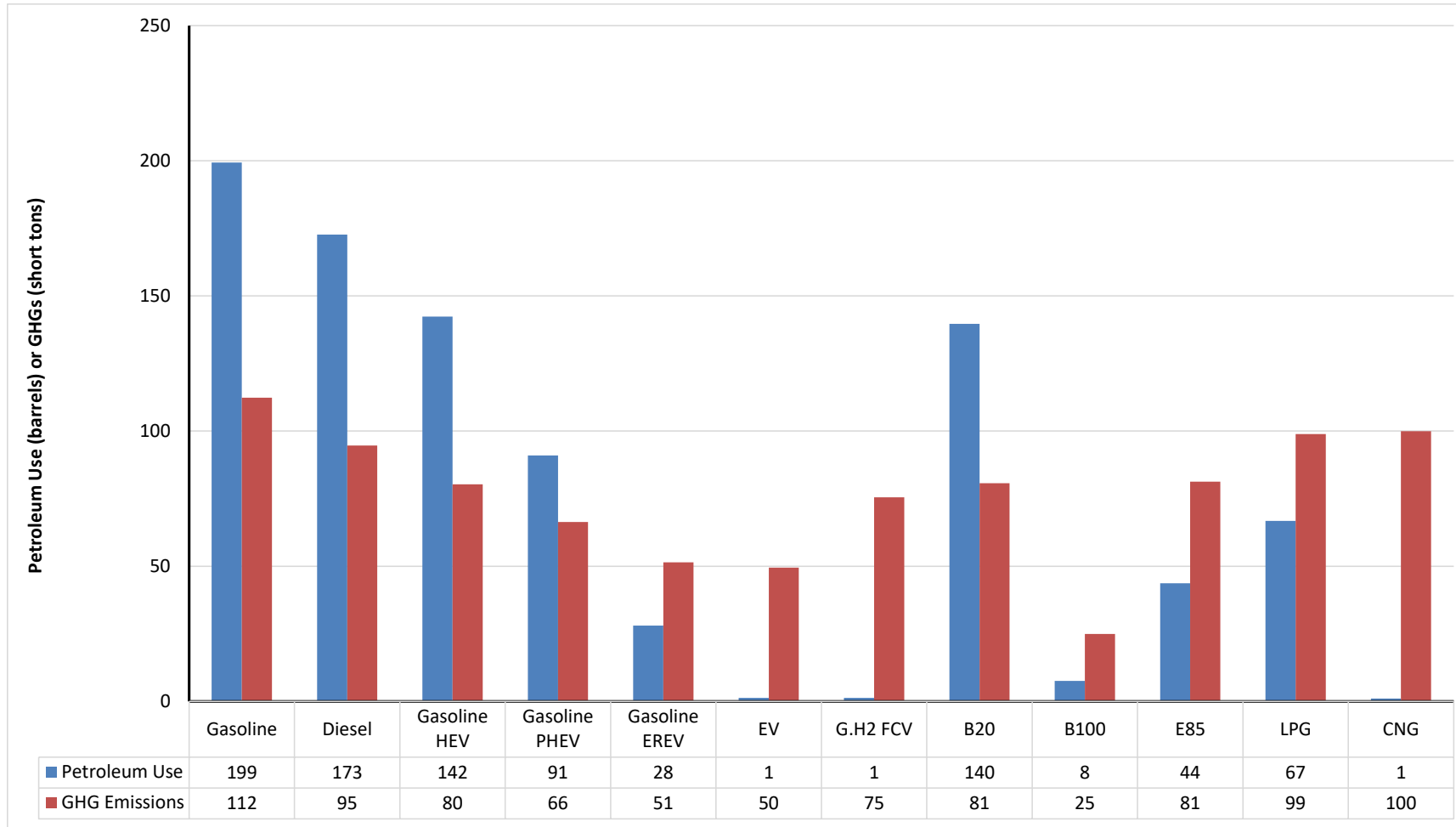
- **7th step: if examining infrastructure costs, enter additional data on “Payback” sheet**
 - Enter station type (via drop down), number of stations, and station & O&M costs

	Gasoline	Diesel	Gasoline HEV	Gasoline PHEV	Gasoline EREV	EV
Infrastructure Inputs						
Station/EVSE Type	New Private	New Private	New Private	Level 2 - Parking Garage	Level 2 - Parking Garage	Level 2 - Parking Garage
Number of stations/EVSEs	0	0	0	13	13	13
Total Refueling Station/EVSE Cost	\$0	\$0	\$0	\$40,556	\$40,556	\$40,556
Total Incentive	\$0	\$0	\$0	\$0	\$0	\$0
Maintenance Depot Cost	\$0	\$0	\$0	\$0	\$0	\$0
Annual Private Station/EVSE Operation & Maintenance	\$0	\$0	\$0	\$9,100	\$9,100	\$9,100
Default Refueling Station/EVSE Cost	\$0	\$0	\$0	\$40,556	\$40,556	\$40,556
Default Annual Private Station/EVSE O&M Costs (\$/yr)	\$0	\$0	\$0	\$9,100	\$9,100	\$9,100
Annual Private Fueling Labor & Misc. Costs (\$/yr)	\$0	\$0	\$0	\$0	\$0	\$0

Note: Several fuels are not shown for clarity in this presentation

AFLEET TUTORIAL – SIMPLE PAYBACK AND TCO CALCULATORS

- View results on “Payback Outputs” sheet



Note: Several fuels are not shown for clarity in this presentation



**Session #13: Sustainable Fleet Analytical
Tools & Information for Fleet Decisions**

November 10, 2020