NC STATE UNIVERSITY

SUSTAINABLE FLEET TECHNOLOGY

VIRTUAL CONFERENCE 2020

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

November 10, 2020

NC CLEAN ENERGY TECHNOLOGY CENTER

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

https://www.sustainablefleetexpo.com/

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SUSTAINABLE FLEET TECHNOLOGY
VIRTUAL CONFERENCE 2020

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

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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**

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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**

NC CLEAN ENERGY TECHNOLOGY CENTER

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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

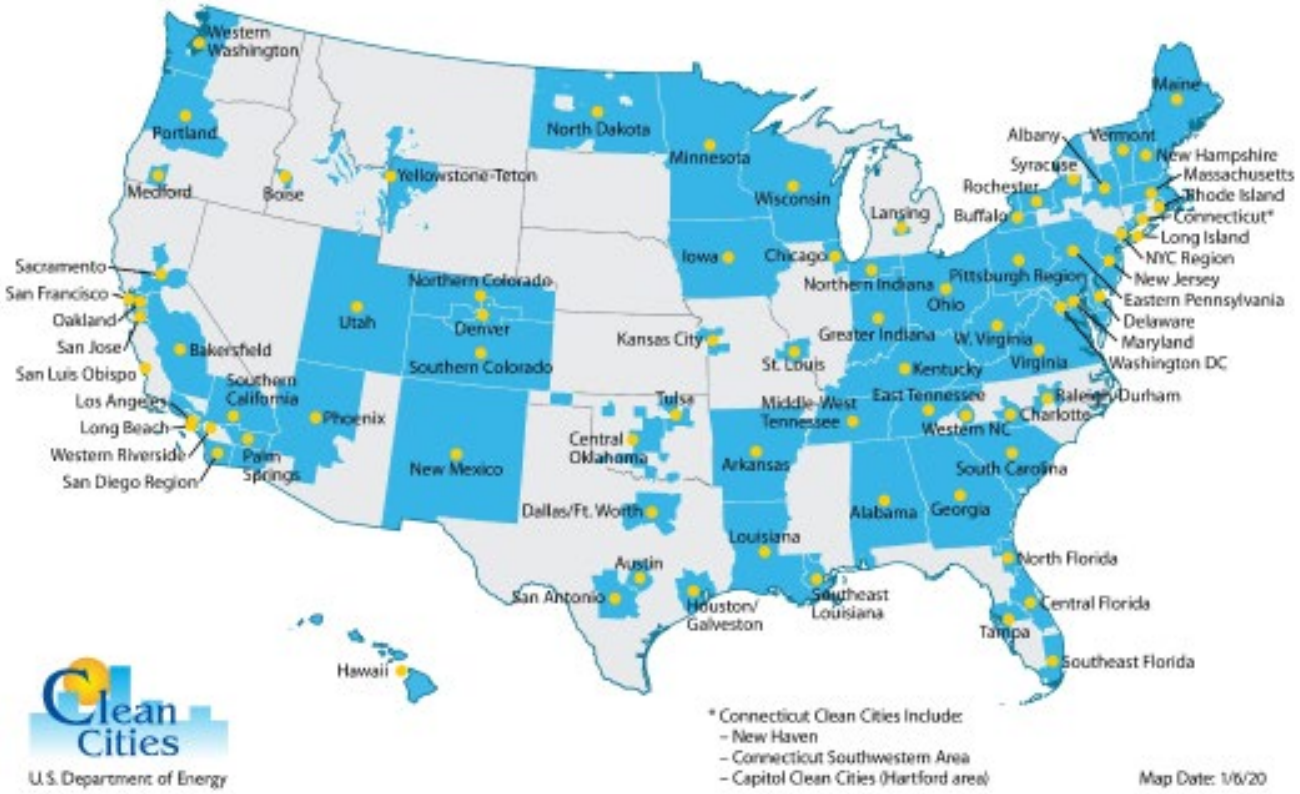
Centralina Regional Council

CENTRALINA CLEAN FUELS COALITION
A US DOE CLEAN CITIES COALITION

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**



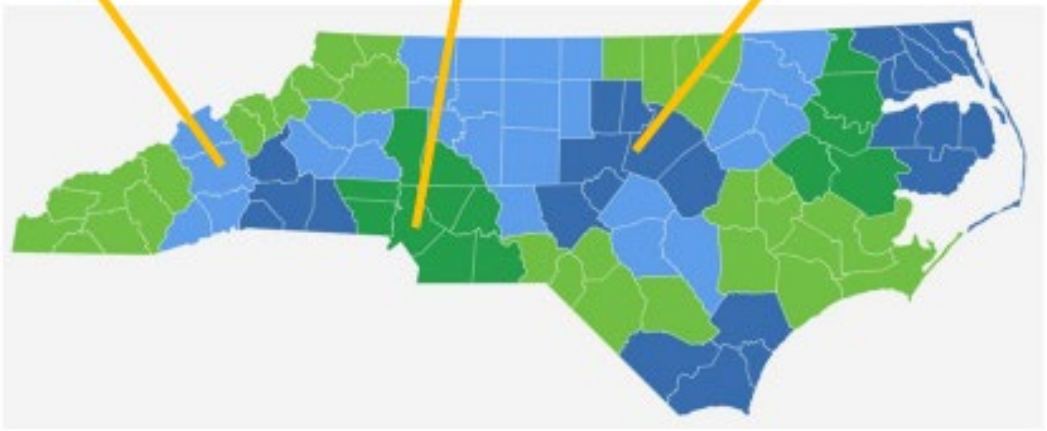
Centralina Clean Fuels Coalition

NC's Clean Cities Coalitions

LAND of SKY CLEAN VEHICLES COALITION

CENTRALINA CLEAN FUELS COALITION
A US DOE CLEAN CITIES COALITION

TRIANGLE CLEAN CITIES



CENTRALINA
REGIONAL COUNCIL

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.

Coalition Strategies

Light-, Medium-, and Heavy-Duty Vehicles

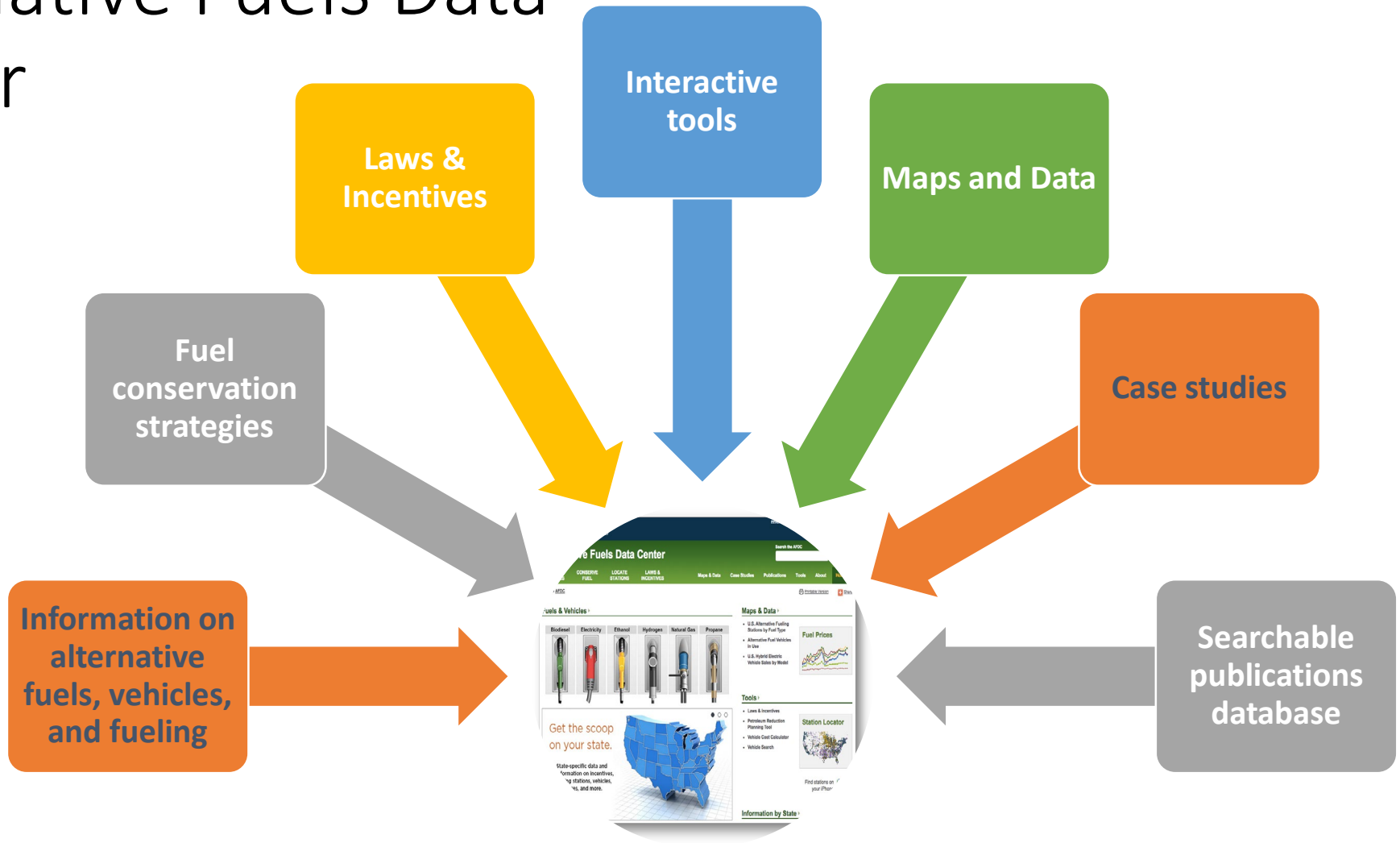
New Mobility Choices and Emerging Transportation Technologies

Idle Reduction Measures and Fuel Economy Improvements

Alternative and Renewable Fuels and Infrastructure

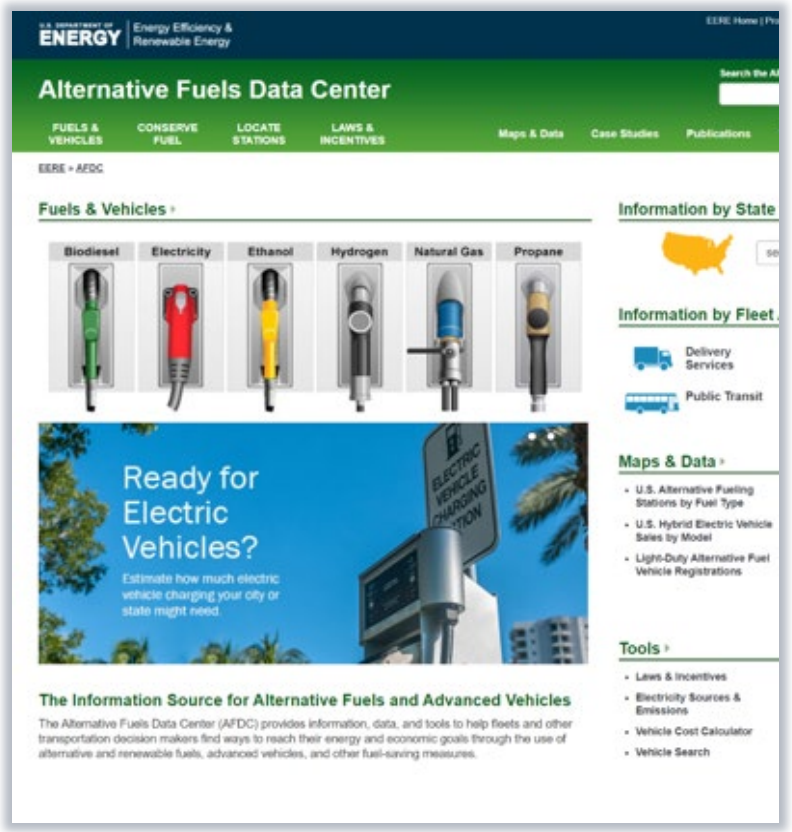
Clean Cities
U.S. Department of Energy

Alternative Fuels Data Center



Clean Cities
U. S. Department of Energy

Resources



afdc.energy.gov

fueleconomy.gov

Clean Cities
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

Clean Cities
U. S. Department of Energy

CENTRALINA
CLEAN FUELS COALITION
A US DOE CLEAN CITIES COALITION

CENTRALINA
REGIONAL COUNCIL

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

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OAK RIDGE National Laboratory

Fueleconomy.gov

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

EPA United States Environmental Protection Agency

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November 10, 2020

Stacy C. Davis

Current Team Members

Gina Accawi
Debbie Bain
Robert Boundy
Kita Cranfill
Stacy Davis
Colby Earles
Robert Gibson
Kerry Hake
Janet Hopson
Shean Huff
Jia (Lisa) Li
Karen Nolen
Jackie Richardson
Scott Sluder
John Thomas
W. T. Wilson

The Fuel Economy Information Program at ORNL

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

1. Annual Fuel Economy Guide (required by statute)
2. Fueleconomy.gov website
3. Fuel economy research

- **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

Finding Find a Car Searches

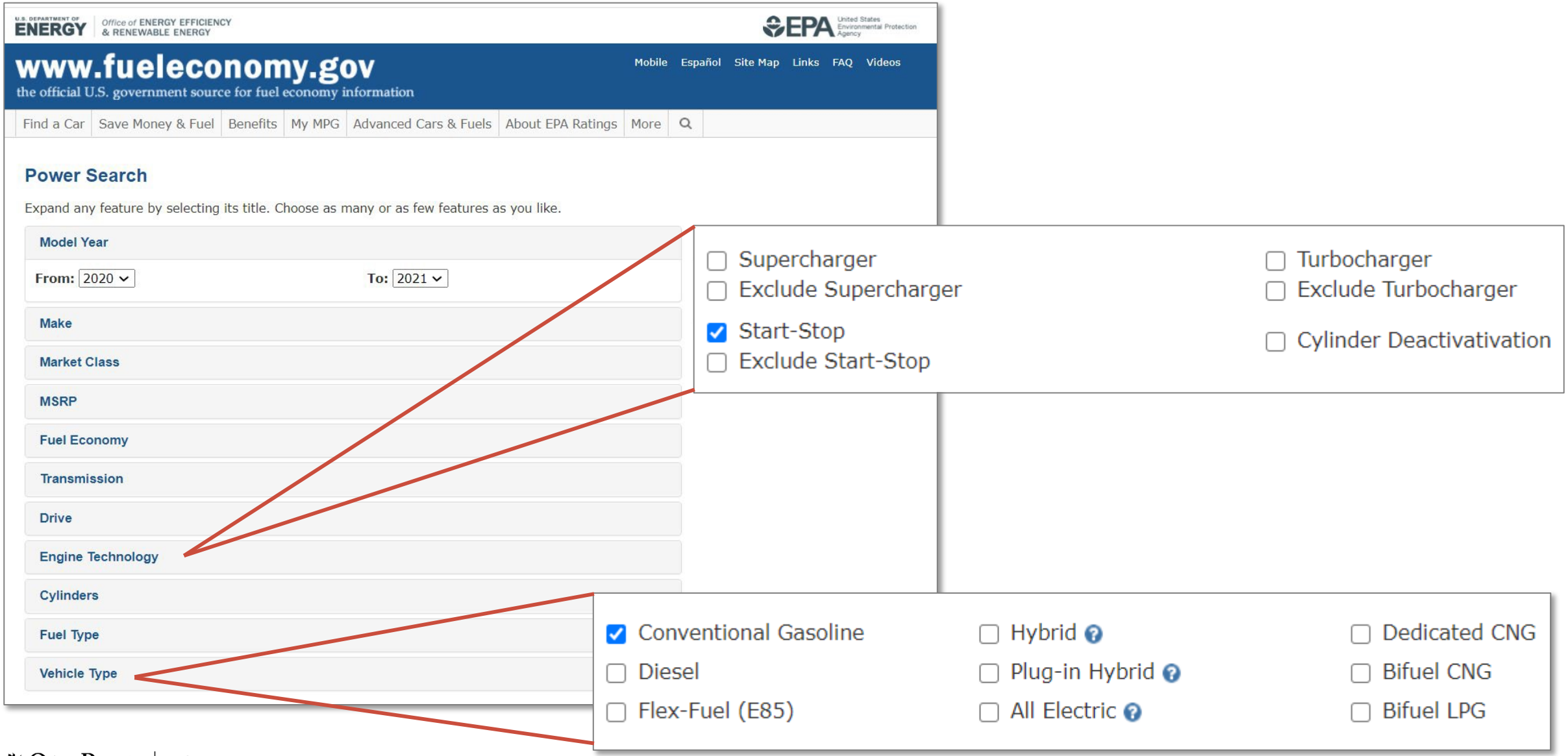
Click on "Find a Car" top menu

Power Search

Find a Smartway Vehicle

Power Search

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



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
2021 Hyundai Elantra 2.0 L, 4 cyl, Automatic (AV-S1), Regular Gasoline	37 MPG combined (33 city, 43 hwy) 2.7 gal/100 mi	NA	$850
2020 Volkswagen Jetta 1.4 L, 4 cyl, Automatic (S8), Turbo, Regular Gasoline	34 MPG combined (30 city, 40 hwy) 2.9 gal/100 mi	NA	$950
2021 Honda Accord 1.5 L, 4 cyl, Automatic (variable gear ratios), Turbo, Regular Gasoline	33 MPG combined (30 city, 38 hwy) 3 gal/100 mi	NA	$950
2021 Volkswagen Jetta 1.4 L, 4 cyl, Automatic (S8), Turbo, Regular Gasoline	33 MPG combined (29 city, 39 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

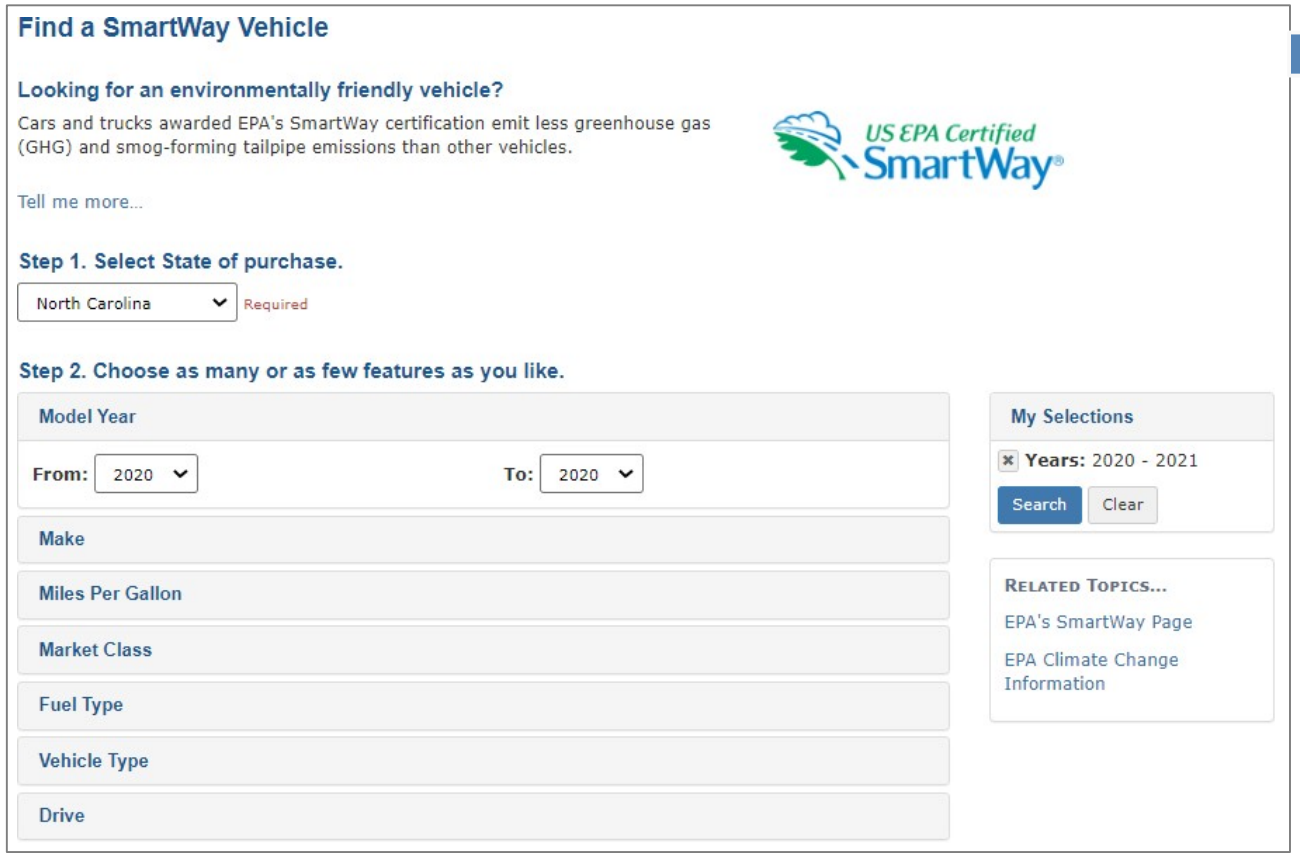
Fuel Economy | Energy and Environment | Safety | Specs

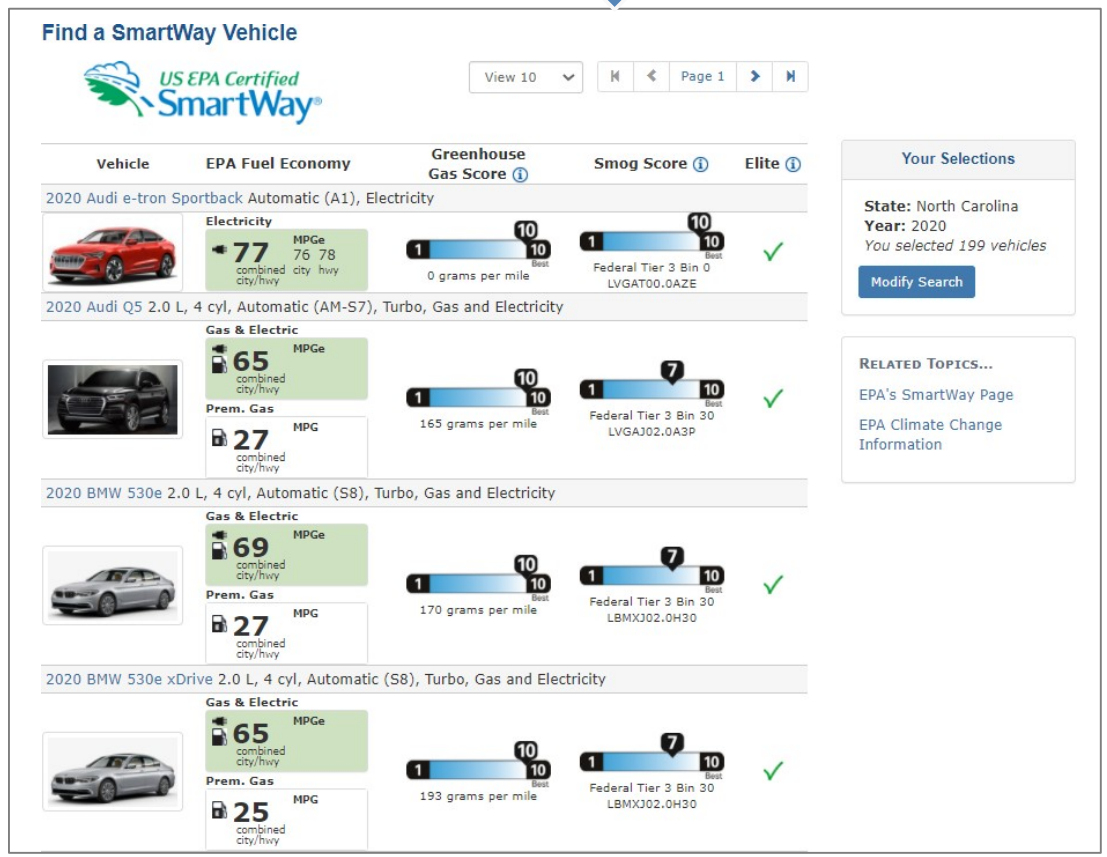
Personalize | Edit Vehicles

	2021 Hyundai Elantra	2020 Volkswagen Jetta	2021 Honda Accord	2021 Volkswagen Jetta
	Gasoline Vehicle	Gasoline Vehicle	Gasoline Vehicle	Gasoline Vehicle
	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 (33 city, 43 highway) 2.7 gal/100mi	Regular Gasoline 34 MPG combined (30 city, 40 highway) 2.9 gal/100mi Gasoline 449 miles Total Range	Regular Gasoline 33 MPG combined (30 city, 38 highway) 3.0 gal/100mi	Regular Gasoline 33 MPG combined (29 city, 39 highway) 3.0 gal/100mi
Unofficial MPG Estimates from Vehicle Owners Learn more about "My MPG" Disclaimer	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* Note: The average 2021 vehicle gets 27 MPG	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





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

Find Trip Calculator and Fuel Savings Calculator

https://fueleconomy.gov/trip/

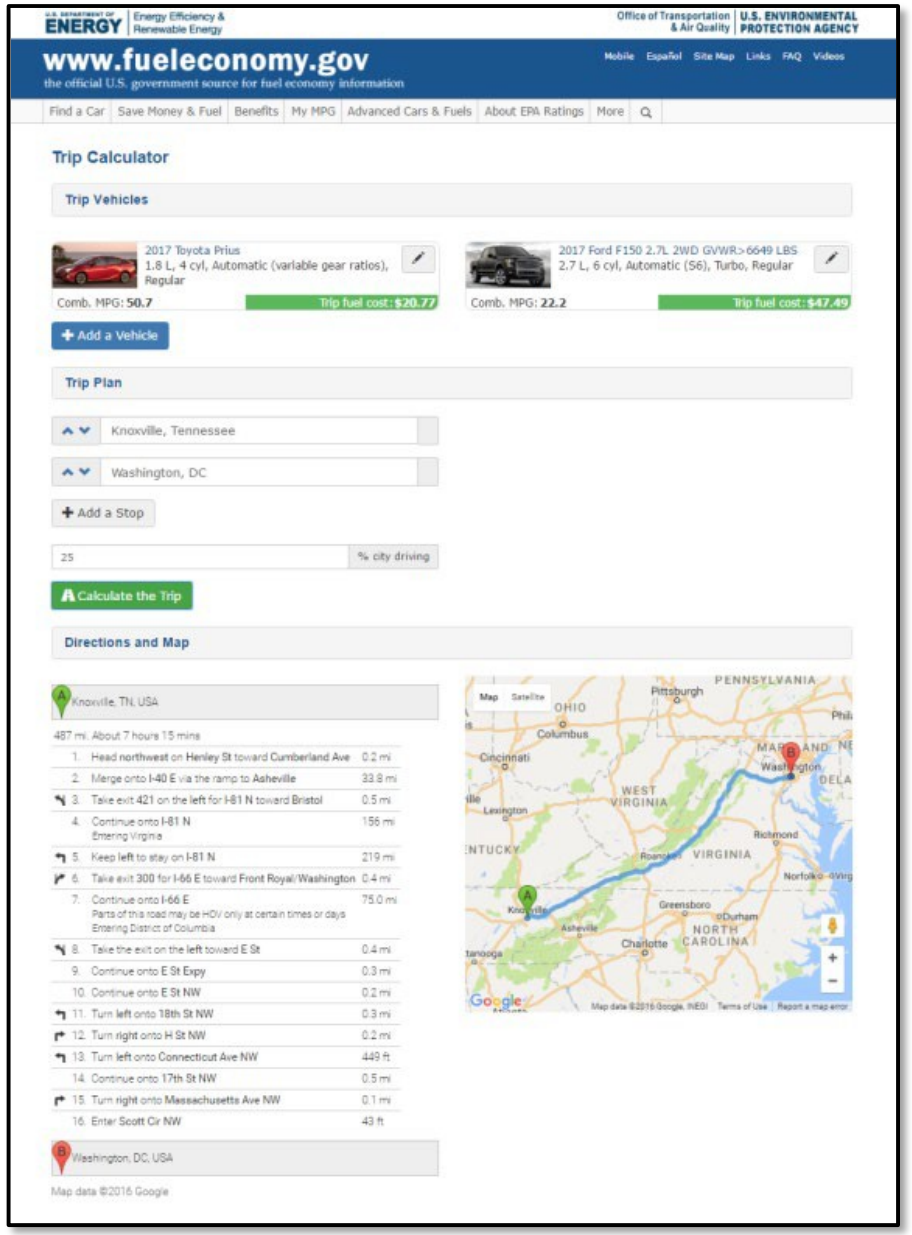
https://fueleconomy.gov/feg/savemoney.jsp

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!

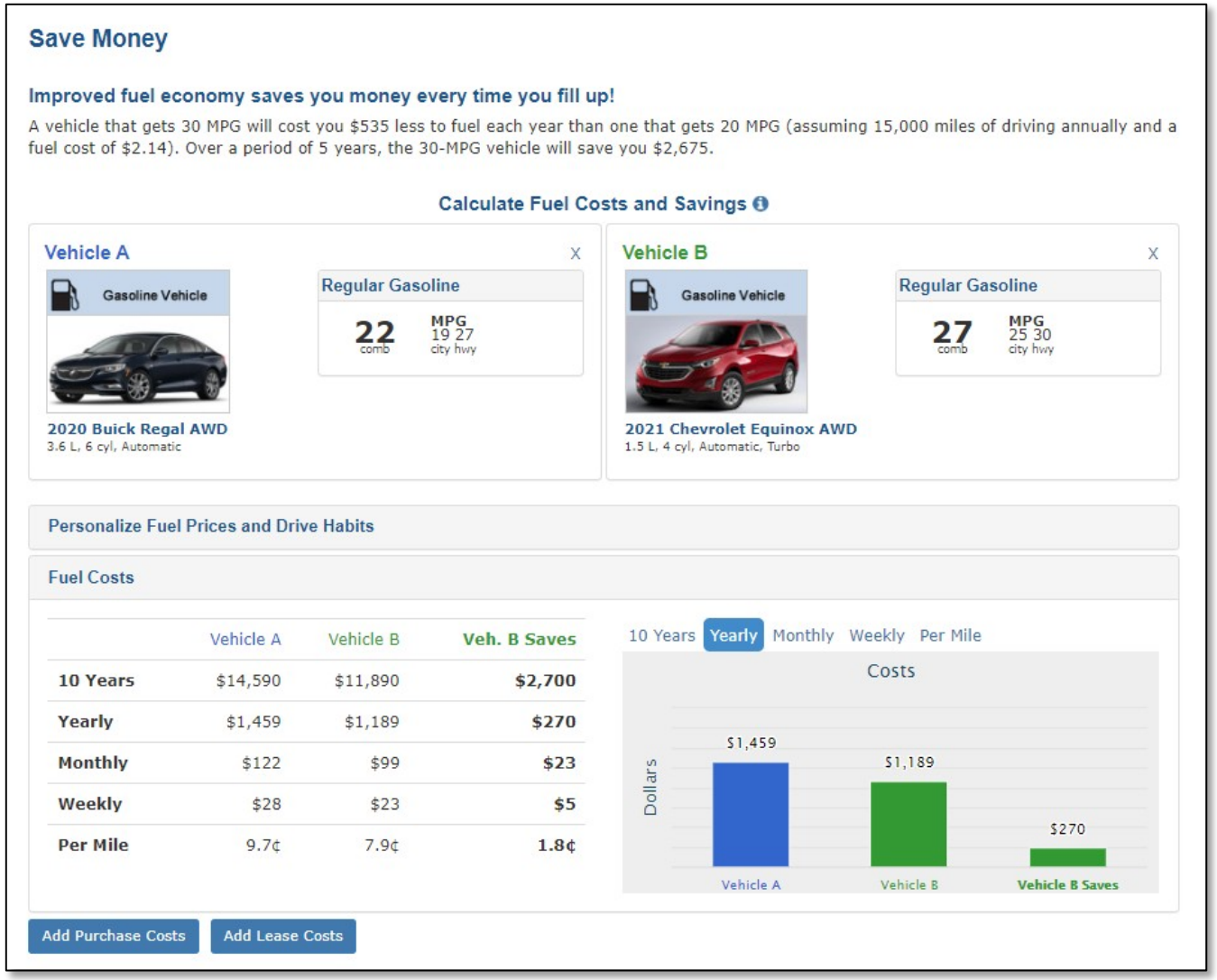


OAK RIDGE National Laboratory | NATIONAL TRANSPORTATION RESEARCH CENTER

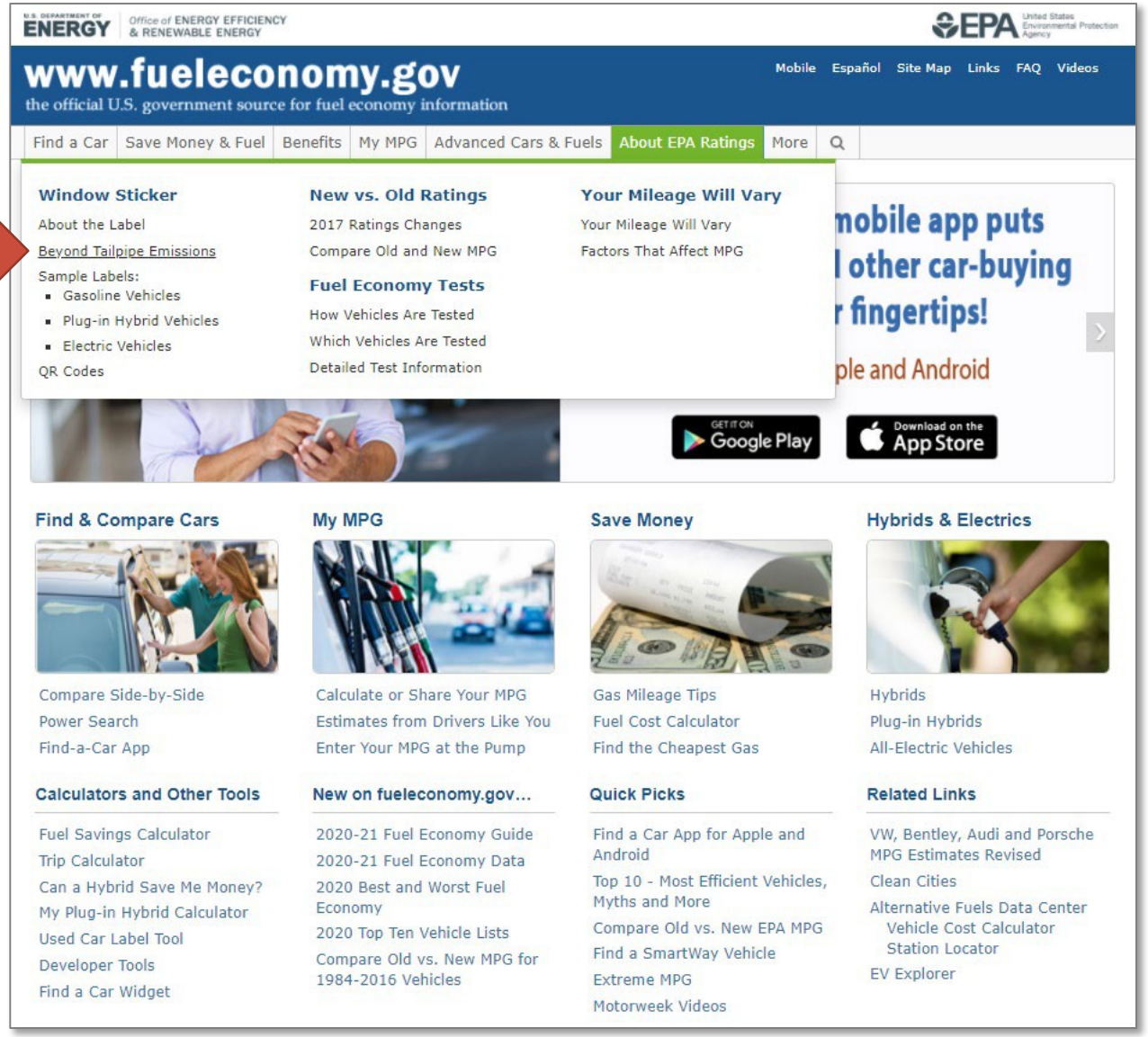
Fuel Savings Calculator

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



Finding Beyond Tailpipe Calculator



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.

Beyond Tailpipe Results

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

Beyond Tailpipe Emissions Calculator

Vehicle:

2018

Vehicle

Your Location:

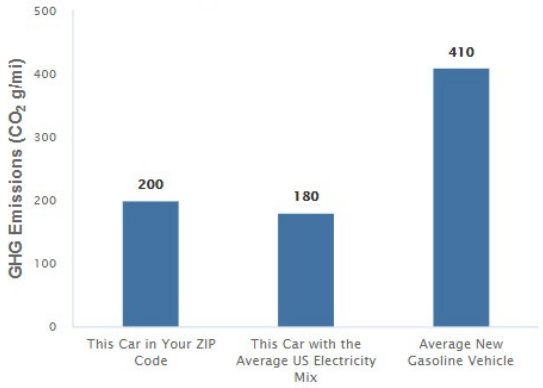
37771 (Lenoir City, TN)

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

Select vehicle

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

Comparing Total GHG Emissions*



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

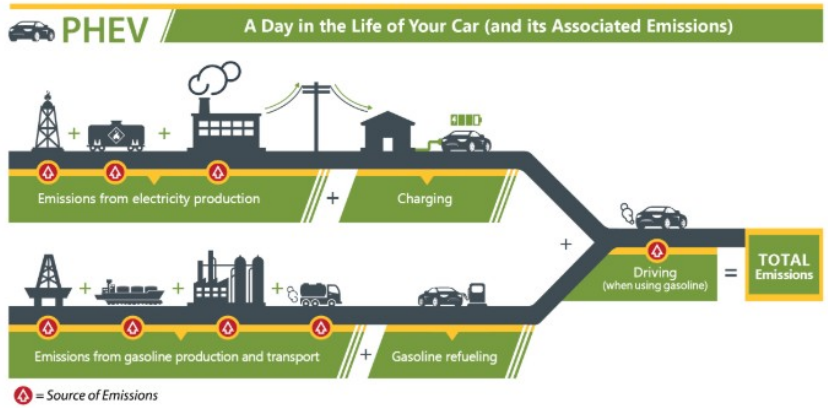
About these calculations

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 (CO_2) 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. CO_2 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 CO_2-intensive feedstocks. Plus, purchasing green power could lower your CO_2 emissions even more.

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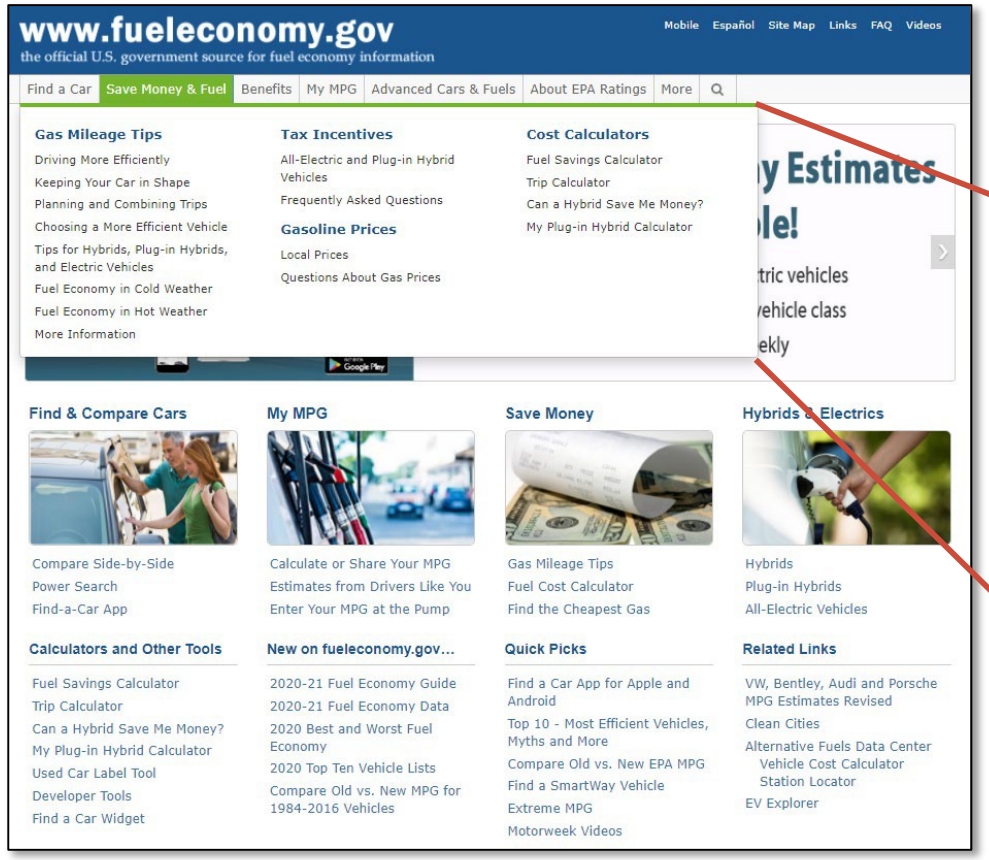
Save Money and Fuel



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

Gasoline Prices

Local Prices

Questions About Gas Prices

Cost Calculators

Fuel Savings Calculator

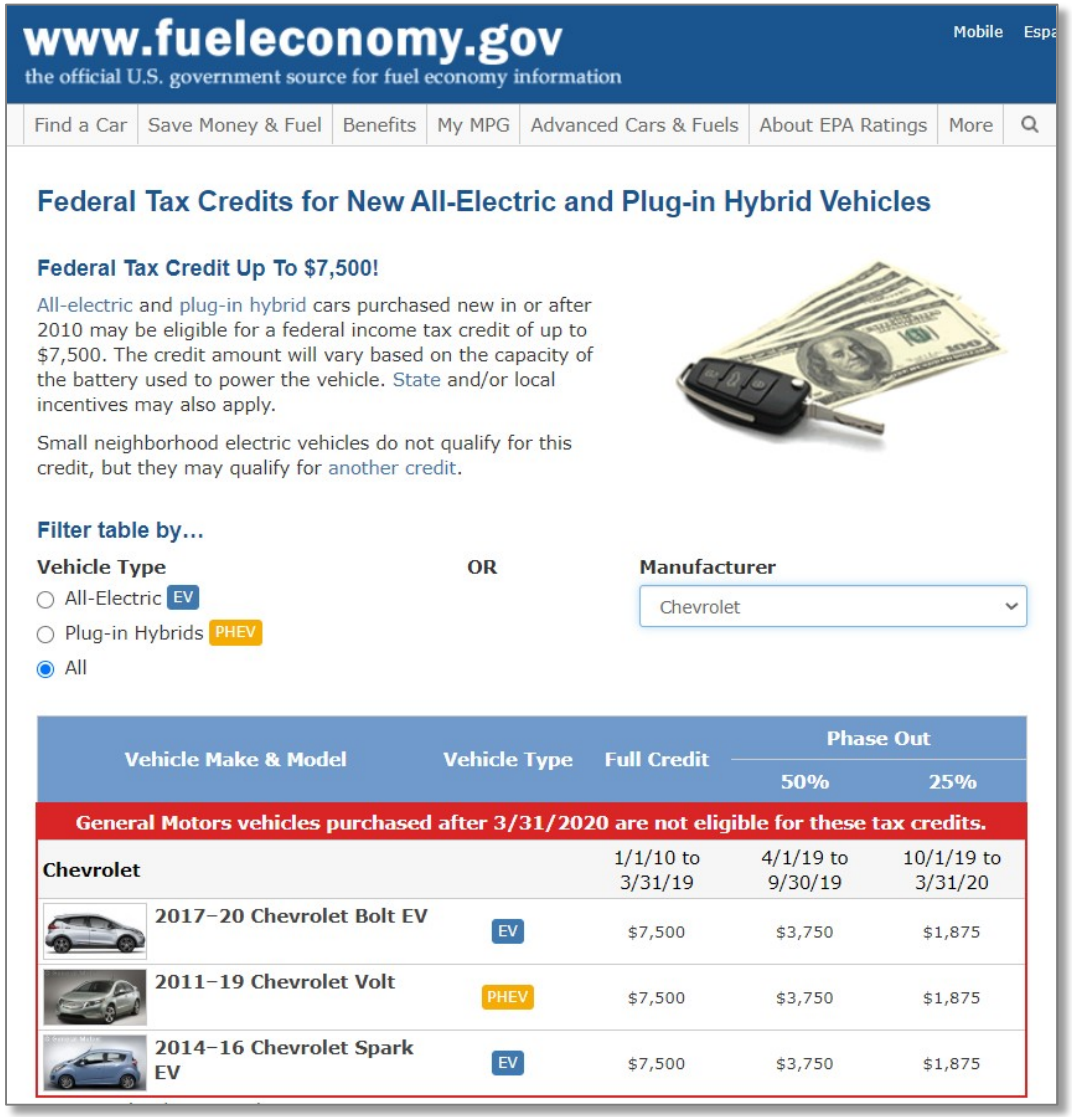
Trip Calculator

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



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

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

OR

Manufacturer: Chevrolet

Vehicle Make & Model	Vehicle Type	Full Credit	Phase Out 50%	Phase Out 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

Stacy C. Davis
Oak Ridge National Laboratory
(865) 341-1256
davissc@ornl.gov

Patricia Weikershimer
PWeikersheimer@anl.gov
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

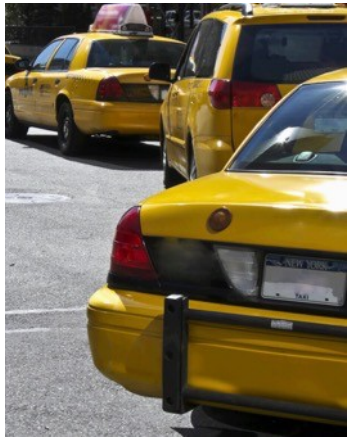
Argonne NATIONAL LABORATORY

IDLEBOX FOR IDLE REDUCTION EDUCATION AND OUTREACH

PATRICIA WEIKERSHEIMER
Argonne National Laboratory
pweikersheimer@anl.gov

November 10, 2020

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?

STOP Idling.
START $aving.

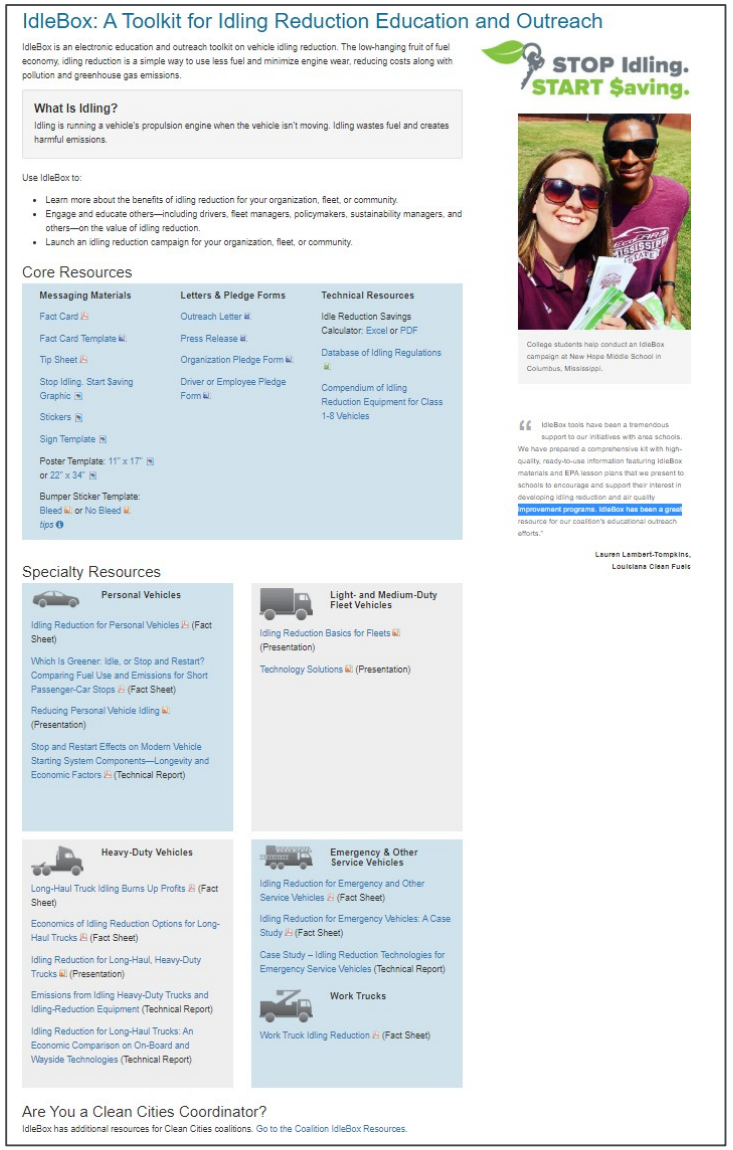
IdleBox is an **electronic, modular toolkit** to help you advance the acknowledged low-hanging fruit of fuel economy—**idling reduction**.

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.

STOP Idling. START $aving.

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 improvement programs. IdleBox has been a great resource for our coalition's educational outreach efforts."

Lauren Lambert-Tompkins, Louisiana Clean Fuels

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

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)

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 $aving Graphic
- Stickers
- Sign Template
- Poster Template: 11" x 17" or 22" x 34"
- Bumper Sticker Template: Bleed or No Bleed

tips

Letters & Pledge Forms

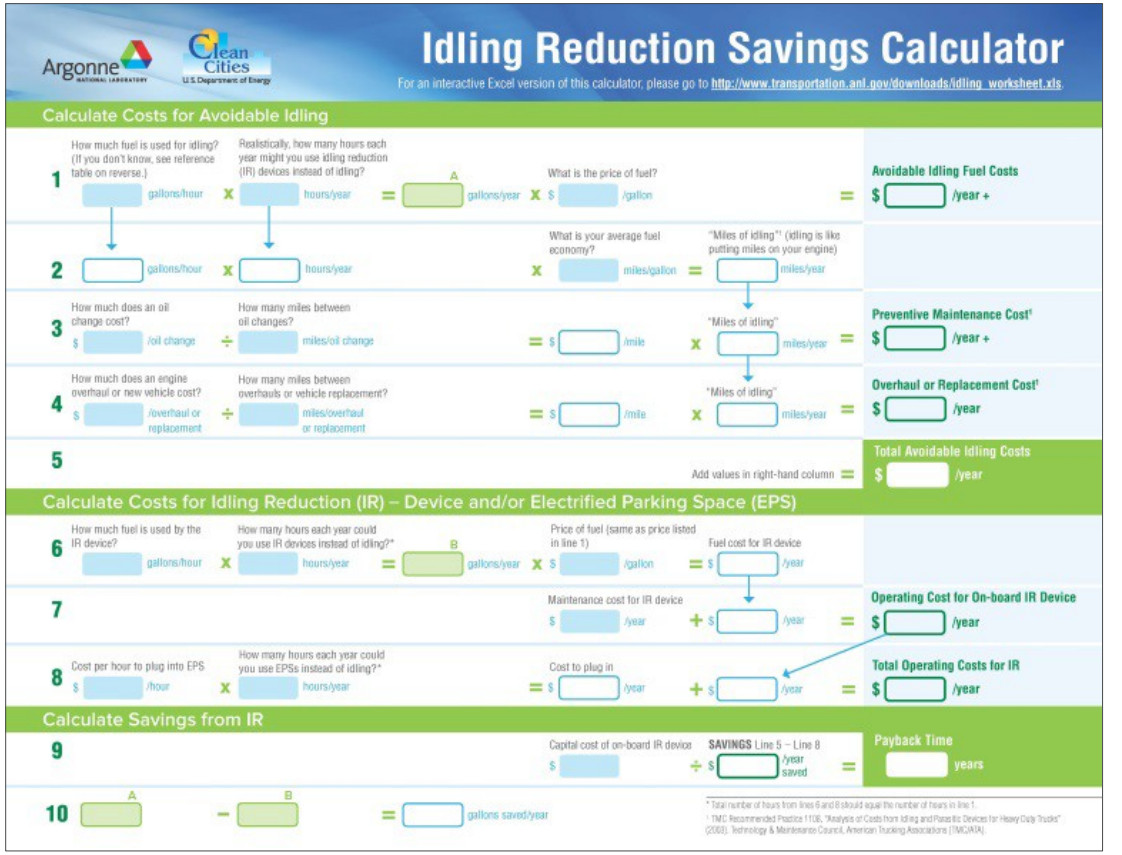
- Outreach Letter
- Press Release
- Organization Pledge Form
- Driver or Employee Pledge Form

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.



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

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

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Services provided	Vehicle type (LD, MD, HD, trailer)	Power source	Company/Product(s)	EPA verification‡	Notes
Idle management					
	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)

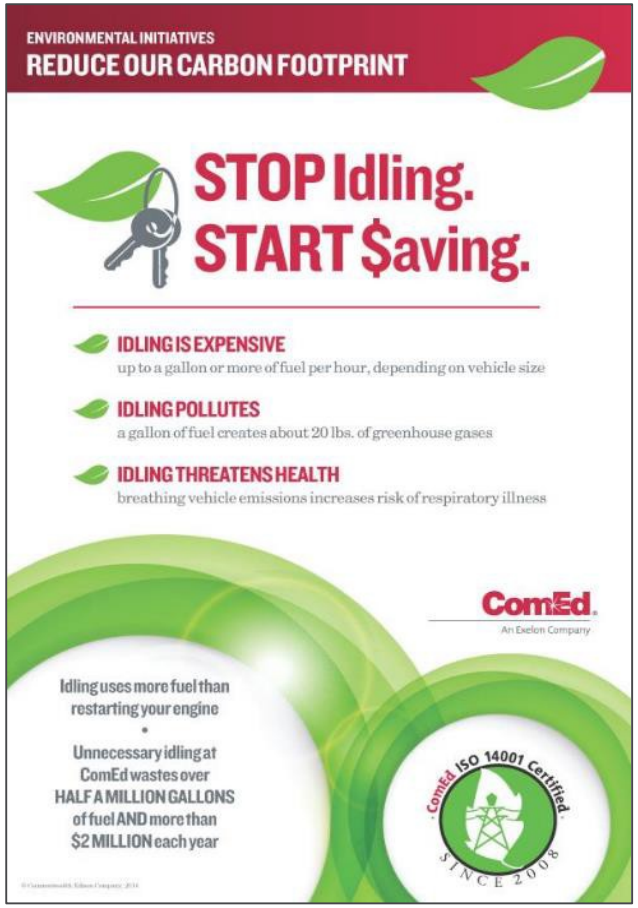
Idling Reduction For Emergency Vehicles: A Case Study (Fact Sheet)

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

Work Trucks

Work Truck Idling Reduction (Fact Sheet)

OTHERS' USE OF IDLEBOX MESSAGING



ComEd, Illinois's largest electric utility

Bank of Utah

Kane County, Illinois

THANK YOU

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

Argonne's Technology Integration/Clean Cities Team supporting 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

2020 SUSTAINABLE FLEET TECHNOLOGY VIRTUAL CONFERENCE

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"AFLEET TOOL" TO ANALYZE THE COSTS AND BENEFITS OF ALTERNATIVE FUEL VEHICLES

ANDY BURNHAM
Principal Environmental Scientist
aburnham@anl.gov

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

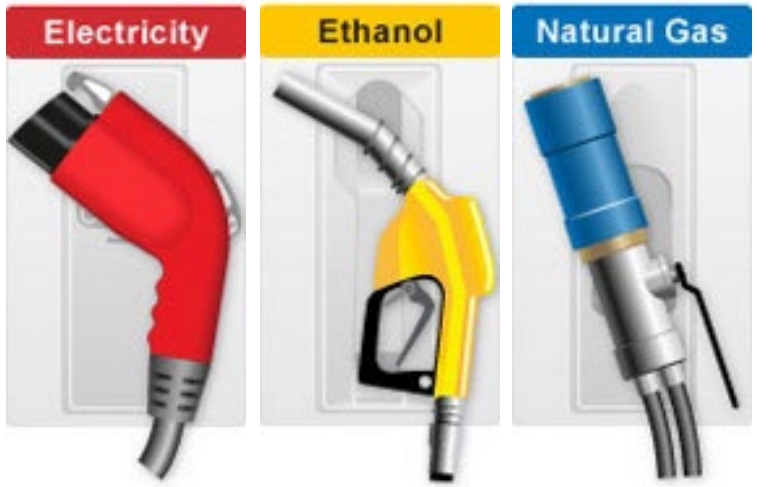
Compares NOx, PM, GHGs and cost-effectiveness

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, H_2, 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

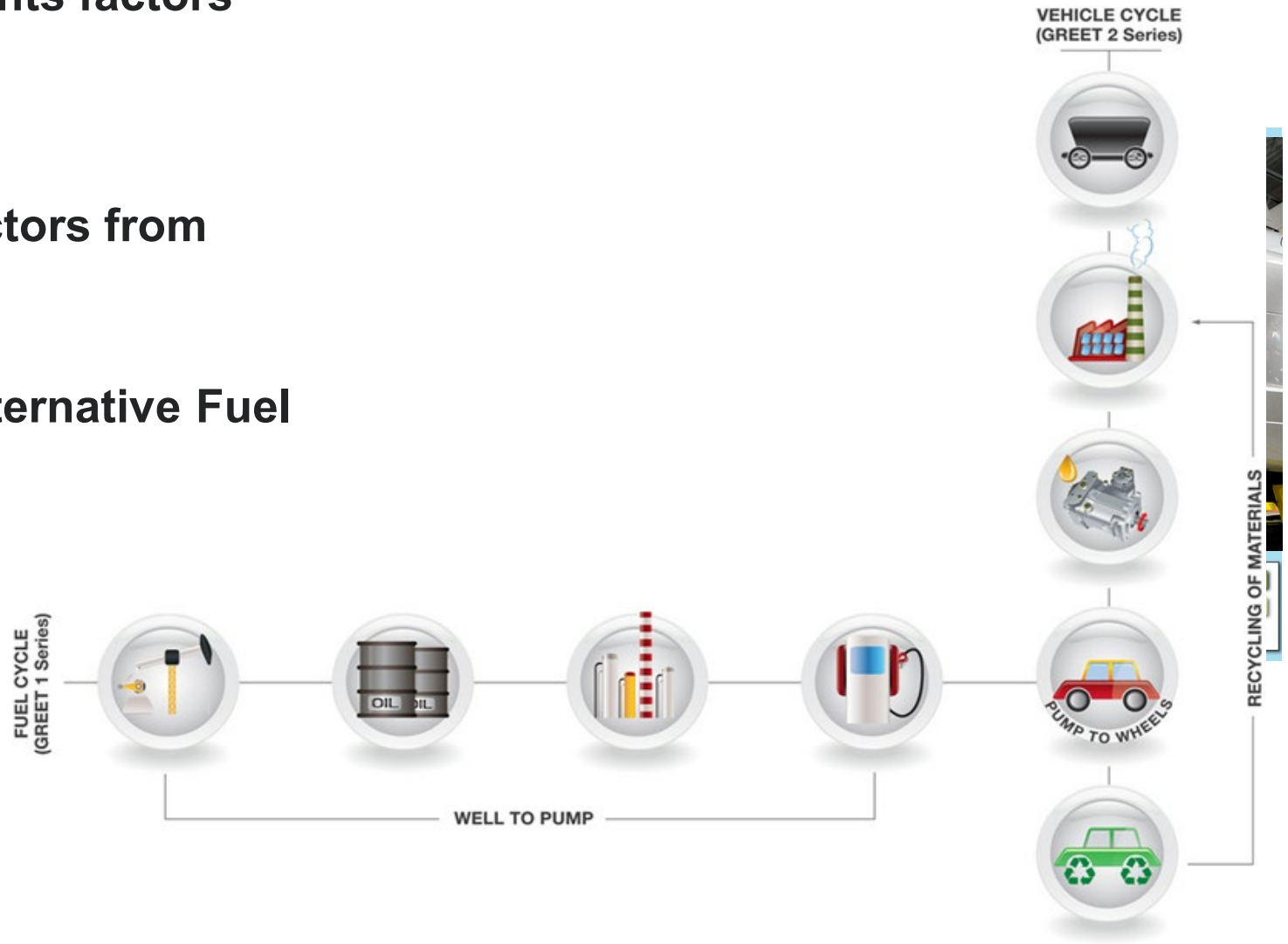
AFLEET TOOL'S CALCULATION METHODS

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

*red text = new feature

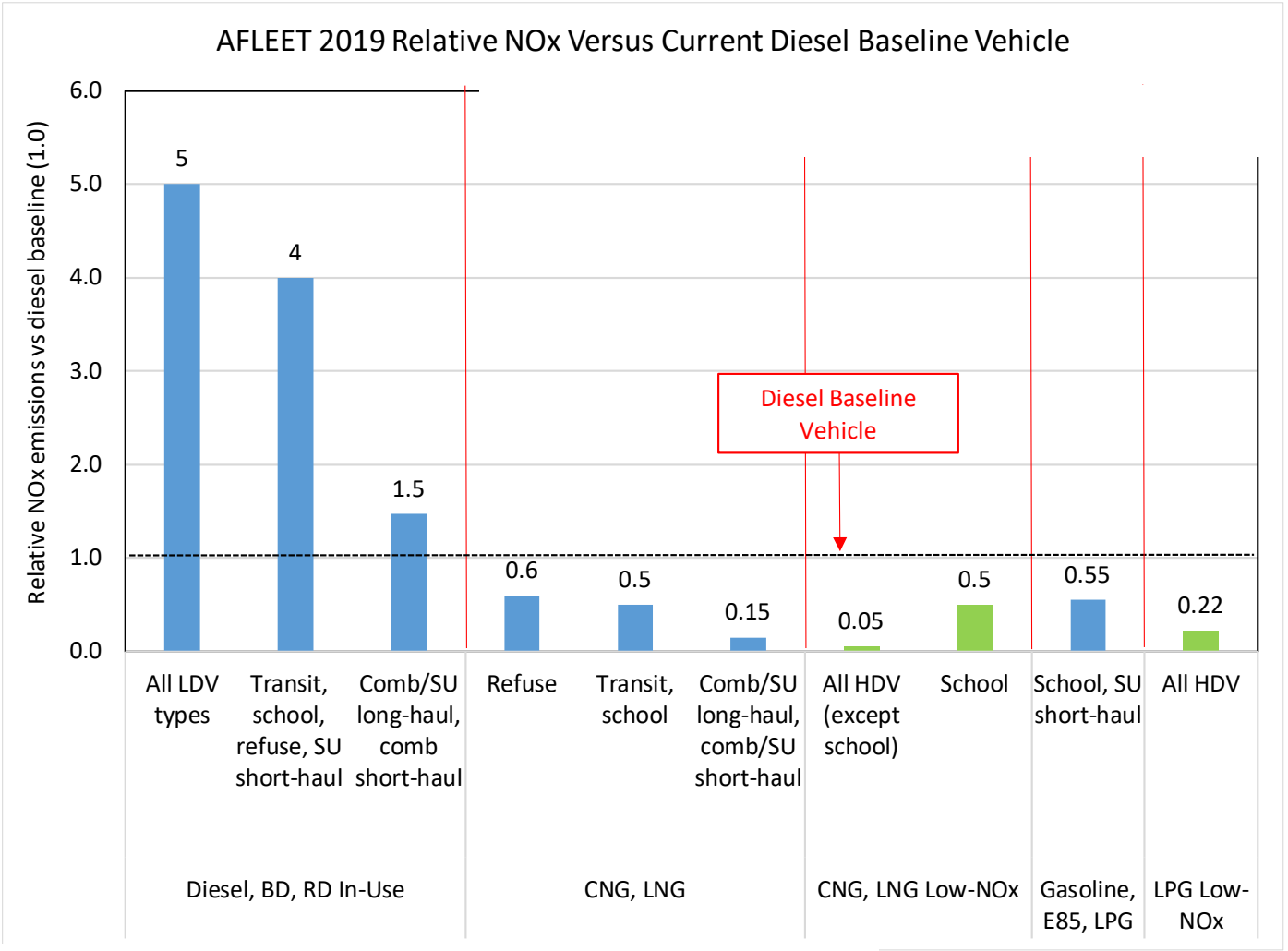
KEY DATA SOURCES

- **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 NOx feature**
  - EPA's MOVES (& DEQ) needs to revise diesel NOx
- **Heavy-duty low-NOx feature**
  - Added LPG low-NOx in AFLEET 2019



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

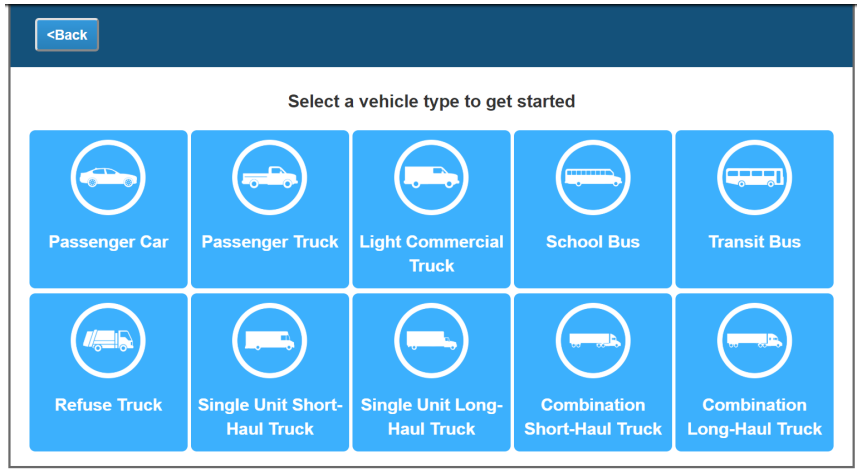
Cai, 2017, Wells to Wheels: Environmental Implications of Natural Gas As A Transportation Fuel

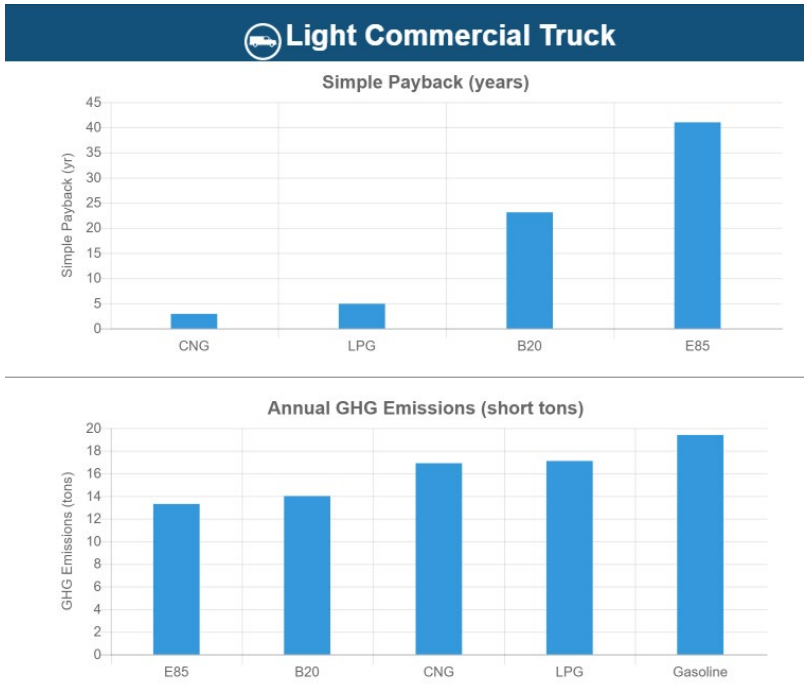
Sandhu, 2017, In-Use Emission Rates for MY 2010+ Heavy-Duty Diesel Vehicles

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/**





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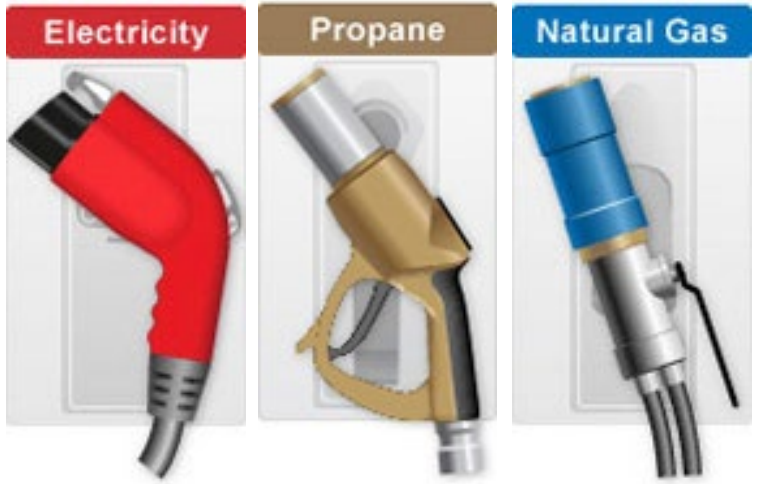
HDVEC Introduction

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 & $PM_{2.5}$
  - 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

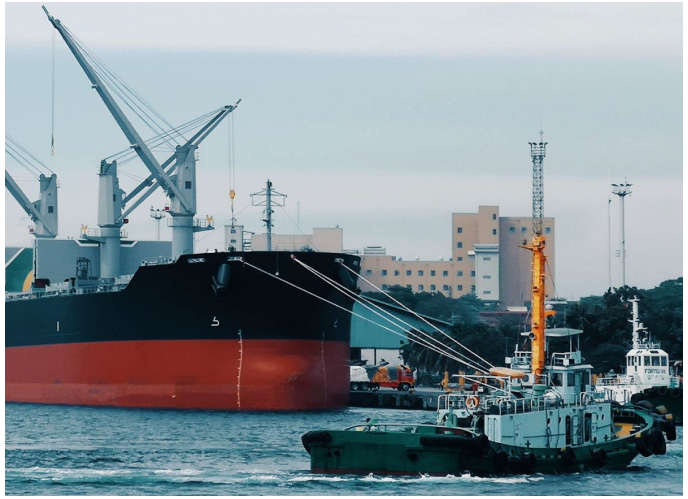
- **Environmental Mitigation w/ Scrappage**
  - New AFV vs. new diesel, plus additional benefit from early retirement of scrapped vehicle

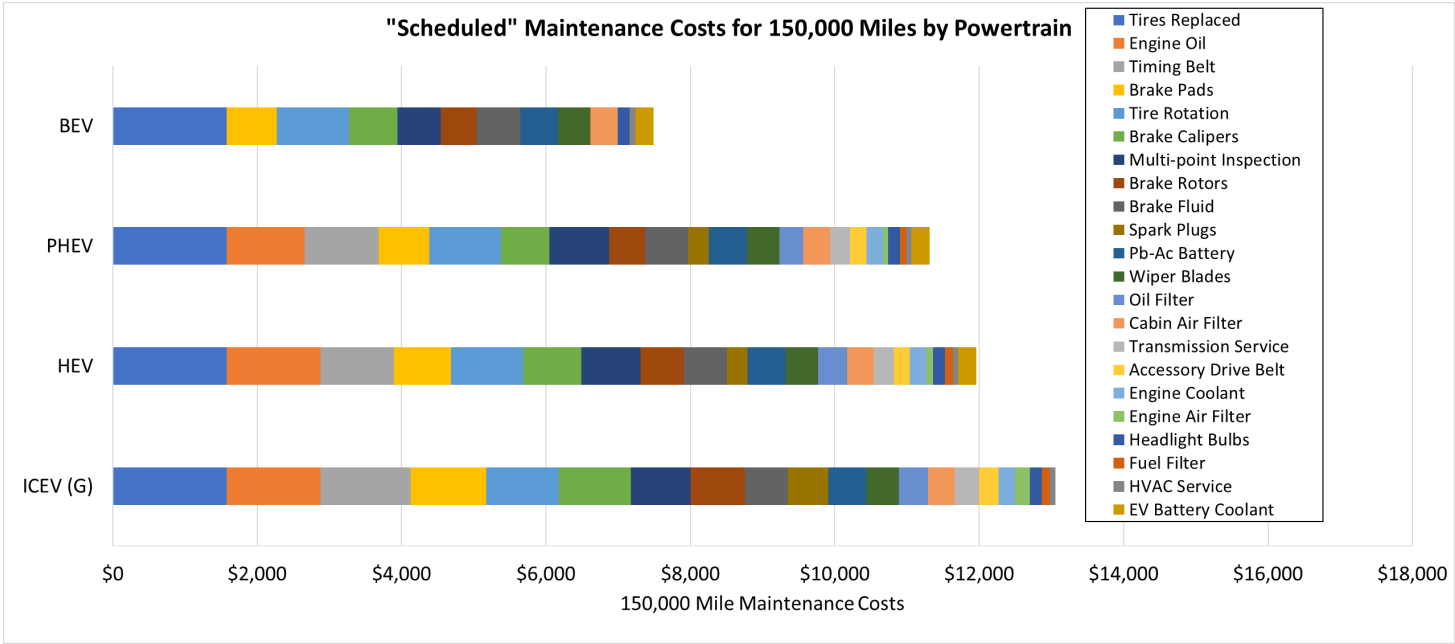
- **Environmental Mitigation w/ Repower**
  - Vehicle after repower vs. diesel vehicle before repower

- **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

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

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

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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

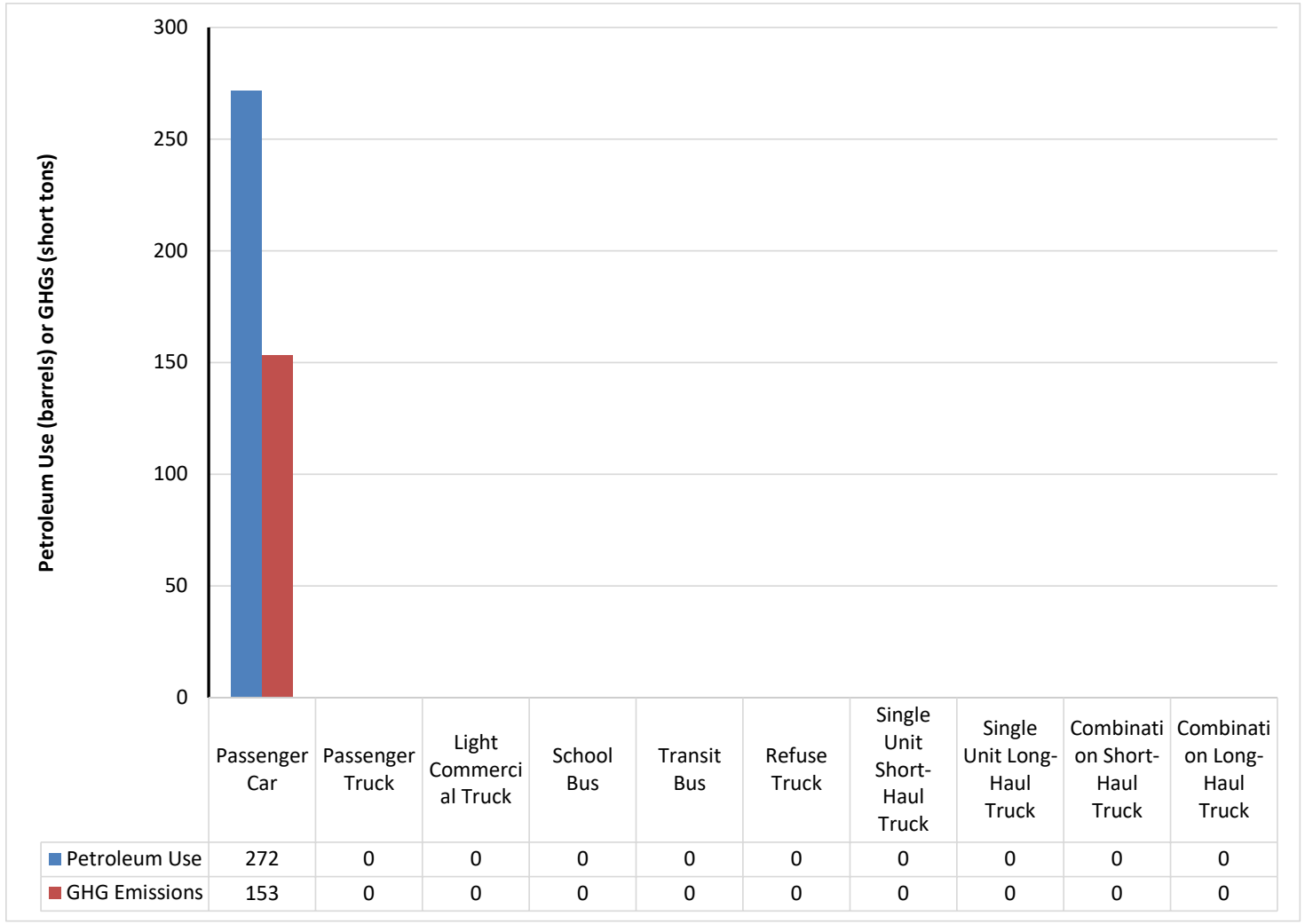
AFLEET TUTORIAL – FLEET FOOTPRINT CALCULATOR

- **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**



	Passenger Car	Passenger Truck	Light Commercial Truck	School Bus	Transit Bus	Refuse Truck	Single Unit Short-Haul Truck	Single Unit Long-Haul Truck	Combination Short-Haul Truck	Combination Long-Haul Truck
Petroleum Use	272	0	0	0	0	0	0	0	0	0
GHG Emissions	153	0	0	0	0	0	0	0	0	0

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
Light-Duty Vehicle Inputs							
Vehicle Type	Passenger Car						
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

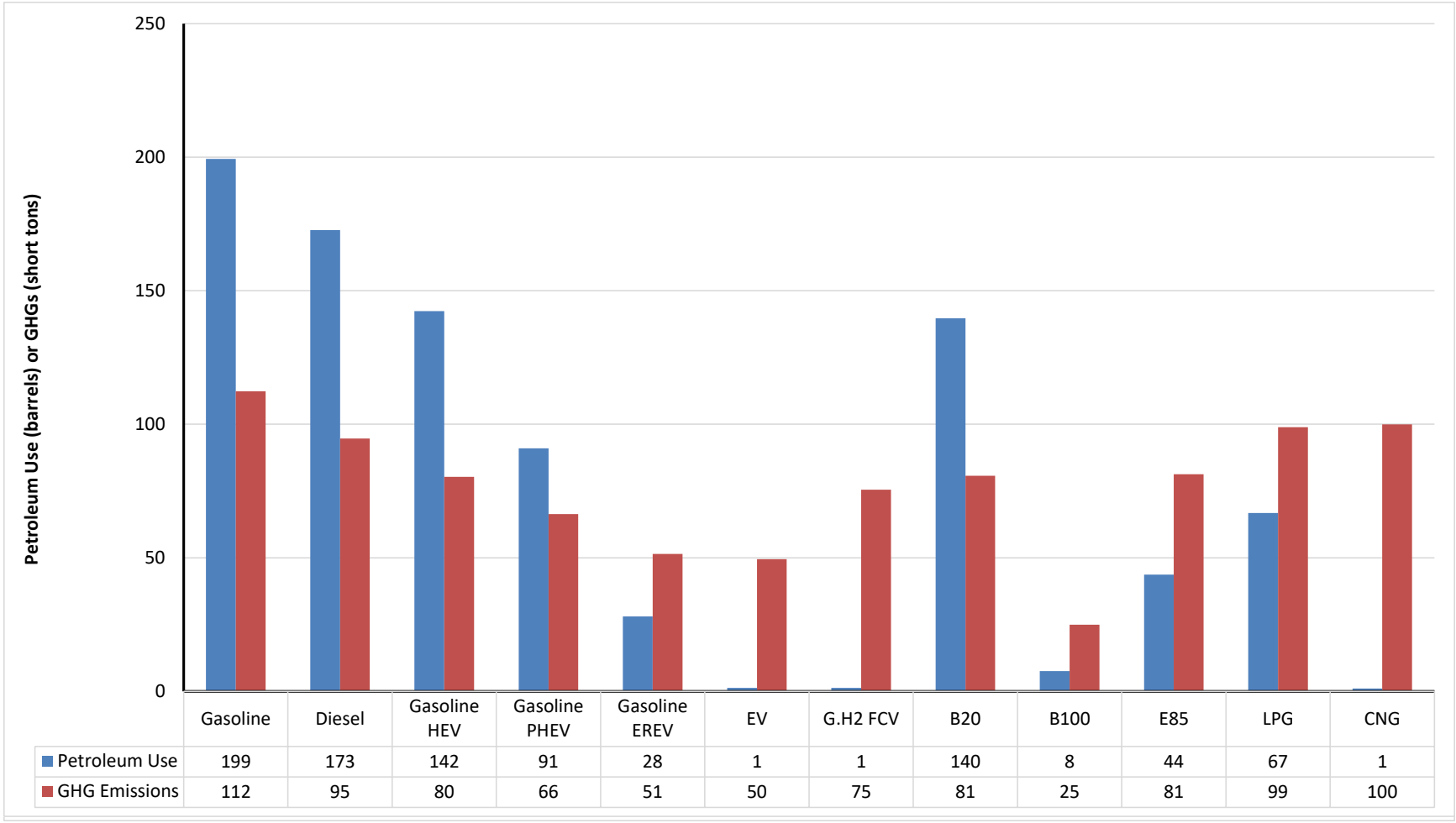
- **7th step: if examining infrastructure costs, enter additional data on "Payback" sheet**
  - Enter station type (via drop down), number of stations, and station & O&M costs

	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 & Mainter	$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 (	$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**



	Gasoline	Diesel	Gasoline HEV	Gasoline PHEV	Gasoline EREV	EV	G.H2 FCV	B20	B100	E85	LPG	CNG
Petroleum Use	199	173	142	91	28	1	1	140	8	44	67	1
GHG Emissions	112	95	80	66	51	50	75	81	25	81	99	100

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

Argonne NATIONAL LABORATORY

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NC CLEAN ENERGY TECHNOLOGY CENTER

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION