# Future Automotive Systems Technology Simulator (FASTSim)

The Future Automotive Systems Technology Simulator (FASTSim) provides a simple way to compare powertrains and estimate the impact of technology improvements on light-, medium-, and heavy-duty vehicle efficiency, performance, cost, and battery life. Created by the National Renewable Energy Laboratory, FASTSim accommodates a range of vehicle types—including conventional vehicles, electric-drive vehicles, and fuel cell vehicles—and is available for free download in Microsoft Excel and Python formats at *www.nrel.gov/fastsim*.

FASTSim flow of analysis
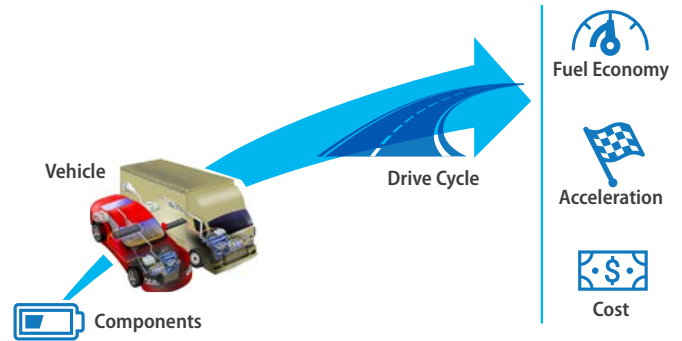
FASTSim Highlights

This extremely fast simulation tool features a streamlined user interface and can rapidly perform a variety of tasks:

• < 0.1 second to simulate second-by-second standard duty cycles
• < 10 seconds to estimate vehicle efficiency, fuel economy, acceleration, battery life, and cost
• < 5 minutes to perform powertrain comparisons of efficiency and cost.
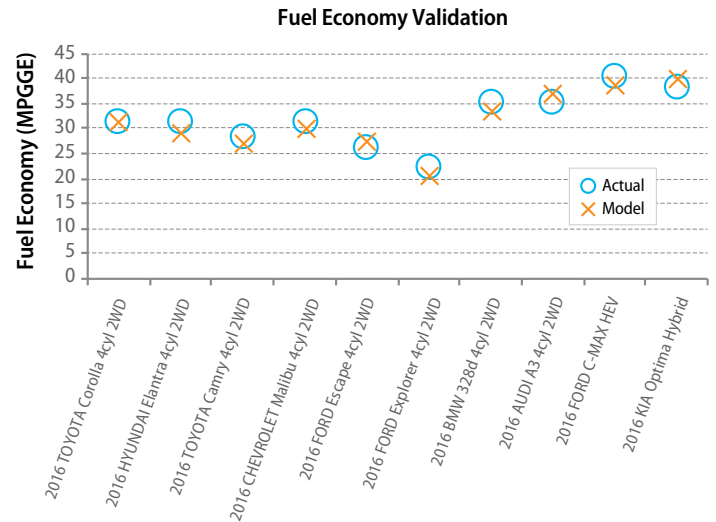
FASTSim models a wide variety of vehicle powertrains and fuel converter types:

• Conventional vehicles (CVs) – spark ignition, Atkinson, diesel, and hybrid diesel
• Electric-drive vehicles – hybrid (HEV), plug-in hybrid (PHEV), and all-electric (EV)
• Hydrogen fuel cell vehicles (FCVs).

The default model includes a variety of vehicles and duty cycles and an option for adding additional vehicles and custom cycles:

• Packaged with more than 20 vehicles
• User interface enables addition of more vehicles
• Includes standard U.S. drive cycles as well as European and Japanese cycles.

Sample validation results for a variety of vehicles

Answering Research Questions with FASTSim

Thousands of researchers in academia, government, and industry have downloaded FASTSim to date. FASTSim's ability to rapidly simulate fuel and energy consumption results facilitates large-scale evaluation of vehicle performance under a range of driving conditions. This enables researchers to quantify relative energy consumption differences among a variety of vehicle or powertrain alternatives and determine how these differences change in varying driving environments or applications.
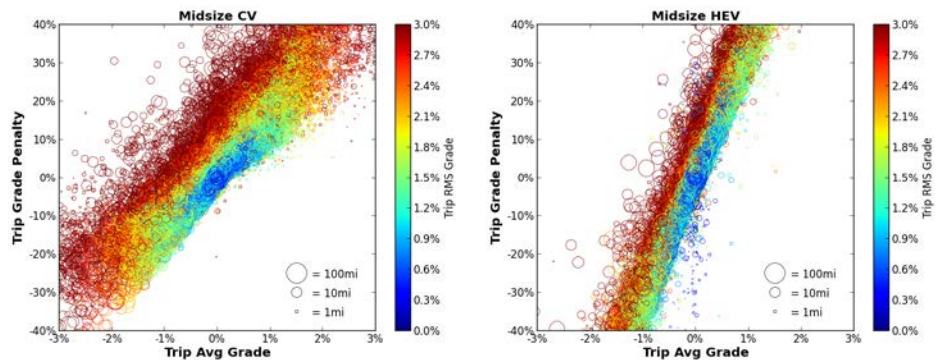
Sample published results showing simulated results from tens of thousands of duty cycles
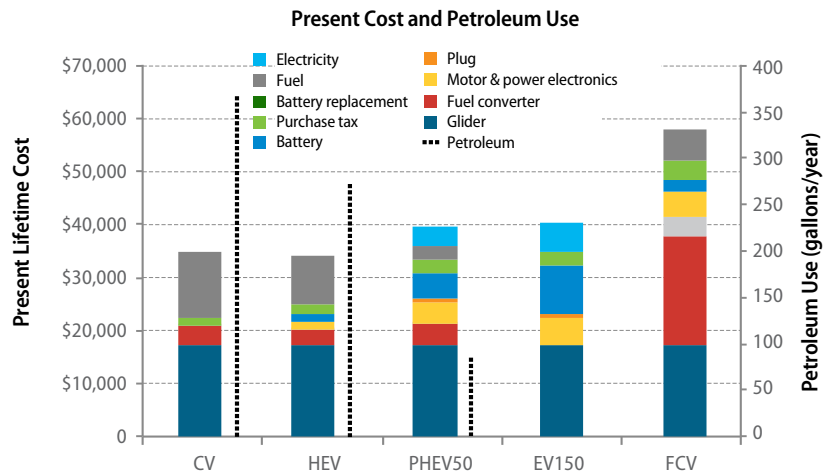
Microsoft Excel Version of FASTSim

Easy to Use, Enables Flexible Analysis

The Excel version of FASTSim features an interactive user interface that simplifies the process of importing new vehicle data and custom drive cycles. It can also handle design-of-experiment inquiries.

Enhanced Capabilities

In addition to calculating energy consumption, the Excel version of FASTSim enables life-cycle cost comparisons, battery life comparisons, component sizing tradeoffs, and more.

Present Cost and Petroleum Use

Legend:
- Electricity
- Fuel
- Battery replacement
- Purchase tax
- Battery
- Plug
- Motor & power electronics
- Fuel converter
- Glider
- Petroleum

Y-axis (left): Present Lifetime Cost — $10,000 to $70,000
Y-axis (right): Petroleum Use (gallons/year) — 0 to 400
X-axis: CV, HEV, PHEV50, EV150, FCV

Powertrain comparison example

Python Version of FASTSim

**Compatible with Large Datasets**

The Python version of FASTSim easily integrates with large duty-cycle databases. Pairing with the Transportation Secure Data Center at *www.nrel.gov/tsdc*, for example, facilitates multi-day simulations incorporating vehicle dwell times.

When paired with geo-spatial cycles, FASTSim helps users draw conclusions at the regional level by incorporating such factors as temperature, roadway characteristics, or driving behavior.

Customizable for More Specific Analysis

The component models in the Python version are easily expandable and can be adjusted to incorporate additional energy consumption impacts.

Model flexibility and speed simplify A/B comparisons for a vehicle powertrain, control strategy, or technology. Its large number of included vehicles and computational efficiency makes calculating impacts at the fleet-level easy.

Real-World Impacts

Drive Cycle Database

FASTSim Python

Enhanced Component Models (optional)
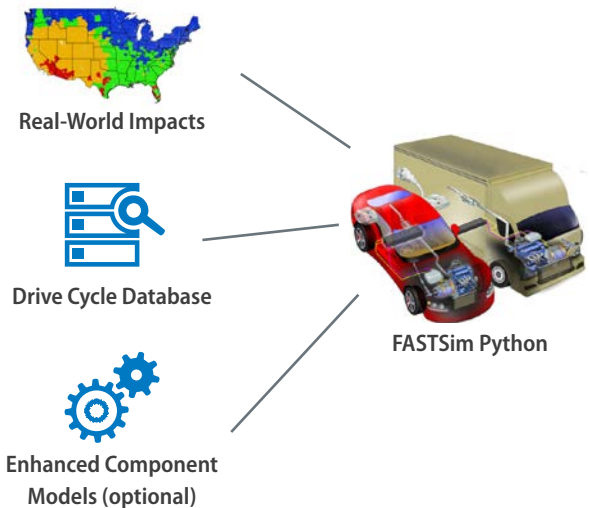
Workflow for large-scale, regional studies

Contacts

Visit the website at *www.nrel.gov/fastsim* for more information or to download a free copy of FASTSim.

For general inquiries or suggestions, please contact *fastsim@nrel.gov*.

To discuss partnership opportunities or potential technology benefit evaluations (such as customized national-level off-cycle benefit quantifications), contact *Eric.Wood@nrel.gov*.