Progress on Fuel Efficiency and Market Adoption

Introduction

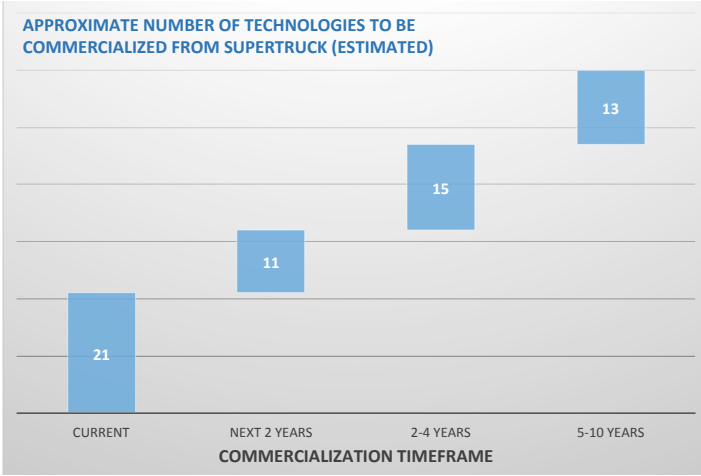
The Department of Energy (DOE) launched the SuperTruck initiative in 2009 with the goal of developing and demonstrating a 50 percent improvement in overall freight efficiency (expressed in a ton-mile per gallon metric) for a heavy-duty Class 8 tractor-trailer.

To date, the industry teams participating in the initiative have successfully met or are on track to exceed this goal, leveraging suites of technologies that hold significant potential for market success.

- Cummins/Peterbilt have demonstrated a freight efficiency improvement of 86 percent on an on-road 500+ mile two-day round trip highway test route.
- Daimler demonstrated a freight efficiency improvement of 115 percent through on-road vehicle testing over a 5-day, 312-mile round trip.
- Volvo demonstrated 88 percent improvement over a customer drive-cycle.
- Navistar is on track to meet the freight efficiency goal and is projecting an improvement of 80 percent or more.

Daimler Super Truck
Source: Daimler 2015 DOE Vehicle Technologies Office

SuperTruck teams have successfully commercialized approximately 21 technologies to date, including breakthroughs in the areas of aerodynamics and engine/drivetrain integration. These capabilities hold enormous value for current fleet buyers due to their cost-effectiveness and fuel saving potential. An estimated 26 additional technologies have the potential to succeed in the market in the next 2-4 years, while roughly 13 SuperTruck technologies offer the promise of additional fuel savings within the next five or ten years, particularly in the areas of more advanced aerodynamics packages and further engine thermal efficiency improvements.



These results are significant because, as estimated by the U.S. Department of Transportation, Class 8 tractor and trailers use approximately 28 billion gallons of fuel per year (or around 22% of total transportation energy use). This fuel is used in about 2.5 million trucks, which travel approximately 66,000 miles per year per truck. The results of these teams demonstrate the enormous fuel and efficiency savings that can be gained from technological innovation.

To date, the SuperTruck teams have been very successful at meeting or exceeding the goals set forth by the SuperTruck initiative with suites of technologies that can potentially achieve market success.

Current and Near-Term Supertruck Technologies

A number of technologies included in the SuperTruck initiative have already been developed for commercial products, or are nearing that stage. Table 1 lists both current commercialized technologies and near-commercial technologies that manufacturers expect to deploy within the next two years. These technologies have either been deployed in some vehicles or are expected to be commercially available in the 2016 to 2017 timeframe.

	Commercialized technologies (current)	Near-commercial technologies (next 2 years) Technology Readiness Level 8 (End of System Development)
Engine	• Downspeeding • Intelligent torque management • Integrated engine/transmission controls	• Friction loss reduction (lubricants, materials and coatings) • Parasitic loss reduction (engine accessories) • Improved conventional combustion • Improved aftertreatment • Improved air handling (Exhaust Gas Recirculation [EGR], turbocharger) • Synthetic engine lubrication
Driveline	• Automated manual transmissions (AMTs) • Predictive transmission shifting • Optimized transmission gear ratios for downspeed engines • Transmission/engine integration • 6x2 axles • Neutral shifting on downgrades • Reduced parasitic losses (lubricants and transmission design)	• Improved driveline lubricants for reduced friction
Aerodynamics	• Tractor aerodynamics (bumper designs, roof fairings, chassis fairings, tractor/trailer gap fairings) • Trailer aerodynamics (side skirts, boat tails, gap fairings)	• Trailer aerodynamics (full trailer skirts including trailer wheels, engineered trailer surfaces for reduced drag)
Weight Reduction	• Aluminum fifth wheel • Aluminum tractor and trailer wheels • Aluminum driveshaft	• Lightweight brakes
Tire Rolling Resistance	• Single wide-base tires (tractor and trailer tandems) • Reduced rolling resistance tire compounds and designs	• Continued improvement in tire compounds and designs
Energy Management	• Predictive Global Positioning System (GPS) cruise control • Eco-driving feedback systems • Light Emitting Diode (LED) lighting • Overnight idling reduction (Auxiliary Power Unit [APU] or battery)	• Improvements to overnight idling reduction systems

Table 1. SuperTruck Technologies – Current and Near-Term Deployment

Opportunities for Mid- and Long-Term Technology Adoption

Additional technologies require more than two years of development to be commercially viable because of technology readiness, cost reduction, or regulatory compliance, among other factors. Technologies at this stage of readiness still require further research and development before their technical and commercial viability can be assessed. Table 2 lists these mid- to longer-term technologies.

	Mid-term technologies (2-4 years from commercialization) Technology Readiness Level 6-7 (System Demonstration)	Longer-term technologies (5 or more years from commercialization) Technology Readiness Level 4-5 (Component Validation)
Engine	• High pressure fuel injection systems • Improved combustion (e.g., piston bowl designs) • Further improvements to air handling (turbocharger, EGR) • Electrified auxiliaries (water pump, cooling fan, etc.)	• Waste heat recovery • Advanced engine controls • Engine structural materials for higher peak cylinder pressures
Driveline	• Dual clutch AMTs • Gear coatings and lubricants for reduced friction	• Electrified auxiliaries • Hybridization
Aerodynamics	• Active aerodynamic features (grill shutters, etc.) • More extensive redesigns of tractor aerodynamic surfaces (cabs, hoods, etc.) • Tractor and trailer underbody aerodynamics • Tractor/trailer gap reduction	• Cameras to replace mirrors • Articulating/active tractor/trailer gap closures • Reconfiguration of tractor and trailer to reduce aerodynamics (e.g., engine and transmission placement, etc.)
Weight Reduction	• Lightweight suspension components • Lightweight driveline components	• Lightweight frame rails
Tire Rolling Resistance	• Automatic tire inflation systems	• Novel low rolling-resistance tire compounds
Energy Management	• Battery-based idle management systems • Cab thermal management	• Advanced predictive engine accessory and driveline controls • Wind/weather-based cruise control • Solar energy harvesting

Table 2. SuperTruck Technologies - Mid- to Longer-Term Deployment

Conclusion

Many SuperTruck technologies have already achieved a level of market adoption that have proven attractive to truck purchasers because of their positive return on investment (ROI) and the ease with which they can be incorporated into fleet operations. Fuel efficiency and greenhouse gas regulations have also driven greater introduction of these technologies.

Some have reached the market in packages of technologies that are specifically marketed as beneficial to fuel efficiency.

For example, Peterbilt has made improvements to its aerodynamics packages for Class 8 tractors as a result of findings from the Cummins/Peterbilt project. The Peterbilt Model 579 EPIQ improves fuel efficiency over the conventional model by up to 14 percent through an array of fuel economy enhancement features.

Among these features are tractor-side fairings that close the gaps between the fender and front steer wheels; a front air dam to prevent air from flowing under the truck; and fairings that

extend down the side of the tractor to direct airflow away from the underside of the truck. The truck also incorporates some engine downsizing and engine/transmission optimization with an automated manual transmission.

In other cases, technologies are marketed individually. Technologies like 6x2 axle sets, aluminum fifth wheels, and other lightweight components have been explored in SuperTruck and subsequently commercialized. For example, SuperTruck research played a critical role in designing Volvo's 2017 powertrain system, which provides improved efficiency and performance through features such as refined turbo-compounding systems.

Continued progress in reducing cost and improving reliability is still needed for technology suites that have yet to reach commercialization. To address this challenge, DOE has launched the SuperTruck II program to drive progress even further, setting a bold goal of achieving greater than 100 percent improvement in freight efficiency. The goal is to develop technologies that can reach the market quickly while saving money and delivering the same or better performance than 18-wheelers of today.

Background

SuperTruck projects involve the major truck manufacturers providing Class 8 over-the-road trucks for the North American market: Daimler Trucks North America; Navistar, Inc.; and Volvo Trucks North America.

Truck manufacturer PACCAR was also involved in the SuperTruck initiative through a partnership with Cummins, Inc. and PACCAR's Peterbilt brand.

Together, the companies in the SuperTruck initiative represent over 99 percent of the U.S. market share for trucks, as shown in Figure 1. Read more about the SuperTruck program at http://1.usa.gov/28XYObP.

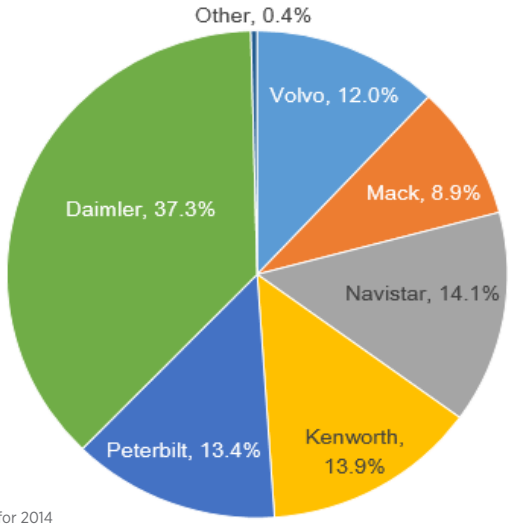
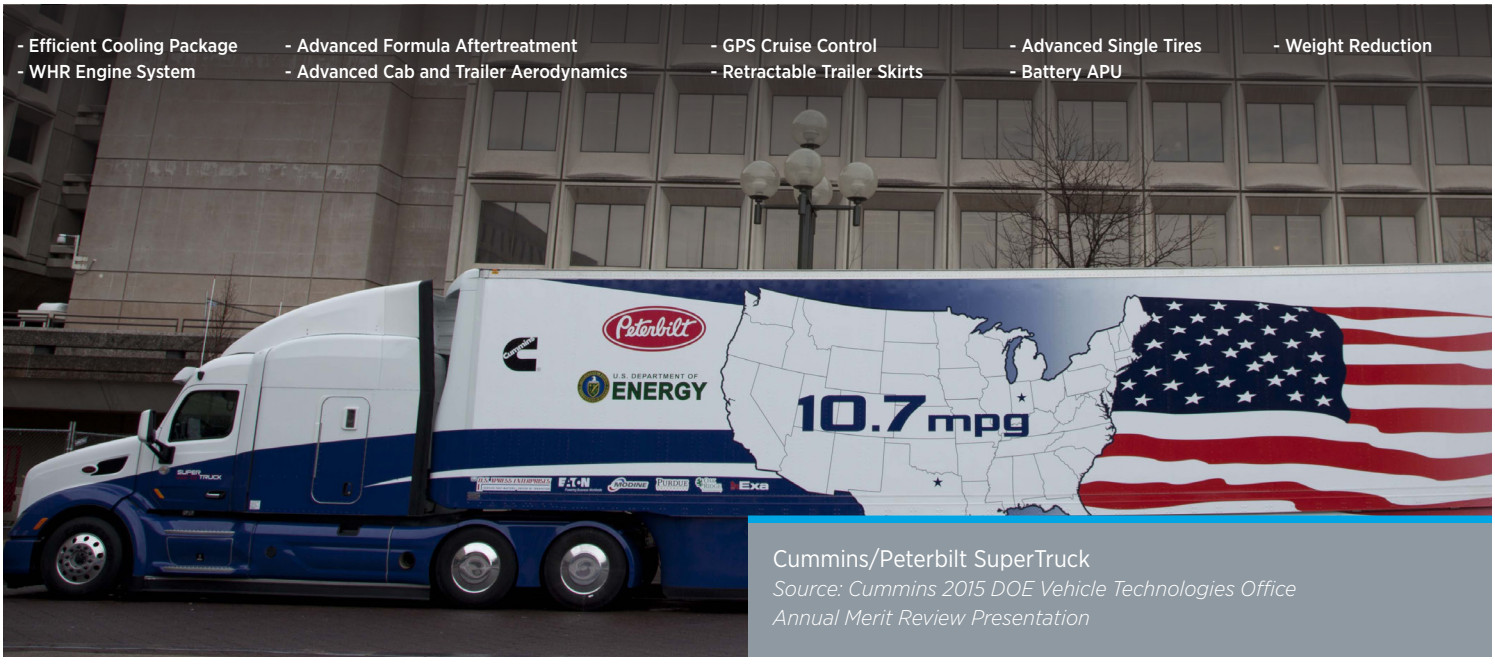


Figure 1. U.S. Truck Sales Market Share.
Source: Wards Communications



Cummins/Peterbilt SuperTruck
Source: Cummins 2015 DOE Vehicle Technologies Office Annual Merit Review Presentation