# Semi-Truck Freight Transportation

**Summary:** This initiative presents a specific measure that can be adapted to decrease greenhouse gas (GHG) emissions from the state's Semi-Truck freight transportation sector. This sector is forecast for continued growth, despite the economic downturn and decreased transportation funding. Primarily, this measure's aim is to improve the fuel efficiency of semi-trucks registered in the Commonwealth. A target of installing trailer fairings, also known as trailer side skirts, on 50 percent of the Commonwealth's registered tractor and trailer fleet by 2030, is the intent of this initiative.

**Other Agencies Involved:** PennDOT

## Improve Trucking Fuel Efficiency

**Semi-Truck Transport:** About 61 percent of the freight that is moved in the U.S. is carried by truck transport. In the U.S. more than 36 billion gallons of diesel fuel (EIA, 2013) is used by truck transport. In Pennsylvania alone approximately 851 million gallon of diesel fuel will be used by semi-trucks hauling freight in 2015. In a program to reduce GHG emissions and improve fuel efficiency of tractor trailers and other heavy duty vehicles the United States Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) have developed the Heavy Duty National Program (HDNP). This program will be adopted in two phases the first effecting heavy duty vehicles model year 2014-2018 and phase II effecting model year 2018 -2025. The program is designed to increase fuel efficiency standard of newly manufacture heavy duty engines and vehicles. The initiative brought forth in this work plan is a voluntary program designed to encourage owner operators and fleets to reduce air pollution and GHG emissions through lower fuel consumption on tractor trailers not subject to the HDNP by retrofitting vehicles with add-on aerodynamic technologies. The option explored her entails deployment of available fuel use reduction technology. By identifying and promoting fuel-saving retrofit technologies, the program enables the owners and operators of truck fleets to better understand how to reduce fuel consumption via the most economical means available. In many cases, fuel-saving retrofits can result in net cost savings over the long run. The technology option analyzed here is listed below:

**Trailer Fairings:** Adding side fairings (e.g., skirts) to trailers reduces aerodynamic drag and improves fuel economy by 3 percent – 7 percent (ICCT 2014). For the purpose of this analysis a fuel savings of 4.5 percent is used. Side skirts have the largest rate of adoption among aerodynamic technologies for trailers, around 40% of new box trailers are sold with side skirts and roughly 50% of side skirt market is for retrofitting existing trailer

The technology option, considered in the semi-truck analysis, is based on EPA's SmartWay Transport Partnership (EPA, 2009b). The option considered is the installation of fairings (e.g., side skirts) to improve vehicle aerodynamics.

While the cost associated with installing trailer fairings ($1100) is modest compared to the cost of a tractor-trailer, any up-front cost may be prohibitive for some truck owners. Low interest revolving loan programs are good financial assistance options. With a payback period of roughly 0.6 year, the money loaned from the initial fund is quickly returned and used for new loans. A loan program partnered with a government agency and an organization like Lending Tree, where individuals and companies are provided with access to a network of loan lenders, would be beneficial to owners. The advantage is that these lenders will bid on the loan request, lowering the interest rate and simplifying the process of acquiring a loan.

**Potential GHG Reductions and Economic Costs:**

Table 1 summarizes the emission benefits and costs of the measures applied to truck freight.

**Table 1: Estimated GHG Emissions Reductions and Cost-Effectiveness**

| | | |
|---|---|---|
| GHG emission savings (2030) | 0.243 | $MMtCO_2e$ |
| Net Present Value (2013-2030) | -48.4 | $million |
| Cumulative Emissions Reductions (2013-2030) | 2.07 | $MMtCO_2e$ |
| Cost-effectiveness (2013-2020) | -309 | $/tCO_2e$ |

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent. Negative numbers indicate cost savings.

The estimated GHG emission reductions from installing trailer fairings are based on diesel fuel savings. To calculate these emissions, the total 2011 Pennsylvania tractor trailer Fleet VMT (Vehicle Miles Traveled) data was projected out to 2030 using a 1 percent increase rate as recommended by the Argonne National Laboratory/RITA. The fraction of VMT traveled by the number of vehicles adopting the technologies was then calculated and the amount of fuel needed to travel those miles at the average 6.5 MPG was obtained. Fuel usage required by the vehicles that have been fitted with the technology was then calculated. Emission reductions were then calculated by using the fuel usage reduction figures extended over the implementation period of 2015 through 2030. Total fuel savings is multiplied by GHG emissions per gallon of diesel fuel consumed (25.02 lbs. $CO_2e$/gal Argonne Lab/Greet) to obtain the total annual GHG emission reduction. Total fuel savings realized for the implementation period at a 50 percent installation rate is 182, million gallons.

**Heavy-Duty Trucks*:* Costs Associated with Installing Fairings**

The cost of retrofitting a trailer with side fairings is approximately $1,100 (ICCT, 2014). The total cost of retrofitting is calculated by multiplying the number of trailers being retrofitted in a given year by $1,100. Fuel cost savings are simply the diesel fuel saved multiplied by the price per gallon of diesel fuel (AEO 2014). Net costs are the installation costs minus the fuel cost savings.

**Heavy-Duty Trucks: GHG Reduction from Installing Fairings**

At highway speeds, aerodynamic drag accounts for the majority of truck energy losses (EPA, 2004b). Reducing drag improves fuel efficiency. Since a majority of long-haul tractor trucks on the road already contain aerodynamic features, such as air deflectors mounted on the top of the cab, drag-reduction options should focus on trailer aerodynamics (Bynum, 2009). The addition of side fairings to a trailer can reduce fuel consumption by 4.5 percent (EPA, 2009b). These panels are attached to the side or bottom of the trailer and hang down to enclose the open space between the rear wheels of the tractor and the rear wheels of the trailer. Such enclosure reduces wind resistance. The estimated GHG emissions reductions from installing side fairings on trailers are based on diesel fuel savings. Fuel savings are based on the total diesel fuel used, the percent fuel savings associated with the retrofits, and the penetration rate for tractor-trailer combinations. Since there are more trailers than tractor-trucks, the probability of realizing the fuel savings associated with a trailer retrofit is a one to one ratio of tractor-trucks to trailers.

**Table 2. GHG Emission Reduction, Fuel Savings and Installation Cost for Installing Fairings**

| 50% adoption | | | | | | |
|---|---|---|---|---|---|---|
| | Cumulative Adoption @1377 annually | Fuel Reduction (gal) | Emissions Reduction (tons) | Fuel Savings ($MM) | Installation Cost | Delta Cost |
| | | | | | | |
| 2015 | 2754 | 1,338,875 | 16,749 | 5.06 | $3,029,400 | -$2,031,547.50 |
| 2016 | 5508 | 2,677,750 | 33,512 | 10.26 | $3,029,400 | -$7,226,382.50 |
| 2017 | 8262 | 4,016,626 | 50,268 | 15.58 | $3,029,400 | -$12,555,108.88 |
| 2018 | 11016 | 5,355,501 | 67,024 | 20.99 | $3,029,400 | -$17,964,163.92 |
| 2019 | 13770 | 6,694,376 | 83,780 | 26.38 | $3,029,400 | -$23,346,441.44 |
| 2020 | 16524 | 8,033,251 | 100,536 | 31.89 | $3,029,400 | -$28,862,606.47 |
| 2021 | 19278 | 9,372,126 | 117,292 | 37.58 | $3,029,400 | -$34,552,825.26 |
| 2022 | 22032 | 10,711,001 | 134,048 | 43.27 | $3,029,400 | -$40,243,044.04 |
| 2023 | 24786 | 12,049,877 | 150,804 | 49.04 | $3,029,400 | -$46,013,599.39 |
| 2024 | 27540 | 13,388,752 | 167,560 | 54.89 | $3,029,400 | -$51,864,483.20 |
| 2025 | 30294 | 14,727,627 | 184,316 | 61.41 | $3,029,400 | -$58,384,804.59 |
| 2026 | 33048 | 16,066,502 | 201,072 | 67.48 | $3,029,400 | -$64,449,908.40 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2027 | 35802 | 17,405,377 | 217,828 | 72.93 | $3,029,400 | -$69,899,129.63 |
| 2028 | 38556 | 18,744,253 | 234,584 | 79.10 | $3,029,400 | -$76,071,347.66 |
| 2029 | 41310 | 20,083,128 | 251,340 | 85.55 | $3,029,400 | -$82,524,725.28 |
| 2030 | 44064 | 21,422,003 | 268,096 | 92.11 | $3,029,400 | -$89,805,212.90 |
| | | | | | | |
| TOTAL | 44,064 | 169,084,620 | 2,278,812 | 735.55 | $48,470,400 | -$705,075,331.06 |
| | | Mt | 2,066,882.87 | | | |
| | | MMt | 2.07 | -$309.40 | | |

**Ease of Implementation:**

The ease at which implementation depends on the perceived savings, which is heavily dependent on education and on the price of fuel.

**Barriers to Implementation**

- The trucks and the trailers can oftentimes be owned by different people, so the benefits are diffused between the owners, truck owner/operator vs. trailer owner/operator.
- The fleet that might own the trailer doesn't have as much of an incentive to retrofit because they don't pay for fuel

**Implementation Steps:**

- Modify the Small Business Advantage Grant Program criteria to allow independent owner/operators to qualify for a grant/or loan to retrofit their vehicles.
- Promote EPA SmartWay truck transport initiative loan programs.
- Introduce an education program by distributing fuel saving technology information pamphlets to owner/operators and trucking companies.

**Key Assumptions:**

- The trucking analysis assumes that the penetration rates for the and fairing retrofits are feasible by 2030.
- The cost of trailer aerodynamic technologies – particularly side fairings (skirts) have decreased in recent years due to more market entrants driving competition and higher deployment volumes reducing the cost per unit. Since the technology options analyzed for trucks are retrofit options, new trucks entering the fleet are not considered. Under business as usual, the fuel economy of the existing truck fleet is assumed to remain constant through 2030.
- For fleets, where more trailers than tractors are owned, the payback period is longer

**Key Uncertainties:**

- The fuel efficiency gains for truck and trailer retrofits are based on test track conditions. The actual on-road fuel efficiency improvement may be less.

- The diesel fuel consumed by heavy-duty trucks in Pennsylvania is approximated based on an estimate of heavy-duty truck VMT in the state.
- The actual diesel fuel consumed may be different.

**Potential Benefits:**

Additional potential benefits of changing behaviors to decrease GHG emissions from freight transportation include:

- Decreased emissions of ozone precursors (VOC and $NO_x$), CO, and PM.
- Decreased motor fuel use
- GHG emissions reductions
- Direct support of Smart Transportation initiatives, projects, and programs.

**Potential Interrelationships With Other GHG Reduction Measures:**

These measures aimed at changing behavior need to be implemented in coordination with system changes within the transportation sector, and with transportation-focused land-use measures.

**References:**

ICCT, 2014 International Council on Clean Transportation "Costs and Adoption of Fuel-Saving Technologies for Trailers in the North American On-Road Freight Sector" February 2014.

U.S. DOE, 2013. U.S. Department of Energy, Energy Information Administration, " Sales of Distillate Fuel Oil by End Use" November 2013 at http://www.eia.gov/dnav/pet/pet_cons_821dst_dcu_nus_a.htm
2009.

U.S. DOE, 2009b. U.S. Department of Energy, Energy Information Administration, "Energy Prices by Sector and Source (Mid-Atlantic Region)," Table 12 in Supplemental Tables to the Annual Energy Outlook 2009, at http://www.eia.doe.gov/oiaf/aeo/supplement/stimulus/regionalarra.html.

U.S. DOT, 2008b. U.S. Department of Transportation, Federal Highway Administration, "Truck and Truck-Tractor Registrations - 2007," Table MV-9 in Highway Statistics 2007, November 2008, at www.fhwa.dot.gov/policyinformation/statistics/2007/mv9.cfm, accessed 27 May 2009.

U.S. DOT, 2008c. U.S. Department of Transportation, Federal Highway Administration, "Trailer and Semitrailer Registrations - 2007," Table MV-11 in Highway Statistics 2007, November 2008, at www.fhwa.dot.gov/policyinformation/statistics/2007/mv11.cfm

U.S. EPA, 2004b. U.S. Environmental Protection Agency, SmartWay Transport Partnership, "A Glance at Clean Freight Strategies: Improved Aerodynamics," EPA420-F-04-012, February 2004, at http://www.epa.gov/smartway/transport/documents/carrier-strategy-docs/aerodynamics.pdf, accessed 28 May 2009.

U.S. EPA, 2009b. U.S. Environmental Protection Agency, SmartWay Transport Partnership, "Technologies, Policies, and Strategies: Upgrade Kits," at http://www.epa.gov/smartway/transport/what-smartway/upgrade-kits-tech.htm, accessed 28 May 2009.

U.S. Energy Information Administration, Annualy Energy Outlook 2014 Early Release, December 16,2013.

Center for Climate and Energy Solutions,"Federal Vehicle Standards" at http://www.c2es.org/federal/executive/vehicle-standards

U.S. EPA, 2011. U.S. Environmental Protection Agency, "EPA and NHTSA Adopt First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium-and-Heavy Duty Vehicles" Regulatory Announcement, August 2011