Heavy-Duty Freight Efficiency Analysis

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Executive Summary

Environmental Defense Fund (“EDF”) is a large non-profit, representing close to half a million members across the United States. Since its founding, the organization has focused its efforts in four key areas: Climate Change, Species and Habitat Preservation, Human Health, Ocean and Marine Life. EDF’s successful approach to solving problems is the result of partnerships it has established with leading organizations and corporations across the country which share a vested interested in pursuing the same goals and interest as EDF.

The EDF S-Lab team was asked to assist in analyzing the viability of a new initiative, intended to improve the efficiency of the heavy-duty freight trucking fleet across the United States through the use of existing technologies. More specifically, our team was asked to review the viability of alternative business models to achieve this goal. This paper will discuss:

1. The current state of environmental impact from trucking and of United States Environmental Protection Agency (US EPA) regulations and programs. In addition, we will discuss the impact of those regulations on the actions of trucking fleets
2. The Energy Service Corporation (ESCO) model, and its likely efficacy as a lever to improve truck fleet efficiency, specifically as a potential part of EDF’s Corporate Partnership Program
3. An alternative model, its chances of success, and its potential impact as viewed through a case study of one major US trucking hub

Project Parameters

Generally, EDF aims to take on projects that meet the following criteria:

1. **Significant Environmental Impact** – EDF tries to allocate its efforts to those projects which present significant environmental contributions. This required an assessment of the contributions any truck fleet improvements would make towards reducing emissions of carbon and carbon equivalents. Reductions in nitrogen oxides (NOx) and particulate matter could also be considered.
2. **Novel Initiative** – EDF indicated that its resources and time are limited and would be best spent furthering a cause which was relatively unattended.
3. **Potential to be a “Game Changer”** – EDF believes that it is essential to partner with organizations which will ultimately lead the industry to adopt new practices and methodologies. Our solution would have to offer this kind of leverage.
4. **Sound business case** – The last component of the analysis would assess the financial viability of the proposed undertaking. The initiative must be attractive to potential partners, presenting opportunities for cost-savings or long-term strategic positioning.
Research Methods
The EDF S-Lab team has undertaken some basic research of the current market dynamics present in the Heavy-Duty Freight Trucking industry (“HDFT Industry” or “HDFT”) to understand the key influence levers within the sector. We have also reviewed the substantial research that has already been conducted on HDFT efficiency improvements by other government organizations, non-profit organizations and private enterprise groups. Since EDF was specifically focused on choosing a particular business model that could drive industry change, and not on simply ranking the best retrofit technologies, we collected and evaluated feedback from industry stakeholders. In this regard we conducted several interviews with various organizations in an effort to better understand their views on proposed efficiency improvements. Finally, we attempt to quantify the environmental and financial impacts of the various alternative business models.

Summary Conclusions
There is significant opportunity to generate meaningful emission reductions by pursuing HDFT efficiency improvements; however it is unlikely to result from a for-profit business model, such as an Energy Service Company. Many large corporate fleets already enjoy the benefits of existing HDFT efficiency improvement technologies, whereas the small and medium sized fleets present significant logistical problems to a sustainable for-profit business model.

One alternative to this model is a simpler financing model for HDFT efficiency upgrades. This model has been implemented by Cascade Sierra Solutions (CSS) and has experienced success since its inception in 2006, reporting cumulative savings of over 51,000 metric tons of CO₂ and $5 million in fuel costs by a “fleet” of 2052 vehicles. CSS helps owner-operators secure federal grants and government subsidized loans for the purchase and installation of HDFT EPA SmartWay technologies through the operation of retail-style kiosks on highways that provide information directly to these truckers. At this time, we believe this model presents the most feasible solution with the maximum environmental impact.

Given the work already underway by other organizations in this field, we believe it would not be the best use of EDF’s time or money to focus on this issue through the development of new initiatives. However, we do see significant opportunities for secondary support roles of existing initiatives. Specifically, we believe an expansion of the CSS business model to one or more key trucking hubs in the Eastern United States could generate significant, but incremental, emission reductions. However, it is unclear what role, if any, EDF will have in this undertaking.

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I. Current Impacts, Regulations, and Technology Adoption

Environmental Impact
The U.S. is currently the largest emitter of carbon gas per capita in the world\(^2\), and one third of all U.S. emissions come from the transportation sector\(^3\). The narrow focus on HDFT efficiency improvements does not account for the largest share of the U.S. emissions market; most emissions come from light passenger vehicles. However, it does focus on one of the more actionable segments within the transportation sector.

Vehicle exhaust emissions have been a key focus of government regulatory agencies over the past fifty years. Although the EPA has enacted stricter and stricter regulations on trucks (see discussion of these regulations which implement the Clean Air Act below), the long life of most trucks\(^4\) creates a significant delay between implementation of a regulation and realization of its environmental impact. Greenhouse gases in the Heavy Duty Trucking industry have risen by over 50 percent since 1990 compared to approximately 12 percent for light duty vehicles\(^5\). Since class 7 and 8 trucks represent only 40 percent of the heavy truck population (classes 3-8), but almost 80 percent of fuel consumption, this is an attractive focus point.

Some progress has been made in overall emissions reductions, especially on the technology front. As part of the EPA’s 2001 Ultra Low Sulfur Diesel Initiative, particulate and NOx emissions are to be reduced dramatically through advanced filter technology. This progress is certainly encouraging; however, little effort has been focused on fuel efficiency. In fact, the average fuel economy of U.S. Freight Combination trucking rose by only 0.2 percent from 1970 to 2006. It is crucial that any new business model address fuel efficiency as well as pollution reduction.

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2 Netherlands Environmental Assessment Agency: Dossier Climate Change
3 http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html#transportation
5 Cascade Sierra Solutions Typical Truck Lifecycle. URL https://secure.cascadesierrasolutions.org/about/
6 Transformational Trucking Charrette – Pre-Read Materials, Rocky Mountain Institute, April 2009
Key Regulations Governing Heavy Duty Truck Emissions

The EPA is charged with implementing the Clean Air Act, originally passed in 1963 and strengthened many times over the past several decades. The 1990 Amendments represent the last major change in the law, and they focused on addressing the problem of acid rain\(^7\). However, it is clear that the Agency has been focused on making trucks cleaner and cleaner. A discussion of the most recent changes follows.

Model Years 1987 – 2003

For vehicles above 8500 pounds, the US EPA’s standards were slightly weaker than those in California during this time. However, the federal standards did get tightened to essentially match the strictest state standards in four key areas:

1. NO\(_x\)
2. Hydrocarbons
3. Particulate matter
4. Carbon monoxide

Though the gradual tightening of standards happened at different rates for each of these compounds, by 1998 heavy duty diesel engines could emit 1.3 g/bake hp-hr of hydrocarbons, 15.5 g/bhp-hr of carbon monoxide, 4.0 g/bhp-hr of NO\(_x\), and 0.1 g/bhp-hr of particulate matter\(^8\). At the same time, the EPA advanced voluntary Clean Fuel Fleet standards that had much lower thresholds for Ultra-low Emissions Vehicles. In addition to those few drivers and fleets meeting this standard by choice, several regions were required by the US EPA to hold a percentage of new vehicles to this standard. Its implementation was often delayed by negotiations hinging on the availability of the appropriate technology\(^9,10\).

Model Year 2004

In 1995, with the environmental improvements dictated by the earlier regulations flattening out, the US EPA met with the California Air Resources Board (CARB) and representatives from the heavy duty engine industry. Together, this group agreed to work to reduce NO\(_x\) to half of

\(^7\) URL http://www.epa.gov/air/caa/CAA_history.html
\(^9\) http://www.epa.state.il.us/air/clean-fuel-fleet/faq.html
\(^10\) http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-316:1
the 1998 standard (from 4.0 to 2.0 grams/bhp-hr) and published this commitment in a Statement of Principles.\(^{11}\)

In 1997, these principles were codified in new US EPA regulations to be phased in by 2004 that matched federal standards with California’s for engine specs in order to allow manufacturers to have just one engine design to cover the entire country. The required useful life of an engine was also extended from 8 to 10 years, though many users (owner-operators, small fleet owners, drivers of port drayage trucks) run these engines for over 20 years.\(^{12}\) The new regulations also reduced both the allowable levels of hydrocarbons and the maximum combined levels of hydrocarbons and NOx. Significantly, the regulations did not change the allowable amount of carbon monoxide. It is likely that over 60 percent of the US fleet, corresponding to the percentage driven in fleets of fewer than five trucks and therefore likely to be making use of trucks older than ten years, has not made these retrofits.\(^{13}\)

**Model Year 2007**

A series of regulations enacted in 2000, which addressed diesel fuel composition in addition to engine operation, called for further increases in cleanliness to be implemented by the 2007 truck model year. Specifically, NOx, particulate matter, and a variety of hydrocarbons were cut almost to zero.

In addition to these engine changes, the EPA supported making low-sulphur diesel fuel more widely available. In the past, catalytic converters had been ruined by sulphur in the fuel, giving rise to the perception of diesel as a more “dirty” fuel than gasoline. In order to complement new clean engine technologies, this new version of the fuel became the most widespread diesel fuel in the marketplace. The systems that require this newer fuel address both NOx and particulate matter. In addition, the 2000 revisions required the use of on-board diagnostics to be phased in by 2005.

**Changes Under the Obama Administration**

While the regulations for all emissions components except for CO have been driven nearly as low as they can go, the new administration has still made an impact on this industry by beginning to fund the Diesel Emissions Reduction Act (DERA). This law was passed in 2005 with wide bipartisan support and at that time authorized $1 billion to retrofit diesel engines over five years, but it was never funded. The current administration has set aside $300 million as a part...
of the American Recovery Reinvestment Act of 2009, more commonly known as the “Stimulus Package”\(^{14}\).

**Impact of Regulations**

Together these regulations create a serious incentive for fleets and truckers to retrofit aging trucks and replace them with more efficient ones. However, the cost of the SmartWay technology, all of which has been verified in terms of environmental impact by the US EPA, slows the pace of implementation. In addition, the role of the federal government as funder of these improvements provides a barrier to access, since the applications can be complicated or call for information that some drivers do not have readily available\(^{15}\). Such a barrier provides a ready “market” for a third party to simply provide guidance, technical assistance, and access to loan and grant applications.

**Existing Technologies, Benefits and Limitations**

The majority of the mainstream technologies that are available for improving fuel efficiency in heavy-duty trucks can be found through the EPA SmartWay Transport Program. This program has many parts, but the main focus of this section of the report is to discuss the verified technologies that EPA has tested and recommended to reduce emissions from diesel powered vehicles.

We believe that the technologies that are EPA verified are the only set of technologies that should be discussed in the context of this project. Conversations with industry participants and fleet operators often highlighted the challenge of sorting through the plethora of technologies promoted by various OEMs, resellers, and self-styled efficiency consultants. The use of the EPA verified technologies as a benchmark set of tested technologies would allow industry participants to know that a government agency has tested and approved this set, and would reduce the uncertainty that many of the participants face, thus improving the potential to adopt and install them. In addition, it appears that large, professionally managed fleets already make use of some or all of these tools, only avoiding them when a specific tool interferes with the driving patterns of a particular fleet\(^{16}\). Many small fleets and owner-operators, though, have not purchased any of these technologies.

While it is likely that there are many more technologies in the industry pipeline that are yet to be EPA-verified, for our purposes it is certainly an adequate list of improvements that would decrease emissions of nearly any small fleet. Below we provide a brief description of the technologies that are currently EPA verified.

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\(^{14}\) National Clean Diesel Campaign. URL http://www.epa.gov/otaq/diesel/index.htm

\(^{15}\) Gustafson interview, April 30, 2009.

\(^{16}\) Interview with Mike Payette, Staples Corp. April 30, 2009.
EPA Verified Technologies

Idle Reduction Technologies
1. Electrified Parking Spaces – runs the heating, cooling, electrical power when idling, thus reducing the need for the engine to be running
2. Auxiliary Power Units and Generator Sets – for Class 8 trucks mainly, it contains an EPA certified engine and supplies cooling, heating and electrical power
3. Fuel Operated Heaters – provides heat only to Class 8 trucks
4. Battery Air Conditioning Systems – an independent electric cooling system run off batteries, operates when the truck is turned off
5. Thermal Storage Systems – provides air conditioning when the truck is turned off, stores energy when the truck is driven
6. Automatic Shut-down/ Start-Up Systems – controls the engine start/stop based on certain parameters (time, temperature, battery charge, etc)

Aerodynamic Technologies
1. Trailer Gap Reducers (should be used with side skirts)
2. Trailer Boat Tails
3. Trailer Side Skirts
4. Advanced Trailer End Fairings
5. Advanced Trailer Skirt

Low Rolling Resistance Tires
Specific manufacturer tires and types are verified (Bridgestone, Continental, Goodyear, Michelin, Yokohama, Hankook).

Engine Retrofit Technologies
A list of specific diesel retrofit technologies, mainly electrical systems to supplant engines when the truck is parked and mufflers, filters, and catalyzers that remove pollutants from a truck's emissions is available at the EPA SmartWay Transport website. Each of these technologies will bring a truck’s NOx emissions into compliance with 2009 requirements.

Additional Technologies and Methods for Consideration
Although not specifically endorsed by the EPA, other methods do exist for reducing heavy truck gross emissions. Foremost among these is improving driver performance through training and monitoring. Most large fleets already have in place some sort of monitoring device onboard their trucks; in many cases these were installed to promote safe and fuel-efficient driving
behavior but have been retrofit to upload data regarding vehicle performance and driver speed. Others partner with engine manufacturers to optimize engine speed limits and decrease shift points to force drivers to shift earlier, thereby saving fuel. For these large organizations, the fuel savings from having drivers travel at 55 mph far outweighs the extra transit time or salary costs. For independent operators and smaller fleets, the incentives are shifted; sometimes making an on-time delivery can seem more important. More frequently, drivers are simply not trained to think about vehicle efficiency when operating. As a result, driver training and monitoring programs have fuel-saving benefits commensurate with many of the above technologies and a very attractive payback period of 1 to 3 years. In addition, it is estimated that increased use of supply chain optimization software and of arrangements that facilitate backhauling, the practice of re-filling empty trucks with new cargo for their return trip, could have an even larger impact that increasing the adoption of these new technologies.

**Industry Acceptance of New Technologies**

It is clear that the EPA Smart Way technologies are well-accepted within the industry and that many large organizations have already implemented most technologies into their fleets. The remaining opportunity remains at the individual trucker level and the smallest fleets (fewer than five vehicles).

Large fleets, which are under the management of larger corporations such as Staples or Wal-Mart, are already focused on fleet management issues and seem well educated in existing technologies aimed at improving fuel efficiency. Mike Payette, who manages a fleet of over 2000 trucks for the Staples Corporation, described detailed processes for determining which SmartWay technologies reduced emissions and/or demanded less fuel and noted that “any fleet with a professional fleet manager will do it this way,” referring to Staples’ rigorous review of new technologies. In addition to these reviews, Staples also conducts its own experiments to determine how different technologies perform when they interact.

In other words, professional fleet managers need to be convinced one at a time to use new technologies because of their need to test upfits for their own fleet’s needs. For different reasons ranging from lack of capital to the prevalence of various “consultants” who make their living peddling untested gadgets and fuel additives claiming to improve truck performance, owner-operators and small fleet managers also demand retail-type attention in order to begin using new products.

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17 Payette interview, April 30, 2009.
19 Interview with Professor Chris Caplice, MIT Sloan MLOG program. May 1, 2009.
20 Payette interview, April 30, 2009.
II. Energy Service Companies

EDF has specifically asked the MIT S-lab team to determine the viability of an ESCO in the heavy-duty trucking industry. This business model is predominantly used in the real estate sector, though it has worked successfully in other sectors as well. In the real estate sector, a typical example of an ESCO is as follows:

Real Estate ESCO example: The ESCO either identifies a target building (often commercial) or is approached by a building owner. Working with that owner, the ESCO performs an energy audit of the building to identify areas for potential energy savings. There are a standard set of options that are usually selected, such as more efficient HVAC installations or window replacements. The ESCO then pays all the upfront costs of the installation, guaranteeing a specific amount of energy savings over the baseline established during the initial audit. The ESCO and building owner then agree on a plan to split the energy savings that result, giving each party an incentive to agree to the process.

An ESCO in the heavy-duty trucking industry would exhibit similar characteristics to the real estate companies. The company would act as a financier for installing technologies on trucks in a similar manner, paying for the installations up front and sharing the fuel savings with a truck/fleet owner over the course of the life of the truck. The ESCO would be responsible for choosing the technologies and verifying the fuel savings that were obtained.

We spoke with several industry participants to gauge their reactions to this concept and to feel out potential issues we had not yet realized through our background research. These participants represented members of the academic community, fleet managers, government and NGO representatives, and executives at current ESCOs. While there was some interest in working on the idea, most people we spoke with seemed to believe that there were a number of factors that were working against the business model. Some of the main factors we discovered were as follows:

- **Industry Fragmentation** – Many industry participants we spoke with mentioned how the heavy-duty trucking industry is unlike most other industries in that it is heavily fragmented. Large corporate fleets are mostly well managed, but other fleets often have finance groups running them based on “the numbers” only without understanding the intricacies of fleet management, or are not truly managed at all. Independent owner/operators sometimes belong to smaller fleets, but are often on their own, with drivers spending most of their time driving and unable to find time to think or learn about new technologies and how they can benefit them. This fragmentation makes it difficult for an ESCO to enter and provide a systematic approach to improving fuel efficiency.
Independent Owner/Operators – The smaller truck owner/operators make up the largest proportion of truck owners. This means that an ESCO would have to work with a large number of individuals, each with their own credit rating, financial status, awareness of technology, model of truck, etc. This individualism is markedly different from the real estate sector, where an ESCO can often take a more blanket approach to buildings as they are much more similar.

Measurement of Savings – In the real estate sector, buildings are already monitored for their energy usage, so measuring the savings after installation of energy savings measures is relatively simple. In the heavy-duty trucking industry, the independent owner/operators are legally required to keep an accurate log of miles traveled, hours on the road, fuel purchased and other information, but since driving conditions change every day, it is unlikely that this log could establish a baseline trusted by both parties. Fleet owners also vary in the level of rigor they apply to keep track of their individual drivers’ fuel usage. This also makes it difficult to have a baseline to compare savings against. The various fuel regulations in the US also change based on location and by season, so there are many other variables that play into fuel usage, making claims of savings based on installed technologies difficult. A driver or fleet operator may believe the ESCO is claiming savings that were not actually realized, while the ESCO might not believe the numbers being given by the drivers, thus creating an incentive difference between the parties. As an aside, this is being observed in the real estate industry as well. A report by the GAO investigates the actual savings and casts doubt on whether these savings are sustainable over time21. It also looks critically at the incentive structures when the ESCOs are monitoring and validating all of the performance metrics.

Based on these factors and other considerations, we believe that an ESCO in the heavy-duty trucking industry as we have described would have significant barriers to successful implementation. There may be other ways to implement an ESCO, however, that we have not followed up on. One specific alternative that we reviewed was to have the heavy-duty truck manufacturers become involved in promoting and installing the fuel saving technologies on their trucks before initial purchase. However our initial round of interviews revealed that the incentives for the manufacturers were not in place to make that model work. Fleet managers often had different needs from their trucks, so manufacturers are currently best served by producing and selling “bare bones” models to the different fleets and letting the managers

equip them as needed. Because of these differences, manufacturers have no incentives to change the way they provide their trucks.

In conclusion, we focused on the four criteria that EDF had presented as their metrics for a successful project and mapped our findings for an ESCO to determine whether this would be a worthwhile endeavor. The results are as follows:

- **Significant Environmental Impact** – There are potentially significant GHG emission reductions that could be achieved if market penetration were high and an ESCO could successfully be established. However, our findings indicate that this would be difficult given the industry conditions.

- **Novel Initiative** – While there is no ESCO currently operating in the industry, the EPA SmartWay transport program and Cascade Sierra Solutions are approaching the problem in a different way, so there are certainly other players in the space.

- **Potential to be a “Game Changer”** – Since we have determined that an ESCO would not be feasible in this industry, it seems unlikely to have a game changing impact. If it did work, the most appropriate analog to large, professionally managed buildings is the largest fleets. These firms already do most of the work that an ESCO would take on.

- **Sound Business Case** – An ESCO could provide capital to help with financing, but our determination is that the financial feasibility of an ESCO does not exist due to the numerous reasons listed above.

### III. An Alternative Model and Case Study of Knoxville, Tennessee

**Cascade Sierra Solutions’ model**

CSS opened in 2006, growing out of the “Everybody Wins” program established in Oregon to help truck drivers get federal grants and tax credits that helped finance a lease-to-own program for auxiliary power units. CSS aims to roll out this type of program on a larger scale, operating sites in Coburg and Portland, Oregon, and Sacramento, California.

At these sites, CSS staff operates retail-style booths that showcase SmartWay-approved technology and match owner-operators with financing options and trained installers. They are able to devote one-on-one attention to each driver who stops in, overcoming the barriers presented by complex loan, grant, and tax credit applications. They are also able to demonstrate the financial savings for each driver and then construct a financing package that matches cash flow generated from the projected cost savings. Truckers are, in effect, making
money each month while implementing environmentally beneficial improvements to their trucks.

According to Jon Gustafson, CSS’s Vice President for Marketing and Sales, opening such a site requires little capital investment. “The most important ingredient,” according to Gustafson, “is a well connected network of people on the vendor side and the market side. With that, the costs might be as low as the cost to get organized plus some working capital.” In three years of operation in the Pacific Northwest, CSS has worked with over 2000 vehicles, generating an average fuel savings of 11.40 percent. While such an approach does not immediately appear to favor a corporate partnership, could involvement in a CSS-type retail operation help EDF realize its goal of transforming the US truck fleet to become a clean, efficient one? Our answer is yes.

**Definition of “Success”**

If EDF is to work in the owner-operator segment of the trucking industry, the definition of success cannot be fast, industry-changing work. CSS has demonstrated that a slow, retail approach is what works to convince independent drivers to make investments in their vehicles. Therefore, EDF would have to aim for:

1. Local environmental impacts
2. City-by-city or region-by-region change of installed base
3. Savings measured on a per-driver, not per-fleet basis
4. A donor and mentor role for corporate partners, not a value chain role

Another germane question is whether product availability and access to capital for small fleets would generate a significant environmental impact. CSS has saved 51,000 metric tons of CO$_2$ since its inception, while making improvements to about 1500 of the 2000 trucks it counts as members. This is the rough equivalent of taking 8,000 passenger cars off the road and also represents a tiny fraction of the owner-operator driven trucks in the US, meaning that most of this market is yet to be tapped (a car is estimated by the EPA to release 5.46 metric tons of CO$_2$ equivalents each year). They have had this impact while operating at three sites that see

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22 E-mail correspondence. May 7, 2009. 
24 Secure cascadesierrasolutions.org/about/ 
25 http://www.epa.gov/solar/energy-resources/refs.html#vehicles
a total of about 13,000 unique trucks pass through each day. Of those, one thousand drivers stop into the CSS store each year and half of them make purchases\textsuperscript{26}.

But what if a similar operation could reach more trucks each day? To do so, we can examine the impact of two key variables:

- Location: Is there a site with many more trucks passing through each day?
- Penetration rate: Can the pace of adoption from CSS’s current 3.8 percent yield (500 yearly purchases/13000 drivers)? Can this be driven simultaneously with traditional marketing and also word-of-mouth?

Our research, combined with the financial and environmental modeling done by the Rocky Mountain Institute, suggest an impact of roughly two orders of magnitude over that of CSS’s West Coast operations.

Knoxville, Tennessee, sits at the intersection of Interstates 40 and 75. Together with Memphis and Nashville, it makes up a corridor used by trucks traveling to Atlanta from the North and to Dallas from the Northeast. Knoxville sees 27,000 unique trucks per day and is home to numerous truck stops and related businesses\textsuperscript{27}.

Clearly, this represents a much larger local market than that of Portland or Sacramento. First, we will make a set of assumptions that govern the uptake of new technologies into the Knoxville independent owner-operator market.

1. 65 percent of those trucks are driven by owner-operators (17550 trucks).

2. The likelihood that someone not using SmartWay technologies would stop into a CSS-style store because of external marketing is .03, which is considered the average for new technologies\textsuperscript{28}.

3. The likelihood that someone not using SmartWay technologies would stop into a CSS-style store because of word-of-mouth is 0\textsuperscript{29}, while the average for new technologies is 0.38\textsuperscript{30}.

Next, we ran these assumptions through the RMI model, which matches adoption of different SmartWay technologies to their environmental and financial impacts. Over ten years of operation, the effort would make improvements to 5000 trucks and save each driver over

\textsuperscript{26} E-mail correspondence with Jon Gustafson. May 7, 2009.
\textsuperscript{27} “Tennessee Highway Becomes World’s Largest Emissions Lab,” http://findarticles.com/p/articles/mi_m0FZX/is_2_69/ai_98247089/
\textsuperscript{28} http://www.12manage.com/methods_bass_curve_diffusion_innovation.html
\textsuperscript{29} Caplice interview, May 1, 2009.
\textsuperscript{30} http://www.12manage.com/methods_bass_curve_diffusion_innovation.html
10,000 gallons of fuel. Industry wide, these savings would come to 3 million fewer metric tons of CO₂ equivalents, which matches the impact of over 500,000 passenger cars, 282,000 homes, or almost 1 coal-fired power plant. Impacts with slight increases in adoption rate, especially those that include even a small word-of-mouth effect, are striking:

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In all cases, the cost per ton of CO₂ equivalent is roughly $24 – significantly less than most cost estimates under either a cap-and-trade or carbon tax regime. Add to these results the fact that Knoxville is growing at 1 percent per year and the possibility to generate a significant environmental impact with little capital outlay is clear.

**Summary of Knoxville Case Study vs. EDF scorecard**

| | Significant Environmental Impact | Novel Initiative | Potential to be a “Game Changer” | Sound business case |
| | Yes | No | Yes | No |

Is the provision of technical assistance and financing for the trucking industry currently being done by anyone?

Clearly, this program does not meet EDF’s second criterion. Not only has CSS established this kind of operation already, albeit in a smaller market than EDF could access on the East Coast or Mid-Atlantic region, but the basic concept of a non-profit organization that provides technical assistance to help end users access capital and technology is not new. However, the program does represent one of the only programs directly influencing the owner-operator market.

outside of trade groups, and those groups can often look out for very short term economic interests. For example, the Owner-Operators Independent Drivers Association (OOIDA) has made opposing laws that would require speed limiters a key issue, despite the fact that limiters are well known as a technology that improves fuel efficiency and saves money\textsuperscript{32}. In short, CSS is essentially alone in this space and committed to its own plans to grow very slowly. EDF could be effectively alone in most of the country, but replicating an organization such as CSS would not actually be a unique effort.

**If successful, could it spark market-driven change throughout the industry?**

Because owner-operators represent such a large portion of the trucks on the road, any effort that can reach many of them has to be considered a potential “game-changer.” At issue, though, are the tactical issues surrounding marketing to this segment of the drivers.

Nearly all the communication with these drivers would have to be external marketing. Experts on technological innovation have noted that word-of-mouth is quite weak among this sector\textsuperscript{33}. In addition, it is unlikely that trade groups such as OOIDA, which has 160,000 members driving 240,000 trucks across the US and Canada, would support all of the issues advanced by such a group, possibly contributing to negative word-of-mouth\textsuperscript{34}.

**Are there significant financial returns for the parties taking on risk?**

The financial returns for this type of work are quite small and have not drawn in private firms. CSS is almost entirely grant-supported and is clearly not operating like a for-profit lender. Indeed, they exist to fill a gap left by the market, which is skittish about lending money to small business owners with very slim margins and heavily depreciated assets.

CSS has mitigated the risk associated with the kind of financial relationship that they build with owner-operators by emphasizing their relationship with the federal government, crafting loan agreements so that payments can be covered by free cash flow generated by new technology, and developing one-on-one relationships with their clients. The financial returns come directly to the drivers, who come to own more efficient vehicles that cost less to operate. CSS has to date been satisfied to meet an environmental and social bottom line, while looking only to generate enough surplus to maintain and slowly grow their operations. To date, this work does not provide an ROI that would be attractive to private investors. Additionally, as in many industries, the ongoing financial crisis has dried up capital markets for small fleet operators. With profits falling based on competition for fewer contracts, many experts are predicting some

\textsuperscript{32} http://www.ooida.com/Issues&Actions/Issues/speed_limiters/speed_limiters.htm
\textsuperscript{33} Caplice interview, May 1, 2009.
\textsuperscript{34} http://www.ooida.com/Who_We_Are/index.shtml
industry consolidation and failure of weak players, especially if fuel prices begin an upward trend\textsuperscript{35}.

**Conclusions**

Based on our current research we believe that there is significant opportunity to generate meaningful emission reductions by pursuing HDFT efficiency improvements, however it is unlikely to result from a for-profit business model such as an Energy Savings Company. It also unclear what role, if any, EDF will have in this undertaking given the extensive work already undertaken in this field by other organizations such as RMI and CSS.

As mentioned previously, we focused on the four criteria that EDF had presented as their metrics for a successful project and mapped our findings for an ESCO to determine whether this would be a worthwhile endeavor. The results are as follows:

- **Significant Environmental Impact** – There are potentially significant GHG emission reductions that could be achieved if market penetration were high and an ESCO could successfully be established. However our findings indicate that this would be difficult given the industry conditions.

- **Novel Initiative** – While there is no ESCO currently operating in the industry, the EPA SmartWay transport program and Cascade Sierra Solutions are approaching the problem in a different way, so there are certainly other players in the space.

- **Potential to be a “Game Changer”** – Since we have determined that an ESCO would not be feasible in this industry, it seems unlikely to have a game changing impact.

- **Sound Business Case** – An ESCO could provide capital to help with financing, but our determination is that the financial feasibility of an ESCO does not exist due to the numerous reasons listed above.

We believe the greatest leverage towards achieving significant emissions reductions in the HDFT industry lies in educating and changing the driving behavior of the thousands of owner-operators and small fleet owners on US highways. Given the current work already underway by other organizations in this field, we believe it would not be the best use of EDF time or money to focus on this issue through the development of new initiatives. However, we do see significant opportunities for secondary support roles of existing initiatives. Specifically, we believe an expansion of the CSS business model and a greater focus on transport logistics and policy will allow EDF to achieve more radical emission reductions.

http://www.msnbc.msn.com/id/30728469
Despite the inability to deploy an ESCO model in this case, EDF may continue to promote these technologies within the industry through any of the following strategies:

1. Work with the EPA to establish a Gold Certification that can have priority in RFPs. Make the criteria for this designation achievable by owner-operators.

2. Work with MIT Sloan’s Sustainability Lab and MLOG program to convene several meetings of academics, fleet leaders, OEMs and trade groups to establish wider acceptance of verified technologies and greater production of products such as governed engines.

3. Work with EDF’s corporate partners to fund study and establishment of a second CSS site at a heavily trafficked area in the Eastern US.

Fuel efficiency in the HDFT industry is and will continue to be one of the most important factors towards achieving significant GHG emission reductions. We invite EDF to reflect on its organizational capabilities, and more specifically its strong corporate partnerships to support and promote existing industry initiatives.