Assessing the Regional Implications of Advanced Truck Stop Electrification:

A Report to EPA

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Background

NESCAUM, in conjunction with a diverse group of project partners and through the financial support of EPA, has initiated an advanced truckstop electrification (ATE) demonstration project at two participating locations in New York State. Utilizing an anti-idling technology from IdleAire Corporation[1] of Knoxville, TN, the project partners seek to mitigate emissions associated with Class 8, over-the-road diesel tractors during extended periods of idle. Based on preliminary research conducted at the Hunts Point Cooperative Market project location in The Bronx, NY, it is common for these large diesels to idle up to 14 hours while waiting for authorization to load or off-load cargo. At the second project location along the I-90 Thruway in Syracuse, NY, long-haul drivers may idle up to 8 hours or more, primarily to satisfy "hours of service" requirements under federal transportation law.

The project is designed first and foremost to address the issue of extended diesel idling, recognizing that the contribution of these sources may significantly impact local air quality. Diesel exhaust is identified by EPA as a probable human carcinogen, generates elevated levels of NOx, HC, PM, CO, CO2, and volatile organic compounds from combustion. It is this menu of gases and particles that contributes to the formation of ground-level ozone, smog, global warming and elevated levels of asthma in "at-risk" or hyper-senstive populations. Thus on a daily, weekly, monthly, and annual basis, large "clusters" of Class 8 diesels at truck stop locations throughout the country present a real impact to surrounding air quality, one NESCAUM seeks to mitigate through the demonstration of ATE technology, and to quantify through EPA funding. In addition to quantifying the environmental benefits of the project, NESCAUM will also quantify the energy, economic, and user benefits of transferring to a fixed-location, anti-idling practices.

Emissions Reductions

To date, actual emissions reductions from the deployment of IdleAire's technology to NESCAUM's two project locations are being achieved but are not quantified. Two of the three locations (Syracuse-DeWitt, Hunts Point) are installed, operational, eliminating emissions from idling, and collecting transactional data[2], with the third (Syracuse – Chittenango) expected to come on-line in the next 8 weeks.

In an effort to assess the estimated or potential emissions reductions associated with the use of the three IdleAire systems deployed to the project, NESCAUM worked in collaboration with IdleAire Technologies and the project partners to quantify a projected range of environmental benefits. Results of initial findings, based on a number of sources, are presented in the following two tables.

[1] More information on the fixed location anti-idling solution selected for this project can be found at http://www.idleaire.com.
[2] Web cameras monitor the Syracuse – DeWitt system and Hunts Point system in real time.

Table 1 provides a comparative analysis of emissions from heavy duty diesel engines at idle with the emissions from power plants generating equivalent electrical power. This table serves to support IdleAire's premise that fossil fuels can be transformed into useable energy more cleanly and efficiently by commercial power plants than by idling diesel combustion engines. Using the power grid to support in-cab services to a truck during layover releases to the atmosphere about 1/60th as much PM, and 1/20th as much NO_X as would the truck's diesel engine.

TABLE 1: EMISSIONS REDUCTIONS ACHIEVABLE BY TRUCK ELECTRIFICATION (PERCENT)

Type	NO_X	PM	VOC	CO	CO_2
IDLING EMISSIONS (GRAMS/TRUCK/HR)[3]	122	2.19	36.4	118	10,070
Emissions to generate equivalent electrical power (grams/hr)[4]	6.04	0.035	0.054	0.481	3,014
Percent emissions reduction	95.0%	98.4%	99.9%	99.6%	70.1%

Table 2 provides and estimation of the emissions reductions theoretically obtainable by operating 44 truck spaces in Syracuse and 28 spaces in Hunts Point at 50% utilization annually (12 hrs/day, on average).

TABLE 2: ELECTRIFICATION EMISSIONS REDUCTIONS AT HUNTS POINT (METRIC TONS/YEAR)

Type	Spaces	NO_X	PM	VOC	CO	CO_2	Total
Hunts Point Syracuse	28 44	14.98 23.54	0.27 0.43	4.48 7.04	14.47 22.75	1235 1940	1269 1993
Emissions to generate equivalent electrical power	28 44	0.74 1.17	0.004 0.007	0.001 0.012	0.062 0.10	369 580	370 581
Emissions Removed	72	36.61	0.69	11.50	37.05	2226	2312

[3] Emission factors for heavy-duty diesel trucks have been developed using three sources: U.S. EPA (Mobile5 model), Colorado Institute for Fuels and Environmental Research, and University of California Davis. The values used here are averages derived from these three studies. Emission factors for refers are not included.

[4] Emission factors for equivalent production of electric power are based on work by the Argonne National Laboratory (Stodolsky, Frank, Linda Gaines, and Anant Vyas. *Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks*. Argonne National Laboratory ANL/ESD-43 June 2000). Argonne assumed 4.3kW per operating hour. Emissions per kWh based on current U.S. mix of oil, natural gas, coal, nuclear, and other sources, as specified by Argonne's GREET model.

A brief commentary on the calculations, methods, and practical use of the data is warranted, as follows:

- Recent analysis performed by EPA for heavy-duty diesel emissions factors at Aberdeen Proving Grounds in 2002 and data from EPA's Mobile6 model may serve to refine NESCAUM's projections.
- Emissions factors for equivalent electrical generation will experience region-to-region variation and are highly dependent on the utility provider and mix of fuel sources for generation.
- A conservative utilization rate of 50% for the IdleAire system was used for estimating emissions reduction. Higher utilization rates are likely achievable in the future.
- Emissions calculations at Hunts Point do not reflect contributions from refer engines, or small, trailer mounted diesel engines that provide cooling to refrigerated trailers. It is estimated that refer engines add up to 30% more emissions to the total emissions profile of a tractor-trailer.
- Actual emissions reductions achieved for the ATE project will be dependent on actual data generated and recorded in the field.

ATE Work Group and Regional Implications

In July, 2002, NESCAUM formed a work group with a broad range of stakeholders to determine a method to fast-track or accelerate the implementation of ATE at fixed locations throughout the Easternmost region of the U.S. from Maine to Florida. This work group, led by NESCAUM through the EPA CATC grant, also engaged in a mapping exercise for the I-95 corridor, to map approximately 200 truck stop locations by GPS coordinates within a legend that also identified 2000 Census population density, 1 hour and 8 hour Ozone attainment status, and utility jurisdiction. The maps can be viewed via the internet at http://64.2.134.196/datamaps/I-95_Ozone_Maps/TSE_Maps.html.

To date, four conference calls have been held, however a final work product and summary report is not anticipated to be available for another 2 to 3 months. Interim feedback, nonetheless, strongly supports the formation of a regional ATE program throughout the I-95 corridor states. The work group recognizes that the success of a regional program using a fixed location anti-idling technology is dependent on a number of factors, no more so than system demand and defensibility against competing, on-board technologies.

The issue of on-board, OEM systems in coming model year vehicles and the direction of the on-road diesel vehicle manufacturing market will be a topic of our next discussion, however the age of the national U.S. class 8 truck fleet was examined as a potential predictor of technology obsolescence risk for deploying a fixed location anti-idling technology. Our findings indicate that most long haul class 8 fleet owners turn their engines over within five years, but no incentives exist to re-power with cleaner engines and/or auxiliary equipment that would significantly reduce idling. Long haul fleets aside, the average life of all class 8 vehicles is 29 years, according to DOE's Transportation Energy Data book: Edition 22[5].

EPA has asked NESCAUM to comment on the economic and environmental implications of regional ATE expansion throughout the I-95 corridor. From an economic perspective, preliminary research of FHWA data from a 1999 investigation of private and public truck stop capacity indicates significant truck stop overcrowding along major corridors in the Northeast. Based upon this data and upon discussions with regional truck stop operators and operator organizations participating in the workgroup, it was concluded that: 1) An inherent demand and; 2) the regulatory impetus to reduce excessive idling exist in the region to support ROI and payback models associated with ATE installation, absent any sources of co-funding, matching funds, regulatory or market-based incentives such as CO2 banking and SIP credits.

A business case can also be made for ATE participation for both fleet and/or vehicle owners and for truck stop operators. For fleet owners, financial benefits of ATE utilization are realized two ways. First, the basic IdleAire service is priced lower than the cost of fuel consumed during idling, so there is a direct economic benefit to the fleet in the form of saved fuel expenses. Second, truck owners stand to derive a cumulative avoided engine maintenance benefit by preventing engine idling.. According to the American Truck Association's Truck Maintenance Council, class 8 vehicles idle up to 2350 hours annually. The elimination of 2350 hours of idling is equivalent to preventing 18,000 miles over the road. For truck stop operators, IdleAire offers a direct financial incentive to host an ATE system through a revenue sharing model. In exchange for leasing property to IdleAire to accommodate the ATE system, host operators are given a percentage, typically 15% of gross revenues generated from operations. Over time, this could become a dependable, steady revenue stream for participating operators, and also serve to support a business decision to invest in an ATE installation.

From an environmental benefits perspective, it is fairly simple to extrapolate the Syracuse and Hunts Point emissions reduction projections to assess potential regional benefits. Regional benefits, for the purpose of this analysis, will be determined by calculating the net emissions reductions resulting from the installation of one, large 500 IdleAire system per I-95 member state, in a hypothetical area of greatest truck stop concentration ("cluster") within that state. Benefits will accrue to the region over a 10 year lifetime, starting at a 50% system utilization rate (12 hours/day) and growing 10% annually to 2008, and then 5% thereafter until full utilization is achieved in year 7[6]. Due to operational, logistical, and equipment constraints, I restrict full utilization to 95% of total potential. That may still be overly optimistic, as it is not known what utilization rates are actually achievable in the operating environment. The same emissions factors and equivalent power plant emissions data from the ATE project calculations will be employed. A total of 7000 spaces are developed for the calculation, or 500 per state for each of the 14 member states.

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[5] More rich data relevant to this discussion can be found at: http://www-cta.ornl.gov/cta/data/Chapter6.html.

[6] The full worksheet associated with these calculations, entitled "Regional ATE Emissions Calculations 2005 -2014.xls" is also provided with this report.

Table 3: Regional Emissions Reductions Achieved though ATE deployment, I-95 Corridor, Year 1: 2005 (Metric Tons/Year)

Year	ATE Spaces	Capacity	Emissions	NOx	PM	VOC	CO	CO2	Metric Tons / Yr
2005	7000	50%	Vehicles	3740.52	67.15	1116.02	3617.88	308746.20	317287.77
			Power grid	185.50	1.10	1.75	15.26	92316.00	92519.61
			Reductions	3555.02	66.05	1114.27	3602.62	216430.20	**224768.16**

At 50% capacity, cumulative emissions reductions of 224.7 thousand metric tons /year are achieved in the region in year 2005.

Table 4: Regional Emissions Reductions Achieved though ATE deployment, I-95 Corridor, Years 2-10: 2006 through 2014 (Metric Tons/Year)

Year	ATE Spaces	Capacity	Emissions	NOx	PM	VOC	CO	CO2	Metric Tons / Yr
2006	7000	60%	Vehicles	4488.62	80.57	1339.23	4341.46	370495.44	380745.32
			Power grid	222.60	1.32	2.10	18.31	110779.20	111023.53
			Reductions	4266.02	79.26	1337.13	4323.14	259716.24	**269721.79**
2007	7000	70%	Vehicles	5236.73	94.00	1562.43	5065.03	432244.68	444202.88
			Power grid	259.70	1.54	2.45	21.36	129242.40	129527.45
			Reductions	4977.03	92.46	1559.98	5043.67	303002.28	**314675.42**
2008	7000	80%	Vehicles	5984.83	107.43	1785.64	5788.61	493993.92	507660.43
			Power grid	296.80	1.76	2.80	24.42	147705.60	148031.37
			Reductions	5688.03	105.67	1782.84	5764.19	346288.32	**359629.06**
2009	7000	85%	Vehicles	6358.88	114.15	1897.24	6150.40	524868.54	539389.21
			Power grid	315.35	1.87	2.98	25.94	156937.20	157283.34
			Reductions	6043.53	112.28	1894.27	6124.45	367931.34	**382105.87**
2010	7000	90%	Vehicles	6732.94	120.86	2008.84	6512.18	555743.16	571117.98
			Power grid	333.90	1.98	3.15	27.47	166168.80	166535.30
			Reductions	6399.04	118.88	2005.69	6484.72	389574.36	**404582.69**
2011	7000	95%	Vehicles	7106.99	127.58	2120.45	6873.97	586617.78	602846.76
			Power grid	352.45	2.09	3.33	28.99	175400.40	175787.26
			Reductions	6754.54	125.49	2117.12	6844.98	411217.38	**427059.50**
2012	7000	95%	Vehicles	7106.99	127.58	2120.45	6873.97	586617.78	602846.76

			Power grid	352.45	2.09	3.33	28.99	175400.40	175787.26
			Reductions	6754.54	125.49	2117.12	6844.98	411217.38	**427059.50**
2013	7000	95%	Vehicles	7106.99	127.58	2120.45	6873.97	586617.78	602846.76
			Power grid	352.45	2.09	3.33	28.99	175400.40	175787.26
			Reductions	6754.54	125.49	2117.12	6844.98	411217.38	**427059.50**
2014	7000	95%	Vehicles	7106.99	127.58	2120.45	6873.97	586617.78	602846.76
			Power grid	352.45	2.09	3.33	28.99	175400.40	175787.26
			Reductions	6754.54	125.49	2117.12	6844.98	411217.38	**427059.50**

In operating years 2 through 10, system utilization climbs from 60% in 2006 to a maximum of 95% in 2011. In 2011, 427 thousand metric tons of emissions reductions per year are achieved in the region at maximum utilization.

Table 5: Cumulative Regional Emissions Reductions Achieved though ATE deployment, I-95 Corridor, All Years: 2005 through 2014 (Metric Tons)

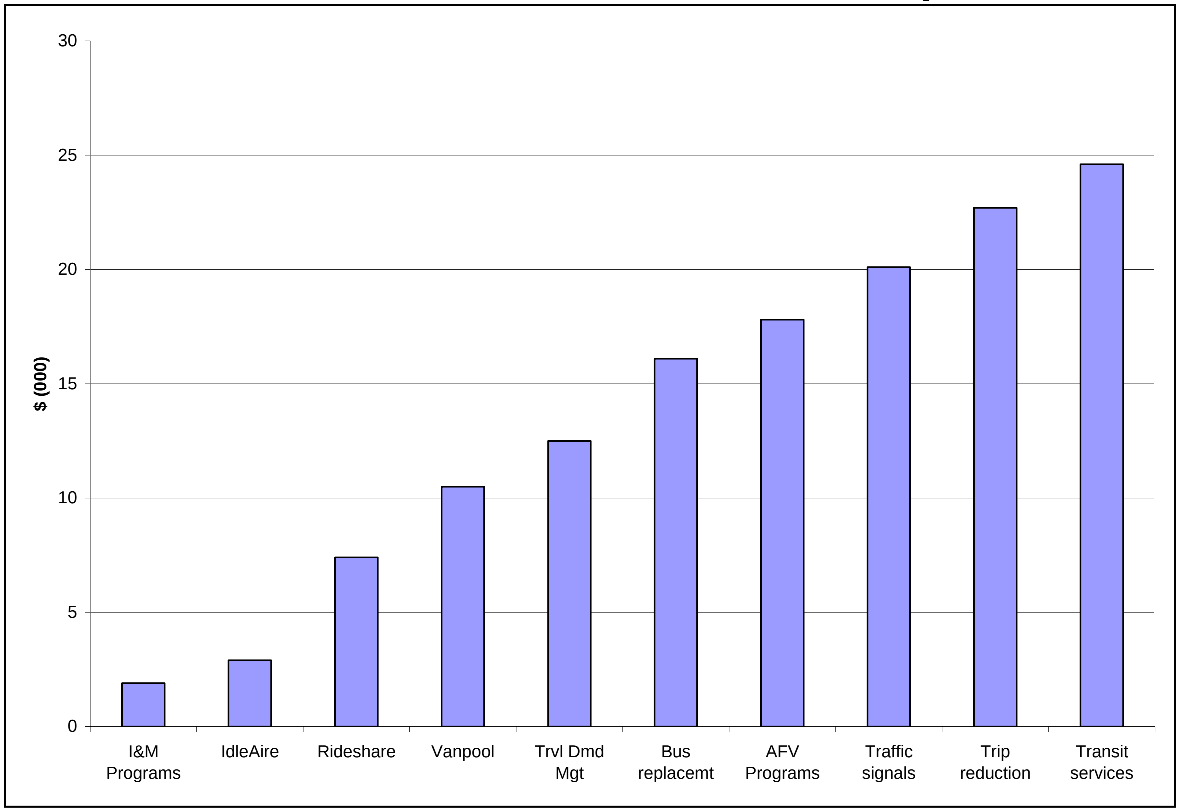
Years	ATE Spaces	Capacity	Emissions	NOx	PM	VOC	CO	CO2	Total Metric Tons
10	7000	81.50%	Reductions	57947	1077	18163	58723	3527812	**3663721**

In the 10 year operating period, a cumulative total of 3.66 million metric tons of emissions reductions are achieved. This calculation assumes that the regional ATE system operates at an average utilization rate of 81.50%. An average utilization rate of 81.5% is equivalent to the system operating 19.56 of a possible 24 hours each day, or 297 of a possible 365 days each year.

<u>Cost Effectiveness</u>

The cost effectiveness of the IdleAire system, in terms of dollars per ton of NOx reduced as compared to other technologies in the CMAQ transportation program, is displayed in the following chart:

COST-EFFECTIVENESS PER TON OF NO_X REDUCTION. IDLEAIRE VERSUS THE TEN BEST TECHNOLOGY CATEGORIES IN THE U.S. DEPARTMENT OF TRANSPORTATION'S CMAQ PROGRAM[7]



A more quantitative and project-relevant gauge used to evaluate the cost effectiveness of ATE for the I-95 corridor region is required. Based on our experience, NESCAUM believes the installation cost of an IdleAire system to be $10,000.00 per space or unit, with a 50 space minimum per installation. The deployment, then, of 7000 spaces to the 14 member state regional requires a total capital cost of $70 million prior to 2005. If the system delivers 3.66 million metric tons of emissions reductions over it's 10 year operating life, than the cost-effectiveness of IdleAire's system works out to ($70 million / 3.66 million tons), or $19.10/ metric ton for all pollutants. Bearing in mind that CO2 represents the largest quantity of any of the pollutants reduced, NOx reductions should also be calculated. For NOx alone, the system achieves a cost-effectiveness of ($70 million / 57947 tons), or $1208 / metric ton. Please note, each of these "cost performance" figures are highly dependent on overall system usage. A more conservative approach, using emissions reductions figures based on 50% utilization rates may be warranted. This analysis does not

[7] National Research Council (U.S.) Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program. *The Congestion Mitigation and Air Quality Improvement Program: Assessing 10 years of Experience,* Special Report 264, Washington, D.C., National Academy Press, 2002, Table E-1, p 320

factor in co-funding or cost sharing from any outside sources, such as utilities or state entities, nor does it assume any discounts from IdleAire.

Expectations

NESCAUM looks forward to moderating the next two ATE work group discussions on sources of funding and the state of on-board, anti-idling technologies with participating stakeholders, and putting forth a summary report that is reflective of the group's efforts.

Research of the environmental, energy, economic, and user benefits of ATE, also supported by the CATC grant, will be conducted in the next 12 months, and case studies developed for the two participating locations (Syracuse, Hunts Point).

From a regional perspective, NESCAUM anticipates working together with EPA, DOE, and selected members of the ATE work group to disseminate our findings and discuss the creation of a regional ATE program.

Importance of Additional Funding

The CATC grant program, and in particular the financial assistance provided by EPA to NESCAUM under assistance ID NO. R-82921001-0, has enabled us to adequately address the issue of anti-idling in the Northeast through the ATE workgroup, however much work remains in this area. With the support of additional EPA funding, NESCAUM will be in a position to further refine the ATE mapping exercise to include stuck stop data for all highways and major routes intersecting I-95. This will allow us to pinpoint "clusters" of high-density truck idling areas best suited for ATE installation within each of the 14 member states. Moreover, NESCAUM seeks to utilize our experience, negotiated contracts, and IT and GPS team to create a national ATE mapping exercise and database for EPA and DOE. This roadmap-like resource will aid both agencies in their approach to regional and municipal planning organizations to facilitate discussion of an ATE program in each arterial corridor throughout the country. We anticipate submitting a request for $100,000.00 in extension funding under the CATC program for 2003, or in new funding from EPA OTAQ to carry out this important work.