

Regional Air Quality Council

Preliminary "High Level" Evaluation Tool for Supporting Initial Prioritization  
Of Ozone Reduction Measures

Draft: Not for Distribution

September 20, 2010

**Subcommittee:** Motor Vehicles and Fuels

**Measures Contained in this packet:**

- I/M Program Enhancements - More Stringent Pass/Fail Standards
- I/M Program Enhancements - Evaporative Emission Testing via High Emitter Remote Sensing
- I/M Program Enhancements - On Board Diagnostic (OBD) Testing
- Remote Sensing Based High Emitter Program
- Cash for Clunkers
- Diesel Retrofits
- Truck Stop Electrification

Regional Air Quality Council | Fuels and Motor Vehicles Subcommittee | Overview of Strategies Analyzed

Measure	Description of Measure	Experience in Colorado/Other Areas	Existing Authority or Needed Approvals	Implementation/SIP Measure Feasibility	Additional Analysis Needed	Subcommittee Recommendation and Next Steps
<b>I/M Program Enhancements – More stringent Pass/Fail Standards</b>	Reduce vehicle emissions testing pass/fail criteria within the Vehicle Inspection and Maintenance (I/M) Program to increase the benefit from the program.	The I/M Program is currently in place in Colorado. Reducing pass/fail criteria would be a regulatory change to the existing program.	AQCC has the authority to adopt tighter emissions standards.	This strategy could be implemented and included in the SIP.	-APCD currently performing analyses -MOVES modeling -Cost analysis	Subcommittee recommends continuing evaluation as part of APCD assessment of I/M options.
<b>I/M Program Enhancements – Evaporative Emission Testing via High Emitter Remote Sensing</b>	Roadside remote sensing technology is currently used to identify vehicles with emissions problems in the Denver area. Using roadside remote sensing technology to identify high evaporative emitters of volatile organic compounds (VOC) may increase the benefit from the I/M program.	Pilot studies are currently in operation in Colorado.	AQCC has the authority to adopt an evaporative emissions check in the I/M Program.	Currently, EPA does not provide SIP credit for this strategy. Colorado must demonstrate this is an effective control option to EPA to be included in the SIP.	Significant additional analysis on the costs and benefits based on the current pilot program by CDPHE/RAQC.	Subcommittee recommends continuing evaluation as part of APCD assessment of I/M options.
<b>I/M Program Enhancements – On Board Diagnostics (OBD) Testing</b>	On-board diagnostic (OBD) testing uses information from the vehicle’s computer to predict vehicle operating and emissions problems. Addition of an OBD test may increase the benefit from the program.	Currently, Colorado requires OBD testing for data gathering purposes.	AQCC has the authority to adopt regulatory requirements for an OBD based I/M Program or to require an OBD test to supplement the current I/M240 test.	A program using OBD testing as either a replacement or a supplement could be implemented and included in the SIP.	-Additional analysis of the disparity between modeled and actual emissions benefits between I/M240 testing and OBD. -Cost analysis -Analysis of program structure	Subcommittee recommends continuing evaluation as part of APCD assessment of I/M options.

Regional Air Quality Council | Fuels and Motor Vehicles Subcommittee | Overview of Strategies Analyzed

Measure	Description of Measure	Experience in Colorado/Other Areas	Existing Authority or Needed Approvals	Implementation/SIP Measure Feasibility	Additional Analysis Needed	Subcommittee Recommendation and Next Steps
<b>Remote Sensing Based High-Emitter Program</b>	Roadside remote sensing technology is currently used in a voluntary program to identify vehicles with emissions problems in the Denver area. This strategy would replace the current I/M Program with a program that utilizes only remote sensing to identify vehicles with high emissions.	Colorado has been investigating a remote sensing based high-emitter program since 2003.	The AQCC adopted a pilot remote sensing based high-emitter program and has the authority to adopt a full-scale program.	Currently, EPA does not provide additional SIP credit for this strategy. Colorado must demonstrate this is an effective control option to EPA to be included in the SIP.	-CDPHE is currently in the process of analyzing results from the pilot program.  -Cost analysis	Subcommittee recommends tabling a mandatory program; however pursuing voluntary efforts has merit.
<b>Cash for Clunkers</b>	A cash for clunkers program would identify older, higher polluting vehicles for purchase and permanent retirement.	The RAQC/CDPHE are currently operating a voluntary cash for clunkers program with SEP funds.	A mandatory program would require legislative action to fund the program and establish eligibility requirements.	A mandatory program with a dedicated source of funding could be included in the SIP.	Program eligibility requirements would need to be developed to analyze costs and benefits.	Subcommittee recommends tabling as a SIP measure but continuing to pursue voluntary efforts.
<b>Diesel Retrofits</b>	Older diesel vehicles have higher emissions than newer diesel vehicles. Diesel retrofits use different technologies to reduce emissions from these older vehicles.	Colorado currently has a robust voluntary diesel retrofit program through the RAQC, CDPHE, the City and County of Denver, school districts and local governments. Other states have mandatory programs in place.	A mandatory program would require legislative approval and regulatory development by the AQCC.	EPA has guidance on taking SIP credit for these programs. California has a major diesel retrofit program (\$120M) included in their SIP.	Significant additional development of this strategy to identify what sectors would be required to install retrofits is needed. Without a program framework it is impossible to determine program costs and benefits.	Subcommittee recommends tabling as a mandatory measure due to program costs and pursuing funding for voluntary efforts instead.

Regional Air Quality Council | Fuels and Motor Vehicles Subcommittee | Overview of Strategies Analyzed

Measure	Description of Measure	Experience in Colorado/Other Areas	Existing Authority or Needed Approvals	Implementation/SIP Measure Feasibility	Additional Analysis Needed	Subcommittee Recommendation and Next Steps
<b>Truck Stop Electrification</b>	Truck stop electrification (TSE) can be installed at area truck stops so that cab cooling and heating is provided by a unit that is inserted into the window of the vehicle so that the engine does not need to idle.	Colorado currently has approximately 20 TSE spaces in the state.	A mandatory program would require legislative approval and regulatory development by the AQCC.	There are no known programs included in SIPs. However, EPA has guidance on taking SIP credit for these programs.	-Evaluation of EPA guidance for taking SIP credit.  -Additional analysis of the power plant emissions required to provide TSE services.	Subcommittee recommends tabling a mandatory program at this time due to cheaper alternatives.
<b>Signal Timing and Coordination</b>	Signal timing is the process of making traffic signals work together as opposed to independently. This process reduces emissions on certain corridors by reducing vehicle wait times.	DRCOG has a Regional Traffic Signal System Improvement Program (TSSIP) that identifies critical corridors for improvement. Other areas in the country have similar efforts in place.	This program is in place and operated by DRCOG.	Emissions reductions can be calculated for DRCOG's program. At this time, DRCOG's models do not have the sophistication to translate these benefits to a regional level that would be required for a SIP. However, Phoenix has included this in their SIP. Their methodology is being investigated.	-Evaluation of Phoenix's SIP methodology.	Subcommittee recommends pursuing information on Phoenix's SIP program and methodology.

Regional Air Quality Council | Fuels and Motor Vehicles Subcommittee | Overview of Strategies Analyzed

Measure	Description of Measure	Experience in Colorado/Other Areas	Existing Authority or Needed Approvals	Implementation/SIP Measure Feasibility	Additional Analysis Needed	Subcommittee Recommendation and Next Steps
<b>Eco-Driving Education</b>	Eco-driving programs are designed to educate drivers in techniques (i.e., avoiding rapid acceleration, reducing speeds, etc.) that can reduce gas consumption and emissions. These programs can take the form of direct driver education in a classroom, tracking employee driving through technology or as a public awareness campaign.	There are a number of programs in existence and they are common in fleet operations. Both the City and County of Denver and Encana Oil & Gas have programs that focus on improving driver behavior.	Legislative action and regulatory development would be required to implement a mandatory program.	There is no demonstrated ability to take SIP credit for this measure. There are no known eco-driving programs included in SIPs.	-Additional analysis of potential emissions reductions.	Subcommittee recommends tabling a mandatory program and pursuing voluntary education efforts.

Preliminary “High-Level” Evaluation Tool for Supporting Initial Prioritization  
of Ozone Reduction Measures

Draft: Not for Distribution

**September 15, 2010**

**Measure type:** Motor Vehicles

**Measure name and description:** I/M Program Enhancements-More Stringent Pass/Fail Standards

The State of Colorado operates a Vehicle Inspection and Maintenance (I/M) Program in the 7-County Denver Metro Area (DMA). Commencing in late 2010, the program will be expanded to non-attainment areas within Larimer and Weld Counties. Under the program, all vehicles registered within the program area must meet established carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) pass/fail criteria. These pass/fail standards are typically referred to as “emission cutpoints.” To ensure compliance with established emission cutpoints, vehicles must undergo periodic emissions testing at the time of their registration renewal (I/M 240 testing). Vehicles that fail the tests must be repaired and pass a retest before they can be re-registered. In 2009, approximately 60,000 vehicles failed their emissions test in the Denver Metro Area. Based on DMA fail rates, approximately 15,000 vehicles from Larimer and Weld Counties are projected to fail per year upon expansion of the program to those counties.

The environmental benefit from the program is derived primarily from the emission reductions that occur when vehicles failing the initial test are repaired to ensure compliance with program requirements, with additional reductions occurring as a result of pre-inspection vehicle maintenance. While most inspected vehicles within the AIR Program area pass the established standards, those that fail contribute disproportionately to the overall emissions of the vehicle fleet.

Based on Mobile 6.2 modeling, the I/M Program in the DMA reduced ozone precursor emissions by approximately 16 tons per day in 2009 (VOC + NO<sub>x</sub> + 1/60 CO). Based on modeling for 2015, the projected benefit for the entire program area (including Larimer and Weld Counties) is approximately 18 tons per day (approximately 8 tpd VOC, 8 tpd NO<sub>x</sub> and 2 tpd CO (120 tpd/60)) .

By adopting more stringent or lower I/M program emission cutpoints, we could achieve additional emission reductions from motor vehicles through the identification and repair of more vehicles with excess emissions.

**Preliminary sense of anticipated air quality benefits (e.g. NO<sub>x</sub>/VOC reductions? Potential reduction amount?):**

The amount of emission reductions from an I/M 240 program will vary depending on the emission cutpoints that are adopted. Recognizing that the emission levels of vehicles can only be lowered so much through maintenance and repair, the Mobile6.2 emissions model only recognizes emission cutpoints down to a certain level of stringency. Using the most stringent

emission limits allowed under the model, additional benefits beyond those currently achieved by the I/M program, are as follows:

- Approximately 0.5 TPD reduction in VOC emissions from on-road vehicles (approximately 0.7% of on-road VOC)
- Approximately 0.5 TPD reduction in NO<sub>x</sub> emissions from on-road vehicles (approximately 0.7% of on-road NO<sub>x</sub>)

#### **Preliminary sense of anticipated costs and economic impacts**

Based on projections from 2009 actual program data, adopting the most stringent cutpoints allowed under the model will result in approximately 50,000 additional failing vehicles, and a corresponding increase in vehicle repair costs attributable to the program. Based on 2009 inspection data from the DMA program, and projecting this data out to include the expansion of the program into Larimer and Weld Counties, using the most stringent cutpoints allowed under the model would increase the cost of the program in 2009 by approximately 13 million dollars.

#### **Additional technical analysis needed to refine benefits/costs estimates:**

Emission reduction analysis needs to be conducted using the MOVES mobile source emission model since the MOVES model will need to be used for the next SIP. Additionally, actual test data from the current I/M program needs to be considered in order to validate the results, and examine the apparent disconnect between the relatively small emission reductions as calculated by the Mobile model, and the large number of additional vehicles projected to fail if the new emission cutpoints were adopted. Finally, additional analysis is needed to more accurately predict the actual costs from this proposed strategy, through a more in-depth analysis of predicted fail rates that would occur if more stringent cut-points were adopted, including analysis of actual program data from Larimer and Weld Counties rather than the projected data used for this high level assessment.

#### **Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

The AQCC has authority to adopt regulatory requirements regarding the inspection and maintenance program including the adoption of emission cutpoints. CDPHE and Department of Revenue would jointly implement and oversee the program.

#### **Demonstrated ability to take "SIP Credit" for the measure:**

Colorado can take SIP credit for adopting more stringent cutpoints up to the amount allowed by the approved emission model. To receive additional credit would require an extensive demonstration that the more stringent cutpoints produced greater emission reductions than is accounted for under the model.

#### **Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

Colorado could adopt more stringent cutpoints in the near term. The full benefit would only be achieved, however, after the completion of a full (2 year) inspection cycle.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

Adopting more stringent cutpoints would improve the fuel economy of vehicles repaired under the program, thereby reducing greenhouse gas emissions, reducing fuel consumption and saving motorists money on fuel.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

While adopting more stringent cutpoints will achieve additional emission reduction benefits from the inspection and maintenance program, it will also increase the risk that vehicles without any emissions related problem will fail. In setting cutpoints, it is imperative that they are set at a level that well maintained vehicles can meet.

Preliminary “High-Level” Evaluation Tool for Supporting Initial Prioritization  
of Ozone Reduction Measures  
Draft: Not for Distribution  
**September 17, 2010**

**Measure type:** Motor Vehicles

**Measure name and description:** I/M Program Enhancements- Evaporative Emission Testing via High Emitter Remote Sensing

The State of Colorado operates a Vehicle Inspection and Maintenance (I/M) Program in the 7-County Denver Metro Area (DMA). Commencing in late 2010, the program will be expanded to non-attainment areas within Larimer and Weld Counties. Pursuant to the program, vehicles registered in the program area must meet established criteria (cutpoints) for emissions of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs). While the program requirements include a rigorous test for tailpipe emissions, with the exception of a gas cap pressure check, there is currently no testing requirements to identify vehicles with high VOC evaporative emissions emanating from vehicles’ fuel systems. With the advent of stricter new vehicle tailpipe VOC emission standards, evaporative VOC emissions have become an increasingly larger source of the overall VOC emissions from the vehicle fleet. Based on recent calculations, evaporative emissions may now represent more than 60% of all mobile source VOCs in the non-attainment area.

Identifying and requiring the repair of high evaporative emitting vehicles would help to reduce this important source of VOC emissions. Currently, however, because of technological limitations, and the time and expertise it takes to determine whether a vehicle is a high evaporative emitter, conducting an evaporative emissions test on all vehicles as part of the current I/M test is not a viable option. CDPHE is working with both EPA and the RAQC on identifying likely high evaporative emitters while they drive on the public roadways using remote sensing technology. If these efforts prove successful, remote sensing technology could be used to identify likely high emitters, which would then be required to come in for further testing. Vehicles that were confirmed as high evaporative emitters would then be required to undergo repairs to reduce their evaporative emissions.

**Preliminary sense of anticipated air quality benefits (e.g. NO<sub>x</sub>/VOC reductions? Potential reduction amount?):**

The work to identify high evaporative emitters using remote-sensing is still very preliminary. From 2008-2009, CDPHE conducted evaporative emissions testing as part of its larger remote sensing based high emitter pilot program. As part of the program, the RAQC funded the repair of vehicles determined to have high evaporative emissions. Based on this work, CDPHE calculated that a full-scale program would reduce evaporative emissions by 0.6 tons per day through the identification and repair of vehicles with excess evaporative emissions. Further, because of limitations in the testing methods used to measure the amount of evaporative

emissions reduced, this reduction figure likely underestimates the actual benefits that could be achieved from such a program.

**Preliminary sense of anticipated costs and economic impacts**

CDPHE has not yet calculated the costs of a potential evaporative emission program.

**Additional technical analysis needed to refine benefits/costs estimates:**

Significant additional analysis on the potential costs and benefits of such a strategy needs to be completed.

CDPHE is currently working with EPA to refine the methodology used to identify likely high evaporative emitting vehicles using remote sensing technology. Based on this work, EPA has developed a new way to use remote sensing measurements to identify high evaporative emitting vehicles. CDPHE and the RAQC recently began using this new methodology to identify likely high evaporative emitters as part of a voluntary repair assistance program. Data generated from this repair assistance program, along with EPA and CDPHE's ongoing study will provide significant additional information on the potential benefits of a remote sensing based high evaporative emitter program.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

The AQCC has authority to adopt regulatory requirements regarding the inspection and maintenance program, including the adoption of an evaporative emissions check. CDPHE and Department of Revenue would jointly implement and oversee the program. If adopted, such a program would be the first of its kind.

**Demonstrated ability to take "SIP Credit" for the measure:**

Currently, EPA does not provide SIP credit for a remote sensing evaporative emissions program. This is one of the reasons we are working with EPA to evaluate this measure as an emission control option. To receive additional credit for such a program would require extensive further demonstration of the emission reductions from such a program.

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

It is unclear whether an evaporative emissions program could be include in the next ozone SIP, although we believe it would be unlikely due to the significant further evaluation currently underway.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

Adopting an evaporative emissions program would save fuel and associated money

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

Based on preliminary work, use of remote sensing devices to identify high evaporative emission vehicles, could potentially develop into a significant strategy to reduce VOC emissions. Given the current state of our knowledge, however, such reductions remain very speculative.

Preliminary “High-Level” Evaluation Tool  
for Supporting Initial Prioritization of Ozone Reduction Measures

Draft: Not for Distribution

**September 17, 2010**

**Measure type:** Motor Vehicles

**Measure name and description:** I/M Program Enhancements-On Board Diagnostic (OBD) Testing

The State of Colorado operates a Vehicle Inspection and Maintenance (I/M) Program in the 7-County Denver Metro Area (DMA). Commencing in late 2010, the program will be expanded to non-attainment areas within Larimer and Weld Counties. This program utilizes I/M 240 testing to measure tailpipe emissions of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs). This approach allows Colorado to determine whether a vehicle is a high emitter and therefore in need of emission related repairs.

Colorado is unique. Other jurisdictions around the Country have transitioned from using I/M 240 to test vehicles to using vehicle on-board diagnostic systems (OBD). Unlike the I/M 240 test, which measures a vehicle’s actual emissions from the tailpipe, OBD testing uses information regarding a vehicles operation and performance, which is stored in a vehicle’s on board computer. This information is then used to evaluate vehicle emissions and determine whether repairs are needed to meet emission requirements. Currently, Colorado requires a testing contractor to conduct OBD testing, but the results from the test are advisory only and not used to fail vehicles.

The reason for Colorado’s present disinclination to transition to OBD is that we believe more accurate measurements occur using I/M 240; although we continue to evaluate this as part of efforts to further enhance Colorado’s I & M program. One future option may be to pursue greater emission reductions, by requiring pass/fail OBD testing either to supplement or to replace the current I/M 240 test.

**Preliminary sense of anticipated air quality benefits (e.g. NO<sub>x</sub>/VOC reductions? Potential reduction amount?):**

Based on Mobile 6.2 modeling for 2015, the projected benefit for the I/M program utilizing the current I/M 240 testing approach is approximately 18 tons per day (approximately 8 tpd VOC, 8 tpd NO<sub>x</sub> and 2 tpd CO (120 tpd/60).

According to the model, replacing the I/M 240 test with an OBD test, while maintaining the other elements of the current I/M program, would increase the emission reduction benefits of the program as follows:

- Approximately 2.8 TPD reduction in VOC emissions from on-road vehicles (approximately 3.5% of on-road VOC)

- Approximately 2.0 TPD reduction in NO<sub>x</sub> emissions from on-road vehicles (approximately 2.7% of on-road NO<sub>x</sub>)

OBD testing can also be used as a complement to I/M 240 testing. The Mobile 6.2 model does not recognize any emission reduction benefit from conducting dual testing, presumably based on the belief that any failing vehicles identified by an I/M 240 test would also be identified by an OBD test. Based on analyses of Colorado program data as well as studies from other jurisdictions, however, there is far from complete overlap between the failing vehicles identified by OBD testing and the vehicles identified by I/M 240 testing. Accordingly, conducting dual testing would result in the identification of more failing vehicles than either I/M 240 or OBD testing alone, and consequently achieve greater emission reductions from the repair of these vehicles than either testing system, regardless of what the model predicts. Based on an analysis of 2008 I & M program data by an independent contractor, requiring pass/fail OBD testing in conjunction with the current I/M 240 test would result in the following additional emission reductions above the current I/M program:

- Approximately 1.3 TPD reduction in VOC emissions from on-road vehicles (approximately 1.6% of on-road VOC)
- Approximately 2.9 TPD reduction in NO<sub>x</sub> emissions from on-road vehicles (approximately 3.9% of on-road NO<sub>x</sub>)

#### **Preliminary sense of anticipated costs and economic impacts:**

Based on a preliminary cost analysis, APCD has calculated that replacing the current I/M 240 test with an OBD test would add approximately \$5.1 million to the cost of the program, due to a significant increase in the number of failing vehicles requiring repairs. These costs would be born my vehicle owners. These costs are based on 2009 program data for the Denver Metro Area, and estimates for the soon to be started North Front Range Area.

The contractor, which analyzed the potential benefits of using OBD testing in conjunction with I/M 240 testing, calculated that such a strategy would cost approximately \$4.2 million, based on 2008 data from the Denver Metro Area alone.

#### **Additional technical analysis needed to refine benefits/costs estimates:**

Additional analysis on the relative benefits of I/M 240 and OBD testing are needed. While the Mobile 6.2 model calculates significant additional benefits from OBD testing, analysis of current program data comparing vehicles failing the current I/M 240 test and vehicles that “fail” the current advisory-only OBD test indicates that OBD testing may miss between 40% and 60% of the high emitting vehicles identified by I/M 240.

Given this broad range of potential inaccuracy, it is very possible that OBD testing actually reduces emissions less than I/M 240 testing. APCD is currently conducting an extensive study on the relative merits of the two testing systems. This study will be ongoing, and is intended to provide tangible information to help inform us as to whether a switch to an OBD based system is warranted as part of the next SIP.

Emission reduction analysis needs to be conducted using the MOVES mobile source emission model since the MOVES model will need to be used for the next SIP.

Finally, additional analysis is needed to more accurately predict the actual costs from this proposed strategy, through a more in-depth analysis of predicted fail rates that would occur if OBD testing were adopted either as a supplement to or replacement of the current I/M 240 testing. This analysis would be based on the most current program data available, including analysis of actual program data from Larimer and Weld Counties rather than the projected data used for this high level assessment.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

The AQCC has authority to adopt regulatory requirements for an OBD based I/M program, or to require an OBD test to supplement the current I/M 240 based program emitter program. CDPHE and Department of Revenue would jointly implement and oversee the program.

**Demonstrated ability to take "SIP Credit" for the measure:**

SIP credit for an OBD based program is clearly available. Achieving additional SIP credit for a dual testing program will require an extensive demonstration that such a program would achieve additional emission reductions. Since other jurisdictions have not adopted a dual OBD I/M 240 testing program it is unclear whether EPA would grant additional credit for dual testing. Depending on the results, CDPHE's study of the relative merits of the two testing systems could form the basis for demonstrating to EPA that additional SIP credit for a dual testing system is warranted.

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

A program using OBD testing as either a replacement or a supplement could be implemented for 2015.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

Like all I/M programs, these strategies would improve the fuel economy of vehicles repaired under the program, thereby reducing greenhouse gas emissions and saving motorists money on fuel.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

OBD testing is only available for 1996 and newer vehicles. Older vehicles are not equipped with OBD systems capable of assessing emission related problems. The benefit numbers presented above assume that 1995 and newer vehicles would be tested using the two-speed idle test that Colorado currently uses to test 1981 and older vehicles, since this is the testing package currently employed in most other jurisdictions that use OBD testing.

Preliminary High-Level Evaluation Tool  
for Supporting Initial Prioritization of Ozone Reduction Measures

Draft: Not for Distribution

**9-9-10 Draft**

**Measure type:** Motor Vehicles

**Measure name and description:** Remote Sensing Based High Emitter Program

Use remote sensing technology to identify high emitting vehicles as they are driven on public roadways. The program could be structured as either a supplement to the existing vehicle inspection and maintenance (I/M) program, or as a stand-alone program that replaces the existing program. From 2008 through 2009, CDPHE operated a pilot program to test the potential benefits of using remote sensing technology to identify high emitting vehicles. In September 2009, CDPHE presented emission benefit information to the AQCC based on data generated during calendar 2008. CDPHE will present data from 2009 to the AQCC during its September meeting.

**Preliminary sense of anticipated air quality benefits (e.g. NO<sub>x</sub>/VOC reductions? Potential reduction amount?):**

The amount of emission reductions from a remote sensing based high emitter program will vary significantly depending on the selection criteria. As a general matter using a selection criteria that identifies a large number of potential high emitting vehicles will yield the greatest benefit, but will also increase the likelihood that a vehicle identified as a potential high emitter by remote sensing will in fact be clean when subjected to follow-up testing. During the pilot program, CDPHE used a variety of different selection criteria.

Based on an analysis of the various selection criteria, and using optimistic benefit calculation assumptions, CDPHE calculates a maximum benefit from a full-scale stand-alone remote sensing based high emitter program of approximately 2.6 tons per day reduction of ozone precursor emissions (VOC + NO<sub>x</sub> + 1/60CO) for 2009. This represents 16.5% of the emission benefit reduction from the current I/M program (15.9 tons per day ozone precursor reduction for 2009 based on Mobile 6.2 modeling). As an add on to the existing program, the benefit would be approximately one-third as much, or 0.9 tons per day, based on an optimistic calculation scenario.

**Preliminary sense of anticipated costs and economic impacts**

Costs associated with a stand-alone program include capital and operating costs of the remote sensing devices, capital and operating costs of the confirmatory test centers, the cost of repairs for motorists failing the confirmatory test, and state administrative costs. For an add-on program the costs of the remote sensing devices and to some extent the costs of the confirmatory test centers are already incurred in the cost of operating the current program.

CDPHE has not yet calculated actual costs for a full scale program, either as a stand-alone option or as an add-on to the current program.

**Additional technical analysis needed to refine benefits/costs estimates:**

If this strategy is considered a detailed cost analysis will need to be performed.

Additional analysis is needed to assess the use of remote sensing technology to identify high evaporative VOC emitting vehicles. CDPHE and EPA are currently undertaking a large study of this issue.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

The AQCC has authority to adopt regulatory requirements for a remote sensing based high emitter program. CDPHE and Department of Revenue would jointly implement and oversee the program.

**Demonstrated ability to take "SIP Credit" for the measure:**

Currently EPA has not approved SIP credit for remote sensing based high emitter programs anywhere in the country. It is questionable whether EPA could be convinced to approve SIP credit for a Colorado anytime in the near future.

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

While a program could be implemented prior to 2015, it is unclear whether EPA would approve any SIP credit for it.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

Like all I/M programs, a remote sensing based high emitter program would improve the fuel economy of vehicles repaired under the program, thereby reducing greenhouse gas emissions and saving motorists money on fuel.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

A number of other jurisdictions have experimented with using remote sensing technology to identify high emitting vehicles. To date, none of these experiments has shown that remote sensing technology can generate anywhere near the amount of emission reductions obtained by traditional I/M programs that rely on periodic inspection of the entire vehicle fleet.

Preliminary “High-Level” Evaluation Tool for Supporting Initial Prioritization  
of Ozone Reduction Measures

**Draft: Not for Distribution**

**Measure type:** Motor Vehicles

**Measure name and description:** Cash for Clunkers

‘Cash for clunkers’, also known as ‘Accelerated Vehicle Retirement’ Programs (AVR), ‘Salvage’ Programs and ‘Scrappage’ Programs have been in existence since the early 1990’s. The primary goal of an AVR program is to identify older higher-emitting vehicles to accelerate fleet turnover to newer, cleaner vehicles. The primary eligibility criteria under these programs are either a failing emissions test and/or a model year cut off.

UNOCAL Corporation implemented the first program in Southern California in 1990. The RAQC operated an AVR program from 1993 – 1994 and again in 2009 – 2010. The RAQC’s current AVR program is part of the Repair Your Air Campaign (RYAC) that first attempts to repair vehicles. If vehicles are deemed non-repairable due to cost the RAQC will salvage them. California and Texas have voluntary programs. A number of foreign countries, such as Canada, also have AVR programs.

**Preliminary sense of anticipated air quality benefits (e.g. NOx/VOC reductions? Potential reduction amount?):**

We developed the program benefits contained in Table 1 using the RAQC’s current AVR program. Emissions tests from salvaged vehicles are used to calculate annual baseline emissions data. Because RAQC does not test the emissions of the replacement vehicle purchased by the owner, estimates provided by CDPHE on average emissions of vehicles in the Inspection and Maintenance Program are subtracted from this baseline to get the program benefit.

To-date, the RAQC salvaged over 200 vehicles. For the purposes of comparing the benefits of this strategy to the alternative fuels strategy assessment, the RAQC has assumed that 1,000 (rather than the actual 200 vehicles) have been salvaged.

**Table 1 – AVR Program Benefits Per 1,000 Vehicles**

	VOC	CO	NOx
Total Tons Per Day Per 1,000 Salvaged Vehicles	0.274	1.669	0.027

For the AVR program, benefits of 7 grams/mile VOC, 45 grams/mile CO and 0.7 grams/mile NOx were calculated for the over 200 vehicles salvaged under the program based on emissions testing performed at CDPHE. Because of limitations on the testing methods used to calculate emissions for the salvaged vehicles, actual reduction benefits could be higher. Another issue that impacts emissions data is that some vehicles are unsafe to test so emissions could be higher for these vehicles. Salvaged vehicles are permanently removed from area roads.

**Preliminary sense of anticipated costs:**

The RAQC currently offers \$1,000 per vehicle under its voluntary Repair Your Air Campaign (RYAC). California and Texas offer \$1,500 - \$3,500 per vehicle. Titling fees are an additional cost

that must be factored into these programs. However, program income from the scrap metal from salvaged vehicles can offset some costs.

**Additional technical analysis needed to refine benefits/costs estimates:**

To further refine the benefit estimates of this program, we would need to develop program eligibility requirements. We then determine how many vehicles would be eligible for the program and estimate the associated program benefits.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

While a voluntary program needs no authority (but does need funds), a mandatory program would need legislative action not only to fund it, but also to establish program eligibility requirements. The current RAQC salvage program is funded by two supplemental environmental projects (SEPS). Larger sources of funding would be required for a mandatory program.

**Demonstrated ability to take "SIP Credit" for the measure:**

Only a mandatory program could receive SIP credit. There are no known mandatory programs in the United States.

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

While it is conceivable that such a program could be in place in time to receive SIP credit, implementation of a salvage program would be difficult in the current economic situation because funding for it would be difficult to secure.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

The primary co-benefits of an AVR program are greenhouse gases and increased fuel economy. Quality of life is also enhanced since most vehicle eligible for these programs are older and can have other operational problems such as evaporative leaks that impact passenger health and safety issues.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

Car collectors are concerned about cash for clunkers programs because of the potential for individuals to salvage valuable collector items. However, RAQC worked with the Old Car Council of Colorado to secure their support for our current AVR project.

Preliminary “High-Level” Evaluation Tool for Supporting Initial Prioritization  
of Ozone Reduction Measures  
**Draft: Not for Distribution**

**Measure type:** Motor Vehicles

**Measure name and description:** Diesel Retrofits

A diesel retrofit is a technology or fuel that reduces emissions from older diesel vehicles. The EPA’s definition of retrofit is, “broadly defined to include any technology, device, fuel or system that, when applied to an existing diesel vehicle or engine, achieves emission reductions beyond that required by EPA regulations at the time of a vehicle or engine’s certification. Retrofit technologies may include EPA verified emission control technologies and fuels and CARB-verified emission control technologies. Note that diesel technologies are verified for specific types of vehicles or engines, defined in the “applicability” sections of the EPA/CARB verified technology lists.”

The Environmental Protection Agency (EPA) has set stringent standards for newer diesel vehicles to reduce their emissions. However, these older diesel vehicles are certified under less stringent standards in the past. These vehicles are ideal candidates for diesel retrofits to reduce their emissions.

Diesel retrofits cover a wide range of technologies and vehicle types. Retrofits can be performed on heavy-duty school buses, dump trucks, refuse vehicles, construction equipment, over-the-road trucks, delivery vehicles and many other types of equipment. The primary areas of retrofit include:

- Tailpipe and engine crankcase retrofits;
- Idling reduction retrofits;
- Aerodynamic retrofits (primarily for over-the-road trucks);
- Alternative fuels;
- Engine upgrades and replacements (primarily off-road equipment); and
- Full vehicle replacements.

**Preliminary sense of anticipated air quality benefits (e.g. NO<sub>x</sub>/VOC reductions? Potential reduction amount?):**

Using EPA’s Diesel Emissions Quantifier (DEQ), RAQC obtained a sense of the estimated emissions benefits from various vehicle types. Table 1 shows the range of these vehicle types and their associated benefits. Scenarios were developed using the DEQ and each type of vehicle was retrofitted with a tailpipe diesel oxidation catalyst (DOC) which has the lowest emissions reductions and a tailpipe diesel particulate filter (DPF) which has the highest emissions reductions. This provides a range of emissions benefits that could be expected from a diesel retrofit program.

We also considered idle reduction preheaters to show benefits from idle reduction equipment. These units provide additional benefits above the tailpipe retrofits. The DEQ does not provide idle reduction options for off-road equipment. In this case, over the road trucks retrofitted with auxiliary power units were included. Replacing engines in off-road construction equipment is another retrofit that could provide solid emissions benefits. This scenario is shown on the last line of the table.

**Table 1 – Emissions Benefits Per 1,000 Vehicles Retrofitted (tpd)**

	NOx	PM	VOC	CO
Bus DOC	0.000	0.002	0.016	0.067
Refuse Truck DOC	0.000	0.007	0.053	0.318
Off-Road DOC	0.000	0.017	0.048	0.116
Bus DPF	0.000	0.007	0.029	0.201
Refuse Truck DPF	0.000	0.030	0.096	0.955
Off-Road DPF	0.000	0.072	0.087	0.347
Bus Preheater	0.102	0.003	***	***
Refuse Truck Preheater	0.170	0.005	***	***
Truck with Auxiliary Power Unit	0.858	0.020	***	***
Off-Road Engine Replacement	0.347	0.000	0.045	0.022

\*\*\*While the DEQ does not calculate emissions benefits for these pollutants, installing pre-heaters and APUs will reduce fuel burning and thereby reduce VOC and CO emissions. If these strategies move forward, additional work is needed to calculate VOC and CO emission reductions from these strategies. Based on prior analyses of the VOC and CO emission benefits from reduced fuel burning, however, CO reductions from these strategies are likely to be similar to the NOx reductions and VOC reductions are likely to be between 10% and 20% of the NOx reductions.

The DEQ is approved for EPA grant writing but not for SIPs. The DEQ provides estimates of the emissions the area could realize from a retrofit program.

**Preliminary sense of anticipated costs:**

Costs vary widely depending on the technology and the vehicle being retrofitted. Estimated costs from the scenarios discussed earlier are shown below. Engine replacements are not shown in the table due to wide variations in cost. These costs are developed from current RAQC program costs and research.

**Table 2 – Retrofit Equipment Costs Per Vehicle**

	Low Cost	High Cost
Bus DOC	\$ 1,000	\$ 1,200
Refuse Truck DOC	\$ 1,000	\$ 2,500
Off-Road DOC	\$ 1,000	\$ 3,100
Bus DPF	\$ 8,000	\$ 10,000
Refuse Truck DPF	\$ 8,000	\$ 10,000
Off-Road DPF	\$ 8,000	\$ 20,000
Bus Preheater	\$ 1,400	\$ 3,000
Refuse Truck Preheater	\$ 3,000	\$ 8,300
Off-Road Preheater	\$ 3,000	\$ 9,000
OTR APU/TSS	\$ 4,000	\$ 14,000

Table 1 and Table 2 show that a DPF get up to 4 times the PM emission benefit of a DOC at up to 10 times the cost. Based on our experience, fleets are reluctant to retrofit these advanced technologies on older vehicles that are not designed for them due to maintenance issues.

**Additional technical analysis needed to refine benefits/costs estimates:**

Additional development of this strategy is required in order to fully understand its costs and benefits. Specifically, we must determine what types of diesel vehicles reside in the Denver metropolitan area and what types of technologies can be used to reduce their emissions. EPA's 2006 *Diesel Retrofits: Quantifying and Using Their Benefits in SIPs and Conformity Guidance for State and Local Air and Transportation Agencies* discusses the use of the National Mobile Inventory Model 2005 (NMIM) with MOBILE6.2 and NONROAD2005 to quantify program benefits in SIPs and conformity determinations.

Benefits from this program can be refined using the DEQ, but any measures used in a SIP would have to be modeled through an EPA approved modeling methodology.

Additional analysis would also need to include how effective other state mandatory (see below) programs might be if applied in Colorado.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

Voluntary efforts to retrofit diesel vehicles are underway by the RAQC, CDPHE and the City and County of Denver as well as by private fleets using their own funding. Many states have voluntary efforts in place. There is presently no mandatory program in Colorado.

However, states including California, Illinois, New Jersey, New York and Rhode Island have mandatory programs with varying specific requirements. California's program is the most stringent since it regulates the majority of diesel sources including transit buses, garbage trucks, long haul trucks, transport refrigeration units, stationary and portable diesel generators, port equipment, rail equipment, public utility vehicles, off-road engines, ocean going vessels, harbor craft and other private vehicles. The State has many requirements covering the regulation of these different emissions sources. For example, public agency and utility and solid waste collection vehicles must install the best available control technology (BACT) and register their vehicles with the State. The State also has a strong enforcement component to their program, which means significant funds have been allocated for enforcement. Criminal and civil penalties can be levied against fleets not complying with the State's regulations.

A mandatory program in Colorado would require legislative approval and regulatory development by the Air Quality Control Commission. An enforcement component would need to be developed.

A funding source could be developed as a part of the program similar to California's Diesel Retrofit Program, known as the Carl Moyer Program. This program is funded through a combination of smog check exemption fees that new vehicle owners pay, a new fee on tires and vehicle registration fees. According to the South Coast Air Quality Management District total state funding for this program is an estimated \$120 million a year.

**Demonstrated ability to take "SIP Credit" for the measure:**

California has used diesel retrofits in their SIPs.

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

A mandatory program would be required for SIP credit and could be in place for SIP inclusion, provided that the Legislature enacts a mandatory program and the AQCC adopts regulations to implement the program.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

Diesel particulate matter is a known human carcinogen. Reductions of this pollutant would increase quality of life.

Reductions of black carbon from diesel PM offers an added benefit to reducing climate change due to its high global warming potential. Black carbon is estimated to be up to 4,500 times higher than that of CO<sub>2</sub> on a per gram of emission basis (MECA, 2009, Retrofitting Emissions Controls for Diesel Powered Vehicles).

In addition, significant fuel savings are realized by not idling the truck's main engine. This also provides cost savings through less wear and tear on the engine.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

The RAQC has operated a voluntary diesel retrofit program since 2003 that has retrofitted many vehicles including:

- An estimated 800 diesel oxidation catalysts (DOC), 200 closed crankcase filtration (CCF) systems and 800 idle reduction preheaters on school buses;
- An estimated 100 DOCs, 50 CCFs, 100 idle reduction preheaters, and three advanced hybrid/hydraulic launch assist vehicles on public works vehicles;
- An estimated 100 DOCs, 100 CCFs and 100 idle reduction preheaters on private delivery trucks;
- An estimated 150 auxiliary power units (APU), 25 sets of aerodynamic fairings and 25 sets of low rolling resistance tires for over the road trucks; and
- Three engines for area construction companies and Denver International Airport.

All the equipment installed under the RAQC's Diesel Retrofit Program has been verified by EPA and the California Air Resources Board to ensure that air quality benefits are realized. Benefits are being refined as the RAQC finalizes its American Reinvestment and Recovery Act (ARRA) funding. Emissions are controlled at the tailpipe by the DOCs and are active whenever the vehicle engine is operating.

Benefits associated with the idle reduction preheater and APU depend on whether the vehicle owner turning this equipment on. Vehicle owners have an incentive to use these units because they save fuel and money. Further emission reductions are realized by the aerodynamic equipment and low rolling resistance tires because they reduce aerodynamic drag and thus lower emission levels. New engines emit less pollution through upgrades to the way the engine operates.

Certain retrofits can be installed only on certain vehicles of certain model years according to EPA and California Air Resource Board (CARB) requirements. Vehicle tampering can be enforced by

EPA if vehicles are retrofitted outside these requirements. Off-road retrofits are very difficult to perform due to this issue.

Preliminary “High-Level” Evaluation Tool for Supporting Initial Prioritization  
of Ozone Reduction Measures  
**Draft: Not for Distribution**

**Measure type:** Motor Vehicles

**Measure name and description:** **Truck Stop Electrification (TSE)**

The Department of Energy (DOE) and the Department of Transportation (DOT) estimate up to 5,000 truck stops offer truck parking and other services. Due to DOT mandatory rest requirements for drivers, truckers live in their vehicles for extended periods of time. They often park at area truck stops to rest and recuperate. During certain times of year, resting truckers may idle their engines to provide sleeper compartments with air conditioning, heating and electricity for appliances.

Truck stop electrification requires infrastructure development that allows truckers to "plug in" vehicles to operate necessary systems without idling the engine. In some cases, a stand-alone system is put in the window of the cab that provides heating, ventilation, and air conditioning directly to the sleeper compartment. In others, a unit on the tractor is plugged into an outlet so it can run off electricity as opposed to diesel fuel. The electrical systems are usually owned and maintained by private companies that charge an hourly fee.

As an alternative to TSE services, a stand alone diesel or battery operated auxiliary power unit (APU) can be installed on the truck. APUs are advantageous because they require no infrastructure development and they move with the vehicle. Like TSE, APUs provide the operator air conditioning, heating and electricity for appliances. These units have been a strong focus of both RAQC and CDPHE retrofit efforts.

**Preliminary sense of anticipated air quality benefits (e.g. NOx/VOC reductions? Potential reduction amount?):**

EPA’s Diesel Emissions Quantifier (DEQ) can be used to estimate emissions reductions for TSE. The scenario used in this analysis determines benefits if 100 spaces at area truck stops were electrified. The emissions to generate the electricity at the power plant are not included here.

**Table 1 - Estimated Benefits from TSE (tpd)**

	NOx	PM	HC	CO
100	0.087	0.002	0.004	0.005

The DEQ is approved for EPA grant writing but not for SIPs. The DEQ provides estimates of the emissions the area could realize from a TSE program.

**Preliminary sense of anticipated costs:**

EPA estimates the cost of each parking space that is electrified between \$7,000 - \$15,000. An ANTARES Group, Inc. 2004 study indicates that the cost for TSE services is approximately \$1.50 an hour.

**Additional technical analysis needed to refine benefits/costs estimates:**

- Evaluation of EPA guidance for states to use to include long duration truck idling in their SIPs and Conformity needs to occur to refine benefits and cost estimates of this

measure. This 2004 *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity* describes the methodology that must be used for SIP credit.

- Additional analysis is also required to determine the additional emissions from power plants caused by the increased power demand from this measure. Implementation of HB1365 will reduce the power plant emissions associated with truck stop electrification since some area power plants would be operating on natural gas instead of coal.

**Implementation feasibility (e.g. Who has authority? Who needs it? Who implements the measure?):**

A voluntary effort would require no authority. However, a voluntary effort would provide limited emissions benefits for inclusion in a SIP. Due to the cost per space for TSE, implementation of a mandatory program would make the most sense if this strategy were to be pursued for SIP inclusion. A mandatory program would require legislative and regulatory authority.

**Demonstrated ability to take "SIP Credit" for the measure:**

EPA has guidance for taking SIP credit for a mandatory program. EPA's 2004 *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity* details that the measure must be quantifiable, count as an emissions surplus and is federally enforceable. This last requirement requires that the emissions reductions be part of a rule or regulation

**Likelihood that measure could be in place in time for SIP inclusion (approx 2015); and, if later, how much later (e.g. 2 years? 10 years, etc?):**

This measure could be in place in time for SIP inclusion. Legislative action could be taken in the next session and regulations could be developed prior to 2015 by CDPHE and the AQCC.

**Preliminary Assessment of Co-benefits (e.g. other air quality, economic, quality of life, transportation etc):**

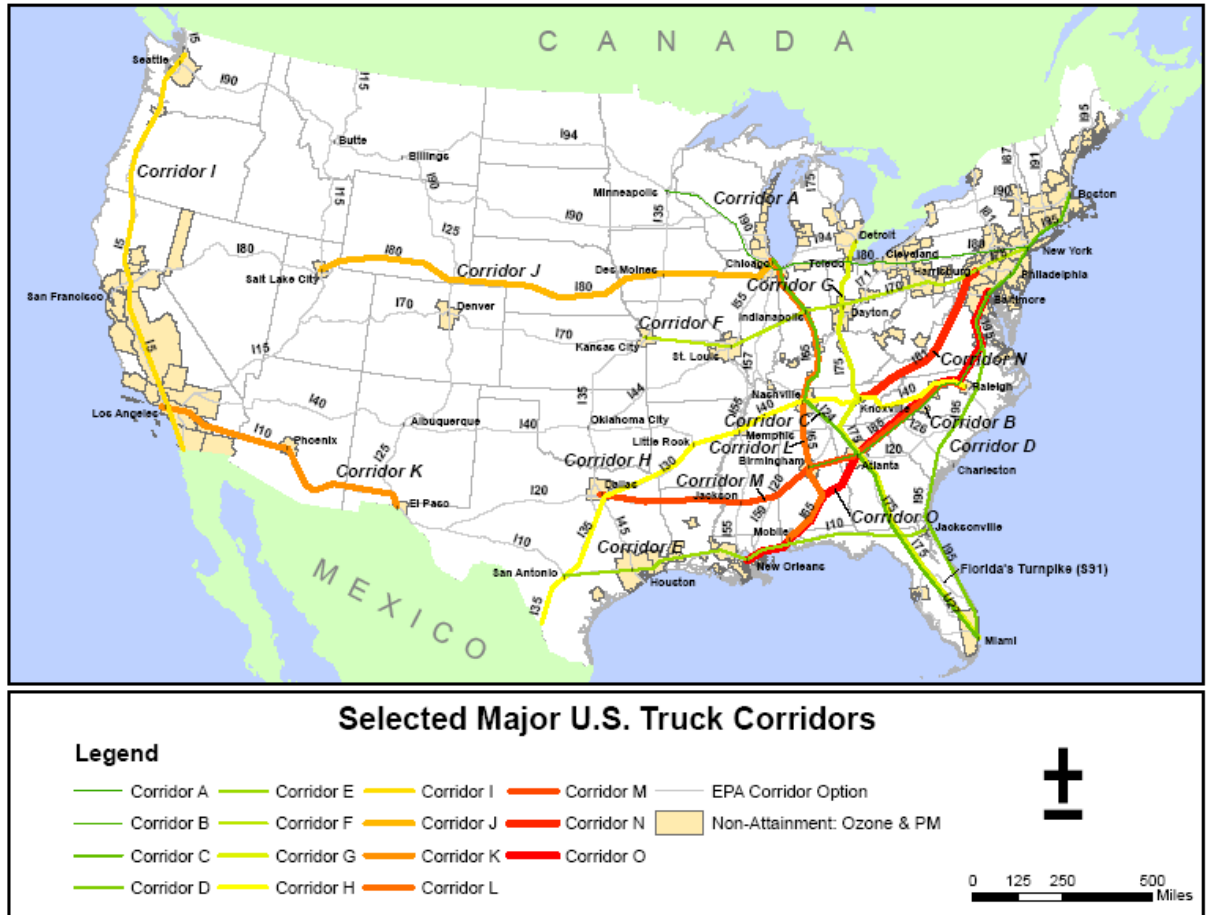
Diesel particulate matter is a known human carcinogen. Reductions of this pollutant would increase quality of life.

Reductions of black carbon from diesel PM offers an added benefit to reducing climate change due to its high global warming potential. Black carbon is estimated to be up to 4,500 times higher than that of CO<sub>2</sub> on a per gram of emission basis (MECA, 2009, Retrofitting Emissions Controls for Diesel Powered Vehicles).

In addition, significant fuel savings are realized by not idling the truck's main engine. This also provides cost savings through less wear and tear on the engine. This cost is estimated at \$0.92 per hour in the ANTARES Group, Inc. 2004 study.

**Other Considerations/Comments (e.g. Employed elsewhere, particular challenges/opportunities etc?):**

According to the National Renewable Energy Laboratories (NREL) there were 138 TSE sites in the United States in 2009. In a study for EPA's Office of Transportation and Air Quality (OTAQ), researchers identified 15 corridors (shown in the map below) that were prime locations for TSE. Some states have TSE along these corridors but more must be done on a national level to link these sites.



A number of states are pursuing TSE development. However, funding for these efforts is limited. At this time, the Colorado Motor Carriers Association (CMCA) indicates there is one facility with truck stop electrification in Commerce City. The CMCA indicates that TSE has become less viable due to its higher cost compared with on-board APUs that cost half the amount of an electrified space and travel with the vehicle. According to many truckers, TSE spaces are usually full due to a lack of supply which makes on-board APUs more desirable.