Money-wise Trucking Guide
How Laredo’s Commercial Truck Drivers Can Go Green and Save Green
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Rio Grande International Study Center

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Executive Summary

Laredo, Texas is the nation’s largest port of entry, with most trade passing through the city by way of diesel-powered commercial trucks. As more and more diesel trucks cut through the heart of the city, they sit idling in traffic, at warehouses, and even in neighborhoods. Engine idling is a significant source of air pollution and causes wear and tear to the truck’s engine.

Reducing the idling of heavy-duty diesel trucks has long been recognized as a particularly low-hanging fruit of fuel efficiency and emissions reduction. The Rio Grande International Study Center (RGISC) reviewed several idling reduction technologies to provide information to drivers and fleet operators that will help them to make decisions about adopting idling reduction technologies based on affordability, technology application, and emissions savings. A summary of our findings is provided in Table 1.

Table 1 Summary of technologies by affordability, application, and emission savings.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Payback period less than 5 years</th>
<th>Saves over $2000 per year</th>
<th>Suitable for rest-period</th>
<th>Suitable for traffic</th>
<th>Cab Heating</th>
<th>Cab Cooling</th>
<th>Cargo refrigeration</th>
<th>Rank by annual emissions saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic engine start/stop system</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>3</td>
</tr>
<tr>
<td>Battery APU</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>2</td>
</tr>
<tr>
<td>Diesel APU</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>4</td>
</tr>
<tr>
<td>Diesel-fired Heater</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>7</td>
</tr>
<tr>
<td>Electrified Parking Space</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>Heat Recovery</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>6</td>
</tr>
<tr>
<td>Solar No-Idle HVAC</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>Solar TRU</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>1</td>
</tr>
<tr>
<td>Storage Cooling</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>5</td>
</tr>
</tbody>
</table>

All of the technologies reviewed in this guide provide a 100% return on investment within ten 10 years at a fuel price of $3.00 per gallon. On this timeframe, most of the technologies will also save drivers and fleets tens of thousands of dollars in addition to payback over a ten year period because they pay for themselves on a short timeframe and the savings continue to accrue after that.

These technologies are exciting not only because of the considerable savings they offer, but also because of the potential health and climate benefits that can be realized through their implementation. Diesel emissions can be harmful to people, causing cancer, chronic obstructive pulmonary disease, and exacerbating respiratory conditions such as asthma or emphysema. Reducing air pollution is particularly important in the wake of COVID-19, an infectious disease with respiratory symptoms. For Laredo, the benefits of reducing air pollution cannot be understated, as the percentage of our population lacking health insurance is three times the national average.
I. Introduction
Laredo, Texas is the nation’s largest port of entry—surpassing even Los Angeles—with $231.58 billion in imports and exports in 2019. Most trade passes through the city by way of diesel-powered commercial trucks, numbering around 14,000 per day. Trade, transportation, and utilities make up the largest source of jobs in Laredo’s economy.

As more and more diesel trucks cut through the heart of the city, they sit idling in traffic, at warehouses, and even in neighborhoods. Engine idling is a significant source of air pollution and causes wear and tear to the truck’s engine. Reducing the idling of heavy-duty diesel trucks has long been recognized as a particularly low-hanging fruit of fuel efficiency and emissions reduction.

The purpose of this guide is to provide a resource for Laredo’s commercial trucking sector to learn ways that their business can help to clear the air and protect our community’s health and well-being while saving money. Laredo takes great pride in being the largest port and can be a leader in being the cleanest port with careful planning and leadership. Commercial truck drivers are an important piece in this solution and can help to solve air pollution and related climate impacts.

Here, we present cost-saving technologies that reduce idling emissions, as one way of addressing these larger, pressing environmental concerns. The average U.S. truck driver spends about $3,000 to $5,000 per year on the cost of fuel spent while idling. By implementing best practices and idling reduction technologies, truck drivers can reduce fuel and engine maintenance costs, while also reducing emissions.

Emissions from diesel combustion expose our community to air pollution and include climate-warming greenhouse gas (GHG) emissions, which can lead to increased air pollution. This is particularly important for Laredo, because some of our census blocks rank among the highest in the state for proximity to traffic, increasing our community’s risks of asthma complications, decreased lung function, cardiovascular disease, adverse birth outcomes, and childhood cancer. Reducing idling emissions in Laredo is important because some residential neighborhoods and schools were developed adjacent to such facilities, with no local zoning regulations in place to limit this development practice, creating a high potential for human health consequences associated with emissions from diesel engine idling.

Laredo’s population is over 95% Hispanic, more than 30% live in poverty, and the percentage of the population without health insurance is three times the national average. These factors increase the health consequences of air pollution to Laredo’s population.

II. Diesel Emissions and Public Health
When diesel exhaust is released into the air, individuals can be exposed to particles and other combustion byproducts just by breathing. The prevalence of diesel-powered engines, especially in a major port such as Laredo, makes it almost impossible to avoid exposure to diesel exhaust or its byproducts.

The public health impacts of diesel emissions are well documented, particularly in children. Diesel emissions are known to include carbon dioxide (CO₂), a greenhouse gas (GHG), and air pollutants including particulate matter (PM), sulfur oxides (SOx), nitrogen oxides (NOₓ), carbon monoxide (CO), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs). Generally, diesel emissions
are known to increase risk of cancer and respiratory diseases such as asthma and chronic obstructive pulmonary disease.\textsuperscript{14}  The known impacts of each type of diesel air pollutant are described in more detail in Table 2.

Exposure to diesel exhaust can cause inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks.\textsuperscript{15}  Every year, diesel emissions cause thousands of premature deaths, as well as hundreds of thousands of asthma attacks, and millions of lost workdays.\textsuperscript{16}  Children, who tend to spend more time outdoors, and outdoor workers are particularly at risk.  Children are particularly susceptible to fine particulate ($\text{PM}_{2.5}$) emissions from diesel because the small size of the particles can penetrate children’s narrower airways reaching deeper parts of the lung.\textsuperscript{17}

<table>
<thead>
<tr>
<th>Air pollutant</th>
<th>Health Impacts$^{18}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (PM)</td>
<td>Aggravated asthma, exacerbation of allergic symptoms, reduced growth of lung function, increased hospital admissions, emergency room visits, and doctor visits for respiratory diseases, especially in children with lung diseases such as asthma; respiratory-related infant mortality.</td>
</tr>
<tr>
<td>Sulfur Oxide (SOx)</td>
<td>Breathing difficulties for those with pre-existing asthma; wheezing, chest tightness, or shortness of breath. Short term exposure associated with increased respiratory symptoms in children especially those with asthma or chronic respiratory symptoms.</td>
</tr>
<tr>
<td>Nitrogen Dioxides (NO2)</td>
<td>Irritation of the eyes, nose, and throat; may cause shortness of breath. Increased respiratory illnesses and symptoms, including severe asthma symptoms. Increase in the number of emergency room visits and hospital admissions for respiratory causes, especially asthma.</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>Reduced capacity of the blood to carry oxygen, decreasing the supply of oxygen to tissues and organs such as the heart.</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants</td>
<td></td>
</tr>
<tr>
<td>- Benzene</td>
<td>Drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness.\textsuperscript{19} Fatal at very high levels. Potential reproductive and developmental effects. Carcinogenic.</td>
</tr>
<tr>
<td>- Formaldehyde</td>
<td>Irritation of the eyes, nose, and throat.\textsuperscript{20} Impaired learning and changes in behavior. Increased cancer risk.</td>
</tr>
<tr>
<td>Ground-level Ozone</td>
<td>Airway inflammation, reduced lung function, increased susceptibility to respiratory infection, respiratory symptoms such as cough, wheezing, chest pain, and shortness of breath. Aggravates respiratory illnesses such as asthma, bronchitis; contributes to development of asthma in children, especially those with certain genetic susceptibilities and children who frequently exercise outdoors.</td>
</tr>
</tbody>
</table>

Table 2 Respiratory Health Impacts of Diesel Emissions
Health Impacts in Laredo

The CDC 500 Cities Project provides data on 27 chronic disease measures for the 500 largest American cities. Laredo is included in the dataset, along with 46 other Texas cities, and ranks 37th out of these large Texas cities for adult asthma. Overall, these data indicate that adult asthma in Laredo, Texas is below average for large Texas cities and the nation (Table 3). Similarly, the age-adjusted childhood asthma hospital discharge rate per 10,000 people in Webb County falls into the lower range of 2.8 to 5.4, compared to a state average of 8.6 per 10,000 people.

Table 3 Age-adjusted adult asthma prevalence by geography, CDC 500 Cities Project, 2017 estimates.

<table>
<thead>
<tr>
<th>Geography</th>
<th>Adult asthma prevalence (% , age-adjusted)</th>
<th>Chronic obstructive pulmonary disease (% , age adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>8.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Laredo, Texas</td>
<td>7.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Other Texas cities</td>
<td>6.8 to 9.7</td>
<td>3.5 to 7.3</td>
</tr>
</tbody>
</table>

It is also worth noting that asthma rates in Webb County may be under-counted in U.S. datasets, because many individuals in border communities go to Mexico to access healthcare. Lack of access to health insurance is three times higher in Laredo compared to the national average, which could cause families to delay or avoid seeking care. These factors may affect the estimates of overall asthma prevalence between Laredo and Nuevo Laredo. Additional studies are needed to better understand health outcomes and risk factors in the region.

Some research has also indicated that certain birth defects are associated with increased levels of ozone and particulate matter pollution, though more research is needed in this area. In particular, research has shown an association between traffic-related air pollution (i.e. particulate matter and nitrogen oxides) and risk of autism.

Estimates of autism prevalence among Hispanic populations are unexpectedly low. The CDC has noted that studies have shown that autism spectrum disorder may be undiagnosed among many Hispanics due to stigma, lack of access to healthcare services due to immigration status or low-income, and language barriers. These factors underscore the need to conduct more robust studies and to reduce air pollution in Laredo, which is a predominantly Hispanic city.

Emissions in Webb County

Nationally, the transportation sector accounts for 2% of coarse particulate matter ($\text{PM}_{10}$), 5% of fine particulate matter ($\text{PM}_{2.5}$), over 52% of NO$_x$ emissions, and 29% of GHG emissions. There are several sources of air pollution in the transportation sector, sometimes referred to as “mobile sources” (Figure 1). Out of the transportation sector, medium- and heavy-duty trucks make up 23% of GHG emissions in the U.S., 23% of NO$_x$ emissions, and approximately 21% of PM emissions.

In Texas, emissions from mobile sources are responsible for 33% of GHGs, 40% of NO$_x$ emissions, and approximately 4% of PM emissions. Within the mobile source sector, on-road heavy duty vehicles make up about 11% of NO$_x$ emissions and one-quarter of PM emissions in Texas.
These data indicate that statewide heavy-duty diesel vehicles contribute to a significant amount of air pollution. However, at the local level, other sources of air pollution may mask the impact of heavy-duty diesel vehicles. For example, Webb County is one of the top three gas-producing counties in Texas.\(^41\) Emissions from the oil and gas sector dwarf emissions from heavy-duty diesel in Webb County.

Meanwhile, on-road heavy-duty diesel vehicles in Webb County were estimated to be the source of 6% of county-wide NO\(_x\) emissions in 2017 (Figure 2), 4% of PM\(_{2.5}\) emissions, and 5% of PM\(_{10}\) emissions.\(^42\) Compared to other counties, mobile source fine particulate matter emissions in Webb County have been moderately high (see Figure 3).\(^43\) These data indicate that county-level data may be more relevant for assessing exposure to rural populations, rather than urban areas. Many of the sources of emissions that are the highest in Webb County are located in predominantly rural parts of the county, including oil and gas production (Figure 2) and dust from roads or crops and livestock (Figure 4). Within Laredo city limits, it is likely that a greater portion of emissions are coming from on-road heavy-duty diesel vehicles.
Figure 2 Heavy-duty diesel vehicles are the third-highest source of NO\textsubscript{x} emissions in Webb County, at 6%.

Webb County Sources of NO\textsubscript{x} emissions, 2017

- 72% - Oil & Gas Production
- 12% - Biogenics - Vegetation and Soil
- 6% - On-Road Diesel Heavy Duty Vehicles
- 4% - On-Road non-Diesel Light Duty Vehicles
- 2% - Non-Road Equipment - Diesel
- 1% - Natural Gas Industrial Boilers
- 1% - Locomotives
- 1% - Aircraft
- 1% - Other sources

Figure 3 Fine Particulate Matter Emissions from Mobile Sources in Tons per Square Mile (Source: EPA, 2014)
Figure 4 On-road diesel heavy duty vehicles are the eighth highest source of PM$_{2.5}$ emissions in Webb County, at 4%.

Webb County sources of PM$_{2.5}$ emissions, 2017

- 20% - Unpaved Road Dust
- 19% - Oil & Gas Production
- 16% - Paved Road Dust
- 12% - Crops & Livestock Dust
- 5% - Commercial Cooking
- 4% - Construction Dust
- 4% - Prescribed Fires
- 4% - On-Road Diesel Heavy Duty Vehicles
- 3% - Non-Road Equipment - Diesel
- 3% - Waste Disposal
- 2% - Natural Gas Industrial Boilers
- 2% - On-Road non-Diesel Light Duty Vehicles
- 1% - Aircraft
- 5% - Other sources
Particulate matter and nitrogen oxide are the pollutants of greatest concern when it comes to the public health impacts of diesel emissions. However, carbon dioxide - one of the most significant GHGs that contributes to global warming - is also emitted from diesel fuel combustion, presenting an indirect public health concern. That is, global warming increases the number of warm days per year, creating an environment ripe for ground-level ozone formation. This could have a potential significant impact for Laredo, where meteorological data shows that the city is getting hotter.

For example:

- since 1986, there has been an increase in the number of days per year when the daily low is 80°F or higher (Figure 6);
- since 2000, days with maximum temperatures of 105°F or higher are also on the rise (Figure 7);
- the number of freezing days per year has also declined over the past two decades. Only five years in the past decade have had more than two freezing days, compared to eight years in the prior decade (Figure 8).

**Ozone & Climate Change**

In addition to direct health impacts from the emissions listed above, NOx and VOCs combine in sunlight to produce ground-level ozone or “smog,” which is also known for causing and exacerbating respiratory health conditions such as asthma. Ozone occurs in two places in the atmosphere: first, in the stratosphere at about 33,000 feet above ground; and second, at the ground level. As explained in Figure 5, ozone is “Good Up High, Bad Nearby.” In the stratosphere, naturally-occurring ozone forms a protective layer that absorbs ultraviolet (UV) radiation from the sun and protects us from experiencing too much UV radiation at the ground level. Ground-level ozone is harmful to human health. In Texas, ground-level ozone is most common on sunny days with light winds, typically from March to October.
Figure 6

Daily low temperature at or above 80° F

Figure 7

Daily high temperature at or above 105° F
Figure 8

Days with freezing temperatures (≤ 32° F)

[Graph showing days with freezing temperatures from 1986 to 2019]
Research has not been conducted to evaluate the impact of GHGs on this local meteorological trend, though these observations do align with broader national and regional studies demonstrating the impact of GHGs on warming in Texas (Figure 9).47

Figure 9 According to the Fourth National Climate Assessment (2018), “under both lower- and higher-scenario climate change projections, the number of days exceeding 100°F is projected to increase markedly across the Southern Great Plains by the end of the century (2070–2099 as compared to 1976–2005).” Sources: NOAA NCEI and CICS-NC.

Late 21st Century

Lower Scenario
(RCP4.5)

Higher Scenario
(RCP8.5)

Change in Number of Days

20 30 40 50 60 70 80 90 100

Air Quality Monitoring in Laredo, Texas
Although the EPA’s national emissions inventory indicates which sources of emissions are likely to be the largest at the county level, local air quality monitoring in the City of Laredo can help to demonstrate the extent to which these emissions are exceeding regulatory requirements or otherwise causing a health concern.

Laredo currently has three air quality monitors, each measuring different pollutants (Figure 10).48 The U.S. Environmental Protection Agency (EPA) regulates six “criteria” air pollutants, including carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.49 Concentrations of these pollutants may not exceed the EPA’s threshold over certain time frames. Table 4 lists criteria pollutants that are known to come from diesel combustion, along with Laredo’s compliance values for the year 2019 or 2017 to 2019, as applicable.
Figure 10 Out of Laredo’s three air quality monitors, one collects data on $PM_{2.5}$, two collect data on $PM_{10}$, one collects data on ozone, and one collects data on carbon monoxide.

Although Laredo is in “attainment” or compliance with federal air quality standards, according to these air quality monitors, many census block groups in the city are in the 80th percentile or higher in the state for proximity to traffic (Figure 11). This means that, by comparison, people living in 80% of the census block groups in the rest of Texas are less exposed to traffic pollution than residents in Laredo. This level of traffic proximity warrants additional precautions to protect the health of Laredo’s population.
Figure 11 EJSCREEN map demonstrating census block groups in Laredo where proximity to traffic by state percentile. (Source: U.S. EPA, 2020)
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Primary and Secondary</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
<th>Laredo</th>
<th>Laredo Bridge</th>
<th>World Trade Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>primary</td>
<td>8 hours</td>
<td>9 ppm</td>
<td>Not to be exceeded more than once per year</td>
<td>Compliant. Monthly maximums for 2019 range from 0.3 to 4.2.</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 hour</td>
<td>35 ppm</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO2)</td>
<td>primary</td>
<td>1 hour</td>
<td>100 ppb</td>
<td>98th percentile of 1-hour daily maximum concentrations, averaged over 3 years</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>1 year</td>
<td>53 ppb</td>
<td>Annual Mean</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ozone (O3)</td>
<td>primary and secondary</td>
<td>8 hours</td>
<td>70 ppb</td>
<td>Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years</td>
<td>Compliant. Three-year average is 56.*</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Particulate Matter (PM)</td>
<td>primary</td>
<td>1 year</td>
<td>12.0 μg/m³</td>
<td>annual mean, averaged over 3 years</td>
<td>NA</td>
<td>NA</td>
<td>Compliant. Three-year average is 10.2.*</td>
</tr>
<tr>
<td></td>
<td>secondary</td>
<td>1 year</td>
<td>15.0 μg/m³</td>
<td>annual mean, averaged over 3 years</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>24 hours</td>
<td>35 μg/m³</td>
<td>98th percentile, averaged over 3 years</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>PM₁₀</td>
<td>primary and secondary</td>
<td>24 hours</td>
<td>150 μg/m³</td>
<td>Not to be exceeded more than once per year on average over 3 years</td>
<td>Compliant. Three-year max is 81.*</td>
<td>Compliant. Three-year max is 75.*</td>
<td>NA</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO2)</td>
<td>primary</td>
<td>1 hour</td>
<td>75 ppb</td>
<td>99th percentile of 1-hour daily maximum concentrations, averaged over 3 years</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>secondary</td>
<td>3 hours</td>
<td>0.5 ppm</td>
<td>Not to be exceeded more than once per year</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
Laredo is in compliance for all pollutants that are measured, although several months of data between June 2017 and February 2018 were noted as invalid due to data quality concerns for each particulate matter monitor and the ozone monitor (Table 4). There are no active nitrogen dioxide nor sulfur dioxide monitors in Laredo.

Monthly values for carbon monoxide and PM$_{10}$ were well below the EPA standard. Laredo remains in compliance for PM$_{2.5}$ but is approaching the primary standard of 12.0 μg/m$^3$, which means that voluntary measures such as implementing idling reduction technologies can help the city to remain in compliance for fine particulate matter standards.

Similarly, although Laredo is in compliance with the ozone standard, there have been days with measurements of ozone that are greater than 70 ppb. As Laredo’s population grows over the next few decades, increased traffic could also lead to increased pollution. Without more air quality monitors placed along the most important commercial truck routes, which are located in and around dense residential areas, it will be difficult to gauge the true impact of such traffic on the local populace. It is also worth noting that several studies have observed health effects from ozone levels as low as 60 ppb. Therefore, reducing ozone pre-cursors and particulate matter emissions are still worthwhile activities even though Laredo is currently in compliance with the EPA standards.

Additional air quality monitors that measure ozone and fine particulate matter are needed to help to better refine what we know about air quality in Laredo. The TCEQ determines the location of air quality monitors based on population size, emission inventories, and trends from existing monitors.

Laredo is the 10th largest city in Texas with a population of approximately 260,000. Compared to other Texas cities that have an estimated population between 160,000 and 360,000, Laredo has slightly more than the average of 2 monitors per city (Table 5). However, many of the other Texas cities of comparable size are in the Dallas-Fort Worth ozone non-attainment area and are part of a broad network of air quality monitors, which may enable more extensive regional monitoring and modeling than would be possible in Laredo. Corpus Christi and Amarillo each have more monitors than Laredo, likely warranted by the presence of petrochemical industry in Corpus Christi and the Pantex nuclear facility in Amarillo. Due to the sheer daily volume of diesel commercial trucks moving through Laredo, additional air quality monitors are warranted.
<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
<th>Number of Air Quality Monitors</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corpus Christi</td>
<td>326,586</td>
<td>7</td>
<td>Frisco and Rockwall are within 10 miles, and each have monitors. Plano is in Collin County, which is in the DFW ozone nonattainment area.</td>
</tr>
<tr>
<td>Plano</td>
<td>287,677</td>
<td>2</td>
<td>Closest monitor is within 10 miles. Garland is in Dallas County, which is in the DFW ozone nonattainment area.</td>
</tr>
<tr>
<td>Laredo</td>
<td>262,491</td>
<td>3</td>
<td>Three monitors present within a 5 mile radius. Irving is in Dallas County, which is in the DFW nonattainment area.</td>
</tr>
<tr>
<td>Lubbock</td>
<td>258,862</td>
<td>1</td>
<td>Three monitors are located 10 - 15 miles away from McKinney in Frisco. McKinney is in the DFW nonattainment area.</td>
</tr>
<tr>
<td>Garland</td>
<td>239,928</td>
<td>1</td>
<td>The total of six monitors includes three monitors around the Pantex nuclear facility, and does not include the monitor at Borger, nearly 40 miles from Amarillo.</td>
</tr>
<tr>
<td>Irving</td>
<td>239,798</td>
<td>3</td>
<td>Three monitors are located 10 - 15 miles away from McKinney in Frisco. McKinney is in the DFW nonattainment area.</td>
</tr>
<tr>
<td>Frisco</td>
<td>200,490</td>
<td>3</td>
<td>The next two closest monitors are located over 20 miles away in Harlingen and Port Isabel.</td>
</tr>
<tr>
<td>Amarillo</td>
<td>199,371</td>
<td>6</td>
<td>Three monitors around the Pantex nuclear facility, and does not include the monitor at Borger, nearly 40 miles from Amarillo.</td>
</tr>
<tr>
<td>McKinney</td>
<td>199,177</td>
<td>0</td>
<td>Three monitors are located 10 - 15 miles away from McKinney in Frisco. McKinney is in the DFW nonattainment area.</td>
</tr>
<tr>
<td>Grand Prairie</td>
<td>194,543</td>
<td>3</td>
<td>No monitors are located in Grand Prairie, but three are located in Arlington, within 10 miles of Grand Prairie. Grand Prairie is also located within the DFW nonattainment area.</td>
</tr>
<tr>
<td>Brownsville</td>
<td>182,781</td>
<td>1</td>
<td>The total of six monitors includes three monitors around the Pantex nuclear facility, and does not include the monitor at Borger, nearly 40 miles from Amarillo.</td>
</tr>
</tbody>
</table>
Air Quality Monitoring in Nuevo Laredo, Tamaulipas, Mexico
Inextricably linked to Laredo, both culturally and commercially, lies the Mexican border city of Nuevo Laredo: the third largest city in the state of Tamaulipas. Cross border trade between both cities forms the backbone of how commerce moves between both countries. Mexico regulates the same six criteria air pollutants as the U.S. There are four air quality monitors in Nuevo Laredo, which represents half of the air quality monitors in the entire state of Tamaulipas (Figure 12). Each monitor measures PM$_{10}$ only. Between 2011 and 2015, insufficient data was collected from the monitors in Nuevo Laredo to determine compliance with the particulate matter standard.

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Figure 12 Location of monitoring stations in the state of Tamaulipas, Mexico. Four monitoring stations in Nuevo Laredo, Tamaulipas are visible in the upper left quadrant.

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Fuente: Elaboración propia con información proporcionada por la Secretaría de Desarrollo Urbano y Medio Ambiente del estado de Tamaulipas
In Nuevo Laredo, the estimated largest sources of particulate matter emissions are from paved and unpaved roads. The largest source of NO\textsubscript{x} and carbon monoxide is from vehicles, with vehicles over three tons and tractor trailers causing the 3rd highest amount of NO\textsubscript{x} emissions (15%).\textsuperscript{61}

Using an inventory method, the level of fine particulate matter in Nuevo Laredo was estimated at 26.8 μg/m\textsuperscript{3}, more than double the 12 μg/m\textsuperscript{3} standard in Mexico. The same study estimated that 153 cardiovascular and cardiopulmonary deaths could be avoided by meeting the standard (Figure 13).\textsuperscript{62}

![Figure 13 Estimated avoidable deaths from meeting the fine particulate matter standard are depicted in light blue below, out of the total number of cases (dark blue, scale across the top of the chart).](image)

### III. Cost-effective Technologies to Reduce Diesel Emissions

During rest periods, long haul trucks may idle between six to 16 hours per day.\textsuperscript{63} This is not only a waste of fuel and money, but also adds to engine wear and tear and increases the number of annual oil changes needed. Some drivers may be surprised to learn that engine idling for longer than 10 seconds consumes more fuel than does a restart and prevents the engine from operating at an efficient temperature, resulting in incomplete fuel combustion which leaves fuel residues in the exhaust. Over one year, engine idling is equivalent to 322,000 extra km (200,000 miles) of engine wear and adds operational costs of between $4,000 to $7,000 per truck.\textsuperscript{64}

In this guide, we explore idling reduction technologies that apply during rest periods (e.g. 6 to 16 hours per day). During rest periods, power from idling is typically used for Heating Ventilating and Air Conditioning (HVAC), and “hotel loads” (i.e. electricity used to power appliances and other electronics such as laptops or cell phones).

We also provide information on one technology that can reduce fuel use and idling for refrigerated freight. Some of the technologies presented here may also be employed in trade traffic conditions, for example while waiting at ports of entry, or while waiting in line to dock at a warehouse.

We produced this guide primarily from the perspective of technologies that would be affordable and feasible to use by owner-operator truck drivers. Although some of the technologies have a relatively high upfront cost and financing may be more accessible to companies with larger fleets.
We define owner-operator truck drivers using a definition provided by the Federal Motor Carrier Safety Administration (FMCSA):  

“Owner-operators are individuals who own their own commercial vehicle or small fleet, typically truck tractors. Most often, they serve as the driver of these vehicles. If they have their own operating authority, they may haul loads as a for-hire motor carrier using their vehicle. Alternatively, they can provide their vehicle and driving services to another motor carrier under a lease for a contracted period of time and operate under that carrier’s authority.”

There are approximately 460,000 “For Hire” Truck Tractor operators in the United States, and this category makes up 57% of the total operators in the United States, but may represent only about 9% of Truck Tractor vehicles in operation. Because they are not associated with a larger company that may have a research division, it may be more difficult for owner-operator truck drivers to access resources about how to improve efficiency and reduce idling.

Diesel idling emissions can occur during different activities. For long-haul truckers, periods of idling could take place during traffic congestion, overnight rest periods, or while waiting to dock, for example. For drayage transport – the process of transferring cargo between tractors as they cross from one side of the border to the other - idling can take place during traffic congestion at the port of entry or inspection stations, or while waiting to dock, though an overnight rest period would be unexpected in most cases (Figure 14).

Figure 14 Flow of drayage traffic from Mexico to the U.S.A. (Image Source: Birt et al., 2015)
Laredo Port of Entry and Drayage Emissions
Laredo, Texas is the nation’s largest port of entry with $231.58 billion in imports and exports in 2019, and nearly 14,000 diesel-powered commercial trucks per day passing through the city. Top imports by value include vehicles and machinery, while top exports include machinery and electronics. Edible vegetables and fruits rank 7th as a top commodity by weight (rather than by value) that is shipped through the port, which indicates that refrigerated freight is relatively important in Laredo (Figure 15). Refrigerated freight is of interest because of the additional emissions that come from idling refrigeration units.

A recent analysis ranked Laredo’s Bob Bullock Loop third in the state of Texas on a list of the top 100 most truck-congested roadways in Texas. This is relevant, because most emissions in Laredo from truck traffic are due to congestion and delays at the border, and because the Loop is flanked by residential neighborhoods.

Figure 15 Laredo Port Top 10 Commodities by weight, January 2019 – December 2019 (Source: Bureau of Transportation Statistics). Orange indicates the commodity has experienced a decline in trade, blue indicates the commodity has experienced an increase in trade.

<table>
<thead>
<tr>
<th>Top 10 Commodities</th>
<th>Weight in Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles Other than Railway</td>
<td>14,281,660,882</td>
</tr>
<tr>
<td>Salt; Sulfur; Plaster and Cement</td>
<td>10,073,196,179</td>
</tr>
<tr>
<td>Computer-Related Machinery and Parts</td>
<td>6,345,235,249</td>
</tr>
<tr>
<td>Electrical Machinery; Equipment and Parts</td>
<td>3,532,142,178</td>
</tr>
<tr>
<td>Beverages; Spirits and Vinegar</td>
<td>2,589,771,001</td>
</tr>
<tr>
<td>Iron and Steel</td>
<td>2,239,075,367</td>
</tr>
<tr>
<td>Edible Vegetables and Roots</td>
<td>2,231,309,371</td>
</tr>
<tr>
<td>Articles of Iron and Steel</td>
<td>2,116,841,368</td>
</tr>
<tr>
<td>Plastics and Articles</td>
<td>1,999,077,263</td>
</tr>
<tr>
<td>Ceramic Products</td>
<td>1,463,196,617</td>
</tr>
</tbody>
</table>
Aside from cross-border traffic congestion, opportunities for diesel emission hot spots are created at warehouses, where long-haul trucks drop loads that are then loaded onto drayage trucks for delivery across the border (Figure 14). Diesel emission hot spots from idling can occur at warehouse facilities while trucks wait in line to dock.

Drayage across the border has been necessary in part because Mexican trucks are generally not allowed to transport goods long distances throughout the U.S. This restriction generally applies to U.S. trucks traveling into Mexico, as well. However, a long-held provision of the North American Free Trade Agreement (NAFTA) was realized in the recent United States Mexico and Canada Agreement (USMCA), allowing a limited number of Mexican freight carriers to conduct long-haul trucking into the U.S., provided that their trips are not between two points within the U.S.\textsuperscript{74}

It is critical to note that environmental emission standards for trucks in the U.S. and Mexico are different. Mexican emission standards for heavy-duty trucks have typically lagged behind U.S. standards which were first issued in 1974.\textsuperscript{75} Mexico issued its first standards in 1994, which were not updated until 2018. The new emission standards in Mexico require new heavy duty diesel vehicles to meet a standard equivalent to the US 2010 and Euro VI standards.\textsuperscript{76} Older, more polluting trucks from Mexico will remain on the road until they are no longer useful or economic, but the implementation of these standards indicates that emissions in border towns like Laredo are likely to trend downward in the future.\textsuperscript{76}

**Affordability**

Table 6 below summarizes various technologies that can be used by owner-operator truck drivers or fleet operators to reduce engine idling. Many of these descriptions are summarized from the U.S. Department of Energy’s “Long-Haul Truck Idling Burns Up Profits,” which provides additional considerations for services and applicability of the technologies.\textsuperscript{77} Additionally, eNow Inc. provides a description of Solar No-Idle HVAC and solar Transport Refrigeration Unit (TRU) technologies, which are also a viable idle reduction technology.\textsuperscript{78, 79} A more thorough list of idling reduction technologies is available on the EPA’s SmartWay website.

Reducing the idling of heavy-duty diesel trucks has long been recognized as a particularly low-hanging fruit of fuel efficiency and emissions reduction. The most cost-effective solution for any truck or fleet depends on where, how long, and what services are required during the driver’s rest period. Technologies that are cost effective for reducing overnight idling may be less attractive for workday idling at a warehouse, for example, because the fewer hours trucks idle per day while working is likely to result in a longer payback period.\textsuperscript{80} While some of the technologies we explore are suitable for drayage operations, others are more suitable for long-haul trucking.
**Table 6** Descriptions of different types of idle reduction technologies and services provided by each. (U.S. Department of Energy, 2015; and eNow Inc., 2019)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
<th>Services provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic engine start/stop system (AESS)</td>
<td>AESS turns the engine on or off to maintain cab temperature.</td>
<td>Cooling, heating, electricity (intermittent)</td>
</tr>
<tr>
<td>Auxiliary Power Unit (APU)</td>
<td>Separate power unit from the engine that can be diesel-powered or battery powered. Diesel-powered APUs sometimes emit more PM than modern diesel truck engines. Some APUs can also be equipped to plug into a power pedestal allowing them to access power from the electrical grid.</td>
<td>Cooling, heating, electricity</td>
</tr>
<tr>
<td>Diesel-fired heater</td>
<td>These types of heaters use the vehicle’s fuel for heat. A coolant heater helps to circulate the vehicle’s coolant and reduce the impact of cold starts, and happens to warm the cab partially while doing so. A cab/bunk heater directs heat toward the cab/sleeper area.</td>
<td>Heating</td>
</tr>
<tr>
<td>Electrified Parking System (EPS)</td>
<td>Provided at truck stops or designated facilities, truck drivers can physically connect an HVAC attachment to the truck window to access cooling and heating through a duct. Many systems also provide connection to electricity via plug-in power inside and outside the cab, satellite television and internet access.</td>
<td>Cooling, heating, electricity, satellite television and internet.</td>
</tr>
<tr>
<td>Heat recovery</td>
<td>Heat recovery systems use an electric pump to circulate engine heat to the cab while the engine is off, lasting up to four hours.</td>
<td>Heating (limited duration)</td>
</tr>
<tr>
<td>Solar No-Idle HVAC</td>
<td>Battery APU charged by a solar system, which is attached to the roof of the trailer and/or tractor, intended for specific uses, such as HVAC and hotel loads.</td>
<td>Cooling, heating, electricity</td>
</tr>
<tr>
<td>Solar Transport Refrigeration Unit (TRU)</td>
<td>Solar systems attached to the roof of the trailer and/or tractor charge auxiliary batteries intended for specific uses. A solar TRU can provide refrigeration for trailer cargo, such as food products.</td>
<td>Cooling, heating, electricity, refrigeration, battery maintenance, liftgate power</td>
</tr>
<tr>
<td>Storage cooling</td>
<td>This IR device stores engine energy to charge a battery or freeze a block of ice to use as cooling when the vehicle is stopped.</td>
<td>Cooling</td>
</tr>
</tbody>
</table>
In calculating cost-effectiveness, we used Argonne National Laboratory’s Vehicle Idle Reduction Savings Worksheet which can be downloaded for free online. A copy of the worksheet is provided in Appendix A. Vehicle owners and fleet owners can use the worksheet to estimate cost savings and the time to reach return on investment (“payback period”) associated with idling reduction technologies. The calculations in the worksheet consider costs of fuel and maintenance from idling compared to the upfront and maintenance costs of idling reduction (IR) and electrified parking space (EPS) technologies. Our analysis represents a rough estimate based on average fuel efficiency for class 8 trucks.

The U.S. Department of Energy (DOE) has analyzed typical payback periods for several IR devices and EPSs at an average fuel cost of $3.00 per gallon. The national average cost of diesel in the United States ranged from $1.998 per gallon to $3.365 between 2015 and 2019. During the month of March 2020, when the coronavirus pandemic caused oil prices to crash, the average weekly price of diesel on the Gulf Coast was at least $2.325 per gallon.

In this analysis, we considered fuel prices of $2.25 per gallon and $3.00 per gallon. Analyses from the U.S. DOE (2015) have demonstrated that most popular technologies save money over a five-year period when fuel costs are higher than $2.25 per gallon. When fuel prices are higher, IR and EPS technologies offer the potential to save drivers more money, as is demonstrated in Table 7.

There are several factors that affect the overall cost savings of each technology, and each vehicle will likely achieve different cost savings per year, depending on when and how often idling is typically used and the fuel efficiency of the vehicle. The assumptions used in our analysis are provided in Table 8.

Table 7 Savings at various fuel prices and typical years to payback.

<table>
<thead>
<tr>
<th>Technology</th>
<th>$2.25/gallon</th>
<th></th>
<th>$3.00/gallon</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net savings per year</td>
<td>Typical years to payback</td>
<td>Net savings per year</td>
<td>Typical years to payback</td>
</tr>
<tr>
<td>Idling</td>
<td>$0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Automatic engine start/stop system</td>
<td>$2,444</td>
<td>0.8</td>
<td>$3,186</td>
<td>0.6</td>
</tr>
<tr>
<td>Battery APU</td>
<td>$2,906</td>
<td>2.8</td>
<td>$3,986</td>
<td>2</td>
</tr>
<tr>
<td>Diesel APU</td>
<td>$1,039</td>
<td>9.6</td>
<td>$1,646</td>
<td>6.1</td>
</tr>
<tr>
<td>Diesel-fired Heater</td>
<td>$1,071</td>
<td>1.1</td>
<td>$1,404</td>
<td>0.9</td>
</tr>
<tr>
<td>Electrified parking space</td>
<td>$126</td>
<td>0</td>
<td>$1,206</td>
<td>0</td>
</tr>
<tr>
<td>Heat Recovery</td>
<td>$1,152</td>
<td>0.5</td>
<td>$1,512</td>
<td>0.4</td>
</tr>
<tr>
<td>Solar No-Idle HVAC</td>
<td>$3,456</td>
<td>3.2</td>
<td>$4,536</td>
<td>2.4</td>
</tr>
<tr>
<td>Solar TRU</td>
<td>$6,960</td>
<td>12.2</td>
<td>$8,940</td>
<td>9.5</td>
</tr>
<tr>
<td>Storage Cooling</td>
<td>$1,899</td>
<td>4.6</td>
<td>$2,484</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Table 8 Cost and use assumptions made to calculate savings per year and payback periods for each technology (Sources: U.S. DOE, eNow)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Fuel use (gallons/hour)</th>
<th>Typical Equipment Cost ($)</th>
<th>Maintenance Cost per year</th>
<th>Cost per hour of use</th>
<th>Hours per year using IR*</th>
<th>Hours per year using shorepower electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idling</td>
<td>0.6 - 1.5</td>
<td>NA</td>
<td>$216</td>
<td>$1.35 - $4.50</td>
<td>1,800</td>
<td>NA</td>
</tr>
<tr>
<td>Automatic engine start/stop system</td>
<td>0.25</td>
<td>$2,000</td>
<td>NA</td>
<td>NA</td>
<td>1,800</td>
<td>NA</td>
</tr>
<tr>
<td>Battery APU</td>
<td>NA</td>
<td>$10,000</td>
<td>$100</td>
<td>$1.00</td>
<td>1,350</td>
<td>450</td>
</tr>
<tr>
<td>Diesel APU</td>
<td>0.2 - 0.5</td>
<td>$10,000</td>
<td>$1,000</td>
<td>NA</td>
<td>1,800</td>
<td>NA</td>
</tr>
<tr>
<td>Diesel-fired Heater</td>
<td>0.04 - 0.08</td>
<td>$1,200</td>
<td>NA</td>
<td>NA</td>
<td>600</td>
<td>NA</td>
</tr>
<tr>
<td>Electrified Parking Space</td>
<td>NA</td>
<td>$5</td>
<td>NA</td>
<td>$1.85</td>
<td>NA</td>
<td>1,800</td>
</tr>
<tr>
<td>Heat Recovery</td>
<td>Negligible</td>
<td>$600</td>
<td>NA</td>
<td>NA</td>
<td>600</td>
<td>NA</td>
</tr>
<tr>
<td>Solar No-Idle HVAC</td>
<td>NA</td>
<td>$10,900</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1,800</td>
</tr>
<tr>
<td>Solar TRU</td>
<td>NA</td>
<td>$85,000</td>
<td>$3,640</td>
<td>$0.90</td>
<td>3,000</td>
<td>600</td>
</tr>
<tr>
<td>Storage Cooling</td>
<td>0.15</td>
<td>$8,650</td>
<td>NA</td>
<td>NA</td>
<td>1,200</td>
<td>NA</td>
</tr>
</tbody>
</table>

*See Appendix B - Idling Hours per Year Assumptions
The technologies that save the most money and payback faster are the most affordable. Some of the more affordable technologies include (Figure 16):

1. Solar No Idle HVAC
2. AESS
3. Battery APUs

Meanwhile, diesel APUs are not as affordable, because they take nearly ten years to pay off and do not save as many dollars per year as most of the other technologies. While Solar TRU saves the most money per year, there is a long payback period. For refrigerated freight fleets and those who can access financing, solar TRUs could represent an excellent long-term savings opportunity. In counties and states that offer grants or tax rebates, affordability can improve considerably. Additionally, functional aspects such as flexibility of the technology are worth considering. Since Solar TRU is attached to the vehicle and trailer, it can be used anywhere, unlike EPS systems which are location dependent.

EPS performs well in terms of providing immediate payback, though the overall savings per year are minimal and use of the technology is priced essentially at a break-even point. However, EPS users might be more likely to choose this offering because it is quieter, allowing for more comfort during rest periods, and because EPS providers include other offerings such as internet and television access. EPS requires only a $5 upfront investment for equipment (a window attachment that connects to an HVAC duct), making it extremely easy to access for any driver with virtually no commitments or risk. EPS can only be accessed at locations where EPS has been installed, such as truck stops or fleet parking lots. For this reason, combining EPS with other IR technologies can help drivers achieve greater savings over time.

While still effective, heat recovery, diesel-fired heaters, and storage cooling do not perform as well as other technologies. Heat recovery systems and diesel fired heaters have a lower up-front cost than the other technologies but may be more suitable for drivers in colder climates.

For hotter climates, like Laredo, storage cooling might be a more useful technology, but the technology has a high upfront cost and the number of years to payback is higher than AESS, Battery APUs, and Solar No Idle HVAC. Additionally, those three technologies provide more services than storage cooling alone.

Figure 16 Annual cost savings compared to the length of time to reach a return on investment can help to demonstrate affordability of IR and EPS Technologies. Values are based on fuel prices of $2.25 per gallon.

Savings per year compared to years to reach return on investment
Similarly, heat recovery systems are affordable, but cannot provide air conditioning or power electrical appliances. A Solar No-Idle HVAC system is very affordable in terms of its short time to payback, and is suitable for HVAC and electrical appliance loads, but savings are highest for drivers who spend more time idling during daylight periods. This could be an opportunity for drivers in Laredo, as daytime idling is more common at ports and border crossings.\textsuperscript{86} Additionally, eNow has predicted that “Day rest periods will be increasingly more common with new Hours of Service (HOS) rules that took effect, which effectively require drivers to rest for between 34 and 48 hours continuously once a week.”\textsuperscript{87}

**Emission Reductions**

After calculating the average fuel savings of each technology compared to idling, we estimated the total emission reductions of CO\textsubscript{2}, NO\textsubscript{x}, PM\textsubscript{2.5}, PM\textsubscript{10}, and CO for each idling reduction technology per vehicle per year.\textsuperscript{89,90} The total mass of emissions for all pollutants was also estimated in aggregate emission savings per vehicle per year (Table 9). Solar Transport Refrigeration Units (Solar TRU) can save the greatest amount of emissions per year, followed by Battery APU, Solar No-Idle HVAC, and Electrified Parking Spaces. Out of these technologies, stand-alone heating and cooling technologies save the least emissions, but this is because they are only used in situations where the weather warrants their use. Greater emission savings can be achieved when stand-alone heating or cooling technologies are combined with other idling reduction technologies or electrified parking spaces. However, such practices may reduce affordability. Diesel APUs and Automatic Engine Start/Stop Systems occupy a middle ranking for aggregate emissions saved, because they can be used year-round, but do not save as many emissions as some other year-round technologies because they still require diesel combustion.

**Cost-Free Actions Any Driver Can Take to Reduce Idling**

Drivers are an important part of reducing idling and can reduce greenhouse gas emissions and air pollution by practicing good habits. The North American Council for Freight Efficiency compiled this simple list of cost-free actions drivers can take to optimize system performance and reduce idling:\textsuperscript{88}

**Cooling during rest periods:**
- Pre-cool the cab by running the A/C before shutting the truck down for the night
- Park on concrete instead of asphalt
- When parking the truck, try to find a shaded area
- Make sure the cab’s windshield is facing away from the sun
- Ensure all doors and windows are tightly closed
- Use reflective covers for the windshield and windows
- Pull down shades and cover sleeper cab windows and skylight
- Fully and tightly close the bunk curtain
- Set the temperature and fan speed on the controller at a reasonable number
- Switch off heat-producing appliances inside the cab
- Turn off the HVAC system as soon as possible after waking up
- Only use the APU when it’s truly needed — mainly when sleeping or sitting idle-free for long periods. Do not use the APU when fueling, eating, etc.
- Always plug into off-board AC power (if the truck is so equipped) whenever possible to keep charging the truck’s batteries (even when not using your APU)
- Be conservative with hotel power loads especially when maximum cooling is needed

**Tips for maintaining an efficient idle-reduction system:**
- Daily inspection of the system
- The system components need to be inspected but that inspection will vary depending on the type of system in use. For example, with a diesel APU, check for leaks, and inspect oil level, fuel and refrigerant lines and connections, hoses, belts, electrical cables and connections
- Do not block the air flow between the return air flow duct and the evaporator
- Keep the condenser assembly clean and free of debris or obstructions
Table 9 Annual emissions savings per vehicle per year (tons per year).

<table>
<thead>
<tr>
<th>Technology</th>
<th>CO₂</th>
<th>NOₓ</th>
<th>PM₂.5</th>
<th>PM₁₀</th>
<th>CO</th>
<th>Aggregate emissions saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic engine start/stop system</td>
<td>10.1</td>
<td>0.04</td>
<td>0.001</td>
<td>0.001</td>
<td>0.03</td>
<td>10.2</td>
</tr>
<tr>
<td>Battery APU</td>
<td>14.7</td>
<td>0.06</td>
<td>0.002</td>
<td>0.002</td>
<td>0.05</td>
<td>14.8</td>
</tr>
<tr>
<td>Diesel APU</td>
<td>8.3</td>
<td>0.04</td>
<td>0.001</td>
<td>0.001</td>
<td>0.03</td>
<td>8.3</td>
</tr>
<tr>
<td>Diesel-fired Heater</td>
<td>4.5</td>
<td>0.02</td>
<td>0.001</td>
<td>0.001</td>
<td>0.01</td>
<td>4.6</td>
</tr>
<tr>
<td>Electrified Parking Space</td>
<td>14.7</td>
<td>0.06</td>
<td>0.002</td>
<td>0.002</td>
<td>0.05</td>
<td>14.8</td>
</tr>
<tr>
<td>Heat Recovery</td>
<td>4.9</td>
<td>0.02</td>
<td>0.001</td>
<td>0.001</td>
<td>0.02</td>
<td>4.9</td>
</tr>
<tr>
<td>Solar No Idle HVAC</td>
<td>14.7</td>
<td>0.06</td>
<td>0.002</td>
<td>0.002</td>
<td>0.05</td>
<td>14.8</td>
</tr>
<tr>
<td>Solar TRU</td>
<td>24.5</td>
<td>0.11</td>
<td>0.003</td>
<td>0.003</td>
<td>0.08</td>
<td>24.7</td>
</tr>
<tr>
<td>Storage Cooling</td>
<td>8.0</td>
<td>0.03</td>
<td>0.001</td>
<td>0.001</td>
<td>0.03</td>
<td>8.0</td>
</tr>
</tbody>
</table>

**Results: Cost-Effectiveness**

Above, we provide an estimate of the dollar savings per year, and time for the technology investment to pay off. However, the total emissions reduced are also a valuable point for considering any idle reduction technology. An ideal technology will not only meet the driver’s needs for comfort and cost savings but will also reduce the greatest amount of emissions over time.

Some of the technologies take longer than others to pay off. Examining the total savings and emission reductions over a longer period of time offers an easy way to compare these technologies. The 10-year average cost of diesel for 2010 – 2019 was $3.11 per gallon, which indicates that an average price of $3.00 per gallon is a reasonable assumption to use in exploring cost effectiveness for technologies implemented today.
At $3.00 per gallon average fuel price, all of the technologies pay off within 10 years (Table 7). After 10 years, the technologies that save the most money are Solar No-Idle HVAC, Battery APU, and Automatic Engine Start/Stop Systems (AESS). The technologies that save the least money after 10 years are the Solar TRU and the diesel-fired heater.

The three technologies that save the most money and the most emissions are Solar No-Idle HVAC, AESS, and Battery APU (Figure 17). Heat recovery and diesel-fired heaters save the least emissions, though the cost savings are comparable to storage cooling, EPS, and Solar TRU which offer higher emission savings. Diesel APUs save nearly as many emissions as AESS but result in far fewer cost savings over time. Despite their relatively moderate 10-year cost savings, Solar TRUs deserve attention for their considerable emission savings. Moreover, drivers that use a Solar TRU longer than 10 years, could achieve annual savings greater than $8,500 (see Table 7), which provides a considerable incentive.

Figure 17 Ten-year cost and emissions savings for various IR and EPS technologies at fuel prices of $3 per gallon.
Electric Vehicles, Batteries, and the Grid

Looking ahead, heavy-duty electric vehicles (EVs) are expected to increase in market share of the freight market in the next one to two decades. We interviewed Chris Wolfe, a consultant for Environmental Defense Fund to learn more about the future of emissions reductions in trucking.

Batteries used for electric vehicles are easier and less expensive to maintain than APUs and diesel fired heaters. Modern battery technology has evolved to be lighter weight, faster to charge, and handle inconsistent use—which caused problems with older battery technologies. These advantages indicate that fleet operators, warehouse owners, and truck stops could be making some big changes to their infrastructure over the medium term to accommodate heavy-duty electric trucks.

These changes also mean that the electric grid will have to be prepared for additional demand for electricity. Even trucks that use shore power with battery APUs can add significant demand to the electric grid. Efficient power can be generated with no additional emissions through the installation of solar panels above truck parking lots, supplemented by the grid.

Some companies are also developing ways for EV batteries to be used as a back-up power source for buildings during grid power outages. Solar TRUs could easily be integrated into such a system. Down the road, utilities could develop “time-of-use incentives” that pay solar trucks and/or EV battery owners for generating or storing electricity during times of day when the electric grid is experiencing highest demand. This would make heavy-duty electric vehicles an important part of a resilient electric supply and provide an additional source of income for drivers.
Figure 19 Solar No-idle HVAC relies on a lightweight solar panel attached to the tractor roof, and connected to a battery APU. (Photo credit: Mesilla Valley Transportation, cited by eNow)

Figure 20 Battery Auxiliary Power Units are attached to the tractor. (Photo credit: Idle Free Systems).
**Results: Potential City-Wide Emission Reductions**

If 25% of the 14,000 trucks per day that travel through Laredo used Solar No-Idle HVAC, Battery APUs, or EPS, over 51,000 tons of aggregate air pollution per year could be avoided (Table 10). These technologies could reduce emissions of PM$_{2.5}$ and NO$_x$ by seven tons per year and 225 tons per year, respectively (Table 10). Reducing seven tons of PM$_{2.5}$ alone would be equivalent to 13% of Webb County’s PM$_{2.5}$ emissions from on-road heavy duty diesel vehicles.$^{93}$ Reducing 225 tons of NO$_x$ alone would be equivalent to 12% of Webb County’s NO$_x$ emissions from on-road heavy duty diesel vehicles.

The public health benefits of these avoided emissions cannot be understated, particularly right now as our planet faces the impacts of COVID-19, which is a respiratory illness. A recent Harvard study found that “an increase of only 1 ug/m$^3$ in PM$_{2.5}$ is associated with a 15% increase in the COVID-19 death rate.”$^{94}$ One microgram (ug) is one millionth of a gram. Even without the current pandemic, PM$_{2.5}$ results in more than 100,000 deaths in the United States each year, “more than traffic accidents and homicides combined” according to CDC data.$^{95}$

Laredo’s three-year average particulate matter concentration is 10.2 ug/m$^3$ (see Table 4). The mass of emissions savings (i.e. grams or tons) does not translate easily into concentration changes (i.e. parts per billion or micrograms per cubic meter), because the concentration of a given pollutant in air is dependent on wind and other environmental factors. Detailed modeling is needed to estimate the impact of potential voluntary emission reductions from the trucking sector on air quality in Laredo.
Table 10 Approximate estimated annual avoided air pollution (tons/year) if 25% of trucks crossing the Laredo Port of Entry adopted IR or EPS technology.

<table>
<thead>
<tr>
<th>Technology</th>
<th>CO\textsubscript{2}</th>
<th>NO\textsubscript{x}</th>
<th>PM\textsubscript{2.5}</th>
<th>PM\textsubscript{10}</th>
<th>CO</th>
<th>Aggregate emissions saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic engine start/stop system</td>
<td>35,378</td>
<td>155</td>
<td>5</td>
<td>5</td>
<td>115</td>
<td>35,657</td>
</tr>
<tr>
<td>Battery APU</td>
<td>51,458</td>
<td>225</td>
<td>7</td>
<td>7</td>
<td>167</td>
<td>51,865</td>
</tr>
<tr>
<td>Diesel APU</td>
<td>28,945</td>
<td>127</td>
<td>4</td>
<td>4</td>
<td>94</td>
<td>29,174</td>
</tr>
<tr>
<td>Diesel-fired Heater</td>
<td>15,866</td>
<td>69</td>
<td>2</td>
<td>2</td>
<td>52</td>
<td>15,992</td>
</tr>
<tr>
<td>Electrified Parking Space</td>
<td>51,458</td>
<td>225</td>
<td>7</td>
<td>7</td>
<td>167</td>
<td>51,865</td>
</tr>
<tr>
<td>Heat Recovery</td>
<td>17,153</td>
<td>75</td>
<td>2</td>
<td>2</td>
<td>56</td>
<td>17,288</td>
</tr>
<tr>
<td>Solar No Idle HVAC</td>
<td>51,458</td>
<td>225</td>
<td>7</td>
<td>7</td>
<td>167</td>
<td>51,865</td>
</tr>
<tr>
<td>Solar TRU</td>
<td>85,764</td>
<td>375</td>
<td>11</td>
<td>12</td>
<td>279</td>
<td>86,442</td>
</tr>
<tr>
<td>Storage Cooling</td>
<td>27,873</td>
<td>122</td>
<td>4</td>
<td>4</td>
<td>91</td>
<td>28,094</td>
</tr>
</tbody>
</table>

The mass of potential reduced carbon dioxide emissions is perhaps the most impressive estimated result of a 25% adoption rate. To help explain the impact of this amount of emission reductions, climate scientists and economists have calculated the “social cost of carbon,” an estimate of the long-term damages from climate change of carbon dioxide emitted in one year. These damages might include loss of property due to flooding, crop failure, loss of ecosystem services such as water flow in the Rio Grande, and other damages. The estimates are imprecise, but a range of possible values is available from the U.S. Environmental Protection Agency. At the low-end, EPA estimates $12 per ton of carbon dioxide emitted in the year 2020. On the high end, $123 per ton.\(^\text{96}\)

At 25% adoption of one of the most cost-effective technologies (i.e. Solar No-Idle HVAC or Battery APUs), 51,458 tons per year in carbon dioxide reductions could potentially prevent between $600,000 and $6,300,000 in damages. Adopting idle-reduction technologies not only saves thousands of dollars per year for drivers but can also save millions of dollars per year for society.
IV. Conclusion

Affordable technologies and no-cost behavior changes are readily available to help truck drivers and fleets manage the costs of idling. These solutions save money for drivers and fleets, protect human health, and reduce the impacts and costs of climate change.

Despite the significant amount of commercial truck traffic in Laredo and the number of census block groups in Laredo that are in the 80th percentile or higher for proximity to traffic, Laredo’s air quality monitoring network is limited. Based on our interviews with local owner operators and industry representatives, reducing diesel emissions and embracing anti-idling technologies has not been a local priority.

Trade and commerce are often viewed through a singular lens of prosperity and bottom-line economics. The data compiled in this report demonstrate that Laredo can achieve the triple-bottom-line - people, planet, and profit - by taking the lead in becoming a greener port.

We believe that this report and its findings can help to educate and raise awareness among key stakeholders, which will be reinforced through subsequent outreach events in-person and through various media outlets and platforms.

Implementing cost-effective idling reduction technologies in Laredo can have major benefits for our community, which is poorly equipped to handle the health impacts of air pollution and damages of climate change because of our high poverty rate and lack of health insurance. Moreover, Laredo has an opportunity to become a leader in emissions reductions because of our status as the nation’s largest port of entry.

The most cost-effective technologies available for idling reduction save the greatest amount of money and emissions. In our analysis, Solar No-Idle HVAC, Automatic Engine Start-Stop Systems, and Battery Auxiliary Power Units had the best balance of saving money and emissions. Our analysis represents a rough estimate based on average fuel efficiency for class 8 trucks, and hypothetical scenarios of how many hours per year a given IR technology or EPS will be used (Appendix B). Vehicle owners can conduct their own analysis tailored to their vehicle by using Argonne National Laboratory’s Vehicle Idle Reduction Savings Worksheet (Appendix A). Additionally, various manufacturers and models of idle reduction technology can be browsed on the EPA’s SmartWay website.

The upfront costs of idling reduction technologies may be a barrier to adoption for many owner-operator truck drivers or small fleets. Emission reductions can still be achieved by using electrified parking spaces where they are available, which have a very low upfront cost and produce immediate savings. In addition, federal and state grants like the U.S. EPA’s Diesel Emission Reduction Act (DERA) Program and the Texas Commission on Environmental Quality’s Texas Emission Reduction Program (TERP) could help to offset the upfront costs of technologies, but are not easily available in counties that are in compliance with federal air quality standards, such as Webb County.
RGISC is conducting outreach to truck drivers and forwarding facilities in Laredo Texas to encourage use of IR technologies and EPS. Areas where idling emissions can be prioritized include high traffic corridors and warehouse districts located near populations of children, elderly people, and those with underlying health conditions. Places where schools, nursing homes, and hospitals are located adjacent to truck stops or forwarding warehouses where trucks are likely to idle in queue are the places where emission reductions can yield the biggest benefits.

There are many more ways that Laredo can approach reducing emissions from the commercial trucking sector. Addressing emissions from idling is a good place to start because idling reduction technologies pay for themselves. Reducing traffic and congestion is another important way to reduce overall emissions. Notably, greenhouse gas emissions from passenger vehicles make up a larger proportion of emissions than medium and heavy-duty trucks. Municipal strategies to improve public transportation, walkability, bike-ability, and other means of intracity transportation can not only help to reduce emissions from passenger vehicles, but also reduce traffic and subsequently commercial trucking emissions.
# Appendix A – Idling Reduction Savings Calculator Worksheet

## Idling Reduction Savings Calculator


### Calculate Costs for Avoidable Idling

1. How much fuel is used for idling? (If you don’t know, see reference table on reverse.)
   - **gallons/hour**
   - **hours/year**
   - **gallons/year**

2. What is the price of fuel?
   - **$ __________/gallon**
   - **Available Idling Fuel Costs**
     - **$ __________/year**

3. How much does an oil change cost?
   - **$ __________/oil change**
   - How many miles between oil changes?
     - **miles/oil change**
   - **$ __________/mile**
   - **Preventive Maintenance Cost**
     - **$ __________/year**

4. How much does an engine overhaul or new vehicle cost?
   - **$ __________/overhaul or replacement**
   - How many miles between overhauls or vehicle replacement?
     - **miles/overhaul or replacement**
   - **$ __________/mile**
   - **Overhaul or Replacement Cost**
     - **$ __________/year**

5. **Total Avoidable Idling Costs**
   - **$ __________/year**

### Calculate Costs for Idling Reduction (IR) – Device and/or Electrified Parking Space (EPS)

6. How much fuel is used by the IR device?
   - **gallons/hour**
   - **hours/year**
   - **gallons/year**

7. Price of fuel (same as price listed in line 1)
   - **$ __________/gallon**
   - **Fuel cost for IR device**
   - **$ __________/year**
   - **Operating Cost for On-board IR Device**
     - **$ __________/year**

8. Cost per hour to plug into EPS
   - **$ __________/hour**
   - **Cost to plug in**
     - **$ __________/year**
   - **Total Operating Costs for IR**
     - **$ __________/year**

### Calculate Savings from IR

9. **Capital cost of on-board IR device**
   - **$ __________**
   - **SAVINGS: Line 6 – Line 8**
     - **$ __________/year**
   - **Payback Time**
     - **years**

---

*Note: Use of one or more = symbols in calculations will yield a result in dollars, not cents.**
## Appendix B – Idling Hours Per Year Assumptions

<table>
<thead>
<tr>
<th>Technology</th>
<th>Hours per year</th>
<th>Source or basis of the assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary Power Unit (Battery and Diesel)</td>
<td>1800</td>
<td>1800 hours per year are spent idling on average (U.S. DOE, 2015).</td>
</tr>
<tr>
<td>Diesel-fired heater</td>
<td>600</td>
<td>Heating is needed four months per year in Laredo.</td>
</tr>
<tr>
<td>Heat recovery</td>
<td>600</td>
<td>Heating is needed four months per year in Laredo.</td>
</tr>
<tr>
<td>Storage cooling</td>
<td>1200</td>
<td>Cooling is used eight months per year.</td>
</tr>
<tr>
<td>Automatic engine start/stop system</td>
<td>1800</td>
<td>1800 hours per year are spent idling on average (U.S. DOE, 2015).</td>
</tr>
<tr>
<td>Electrified Parking System (EPS)</td>
<td>1800</td>
<td>1800 hours per year are spent idling on average (U.S. DOE, 2015).</td>
</tr>
<tr>
<td>Solar No-Idle HVAC</td>
<td>1800</td>
<td>Assumes daytime rest periods, and same average hours per year idling as other techs.</td>
</tr>
<tr>
<td>Solar Transport Refrigeration Unit (TRU)</td>
<td>On route: 3000</td>
<td>Hours per day using Solar TRU on route: 10.</td>
</tr>
<tr>
<td></td>
<td>EPS at dock: 600</td>
<td>Hours per day using EPS at dock: 6 (2 hours pre-cool, 4 hours charging).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In use 6 days per week, 50 weeks per year.</td>
</tr>
</tbody>
</table>
References and Endnotes

2. Id.
4. The average heavy-duty vehicle in the United States consumes an average of 0.8 gallons of fuel per hour when idling and idles an average of 1,800 hours per year, consuming approximately 1,500 gallons of fuel while not in motion. According to the Energy Information Administration, the average cost of diesel in the United States ranged from $1.998 per gallon to $3.365 between 2015 and 2019.
8. National data from the Centers for Disease Control demonstrate that Hispanic children in the United States are twice as likely to die from asthma as non-Hispanic whites. (see CDC 2016. Death rates for children 0-17 years of age, 2012-2014 (deaths per 1,000,000), cited in U.S. Department of Health and Human Services Office of Minority Health. (2016). Asthma and Hispanic Americans.)


33. Id.


35. Id.


43. The level of PM2.5 in Webb County in EPA's 2014 NEI is comparable to the 2017 NEI.


51. TCEQ responded to our request for more information about the data quality concerns with the following: “An internal investigation revealed training/performance issue with the contracted operations (ex. equipment not being operated according to established applicable protocols). As such, the data associated with these operations was invalidated.”


59. Secretaría de Desarrollo Urbano y Medio Ambiente. (2018). Table 1, p. 46


66. FMCSA doesn’t track data on “owner-operator” truck drivers. The category “For Hire” as opposed to “Private,” “Both,” or “Other” is most likely to describe an “owner-operator” truck driver.


68. According to the March 27, 2020 FMCSA data snapshot, there are around 4.8 million Tractor Truck Vehicles in the United states. If the 460,000 “For Hire” Truck Tractor operators operate only one vehicle, then the percentage of market share could be around 9%.


50. Assuming fuel prices of $2.25 per gallon and $3.00 per gallon, respectively.