National Deployment Strategy for Truck Stop Electrification

by

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ABSTRACT
Economic factors have helped determine the locations for truck stop electrification (TSE), i.e., where the installations can be subsidized by government agencies and where providers of this technology can generate the most revenue. These locations may not necessarily coincide with the optimum locations from a national perspective, which includes factors such as the development of a network of TSE facilities, locations that would have the greatest potential of reducing idling, and locations where the reduction in emissions would have the greatest benefit. The goal of this project was to develop and apply a methodology to identify optimum locations for deploying TSE sites across the nation.

The project team identified and prioritized a total of 15 major truck corridors along the interstate system of the United States using criteria such as corridor length, major activity centers, truck volume, truck growth rates, nonattainment areas, existing TSE sites, number of truck stops, average temperatures, and major intersections. Each corridor was divided into sections or zones of approximately 20 miles in length that were also prioritized using the same criteria. Based on zone rankings and spacing criteria, a set of primary and secondary zones were identified for installing TSE facilities along each corridor. After determining the zones for implementation, the TSE providers would then need to negotiate deals with the truck stops within those zones (only one truck stop per zone should be implemented). This research provides both an approach and optimum locations for implementing TSE sites across the nation.
INTRODUCTION

The U.S. Environmental Protection Agency (EPA) through its SmartWay program has recently awarded $5 million in funding for anti-idling projects. According to EPA Administrator Stephen Johnson, “This is another step forward in our nation’s efforts to conserve fuel, achieve energy independence, and reduce emissions that contribute to soot and smog” (1). As part of this program, the Texas Transportation Institute (TTI) was awarded $3 million for a project that comprises both research and implementation of truck stop electrification (TSE). This paper documents the findings of the first phase of this project, which is to develop a national deployment strategy for TSE and to implement a number of TSE sites according to the newly developed strategy.

The economy of the United States is strongly reliant on heavy-duty diesel trucks to move a vast array of goods across the country. Currently there are more than 500,000 long-haul trucks operating in the United States (2). The U.S. Department of Transportation mandates that truck drivers rest 10 hours for every 14 hours of driving (3). This results in extended periods of time that drivers spend resting and sleeping in the cabs of their trucks. As a consequence, long-haul truck drivers idle their vehicles to operate heating systems and air conditioners, generate electricity, charge their vehicle’s batteries, and warm up the engines.

Although the EPA’s guidance defines long-duration idling as idling that occurs for a period of 15 minutes or longer, studies have found that truck drivers idle their engines from six to 10 hours per day while on the road (4, 5). A typical long-haul truck is on the road for an estimated 250 to 300 days per year, resulting in an average annual idling duration per truck of between 1,500 to 3,000 hours (6, 7, 8). At an idling emissions rate of approximately 135 grams of oxides of nitrogen (NOx) per hour, it is estimated that on a daily basis more than 500 tons of NOx is emitted. In addition to emissions, extended idling can also result in a considerable waste of fuel and can cause wear on the truck engines (more than 3,000 gallons of diesel is wasted on a daily basis nationwide). Studies have shown that a long-haul truck can idle away more than a gallon of diesel per hour (9).

Several methods have been developed to reduce extended truck idling. These methods can be divided into stationary and mobile technologies; the former refers to stationary equipment that can connect to the truck, and the latter refers to equipment onboard the truck, both reducing the need for extended idling. The focus of this research is on the implementation of stationary idle reduction technologies, specifically TSE sites currently produced by companies such as IdleAire Technologies Corporation and Shurepower.

In the case of IdleAire, the company would install an external heating, ventilation, and air conditioning (HVAC) unit at each truck parking space. HVAC is delivered to the truck by a microprocessor-controlled system that mounts in a window on either side of the truck. The unit contains temperature controls, credit card reader, display, and keypad. Temperature control is provided through an air conditioner duct. The unit also provides 110 volts of electric power for appliances inside the cab as well as television, local telephone, and Internet service. An additional 110-volt outlet mounted on the outside of the control console provides an external power hookup for engine block heating (10, 11).

With regard to Shurepower, the HVAC system is internal to the truck, and shorepower is used to power such units when the truck is parked. The Shurepower system gives access to 120-
or 240-volt electrical power from a land-based electrical power source. The Shurepower system has the option of including broadband Internet, cable television, and telephone.

Over the years these companies have implemented more than 30 TSE sites with hundreds more in the planning phase. These companies generally implement at locations where the installation can be subsidized by government agencies and where they can generate the most revenue. These locations may not necessarily coincide with the optimum locations from a national perspective—focusing on the greatest possible emissions reduction, nonattainment areas, and the creation of a national network of electrified truck stops.

The goal of this project is to develop and apply a methodology to identify optimum locations for deploying TSE sites across the nation. This paper explains the development of the evaluation criteria and decision-making methodology as well as the application of this methodology to 15 key truck corridors in the United States. The paper is divided into the following five sections—introduction, methodology, corridor selection, zone selection, and concluding remarks.

**METHODOLOGY**

Long-haul trucks perform the vast majority of their travel on the nation’s interstate system, which is comprised of 62 main interstate routes and approximately 261 spur or radial interstate highways covering about 46,000 miles. In developing a national TSE deployment strategy it was, therefore, decided to focus on the interstate system. This system was used to define 15 major truck corridors. The relative importance of these corridors (from the perspective of benefits accrued from implementing TSE facilities) was then determined. Each corridor was divided into sections or zones of approximately 20 miles in length and then prioritized (again from the perspective of benefits accrued from implementing TSE facilities). The final step was to use the zone rankings and other criteria to select first and second priority zones for implementation. These steps are illustrated in Figure 1, and the following sections describe the process in detail.
CORRIDOR SELECTION

Identification of Corridors

The study team used the Federal Highway Administration’s Freight Analysis Framework (FAF) database to investigate possible national truck corridors (14). Truck volumes and patterns as well as major origins and destinations were considered in identifying the major truck corridors. Fifteen corridors were identified as major truck corridors in the United States. These corridors follow the interstate system, except in some major urbanized areas where they deviate from this system for short distances to track the major truck routes through these areas. Table 1 shows the major origins and destinations, freeways involved, and a description of the path from major city to major city. Figure 2 shows a map of these corridors. As shown in this figure, the majority of corridors are on the eastern side of the United States. This is indicative of the extensive trucking activity occurring on that side of the continent.
<table>
<thead>
<tr>
<th>Number</th>
<th>Origin/Destination</th>
<th>Freeways</th>
<th>Path Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor A</td>
<td>New York–Minneapolis</td>
<td>I80–I90–I94</td>
<td>New York–Cleveland–Toledo–Chicago–Minneapolis</td>
</tr>
<tr>
<td>Corridor C</td>
<td>Chicago–Miami</td>
<td>I65–I24–I75–Florida Turnpike</td>
<td>Chicago–Nashville–Atlanta–Miami</td>
</tr>
<tr>
<td>Corridor E</td>
<td>San Antonio–Jacksonville</td>
<td>I10</td>
<td>San Antonio–Houston–New Orleans–Jacksonville</td>
</tr>
<tr>
<td>Corridor G</td>
<td>Detroit–Miami</td>
<td>I75</td>
<td>Detroit–Dayton–Knoxville–Atlanta–Miami</td>
</tr>
<tr>
<td>Corridor I</td>
<td>San Diego–Seattle</td>
<td>I5</td>
<td>San Diego–Los Angeles–Seattle</td>
</tr>
<tr>
<td>Corridor J</td>
<td>Los Angeles–Chicago</td>
<td>I115–I80–I55</td>
<td>Los Angeles–Salt Lake City–Des Moines–Chicago</td>
</tr>
<tr>
<td>Corridor L</td>
<td>Chicago–Mobile</td>
<td>I65</td>
<td>Chicago–Indianapolis–Nashville–Birmingham–Mobile</td>
</tr>
<tr>
<td>Corridor M</td>
<td>Dallas–Raleigh</td>
<td>I20–I85</td>
<td>Dallas–Jackson–Birmingham–Atlanta–Raleigh</td>
</tr>
<tr>
<td>Corridor N</td>
<td>Knoxville–Harrsburg</td>
<td>I81</td>
<td>Knoxville–Harrsburg</td>
</tr>
</tbody>
</table>
Prioritization of Corridors

As previously noted, the overall goal of implementing TSE facilities is to reduce idling, thereby reducing emissions and fuel consumption. Therefore, corridors were prioritized according to their ability to reduce these aspects through the implementation of TSE facilities. There were 25 criteria considered for prioritizing the national corridors. After deliberation it was decided that the nine criteria shown in Table 2 best address the overall goal. Table 2 also shows the data sources used for quantifying the various measures.
### TABLE 2 Criteria for Prioritizing National Truck Corridors

<table>
<thead>
<tr>
<th>Number</th>
<th>Measure</th>
<th>Description</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corridor length</td>
<td>From origin to destination</td>
<td>Measurements using geographic information system (GIS) software using FAF database (15)</td>
</tr>
<tr>
<td>2</td>
<td>Major activity centers</td>
<td>Activity centers such as major urbanized areas and ports</td>
<td>Maps and local knowledge of the areas (16)</td>
</tr>
<tr>
<td>3</td>
<td>Average daily truck volume</td>
<td>Class 8 truck volume along corridor weighted by segment lengths</td>
<td>FAF database</td>
</tr>
<tr>
<td>4</td>
<td>Truck traffic growth rates</td>
<td>Estimated annual growth rate in truck volume</td>
<td>FAF database (1998 and 2010 volumes)</td>
</tr>
<tr>
<td>5</td>
<td>Nonattainment areas</td>
<td>Number of ozone and PM nonattainment areas</td>
<td>EPA website (17)</td>
</tr>
<tr>
<td>6</td>
<td>Existing TSE sites</td>
<td>Existing TSE sites as well as sites currently under construction</td>
<td>Provided by IdleAire and Shurepower</td>
</tr>
<tr>
<td>7</td>
<td>Number of truck stops</td>
<td>Number of truck stops that have 75 or more truck parking spaces</td>
<td>Provided by IdleAire and other sources</td>
</tr>
<tr>
<td>8</td>
<td>Percentage of corridor experiencing hot and cold days</td>
<td>Percentage of corridor with average maximum temperatures above 90 F or average minimum temperatures below 40 F during two hottest and coldest months of 2005</td>
<td>From Spatial Climate Analysis Service (18)</td>
</tr>
<tr>
<td>9</td>
<td>Number of major interchanges</td>
<td>Number of freeway to freeway interchanges with more than 2,000 trucks per day on crossing freeway</td>
<td>FAF database</td>
</tr>
</tbody>
</table>

After the data were collected for all 15 corridors, a multi-criteria decision-making method was used to rank the corridors in terms of their importance for implementing truck stop electrification. There are many multi-criteria decision-making techniques available. Decision makers often use Multi Attribute Utility Theory (MAUT) as a technique for evaluating projects, programs, and policies with multiple and often conflicting goals. The MAUT technique is popular because it is a relatively intuitive process and fairly easy to implement. It was, therefore, decided to use this methodology in ranking the corridors. The following equation shows the formulation for the MAUT method (19):  

$$ U_j = \sum_{k=1}^{n_k} w_k n_{kj} $$  

(1)

Where:

\[ U_j = \text{utility of alternative } j, \]
\[ w_k = \text{weight of the } k^{th} \text{ criterion, and} \]
\[ n_{kj} = \text{normalized criterion } k \text{ value for alternative } j. \]

Linear normalization was used to provide a scaling for the utility values from zero to one, with zero being the worst possible score and one being the best possible score. A more detailed description of normalization and the application of the MAUT method can be found elsewhere.
Sensitivity analyses were performed using various combinations of criteria weights. It was found that the utility values show very small variability based on weights. Using weights can also be a highly controversial issue, with subjectivity and differing opinions playing a major role. Based on this and the limited differences that the weighting had, it was decided to consider equal weights for all the criteria. Table 3 shows the quantified criteria values for the 15 selected corridors, and Table 4 shows the ranking of the 15 corridors.

**TABLE 3 Criteria Values for Selected Corridors**

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Length (Miles)</th>
<th>Major Activity Centers</th>
<th>Average Daily Truck Volume</th>
<th>Annual Truck Growth Rate</th>
<th>Non-attainment Areas</th>
<th>Existing TSE Sites</th>
<th>Number of Truck Stops</th>
<th>% Above 90ºF or below 40ºF</th>
<th>Major Interchanges</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1231</td>
<td>14</td>
<td>8586</td>
<td>1.79%</td>
<td>11</td>
<td>1</td>
<td>65</td>
<td>50%</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>1271</td>
<td>21</td>
<td>5039</td>
<td>-0.87%</td>
<td>14</td>
<td>5</td>
<td>60</td>
<td>51%</td>
<td>18</td>
</tr>
<tr>
<td>C</td>
<td>1220</td>
<td>19</td>
<td>6435</td>
<td>2.13%</td>
<td>7</td>
<td>1</td>
<td>65</td>
<td>56%</td>
<td>11</td>
</tr>
<tr>
<td>D</td>
<td>1532</td>
<td>20</td>
<td>3224</td>
<td>1.07%</td>
<td>14</td>
<td>3</td>
<td>61</td>
<td>55%</td>
<td>15</td>
</tr>
<tr>
<td>E</td>
<td>1074</td>
<td>14</td>
<td>6202</td>
<td>2.48%</td>
<td>8</td>
<td>4</td>
<td>52</td>
<td>55%</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>1224</td>
<td>12</td>
<td>5572</td>
<td>1.51%</td>
<td>13</td>
<td>2</td>
<td>65</td>
<td>50%</td>
<td>19</td>
</tr>
<tr>
<td>G</td>
<td>1226</td>
<td>18</td>
<td>5745</td>
<td>2.53%</td>
<td>9</td>
<td>3</td>
<td>62</td>
<td>56%</td>
<td>14</td>
</tr>
<tr>
<td>H</td>
<td>1635</td>
<td>19</td>
<td>5503</td>
<td>3.04%</td>
<td>6</td>
<td>5</td>
<td>72</td>
<td>62%</td>
<td>14</td>
</tr>
<tr>
<td>I</td>
<td>1262</td>
<td>17</td>
<td>6106</td>
<td>2.60%</td>
<td>7</td>
<td>2</td>
<td>27</td>
<td>61%</td>
<td>13</td>
</tr>
<tr>
<td>J</td>
<td>1412</td>
<td>8</td>
<td>7654</td>
<td>3.20%</td>
<td>4</td>
<td>2</td>
<td>30</td>
<td>77%</td>
<td>6</td>
</tr>
<tr>
<td>K</td>
<td>803</td>
<td>10</td>
<td>5752</td>
<td>3.21%</td>
<td>4</td>
<td>2</td>
<td>30</td>
<td>77%</td>
<td>6</td>
</tr>
<tr>
<td>L</td>
<td>920</td>
<td>11</td>
<td>5386</td>
<td>1.83%</td>
<td>6</td>
<td>0</td>
<td>46</td>
<td>67%</td>
<td>8</td>
</tr>
<tr>
<td>M</td>
<td>1190</td>
<td>18</td>
<td>5003</td>
<td>1.70%</td>
<td>7</td>
<td>4</td>
<td>65</td>
<td>77%</td>
<td>11</td>
</tr>
<tr>
<td>N</td>
<td>542</td>
<td>9</td>
<td>4558</td>
<td>4.28%</td>
<td>2</td>
<td>1</td>
<td>32</td>
<td>50%</td>
<td>6</td>
</tr>
<tr>
<td>O</td>
<td>1161</td>
<td>20</td>
<td>6005</td>
<td>0.27%</td>
<td>9</td>
<td>3</td>
<td>48</td>
<td>57%</td>
<td>13</td>
</tr>
</tbody>
</table>
### TABLE 4 Ranking of Selected Corridors

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Corridor</th>
<th>Origin/Destination</th>
<th>Utility Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>New York–Minneapolis</td>
<td>0.67</td>
</tr>
<tr>
<td>2</td>
<td>H</td>
<td>Laredo–Raleigh</td>
<td>0.62</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>Chicago–Miami</td>
<td>0.60</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>Boston–Miami</td>
<td>0.60</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>Kansas City–New York</td>
<td>0.59</td>
</tr>
<tr>
<td>6</td>
<td>G</td>
<td>Detroit–Miami</td>
<td>0.58</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>Dallas–Raleigh</td>
<td>0.57</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>Boston–Birmingham</td>
<td>0.54</td>
</tr>
<tr>
<td>9</td>
<td>I</td>
<td>San Diego–Seattle</td>
<td>0.51</td>
</tr>
<tr>
<td>10</td>
<td>O</td>
<td>New Orleans–Baltimore</td>
<td>0.51</td>
</tr>
<tr>
<td>11</td>
<td>J</td>
<td>Salt Lake–Chicago</td>
<td>0.46</td>
</tr>
<tr>
<td>12</td>
<td>L</td>
<td>Chicago–Mobile</td>
<td>0.45</td>
</tr>
<tr>
<td>13</td>
<td>E</td>
<td>San Antonio–Jacksonville</td>
<td>0.41</td>
</tr>
<tr>
<td>14</td>
<td>K</td>
<td>Los Angeles–El Paso</td>
<td>0.39</td>
</tr>
<tr>
<td>15</td>
<td>N</td>
<td>Knoxville–Harrisburg</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 4 shows that Corridor A is clearly the highest ranking corridor for implementing TSE facilities. The utility values of the following six corridors—H, C, D, F, G, and M—vary by only five points, making them all good candidates for implementation. The utility values of the remaining eight corridors show a steady decline to Corridor N, which received the lowest rating.

### ZONE SELECTION

**Identification of Zones**

Each corridor was divided into zones or sectors of approximately 20 miles in length and 3.75 miles in width (1.875 miles on either side of the major freeway). The zones were identified so that they fully included major interchanges and truck stops. Typically more than 50 zones were selected per corridor. The 3.75-mile buffer area along the freeway corridors was used to identify all the truck stops with 75 or more parking spaces that are associated with the zones. Within this buffer area the truck drivers will be prepared to divert from the interchange and visit a truck stop. The buffer area was selected so that truck stops could be captured where truck drivers could make a small detour from the interstate system to get to them. The reason why 75 spaces were selected is because the experience of companies providing idle reduction technologies has shown that truck stops with 75 or more parking spaces are the best candidates for TSE applications.

**Prioritization of Zones**

Only zones with at least one truck stop with more than 75 spaces were considered for prioritization and, therefore, selection. As in the case with the corridors, the zones were prioritized based on their ability to accommodate TSE facilities that could reduce idling and
thereby reduce emissions and fuel consumption. The same criteria as listed in Table 2 (with the exception of length and a slight modification of temperature) were used for prioritizing the zones. Corridor length was obviously not applicable as a criterion for selecting zones, and in the case of temperature, the average maximum temperature during July and August and the average minimum temperatures during January and February were used instead of the percentage of corridor experiencing hot and cold days. Data were collected for each zone using the same sources as listed in Table 2. The MAUT approach as shown in Equation 1 was again applied corridor by corridor to rank the zones within each corridor. As in the case of the corridors, it was decided not to use weights.

**Selection of Zones**

As previously indicated, the following three elements need to be addressed to produce an implementation plan that would have the optimum benefit in terms of reducing emissions and fuel consumption:

- Develop a network of TSE facilities that would provide more than 500,000 long-haul trucks adequate opportunity to hook up to stationary idle reduction technologies during their trips.
- Select locations that would have the greatest potential of reducing idling and, therefore, emissions and fuel consumption.
- Select locations where the reduction in emissions and fuel consumption would have the greatest benefit.

The study team had conversations with truck drivers as well as other individuals involved in the trucking industry to determine the spacing between TSE sites that would provide the best network effect. It was decided that a primary network of TSE sites spaced at approximately 200 to 300 miles would provide the bare minimum to truck drivers. A secondary network that would be implemented after the primary network is in place would result in a spacing of between 100 and 150 miles between TSE facilities. In urbanized areas with higher levels of congestion and, therefore, longer travel times, shorter spacing between TSE facilities would be required.

The ranking exercise produced priority lists of the zones that are available for implementation in each corridor. The following are factors considered in selecting the optimum locations for TSE implementation:

- The zone rankings served as a guideline for selecting the primary and secondary priority zones for implementation.
- In selecting the primary and secondary zones, each corridor was considered individually.
- The spacing between primary zones is approximately 200 to 300 miles.
- The spacing between zones once the secondary zones were included is approximately 100 to 150 miles.
- The primary zones were selected first, and the secondary zones were identified between the primary zones to create optimum spacing.
- In cases where equally good zones are located adjacent to each other, both zones were typically selected and combined to provide more options for implementation.
Local knowledge of the area was used to supplement information on the zone rankings.

In the case of urbanized areas that contain more than one of the selected corridors, the study team used detailed maps and local knowledge to define the routes and to make the zone selections.

In areas where corridors overlap, only one unique set of zones was selected representing both corridors in that area.

All the primary zones on a specific corridor need to be implemented first before any of the secondary zones are implemented.

Table 5 shows the number of existing TSE sites, number of primary and secondary zones selected, and number of truck stops with 75 or more spaces in the primary and secondary zones for each corridor. The table shows that, on average, each corridor has 2.4 TSE sites, and an average of four primary and secondary zones were selected per corridor. A total of more than 100 zones containing more than 300 large truck stops were selected. It should be noted that it is possible to implement more than one TSE site per zone. The number of electrified parking spaces that can be implemented in a zone is determined by the demand for such spaces, which is related to factors such as truck volume, average temperature, proximity of activity centers, number of large truck stops, etc. Development of such a demand model is beyond the scope of this paper.

### TABLE 5 Number of Zones Selected for Primary and Secondary Implementation

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Origin/Destination</th>
<th>Existing TSE Sites</th>
<th>Primary Zones Selected</th>
<th>Truck Stops in Primary Zones</th>
<th>Secondary Zones Selected</th>
<th>Truck Stops in Secondary Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>New York–Minneapolis</td>
<td>1</td>
<td>5</td>
<td>29</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>Boston–Birmingham</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>Chicago–Miami</td>
<td>3</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>Boston–Miami</td>
<td>4</td>
<td>5</td>
<td>17</td>
<td>6</td>
<td>12</td>
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<tr>
<td>E</td>
<td>San Antonio–Jacksonville</td>
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<td>4</td>
<td>8</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>F</td>
<td>Kansas City–New York</td>
<td>5</td>
<td>5</td>
<td>18</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>G</td>
<td>Detroit–Miami</td>
<td>3</td>
<td>4</td>
<td>9</td>
<td>6</td>
<td>19</td>
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<tr>
<td>H</td>
<td>Laredo–Raleigh</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>11</td>
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<tr>
<td>I</td>
<td>San Diego–Seattle</td>
<td>0</td>
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<td>8</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>J</td>
<td>Salt Lake–Chicago</td>
<td>2</td>
<td>7</td>
<td>17</td>
<td>3</td>
<td>8</td>
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<tr>
<td>K</td>
<td>Los Angeles–El Paso</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>L</td>
<td>Chicago–Mobile</td>
<td>4</td>
<td>5</td>
<td>14</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>M</td>
<td>Dallas–Raleigh</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>N</td>
<td>Knoxville–Harrisburg</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>O</td>
<td>New Orleans–Baltimore</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>2.4</strong></td>
<td><strong>3.9</strong></td>
<td><strong>10.7</strong></td>
<td><strong>3.9</strong></td>
<td><strong>10.4</strong></td>
</tr>
</tbody>
</table>
A map showing the locations of the selected zones and tables containing associated information were prepared for each corridor. For example, Figure 3 contains a map showing the locations of the primary and secondary zones along Corridor A. The figure shows that five primary zones and six secondary zones were selected and no existing TSE facilities exist along this corridor.

**FIGURE 3** Primary and secondary zones along Corridor A.

Table 6 contains a description of the selected zones along Corridor A—zone length, towns at the ends of the zones, and coordinates defining the zones. Table 7 contains information on truck stops with more than 75 spaces located in the selected zones along Corridor A—truck stop name, number of spaces, address, and highway location.
Table 6 provides a more detailed description of the identified zones along Corridor A. The table indicates the zone number, highway(s) that designate the corridor within the zone, zone length, start and end town or city (these are provided in an east to west direction and identify the closest town or city to the beginning and end of the zone), and longitude and latitude of the beginning and ending of the zone.

Table 7 provides information on the truck stops with more than 75 parking spaces located within the first priority zones along Corridor A. The table shows the zone number, truck stop name, number of spaces, address, and directions.
TABLE 7 Description of Identified Large Truck Stops along Corridor A

<table>
<thead>
<tr>
<th>Corridor A</th>
<th>Travel Center</th>
<th># Spaces</th>
<th>Address</th>
<th>Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hickory Run Truck Plaza</td>
<td>75</td>
<td>1-80 Exit 41 NW, White Haven, PA</td>
<td>I-80 Exit 274 (PA 534)</td>
</tr>
<tr>
<td></td>
<td>Bandit Truck Stop #2</td>
<td>80</td>
<td>1-80 Exit 41 (Route 534), White Haven, PA 18661</td>
<td>I-80 Exit 41 (PA 534)</td>
</tr>
<tr>
<td></td>
<td>Brennan’s Auto/Truck Plaza</td>
<td>75</td>
<td>1-80 Exit 37, Mifflinville, PA 18631</td>
<td>I-80 Exit 37 (PA 339)</td>
</tr>
<tr>
<td></td>
<td>Truck World</td>
<td>150</td>
<td>6965 Truck World Boulevard, Hubbard, OH 44425</td>
<td>I-80 Exit 234 (OH 7 &amp; US 62)</td>
</tr>
<tr>
<td></td>
<td>TA #058–Youngstown</td>
<td>150</td>
<td>5400 76th Drive, Youngstown, OH 44515</td>
<td>I-80 Exit 223 A (OH 46 S)</td>
</tr>
<tr>
<td></td>
<td>Short Stop Truck Plaza</td>
<td>120</td>
<td>6152 W Market Street, Leavittsburg, OH 44430</td>
<td>I-80 Exit 14</td>
</tr>
<tr>
<td></td>
<td>Speedway #8242–Youngstown</td>
<td>300</td>
<td>871 N Canfield-Niles Road, Youngstown, OH 44515</td>
<td>I-80 Exit 223 A (OH 46 N)</td>
</tr>
<tr>
<td>2</td>
<td>ALRI Truck &amp; Auto Plaza</td>
<td>75</td>
<td>4322 State Highway 5, Newton Falls, OH 44444</td>
<td>I-80 (OHTP) Exit 209 (OH 5 W)</td>
</tr>
<tr>
<td></td>
<td>Pilot #281–Girard</td>
<td>75</td>
<td>2786 Salt Springs Road, Girard, OH 44420</td>
<td>I-80 Exit 226 (Salt Spring Road)</td>
</tr>
<tr>
<td></td>
<td>Petro #20–Girard</td>
<td>322</td>
<td>1 Petro Place, Girard, OH 44420</td>
<td>I-80 Exit 226 (Salt Spring Road)</td>
</tr>
<tr>
<td></td>
<td>Mr. Fuel #5–Girard</td>
<td>100</td>
<td>2840 Salt Springs Road, Girard, OH 44420</td>
<td>I-80 Exit 226 (Salt Spring Road)</td>
</tr>
<tr>
<td></td>
<td>Pilot #003–Austintown</td>
<td>193</td>
<td>1150 North Canfield-Niles Road, Austintown, OH 44515</td>
<td>I-80 Exit 223 B (US 46 N)</td>
</tr>
<tr>
<td></td>
<td>Flying J–Hubbard</td>
<td>150</td>
<td>2226 N Main, Niles, OH 44446</td>
<td>I-80 Exit 234 B (Highway 62)</td>
</tr>
<tr>
<td>3</td>
<td>Stony Ridge Travel Center</td>
<td>200</td>
<td>3491 Latcha Road, Millbury, OH 43447</td>
<td>I-280 Exit 1 B (1 mile N of OHTP Exit)</td>
</tr>
<tr>
<td></td>
<td>TA #087–Toledo</td>
<td>179</td>
<td>3483 Libby Road, Perrysburg, OH 43551</td>
<td>I-80 Exit 71 (Libby Road)</td>
</tr>
<tr>
<td></td>
<td>Fuel Mart #641–Perrysburg</td>
<td>200</td>
<td>3654 Libby Road, Perrysburg, OH 43551</td>
<td>I-80-90 Exit 71 (OH 420 S)</td>
</tr>
<tr>
<td></td>
<td>Petro #17–Stony Ridge</td>
<td>318</td>
<td>26398 Baker Drive, Perrysburg, OH 43551</td>
<td>I-280 Exit 1 B (1 mile N of OHTP Exit)</td>
</tr>
<tr>
<td></td>
<td>Flying J–Perrysburg</td>
<td>150</td>
<td>26415 Warns Road, Perrysburg, OH 43551</td>
<td>I-280 Exit 1 B (1 mile N of OHTP Exit)</td>
</tr>
</tbody>
</table>
### TABLE 7 Description of Identified Large Truck Stops along Corridor A (Continued).

<table>
<thead>
<tr>
<th>Zone</th>
<th>Travel Center</th>
<th># Spaces</th>
<th>Address</th>
<th>Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Pilot #271–Gary</td>
<td>122</td>
<td>2501 Burr Street, Gary, IN 46406</td>
<td>I-80-94 Exit 6 (Burr Street)</td>
</tr>
<tr>
<td></td>
<td>Crazy D’s Truck Stop</td>
<td>100</td>
<td>8121 Melton Road, Gary, IN 46403</td>
<td>US 20 &amp; IN 51</td>
</tr>
<tr>
<td></td>
<td>TA #010–Gary</td>
<td>234</td>
<td>2510 Burr Street, Griffith, IN 46319</td>
<td>I-80-94 Exit 6 (Burr Street)</td>
</tr>
<tr>
<td></td>
<td>Flying J–Lake Station</td>
<td>350</td>
<td>1401 Ripley Street, Lake Station, IN 46405</td>
<td>I-80-94 Exit 15 B (IN 51–Ripley)</td>
</tr>
<tr>
<td></td>
<td>Toll Road BP #70512</td>
<td>200</td>
<td>5105 Plaza Drive (1 South), Portage, IN 46368</td>
<td>I-80-90 MM 22 EB</td>
</tr>
<tr>
<td></td>
<td>Steel City Truck Plaza</td>
<td>344</td>
<td>3001 Grant Street, Gary, IN 46408</td>
<td>I-80-94 Exit 9 A (Grant Street S)</td>
</tr>
<tr>
<td></td>
<td>TA #219–Lake Station</td>
<td>243</td>
<td>1201 N Ripley Street, Lake Station, IN 46403</td>
<td>I-80-94 Exit 15 B (IN 51–Ripley)</td>
</tr>
<tr>
<td></td>
<td>Flying J–Gary</td>
<td>165</td>
<td>3150 Grant Street, Gary, IN 46408</td>
<td>I-80-94 Exit 9 A (Grant Street S)</td>
</tr>
<tr>
<td>5</td>
<td>TA #192–Hudson</td>
<td>90</td>
<td>713 Highway 12, Hudson, WI 54016</td>
<td>I-94 Exit 4 (US 12)</td>
</tr>
<tr>
<td></td>
<td>Ray’s Super Stop</td>
<td>100</td>
<td>501 US Highway 63, Baldwin, WI 54002</td>
<td>I-94 Exit 19 (US 63)</td>
</tr>
<tr>
<td></td>
<td>Kwik Trip #603–Wilson</td>
<td>125</td>
<td>Highway 94 &amp; 128, Wilson, WI 54027</td>
<td>I-94 Exit 28 (WI 128)</td>
</tr>
</tbody>
</table>

Similar maps and tables have been produced for each of the 15 corridors and are currently being developed into an Internet tool that will be accessible to the general public and would be useful to states, metropolitan planning organizations, cities, TSE providers, truck stop owners, etc.

### CONCLUDING REMARKS
Locations for truck stop electrification have previously been determined by economic factors—where government agencies can subsidize the installations and where providers of this technology can generate the most revenue. These locations may not necessarily coincide with the optimum locations from a national perspective. This perspective would involve the following:

- Develop a network of TSE facilities that would provide the long-haul trucks adequate opportunity to connect to stationary idle reduction technologies during their trips.
- Select locations that would have the greatest potential of reducing idling and, therefore, emissions and fuel consumption.
Select locations where the reduction in emissions and fuel consumption would have the greatest benefit.

The goal of this project was to develop and apply a methodology to identify optimum locations for deploying TSE sites across the nation.

Using truck volumes, growth rates, and local knowledge, the study team identified 15 major truck corridors along the interstate system of the United States. These corridors were prioritized using the following nine criteria: corridor length, major activity centers, truck volume, truck growth rates, nonattainment areas, existing TSE sites, number of truck stops (75 or more spaces), average temperatures, and major intersections. A multi-criteria decision-making methodology was used to prioritize these corridors. It was found that the corridor stretching from New York to Minneapolis ranked the highest.

A network of primary and secondary zones was developed for the 15 major corridors. After determining which zones should be implemented, it would be up to the TSE providers to negotiate contracts with the truck stops within those zones. Depending on the demand, it is possible to implement more than one truck stop per zone.

This research provides both an approach and recommended locations for implementing TSE sites across the nation. The product is currently being developed into a user-friendly Internet tool to be used by public- and private-sector entities interested in implementing TSE facilities.
ACKNOWLEDGMENTS

This paper was based on research performed for the Office of Transportation and Air Quality of the U.S. Environmental Protection Agency. The authors would like to thank David Everhart of IdleAire Technologies Corporation and Mike Panich of Shurepower for providing data on truck stops and TSE installations. In addition, the authors would like to thank the following TTI researchers for their assistance with the data analysis effort: Jeff Warner and Meghan Wieters.
REFERENCES


