

A Study of the Rate of Usage and Incentives to Increase the Use
of the Truck Stop Electrification Service at Overnight
Truck Parking Stations in the Dallas-Fort Worth Area

by

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Final Project Report 2019-1-NCTCOG

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May 2019

DISCLAIMER

This report is prepared in cooperation with the North Central Texas Council of Governments, the Regional Transportation Council, the Texas Department of Transportation, the U.S. Department of Transportation, and Federal Highway Administration.

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the views or policies of the Federal Highways Administration, the U.S. Department of Transportation, the Texas Department of Transportation, the North Central Texas Council of Governments, or the Regional Transportation Council. This report does not constitute a standard, specification, or regulation.

The identifying information on truck stops and truck stop electrification companies are removed to comply with the acquired Institutional Review Board approval for this project.

ACKNOWLEDGMENT

The authors wish to acknowledge the sponsorship of the North Central Texas Council of Governments through its University Partnership Program, the Regional Transportation Council, the Texas Department of Transportation, the U.S. Department of Transportation, and Federal Highway Administration. In particular, the directions and insights offered by Mr. Jason Brown, Ms. Huong Duong, Mr. Chris Klaus, Ms. Lori Clark, and Ms. Amy Hodges are greatly appreciated.

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NOMENCLATURE

APU	auxiliary power unit
EPS	electrified parking space
NCTCOG	North Central Texas Council of Governments
TSE	truck stop electrification
TX	Texas
UTA	The University of Texas at Arlington

EXECUTIVE SUMMARY

Overnight idling by diesel-fueled long-haul trucks is a contributor to mobile-source emissions in the Dallas-Fort Worth (DFW) region and a detriment to the region's overall air quality. Truck stop electrification (TSE) systems, also known as electrified parking space (EPS) systems, are commercial products that provide long-haul truck drivers an alternative to idling their engines during rest periods. Currently, two options are available for truck stop electrification: single-system electrification and dual-system electrification. A single-system electrification is an off-board equipment at truck stops and terminals contained in a structure above the truck (called a gantry) or on a pedestal beside the truck. This system provides heating, ventilation, air conditioning (HVAC), and internet access. Alternatively, a dual-system electrification needs both onboard and off-board equipment so that trucks can plug into electrical outlets at truck stops and terminals. Both systems allow drivers to turn off their diesel engines and auxiliary power units (APU) and still have electricity inside the truck's cab for various amenities such as lighting, cooling, heating, TV, Internet, etc. TSE systems also have the added benefit of a better rest period for drivers in the absence of engine vibration, noise, and exhaust fumes from idling.

At the time of the study, there were three public service stations in the DFW area, which are equipped with TSE systems. There was also one private truck terminal with EPS systems in the DFW area. All four stations have single-system electrification systems. One of the public service stations also includes dual-system electrification systems. Informal observations indicate that truck drivers often park in the spaces designated for TSE/EPS systems without using the service and idle their engines overnight. Reasons for this could be due to a lack of awareness of TSE/EPS benefits among long-haul truckers, a lack of adequate enforcement of overnight idling regulations, a lack of enforcement of rules by service stations themselves regarding the use of TSE/EPS, and/or a lack of incentives or encouragement for drivers to use TSE/EPS systems.

In this study, a field data collection was conducted to establish the TSE/EPS usage rates at these four stations in the DFW area, and a survey of drivers, truck stop/terminal owners, TSE/EPS system providers, and on site TSE/EPS system representatives was conducted at these stations to answer the following questions:

1. what are common reasons for idling engines during rest periods while having access to the TSE/EPS systems?
2. what are proper incentives for drivers to use TSE/EPS systems, and
3. what are proper incentives for truck stop/terminal owners to encourage truck drivers to use TSE/EPS services?

The results of field data collection show that the rate of engine idling and TSE/EPS usage rate are different among the four stations. The private terminal had the lowest rate of idling compared to the public service stations since the terminal is fully controlled by a manager, and the drivers are forced not to idle more than a certain amount of time. In contrast, stations without any control over idling have a higher rate of idling.

The results of the survey show that single drivers often idle their trucks more than the drivers who drive as a team. Based on the survey results, drivers mostly prefer direct and monetary incentives, such as discounts on TSE/EPS set-up accessories, fuel price discounts, or coupons for the truck stop shower, food, and laundry services. Truck stop owners are mostly concerned about the amount of profit that they can earn from TSE systems; therefore, one way to motivate truck stop owners is to offer them fixed-rate revenues. Based on the survey results, the best incentives for TSE/EPS system providers is supporting them to modernize and update TSE/EPS equipment, such as enhancing technology to eliminate cigarette and diesel fume smell from the systems, designing light-weight TSE/EPS systems, improving entertainment services in the TSE/EPS systems, and integrating systems with renewable energy systems to provide electricity for TSE/EPS operations (discussed in Chapter 5). Education is the key to TSE/EPS system success. Disseminating knowledge about the advantages of using TSE/EPS systems among drivers is one of the major recommendations of this study. Proposed recommendations for improving TSE/EPS usage rate at truck stops and terminals are:

- 1- Design a bundled discount for truck drivers that includes TSE/EPS services along with other services, such as showers, and food;
- 2- Design large and informative signage that shows drivers how to use TSE/EPS systems. The signs should also provide a list of incentives and mention the available TSE/EPS system spaces in the area;
- 3- Design quiet zones at truck stops and support them through enforcement;
- 4- Conduct educational demonstration at truck stops/terminals to show the advantages of using TSE/EPS systems to truck stop/terminal owners and drivers, and educate drivers how to connect the systems to their trucks;
- 5- Integrate educational programs with truck company driver training courses; and
- 6- Communicate with trucking companies and terminals to motivate them to deploy EPS systems at their terminals.

CHAPTER 1. INTRODUCTION AND SCOPE

Idling long-haul freight trucks waste about one billion gallons of diesel fuel per year in the U.S. (Frey et al., 2009). These trucks are estimated to idle an average of 1460 to 1800 hours per year per truck (Lutsey et al., 2004; Gaines et al., 2006). According to the U.S. Environmental Protection Agency (EPA), long-haul trucks waste almost 960 million gallons of diesel fuel during idling and emit 10.9 million tons of carbon dioxide (CO₂), 180,000 tons of nitrogen oxides (NO_x), and 5,000 tons of particulate matter (PM) on an annual basis (Lim, 2003). This amount of emissions contributes to poor air quality in metropolitan areas, such as Dallas-Fort Worth (DFW) area (Zietsman & Perkinson, 2005).

Truck stop electrification (TSE) systems, also known as electrified parking spaces (EPS), provide truck drivers alternative options for necessary services, such as heating, air conditioning, or power for appliances, without the need for idling (DOE, 2019). Two options are available for truck stop electrification: single-system electrification and dual-system electrification. A single-system electrification is an off-board equipment at truck stops and terminal contained in a structure above the truck (called a gantry) or on a pedestal beside trucks. These systems provide heating, ventilation, air conditioning (HVAC), and internet access. They are connected to the truck by a hose connection to a HVAC system using a window adapter. Alternatively, a dual-system electrification needs both onboard and off-board equipment so that trucks can plug into electrical outlets at truck stops and terminals. Therefore, trucks must be equipped with AC equipment or an inverter to convert 120-volt power to plug in to the electrical outlet to use dual-system electrification (DOE, 2019).

The objectives of this study were to 1) conduct a field data collection effort to assess the extent of truck engine idling instead of TSE/EPS system use at the four service stations in the DFW area to establish a rate of usage and 2) conduct a survey to explain rational reasons for the observed usage rates, and determine what incentives might be provided to drivers (e.g., fuel gift cards, food vouchers, shower vouchers, etc.) to increase their use of the system. Direct observation method (Taylor-Powell & Steele, 1996) was used to collect field data for a week at each station so that the rate of TSE/EPS usage for different nights of a week, and different locations could be determined. Different points of view were collected from drivers, TSE/EPS system providers, truck stop/terminal owners (managers), and on site TSE/EPS representatives through several survey questionnaires at these stations. These surveys were designed to determine why TSE/EPS services were not working effectively and what incentives might be provided to drivers to increase the usage rate of these systems.

This study is organized as follows: Chapter 2 provides information about available truck stop and terminal facilities (e.g., TSE/EPS systems, shower, laundry, etc.) in all four stations equipped with TSE/EPS systems in the DFW area. Chapter 3 includes information about the structure of the survey questionnaires and survey procedures. Five survey questionnaires were designed to determine why TSE/EPS systems were ineffective and what incentives might be provided to

increase their usage rate. Furthermore, different questionnaires were designed to examine ways in which station and terminal owners (managers) could be incentivized to encourage drivers to use the systems and thereby increase the rate of usage. Chapter 4 provides results and detailed findings of the survey questionnaires. Finally, Chapter 5 presents conclusions and recommendations.

CHAPTER 2. FIELD DATA COLLECTION

A data collection sheet (Appendix A) was drafted and submitted to the NCTCOG staff for their review and comments. The data collection sheet was revised and finalized based on the comments and suggestions received from the NCTCOG staff. Upon NCTCOG technical approval, the research team started collecting field data by filling out the data collection sheet. Direct observation method was used for field data collection at stations to determine the TSE/EPS usage rates for different nights of a week.

2.1 TSE/EPS SYSTEMS IN THE DFW AREA

This study focuses on three public truck stops in the DFW area that are equipped with overnight parking TSE systems. It also focuses on a private truck terminal in the DFW area that are equipped with EPS. Table 2-1 shows the availability of TSE/EPS systems at each station. All four stations have single-system electrification systems; one also has a dual-system electrification system.

Table 2- 1 Availability of TSE/EPS systems at the stations

Station	TSE/EPS systems availability	
	Single-system Electrification	Dual-system Electrification
Station 1	✓	-
Station 2	✓	✓
Station 3	✓	-
Station 4	✓	-

TSE/EPS, adjusted TSE/EPS, and space utilization rates were calculated for each station based on the data collected during site visits. The TSE/EPS utilization rate indicates the ratio of number of connected trucks to the number of occupied spaces with TSE/EPS systems (Eq.1). The adjusted TSE/EPS utilization rate indicates the ratio of number of connected trucks to the number of occupied spaces with functional TSE/EPS systems (Eq.2). The space utilization rate also indicates the ratio of number of connected trucks to all available spaces (with TSE/EPS systems) (Eq.3).

$$\text{TSE/EPS Utilization Rate} = \frac{\text{Number of Connected Trucks}}{\text{Number of Occupied Spaces (with TSE/EPS Systems)}} \quad (\text{Eq.1})$$

$$\text{Adjusted TSE/EPS Utilization Rate} = \frac{\text{Number of Connected Trucks}}{\text{Number of Occupied Spaces (with Functional TSE/EPS Systems)}} \quad (\text{Eq.2})$$

$$\text{Space Utilization Rate} = \frac{\text{Number of Connected Trucks}}{\text{All Available Spaces (with TSE/EPS Systems)}} \quad (\text{Eq.3})$$

2.2 STATION 1

Figure 2-1 illustrates a satellite image of Station 1 and truck parking spaces (with and without TSE systems). This truck stop provides a dining area and a convenience store for truck drivers. In total, this station has 101 parking spaces, and 39 of them are equipped with single-system electrification systems. However, only 15 systems were functional at the time of data collection (data collected the summer of 2018). Table 2-2 shows the results of data collection at Station 1. Figure 2-2 illustrates the total number available spaces (with TSE systems), number of occupied spaces (with TSE systems), and number of connected trucks to TSE systems at the station during a week. Table 2-3 shows the TSE, adjusted TSE, and space utilization rates for this station during a week. On average, this station had 14 percent TSE utilization rate, 19 percent adjusted TSE utilization rate, and seven percent space utilization rate.

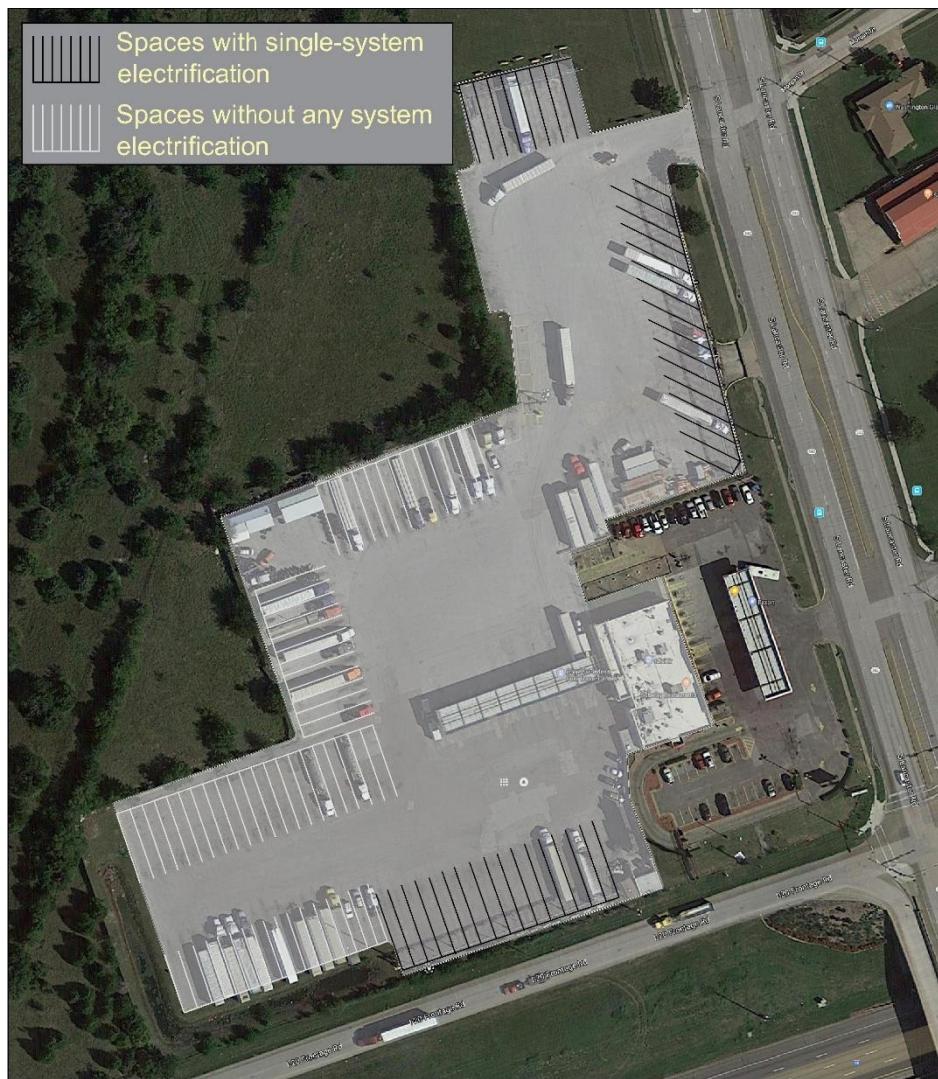


Figure 2- 1 Satellite image of Station 1

Table 2- 2 Data collection results at Station 1*

Items	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Parking Spaces with TSE Systems (Single-system Electrification)**							
Total Available Spaces	39	39	39	39	39	39	39
Occupied Spaces	17	24	17	18	18	24	35
Certified Clean Idle Trucks	12	16	11	11	13	17	24
Connected Trucks	4	2	3	4	2	1	4
Connected Certified Clean Idle Trucks	2	2	3	2	1	1	2
Parking Spaces without TSE Systems							
Total Available Spaces	62	62	62	62	62	62	62
Occupied Spaces	36	36	32	32	41	37	45
Certified Clean Idle Trucks	29	18	23	28	16	31	24

*All site visits were conducted at 11 pm.

** Only 15 TSE systems were functional at the time of data collection.

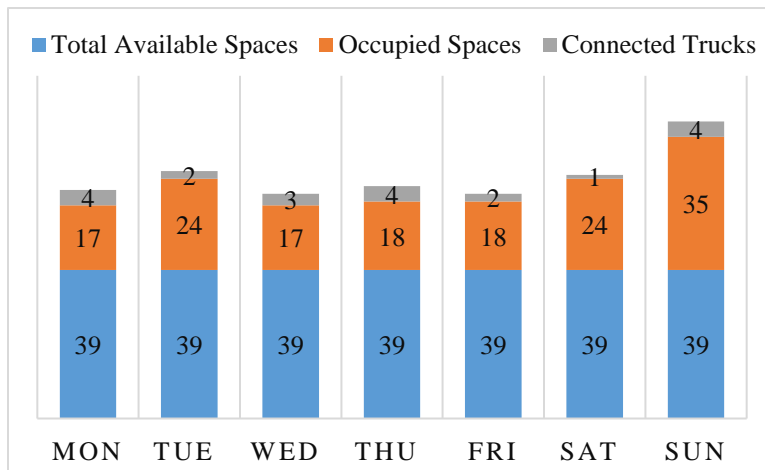


Figure 2- 2 Data collection results at Station 1 (Parking spaces with TSE systems)

Table 2- 3 TSE, adjusted TSE, and space utilization rates at Station 1

Usage Rates	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Weekly Average Rate
TSE Utilization Rate	24%	8%	18%	22%	11%	4%	11%	14%
Adjusted TSE Utilization Rate	27%	13%	20%	27%	13%	7%	27%	19%
Space Utilization Rate	10%	5%	8%	10%	5%	3%	10%	7%

2.3 STATION 2

Figure 2-3 illustrates a satellite image of Station 2, available truck parking spaces (with and without TSE systems), and the location of dual-system electrification pedestals. This station is the only truck stop equipped with both TSE systems in the DFW area. This truck stop provides several services including showers, a dining area, a convenience store, a laundry room, a rest area, a game room, and an ATM machine. In total, this station has 204 parking spaces; 54 spaces are equipped

with single-system electrification systems. However, only 42 TSE systems were functional at the time of data collection (data collected the summer of 2018). Table 2-4 shows the results of data collection at Station 2. Figure 2- 4 illustrates the total number available spaces (with TSE systems), number of occupied spaces (with TSE systems), and number of connected trucks to TSE systems at this station during a week. Table 2- 5 shows the TSE, adjusted TSE, and space utilization rates for single-system electrification systems at this station during a week. On average, this station had 37 percent TSE utilization rate, 44 percent adjusted TSE utilization rate, and 34 percent space utilization rate for single-system electrification systems. Moreover, this truck stop has three dual-system electrification pedestals that provide electric power for 12 trucks. All dual-system electrification systems were functional at the time of data collection. Table 2- 6 shows the TSE, adjusted TSE, and space utilization rates for dual-system electrification systems at this station during a week. The results of the data collection showed zero percent TSE utilization rate, zero percent adjusted TSE utilization rate, and space utilization rate for dual-system electrification systems at this station during data collection.



Figure 2- 3 Satellite image of Station 2

Table 2- 4 Data collection results at Station 2*

Items	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Parking Spaces with TSE Systems (Single-system Electrification)**							
Total Available Spaces	54	54	54	54	54	54	54
Occupied Spaces	47	53	51	51	49	52	53
Certified Clean Idle Trucks	33	47	34	34	32	37	35
Connected Trucks	23	14	23	21	22	9	17
Connected Certified Clean Idle Trucks	18	6	14	11	14	5	10
Parking Spaces without TSE Systems							
Total Available Spaces	150	150	150	150	150	150	150
Occupied Spaces	147	148	138	125	136	110	131
Certified Clean Idle Trucks	105	104	99	102	91	91	84

*All site visits were conducted at 11:30 pm.

**Only 42 TSE systems were functional at the time of data collection.

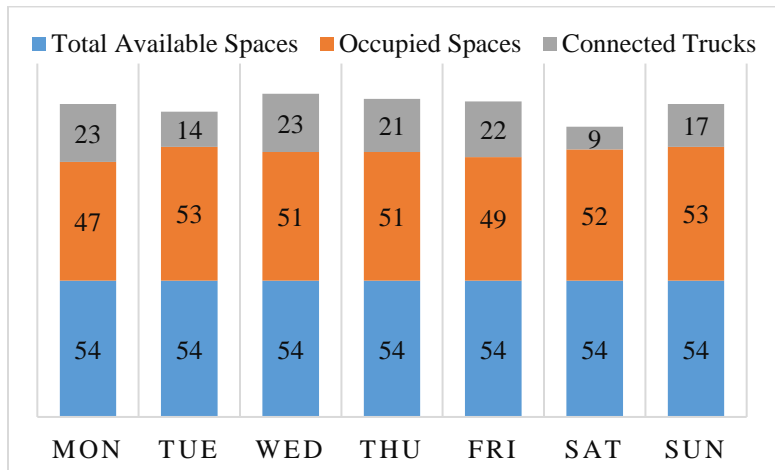


Figure 2- 4 Data collection results at Station 2 (Parking spaces with TSE systems)

Table 2- 5 TSE, adjusted TSE, and space utilization rates for single-system electrification systems at Station 2

Usage Rates	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Weekly Average Rate
TSE Utilization Rate	49%	26%	45%	41%	45%	17%	32%	37%
Adjusted TSE Utilization Rate	55%	33%	55%	50%	52%	21%	40%	44%
Space Utilization Rate	43%	26%	43%	39%	41%	17%	31%	34%

Table 2- 6 TSE, adjusted TSE, and space utilization rates for dual-system electrification systems at Station 2

Usage Rates	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Weekly Average Rate
EPS Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%
Adjusted EPS Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%
Space Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%

2.4 STATION 3

Figure 2-5 illustrates a satellite image of Station 3 and available truck parking spaces (with and without TSE systems). This station is one of the largest truck stops in the DFW area. This stop provides several services to truck drivers including showers, a laundry room, a convenience store, and a dining area. In total, 171 parking spaces are available in this truck stop. Seventy-six out of 171 parking spaces are equipped with single-system electrification systems. At the time of data collection (data collected the summer of 2018), power was shut off to all TSE systems so none of the TSE systems were functional. This was a truck stop operational decision to discontinue TSE availability while a parking space conflict was being resolved. Table 2-7 shows the results of data collection at Station 3. Figure 2-6 illustrates the total number available spaces (with TSE systems), number of occupied spaces (with TSE systems), and number of connected trucks to TSE systems at this station during a week. Table 2- 8 shows the TSE, adjusted TSE, and space utilization rates for this station during a week. This station had zero percent TSE utilization rate, zero percent adjusted TSE utilization rate, and zero percent space utilization rate.



Figure 2- 5 Satellite image of Station 3

Table 2- 7 Data collection results at Station 3*

Items	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Parking Spaces with TSE Systems (Single-system Electrification)**							
Total Available Spaces	76	76	76	76	76	76	76
Occupied Spaces	73	68	73	75	76	76	76
Certified Clean Idle Trucks	51	52	54	50	39	36	48
Connected Trucks	0	0	0	0	0	0	0
Connected Certified Clean Idle Trucks	0	0	0	0	0	0	0
Parking Spaces without TSE Systems							
Total Available Spaces	62	62	62	62	62	62	62
Occupied Spaces	36	36	32	32	41	37	45
Certified Clean Idle Trucks	29	18	23	28	16	31	24

*All site visits were conducted at 11:45 pm.

**None of the TSE systems were functional at the time of data collection.

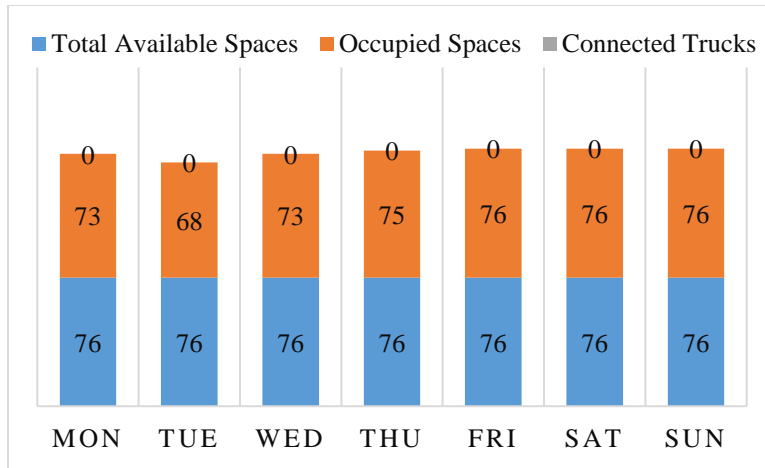


Figure 2- 6 Data collection results at Station 3 (Parking spaces with TSE systems)

Table 2- 8 TSE, adjusted TSE, and space utilization rates at Station 3

Usage Rates	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Weekly Average Rate
TSE Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%
Adjusted TSE Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%
Space Utilization Rate	0%	0%	0%	0%	0%	0%	0%	0%

2.5 STATION 4

Figure 2- 7 illustrates the satellite image of Station 4 and parking spaces (with and without EPS systems). This private truck terminal has several services including showers, a laundry room, a diet and health coaching service, a fitness room, and a full-service mechanic shop for both trucks and trailers. This station has 12 parking spaces equipped with single-system electrification systems. The station manager asks the drivers idling more than 5 minutes to turn off their engines. Table 2- 9 shows the results of data collection at Station 4. Figure 2- 8 illustrates the total number available spaces (with EPS systems), number of occupied spaces (with EPS systems), and number of connected trucks to TSE systems at this station during a week. Table 2- 10 shows the EPS, adjusted EPS, and space utilization rates for this station during a week. On average, this station had 100 percent EPS utilization rate, 100 percent adjusted EPS utilization rate, and 37 percent space utilization rate.



Figure 2- 7 Satellite image of Station 4

Table 2- 9 Data collection results at Station 4*

Items	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Electrified Parking Spaces (EPSs)**							
Total Available Spaces	12	12	12	12	12	12	12
Occupied Spaces	9	6	4	1	4	4	3
Certified Clean Idle Trucks	9	6	4	1	4	4	3
Connected Trucks	9	6	4	1	4	4	3
Connected Certified Clean Idle Trucks	9	6	4	1	4	4	3
Non-Electrified Parking Spaces (Non-EPSs)							
Total Available Spaces	25	25	25	25	25	25	25
Occupied Spaces	21	16	9	3	14	17	8
Certified Clean Idle Trucks	21	16	9	3	14	17	8

*All site visits were conducted at 11:00 am.

**All the EPSs systems were functional at the time of data collection.

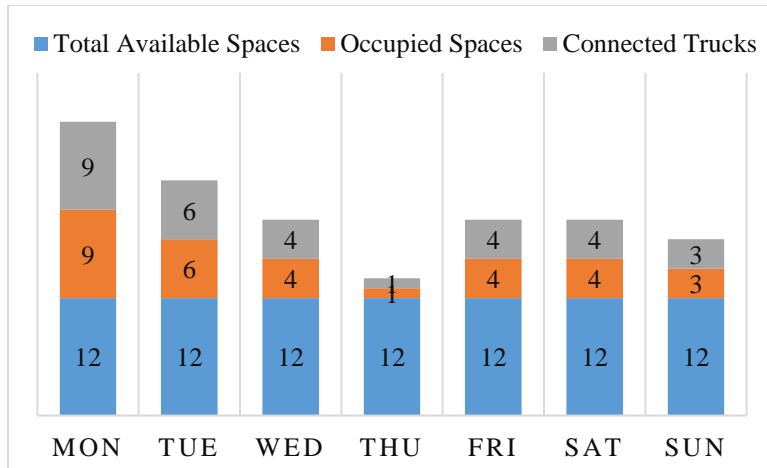


Figure 2- 8 Data collection results at Station 4 (Spaces with EPS systems)

Table 2- 10 EPS, adjusted EPS, and space utilization rates at Station 4

Usage Rates	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Weekly Average Rate
EPS Utilization Rate	100%	100%	100%	100%	100%	100%	100%	100%
Adjusted EPS Utilization Rate	100%	100%	100%	100%	100%	100%	100%	100%
Space Utilization Rate	75%	50%	33%	8%	33%	33%	25%	37%

CHAPTER 3. SURVEY DESIGN AND DISTRIBUTION

Five different survey questionnaires were designed to determine why TSE/EPS services are not working effectively and what incentives might be provided to increase the usage rate of TSE/EPS systems. Survey questionnaire targets were drivers idling their trucks, drivers using TSE/EPS systems, truck stop/terminal owners, TSE/EPS system providers, and TSE/EPS system representatives at truck stops/terminals. The survey drafts were submitted to the NCTCOG staff for their review and comments. The survey questionnaires were revised and finalized based on comments and suggestions received from the panel. Upon NCTCOG technical panel approval, the principal investigator (PI) of the project also acquired UTA Institutional Review Board (IRB) approval before conducting the survey. The research team used a paper-based survey questionnaire to conduct the survey. The final survey questionnaires are presented in Appendix B.

3.1 SURVEY QUESTIONNAIRE STRUCTURE

The survey questionnaires were designed to address the three research questions of the project: 1) what are common reasons for idling engines during rest periods while having access to the TSE/EPS services? 2) What are proper incentives for drivers to use TSE/EPS services, and 3) what are proper incentives for truck stop/terminal owners to encourage truck drivers to use TSE/EPS services? Five different questionnaires were distributed among: 1) truck drivers who let their trucks idle, 2) truck drivers who used TSE/EPS systems, 3) truck stop/terminal owners, 4) TSE/EPS system providers (two TSE/EPS system providers), and 5) on site TSE/EPS system representatives.

In the truck driver questionnaires, both survey questionnaires started with gathering general information on the date and time of the survey followed by questions on drivers' information, such as the number of team drivers, drivers' age, and their education level. The next set of questions collected information about the trucks, such as truck make, truck model, and truck make year, followed by questions related to travel information and drivers' preferences for idling or using TSE/EPS systems. In the questionnaires for TSE/EPS providers, questions were designed to capture the providers' points of view on TSE/EPS systems and possible incentives that can improve TSE/EPS usage rate. The research team met truck stop/terminal owners, distributed questionnaire among them, and collected information about their truck stop/terminal's services, especially regarding the available TSE/EPS systems on site, and their points of view on TSE/EPS systems and possible incentives. A final questionnaire was also filled by an on site representative to collect information about the truck stops/terminal and the TSE/EPS systems at each station.

3.2 STEP-BY-STEP SURVEY PROCEDURE

The research team coordinated with truck stop/terminal owners to get permission before starting the survey. Each interview was conducted by two members of the research team. The subjects (truck drivers) were recruited (direct person-to-person recruitment) using convenience sampling method (Saunders et al., 2007) at the truck stops. The team observed the subjects' truck to see if their trucks were connected to the TSE system to select the corresponding questionnaire. Then, a team member read a brief description of the project and its expected outcomes to each subject. The subjects were asked if they wanted to continue—that is, if they voluntarily agreed to participate in this research. After subjects' verbal approval, the team members continued with the survey by asking each subject the questions and by individually filling out the corresponding questionnaire for each participant. In general, drivers were willing to participate.

CHAPTER 4. SURVEY RESULTS

In total, 46 responses were collected from the surveys distributed between the subjects. These include 40 responses from drivers (20 drivers idling their trucks, and 20 drivers using TSE/EPS systems), two responses from TSE/EPS system providers, three responses from truck stop/terminal owners (or managers), and one response from an on site representative.

4.1 TRUCK DRIVERS IDLING THEIR TRUCKS OVERNIGHT

Twenty responses were collected from drivers who idle their trucks at overnight truck stops at Station 1 (3 responses) and Station 2 (17 responses). Figure 4-1 illustrates drivers' general information including their age, education, etc. Respondents were mostly company drivers (50 percent), and they were mostly single drivers (85 percent). They were also mostly high school or college graduates.

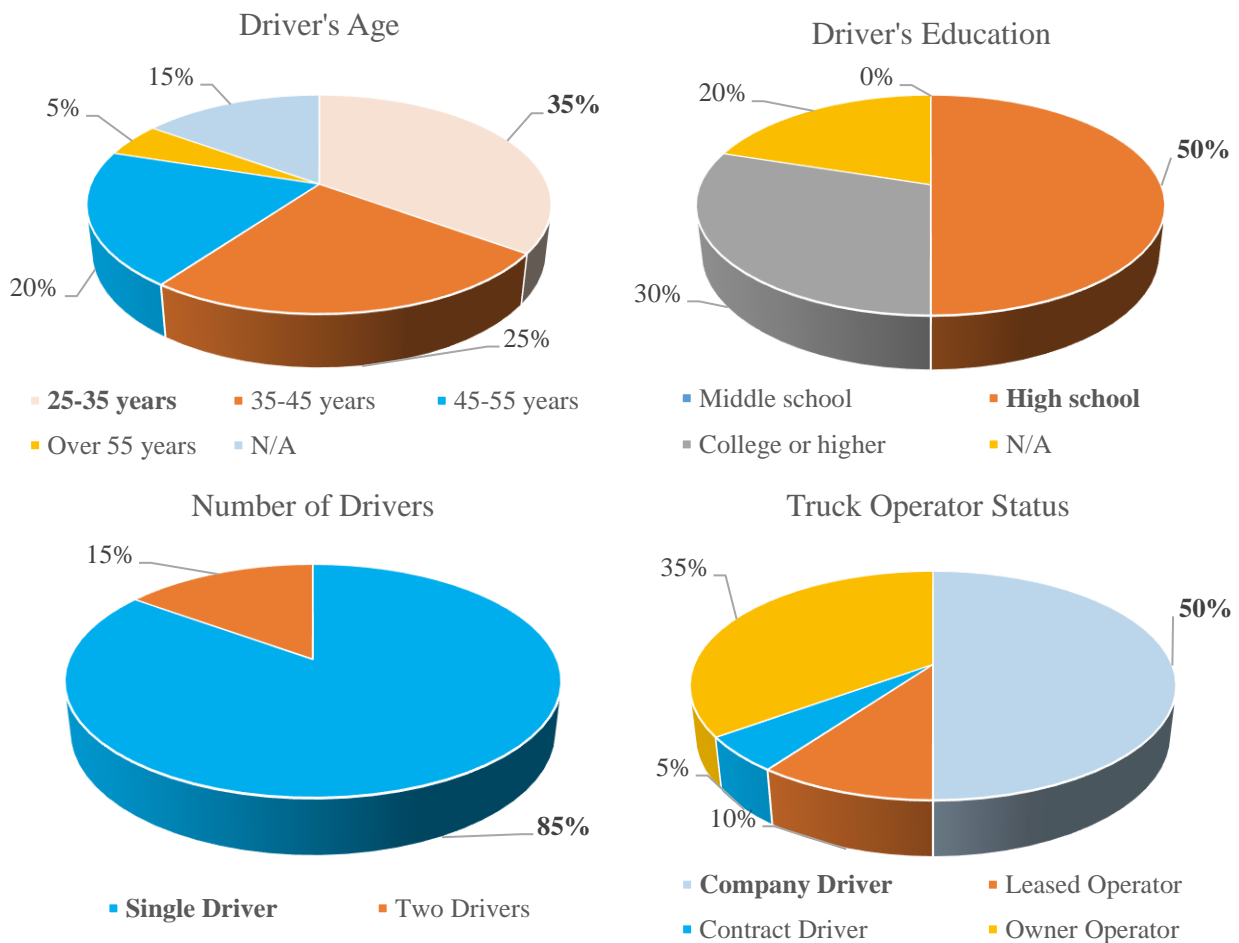


Figure 4- 1 General information of respondents who were idling their trucks at overnight truck stops

Figure 4-2 illustrates information on respondents' trucks. Eighty-five percent of the trucks were Certified Clean Idle, and 55 percent of them were equipped with APUs.

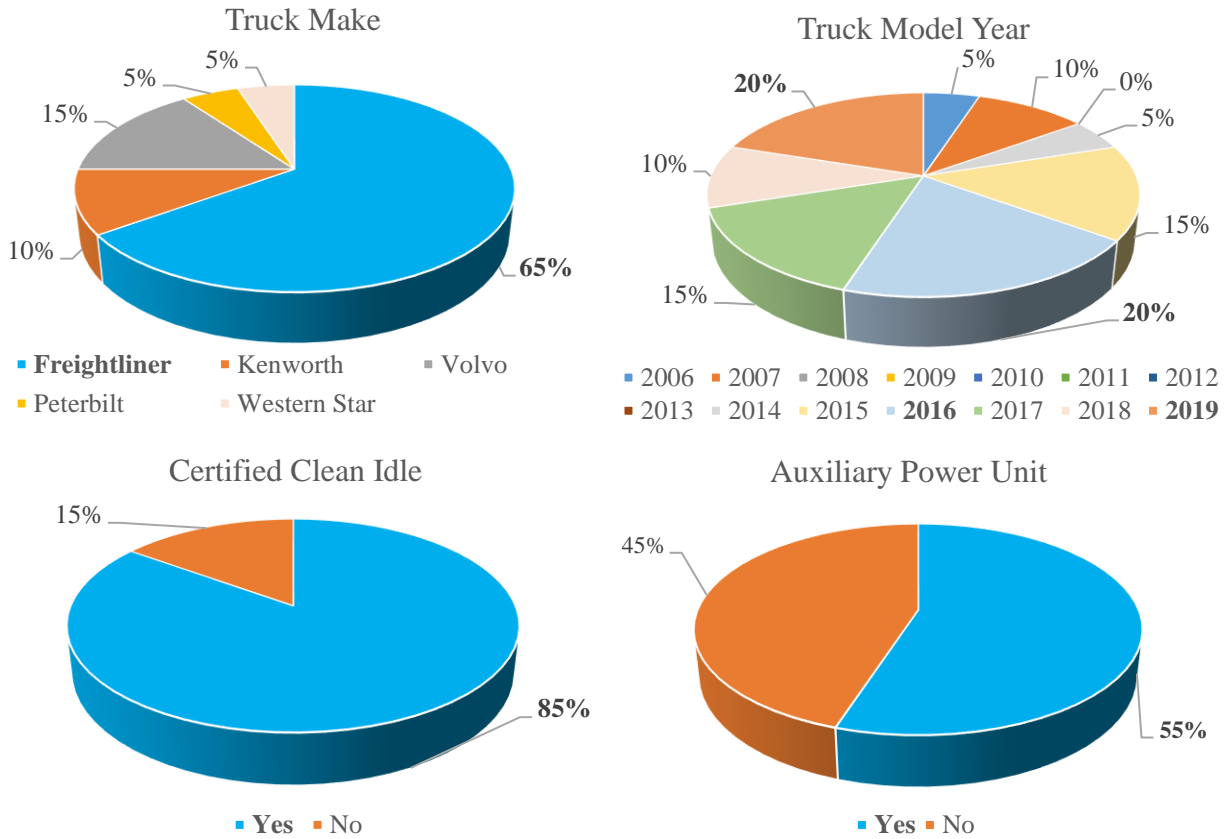


Figure 4- 2 Information on idling trucks

Figure 4-3 illustrates the drivers' choices for overnight parking. Seventy-five percent of the drivers selected truck stops for overnight parking. Twenty percent of them selected rest areas, and five percent of them selected roadside parking lots for overnight parking. They mostly idled their trucks less than 6 hours per day (50 percent) (Figure 4-4). Figure 4-5 illustrates the pattern of idling over a year among the respondents. The figure shows that about 55 percent of the truck drivers' idling pattern did not vary over the year.

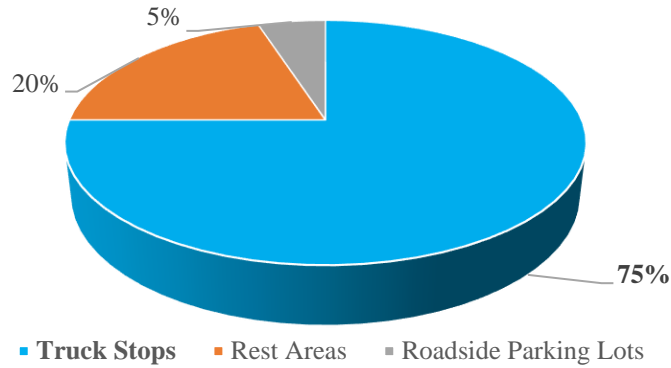


Figure 4- 3 Drivers' choices for overnight parking

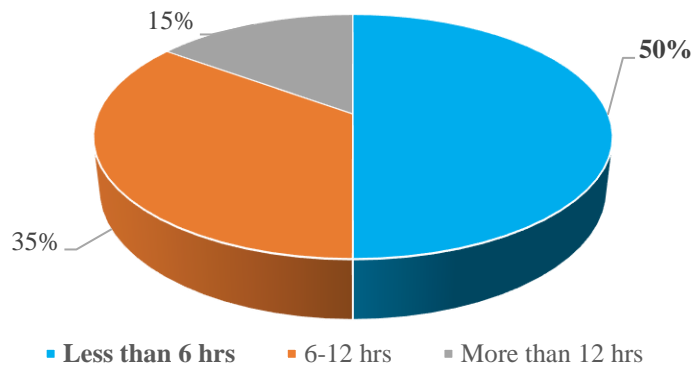


Figure 4- 4 Average idling time per day at truck stops

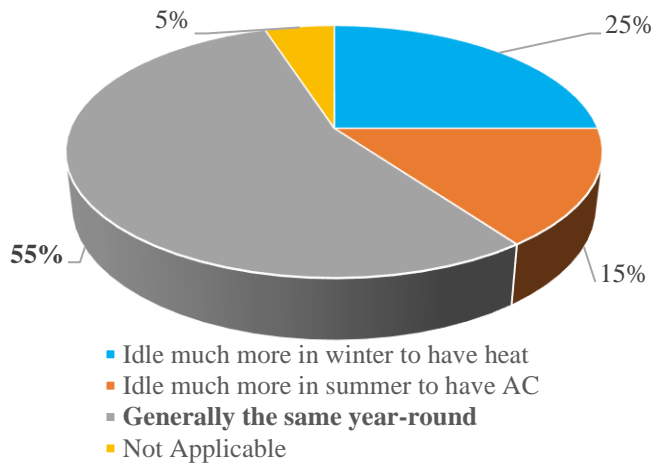


Figure 4- 5 Idling pattern over the year among drivers

The results showed that 80 percent of the respondents had heard about TSE/EPS systems before, and 70 percent of them were aware that the station had TSE/EPS systems. However, only 30 percent of them had ever used these systems in the past. The reasons drivers were reluctant to use TSE/EPS systems are illustrated in Figure 4-6. Twenty-nine percent of drivers selected “low-

quality service” (cigarette and diesel fume smell, broken screen, etc.) and “using an APU” as their most prominent reasons for not using TSE/EPS systems. Figure 4-7 illustrates the percentages of possible incentives selected by the drivers. The participants responded that providing coupons for shower and food, and a discount on diesel prices would be the best incentives to encourage drivers to use these systems.

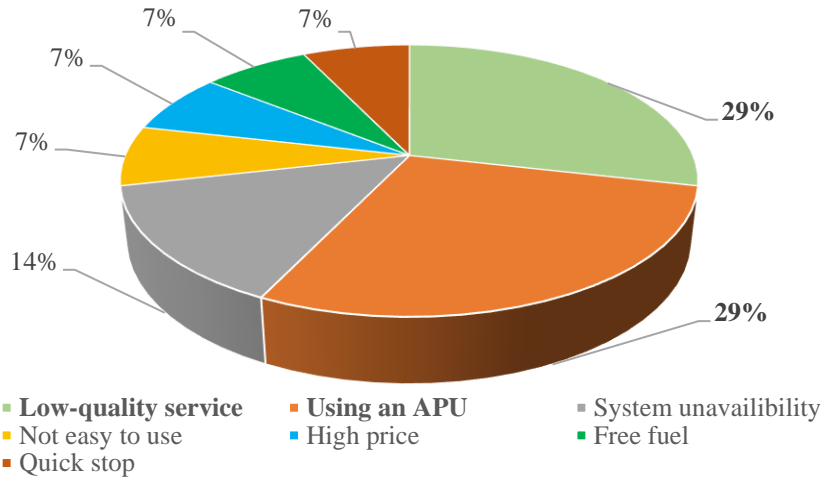


Figure 4- 6 Percentage of reasons drivers were reluctant to use TSE/EPS systems

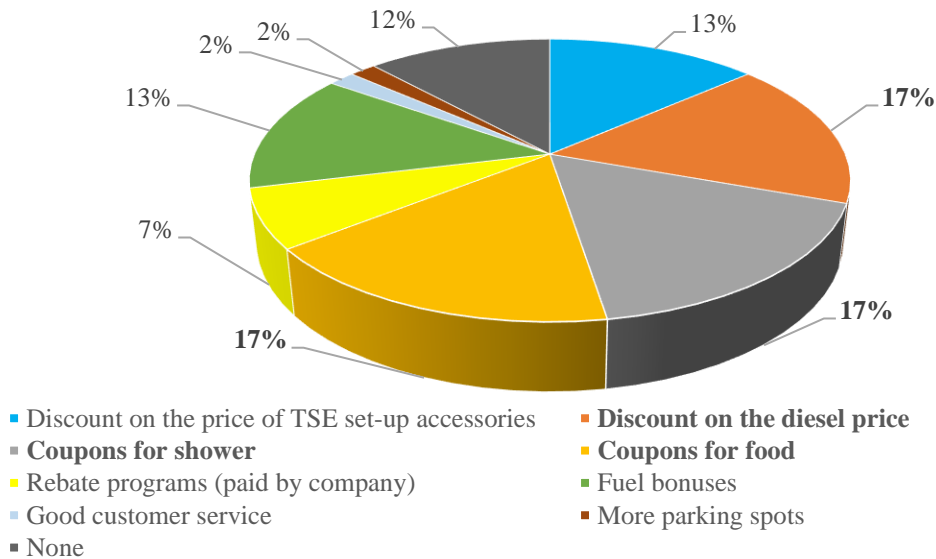


Figure 4- 7 Percentages of possible incentives to improve TSE/EPS usage rate (Selected by the drivers who idle their trucks)

4.2 TRUCK DRIVERS USING TSE/EPS SYSTEMS

Twenty responses were collected from drivers who were using TSE/EPS systems at Station 2 (17 responses) and Station 4 (3 responses). Figure 4-8 illustrates drivers' general information including their age, education, etc. Respondents were mostly owner operators (60 percent). They were mostly team drivers (two drivers). Their age was mostly between 45 and 55 years (55 percent), and they were mostly high school or college graduates.

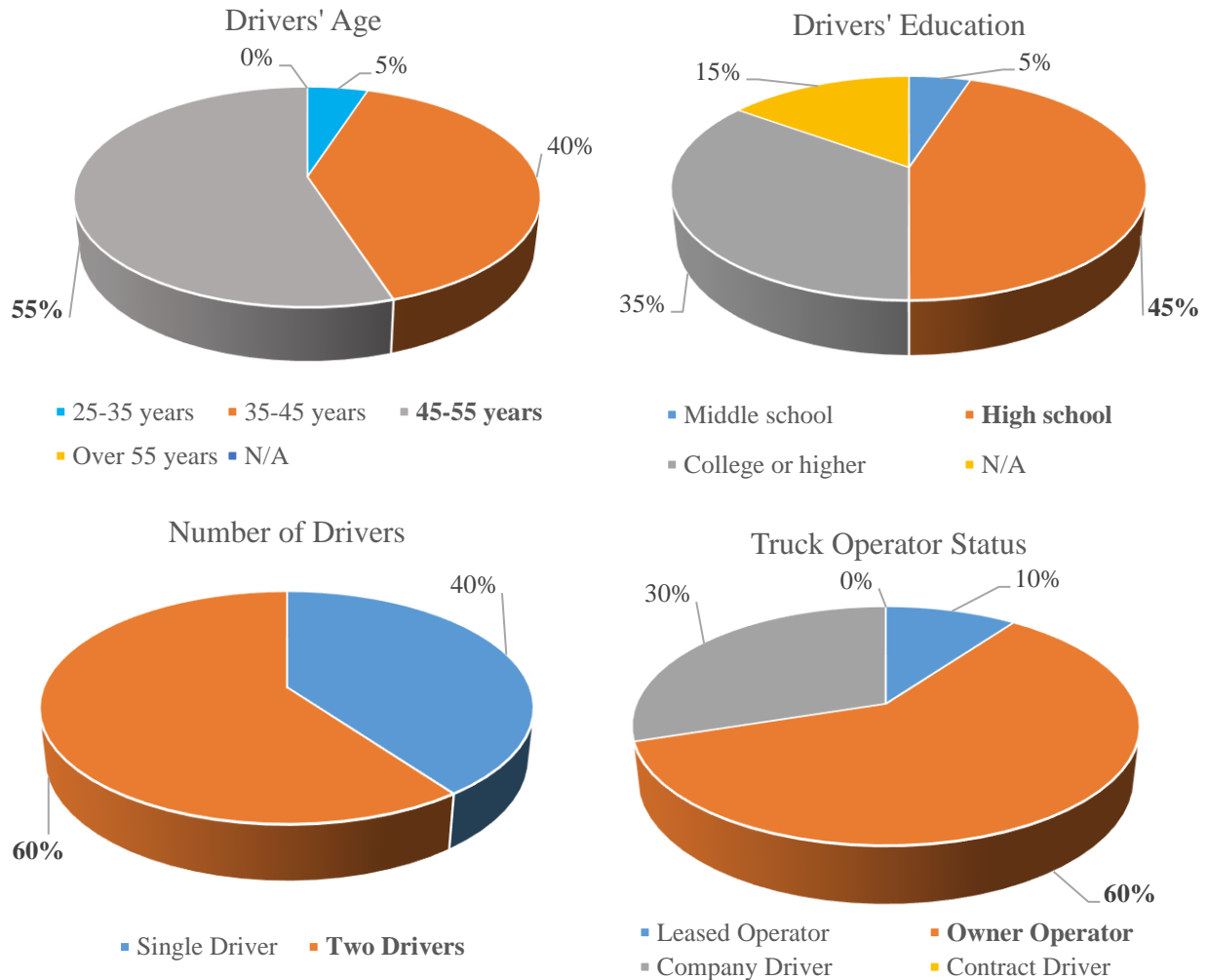


Figure 4- 8 General information of respondents who were using TSE/EPS systems at overnight truck stops

Figure 4-9 illustrates detailed information on trucks, which were connected to TSE/EPS systems. Ninety percent of the trucks were Certified Clean Idle. Only 40 percent of the trucks were equipped with APUs.

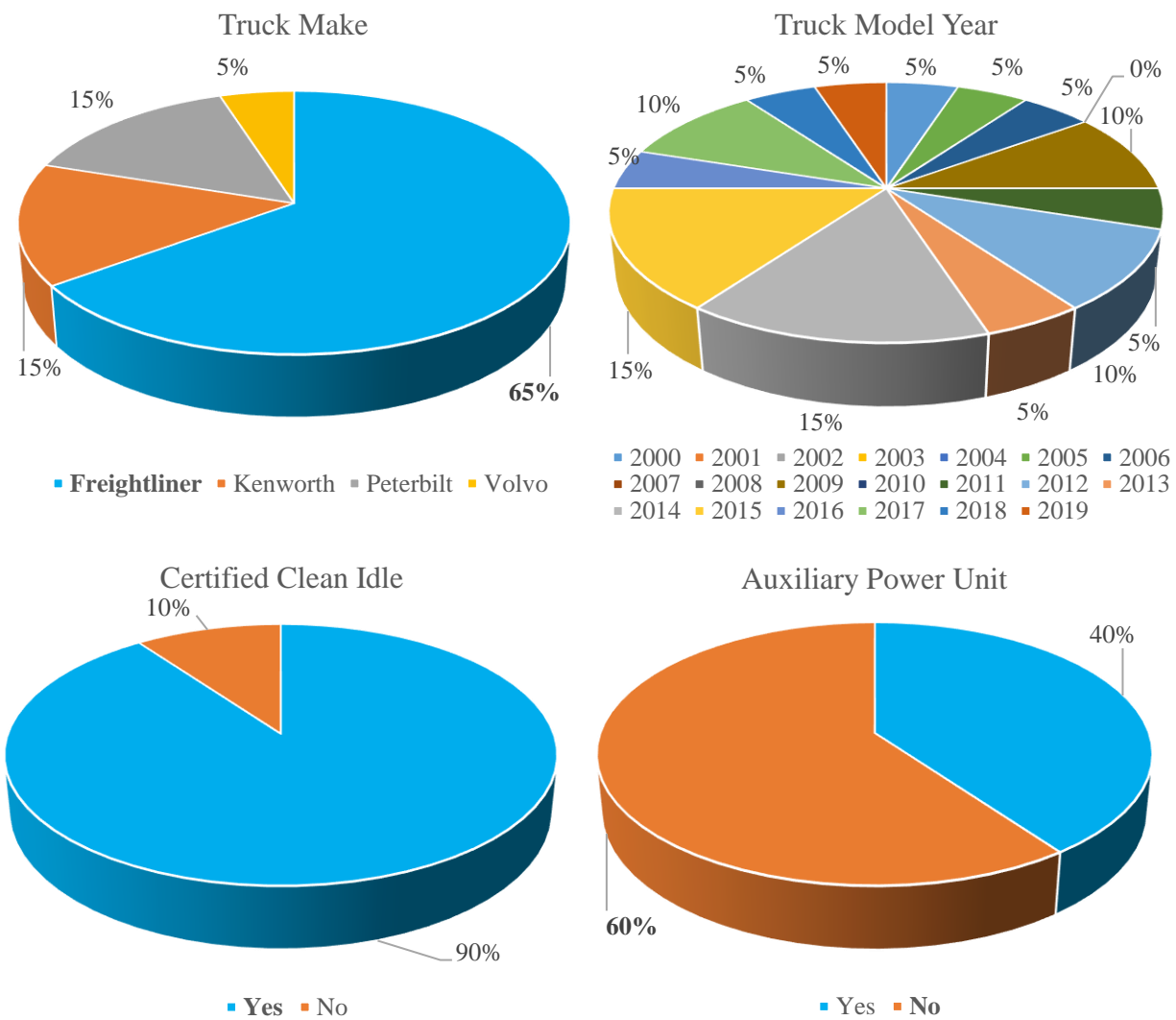


Figure 4- 9 Detailed information on trucks connected to TSE/EPS systems

The results of the survey showed that 58 percent of the drivers selected truck stops, 30 percent of them selected rest areas, and 12 percent of them selected company terminals for overnight parking (Figure 4-10). The respondents mentioned that they choose this station because of available facilities, such as showers, a laundry room, a food court, a resting area and availability of TSE/EPS systems.

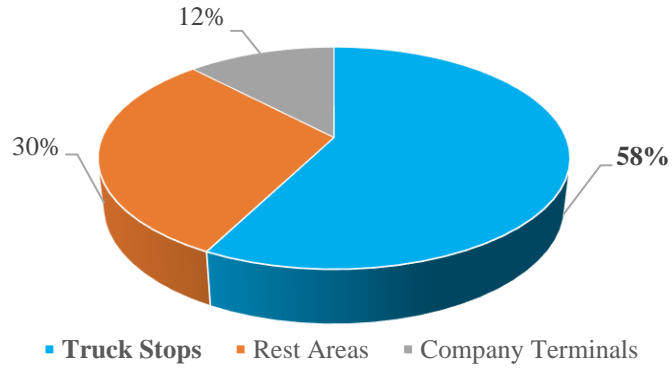


Figure 4- 10 Drivers' choices for overnight parking

The results of survey showed that 64 percent of drivers selected using single-system electrification systems and 20 percent of them selected dual-system electrification systems for controlling climate comfort inside their truck cabins (Figure 4-11). Sixty-five percent of drivers selected using TSE/EPS systems in hot summers (Figure 4-12). Figure 4-13 illustrates drivers' reasons (with percentages) for choosing the TSE/EPS systems over idling. They mostly use TSE/EPS systems for climate control inside the cabin (46 percent). Ninety percent of the drivers did not receive fuel bonuses, and 80 percent of them did not receive cost reimbursements from truck companies for TSE/EPS services.

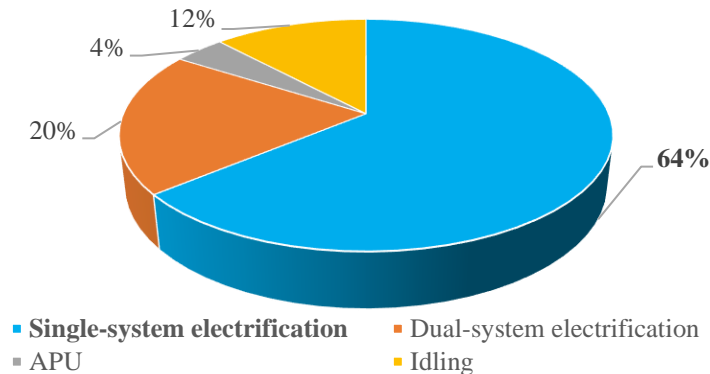


Figure 4- 11 Drivers' choices for climate control of truck cabin under single-system electrification, dual-system electrification, and APU

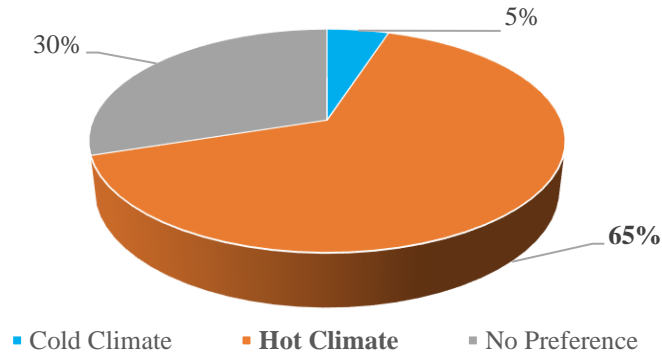


Figure 4- 12 Drivers’ choices for climate control of truck cabin under hot and cold climates or with no preference

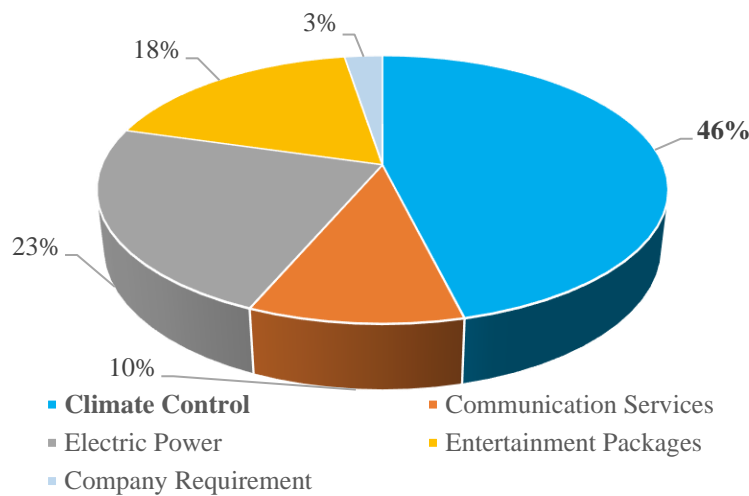


Figure 4- 13 Drivers’ reasons (percentages) for using TSE/EPS systems over APU and idling

Sixty-five percent of the drivers could not find any instructions available on site on how to connect the TSE/EPS system to their trucks (Figure 4-14). All respondents felt comfortable parking in the TSE/EPS designated spaces due to the parking space layout. Only 15 percent of drivers had used smartphone applications (Apps) or online services to obtain information about the TSE/EPS systems and their available locations. Figure 4-15 illustrates the percentage of drivers that preferred locations for having TSE/EPS systems. They mostly indicated that truck stops (44 percent) are the best locations for having TSE/EPS systems.

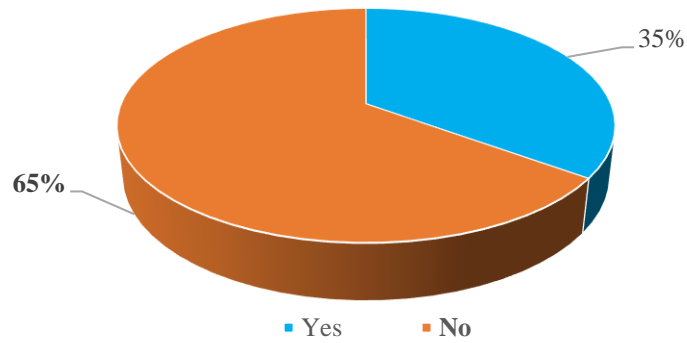


Figure 4- 14 Availability of instructions on site on how to connect TSE/EPS system to trucks

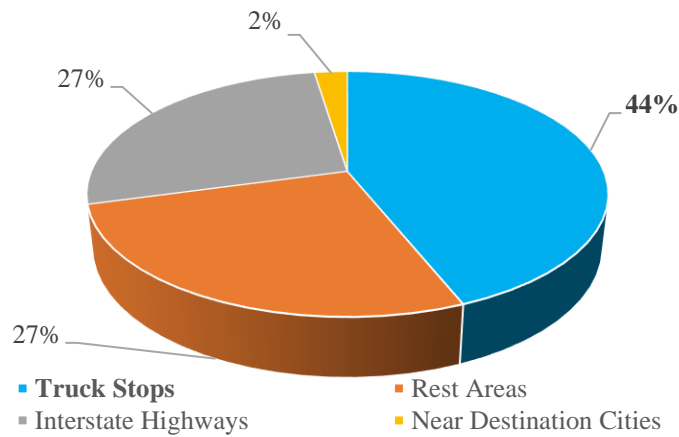


Figure 4- 15 Drivers' preferred locations (percentages) for having TSE/EPS systems

Figure 4-16 illustrates the percentages of possible incentives selected by the drivers using TSE/EPS systems. Respondents indicated that providing coupons for showers, TSE/EPS set-up accessories and discounts on diesel prices could be the best incentives to encourage drivers to use these systems.

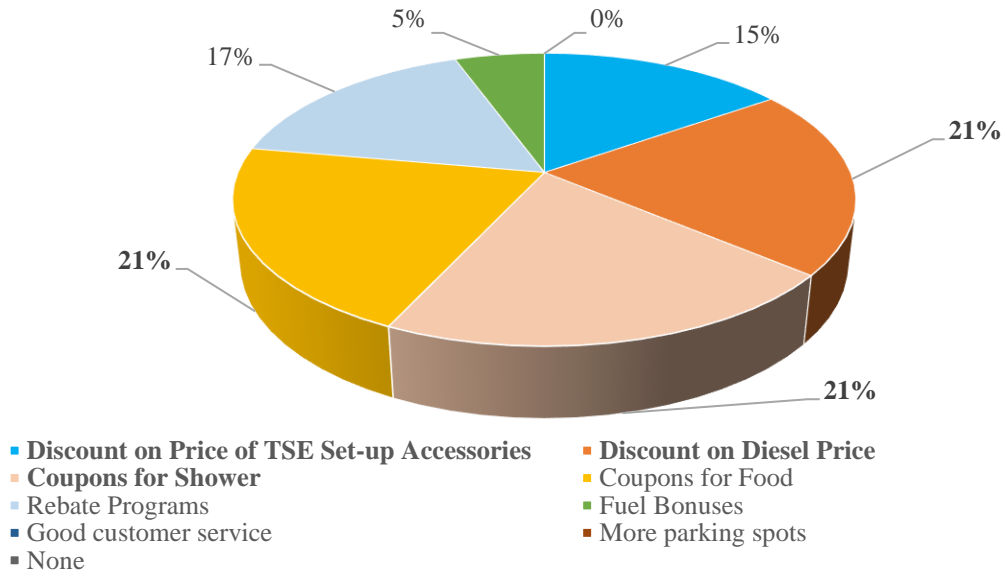


Figure 4- 16 Percentages of possible incentives to improve TSE/EPS usage rate (Selected by the drivers who use TSE/EPS systems)

4.3 TSE/EPS SYSTEM PROVIDERS

Two major TSE/EPS system providers (single and dual-system electrification systems) in the DFW area were interviewed for this study.

4.3.1 Type of Contract Agreement

Several types of contract agreements are used between the single-system electrification provider and truck stop/terminal owners, such as profit-share, revenue-share, fixed-rate, and leased space. On the other hand, revenue-share is the only type of agreement between the dual-system electrification provider and truck stop/terminal owners.

4.3.2 Most Frequently Asked Questions from Truck Stop/Terminal Owners (Managers)

The most important concerns of the truck stop/terminal owners (managers) regarding TSE/EPS systems were the amount of revenue they expect to get from TSE/EPS systems and the parking spaces (layout) required to install the TSE/EPS equipment.

4.3.3 Feedback from Truck Stop/Terminal Owners (Managers) about TSE/EPS Systems

Truck stop/terminal owners (managers) indicated that dangled equipment does not look aesthetically pleasing. They stated that they did not earn as much money as they expected from TSE/EPS systems. However, truck stop/terminal owners (managers) are satisfied with safety, lighting, and camera surveillance due to the presence of TSE/EPS staff on site.

4.3.4 Complaints from Drivers Regarding TSE/EPS Systems

Noise, smell, and vibration made by trucks idling next to the trucks using TSE/EPS systems are the most prominent complaints that TSE/EPS system providers have heard from drivers. Also, system unavailability is another issue that drivers are faced with. The latter problem has been an issue for single-system electrification provider. Truck drivers have also reported a cigarette smoke and diesel fume smell from single-system electrification systems.

4.3.5 Feedback from Truck Drivers about TSE/EPS Systems

Truck drivers indicated that not enough parking spaces were available in the DFW area.

4.3.6 Incentives for Drivers Who Use TSE/EPS Systems

TSE/EPS Providers offer different incentives to drivers for improving TSE/EPS usage rate. Single-system electrification provider offers reward points and discounts on service costs. Dual-system electrification provider offers free hours, first-time use discount, and half price for more than 10 hours of usage. Both providers also indicated that providing more incentives will result in an increase in the usage rate. However, they also indicated that their narrow profit margin limits the possibility of offering more incentives.

4.3.7 Policy Preventing Idling in Spaces Designated For TSE/EPS Systems

Although towing warning signs are available on site at truck stops, the towing is not enforced to prevent idling in the designated spaces.

4.3.8 Effectiveness of TSE/EPS Systems in Reducing Air Pollution

Both providers indicated that using TSE/EPS systems is an effective solution for reducing air pollution in general, and especially in the DFW area. However, providers indicated that their systems become less competitive with APUs and idling due to the decreases in diesel price in the last five years.

4.3.9 Suggestions for Reducing Idling at Truck Stops/Terminals

TSE/EPS providers suggest having quiet zones at truck stops that can reduce complaints from drivers using TSE/EPS systems. They also think that involving fleet terminals can improve the usage rate tremendously since managing fleet terminals are much easier than public truck stops.

4.3.10 Expectations from Local Agencies

TSE/EPS providers expect more support from local agencies such as city, county, and even state administrations by increasing awareness among drivers about the benefits of using TSE/EPS systems through campaigns, educational demonstrations and programs, and more outreach, as well as by offering incentives to reduce the service cost.

4.3.11 General Comments or Suggestions about TSE/EPS Systems

TSE/EPS system providers indicated that most company drivers are not as concerned about idling and wasting fuel since the companies pay their fuel cost. There are several large fleets; most of drivers are fleet drivers. Therefore, involving fleet companies can help force drivers not to idle and use alternative options for overnight parking, such as using TSE/EPS systems or APUs.

Face-to-face discussion with drivers and educate them about the benefits of TSE/EPS systems is the key to the success of these systems. TSE/EPS providers need resources to go out and talk with drivers about the cost of idling. In this regard, marketing campaigns can be effective in helping to educate drivers.

It is expensive to manage TSE/EPS designated spaces since it needs more staff (narrow profit margin causes TSE/EPS providers to use a light staffing model). Truck stop/terminal owners can help TSE/EPS providers in controlling idling same as terminals by enforcing policies that prohibit idling.

4.4 TRUCK STOP/TERMINAL OWNERS (MANAGERS)

At the time of the survey, no TSE systems were available at Station 3. Therefore, only two truck stop managers and one terminal manager were interviewed at Station 1, 2, and 4.

4.4.1 Amount of Truck Idling at Truck Stops/Terminal

Different patterns of idling have been reported by the managers for these three stations. The rate of idling was high, average, and low for Station 1, 2, and 4, respectively.

4.4.2 TSE/EPS Usage Rate at Truck Stops

The TSE utilization rate was high at Station 2 and 4, but it was low at Station 1.

4.4.3 Effectiveness of TSE/EPS Systems in Reducing Truck Idling

All the truck stop/terminal managers indicated that using TSE/EPS systems are an effective solution for reducing truck idling.

4.4.4 Possible Incentives for Motivating Truck Stop/Terminal Owners (Managers)

All the managers indicated that financial incentives and recognition by local agencies like cities can motivate truck stop/terminal owners (managers) to equip their truck stop/terminal with these systems. They also think that having TSE/EPS systems at truck stops/terminals increases the security of truck stops/terminals that can motivate owners (managers) to have them installed in their truck parking areas.

4.4.5 Complaints from Drivers Regarding TSE/EPS Systems

The most prominent complaint that truck stop owners (managers) received from drivers regarding TSE/EPS systems was unavailability of TSE systems. Most of the time, trucks that are idling park at spaces equipped with TSE/EPS systems and block TSE/EPS users' access to these systems. The second major area of concern was the TSE/EPS system's complexity of installation.

4.4.6 Solving Idling Problems by Adding More Spaces Equipped with TSE/EPS Systems

Truck stop/terminal managers indicated that TSE/EPS usage rate is higher during the summer and having more spaces equipped with TSE/EPS systems can increase the usage rate. According to the managers, there are enough TSE/EPS systems at Station 1 and 4. However, more spaces were deemed necessary at Station 2, since this is where the most complaints about TSE/EPS unavailability came from.

4.4.7 Suggestions for Increasing Usage Rate of TSE/EPS Systems

Managers suggested designing a mechanism to force drivers not to idle in TSE/EPS designated spaces and to provide large and informative signage to guide drivers on how to install the system.

4.4.8 General Comments or Suggestions about TSE/EPS Systems

All the managers indicated that TSE/EPS systems are effective in reducing air pollution, but they need to be supported by governmental agencies. Having staff on site can improve the usage rate.

4.5 ON SITE TSE/EPS SYSTEMS' REPRESENTATIVE

Only one on site representative was responsible for all the TSE/EPS systems in the DFW area. This section summarizes the results of interview with this on site representative who was personally working at all of the stations studied in this research.

4.5.1 Available TSE/EPS Systems at Stations

Table 4-1 shows the available systems at each station.

Table 4- 1 Available TSE/EPS systems at Stations

Stations	Number of spaces equipped with TSE/EPS System	Number of functional TSE/EPS Systems
Station 1	39	15
Station 2	54	42
Station 3	76	0*
Station 4	12	12

*All the TSE systems were shut down due to the truck stop owner's operational decision.

4.5.2 Complaints from Drivers Regarding TSE/EPS Systems

System malfunctioning (e.g., module screen damage) was the main complaint drivers had about the TSE/EPS systems.

4.5.3 Policy Preventing Idling in Spaces Designated For TSE/EPS Systems

Although towing warning signs are available on site at truck stops, the towing is not enforced to prevent drivers not to idle in the designated spaces.

4.5.4 Availability of Window Adapters

Window adapters are reusable plastic fillers that are used to fill the gaps between the truck windows and the TSE/EPS modules where the TSE/EPS modules are connected to the trucks. Enough window adapters (with different sizes and shapes) are available at each station.

4.5.5 TSE/EPS Usage Rate

The representative indicated that generally, the usage rate is low, and the main reason for the low usage rate is drivers' unawareness about the benefits of using a TSE/EPS system. This can be solved by a face-to-face discussion with drivers about TSE/EPS systems and their benefits.

4.5.6 Suggestions for Reducing Idling in Truck Stops

Having quiet zones can help reduce idling in TSE/EPS designated spaces.

4.5.7 General Comments or Suggestions Regarding TSE/EPS Systems

Operation expenses are high, and narrow profit margins limit the possibility of having on site representative at truck stops/terminals.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The filed data collection showed that TSE/EPS systems were not working effectively. The results also showed different engine idling rates and TSE/EPS usage rates among the four stations. The results showed that stations like Station 4 where terminal truck EPSs are controlled by a manager or a representative had a higher usage rate compared to the other stations without any control. Based on the survey results, single drivers often idle their trucks more than team drivers.

Based on the survey results, “low-quality service” (cigarette and diesel fume smell, broken screen, etc.) and “using an APU” are the major reasons that drivers are reluctant to use TSE/EPS systems for controlling cabin climate. Moreover, connecting TSE/EPS systems to trucks is complicated and difficult to execute due to heavy modules; moreover, on site provider representatives are seldom available on site to help drivers with this problem. Most truckers prefer discounts on TSE/EPS set-up accessories and diesel price, as well as other monetary incentives like coupons for the shower, food.

Truck stop/terminal owners are mostly concerned about the amount of profit that they can earn from TSE/EPS systems; therefore, one way to motivate them is to offer them fixed-rate revenues. Based on the TSE/EPS providers’ points of view, education is the key to the success of TSE/EPS systems. Disseminating the knowledge about the advantages of using TSE/EPS systems among drivers-especially face-to-face discussions, through demonstrations and educational programs or on site assistance can be a promising solution. It is also critical to support TSE/EPS providers to upgrade and enhance TSE/EPS technology to improve service quality by eliminating the cigarette and diesel fume smell from the systems, designing light-weight TSE/EPS systems, and improving entertainment services. There is also a need to integrate TSE/EPS systems with renewable energy systems to provide electricity for lowering TSE/EPS operation costs that can lead to provide TSE/EPS services for drivers with lower cost.

5.2 RECOMMENDATIONS

Several recommendations have been proposed to improve the usage rate of TSE/EPS systems in the DFW area. These recommendations are as follows:

- 1- Design a bundled discount for truck drivers that includes TSE/EPS services along with other services, such as showers, and food;
- 2- Design large and informative signage that shows drivers how to use TSE/EPS systems. The signs should also provide a list of incentives and mention the available TSE/EPS system spaces in the area;
- 3- Design quiet zones at truck stops and support them through enforcement;
- 4- Conduct educational demonstration at truck stops/terminals to show the advantages of using

TSE/EPS systems to truck stop/terminal owners and drivers, and educate drivers how to connect the systems to their trucks;

- 5- Integrate educational programs with truck company driver training courses; and
- 6- Communicate with trucking companies and terminals to motivate them to deploy EPS systems at their terminals.

Further research and investigations are needed to determine truck idling rate and its variation in truck stops in different time of a year. Further research is also required to investigate truck idling problem in truck stops that are not equipped with TSE systems to determine truck idling rate at DFW area in general.

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APPENDIX A – DATA COLLECTION SHEET

<p>General Information</p> <p>Date: _____ Time: _____ Day: Mon <input type="checkbox"/> Tue <input type="checkbox"/> Wed <input type="checkbox"/> Thu <input type="checkbox"/> Fri <input type="checkbox"/> Sat <input type="checkbox"/> Sun <input type="checkbox"/></p> <p>Temperature: _____ Humidity _____</p> <p>Name of Surveyor (s): _____</p>
<p>Truck Stop Station</p> <p>Station ID: _____</p> <p>Station Name: _____</p> <p>TSE Type: _____</p> <p>Address: _____</p> <p>Available Facilities at Station: Truck Wash <input type="checkbox"/> Motel/Sleeping Rooms <input type="checkbox"/> Convenient Store <input type="checkbox"/></p> <p>Dining Area <input type="checkbox"/> Showers <input type="checkbox"/> Computer/Online Services/Ports <input type="checkbox"/> Others: _____</p> <p>Diesel Price: _____</p> <p>TSE Price: _____</p> <p>Visible Signage Showing that TSE Parking is Available: Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>Visible Usage Rates: Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>TSE Representative on Site: Yes <input type="checkbox"/> No <input type="checkbox"/></p>

Items	Spaces with TSE System	Spaces without TSE System
Number of Available Spaces		
Number of Occupied Spaces		
Number of Trucks Connected to TSE System		
Number of Certified Clean Idle Trucks		
Number of Certified Clean Idle Trucks Connected to TSE System		

Additional Comments:

APPENDIX B - SURVEY QUESTIONNAIRE

Truck Drivers Idling

General Information	
Date: _____	Time: _____ Day: Mon <input type="checkbox"/> Tue <input type="checkbox"/> Wed <input type="checkbox"/> Thu <input type="checkbox"/> Fri <input type="checkbox"/> Sat <input type="checkbox"/> Sun <input type="checkbox"/>
Driver Information	
Number of team drivers: _____	
Driver's Age:	25-35 years <input type="checkbox"/> 35-45 years <input type="checkbox"/> 45-55 years <input type="checkbox"/> Over 55 years <input type="checkbox"/>
Driver's education:	Primary school <input type="checkbox"/> Middle school <input type="checkbox"/> High school <input type="checkbox"/> College or higher <input type="checkbox"/>
Truck Information	
Make: _____	Model: _____ Year: _____
Truck operator status:	Owner operator <input type="checkbox"/> Leased operator <input type="checkbox"/> Company driver <input type="checkbox"/>
Sleeper:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Certified Clean Idle:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Auxiliary Power Unit (APUs):	Yes <input type="checkbox"/> No <input type="checkbox"/>
Refrigerator unit:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Travel Information	
1. How many nights on average do you spend on the road each year? _____	
2. Where do you usually park for the night?	
<input type="checkbox"/> Company terminal	
<input type="checkbox"/> Shipper-Receiver	
<input type="checkbox"/> Rest Areas	
<input type="checkbox"/> Truck Stops	
<input type="checkbox"/> Other, please specify: _____	
3. On average, how long do you idle your truck per day?	
<input type="checkbox"/> Less than six hrs.	
<input type="checkbox"/> 6 to 12 hrs.	
<input type="checkbox"/> More than 12 hrs.	
4. How does your idling vary over the year?	
<input type="checkbox"/> Generally the same year-round	
<input type="checkbox"/> Idle much more in summer to have AC	
<input type="checkbox"/> Idle much more in winter to have heat	
<input type="checkbox"/> Other, please specify: _____	
5. Do you own an Auxiliary Power Unit? <input type="checkbox"/> Yes <input type="checkbox"/> No	
If yes, on average, how long do you idle your truck every day?	
<input type="checkbox"/> Less than six hrs.	
<input type="checkbox"/> 6 to 12 hrs.	
<input type="checkbox"/> Over 12 hrs.	
6. Does your company offer you a fuel bonus?	
<input type="checkbox"/> Yes	

No

7. Have you ever heard about truck stop electrification (TSE)/ electrified parking spaces (EPS) services?

Yes

No

If yes, have you ever used these services before?

Yes

No

If yes, did you find them beneficial?

Yes, explain why: _____

No, explain why not: _____

8. Were you aware that truck stop electrification services are available at this facility?

Yes

No

If yes, what are your reasons for **not** using such services at this facility? Select all if apply:

High price

Not easy to use

Low-quality services

Unavailable vacant system

Unavailable TSE/EPS systems in most of the routes

Other, please specify: _____

9. What incentives could motivate you to use TSE/EPS systems instead of idling?

Discount on the price of TSE/EPS set-up accessories, such as extension cords, portable fan heaters, and outlet power strips

Discount on the diesel price

Coupons for shower

Coupons for food

Rebate programs (paid by company)

Fuel bonuses

Other , please specify: _____

10. Please write any general comments or suggestions about TSE/EPS systems.

Truck Drivers Using TSE/EPS Systems

General Information	
Date: _____	Time: _____ Day: Mon <input type="checkbox"/> Tue <input type="checkbox"/> Wed <input type="checkbox"/> Thu <input type="checkbox"/> Fri <input type="checkbox"/> Sat <input type="checkbox"/> Sun <input type="checkbox"/>
Driver Information	
Number of team drivers: _____	
Driver's Age: 25-35 years <input type="checkbox"/> 35-45 years <input type="checkbox"/> 45-55 years <input type="checkbox"/> Over 55 years <input type="checkbox"/>	
Driver's education: Primary school <input type="checkbox"/> Middle school <input type="checkbox"/> High school <input type="checkbox"/> College or higher <input type="checkbox"/>	
Truck Information	
Make: _____	Model: _____ Year: _____
Truck operator status:	Owner operator <input type="checkbox"/> Leased operator <input type="checkbox"/> Company driver <input type="checkbox"/>
Sleeper:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Certified Clean Idle:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Auxiliary Power Unit (APUs):	Yes <input type="checkbox"/> No <input type="checkbox"/>
Refrigerator unit:	Yes <input type="checkbox"/> No <input type="checkbox"/>
Travel Information	
11. How many nights on average do you spend on the road each year? _____	
12. Where do you usually park for the night?	
<input type="checkbox"/> Company terminal <input type="checkbox"/> Shipper-Receiver <input type="checkbox"/> Rest Area <input type="checkbox"/> Truck Stop <input type="checkbox"/> Other, please specify: _____	
13. What are your reasons for selecting this truck stop for overnight stop? Select all if apply.	
<input type="checkbox"/> For having TSE/EPS systems <input type="checkbox"/> For having food court <input type="checkbox"/> For having resting area <input type="checkbox"/> For having laundry <input type="checkbox"/> For having shower <input type="checkbox"/> Other, please specify: _____	
14. What is your preference for controlling climate comfort inside your truck cabin?	
<input type="checkbox"/> Dual-system electrification <input type="checkbox"/> Single-system electrification <input type="checkbox"/> Idling the truck instead of using TSE/EPS services <input type="checkbox"/> Other, please specify: _____	
15. Does this preference change throughout the year?	
<input type="checkbox"/> Use TSE/EPS more when it's hot outside <input type="checkbox"/> Use TSE/EPS more when it's cold outside <input type="checkbox"/> Use TSE/EPS consistently regardless of weather conditions <input type="checkbox"/> Other, please specify: _____	
16. Do you own an Auxiliary Power Unit? <input type="checkbox"/> Yes <input type="checkbox"/> No	
If yes, why are you choosing to use the TSE/EPS system?	
<input type="checkbox"/> APU doesn't work <input type="checkbox"/> Prefer TSE/EPS to APU, why? please specify: _____ <input type="checkbox"/> Other, please specify: _____	
17. Does your company offer you a fuel bonus?	
<input type="checkbox"/> Yes	

- No
- If yes, would you try using TSE/EPS systems even **without** a fuel bonus? Yes No

18. Does your company pay for TSE/EPS Services?

- Yes
- No
- If yes, would you use TSE/EPS services even **without** rebate program? Yes No

19. Select top two reasons for using TSE/EPS systems:

- Requirement/policy of company
- Rebate by company
- Fuel bonus
- Less noise, vibration, and fumes
- Climate control (cooling, heating, and air conditioning)
- Entertainment packages (TV Channels)
- Communication services (high-speed Internet and WiFi)
- Electric power
- Other, please specify: _____

20. Is any instruction available on site on how to connect TSE/EPS systems to trucks?

- Yes
- No
- If yes, is it easy to follow? Yes No

21. Is it comfortable for you to park in the TSE/EPS designated spaces? Yes No

22. Have you ever used any smartphone applications (Apps) or online services to obtain information about the TSE/EPS systems and their locations? Yes No

23. Which locations are the best for having TSE/EPS systems?

- Interstates
- Near destination dock
- Near destination city
- Truck stops
- Rest stops
- Other diesel stations that are not truck stops
- Others, please specify: _____

24. What incentives could motivate drivers to use TSE/EPS systems instead of idling?

- Discount on TSE/EPS set-up accessories, such as extension cord, portable fan heater, and outlet power strip
- Discount on diesel price
- Coupons for shower
- Coupons for food
- Rebate programs
- Other , please specify: _____

25. Please write any general comments or suggestions about TSE/EPS systems:

Truck Stop/Terminal Owners (Managers)

General Information

Date: _____ Time: _____ Day: Mon Tue Wed Thu Fri Sat Sun

Truck Stop Station

Station ID: _____ Station name: _____

Available TSE/EPS system (Single and Dual-system electrification): _____

TSE/EPS System Information

1. How would you classify the amount of truck idling at your truck stop?
 - More than most truck stops
 - Less than most truck stops
 - Average
 - I don't know

2. How would you classify the use of TSE/EPS at your truck stop?
 - It's used a lot
 - It's not used much

3. Do you think that TSE/EPS systems play effective role in reducing idling?
 - Yes
 - No
 - If no, what could be the reasons for ineffectiveness of such systems? _____

4. What incentives could motivate truck stop/terminal owners to equip their stops with TSE/EPS systems?
 - Financial incentives
 - Tax exemption
 - Minimum revenue guarantee
 - Free insurance coverage
 - Security guarantee
 - Recognition by cities
 - Other , please specify: _____

5. Have you ever heard any complaint from drivers regarding TSE/EPS systems?
 - Yes
 - No,
 - if yes, please specify:
 - System malfunctioning
 - System unavailability
 - Other: _____

6. Do you think that adding more space equipped with TSE/EPS systems can solve idling problems?
 - Yes
 - If yes, please specify your reasons: _____

 - No

- If no, please specify your reasons: _____

7. Are you willing to add more spaces equipped with TSE/EPS systems in your stop?

- Yes
- No

8. What are your suggestions for increasing the usage rate of TSE/EPS systems?

9. Do you ever discuss use of the TSE/EPS system with TSE/EPS representatives?

- Yes
- No

- If yes, how would you describe your relationship/collaboration with them?

10. What is the type of contract agreement (e.g., turnkey installation and operation) between you and the TSE/EPS system provider?

11. Please write any general comments or suggestions about TSE/EPS systems.

Single-system Electrification Provider

General Information

Date: _____ Time: _____ Day: Mon Tue Wed Thu Fri Sat Sun

Truck Stop Station

Station ID: _____ Station name: _____

TSE/EPS System Information

12. How many TSE/EPS systems are available in this station? _____

13. Are all TSE/EPS systems working?

- Yes
 No

- If no, please specify the number of systems that are **not** working: _____

14. Have you ever heard any complaint from drivers regarding TSE/EPS systems?

- Yes
 No,

- If yes, please specify:

- System malfunctioning
 System unavailability
 Higher cost

Other: _____

15. Is there any policy preventing idling in spaces designated for TSE/EPS systems?

- Yes
 No

- If yes, please specify the policy: _____

16. Are window adapters (different sizes and shapes) available on site for trucks?

- Yes
 No

17. How do you evaluate the usage rate at your station?

- High
 Average
 Low

- If low, why? How could it be improved? Please explain: _____

18. What are the most frequently asked questions from drivers about TSE/EPS systems?

19. Do you ever discuss use of TSE/EPS system with truck stop management/representatives?

- Yes
 No

- If yes, how would you describe your relationship/collaboration with them?

20. What are your suggestions for reducing idling in truck stops? (e.g., adding more available TSE/EPS systems)

21. Please write any general comments or suggestions about TSE/EPS systems.

Dual-system Electrification Provider

General Information

Date: _____ Time: _____ Day: Mon Tue Wed Thu Fri Sat Sun

TSE/EPS System Information

1. What is the type of contract agreement (e.g., turnkey installation and operation) between you and truck stop/terminal owners?

2. What are the most frequently asked questions from truck stop/terminal owners about TSE/EPS Systems? What are they most concerned about having TSE/EPS systems in their stops?

3. Have you gathered any feedback from truck stop/terminal owners about TSE/EPS system?
 Yes
 No,
 if yes, please specify: _____

4. What are the most frequently asked questions from truck drivers about TSE/EPS? What are their most concerns regarding TSE/EPS?

5. Have you ever heard any complaint from drivers regarding TSE/EPS?
 Yes
 No,
- if yes, please specify complains you heard about:
 System malfunctioning
 System unavailability
 Higher cost
 Other, please specify: _____

6. Have you gathered any feedback from truck drivers about TSE/EPS systems?
 Yes
 No,
 if yes, please specify: _____

7. Do you provide bonus for TSE/EPS users?
 Yes
 No,
- if yes, please specify: _____

8. Do you consider providing more bonus if it result in an increase in TSE/EPS usage rate?
- Yes
 - No
9. Do you think assigning spaces for TSE/EPS systems results in an increase in TSE/EPS usage rate?
- Yes
 - No
- If yes, please explain: _____
10. How do you evaluate the effectiveness of TSE/EPS systems (in general) in reducing air pollutions?
- Effective, why? Please explain: _____

 - Ineffective, why? Please explain: _____
11. What are your suggestions for reducing idling in truck stops? (e.g., adding more available TSE/EPS systems)
12. What are your expectations from local agencies such as city, county, and even state administrations for supporting TSE/EPS system providers?
13. Please write any general comments or suggestions about TSE/EPS systems.

TSE/EPS System Representative at Truck Stops

General Information

Date: _____ Time: _____ Day: Mon Tue Wed Thu Fri Sat Sun

Truck Stop Station

Station ID: _____ Station name: _____

TSE/EPS System Information

22. How many TSE/EPS systems are available in this station? _____

23. Are all TSE/EPS systems working?

- Yes
 No

- If no, please specify the number of systems that are **not** working: _____

24. Have you ever heard any complaint from drivers regarding TSE/EPS systems?

- Yes
 No,

- If yes, please specify:

- System malfunctioning
 System unavailability
 Higher cost

Other: _____

25. Is there any policy preventing idling in spaces designated for TSE/EPS systems?

- Yes
 No

- If yes, please specify the policy: _____

26. Are window adapters (different sizes and shapes) available on site for trucks?

- Yes
 No

27. How do you evaluate the usage rate at your station?

- High
 Average
 Low

- If low, why? How could it be improved? Please explain: _____

28. What are the most frequently asked questions from drivers about TSE/EPS systems?

29. Do you ever discuss use of the TSE/EPS system with truck stop management/representatives?

- Yes
 No

- If yes, how would you describe your relationship/collaboration with them?

30. What are your suggestions for reducing idling in truck stops? (e.g., adding more available TSE/EPS systems)

31. Please write any general comments or suggestions about TSE/EPS systems.