

**NYSERDA TRANSPORTATION PROGRAM
CASE STUDY:
Electric Refrigeration Transportation Network**

Final

Prepared For:

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1. Introduction

In 2013, New York State's transportation sector consumed more than 1,032 trillion Btus of energy, or 43 percent of the total energy consumed in the state. Approximately 92 percent of transportation energy consumption came from petroleum products. As a result of its reliance on the combustion of petroleum products, New York's transportation sector was responsible for 75 million metric tons of CO₂-equivalent emissions in 2013, or 42 percent of all fuel-borne greenhouse gas emissions in the state.¹

Within this context, NYSERDA's Transportation Program has identified several objectives:

- To reduce and diversify the energy consumed by the transportation sector;
- To minimize greenhouse gas emissions; and
- To create economic development opportunities in New York State.²

The current Transportation Program builds on decades of research conducted with state and federal funding. Beginning in 2016 with the transition to NYSERDA's Clean Energy Fund (CEF), the Transportation Program adopted three focus areas: electric vehicles, public transportation, and mobility management. In addition, the program is continuing to support some freight projects through a long-standing research collaboration with the New York State Department of Transportation (NYSDOT). The project described in this case study – Electric Refrigeration Transportation Network – aligns with the program's focus on freight and transportation electrification.

In 2004, NYSERDA began supporting the adaptation of electric Transport Refrigeration Unit technologies (eTRUs) for the U.S. market. eTRUs are electric-powered refrigerated units required for transporting fresh and frozen foods in trailers. NYSERDA supported the advancement of both eTRUs and the associated eTRU Power Supply Equipment (PSE, which is the electrical equipment connecting eTRUs to a power source) through development of the *Electric-Powered Trailer Refrigeration Unit Market Study and Technology Assessment*. In 2004, eTRUs were already widespread in European markets – according to the *Market Study* at least 50 percent of TRUs in Europe were either eTRUs or hybrid-electric standby units – but the technology remained underutilized in the U.S.³ U.S. PSE was also not readily available or standardized.

NYSERDA's follow-on support between 2005 and 2008 focused on demonstrating eTRU technologies that did not yet have a U.S. market presence. NYSERDA's projects included demonstrations of eTRUs, PSE, and an eTRU energy management system at gated facilities, where electrical safety concerns were addressed through traditional employee training programs. In 2011 NYSERDA supported another eTRU demonstration project – this time at a publicly accessible retail store location – and development of the

¹ NYSERDA. 2015. Patterns and Trends – New York State Energy Profiles: 1999–2013. October 2015. Available at: <http://www.nyserdera.ny.gov/About/Publications/EA-Reports-and-Studies/Patterns-and-Trends>.

² NYSERDA. 2015. Transportation Program: Product Development, Product Demonstration, and Product Deployment, Program Theory and Logic Model Report. August 2015.

³ Shurepower, LLC. 2005. Electric-Powered Trailer Refrigeration Unit Market Study and Technology Assessment. Prepared for NYSERDA. Agreement Number 5485-1. June 24, 2005.

Electrifying the Hudson River Food Corridor: A Conceptual Design report. Lessons learned from the 2011 retail store demonstration project informed the design of NYSERDA’s most recent eTRU project, which focused on standardization of eTRU PSE for both loading dock and stand-alone installations. In 2014 NYSERDA provided funding to New West Technologies to:

“Develop and implement industry recognized national standards to promote the standardization of the eTRU-PSE which generally includes the plug and plug-in interface power box to manage safety, interoperability, power use, and communication.”⁴

External factors in 2016 caused New West Technologies to drop out of the market and halted the 2014 project. This case study, however, considers the entire scope of NYSERDA’s support for eTRU and eTRU infrastructure since 2004, including the extent of the most recent effort. Exhibit 1 provides a summary of relevant projects and NYSERDA funding.

Exhibit 1. NYSERDA’s Funding for eTRU Technologies

Project	Project Years	NYSERDA Funding
Market assessment and demonstration projects	2004-2011	\$860,900
Demonstration project at Hannaford retail location	2011	\$298,686
Electrifying the Hudson River Food Corridor	2011	\$50,000
Industry recognized standards for eTRU Power Supply Equipment	2014	\$97,972

Exhibit 2 provides additional detail on the focus of this case study. In particular, the primary intent of this case study is to understand the market development impacts of the projects, including benefits achieved to date and the potential for future benefits in other market segments or applications.⁵

⁴ NYSERDA. 2014 Product Development Project Summary.

⁵ This case study is part of a suite of six case studies with an overall purpose of: (1) highlighting important transportation research and development accomplishments in New York State; (2) understanding the role that the Transportation Program played in achieving those outcomes; and (3) informing Transportation Program strategy by identifying effective approaches that NYSERDA can build on and remaining market barriers to address.

Exhibit 2. Evaluation Scope

Evaluation Question	Data Sources and Analytic Methods
1. To what extent did NYSERDA-funded demonstrations build an eTRU network across New York State (e.g., number and geographic distribution of NYSERDA-supported eTRUs and eTRU infrastructure)?	<ul style="list-style-type: none"> • Information provided by NYSERDA project partners as part of standard follow-on reporting requirements • In-depth interviews with NYSERDA project manager and two project partners (Shorepower Technologies and Carrier Transicold)
2. Have NYSERDA's project partners expanded their use of eTRUs and eTRU infrastructure (e.g., ratio of leveraged investment to NYSERDA investment)?	
3. How widely adopted are eTRUs and eTRU infrastructure across New York State and the U.S.?	<ul style="list-style-type: none"> • Information provided by NYSERDA project partners as part of standard follow-on reporting requirements • In-depth interviews with NYSERDA project manager and two project partners (Shorepower Technologies and Carrier Transicold) • In-depth interviews with the California Air Resources Board (CARB), Atlantic Dynamics, LLC and two academic experts in transportation systems, Dr. Constantine Samaras and Dr. Yeganeh Hayeri • Market research and literature review of eTRU technologies in U.S. and European markets

The following sections of this report discuss the evaluation questions, methods, and findings in detail. Section 2 summarizes the results of the case study analysis for each of the three evaluation questions listed in Exhibit 1. Section 3 then discusses the strategic implications of those findings, including the potential for future replications in new markets or applications, effective approaches that NYSERDA can build on, and remaining barriers to address. Section 3 also proposes “leading indicators of success” – or short-term metrics that indicate a project is likely to achieve long-term goals – that NYSERDA could use to evaluate future replications.

2. Project Outcomes

The following three sections discuss each of the three evaluation questions in detail. First, Section 2.1 summarizes the NYSERDA-supported eTRU projects in New York State. Section 2.2 then discusses the expansion of eTRU use by project partners following the NYSERDA demonstration projects. Finally, Section 2.3 describes the broader market adoption of eTRUs and eTRU infrastructure in New York State and the U.S.

2.1 Number and Distribution of NYSERDA Supported eTRU Projects

NYSERDA supported the purchase of eTRUs and installations of eTRU infrastructure through four demonstration projects, each focused on addressing previously identified barriers:

- **2005** – eTRU demonstration project at Maines Paper & Food Services in Conklin, NY: included ten eTRU demonstration trailers and six power supply units that had two connections each (five parking spaces and one dock, totaling 12 connections). This project validated cost assumptions for the installation of eTRUs and PSE and demonstrated the overall value of eTRUs to the trucking industry. The U.S. Environmental Protection Agency (EPA) provided additional funding for this project.
- **2006** – eTRU demonstration at Willow Run Foods in Kirkwood, NY: included nine eTRU trailers and six eTRU power supply units (one eTRU connection installed at a staging area and five dock-located power supply units). This project was focused on integrating the PSE into the loading dock to minimize safety risks associated with accidentally driving off while still plugged into the power supply. The U.S. Department of Energy (DOE) provided additional funding for this project.
- **2008** – eTRU energy management system at the New York State correctional facility in Rome, NY: used existing power supply connections and six eTRU trailers to create a monitoring and control system. This project focused on coordinating on-site electrical consumption to reduce peak demand effects.
- **2011** – eTRU pilot project with Hannaford Brothers at Schodack distribution center and one retail location in East Greenbush, NY: included the purchase of 15 eTRU trailers and installation of six power supply units, one at the retail location and five at the distribution center – including four at loading docks and one in a staging area parking lot. This project addressed safety issues associated with using PSE at non-gated, publicly accessible retail locations.

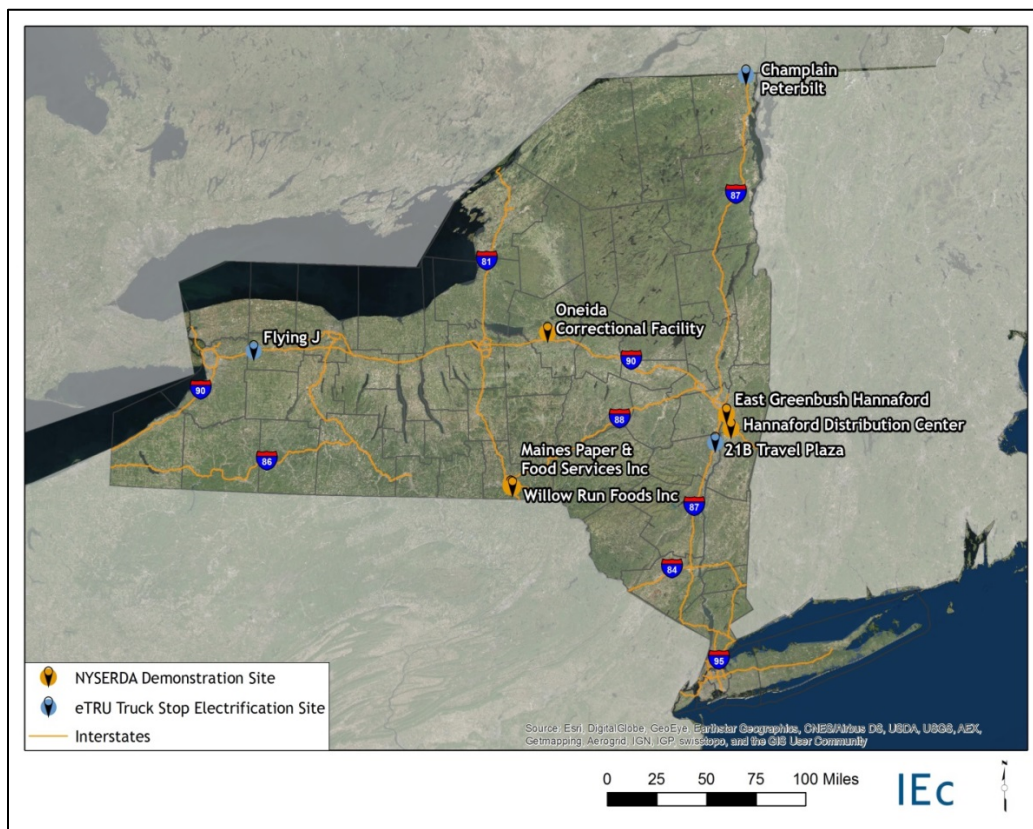
In addition to these demonstrations, between 2011 and 2013 NYSERDA was a partner for New York State projects funded through DOE's *Interstate Electrification Improvement Project*, which focused on reducing idling of trailers at truck stops and decreasing emissions from diesel combustion.⁶ As part of this

⁶ Shorepower Technologies. 2015. Interstate Electrification Improvement Project: Final Report. Prepared for U.S. Department of Energy National Energy Technology Lab. July 2015. Cooperative Agreement Number: DE-EE0002613.

project, Shorepower Technologies installed 480-volt eTRU power supply units at three truck stops across the state, including Champlain at the Canadian border (two eTRU connections), Pembroke in Western New York (five eTRU connections), and West Coxsackie in the Hudson Valley (six eTRU connections).⁷ This project also provided rebates to drivers, including those based in New York State and elsewhere, to purchase eTRUs and electric standby TRUs.⁸ Exhibit 3 presents the number and geographic distribution of NYSERDA-supported eTRU and eTRU infrastructure projects across New York State.⁹

Overall, NYSERDA’s work between 2005 and 2011 directly supported the purchase of 40 eTRU trailers and 37 power supply connections. As shown in Exhibit 3, these installations are distributed across New York State along several interstate highways. Although these four demonstrations are not – and were not intended to be – sufficient to fully support widespread, long-haul eTRU use, they were essential to demonstrating the use of eTRUs in New York State to support establishment of a broader market, according to interviews with Carrier Transicold and Shorepower Technologies.

Exhibit 3. Map of NYSERDA-Supported eTRU Projects



⁷ Message with Joe Licari, Eastern Regional Director at Shorepower Technologies.Re:NYSERDA eTRU Case Study. September 29, 2016. E-mail.

⁸ Shorepower Technologies. 2016. Shorepower Truck Stop Electrification Commercialization. Final Report. Prepared for the New York State Energy Research and Development Authority. March 2016. NYSERDA Agreement No. 21142

⁹ As mentioned in the introduction of this case-study NYSERDA’s work also involved a 2004 market assessment, 2011 conceptual design, and 2014 work on standardized eTRU power supply equipment. However, none of this work supported the direct development of physical eTRUs or eTRU infrastructure.

2.2 Expansion of eTRU Use by Project Partners

NYSERDA's eTRU projects were intended to demonstrate the utility of eTRU technology in a real-world setting; lessons learned from the projects were (and are) intended to encourage further adoption of eTRUs. This analysis considered the extent to which project partners have continued or expanded their use of eTRU technologies without additional NYSERDA funding.

Overall, interviews with project partners and research into the eTRU market revealed that several NYSERDA partners have expanded eTRU use beyond the original demonstrations. Specifically, Maines Paper & Food Services, Inc. installed power supply units and adopted eTRUs at their Terrell, TX, location and expanded their eTRU fleet in Conklin, NY.¹⁰ In addition, Shorepower Technologies, which was involved in multiple NYSERDA eTRU and truck stop electrification (TSE) projects, expanded TSE beyond the three NYSERDA-supported locations in New York State to a total of 50 locations nationwide through DOE's *Interstate Electrification Improvement Project*. Although many of these locations only provide power supply units for standby cab power, Shorepower Technologies also installed 150 high-voltage eTRU plugs at 29 of these truck stops. A third project partner, SafeConnect, worked closely with NYSERDA throughout the Hannaford eTRU project to develop the SafeConnect system to enhance PSE cord safety and prevent accidental drive-off. Communication with a representative of SafeConnect indicated that since that project, the company has expanded deployment of its system to 18 states.

Interviews with other project partners identified two projects that did not expand or continue after NYSERDA involvement. First, power supply units may not be regularly used at the Willow Run Foods former demonstration site. In addition, the energy management system installed at Oneida Correctional Facility is no longer operational due to closure of the prison in 2011.¹¹

In general, findings regarding these demonstration sites are limited due to IEC's inability to contact current or former site managers, some of whom have since moved to other positions. Interviews with project partners, however, identified several barriers that have limited expansion and replication of the NYSERDA projects. These barriers are discussed in the following section in the context of the overall eTRU market.

2.3 eTRU Market Adoption Across the U.S.

Interviews and additional research indicate that the market for both eTRUs and power supply units has advanced since NYSERDA's demonstration projects. Both major eTRU manufacturers, Carrier Transicold and Thermo King, currently have multiple eTRU unit models for sale, and the interview conducted with CARB for this evaluation suggested that as of 2016, as many as 15 percent of all trailers and approximately 50 to 60 percent of TRUs nationwide may have electric plug-in capabilities.^{12, 13} Infrastructure has also expanded: as previously noted, SafeConnect has expanded deployment of its PSE

¹⁰ Refrigerated Transporter. 2013. Hybrid power: Reefer fleets cut engine idling time and save big with hybrid refrigeration, shore power systems. November 2013 Accessed at: refrigeratedtransporter.com.

¹¹ Oneida Correctional Facility was one of six prisons Governor Cuomo closed in 2011.

¹² Carrier Transicold, United Technologies. 2013. Vector. Accessed August, 22, 2016 at: <http://www.truepowerofblue.com/vector.html>

¹³ Thermo King. 2016. Trailer: Single-Temp. Accessed August 22, 2016 at: <https://na.thermoking.com/tk-innovation/global/en/products/trailer-single-temperature.html>

system to 18 states, and Shorepower has expanded eTRU PSE to 29 truck stops across the U.S. Exhibit 4 presents additional examples of eTRU technology adoption (not funded by NYSERDA) both in New York State and across the U.S. These examples highlight the geographic expansion of eTRU technologies that has occurred since NYSERDA first began supporting eTRUs and PSE in 2004.

Overall, NYSERDA appears to have had a clear impact on the broader eTRU market, by supporting projects that demonstrated the operability of eTRU technologies in the U.S. Interviews with CARB, Shorepower, and a former project partner from Carrier Transicold indicated that the 2005 Maines Paper & Food Services demonstration project provided a pivotal example of eTRUs' potential in the U.S.¹⁴ The CARB interview also indicated NYSERDA's prominent and helpful role in PSE standardization. NYSERDA's work on the Rome, NY, energy management system was less well-known among interviewees.

Independent of NYSERDA efforts, regulations have also furthered the market adoption of eTRUs in recent years. Idling restrictions in many states (including New York) provide incentives for corporate managers to adopt eTRUs. Most notably, in California the Airborne Toxic Control Measure includes an approach to slowly phase in TRU equipment that reduces diesel particulate matter.¹⁵ The interview with CARB conducted for this evaluation indicated that one of the best potential intermediate-term compliance options is eTRU technologies similar to those demonstrated by NYSERDA. Industry representatives in California noted that this measure is in fact increasing the adoption of eTRUs and other low-emission forms of refrigerated transport. In addition to the Airborne Toxic Control Measure, a 2015 California Executive Order is expected to significantly increase eTRU market adoption. This Executive Order directs improvements in freight efficiency and the use of zero-emission technologies, and in turn prompted development of CARB's *Sustainable Freight, Pathways to Zero and Near-Zero Emissions* document with next steps for market growth.^{16, 17} While NYSERDA did not directly influence these efforts, the successful demonstration of cost-competitive eTRU technologies by NYSERDA and DOE, NYSERDA's collaboration with EPA, and NYSERDA's efforts to publicize eTRU projects through press releases and national conferences likely provided indirect support for the development of regulatory options.

In addition to state measures, one former project partner indicated that the U.S. Food and Drug Administration's (FDA) Food Safety Modernization Act (FSMA), which includes requirements for data analytics on refrigerated truck fleets, may be prompting corporate managers to review and upgrade their TRU equipment sooner than they would have without the legislation.¹⁸ One option for corporate managers to consider to meet these requirements is eTRU.

¹⁴ The project partner from Carrier Transicold interviewed for this case study is not currently employed at Carrier Transicold, but served as project manager during the time that the company worked on NYSERDA's demonstration projects.

¹⁵ Cal. Code Regs. tit. 8, § 2477

¹⁶ California Exec. Order No. B-32-15 (July. 17, 2015), <https://www.gov.ca.gov/news.php?id=19046>

¹⁷ California Air Resources Board. April 2015. *Sustainable Freight, Pathways to Zero and Near-Zero Emissions*. Discussion Document. <https://www.arb.ca.gov/gmp/sfti/sustainable-freight-pathways-to-zero-and-near-zero-emissions-discussion-document.pdf>

¹⁸ Food Safety Modernization Act (FSMA) of 2011. Accessed August 15, 2016 at <https://www.gpo.gov/fdsys/pkg/PLAW-111publ353/pdf/PLAW-111publ353.pdf>

Exhibit 4. Examples of eTRU Market Adoption Beyond NYSERDA-Funded Projects

New York, NY – Pier 92 of the New York Cruise Terminal added power supply equipment provided by Shorepower Technologies. This project was directly inspired by the Maines Paper & Food Service, Inc., demonstration project (April 2007). http://fleetowner.com/management/news/port_reefers_plug_in

Denver, CO – Mile Hi Foods added 17, 460-volt electrical outlets to its loading docks and installed 20 freestanding receptacles in its yard (November 2011). <http://refrigeratedtransporter.com/carriers/mile-hi-foods-uses-vector-trailer-reefer-units>

Chelsea, MA – New England Produce Center repowered approximately 90 diesel Transport Refrigeration Units with all-electric motors powered from pedestals to make the refrigeration units run on electricity rather than diesel fuel (April 2012). <http://www.mjbradley.com/about-us/case-studies/diesel-emission-reductions-through-electrification-new-england-produce-center>

Troy, MO – Witte Brothers makes extensive use of eTRU anti-idling technologies at its facilities including use of 460-volt, three-phase electric power supply units for reefer units (November 2013). <http://refrigeratedtransporter.com/equipment/hybrid-power>

Britain, CT – Guida's Dairy added a fleet of 19 new vehicles including eight trailers and electric power supply units (June 2013). <http://www.refrigeratedfrozenfood.com/articles/86952-guidas-dairy-reduces-its-carbon-footprint>

McCook, IL – Golden State Foods uses SafeConnect electric Standby connection system for their McCook, Illinois distribution center (December 2014). <http://www.refrigeratedfrozenfood.com/articles/88813-golden-state-foods-chooses-safeconnect-electric-standby-for-distribution-center>

While evaluating the central questions of this case study, IEc also explored the impact of market barriers in limiting the success of NYSERDA projects and hindering the recent and potential future expansion of the eTRU market. In some cases, these barriers represent areas of potential focus for NYSERDA in the future. The barriers include:

Barriers Related to Education and Training

- **Corporate management buy-in.** Despite the well-documented financial payback of eTRUs themselves, the initial cost of an eTRU fleet, PSE and accompanying electric infrastructure, and data management systems (e.g., data telematics) may be higher than other options. NYSERDA estimates that the cost of an average eTRU unit is 10 percent higher than the cost of a typical diesel unit; perhaps more significant is the additional cost required to upgrade electrical systems and install PSE. This price premium may dissuade some corporate managers, either because of limited access to capital or failure to consider lifetime costs. Specifically, interviewees indicated that existing data and information on eTRU performance and potential savings is not sufficient. CARB noted that EPA Region 10 is currently attempting to address this barrier by estimating the potential cost savings of converting to eTRU based on TRU engine run times at facilities and total engine run time.

- **Lack of fleet manager and driver engagement.** Compared to conventional TRUs, eTRUs provide enhanced fuel efficiency even when not plugged into power supply units, although savings are greatest when drivers fully utilize power supply units – which interviewees indicated may not be happening. Maximizing fuel savings from power supply units’ use requires maintaining a team of drivers trained on appropriate use of the system and enforcement mechanisms to ensure proper use. Absent incentives for using power supply units, drivers and fleet managers may not fully utilize the technology.
- **Lack of expertise for on-site system management.** On-site PSE management requires careful coordination of vehicles and electrical demand. For example, distribution center managers must ensure that eTRU trailers are parked in proximity to power supply units, avoid grid overload, and ensure that trailers are chilled for the appropriate number of hours prior to food storage. This type of work may require additional expertise from on-site managers.

Technology Limitations

- **Insurance and investment risk.** The lack of PSE standardization may prevent insurance companies from insuring a fleet that uses high-voltage plugs because of the perceived risk of injury associated with this “new” technology. Additionally, the expanding market has not yet coalesced around a design standard. If multiple PSE designs emerge, this could restrict the interoperability of eTRUs and increase fleet and distribution center managers’ reluctance to choose one particular technology. Fleet and distribution center managers may hesitate to invest in PSE until they can obtain insurance and the market has stabilized. NYSERDA’s work to promote PSE standardization considers this barrier, but additional work is needed. Interviews indicated that the insurance industry may trust the Society of Automotive Engineers (SAE) standard more than other potential standards as a third-party certification of safety.
- **Recovery of on-site electricity costs at distribution centers.** Distribution center managers may be reluctant to invest in PSE because of the inability to recover electricity costs for eTRUs that use their PSE but are not owned by the distribution center. Shorepower Technologies currently uses an online billing system that may serve as a model for other on-site distribution center management and billing systems.

Commodity Price Barrier

- **The current low price of diesel.** In the absence of high diesel prices, the financial incentives for eTRU use, and PSE use in particular, are diminished. The monetary benefits of investing in eTRUs and PSE are enhanced when the price of diesel is high relative to the price of electricity. Unlike the other barriers noted above, NYSERDA cannot influence fuel price.

2.4 Overall Results

Overall, review of project materials and interviews with key industry contacts suggest that NYSERDA’s support for eTRUs has had a positive impact on the broader eTRU market. Specifically, NYSERDA’s support for eTRUs was essential for introducing eTRUs to New York State and for demonstrating the benefits of eTRUs across the U.S. Companies involved in NYSERDA demonstration projects – including Carrier Transicold, Shorepower Technologies, and SafeConnect – have expanded their geographic reach

and/or increased market sales of their respective eTRU technologies. Exhibit 5 summarizes the progress achieved by NYSERDA’s eTRU projects to date and indicates remaining market barriers that NYSERDA could address in its future work.

Although the three evaluation questions considered in this case study provide a broad picture of program market impacts, IEc was unable to quantitatively report findings about NYSERDA’s impact on demonstration site replications and the broader eTRU market. The former reflects the scope of this case study and IEc’s inability to contact demonstration site owners to verify findings regarding eTRU and PSE use. The latter reflects the nature of the emerging eTRU market. Companies are often reluctant to share sales data for nascent markets; however, as eTRU technologies become more widespread and the market stabilizes, sales data may become more readily available and NYSERDA may consider revisiting efforts to characterize the markets for eTRU and PSE.

Exhibit 5. Results Summary

Progress Achieved	Gaps in Achievement
Evaluation Question 1: To what extent did NYSERDA-funded demonstrations build an eTRU network across NYS?	
<p>NYSERDA directly supported the purchase of 40 eTRUs and installation of 37 power supply connections:</p> <ul style="list-style-type: none"> • 2005 – eTRU demonstration at Maines Paper & Food Services in Conklin, NY • 2006 – eTRU demonstration at Willow Run Foods in Kirkwood, NY • 2008 – eTRU energy management system at correctional facility in Rome, NY • 2011 – eTRU pilot with Hannaford Brothers at Schodak distribution center and retail location in East Greenbush, NY • 2011-2013 – DOE’s Interstate Electrification Improvement Project, for which Shorepower installed eTRU power supply units in Champlain, Pembroke, and West Coxsackie, NY 	<p>The demonstrations do not – and were not intended to – support widespread eTRU use. Remaining market barriers are discussed in the context of the following evaluation questions.</p>
Evaluation Question 2: Have NYSERDA’s project partners expanded their use of eTRUs and eTRU infrastructure?	
<ul style="list-style-type: none"> • Maines Paper & Food Services, Inc. expanded eTRU fleet in Conklin, NY and adopted eTRUs and PSE in Terrell, TX. • Shorepower installed 150 high-voltage eTRU plugs at 29 truck stop locations. • SafeConnect has expanded deployment to 18 states. 	<p>Interviews indicate that PSE is no longer regularly used at one former demonstration site.</p>
Evaluation Question 3: How widely adopted are eTRUs and eTRU infrastructure across New York State and the U.S.?	
<p>Multiple news articles indicate evidence of fleets purchasing eTRUs and installing power supply units in NY and the U.S.</p> <ul style="list-style-type: none"> • Both major manufacturers (Carrier Transicold and Thermo King) have multiple eTRU models for sale. • Evidence suggests 15 percent of trailers on the road in 2016 may have plug-in capabilities. • The eTRU PSE market has also experienced growth: Shorepower and SafeConnect have expanded into additional states. 	<p>Barriers hindering further growth in the eTRU and PSE markets include:</p> <ul style="list-style-type: none"> • Corporate management buy-in • Lack of fleet manager and driver engagement • Lack of expertise for on-site system management • Insurance and investment risk • Recovery of on-site energy costs at distribution centers • The current low price of diesel

3. Strategic Implications

Review of NYSERDA's eTRU projects and the literature on eTRU and PSE market adoption indicates that a number of barriers to eTRU adoption remain. These are:

- Corporate management buy-in;
- Lack of fleet manager and driver engagement;
- Lack of expertise for on-site system management;
- Insurance and investment risk;
- Recovery of on-site electricity costs at distribution centers; and
- The current low price of diesel.

However, research also identifies several approaches that NYSERDA can build on to address these barriers in future projects. Specifically, NYSERDA may consider continuing efforts to advance technology adoption and reduce technology costs, through the following:

- **PSE standardization.** NYSERDA's influence on the eTRU market to date, as evidenced by the interviews, suggests that NYSERDA is well-positioned to continue with its most recent effort on PSE standardization. Standardization should help address concerns over the risk and uncertainty of PSE, thereby increasing buy-in from insurers and corporate managers, leading to more widespread market adoption.
- **eTRU PSE deployment.** In the interest of reducing air pollution from idling diesel trucks, continued incentives and support for eTRU PSE may be necessary in the absence of more stringent regulation or higher diesel prices. To maximize benefits, future funding opportunities could be enhanced through fleet owner and distribution center outreach (see below).
- **Support for cost-recovery business model at distribution centers.** A developed and proven management and billing system for distribution centers may provide the incentive for managers to invest in PSE. Shorepower Technologies currently uses one example of an online billing system that may be adapted for a potential on-site distribution center management and billing system.

NYSERDA may also consider the following means of supporting additional education and training:

- **Outreach to fleet owners and distribution centers with information on costs, benefits, and system management.** NYSERDA should consider developing and distributing easy-to-understand information on the monetary benefits of eTRUs and PSE to fleet owners and distribution center managers. Despite the financial payback of eTRUs, interviewees indicated that the price premium for eTRUs and associated infrastructure may dissuade corporate managers who fail to consider lifetime cost savings. Coordination with EPA's ongoing research efforts to address this barrier may represent a cost-effective way to develop information and improve outreach. In addition, NYSERDA should consider better publicizing lessons learned from previous demonstrations, such as the energy management system in Rome, NY, to increase knowledge of on-site PSE system management among distribution center managers.

While this evaluation was not able to quantify the market adoption of eTRU technologies resulting from NYSERDA projects, it may be useful to revisit this evaluation if eTRU technologies continue to receive Transportation Program support. As the industry evolves and expands, more data may become available to support quantitative market analysis. NYSERDA could also consider tracking additional metrics as part of future eTRU projects to better understand eTRU and PSE adoption over time. Specifically, NYSERDA could ask project partners to report the number of eTRUs and power supply units in their fleets, as well as annual PSE utilization (e.g., hours of use, number of power supply units used at a given location). This information would support a range of longitudinal analyses as technologies and markets evolve.

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