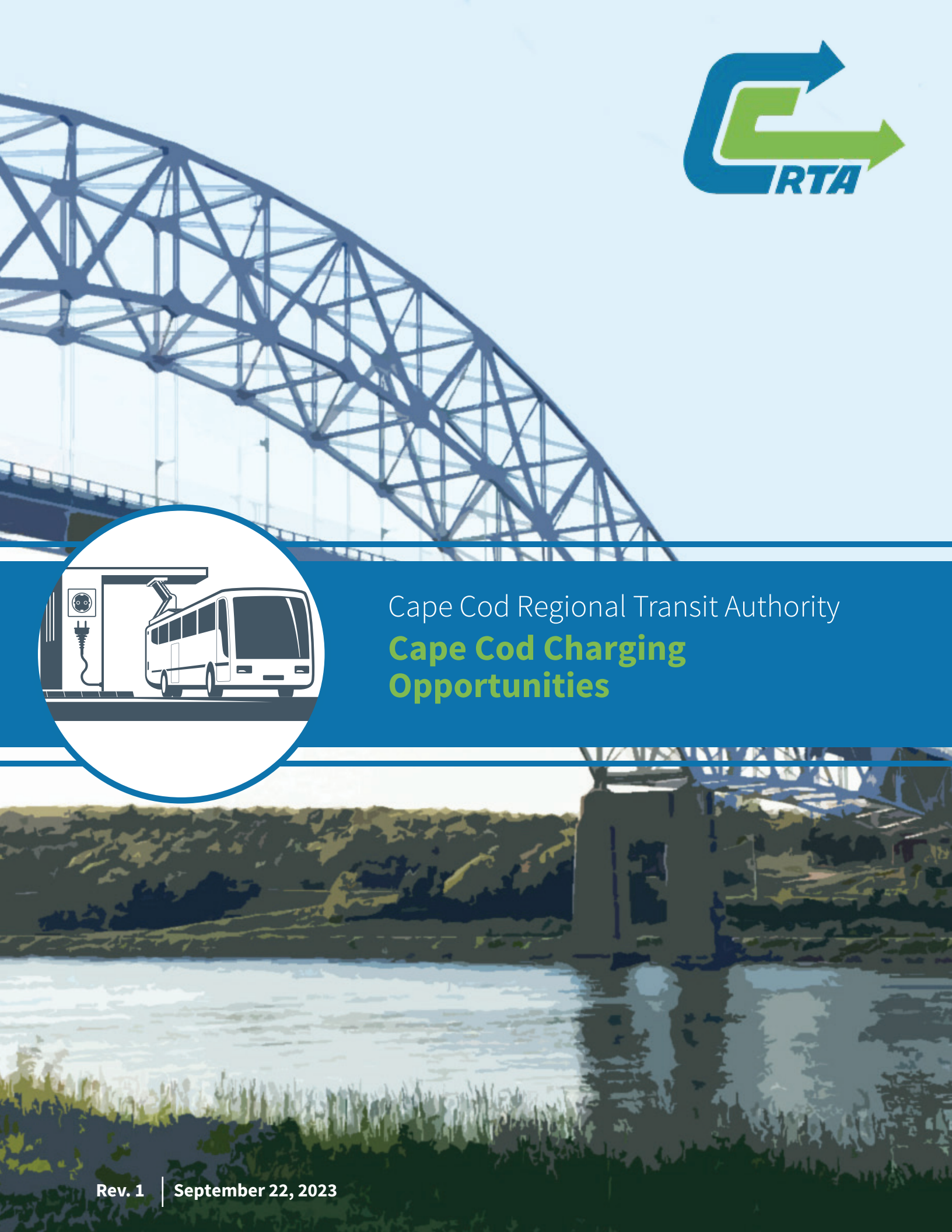

Cape Cod Regional Transit Authority

Cape Cod Charging Opportunities

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Cape Cod Charging Opportunities

9/22/2023	1		Emily Marble	Dan Lang		
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1. Introduction

Cape Cod Regional Transit Authority is in the early states of transition to an electric fleet. Hatch was contracted to support the Authority's zero emission vehicle (ZEV) transition planning exercises. As part of the study, Hatch conducted vehicle and route simulations and comprehensive operations analysis to both predict how electric vehicles would perform on CCRTA's fixed routes and demand-response services and to determine where operational strategies to maintain CCRTA service levels are required due to electric vehicle range limitations.

At a high level, simulation results showed that of the 48 fixed-route service blocks modeled, 27 would be unsuitable for a full day of electric vehicle service with no other operational changes. Demand-response service is more difficult to model because passenger demand is unpredictable and may change daily. Early modeling showed that of four trips modeled, only one could be served by electric vehicles without operational changes.

Because of the battery range issues CCRTA would likely experience, Hatch recommended installation of on-route charging stations at route terminals. This operating strategy would allow fleet vehicles to remain in revenue service for their full shift length without shortening CCRTA's existing bus blocks, or rearranging bus blocks to allow for mid-day depot charging and would mitigate battery range issues for both fixed-route and demand response services.

To determine optimal on-route charging locations, Hatch mapped terminal locations for fixed-route services and areas on Cape Cod with the highest demand-response ridership. These maps were then compared to identify areas of overlap; to identify areas which could host charging infrastructure to serve the entire region. The areas identified also closely align with the most densely populated areas on Cape Cod. From these efforts, four locations were identified as best suited for on-route charging. Once these locations were identified, Hatch reassessed the feasibility of electrifying CCRTA's fixed and demand-response routes assuming on-route charging was installed. As part of this analysis, Hatch provided recommendations for the number of chargers that would be needed at each on-route location.

Planning for fleet charging infrastructure is important to CCRTA as is community-level planning for infrastructure solutions that could serve the Cape Cod region. On-route charging, if located in public places, provides an opportunity to bolster market acceptance of light-duty electric vehicles (EVs) on the Cape by increasing charging opportunities. As the number of EVs and supporting infrastructure in the region grow, there are benefits to the Cape in the form of economic development, workforce development, reduced greenhouse gas (GHG) emissions, and air quality improvements. To achieve these benefits, however, important considerations such as peak demand, location, and interoperability between vehicle model and charging infrastructure must be considered to determine the optimal number of chargers, and types of charging units to be installed.

As part of the ZEV study, CCRTA requested Hatch identify potential fleet and public use charging opportunities for Cape Cod. Included in this report is a broad description of the various ownership models common to charging infrastructure and key considerations for each. Hatch provided a cost comparison for each charging infrastructure model on a per station basis, excluding construction costs. Hatch also highlighted considerations for the four areas identified as suitable on-route charging locations, including utility capacity, and recommended charger types and numbers. As the locations identified for on-route charging are generalized geographic areas, and since CCRTA has not begun conversations with landowners or real estate agents, the utility capacity details are high-level. To obtain actuals, CCRTA would need to file an intake application with exact charger types and quantities for the utility (Eversource) to complete a comprehensive, grid capacity study.

Since technology shifts can introduce operational challenges, it is important that CCRTA prioritize operation of the future, electric fleet, and associated infrastructure planning to ensure a successful and sustainable transition. By focusing on the Authority's fleet first, CCRTA will fulfill its mission and deliver on

the promise to ridership. After success in the early phases of transition, then CCRTA may want to consider options for partnerships and public use charging opportunities to benefit the region.

2. Charging Infrastructure Ownership & Maintenance Models

As CCRTA plans for the development of charging infrastructure, the Authority will need to make decisions on what ownership and maintenance model to choose. Most commonly, a charging station is either site host-owned (also known as fleet user owned), or third party-owned. From a maintenance perspective charging infrastructure can be site host-owned and maintained, site host-owned and third party-maintained, or third party-owned and maintained. A fourth model that is gaining popularity is charging as a service (CaaS). With any of the four ownership models, the fleet user can offer public charging or designate the chargers for fleet use, only. As such, CCRTA can potentially generate revenue streams to offset some of the costs by offering public charging. Each of these ownership models have advantages and disadvantages that need to be considered to design optimal charging solutions for CCRTA's future electric operations. Cost components of each model are discussed in more detail in Section 2.5.

2.1 Owned and Maintained

In this model, the fleet user purchases, installs, and maintains the charging infrastructure which allows for full control over the station and the ability to keep all revenue from the station (if applicable). The fleet user will incur annual network connectivity cost under this model. In this scenario, site hosts are responsible for all associated costs including unforeseen repairs that could lead to charger downtime. The following are key considerations for this ownership model:

Benefits	Drawbacks
+ Less expensive solution long term as there are minimal recurring costs.	+ Requires larger upfront capital investment due to construction, installation, and equipment costs.
	+ Requires troubleshooting and preventative maintenance staff training.
	+ Requires preparedness to quickly respond to charger breakdowns to maintain high uptimes.
	+ Requires "field asset" maintenance such as equipment cleaning, parts checking, and storing charging cables securely.
	+ Requires spare parts inventory.
	+ Requires additional operational considerations and costs associated with electricity and networking.
	+ Requires site security considerations such as lighting, signage, and cameras to prevent vandalism.
	+ Requires early and continuous coordination with the utility.

2.2 Owned and Third Party-Maintained

In this model, the fleet user purchases and installs the charging infrastructure but hires or contracts out to a third party to maintain it. The following are key considerations for this ownership model:

Benefits	Drawbacks
+ Reliable infrastructure as most original equipment manufacturers (OEMs) guarantee specific charger availability or time to use the chargers (uptime) via a maintenance contract.	+ Requires larger upfront capital investment due to construction, installation, and equipment costs.
+ Operational considerations and costs associated with electricity and networking are managed by the third party.	+ Requires early and continuous coordination with the utility.

2.3 Third Party-Owned and Maintained

In this model, charging infrastructure is purchased, installed, and maintained by the third party - the charging infrastructure is essentially leased. The equipment purchase, installation, network connectivity and maintenance costs are incorporated into the fees charged to the fleet users. However, the fleet user is responsible for upstream electrical infrastructure installation and coordaining the service from the utility. The following are key considerations for this ownership model:

Benefits	Drawbacks
+ Minimizes responsibility of the fleet user.	+ Requires larger upfront capital investment related to electrical infrastructure upgrades.
+ Reliable charging infrastructure as the third party leasing the chargers own and maintain them with a guaranteed uptime.	+ Requires written agreement covering equipment maintenance and repair, including response time and equipment down time. This protects the fleet user.
+ Operational considerations and costs associated with electricity and networking are managed by the third party.	+ Requires a minimum term, typically starting at five years.
+ Reduces the risk of the fleet user being stuck with outdated/obsolete assets (stranded assets) if the existing hardware is discontinued as third party would typically be responsible for hardware upgrade.	+ Requires early and continuous coordination with the utility as fleet user remains responsible for utility upgrades and electrical infrastructure.
+ Good option for pilot program testing a technology or market, or for shorter term applications.	+ More expensive option for the long term and this model shifts incurred costs to the operations budget versus the capital budget.

2.4 Charging-as-a-Service (CaaS)

In this model, the companies offering CaaS would build the entire charging infrastructure and would be responsible for ownership and maintenance. The following are key considerations for this ownership model:

Benefits	Drawbacks
+ Offers similar advantages to the third party-owned and maintained model.	+ More expensive option for the long term.
+ Beneficial for scenarios where fleet user encounters challenges raising upfront capital to build the infrastructure (cost would likely fall under an Operations and Maintenance expense rather than a capital expense).	+ Requires a longer commitment term, typically starting at 10 years.

2.5 Ownership Model Cost Comparisons

There are two components to each of the ownership models: upfront capital costs and recurring operations and maintenance costs. Adding these costs over the lifecycle of the asset makes up the total cost of ownership. When considering the ownership model, the lifecycle cost needs to be carefully compared against the benefits and drawbacks that were discussed in the previous section.

The capital cost would typically include the cost of purchasing and installing the chargers while the operations and maintenance cost would include the following expenses, shown in Table 1, dependent on ownership model.

Table 1 Cost Components by Ownership Model

	Owned and Maintained	Owned and Third Party-Maintained	Third Party-Owned and Maintained	Charging-as-a-Service
Charging Equipment Cost	X	X		
Annual Networking/Analytics Cost	X			
Annual Maintenance Cost	X	X		
Annual Lease Cost (includes the Networking/Analytics Cost)			X	
Annual Charging-as-a-Service Cost				X

An **annual networking/analytics cost** is incurred by most connected or networked chargers for connectivity to a cloud service via cellular network. This cost also typically includes access to an online portal for real time equipment monitoring and for downloading usage data.

The **annual maintenance cost** is the cost associated with charger upkeep. For the Owned and Maintained model, the annual maintenance cost is the cost of material and labor required to maintain the chargers. For all other ownership models, the annual maintenance cost is typically the annual maintenance contract cost. The annual maintenance contract includes value added services supplied by a lot of major charging network providers for monitoring and maintaining the chargers. This service typically includes a guaranteed minimum charger uptime or response time for charger-related issues. By contrast, the repairs for unforeseen charger breakdowns are additional costs under the Owned and

Maintained model. Maintenance and CaaS contracts include the networking cost and hence networking costs do not need to be separately accounted for under these ownership models.

An **annual lease cost**, seen with a third party-owned and maintained model, includes the cost of leasing equipment as well as the cost for connectivity, charger maintenance, and guaranteed uptimes. There is usually a required minimum five-year lease agreement.

Lastly, the **annual CaaS** model expands the leasing model further by including the cost of all the upstream electrical equipment - from the utility meter all the way to the charging station - as well as the cost of construction. This model typically requires a minimum 10-year agreement.

Hatch used a representative Level 2 (L2) and Direct Current Fast Charger (DCFC) to illustrate the relationship between the total cost of ownership and the number of years of ownership under each model. Because it is difficult to estimate the land lease cost and full buildout cost for charging infrastructure as the identified sites for CCRTA charging locations are not finalized, the costs of construction and land lease were excluded from this illustration. Construction costs would be the same for all ownership models, except CaaS, and would not impact the relative difference between the total cost of ownership under each model. Lastly, the maintenance cost estimate for the Owned and Maintained model was assumed to be only material cost because the increase in labor cost is assumed to be absorbed by current maintenance staff.

In addition, the illustration excludes the CaaS model because the pricing for CaaS is highly dependent on the application. The annual or monthly cost for the service is typically negotiated with the service provider after the project details are established and site-specific construction costs are estimated. This is because the cost for building the charging infrastructure can vary from site to site.

Table 2 below outlines the typical upfront and recurring costs for a typical Level 2 charger under the three ownership models, excluding CaaS.

Table 2 Dual Port Level 2 Per Unit Costs (Excluding Construction and Land Lease)

	Owned and maintained	Owned and Third Party-Maintained	Third Party-Owned and Maintained
Charging Equipment Cost	$9,000	$9,000	$0
Annual Networking/Analytics Cost	$280		
Annual Maintenance Cost		$500	
Annual Lease Cost (includes the Networking/Analytics Cost)			$2,200

Using these estimates, the total cost of ownership for a typical Level 2 charger was projected for 15-year ownership. As shown in Figure 1, the cost of leasing the equipment far exceeds the cost of owning the equipment, whether the equipment is maintained by the fleet user or maintained through a third-party service contract. In fact, the breakeven point for the three ownership models occurs at approximately five years. From a financial perspective, in most cases owning Level 2 equipment is a better choice.

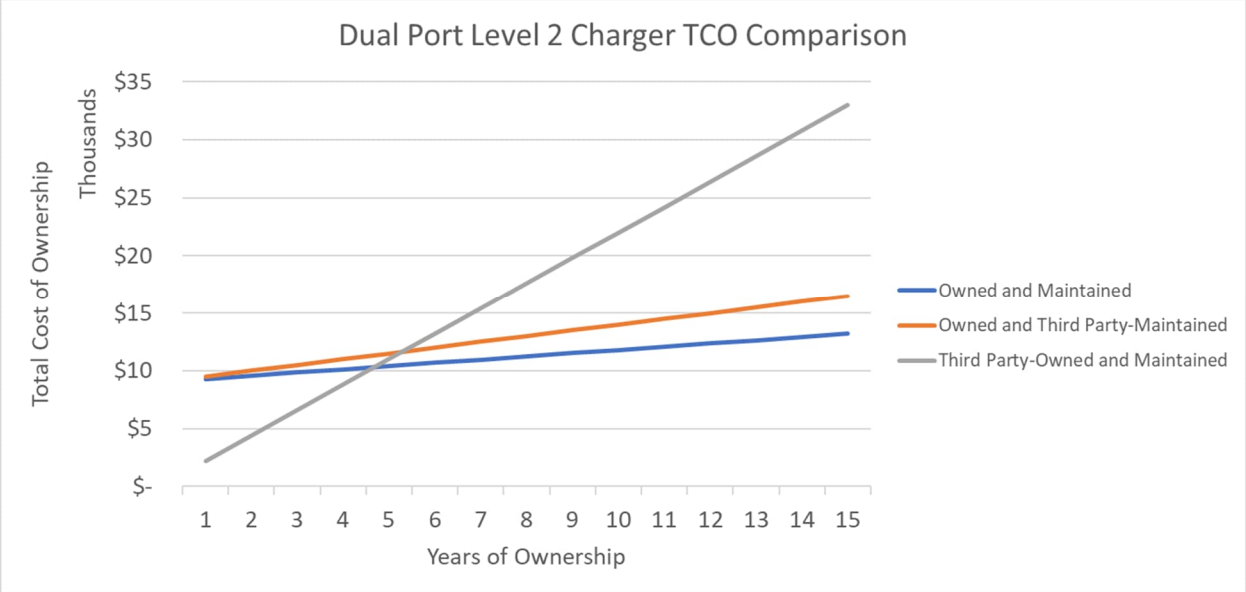

Figure 1 Dual Port Level 2 Charger TCO by Years of Ownership

Table 3 below outlines the typical upfront and recurring costs for a 62.5 kW DCFC under the three ownership models, excluding CaaS.

Table 3 DCFC Per Unit Costs

	Owned and Maintained	Owned and Third Party-Maintained	Third Party-Owned and Maintained
Charging Equipment Cost	$50,000	$50,000	$0
Annual Networking/Analytics Cost	$950		
Annual Maintenance Cost	$500	$3000	
Annual Lease Cost (includes the Networking/Analytics Cost)			$11,500

Using these estimates, the total cost of ownership for a typical DCFC was projected for 15-year ownership. As shown in Figure 2, the cost of leasing the equipment exceeds the cost of owning the equipment, whether the equipment is maintained in-house or maintained through a third-party service contract. Like the Level 2 charger, the breakeven point for the three ownership models occurs at approximately five years. In the long term, owning DCFC equipment can be a better choice from a financial perspective - especially for multiple chargers. On the other hand, DCFCs are more complex than Level 2 chargers with higher maintenance requirements. So, from an operational perspective, leasing the equipment might be worth considering, especially if the fleet user is considering only one or two chargers.

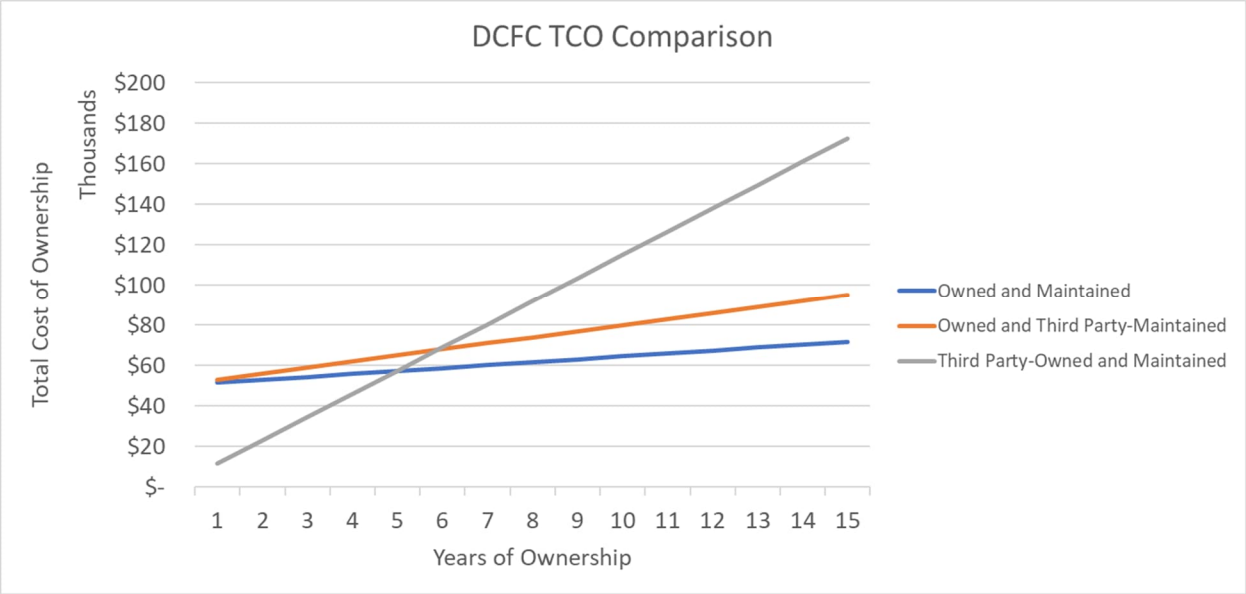

Figure 2 DCFC TCO by Years of Ownership

3. CCRTA Charging Infrastructure Locations

As discussed in Section 1, Hatch identified four locations on Cape Cod as feasible on-route charging locations. The following sections highlight considerations for the areas, including suggestions regarding ownership model, utility capacity, and recommended charger types and numbers.

3.1 Hyannis Transportation Center (HTC)

Hyannis, the primary hub for fixed-route operation and a key base for Dial-a-Ride Transportation (DART) ridership, is an obvious place for a charging station. Hyannis Transportation Center (HTC) is owned by CCRTA, and the site has ample space for additional charging infrastructure. There are currently 20 L2 chargers (ten dual head L2 chargers) for both CCRTA and public use located at HTC. In addition, CCRTA applied for Eversource's Make Ready Incentive Program and has plans to expand charging infrastructure at the terminal which would enable on-route charging for both fixed route and DART vehicle use. Eversource's approved contractors, Maverick Electric Vehicle Services, provided proposed design drawings for HTC, so planning efforts are underway to increase utility capacity at the site. For these reasons, HTC may be best suited for the Owned and Maintained model.

Because HTC is the main hub for CCRTA's services, adding public use charging infrastructure would not be a heavy burden for the Authority, and may not only encourage EV use for Cape residents and visitors but could also attract more CCRTA ridership.

For CCRTA's fleet use, Hatch recommended three 100 kW DCFCs, each with one dispenser, and two 300 kW, single dispenser DCFCs. Since there is additional space available at the site and public chargers would directly benefit CCRTA riders, CCRTA might consider installing additional Level 2 or even DCFCs for public use. The decision to add public chargers should be based on the utilization of the current public chargers, and projections on future usage growth.

3.2 Provincetown

On the other end of the Cape, Provincetown is a strategically important node for CCRTA operations. Although it does not see high demand-response activity, it is far enough from other areas of the Cape that

a demand-response vehicle would likely be unable to complete a full day of service that included a round trip to Provincetown. Additionally, it is the terminal for two CCRTA fixed routes and sees vehicles "parked out" overnight during the summer season. For these reasons, it is an important area to install a charging station for both midday and overnight use. Since CCRTA does not currently own land in this area of the Cape, CCRTA should begin conversations with local landowners regarding commercial property sub-lease agreements for a longer-term commitment as the Authority will need this space for fleet operations well into the future. Then, CCRTA could consider opting for either a Third Party-Owned and Maintained or a CaaS model, dependent on the interests of the landowner. Since this area on the Cape draws large numbers of visitors in the summer, CaaS may be a model that benefits both parties. It would ensure reliable charging infrastructure in Provincetown to meet CCRTA's fleet needs and could expand light duty charging opportunities and revenue streams for the landowner.

MacMillan Pier

For midday use, it is important that the chargers be located close to the terminal at MacMillan Pier so that vehicles can charge during short layovers. According to Eversource, there are several existing utility services with potential to serve up to five, 50 kW DCFCs or 25, 7.2 kW L2 chargers. Space constraints and lack of available land in this location are key considerations for CCRTA.

Hatch recommended one 300 kW, single dispenser DCFC at MacMillian Pier or in that general area for CCRTA's use. Public charging stations may be viable for this area due to high tourism volumes. However, CCRTA would need to ensure charger availability for their fleet vehicles and that a charging schedule could be established and maintained. In addition, CCRTA will need to consider who would be the recipient of the benefits of these chargers. Since the pier is a tourist location, the beneficiaries of the charging stations will not always be CCRTA ridership.

Provincetown Wastewater Treatment Plant

For overnight use, the charging station needs to be in a secure location and needs to be large enough to accommodate several vehicles charging at once, including spare vehicles that may remain there during the day. Because of the busy nature of downtown Provincetown, identifying a location that meets these requirements is challenging, and will require discussion with the Provincetown municipal government and the local community. Hatch selected the town wastewater treatment plant on Route 6 as a potential charging location; however, this site is more complicated from a utility and electric distribution standpoint and current capacity is unknown. CCRTA is encouraged to review all possible locations in the area before beginning construction.

Since this location would be used for overnight park-outs during the summer months, Hatch recommended two 150 kW DCFCs with three dispensers, each. These chargers will be for CCRTA's fleet use. Public charging at this location will not be optimal because the selected site will likely be in a commercial or industrial setting.

3.3 Mashpee

Based on Hatch's study results, since Mashpee is the largest hub of demand-response operation and a terminal location for one CCRTA fixed route, it is another clear candidate for a public charging station. However, like Provincetown, CCRTA does not own land in the area and installation of charging infrastructure will require negotiation with local landowners. Fortunately, Mashpee Commons – the large mall that serves as the area's commercial hub – has ample parking space available where chargers could be installed and is already the site of multiple charging stations for personal vehicles. Eversource confirmed the presence of existing transformers and services in the general vicinity that could be used to feed EV charging.

Like Provincetown, CCRTA should begin conversations with Mashpee Commons landowners regarding commercial property sub-lease agreements for a longer-term commitment. Then, CCRTA could consider a Third Party-Owned and Maintained or CaaS model, dependent on the interests of the landowner. These models would allow for the landowner to recoup upfront capital costs through an agreement with

CCRTA. This offers the path of lease resistance for CCRTA as it would ensure reliable charging infrastructure in this area, limit the Authority's responsibility for maintenance and charger uptime and could expand light duty charging opportunities and revenue streams for the landowner.

Hatch recommended five, single dispenser 100 kW DCFCs for CCRTA's fleet use. Public charging stations will likely do well in this area because of the mall traffic. However, CCRTA will need to consider who would be the recipient of the benefits of these chargers. Charging station are rarely profit generating assets. The monetary benefits of offering EV charging usually comes from the increased foot traffic to the establishments that offer this benefit. Shopping malls would typically offer chargers to attract more customers. If public charging is considered for this location, CCRTA would have to evaluate its benefits to the riders versus the shoppers. Since there is a monitory advantage for the Mashpee commons from this initiative, CCRTA could consider partnering with Mashpee commons to offer this service. Two advantages would be that the cost of building the public charging station would be shared with Mashpee Commons and that fleet charger installation could be negotiated.

3.4 Falmouth

Falmouth and the Woods Hole area also see concentrated demand-response ridership and are the terminals of the trolley routes. The trolley routes pose challenges for EV operations because CCRTA does not currently own or operate charging infrastructure along this route and because electric trolleys have comparatively limited battery capacity. However, given the proximity to Mashpee where a charging station is recommended, and the seasonal, one-vehicle nature of the trolley services, it is likely uneconomical for CCRTA to build a separate charging station in the area. Instead, demand-response vehicles could charge in Mashpee, when necessary, during the driver's lunch break, and the trolley could use the Steamship Authority's nearby Palmer Avenue Parking Lot in Falmouth for charging. Eversource confirmed that existing infrastructure around the Palmer Lot is limited however there is possibility to bring new service to feed EV chargers.

To start, Hatch recommends that CCRTA use one of the Steamship Authority-owned chargers. For a longer-term solution, CCRTA will need to essentially reserve chargers for fleet use, providing the Authority with guaranteed charger availability. The model most closely aligned with CCRTA's needs in this location would likely be CaaS. In this scenario, the Steamship Authority essentially expands its current infrastructure to meet CCRTA's need, allowing CCRTA the use of their infrastructure through a CaaS-type agreement.

CCRTA is encouraged to negotiate with the Steamship Authority to coordinate for potential partnerships, access, and future, shared charging infrastructure. Additional public charging offering can be considered as a part of this shared charging infrastructure, like Mashpee.

4. Conclusion

In conclusion, the four charging locations identified in this report have the potential to provide adequate coverage across the Cape to support CCRTA fleet operations and will help ensure a smooth transition to an electric fleet. When considering the ownership model for charging infrastructure in these locations, CCRTA will need to carefully compare the lifecycle costs against the benefits and drawbacks of each. Continued coordination with Eversource and the regions' utility providers remains a priority. Through the successful transition and implementation of electric fleet operations, CCRTA will become part of a region-wide EV charging network with the potential to grow.