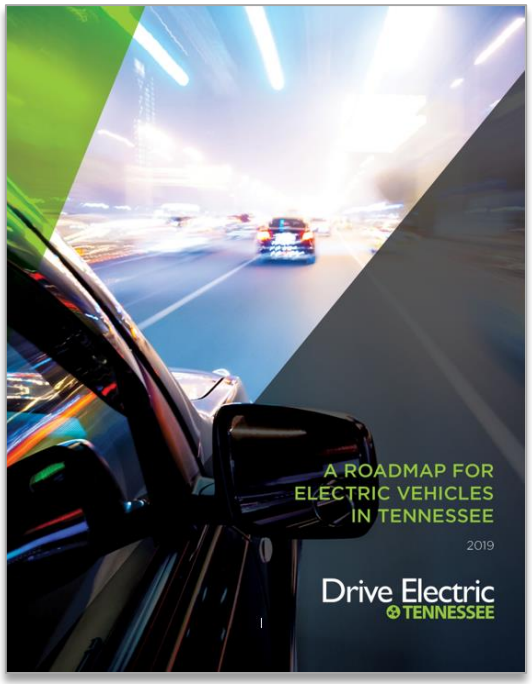
Drive Electric TENNESSEE

ELECTRIC VEHICLE CHARGING NEEDS ASSESSMENT

OCTOBER 2019

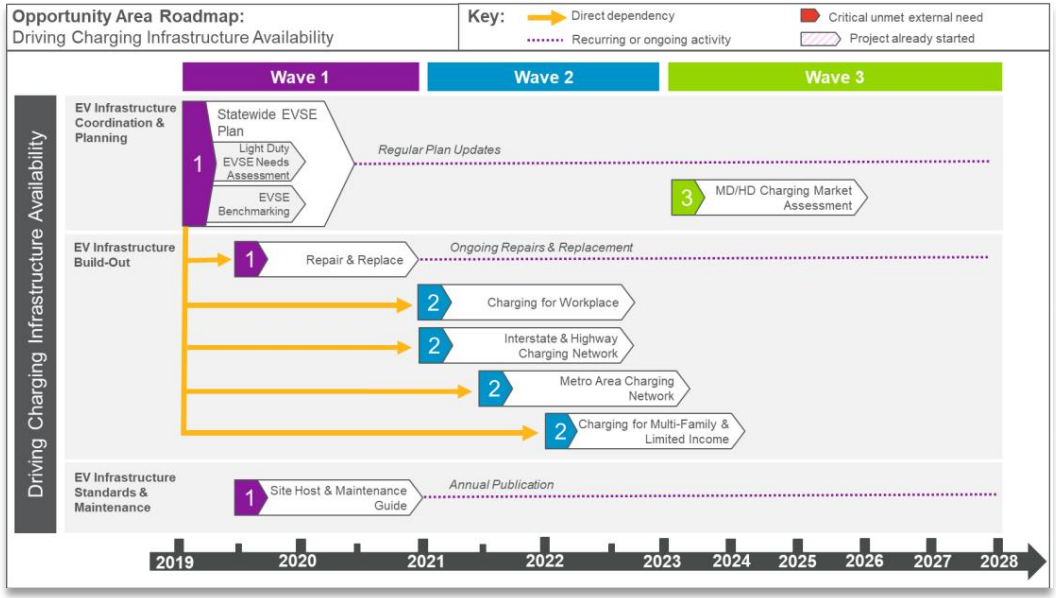
ASSESSMENT BACKGROUND

ORIGINATION FROM THE ROADMAP



The **Electric Vehicle Charging Needs Assessment** kicks off the projects identified in the *Drive Electric Tennessee Roadmap* developed in 2018 by the Drive Electric Tennessee (DET) Consortium. The project, originally called the **Tennessee EVSE Plan**, was identified under the "Driving Charging Infrastructure Availability" opportunity area of the roadmap.

Tennessee Valley Authority (TVA) identified a need to complete this project as a **priority effort under Wave 1** in 2019 following **collaboration alongside** its fellow DET members.



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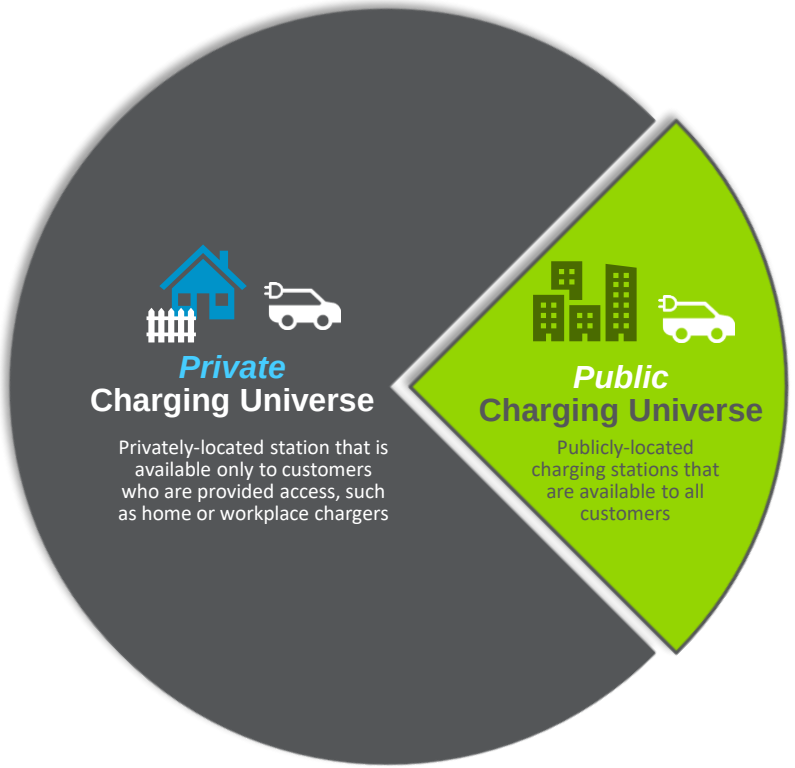
KEY QUESTIONS ADDRESSED IN THE ASSESSMENT



The goal of this project was to develop a strategic assessment for public PEV charging infrastructure in the state of Tennessee. The primary objective was to illuminate tracks for public infrastructure rollout to meet ***DET's Shared Vision*** and ***Mission*** articulated in the ***2019 Roadmap***. The Mission is to support adoption of 200,000 plug-in electric vehicles[1] (PEV) in Tennessee by 2028.

Key questions addressed in the project include:

- What is the ***coverage, usage, and state of repair*** of current charging infrastructure in Tennessee?
- What are the ***PEV charging infrastructure needs*** in the state to ***support goal*** of 200,000 PEVs in Tennessee by 2028?
- What ***gaps exist*** between the current infrastructure and future infrastructure needs?

[1] PEV includes plug-in hybrid electric vehicles (PHEVs) that contain combined internal combustion engine and battery-based powertrains, as well as battery electric vehicles (BEVs) that only contain battery powertrains.

CALIBRATED TN PEV CHARGING BASELINE

TN PEV Charging Sites
Calibrated Baseline Dashboard

Charging Site Status	Count	Percentage
Fully Operational	339	73%
Wounded	26	6%
Private	46	10%
Removed	27	6%
Non-Operational	24	5%
Total	462	100%
Truly Public* Site Status		
Fully Operational	*339*	***87%***
Wounded	*26*	***7%***
Non-Operational	*24*	***6%***
Total	*389*	*100%*

Insights from the *Desk Review* and the *Field Survey* were consolidated to produce the **Light-Duty PEV Charging Calibrated Baseline Dashboard**.

Approximately 9 out 10 existing stations are operational. Field survey resulted in a successful charge at 90% of visited charging stations, consistent with what can be expected across TN's entire PEV charging equipment infrastructure (87% fully operational).

Source: Navigant Onsite Survey, AFDC, PlugShare, ChargeHub, Blink, ChargePoint, PEVgo, Electrify America
* Does not include "private" and "removed" sites to consider only installed public infrastructure

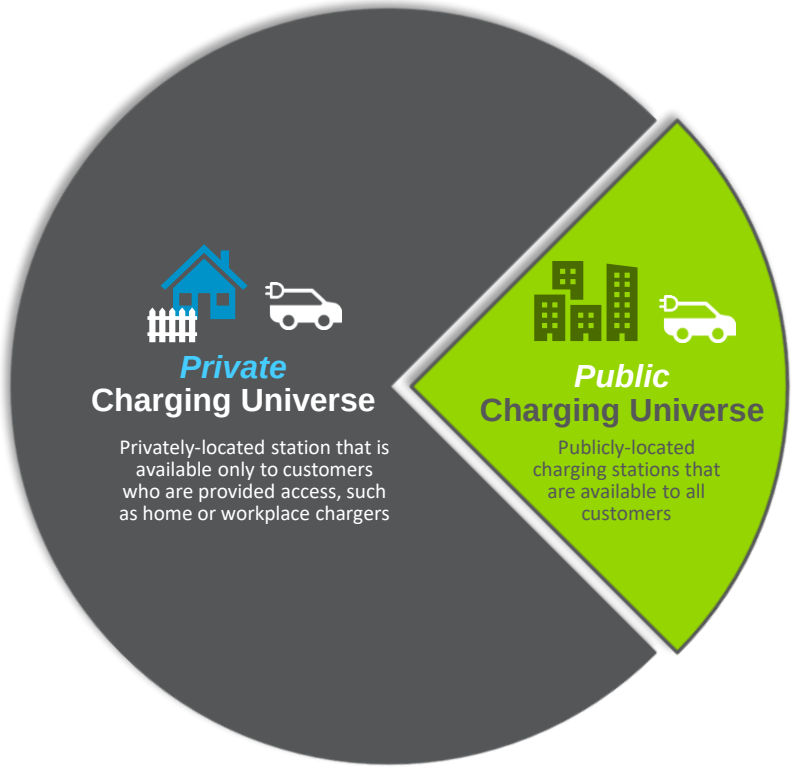
CONCLUSIONS

The current state of PEV charger installations in Tennessee provide a baseline for planning to promote growth toward reaching DET's target of 200,000 PEVs in 2028

- ***Approximately 9 out 10 existing stations are operational*** – Field survey resulted in a successful charge at 90% of visited charging stations, consistent with what can be expected across TN's entire PEV charging equipment infrastructure (87% fully operational).
- ***There are opportunities to improve the user experience of stations*** – Overall, most stations are functional, but there are opportunities to improve how people interact with stations through addressing areas such as improving display screens and providing better directional signage.
- ***There are opportunities to improve the site host experience of stations*** – Following up with site hosts whose service agreements expired to understand the rationale behind the lapses could inform best practices for planning how to avoid wounded and nonoperational stations in future infrastructure rollouts.

METHODOLOGY & ASSUMPTIONS

Navigant's VAST™ Analytics Suite forecasts future charging infrastructure for multiple use-cases, which can be private ("behind the fence") infrastructure, or public ("in front of the fence") infrastructure



- ***Public Charging Universe (Focus of this study)***
  - VAST™ uses a network siting optimization tool to determine optimal sites for charging infrastructure, given road data, vehicle-miles traveled, and PEV adoption.
  - Each potential site has a PEV vehicle-miles traveled associated with it, which translates to site demand
  - Ports are allocated according to total demand, to simulate installations from all agents in the market
  - Site determination is done at a latitude-longitude level. **The sites are optimal according to road network flows only. It does not include aspects such as presence of parking lot, or rental costs. The site location is an approximation of future installation, not a specific recommendation.**
- ***Private Charging Universe***
  - Not examined in this study as these use cases are slated for investigation through other projects in the DET Roadmap (e.g. Charging for Workplace)

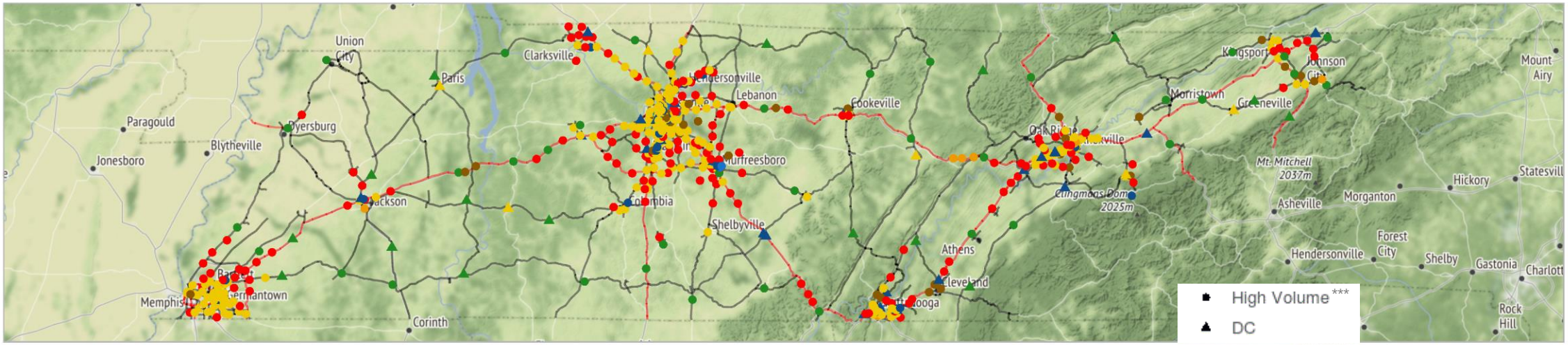
USE CASE DEFINITIONS

Existing	**Today's State** – Set of existing sites calibrated to Task 1 Baseline Assessment results, representing both current state of infrastructure installations in Tennessee as well as new ports for existing sites
Corridor	**Corridor** – Electrify select highway corridors with DCFC to "FAST 50" such that maximum driving distance is 50 miles between stations with multiple charging ports capable of at least 50kW power level.
Primary Market	**Primary Market** – Place sites with highest demand (defined by traffic demand and PEV adoption)
Limited Income	**Limited Income** – Placed on zip codes with high percentage of limited income families*
Multi-Family	**Multi-Family** – Placed on zip codes with high presence of multi-unit dwellings*
Secondary Market	**Secondary Market** – Complete charging network needed to support 200k PEVs in Tennessee by 2028 by building out remaining market sites
Full Buildout	**Long-run Saturation State** – Complete set of sites required to support widespread PEV adoption beyond 200,000 PEVs. No ports were allocated to these sites for this project.

  *Source: US Census American Community Survey

DC SITES AND PORTS

Existing Sites	Corridor*	Primary Market	Limited Income	Multi-Family	Secondary Market
Sites = 48 DC Ports = 147+38 L2 Ports = 25	Sites = 52 DC Ports = 104 L2 Ports = 91	Sites = 276 DC Ports = 588 L2 Ports = **	Sites = 7 DC Ports = 7 L2 Ports = **	Sites = 37 DC Ports = 42 L2 Ports = **	Sites = 147 DC Ports = 158 L2 Ports = **



Notes: Charging locations shown are an approximation of potential future installation, not a specific recommendation. Additional analysis will be required to identify actual charging station locations. With regard to the Corridor use case track, locations shown correspond with potential, relative locations for FAST 50 chargers, which would be spaced at least every 50 miles on selected corridors (FAST 50 chargers: locations spaced no more than 50 miles apart along an identified corridor with multiple charging ports capable of at least 50kW power level.

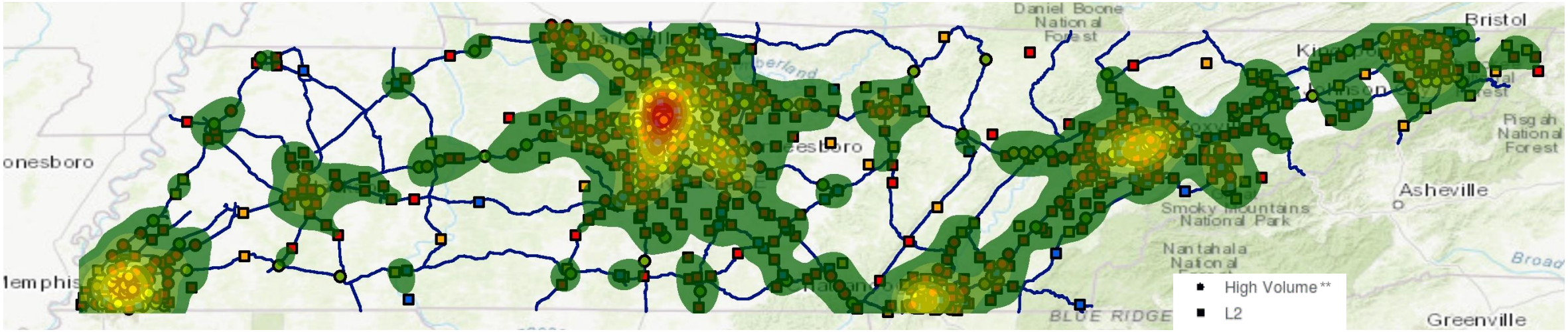
*Corridors include Federal Highway Administration (FHWA) classifications: Interstate, Principal Arterial – Other Freeways and Expressways, Principal Arterial – Other

**Assumes no co-location

***High Volume sites are those with enough demand to include both DC and L2 ports. Whether ports are collocated at one site or installed at nearby sites is a site selection consideration not included in this study.

L2 SITES AND PORTS

Existing Sites	Corridor*	Primary Market	Limited Income	Multi-Family	Secondary Market
Sites = 255 L2 Ports = 693+363	Sites = 0 L2 Ports = 0	Sites = 253 L2 Ports = 2,223	Sites = 48 L2 Ports = 121	Sites = 57 L2 Ports = 251	Sites = 466 L2 Ports = 1,311



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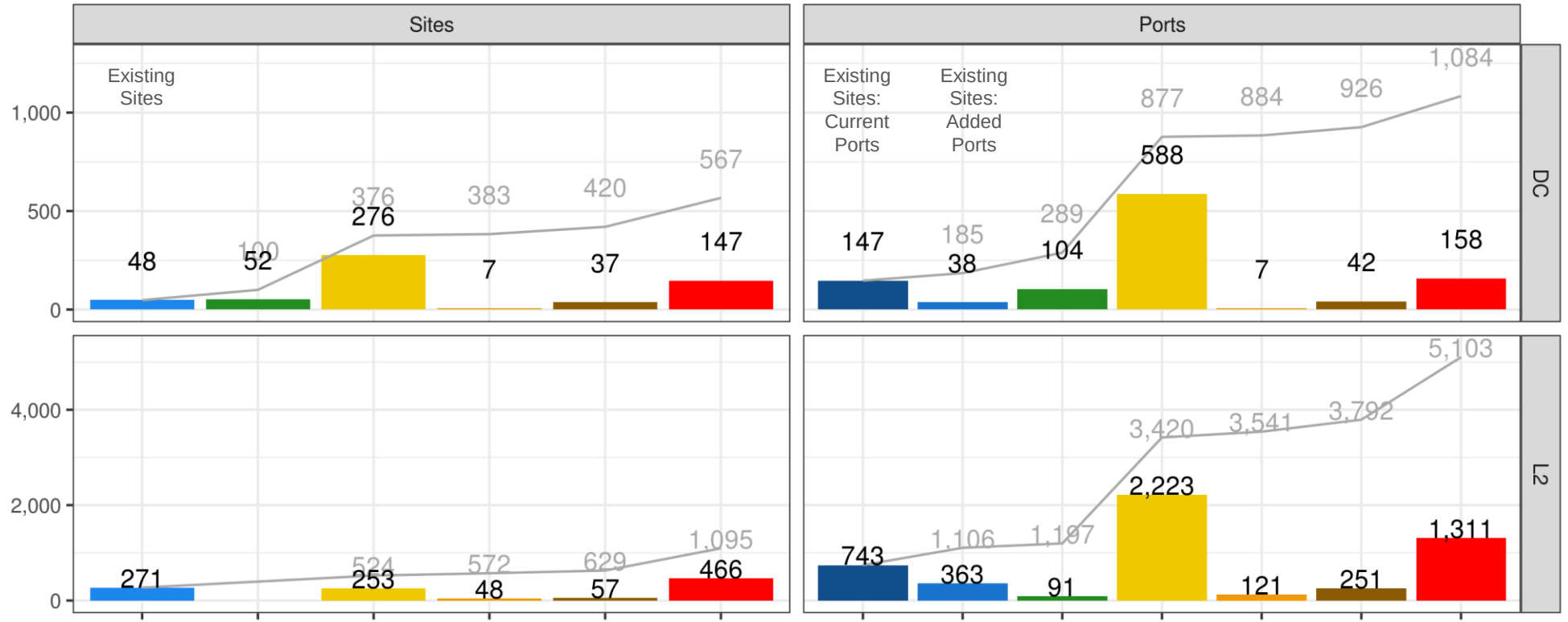
*Corridors include Federal Highway Administration (FHWA) classifications: Interstate, Principal Arterial – Other Freeways and Expressways, Principal Arterial – Other
**High Volume sites are those with enough demand to include both DC and L2 ports. Whether ports are collocated at one site or installed at nearby sites is a site selection consideration not included in this study.

PUBLIC SITES AND PORTS

Existing Sites | Corridor | Primary Market | Limited Income | Multi-Family | Secondary Market



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CONCLUSIONS

Public charging infrastructure investments in Tennessee to support the adoption target of 200,000 PEVs should contain a variety of use cases to maximize availability and thereby unlock latent PEV demand that views range anxiety as a barrier to PEV adoption.

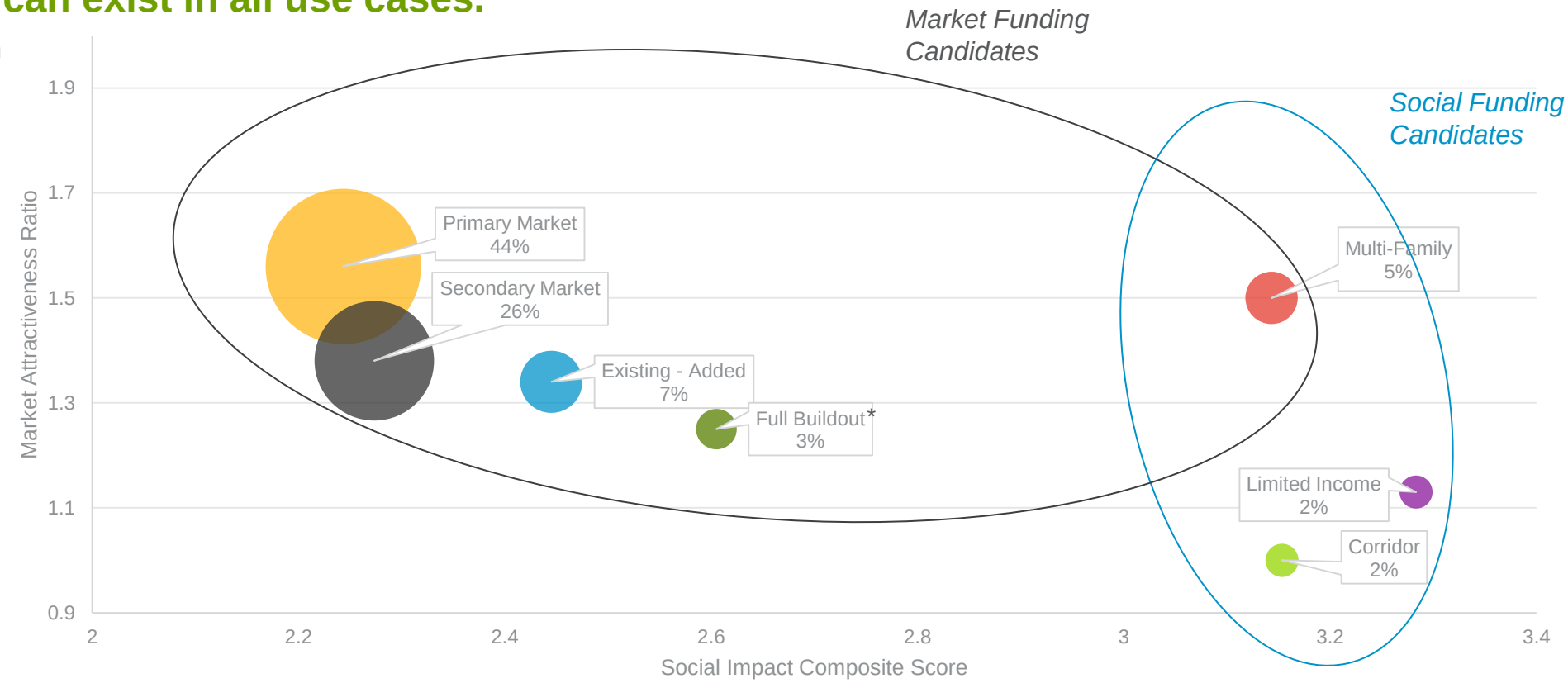
- ***DC Fast Charging Network:***
  - A public DC Fast Charging Network should include Corridor sites along major highways, Primary Market sites with high market attractiveness, and more utilized sites with other use cases.
- ***Level 2 Charging Network:***
  - A public Level 2 charging network would complement the DC Fast Charging network in the Corridor and Primary Market use cases, while forming the majority of the charging infrastructure in the other use cases.
  - A public Level 2 network could also assist with meeting other public good goals, including areas with a high presence of Limited Income families and areas with a higher concentration of Multi-Family dwellings.

SITE PRIORITIZATION BY UTILIZATION (KWH)

Higher revenue opportunity use cases reflect key candidates for funding by market actors; whereas, high social impact use cases would benefit from public funding to support deployment; public-private partnerships can exist in all use cases.

Site Prioritization by Utilization (kWh)

(Use Cases in 2028, Share of Charging Utilization)



Note: Percentages do not total to 100% as 11% of utilization is attributed to ports already existing and are not included in this analysis.
* Full Buildout – Complete set of sites required to support widespread PEV adoption beyond 200,000 PEVs. No ports were allocated to these sites for this project.

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CONCLUSIONS

Recognizing that all use cases play important roles in achieving DET's goals, Navigant's analysis provides insights into which uses cases private and public sector stakeholders can focus efforts for PEV charging infrastructure deployment.

- ***Significant market attractiveness for certain use cases*** – PEV adoption results in significant utilization of the high demand and medium demand stations, which make those stations attractive to private sector investment
- ***Role for publicly-funded infrastructure to reduce range anxiety and ensure equity of access*** – Corridor and lower income stations are important to widespread adoption of PEVs, but are unlikely to be developed by market actors to the extent required to achieve DET's Mission of 200,000 PEVs by 2028
  - Even though these stations are relatively less utilized, these use cases have a significant number of stations and therefore require investment
- ***Public-private partnership potential exists in the multi-family dwelling segment*** – Multi-family use case has both a high market attractiveness and high social impact

CONCLUSIONS

Increased PEV adoption benefits most from broad stakeholder support. The analysis of state and utility support provides insights into common program components for sustained PEV market growth.

State Support

- High PEV population linked to high PEV charging equipment installed population
- Top-down policy support for environmental protection policies correlated with transportation electrification efforts
- State PEV Charging Equipment Scope focuses on filling gaps as market matures
- Marketing & Outreach catalyzes market development efforts driving growth

Utility Use Cases and Comparison

Use Case	Utility	Program	Total $	Key Equipment Targets	Infrastructure Approach	Primary Segments	Rates	Marketing & Outreach	Stakeholder Scale
Corridor	NewYork Power Authority	Evolve NY	$40M	200 DCFC	Equipment Rebate	Public	Growth Incentive	Digital Website Experiential	High
Primary Market	conEdison	Fast Charge Per Plug Incentive	$6.4M	400 DCFC	Equipment Rebate	Public	Growth Incentive	Digital Website	High
Limited Income	Southern California Edison	Charge Ready	$22M	1250 L2	Make-ready Rate-based + Equipment Rebate	Public 50% Disadvantaged Community (DAC)	PEV TOU	Digital Website Print Experiential	High
Multi-Family	Duke Energy Florida	Park & Plug	$8M	530 L2 30 DCFC	Utility Own / Operate	Multi-family Workplace Public	Standard	Digital Website Print	Moderate
Secondary Market	MidAmerican Energy Company	DC Fast Charge Network	$3.5M	15 DCFC	Utility Own / Operate	Public	Standard	Website	Low

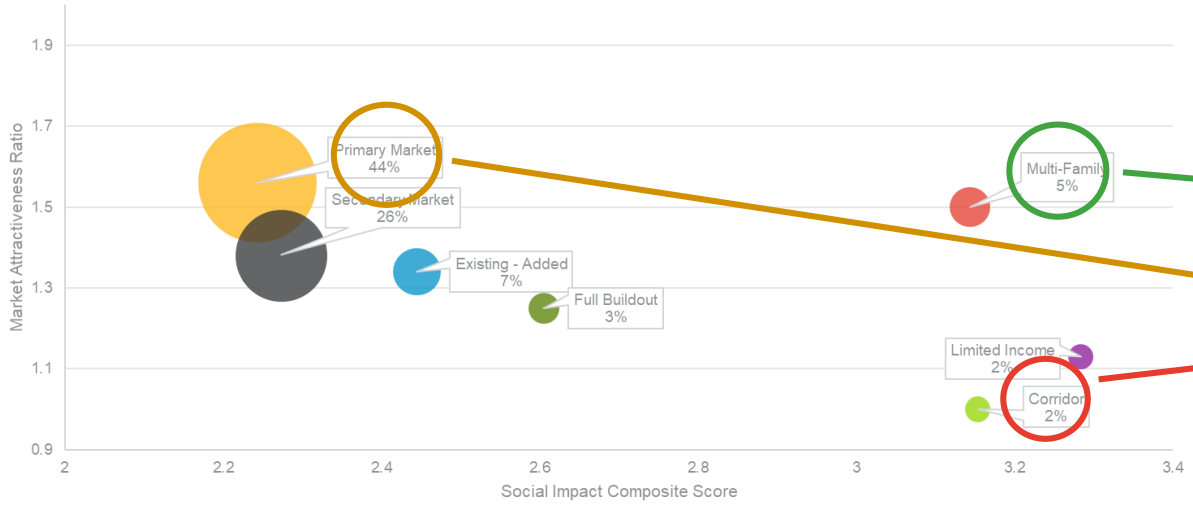
Utility Support

- Make-ready and PEV charging equipment rebates are common infrastructure approaches
- Programs focus on several key Customer Segments
- Leading program designs include PEV Rates
- Marketing & Outreach efforts are strategic and delivered through a multi-channel approach
- Broad stakeholder engagement and support is key for success

EV CHARGING NEEDS ASSESSMENT AND THE DET ROADMAP

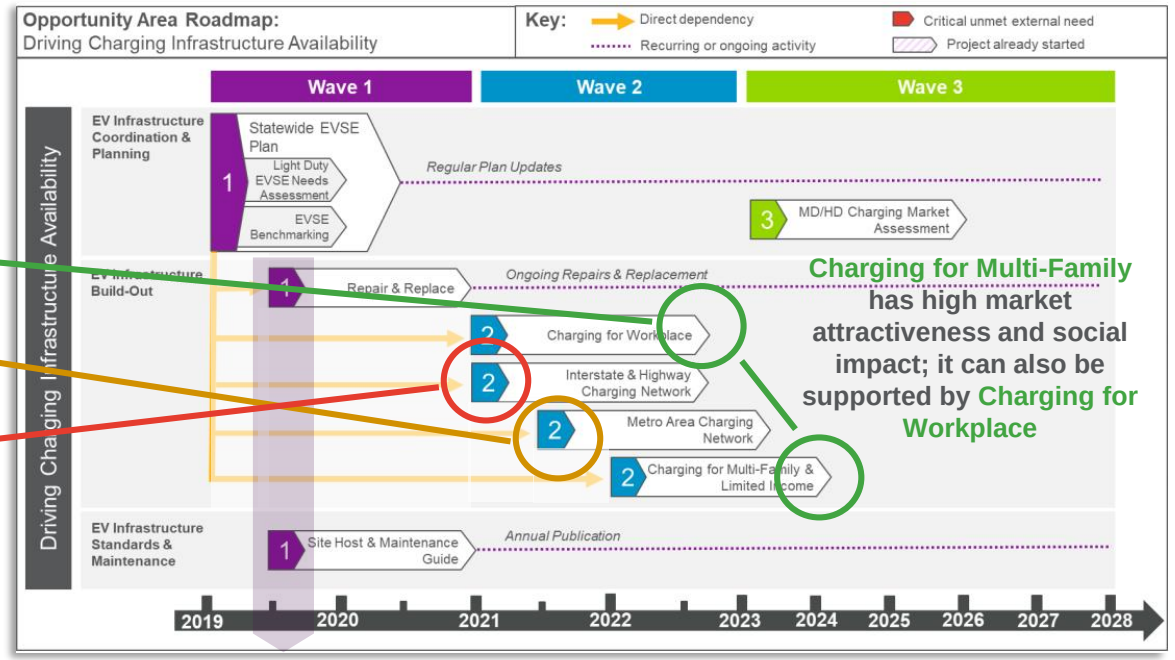
Findings in the Electric Vehicle Charging Needs Assessment reflect the value of moving forward with planned projects in the *Drive Electric Tennessee Roadmap* to drive charging infrastructure availability and unlock market demand.

Site Prioritization by Utilization (kWh) (Use Cases in 2028, Share of Charging Utilization)



High demand stations reflect the opportunity for private investment in Metro Area Charging Networks

Interstate & Highway Charging Network will have significant social impacts, but are less attractive for private market investment



Charging for Multi-Family has high market attractiveness and social impact; it can also be supported by Charging for Workplace

The onsite charging station visits provide guidance on where to Repair & Replace underperforming chargers and develop a Site Host & Maintenance Guide for keeping chargers operational

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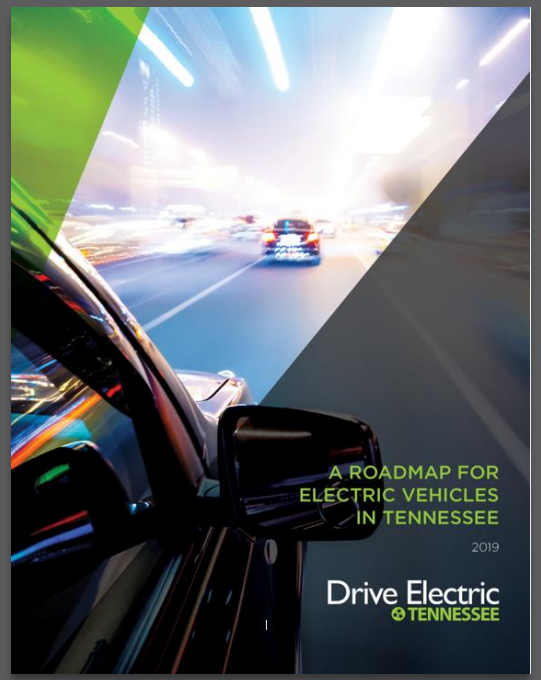

CONNECT WITH US

Contact DriveElectricTN@navigant.com with any questions about the assessment or to get involved with Drive Electric Tennessee.

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APPENDIX

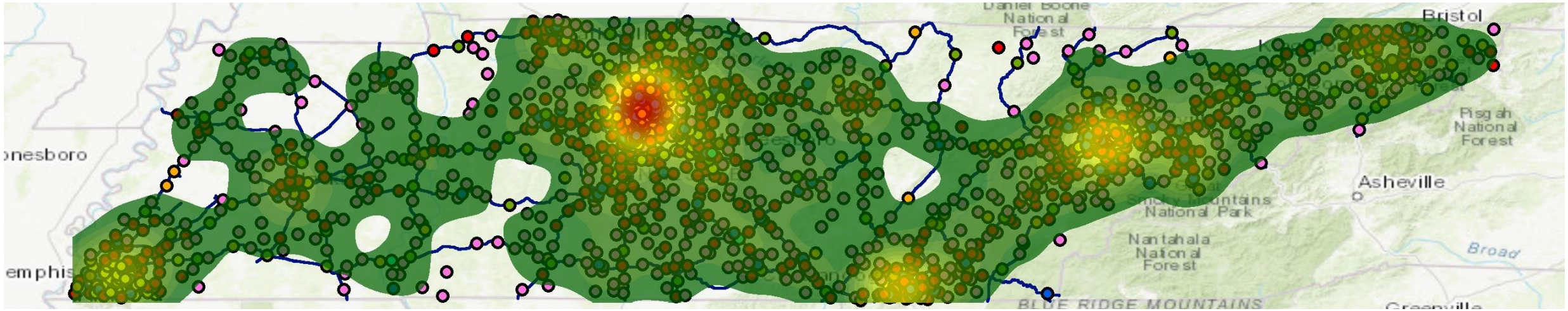
VAST™ PEV CHARGING GLOSSARY

VAST™ Term	Description	Alternate Terms
Site	Geographical boundary including one or more utility service points and PEV charging hardware installations	Premise / Location
Port	One charging plug / cord set on one station	Head / Plug / Connection
Public	Publicly-located station that is available to all customers	In front of the fence
Private	Privately-located station that is available only to customers who are provided access	Behind the fence
Corridor	Stations that are located to allow travel between major metropolitan areas	Highway
Market	Stations that are located to meet competitive local market traffic demand	Retail / Destination

APPENDIX

LONG-RUN SATURATION STATE

Existing Sites | Corridor | Primary Market | Limited Income | Multi-Family | Secondary Market | Full Buildout



Full Buildout includes long term sites beyond 2028 and the 200,000 PEV target

Note: Charging locations shown are an approximation of potential future installation, not a specific recommendation. Additional analysis will be required to identify actual charging station locations.

