Overview: National Grid Electric Highways Study

NYISO
Spring Economic Conference 2023

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Agenda

- Context: Why a highway fast charging study?
- Scenarios, Methodology, Assumptions
- Light-Duty Results
- Medium- and Heavy-Duty Results
- Combined Results
- Key Insights and Discussion

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- **Context: Why a highway fast charging study?**
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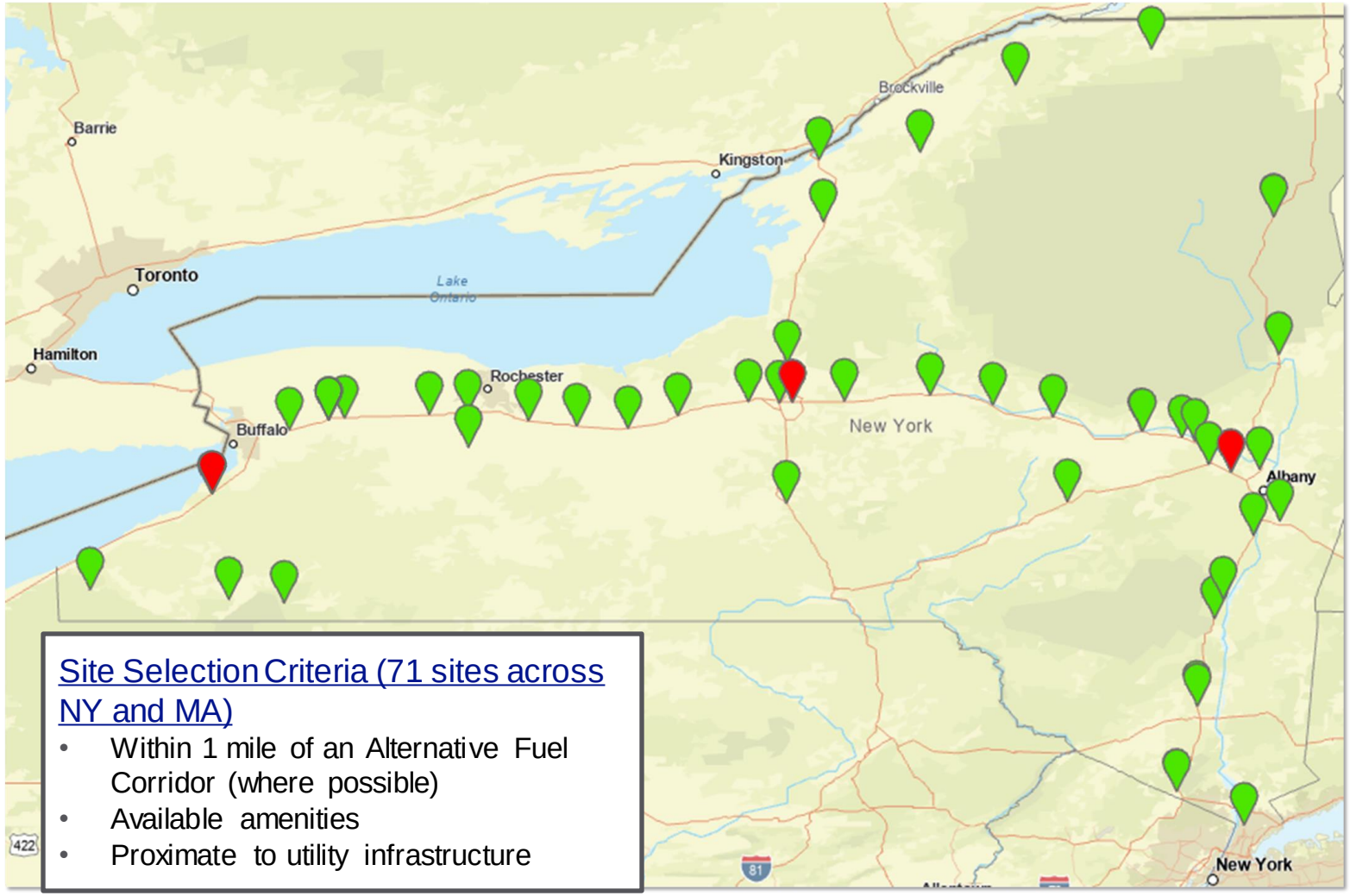
- **Medium- and Heavy-Duty Results**
- **Combined Results**
- **Key Insights and Discussion**

Context, Purpose, Partners, and Site Selection

- **Context:** Highway charging is critical for large-scale EV adoption and is anticipated to require large amounts of electricity.
- **Purpose:** Conduct a first of its kind, site specific study of traffic patterns, and power infrastructure required to support the transport decarbonization mandates of NY and MA.
- Support utility long-term capital planning and informed highway charging planning and deployment.
- Study Partners: **CALSTART, RMI, Geotab, Stable Auto**



Three sites are presented as representative examples of other highway charging sites

1. Angola Travel Plaza	2. DeWitt Travel Plaza	3. Guilderland Travel Plaza
Representative **Large Passenger/Truck Stop**	Representative **Moderate Traffic Stop**	Representative **Busy Passenger Plaza**
~10 Megawatts of Capacity by 2030	**~5 Megawatts of Capacity by 2030**	**~5 Megawatts of Capacity by 2030**

These three representative sites also create a 300-mile charging corridor on I-90

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Methodology, Assumptions, and Scenarios

Light-Duty Vehicles

The LDV results use Stable Auto's insights based on 2.5 years of observations from 3,000+ DCFC in the U.S. today

1. Session power = 75 kW (observed average today) and grows over time.
2. Charger power = 350 kW
3. Session duration = assume a constant change in a vehicle SOC, session duration varies by battery size and charging capacity
4. Assumes a constant change in the state of charge for every vehicle. Because of the difference in vehicle battery sizes, uses a probability distribution to calculate a session duration for each individual session

Medium- and Heavy-Duty Vehicles

The MHDV results use observed distributions of vehicle stops at the candidate sites from Geotab's Altitude platform

1. Randomly selects several charging events to occur in a 15-minute window, based on stops of longer than 10 minutes in the Geotab data for the hour containing the 15-minute window, if each stop results in a charge
2. For each stop, randomly assigns a distance value to the trip ending in the stop and a duration of the stop. The distribution of trip distances and stop durations is assumed to follow a lognormal distribution with parameters matching those in the Geotab data for that time window
3. Energy consumption rates = 1.3 kWh/mi for MDVs and 2.5 kWh/mi for HDVs
4. Power rating = 350 kW or 1 MW, depending on scenario

We considered multiple scenarios focused on achievement of NY State transportation electrification mandates

Directional Considerations

- **Inputs are based on observed behavior and distribution of traffic.** Assumptions of increasing charger speed have been used to show anticipated improvements in vehicle batteries and assumed preferences for shorter dwell times for highway travel.
- **Each weekday and weekend have an identical distribution of expected stop times, trip distances, and stop durations** (i.e., we didn't change inputs for holidays or summer Fridays).
- **Other charging sites are assumed to compete with these highway plazas**. Changes in competition or consumer preferences, such as a large plaza drawing more vehicles, would affect site size and utilization.
- **Cold weather does not affect energy consumption or charging speed.**
- **Each MHDV stop results in a charge**.
- **All ZEVs are assumed to be electric vehicles.** Utilization of hydrogen could reduce charging speed, though could increase site capacity needs if on-site electrolysis is utilized.

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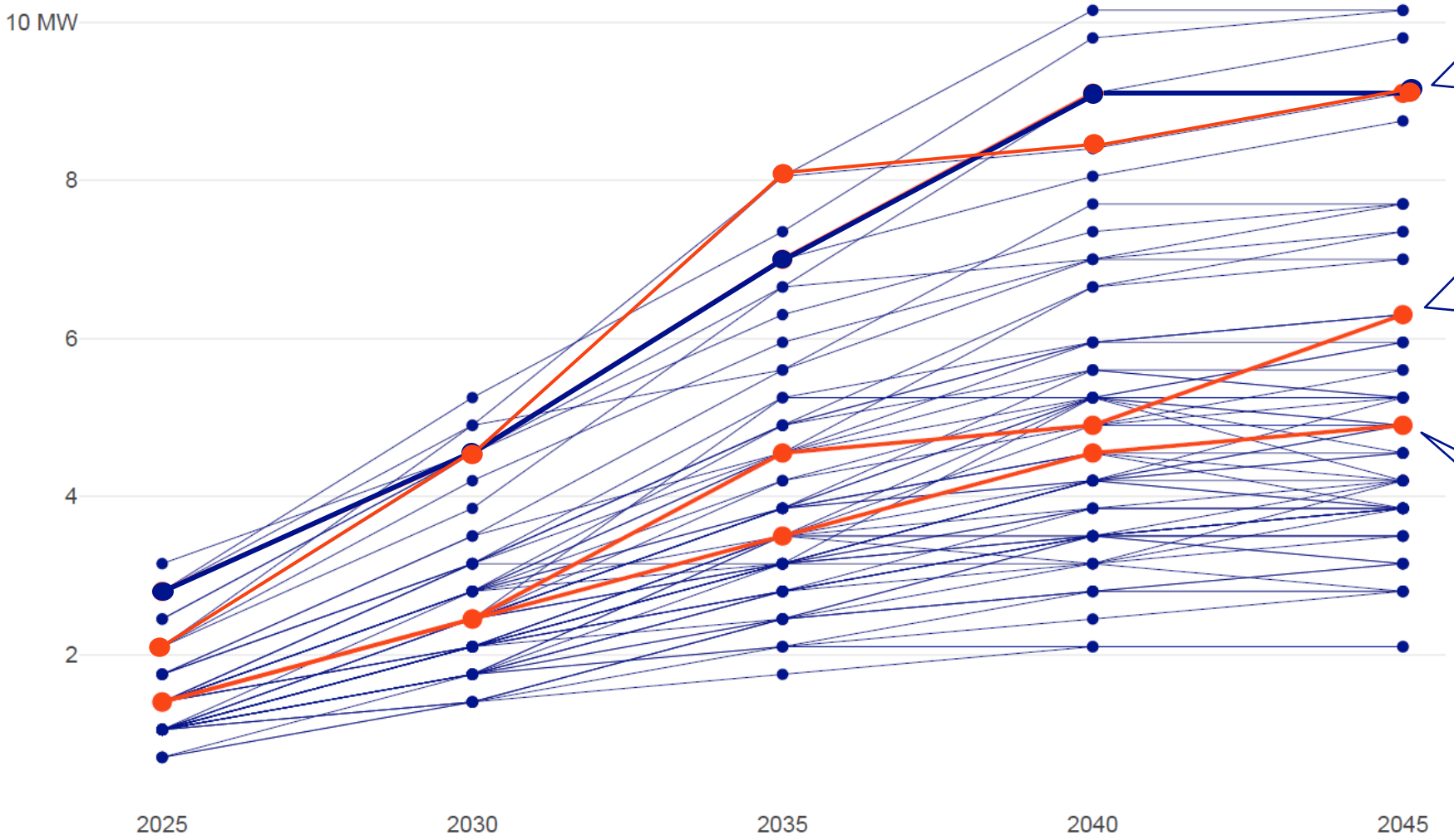
Light-Duty Results: EVSE Capacity Summary

Capacity Needed to Meet Annual Peak Demand for LDVs



Angola Travel Plaza

Representative of **Large MHDV Stops,** this site also sees steep growth in LDV demand, requiring 5 MW of charger capacity by 2030.

Guilderland Travel Plaza

Representative of **Busy Passenger Plazas,** LDV demand at this site grows by 1-2 megawatts every five years, requiring 5 MW of charger capacity by 2035.

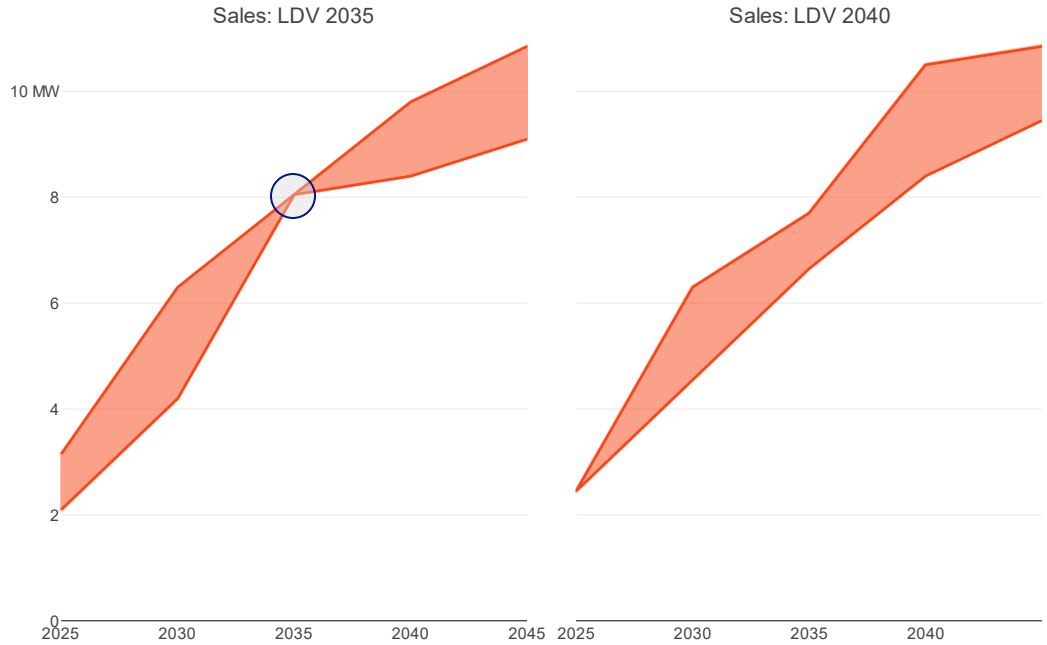
DeWitt Travel Plaza

Representative of a **Moderate Traffic Stop**, this site sees modest but steady LDV growth as EV adoption increases.

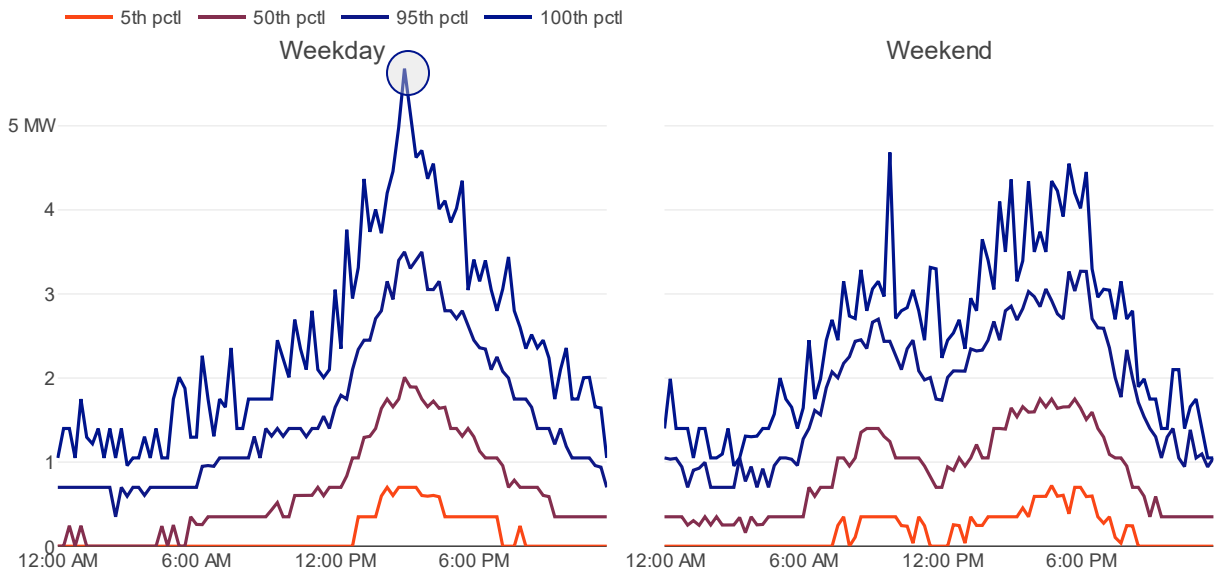
Note: Peak calculations are for EVSE capacity to meet peak demand at a given site – i.e., this is not 1-to-1 with peak demand.

Light-Duty Results: Angola Travel Plaza (East/Westbound)

Capacity Needed to Meet Annual Peak Demand for LDVs



LDV Load Curve Variation, 2035



To meet peak LDV charging demand in 2035, this site requires 20 chargers, which results in 8 MW of site demand. By 2045, the site grows to 26 chargers resulting in 9 MW of site demand.

Upper bound of each area represents optimistic charger utilization

Lower bound represents expected charger utilization

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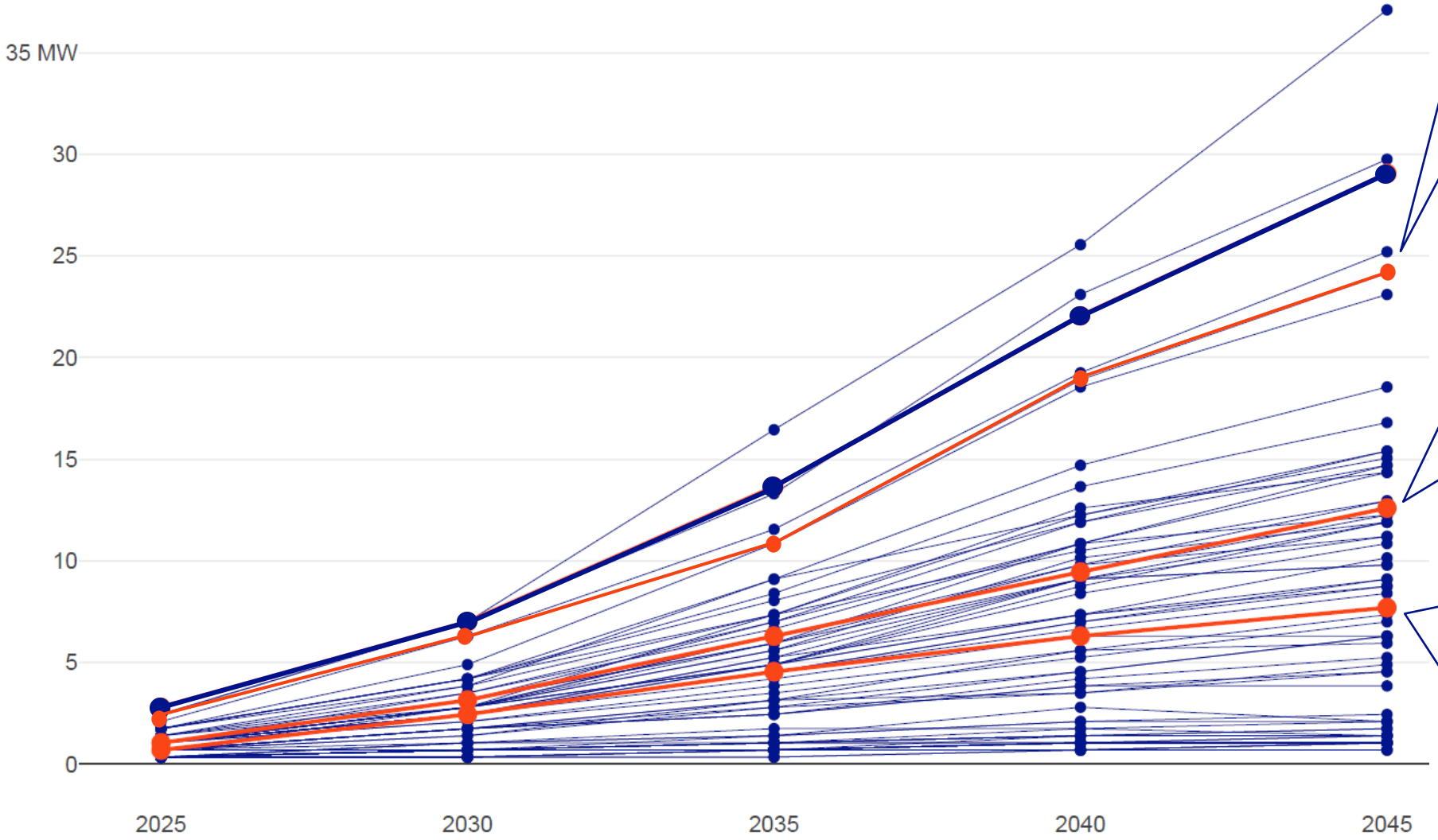
Medium- and Heavy-Duty Results: EVSE capacity summary

Capacity Needed to Meet Annual Peak Demand for MHDVs



Angola Travel Plaza

As a **Large MHDV Stop,** this site requires an order of magnitude higher capacity to meet MHDV charging needs. Between 2030 and 2050, demand increases by roughly 10 MW a decade.

Guilderland Travel Plaza

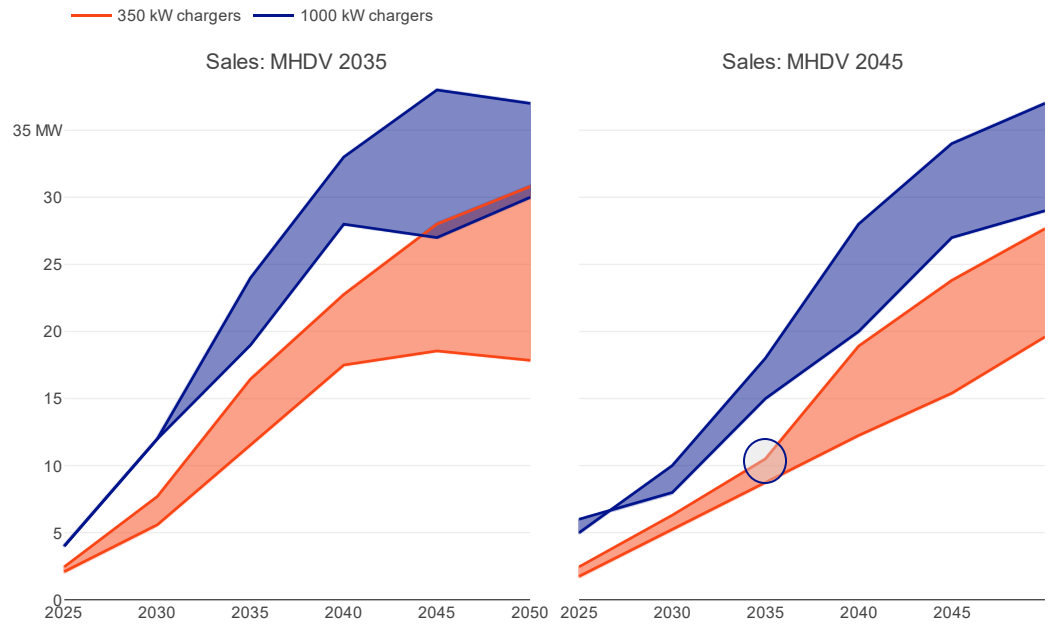
MHDV traffic at this **Busy Passenger Plaza** requires charging capacity to grow by roughly 5-6 MW per decade.

DeWitt Travel Plaza

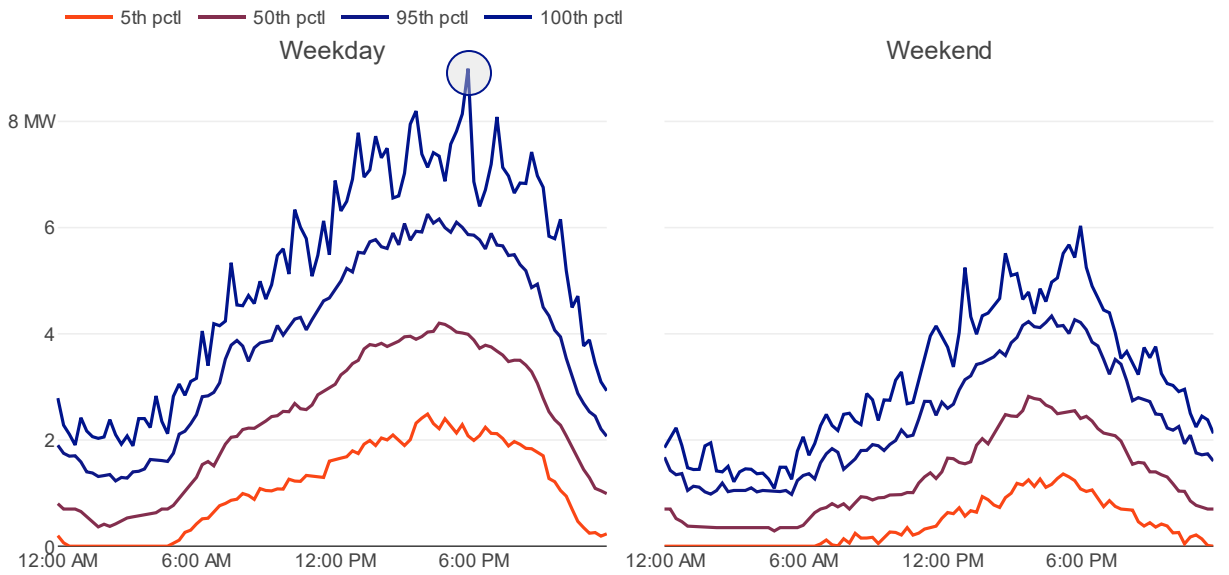
This **Moderate Traffic Stop** sees slower growth through 2030, but even at a smaller site MHDV charging capacity grows to 10 MW by 2045.

Medium- and Heavy-Duty Results: Angola Travel Plaza (East/Westbound)

Capacity Needed to Meet Annual Peak Demand for MHDVs



MHDV Load Curve Variation, 2035



As soon as 2035, this site could need 10 MW of power to meet the MHDV charging demand.

Upper bound of each area represents charging unconstrained by vehicle dwell time

Lower bound is constrained by vehicle dwell time

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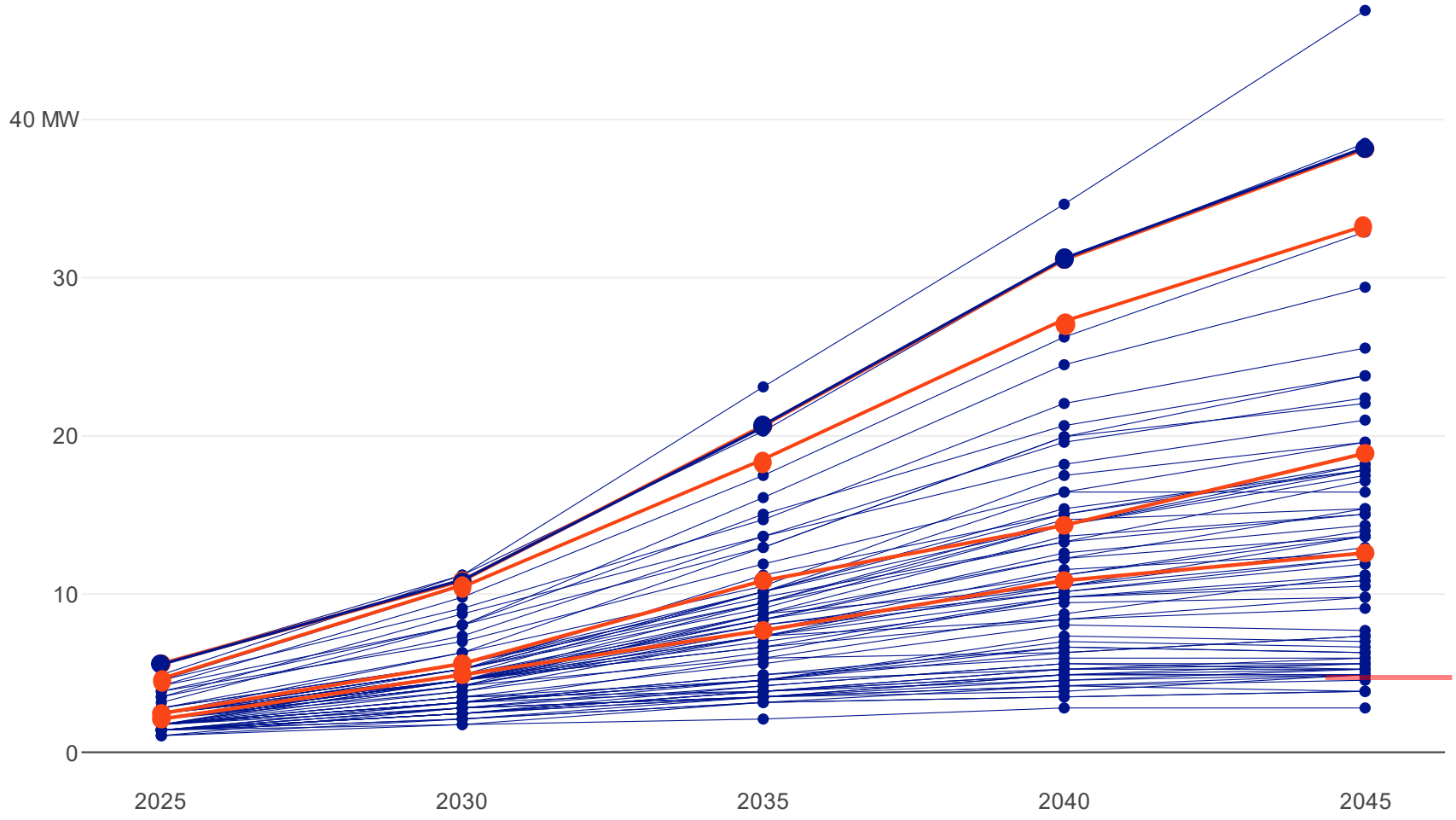
Combined Results: Review of all sites analyzed

Capacity Needed to Meet Annual Peak Demand for All Vehicles



1 Angola Travel Plaza

3 Guilderland Travel Plaza

2 DeWitt Travel Plaza

Typical distribution limit for load interconnection

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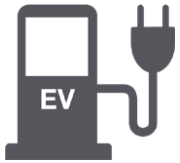
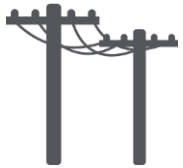
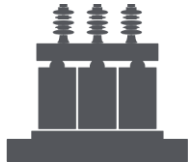
There is a critical need to align infrastructure timelines with electrification roadmaps

~2 Months to Construct	~1-4 Years to Construct	~4-8 Years to Construct
		
Onsite Upgrades	**Distribution Upgrades**	**Transmission Interconnection and Upgrades**

- **Pilot Vehicles**
- **First Stage Electrification**
- **Large-Scale Electrification**

To meet electrification goals and driver needs, National Grid must develop expandable sites that account for future EV growth.

Shared planning on strategic locations, site sizes, and timelines should involve utilities, DOT, Thruway Authority, NYSERDA, and DPS.

Key Insights and Discussion

- Some highway charging sites will **require power levels equivalent to small towns**.
- Efforts to employ managed charging may help to reduce the power requirements at some sites, but do not fit driver expectations and service plaza use case.
- By 2030, some EV loads will exceed our distribution system limits – **transmission interconnection will be required.**
- Anticipatory planning and investment at the sites with the highest charging loads will lower overall costs (e.g., avoids a series of costly distribution upgrades) and allow for timely charger additions to serve increased EV penetration.
- **Guiding charging traffic to no-regrets sites** from a traffic and electric infrastructure perspective will be cost effective and **provide for the best charging experience for New Yorkers**.

Next Steps to Enable Transport Decarbonization

- National Grid, NREL, and RMI won a US Dept of Energy grant to conduct a similar study on MHDV corridor charging in NJ, PA, NY, MA, RI, CT, VT, NH, and ME.
- Following the study National Grid and its partners will submit a MHDV corridor electrification plan to the US DOE.
- NYISO and its stakeholders may want to think proactively about required changes to NYISO tariffs, and regulatory processes that will be required to facilitate the interconnection of these sites.
- Begin to discuss the broader system planning implications of transport electrification.

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Fast charging will be important for highway drivers

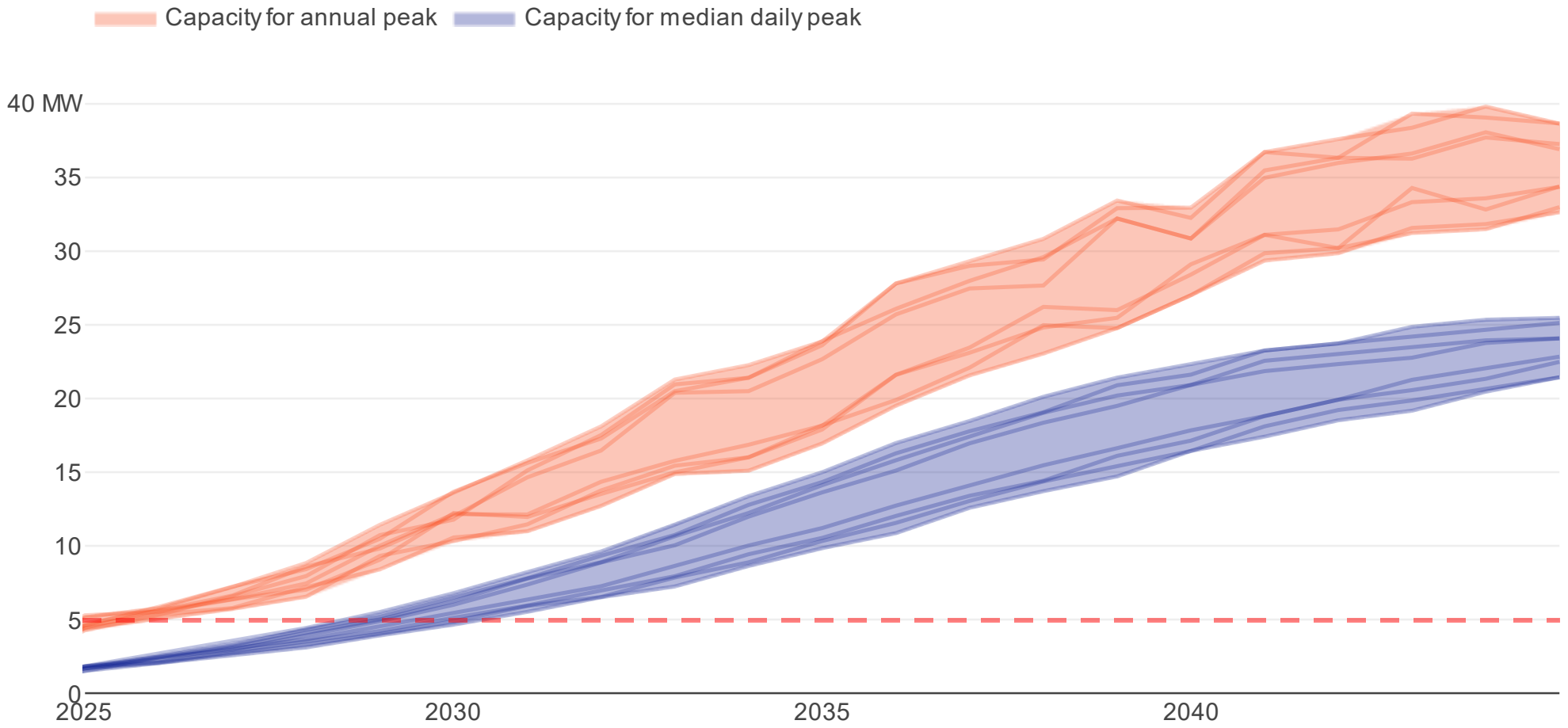
Minutes to Charge 100 Miles of Range

	Tesla Model 3	Nissan Leaf	Ford Mustang Mach-E	Volvo XC40 Recharge	Rivian R1T
Level 1 (1.5 kW)	1,080	1,400	1,560	1,720	2,040
Level 2 (12 kW)	135	175	195	215	255
DCFC (50 kW)	32	42	47	52	61
DCFC (150 kW)	11	14	16	17	20
DCFC (350 kW)	5	6	7	7	9

Allowing customers to charge in a reasonable amount of time will require ultra-fast DCFC at service plazas – and even higher-powered charging for MHDVs (1 MW +) is under development

LDV and MHDV Results: Angola Travel Plaza (E/W)

Capacity Needed to Meet Annual and Median Peak Demand for LDVs and MHDVs

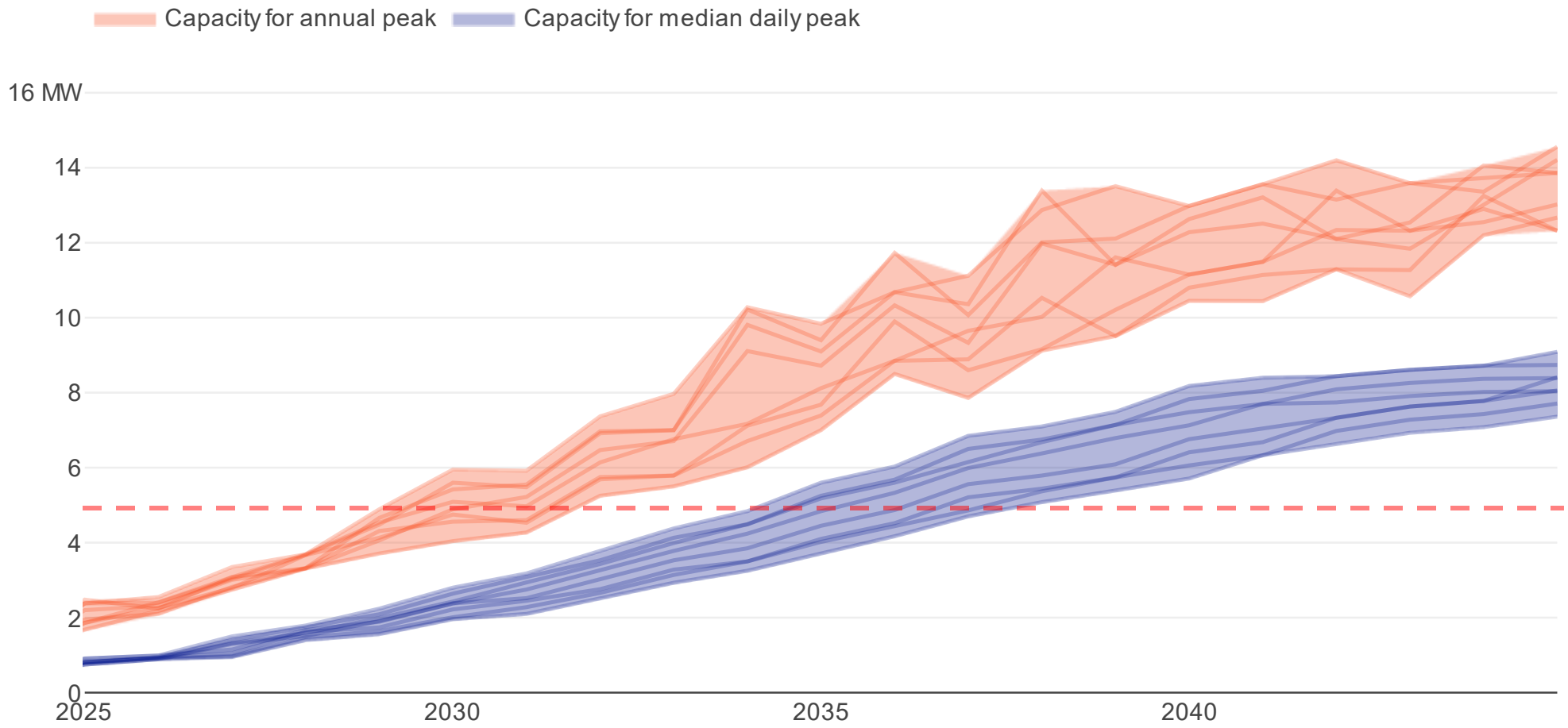


Typical distribution limit for load interconnection

Key Insight	**As soon as 2025-2030, this site could need 5+ MW of EVSE capacity to meet the charging demand** – which would trigger need for a Tx level interconnection.

LDV and MHDV Results: DeWitt Plaza (Eastbound)

Capacity Needed to Meet Annual and Median Peak Demand for LDVs and MHDVs

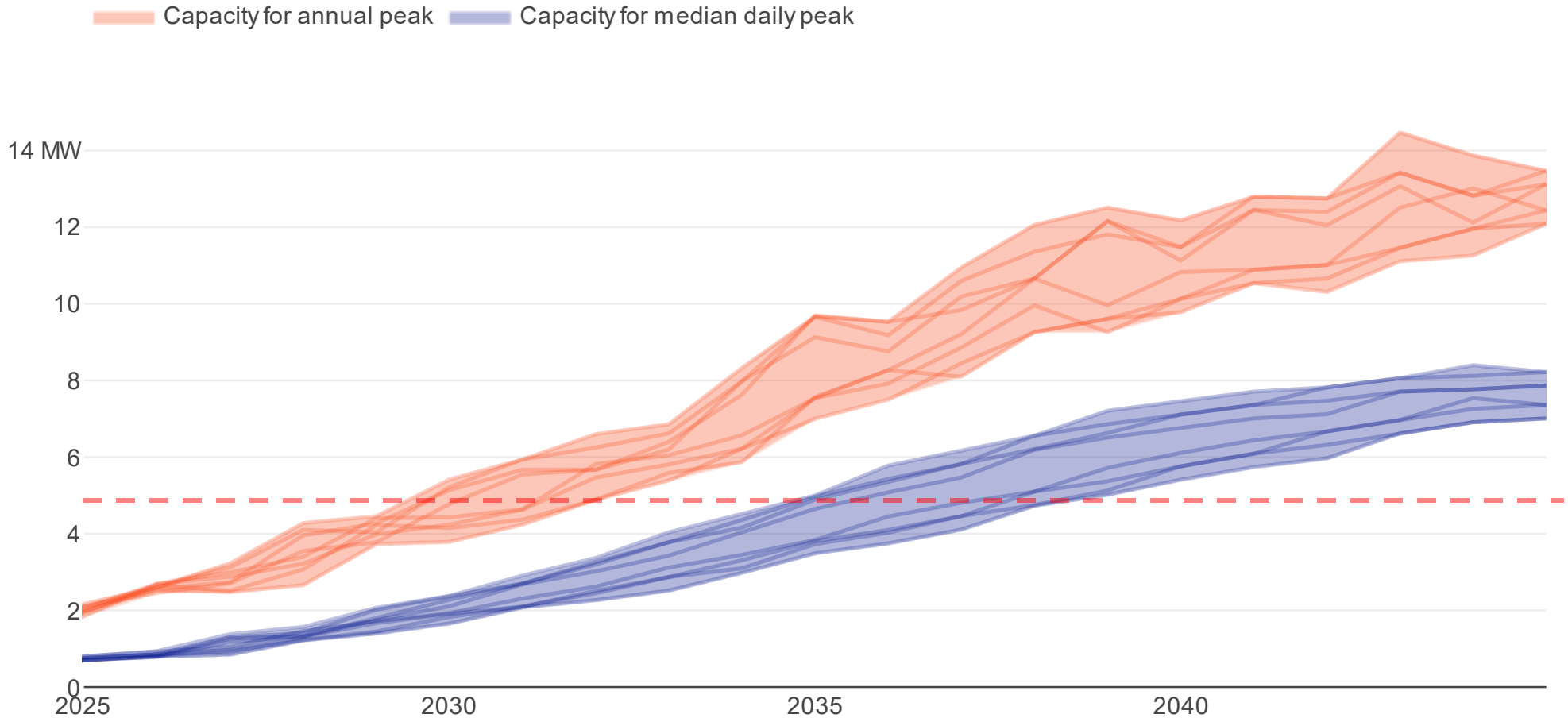


Typical distribution limit for load interconnection

Key Insight	**Site requires 5 MW of capacity as early as 2030, evenly split between LDV and MHDV** – though MHDV will drive even growth in 2035+.

LDV and MHDV Results: Guilderland Plaza (Eastbound)

Capacity Needed to Meet Annual and Median Peak Demand for LDVs and MHDVs



Typical distribution limit for load interconnection

Key Insight	**Site requires 5 MW of capacity by 2030-2035.** In 2040 timeframe, capacity needs trend toward 10 MW.

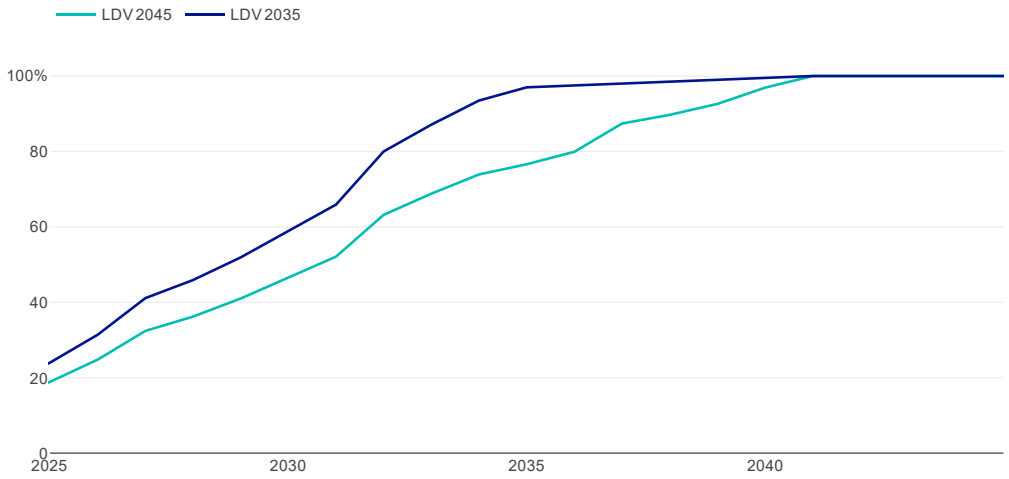
Light-Duty Scenarios

There are two LDV sales scenarios in the study. These sales figures then lead to changes in electric vehicles in operation (VIO) over time as vehicles retire and are increasingly replaced with electric models

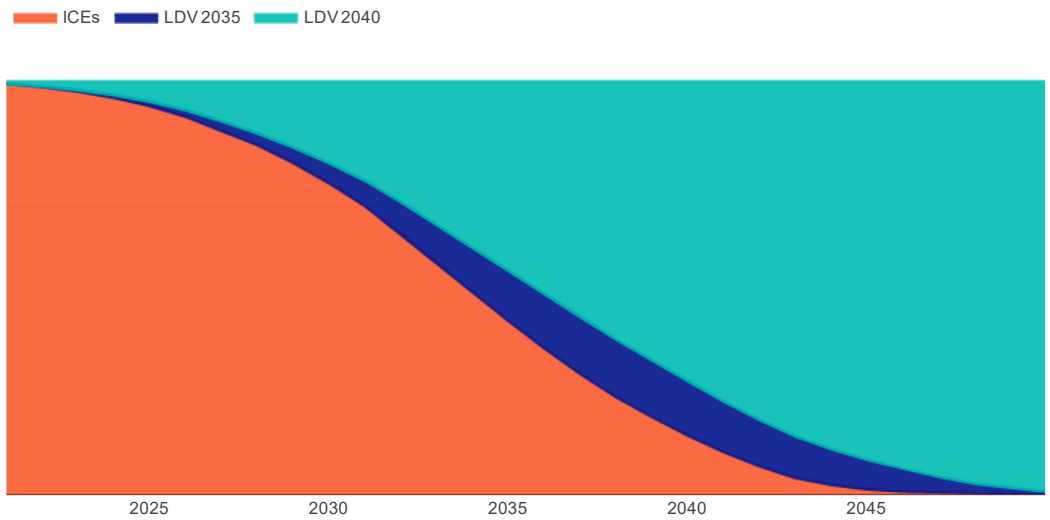
1) 100% LDV sales by 2035 (2021 legislation requirement)

2) 100% LDV sales by 2040 (slower/low case)

Sales Scenarios



VIO Population Scenarios



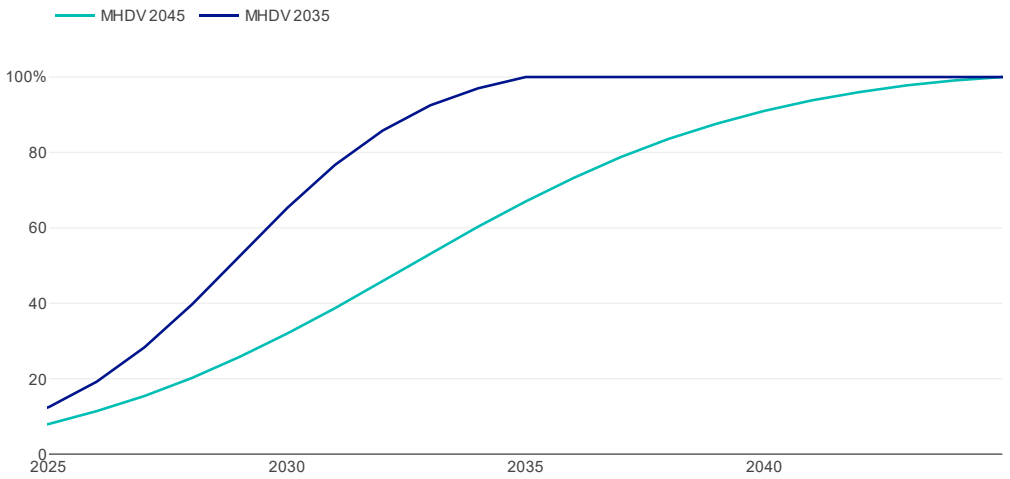
Medium- and Heavy-Duty Scenarios

There are two MHDV sales scenarios in the study. These sales figures then lead to changes in electric vehicles in operation (VIO) over time as vehicles retire and are increasingly replaced with electric models

1) 100% MHDV sales by 2045 (2021 legislation and NY ACT targets for MHDV sales)

2) 100% MHDV sales by 2035 (accelerated/high case – results in 100% electric MHDV in operation before 2050)

Sales Scenarios



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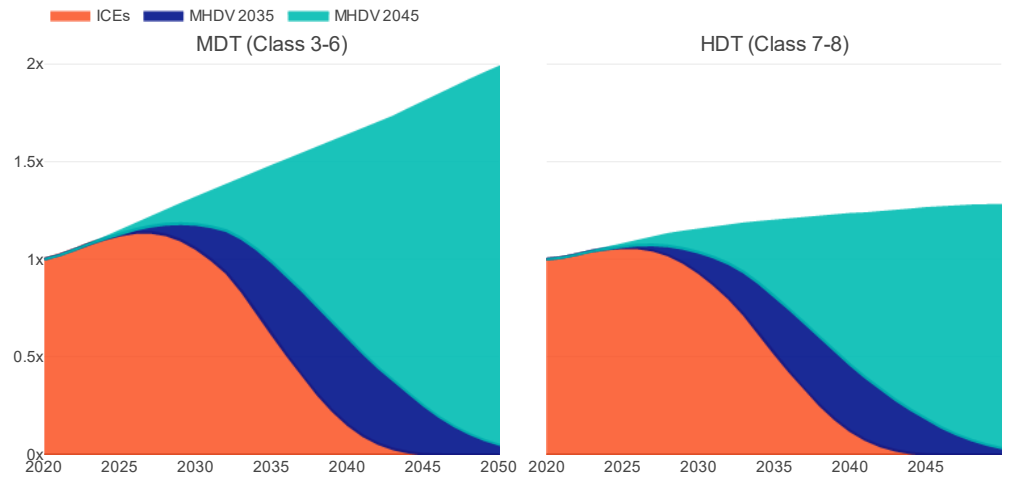
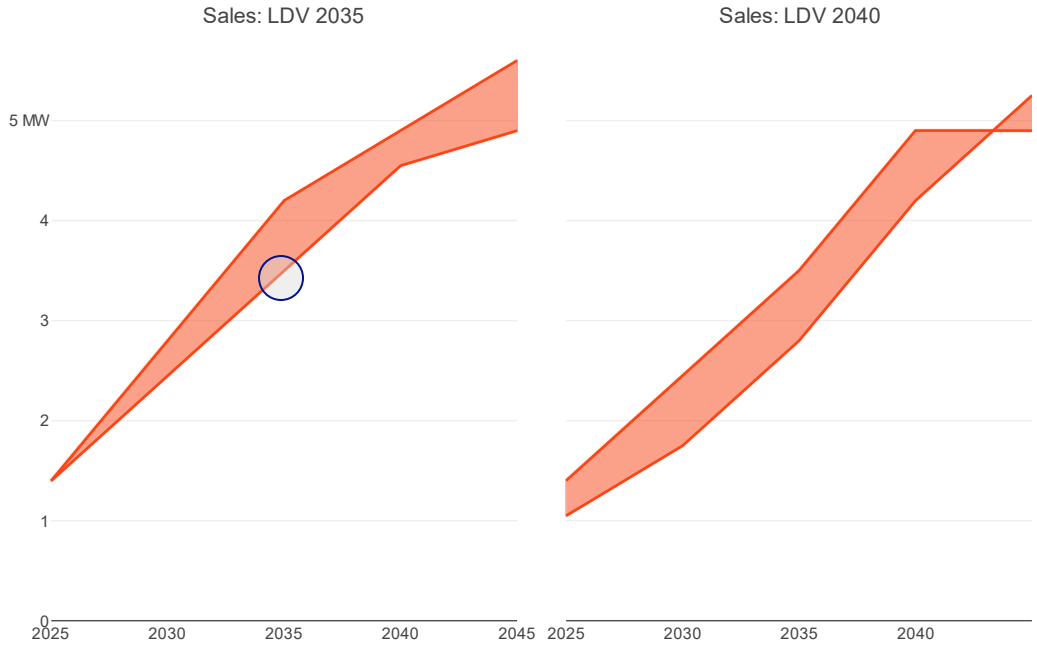
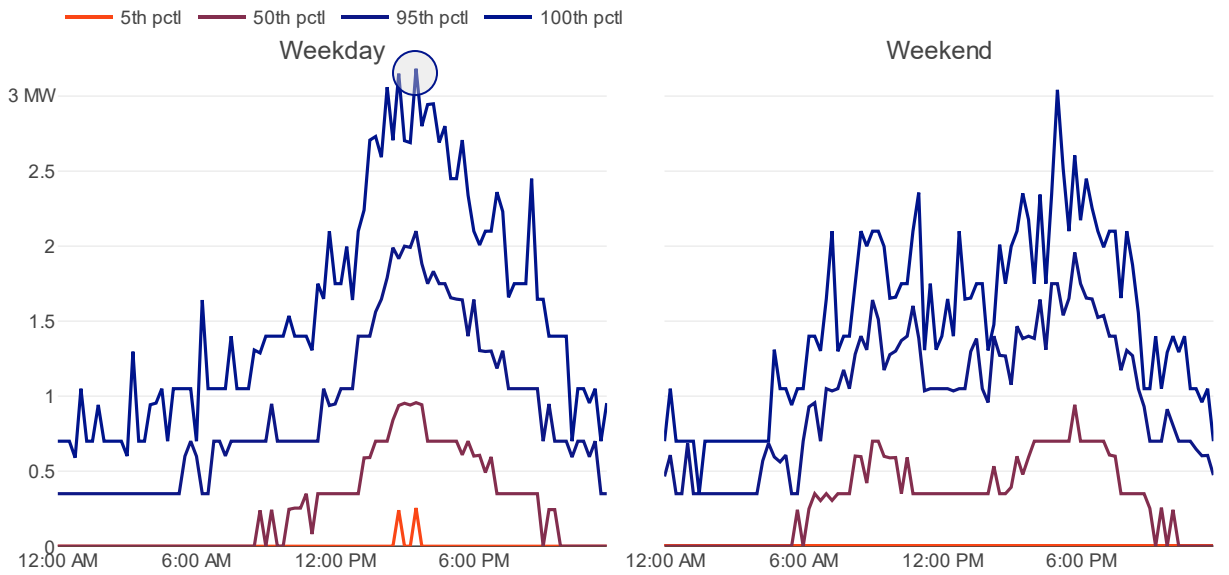


Light-Duty Results: DeWitt Travel Plaza (Eastbound)

Capacity Needed to Meet Annual Peak Demand for LDVs



LDV Load Curve Variation, 2035



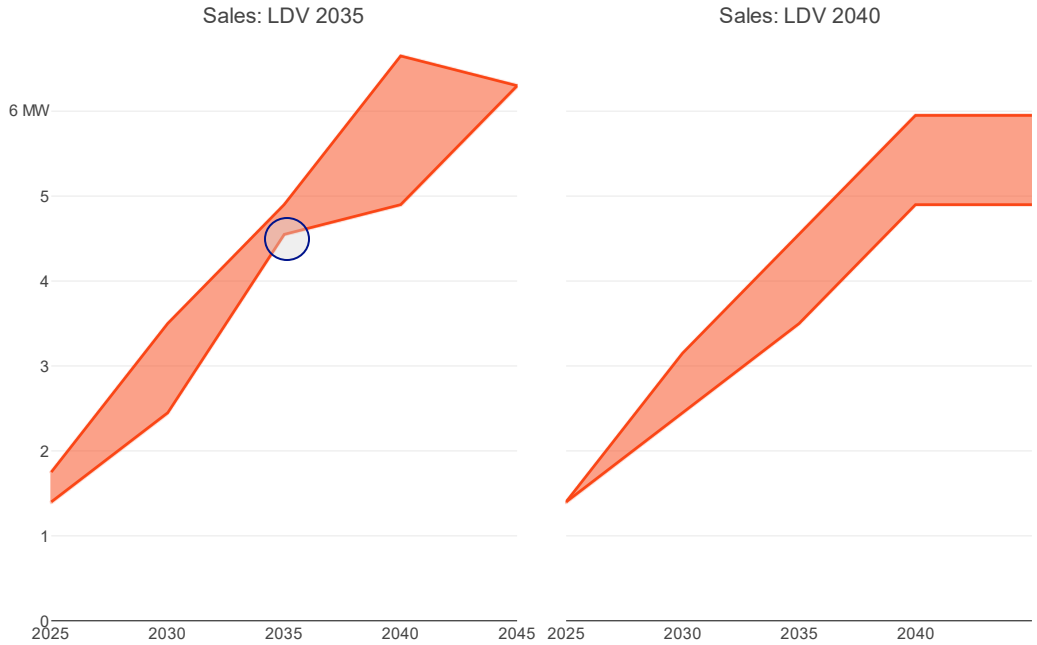
To meet peak LDV charging demand in 2035, this site requires 9 chargers, which results in 3.1 MW of site load. By 2045, the site grows to 14 chargers resulting in 4.9 MW of site demand.

Upper bound of each area represents optimistic charger utilization

Low er bound represents expected charger utilization

Light-Duty Results: Guilderland Travel Plaza (Eastbound)

Capacity Needed to Meet Annual Peak Demand for LDVs



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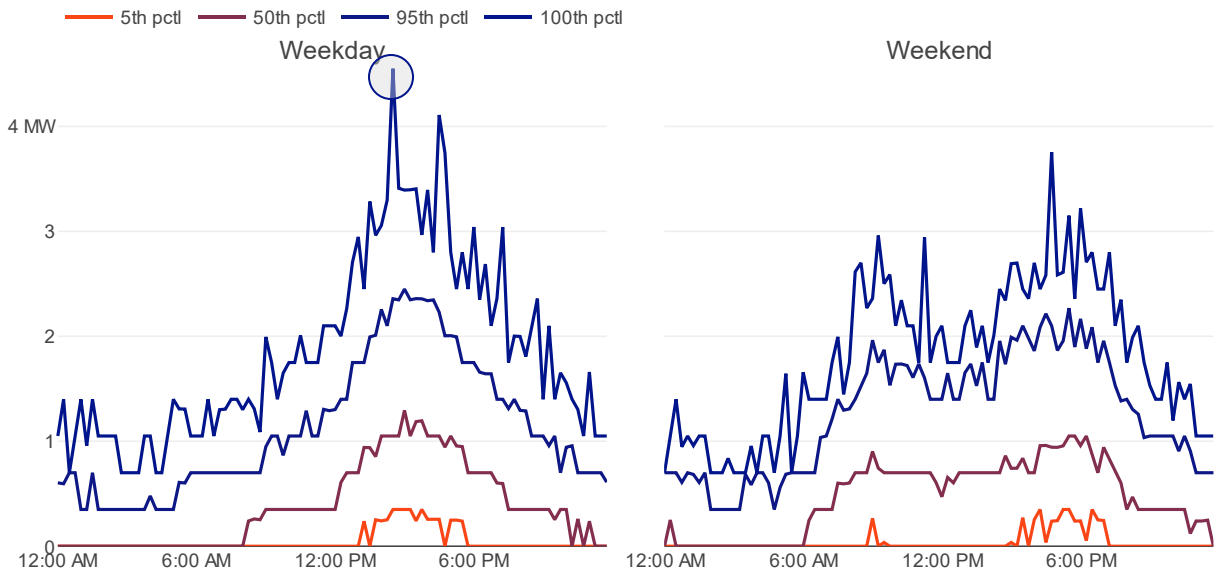


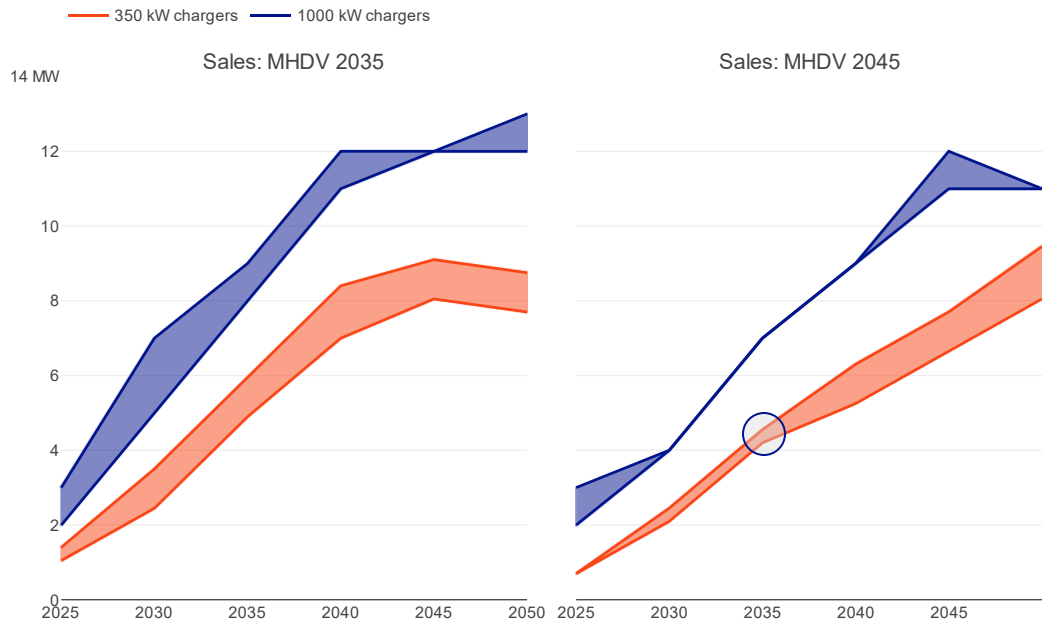
To meet peak LDV charging demand in 2035, this site requires 13 chargers, which results in 4.5 MW of site demand. By 2045, the site grows to 18 chargers resulting in 6.3 MW of site demand.

Upper bound of each area represents optimistic charger utilization

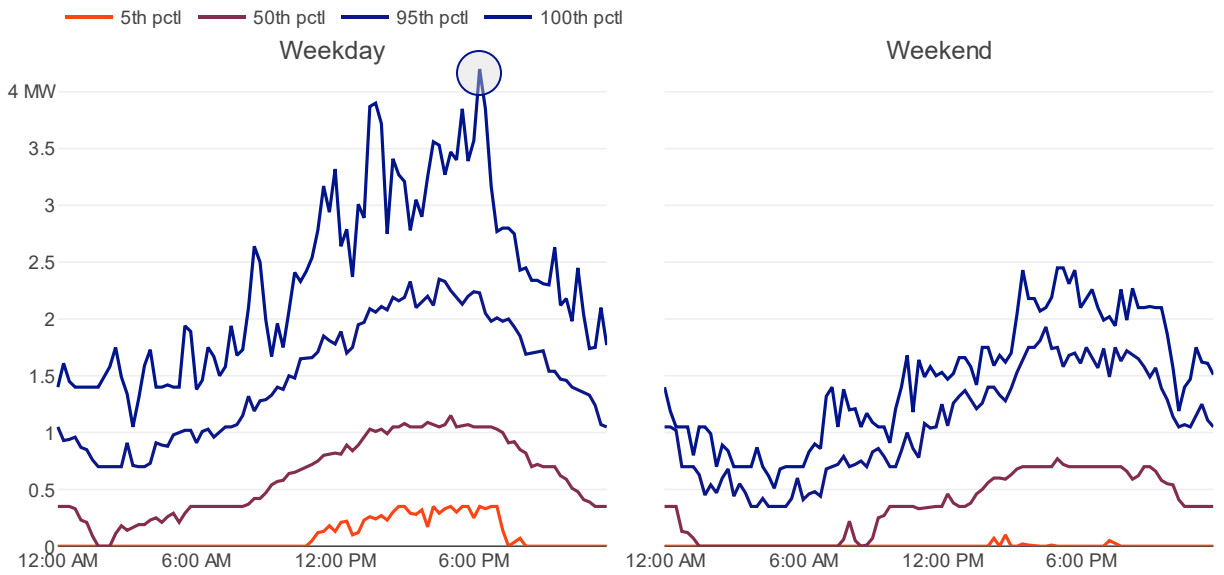
Lower bound represents expected charger utilization

Medium- and Heavy-Duty Results: DeWitt Travel Plaza (Eastbound)

Capacity Needed to Meet Annual Peak Demand for MHDVs



MHDV Load Curve Variation, 2035



MHDV stops increase at this site later in the forecast. In 2035, the site will need 4 MW of power to meet demand.

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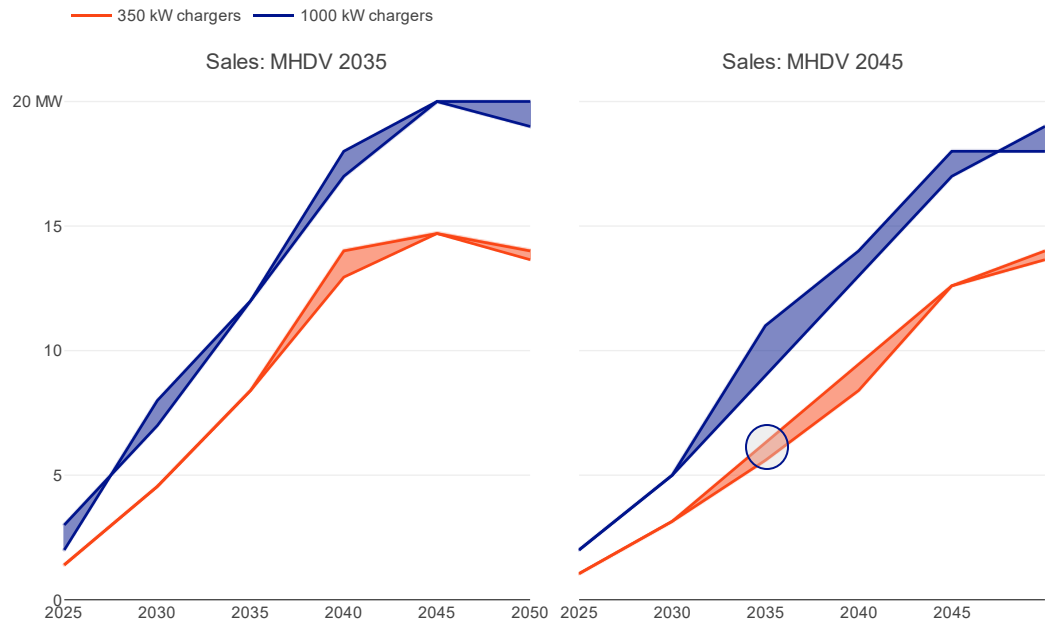
Upper bound of each area represents charging unconstrained by vehicle dwell time

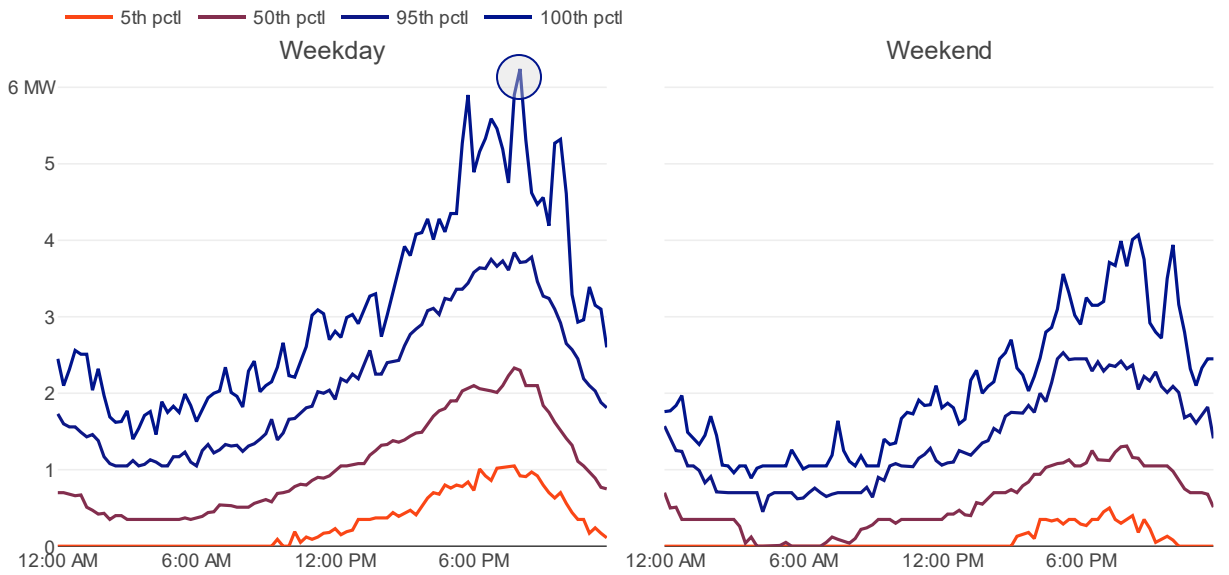
Lower bound is constrained by vehicle dwell time

Medium- and Heavy-Duty Results: Guilderland Travel Plaza (Eastbound)

Capacity Needed to Meet Annual Peak Demand for MHDVs



MHDV Load Curve Variation, 2035

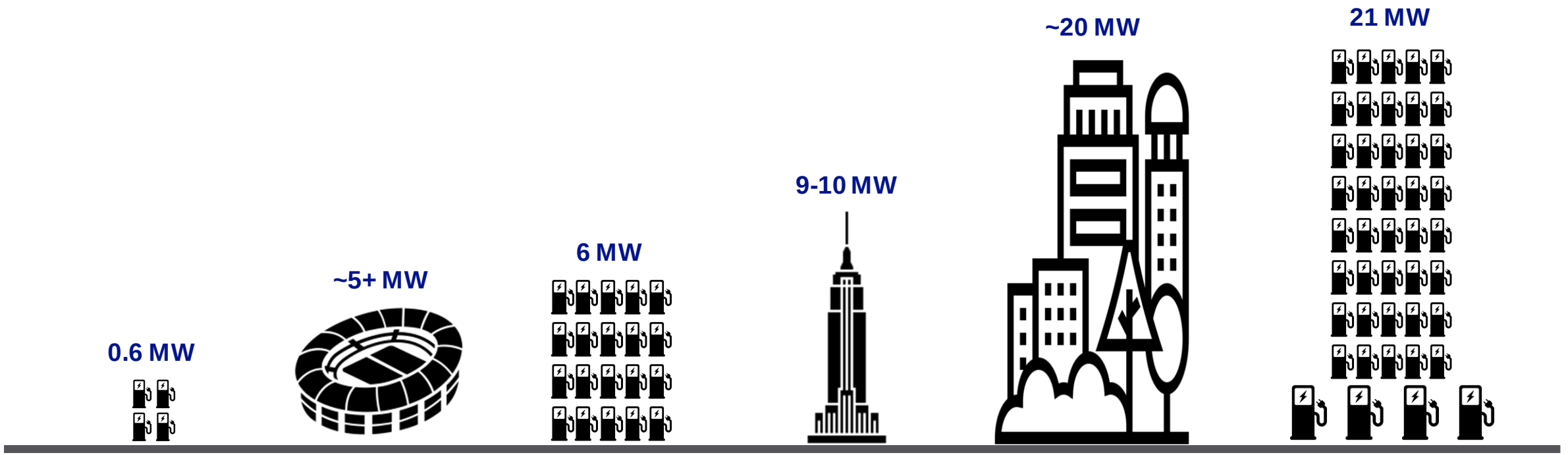


MHDV charging needs increase at a steady pace as trucking electrifies over the period of the forecast, and in 2035 surpass 6 MW.

Upper bound of each area represents charging unconstrained by vehicle dwell time

Lower bound is constrained by vehicle dwell time

Highway charging plazas will have electric demand comparable to much larger users



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