Cost and Usage Trends for Electric Vehicle Chargers:

Evidence from NYSERDA-Funded Level 2 Charging Stations in New York State

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Cost and Usage Trends for Electric Vehicle Chargers:

Evidence from NYSERDA-Funded Level 2 Charging Stations in New York State

Final Report

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Abstract

This report analyzes cost and usage data Level 2 chargers using data from stations funded by the Program Opportunity Notice (PON) 2301 demonstration project (2012–2016) and Charge Ready NY (2018–2021) in New York State.

Costs vary widely between installations depending on site-specific factors. Per-port average costs range from $8,774 to $6,921 between the earlier and later program. Both installation and equipment costs fell between programs. While decreases in equipment costs appear to be a function of real declines in price for charging stations, it is less clear whether observed reductions in installation costs reflect an overall trend in installation cost reductions or if substantial installation cost reductions are possible. However, it appears that more stringent subsidy caps can enforce some cost discipline for charging station installation.

The median charger delivered 1.5 kWh per day (on average) and served 0.14 sessions—or about one per week. However, chargers above the 90th percentile of usage were seven to eight times more productive than the median station and were responsible for about half of all charging activity. The factors contributing to charging station utilization are complex and much of the variation observed in the data remains unexplained. However, the stations with the most overall use are those with commuter-supporting usage patterns meaning that policymakers may find it productive to target program outreach toward locations where commuters can charge.

There is no evidence that congestion is a problem for charging stations in either program and large installations have (thus far) rarely been used to full capacity, a fact that policymakers should consider when deciding on project funding maximums and program design. However, charging station use has grown steadily over time and there is no evidence that the charging station landscape is saturated or that new stations are crowding out usage at existing locations. So as more EVs come into service, stations should see more utilization.

Keywords

cost and usage data, Level 2 chargers, Charge ReadyNY, subsidy caps, cost discipline, commuter-supporting usage patterns, EVs

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Summary

Governments have a key role to play in supporting electric vehicle (EV) charging station deployment. As the EV transition accelerates, and more funding becomes available for charging station deployment, information from early deployment efforts will be invaluable for policymakers designing next-generation funding programs and potential site hosts considering charging stations. However, even though much of EV infrastructure deployed to date has been supported by public funds, information on the cost and use of EV infrastructure is scarce. This report fills that gap for Level 2 chargers using data from stations funded by incentive programs in New York State.

The Level 2 charging stations examined in this report offer mid-level charging speed—supplying about 24 miles of charge an hour, depending on the equipment and vehicle. Unlike faster (and much more expensive) direct current fast chargers, Level 2 chargers are best suited for locations where drivers will park for longer periods of time, such as a long stop at a public destination while a user is at work, or overnight.

The cost and use data analyzed in this report are sourced almost exclusively[1] from charging stations deployed under the Program Opportunity Notice (PON) 2301 demonstration project (2012–2016) and Charge Ready NY (2018–2021). PON 2301 covered 80 percent of project costs while Charge Ready NY offered a flat $4,000 per charger rebate. Use data only covered stations that are part of the EV Connect and ChargePoint networks and thus cover fewer ports than the cost data.

Figure S-1. Summary of Cost and Use Data

275 funded projects	2,641 ports funded	$11.6M public funding	$19.8M total cost
Nine years of session data	2,175 ports reporting	434,578 sessions	4.2 GWh dispensed

S.1 Charging Station Costs

On average, chargers deployed by Charge Ready NY cost $6,921 per charging port, down 21 percent from $8,774 during the previous PON 2301 program. Per-port costs vary widely between installations, with the highest cost projects reaching about $20,000 per port for both programs, though costs varied more widely in the earlier PON 2301 program. On average, installation and equipment costs both contributed about half of the total cost. Most of the variation is driven by installation costs which are dependent on site-specific factors. Due to high outliers, median total costs were slightly lower than average at $6,518 and $7,790, respectively.

Both installation and equipment costs fell between the earlier PON 2301 and the later Charge Ready NY programs. While decreases in equipment costs appear to be a function of real declines in price for charging stations, it is less clear whether observed reductions in installation costs reflect an overall trend in installation cost reductions. The reduction in average installation costs seen in the data may simply be a result of the change in funding structure between the programs enforcing cost discipline on site hosts and discouraging very high-cost installations. This explanation is supported by the observation that there were proportionally more high-cost installations in the PON 2301 program, but median costs were similar to those in the Charge Ready NY data.

S.1.1 Variation in Station Costs

Costs do vary by site host, land use and geography. However, neither differences in geography nor the broad land use categories available for analysis were responsible for much of the variation. Installations at locations categorized as *public* were typically less costly than those at multi-unit dwellings (MUD) or workplaces, but the difference was not substantial, and intra-category variation is much larger than inter-category variation. The same is broadly true of the impact of geography, where the only significant takeaway was that installations in the Albany area were typically higher than downstate deployments, even those that were installed in high-cost New York City.

Expectations are that per-port installation costs should decrease as project sizes increase because fixed costs are distributed across more stations. However, for the New York programs, the per-port costs of deploying charging stations increase between small and midsize projects. It is only when projects get larger than 10 ports that per-port costs appear to fall. However, even then, average per-port costs for 20-port installations are not significantly lower than two or four port installations. While the available data is not sufficient to identify the cause of this trend, one plausible explanation is that there are step increases in fixed costs for charging station installations with more than four ports.

S.2 Station Use

The defining characteristic of the charging use data collected from New York State funded stations is the highly unequal distribution of charging use across stations. Discounting the period of time during pandemic-related travel reductions, the average charger delivered 3.25 kilowatt-hours (kWh) per day over 0.32 sessions or about two 10.5 kWh sessions per week. The median charger delivered 1.5 kWh per day (on average) and served 0.14 sessions—or about one per week. However, chargers with more use than 90 percent of stations were seven to eight times more productive than the median station. Moreover, those high-use stations were responsible for about half of all charging activity.

S.2.1 Use Patterns and Station Land Use

In the early part of New York State's programs, charging sessions almost exclusively occurred during working hours with peak usage occurring in mid-morning. As the market matured, usage began to pick up during evening, weekend, and overnight hours. However, peak usage remains during mid-morning which aligns with patterns of workers arriving at workplaces and plugging in to recharge their vehicles. Moreover, the charging stations with the most overall use are those with typical use patterns that follow a commuter-supporting pattern of sessions that start in the mid-morning and taper off in the afternoon and evening.

The observation that stations used during working hours are more likely to be highly utilized corresponds with the finding that the median workplace charger is twice as performant as the median charger at a public or MUD location, confirming widely held expectations that workplaces, as places where people park their cars for extended periods of time, are generally good locations to put charging stations. However, many stations classified as *public* also benefit from high charging use driven by commuter type charging patterns even if they are not reserved specifically for employees.

On the other hand, MUD-based locations see less use than might be expected from a location well suited to providing overnight charging for residents. Overall usage of chargers at MUDs is low, and few of the highest performing stations are at MUDs. This is a concern given that the direct installation of charging stations at MUDs is considered an important strategy for enabling charging access for MUD residents.

S.2.2 Station Congestion and Saturation

There is no evidence that congestion is a significant problem for charging stations analyzed in the data. While this finding is self-evident for many chargers that are infrequently used, highly used charging station locations also tend to have spare charging capacity, even at peak times. Significantly, no location with more than four installed ports has hit capacity for more than five percent of daytime operating hours. No locations with 12 or more ports have ever reached use capacity during the data collection period. In addition, there is no evidence that excessive idle time, or time where a vehicle is plugged in but not charging, limits station productivity.

On the other hand, charging station use has grown steadily over time and there is also no evidence that the charging station landscape is saturated or that new stations are crowding out usage at existing locations. As charging station deployments from the Charge Ready NY program began to ramp up in 2019, overall system utilization did decline, but this is readily attributable to generally low productivity in early stages of charger deployment, combined with high deployments of new stations. Utilization rates continued to grow at older stations despite increased deployments of new stations.

S.3 Implications for Policymakers and Site Hosts

In the near term, site hosts and policymakers in New York State should expect the full cost of deploying a single Level 2 charging port to be around $6,500, although site hosts should be aware that site-specific costs can easily push that figure up for some installations. While costs for charging equipment might continue to fall as they have in the past, it is unclear whether significant installation cost reductions are possible. Moreover, it appears to be the case that less generous subsidies, at the level of, or even lower than those in Charge Ready NY, can enforce some amount of cost discipline for charging station installations.

Given that large installations have thus far rarely been used to full capacity, site hosts should carefully consider the benefits of installing more than a small number of charging stations in one location at a time. However, installing the *make ready* for additional spots could be way to avoid the costs and disruption of multiple construction projects if site hosts anticipate future growth in charging demand at their location. Policymakers should also consider these complexities when deciding on project funding maximums and program designs.

Overall, utilization for installed charging stations has been low which indicates a mismatch between station deployment and demand for charging. However, outside of the pandemic, use has trended up over time, and there is no evidence yet that charging stations funded by the program are competing with each other, so as more EVs come into service, many stations should see greater utilization.

High-use stations are clearly good investments. Unfortunately, the factors contributing to charging station utilization are complex and much of the variation observed in the New York State data remains unexplained. However, stations that are sited in locations where they can serve commuters are more likely to attract substantial use. This is true whether that charger is at a workplace or any other public site. Policymakers may find it productive to target program outreach activities toward workplaces or public locations where commuters can charge.

1 Introduction

Transportation emissions make up the plurality of climate-change causing greenhouse gas (GHG) emissions in the United States and nearly the majority of those emissions in New York State (Energy Information Agency 2021). Most of those emissions come from light-duty passenger vehicles (U.S. Environmental Protection Agency 2021) making emissions mitigation for those vehicles a top priority in New York State and many other jurisdictions. Encouraging adoption of electric vehicles (EV)—which cause fewer GHG emissions than gasoline cars—is the leading strategy to reduce emissions in the sector. Because EVs require different fueling infrastructure than gasoline vehicles, providing funding for EV charging stations has been a large part of the focus of EV policy.

Despite the significant growth of EV charging infrastructure over the last decade (much of it funded by public dollars) public information about the usage of EV chargers remains scarce. This report seeks to address that gap for Level 2 charging infrastructure by examining use data for stations funded by New York State incentive programs. These data provide a window into how charging usage behavior has evolved in the fourth most populous state in the nation.

Cost data have been more widely reported, although still limited. This study adds to the small body of literature covering the costs of Level 2 charging installation by providing a deep look into the variation of charging station deployment costs and by examining how costs have changed spanning deployments between 2012 and 2020.

1.1 Background

The subject of this report is Level 2 charging equipment which occupies a middle charging speed tier between slower Level 1 charging from a typical electrical outlet and direct current fast chargers (DCFC) which are more costly, complicated equipment and require high voltage power supplies. Level 2 chargers typically deliver around 24 miles worth of charge per hour—although this can vary somewhat depending on equipment and vehicle. Level 2 chargers therefore are best suited for locations where drivers will park long enough to obtain a meaningful charge. Costs and use behavior for Level 2 charging stations are considerably different than for DCFC, and thus the analysis included in this report should not be interpreted as informative for DCFC deployments.

Fueling vehicles with electricity represents a paradigm shift in fueling behavior and infrastructure. Gasoline is dispensed quickly at centralized gas stations, whereas electricity offers more decentralized fueling opportunities that can occur anywhere a vehicle is parked and has access to electricity—although charging with electricity is slower than with fueling with gasoline. While decentralization allows for convenient fueling access at home and other common parking spaces, it also requires new infrastructure investment and new deployment models.

Box 1. Report Key Terms and Definitions

Electric vehicle: a vehicle with an electric powertrain (motor and battery) that can be recharged from a charging station. Includes both battery electric and plug in hybrid electric vehicles.

Charging station: Synonymous with charging equipment, a charging station is a free standing or wall-mounted unit with 1-2 charging ports (plugs). Charging stations are categorized by the amount of power they can deliver.

Charging port: A charging port is the cord and plug assembly that connects a charging station to a vehicle.

Make ready: The electrical and site work required to supply power to a charging station.

Level 2 charger: An alternating current charging station that can deliver between 3.1 kW and 19.2 kW of power or about 12 to 67 miles of range per hour for a typical EV. Commercial L2 stations typically offer 6.6 kW charging. Differentiated from Level 1 (standard wall outlet) and direct current fast chargers.

REDC: Regional Economic Development Councils are 10 distinct economic regions defined by Empire State Development Corporation, which provide useful geographic divisions across which to compare cost and use.

MUD: Multi-Unit Dwellings are buildings or complexes such as apartments, condominiums, or co-ops. Residents of MUDs have historically faced barriers to securing home charging infrastructure.

Lack of charging infrastructure is often cited as an impediment to EV adoption, especially for those who lack access to home charging opportunities. However, with relatively few EVs on the road, it is difficult to make a business case for deploying EV chargers which do not have a guaranteed user base (Atlas Public Policy 2019). This chicken and egg problem threatens to slow widespread adoption of EVs. Policymakers interested in jumpstarting the EV transition—to quickly realize environmental benefits—recognize this gap and have moved to close it by providing public funding for charging station deployment as a way to facilitate faster EV adoption than would otherwise be supported by the market.

1.1.1 Charging Station Incentive Programs in New York State

With a stated goal of 100 percent electric passenger vehicle sales by 2035 (New York State Legislature 2021), electrifying passenger vehicle travel is a key pillar of New York State's climate change mitigation strategy. As part of its efforts to support electrification, the State has invested in charging infrastructure through several station incentive programs starting with the New York State Energy Research and Development Authority (NYSERDA) Electric Vehicle Supply Equipment Demonstration Program (PON 2301) in 2011 and continuing through the Charge Ready NY program launched in 2018. Data reported by funding recipients of these two programs form the basis of this report.[2]

The PON 2301 program offered two rounds of investment funding for EV charging demonstration projects in late 2011 and in 2012. Projects in public locations, workplaces, and MUDs with more than five units were eligible to receive funding. NYSERDA funded up to 80 percent of project costs for up to one million dollars per project. Funding recipients were required to submit detailed descriptions of project costs and usage reports for at least the first four years of operation (NYSERDA 2011).

The Charge Ready NY program began issuing funding in 2018 and concluded at the end of 2021. The program provides a streamlined application process that offers participants a flat $4,000 per-port rebate. An additional $500 rebate is awarded to stations deployed in disadvantaged communities after December 2020.[3] Participating site hosts are required to operate the charging equipment and provide charging data to NYSERDA for a minimum of five years (NYSERDA 2020).

This report analyzes and draws insight from program data on the installation cost and utilization of NYSERDA-funded Level 2 charging stations. It is meant to inform policymakers (in New York State and elsewhere), potential site hosts, and other stakeholders about the cost, usage, and performance of Level 2 chargers deployed though publicly funded programs.

2 About the Data

Data analyzed in the report was provided by NYSERDA, program participants, and charging network providers that manage charging stations deployed under the programs.

- Cost data analyzed in this report covers 275 projects deployed by the PON 2301 program and 428 deployed by Charge Ready NY for a combined 2,641 ports. The cost data in this report represents $11.6 million in public funding and $19.8 million in total public and private costs.
- Charging use data used in this report were collected from 1,288 charging stations with 2,175 ports, covering a nearly nine-year period between April 2012 and December 2020. The data contains information on 434,578 individual charging sessions, during which vehicles spent 988,755 hours charging their vehicles with 4.2 gigawatt-hours of electricity. These data are limited to networked stations that are part of the ChargePoint and EV Connect networks.

The cost data and use data in this report do not fully align. This is at least in part caused by the limitation that charging use data was only obtainable from two charging network providers. Stations in the cost data but not in the session data might have been part of another network or not been networked at all. Finally, no sessions may have been reported for some stations installed late in the covered period.

In addition to the at least 466[4] ports in the cost data not included in the session data, there are not sufficient identifiers in either set of data to fully link even the overlapping use and cost data. Only 699 stations (1,209 ports) can be definitively linked between cost data and use data. Because host land use type information is only included in the cost data, only those session data that can be matched to cost data can be analyzed by land use. Further complicating this issue is that address-level location information is also not available for all stations in the cost data, so not all cost data can be analyzed by geography. However, session data does include ZIP code-level location data.

The consequence of these misalignments is that analyses cover different universes of data depending on the dimensions applied. In this report we present analyses of the following groups of data:

- All cost data (2,641 ports)
- Cost data with address-level location (1,695 ports)
- All session (charging use) data (2,175 ports)
- Session data with address-level location and host land use type (1,209 ports)

When analyzing these data, we use the universe that covers the most ports unless the specific analysis requires dimensional data not included in the larger set.

While we have made every effort to ensure that this report is accessible to general audiences, understanding this analysis requires knowledge of some common statistical terms (see Box 2).

Box 2. Glossary of Statistical Terms

Central measure: A summary figure that describes the center (or typical value) of a group of numbers. Commonly measured as the average, median, or modal value.

Average: Arithmetic mean or the sum of all values in a set divided by the number of values in the set.

Median: The central value in a set of numbers if ordered on a number line. Half the values in a set of numbers are greater than the median and half are less. In the number set [1 2 3 4 9] the median value is three.

Mode: The most common value in a set of numbers. In the number set [1 2 3 3 5] the modal value is three. In a histogram, the mode is the tallest bar.

range of the bulk of the values in a number set. In the number set [1 1 3 5 99] the number 99 is an outlier.

Distribution: How numbers in a specific set are spread between the highest and lowest values. Shown graphically in this report by histograms and box plots.

Variance: How spread-out values are within a distribution. The distribution of the number set [1 1 2 2 3] has low variance compared to [1 5 10 20 30].

Quantile: Quantiles break up values into regularly sized groups of numbers based on their order on a number line. Common quantiles include quartiles (four groups), deciles (10 groups) and percentiles (100 groups). The median value of a set of numbers is equivalent to the 50th percentile.

2.1 Geographic Coverage

Stations in the session data set are concentrated in densely populated areas with the highest concentration around the state capital in Albany along with eight adjacent counties. Regional station deployment (by REDC) is only loosely correlated with population, with New York City and the Capital Region clear outliers in terms of stations deployed per capita. Figure 1 shows a map of charging station deployments across the State for which session data is available, while Table 1 provides a breakdown of the ports at those stations by REDC. Geographic coverage for stations in the located cost data differs slightly from that in the session data.

Figure 1. Locations of Charging Stations in the Session Data Set

Geographic distribution of charging stations included in the session data across New York. Dots represent single charging stations (one-or two-port charging equipment). Specific location is approximate and is based on ZIP code.

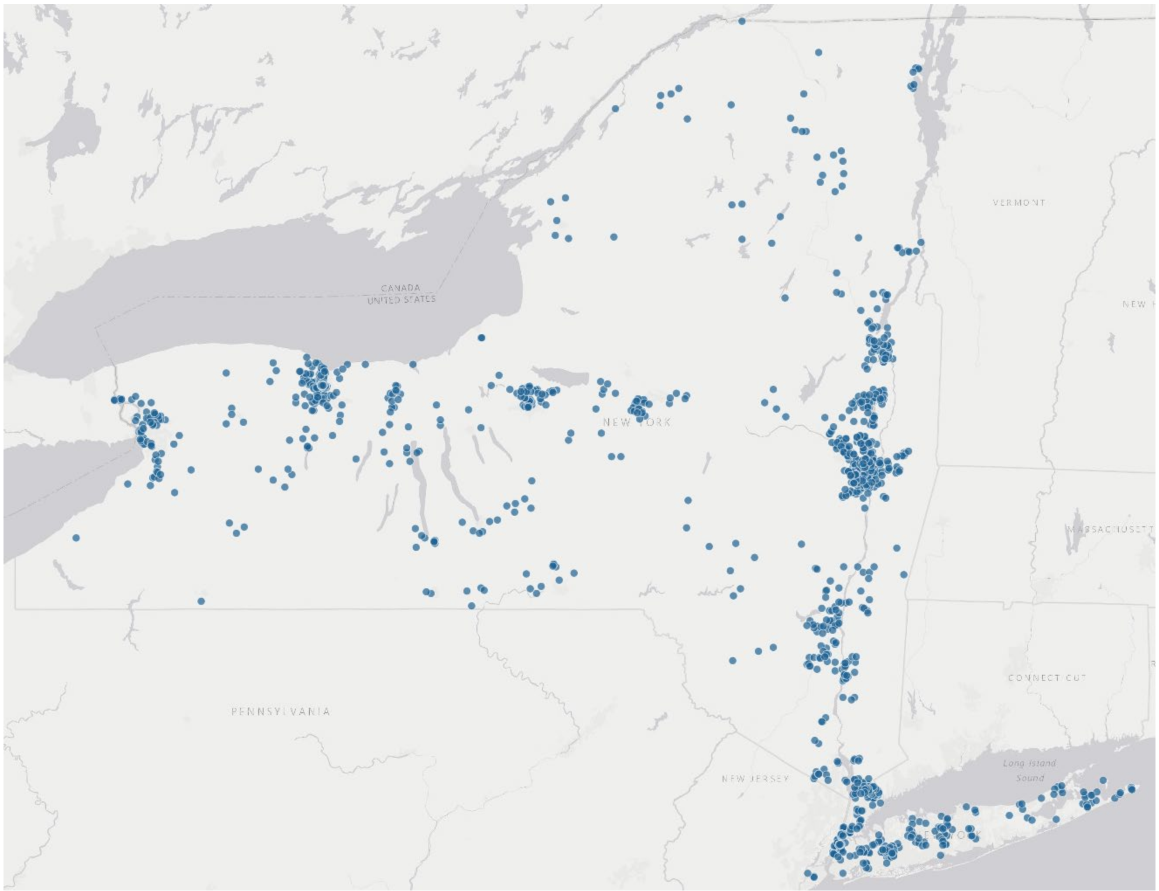


Table 1. Ports in Session Data by REDC Region

REDC Region	Ports	Population	Largest City
Capital Region	705	1,106,088	Albany
Mid-Hudson	346	2,398,150	Yonkers
Finger Lakes	326	1,222,868	Rochester
Long Island	206	2,921,694	Long Beach
New York City	152	8,804,190	New York City
Western New York	145	1,418,057	Buffalo
Central New York	90	785,114	Syracuse
North Country	82	421,694	Watertown
Southern Tier	51	640,036	Binghamton
Mohawk Valley	48	483,358	Utica
Total	**2,151[†]¬**	**20,201,249**	

[†] 24 ports that reported charging use data could not be matched to an REDC

2.2 Land Use

Charging site host land use information is conveyed in the project cost data set and is only available for the 699 matched stations in the session data set.

Table 2 breaks down charging locations by land use type for the 2,641 ports in the project-cost data set. The table separates stations deployed by PON 2301 and Charge Ready due to differences in how land use was reported between the two programs. Stations funded under the Charge Ready program were classified as either a public, MUD, or workplace, where public is a catch-all category for locations that are publicly accessible. Stations funded under the PON 2301 program provided more specific land use detail such as retail, education, and others.

Table 2. Charging Ports by Host Land Use in PON 2301 and Charge Ready

<table>
<tr><th colspan="2">PON 2301</th></tr>
<tr><th>Host Land Use</th><th>Ports</th></tr>
<tr><td>Parking Lot/Garage (NYC)</td><td>123</td></tr>
<tr><td>Educational Service</td><td>102</td></tr>
<tr><td>Prof. and Tech. Services</td><td>72</td></tr>
<tr><td>Hotel</td><td>46</td></tr>
<tr><td>Government/Public Admin.</td><td>45</td></tr>
<tr><td>Transportation Hub</td><td>44</td></tr>
<tr><td>Business Office</td><td>43</td></tr>
<tr><td>Parking Lot/Garage (non-NYC)</td><td>42</td></tr>
<tr><td>Healthcare/Medical</td><td>26</td></tr>
<tr><td>Retail-Big Box-National</td><td>22</td></tr>
<tr><td>Retail-Local-Small Business</td><td>20</td></tr>
<tr><td>Multifamily (MUD)</td><td>16</td></tr>
<tr><td>Restaurant</td><td>16</td></tr>
<tr><td>Parks and Recreation</td><td>15</td></tr>
<tr><td>Arts and Entertainment</td><td>7</td></tr>
<tr><td>Fleet/Freight</td><td>6</td></tr>
<tr><td>Utilities</td><td>1</td></tr>
<tr><td>Total</td><td>646</td></tr>
<tr><th colspan="2">Charge Ready NY</th></tr>
<tr><th>Host Land Use</th><th>Ports</th></tr>
<tr><td>Public</td><td>1,077</td></tr>
<tr><td>Workplace</td><td>552</td></tr>
<tr><td>Multifamily MUD</td><td>366</td></tr>
<tr><td>Total</td><td>1,995</td></tr>
</table>

3 Charging Station Costs

Applicants to the PON 2301 and Charge Ready programs were required to provide information on the cost of charging station equipment and installation. PON 2301 program data includes line-item project costs for: equipment, labor, materials, construction, electrical, overhead, and permitting. Charge Ready participants reported equipment and aggregated installation costs only. These cost data provide a source of information to evaluate charging infrastructure deployment costs in New York State and how they vary by program, time, geography, and land use.

The most relevant cost metrics for charging stations are per-port costs which give an indication of the cost to put in a single charging station, regardless of installation size. This allows an equivalent comparison for costs between installations that have different numbers of ports per site. The following sections examine measures of central tendency (average and median) and the distribution of costs that have been spent on EV charging station projects funded by Charge Ready NY and PON 2301.

Table 3 summarizes per-port total costs, equipment costs, installation costs, and public funding across both programs. Comparing average total costs (combined installation and equipment costs), Charge Ready program deployments cost about 21 percent less than PON 2301. Public funding for the Charge Ready program was fixed at $4,000 per port,[5] whereas PON 2301 funding covered 80 percent of project costs with an average cost 44 percent higher than the standardized Charge Ready award.

Table 3. Cost Summaries by Program

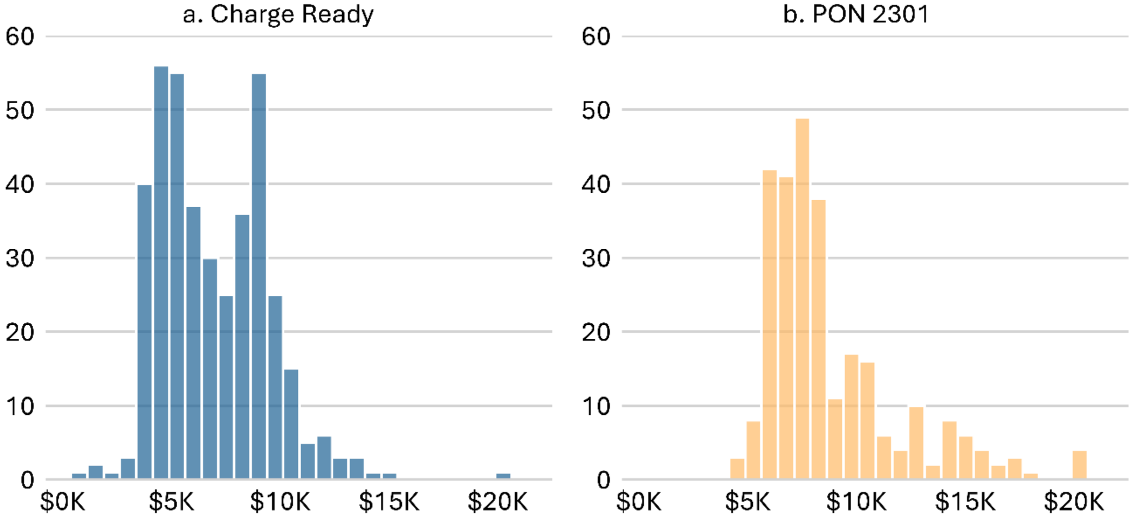
Charge Ready NY				
	Project Cost	**Equipment**	**Installation**	**Public Funding**
average	$6,921	$3,350	$3,571	$4,000
median	6,518	3,484	3,250	4,000
minimum	976	527	302	4,000
maximum	19,990	7,599	17,064	4,000
PON 2301				
	Project Cost	**Equipment**	**Installation**	**Public Funding**
average	$8,774	$4,186	$4,587	$5,777
median	7,790	4,363	3,538	5,274
minimum	4,441	1,863	777	936
maximum	20,433	6,888	17,033	16,883

In both programs, median costs were less than average costs indicating that the distribution of costs has some high-cost projects (outliers), which have the effect of increasing (skewing) the average cost estimate across projects. This feature of the cost distribution can be seen graphically in the histograms in Figure 2. For data where the average is skewed by outliers, median is usually a more instructive central measure because it more closely reflects the cost of a typical installation.

Maximum costs for both programs were very similar. However, minimum total cost for the Charge Ready programs was more than four times less than the minimum cost for the PON 2301 program. It is not clear why the minimum cost for Charge Ready was so much lower. However, very few Charge Ready NY projects were so inexpensive (see Figure 2.a).

Figure 2. Histogram of Project Costs by Program and per Port

Count (y-axis) of charging station deployments within each cost level (x-axis). The width of each column is $750.



The cost-per-port distribution of the Charge Ready program has two distinct cost peaks at around $4,000 dollars and $7,500, on either side of the average installation costs. It is not clear what is causing these two peaks. Given that the incentive offered by Charge Ready is a flat $4,000 per port, it is possible site hosts who could get a large percentage of their costs covered were more likely to apply.

By comparison, distribution of PON 2301 costs peaks only once, close to the median value at around $7,000 and is shifted to the right (indicating overall higher costs) relative to the Charge Ready cost distribution. Moreover, in comparison to the Charge Ready program where projects steeply fell off after $10,000 a port, a far larger portion of PON 2301 projects were above that threshold.

Key takeaways:

- Given the skew of cost distributions, median costs are a more representative metric for a given charger install. However, the presence of high-cost outliers indicates that for some, costs are significantly more expensive.
- Central estimates (average and median) of costs for the Charge Ready program obscure underlying patterns that cause two distinct cost profiles of around $4,000 and $7,500. It is not clear from the data provided with this program what might cause that split in typical costs, and this could be the subject of further research.
- A greater proportion of high-cost projects and no very-low-cost projects meant that average project costs were higher for PON 2301 than the Charge Ready program. Possible explanations for this observed difference are explored in the section: Cost Trends Over Time.

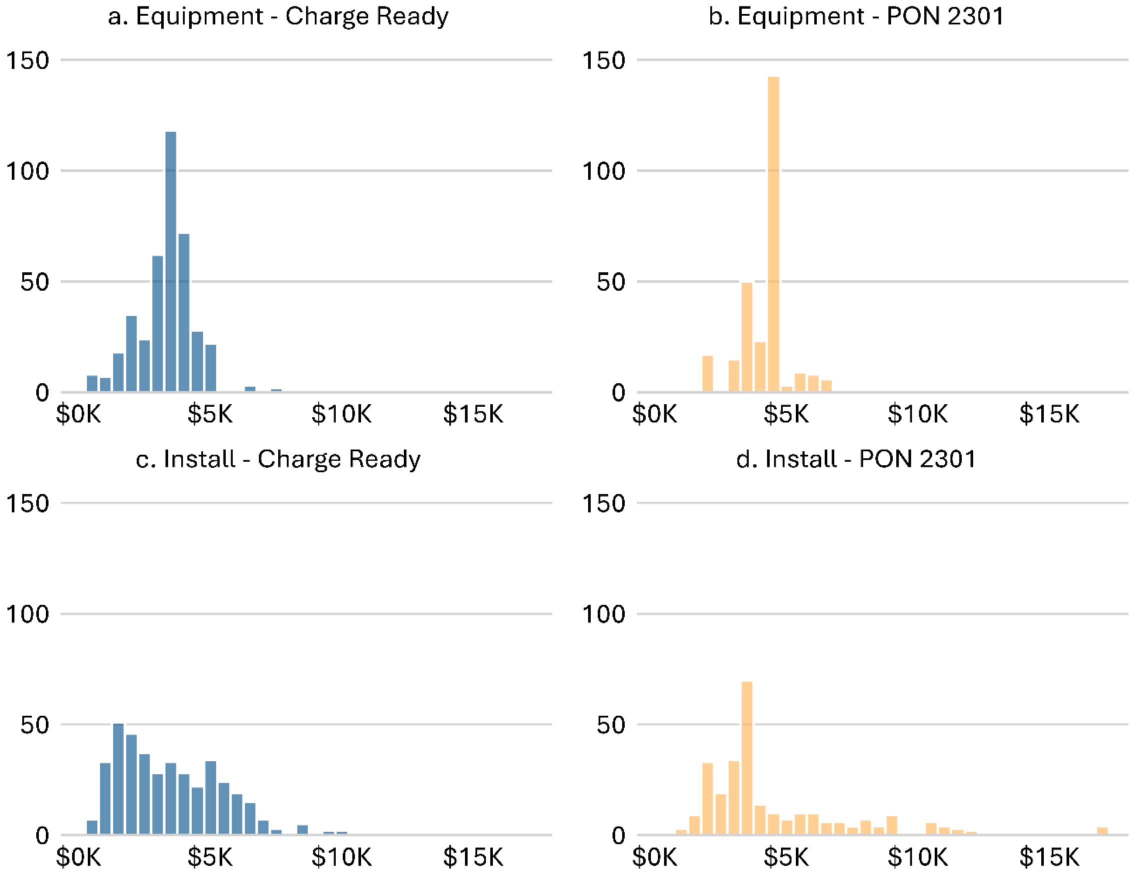
3.1 Costs of Equipment and Installation

Project costs shown in Table 3 are further broken down by charging equipment and installation costs. Installation costs include the labor, construction materials (such as electrical conduit), any electrical upgrades, permitting, and overhead required to install charging equipment. Install costs reported here are an approximation of charging station *make ready,* although do include expenses to install the charging station unit itself, which is not part of make ready costs.

On average, costs for both programs are about evenly split between equipment and installation costs. Median equipment costs for both programs were slightly higher than average costs, which is the result of low-cost outliers that lowered the average cost. For installation, the median is below the average (considerably in the case of PON 2301 installations), indicating the opposite effect driven by high-cost outliers. These patterns can be observed visually in the histograms in Figure 3 which show the distribution of equipment and install costs across the two programs.

Figure 3. Histograms of Equipment and Installation Costs by Program and per Port

Count (y-axis) of charging station deployments within each cost level (x-axis). The width of each column is $500.



The distribution of equipment costs per port is narrow indicating that there is little variation in how much was spent on equipment in either program. This is unsurprising given that charging equipment are off-the-shelf goods subject to competitive market forces. It is notable that participants in the later Charge Ready program paid less on average for charging equipment than participants of the earlier PON 2301 program, a feature of the data that is further explored in the next section.

Conversely, the distribution of installation costs is substantially wider. Moreover, the shape of the installation cost distributions for each program is very similar to the shape of the total cost distributions shown in Figure 3, suggesting that installation costs are responsible for most of the variation in project costs seen in Figure 2. This is a reasonable conclusion, given that unlike equipment costs, installation costs are driven by site factors such as distance to electrical service, need to upgrade panels, as well as geographic factors such as prevailing labor rates (Nicholas 2019).

Comparing the distribution of installation costs in the two programs, most installs are relatively inexpensive with a smaller number of costlier installations. However, the skew in the project costs from PON 2301 is more pronounced than the Charge Ready program, indicating a proportionally larger number of high-cost installations in that program, which explains why, even though the average installation cost between the two programs differs by more than $1,000, the difference in median cost is less than $300.

Key takeaways:

- Charging equipment costs are narrowly distributed across both programs, meaning that most participants spent a similar amount on charging equipment.
- Equipment cost less on average in the later Charge Ready program than the earlier PON 2301 program.
- Installation costs vary widely across both programs, but the earlier PON program has higher average costs, driven primarily by a larger number of deployments with high installation costs.

3.2 Cost Trends Over Time

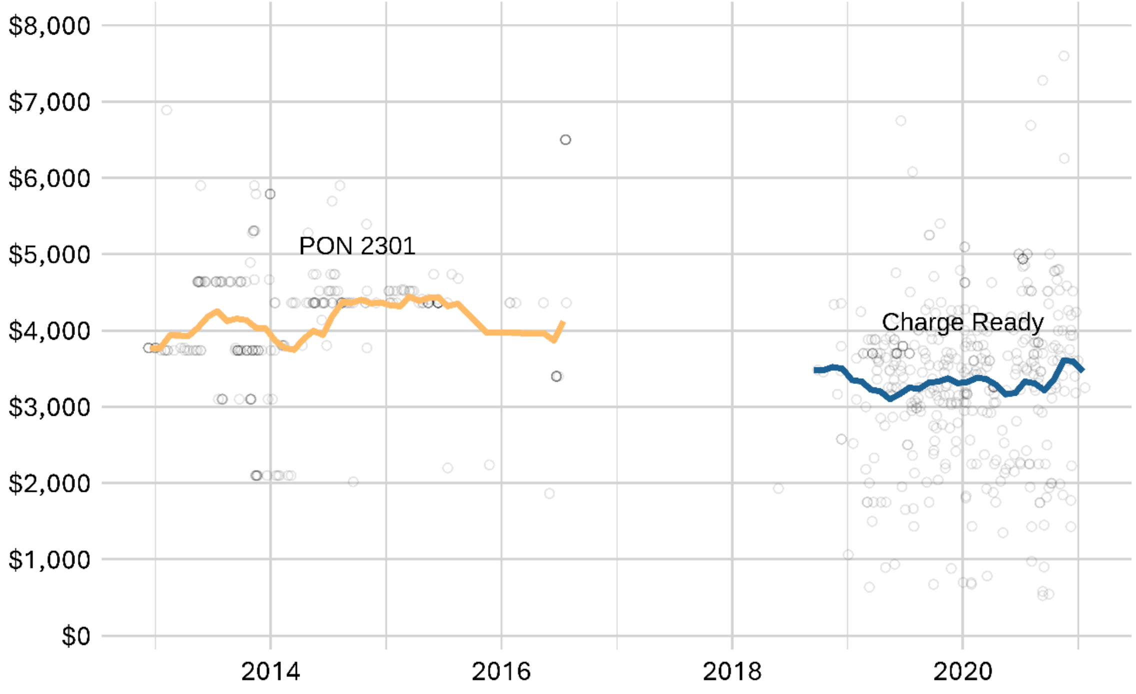
One of the most important questions regarding EV infrastructure is how costs are evolving over time. High penetrations of EVs will invariably require more charging infrastructure deployment and falling charger deployment costs over time would be an encouraging development for the overall cost of the EV transition. Patterns of cost reductions between the earlier PON 2301 program and the later Charge Ready program are suggestive of a reduction in both equipment and installation costs.

Looking at equipment cost trends over time (Figure 5), we see that within each program, average costs were substantively flat for each program although cost differences existed between the two programs. This suggests that either (a) cost reductions occurred between the two programs or (b) cost reductions observed between the programs might be due to factors other than time.

One change between PON 2301 and the Charge Ready program that appears to have contributed to the differences in costs is that the latter allowed MUD participants to use non-networked chargers in their installations. Non-networked chargers are considerably cheaper than their networked counterparts, meaning that cheaper charging equipment might be influencing average costs. Removing MUD installations from the Charge Ready program does increase average equipment cost by about $100; however, equipment costs remain significantly less expensive than in the PON 2301 program, meaning that this change does not account for all of the cost differences between programs.

Figure 4. Trend in Average Charging Equipment Costs across Time and Programs per Port

Lines depict six-month rolling average of install costs across each program. Points are individual installation equipment costs.

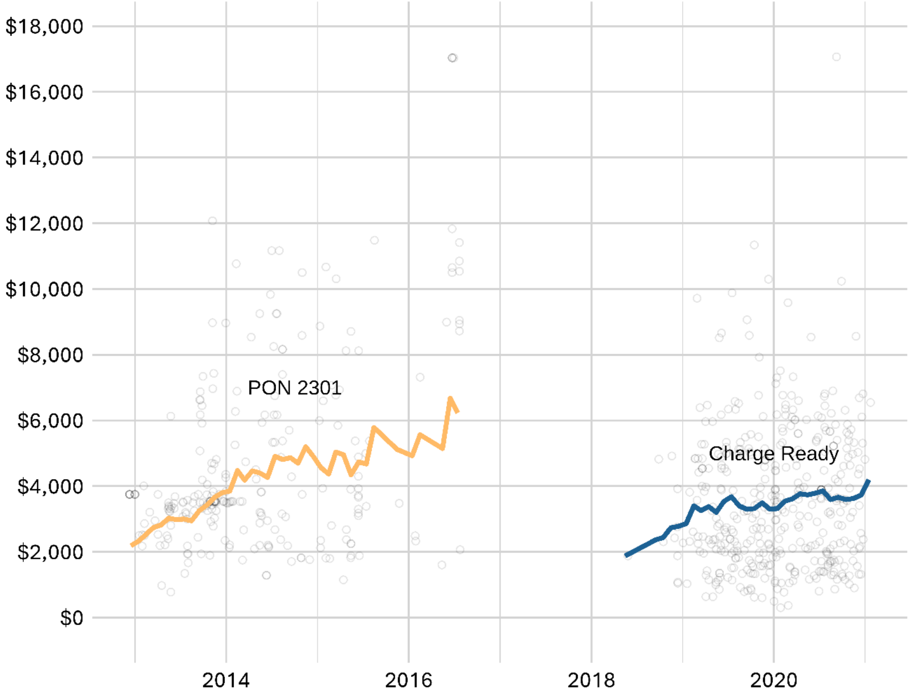


Further evidence that the observed decline in equipment costs is a real trend is that per-port costs for individual manufacturers declined between the two programs. For example, equipment made by the popular charging equipment manufacturer, ChargePoint saw a nine percent decline in cost between the two programs. Moreover, the decline in costs over time is similar to the estimate of a three percent annual decline in equipment costs estimated by the International Council on Clean Transportation in an analysis of the cost to install charging infrastructure (Nicholas 2019).

Installation cost trends over time are a much more complicated story. While overall costs decreased on average between the two programs, within each program cost trends increase over time (Figure 5). It is not clear why average costs increase in the PON 2301 program, although the fewer number of projects in later years of that program might simply mean that observed cost increases are a product of chance. There is also an increase in install costs after 2020 in the Charge Ready program, which might be caused by cost increases in the construction trades that occurred during the COVID-19 pandemic (U.S. Chamber of Commerce 2020).

Figure 5. Trend in Average Installation Costs across Time and Programs per Report

Lines depict six-month rolling averages of install costs across each program. Points are individual installation equipment costs.



Unlike charging station manufacturing, which is a young industry with obvious room for learning and scale-based cost declines, the make ready work of deploying charging stations falls within the purview of mature construction and electrical trades, with fewer obvious avenues for cost reduction. That said, while not consistent within programs, there does seem to be an overall decrease in costs between programs. It is certainly possible that learning and standardization among installers, site hosts, and utilities have reduced the cost to install charging infrastructure. However, perhaps a more compelling explanation for the differences in install costs between the two programs stems from the design differences between the programs.

Per-port funding for the Charge Ready program was capped at $4,000 for most projects, whereas PON 2301 recipients were compensated for 80 percent of project costs ($17,000 per port in program data). This program design change dramatically reduced the incentive to participate for those facing high-cost installations in the Charge Ready program, which would make high-cost installs more likely under the PON 2301 program. Moreover, insofar that site hosts have the ability to control costs (such as choosing install locations closer to electrical service), they would be more incentivized to do so when incentive funding is capped. This explanation of the cost differences between the two programs is supported by the distribution of install costs under the two programs, where the PON 2301 program has a comparatively higher average cost and a higher share of high-cost installations, but a similar median cost.

Key takeaways:

- Average equipment costs declined between the two NYSERDA programs which appears to be reflecting a real reduction in charging equipment prices over time. Those cost reductions appear to have occurred between programs in a discontinuous fashion instead of gradually over time.
- Apparent reductions in average installation costs between the two programs might indicate that learning over time has reduced installation costs. However, observed differences could also reflect the lower incentive amounts in the Charge Ready program relative to the PON 2301 program, which reduced the viability of projects where installation costs are high.

3.3 Installation Cost Breakdown in the PON 2301 Program

One of the strengths of the cost data generated as part of the PON 2301 program was the detailed information on installation costs. Applicants to the program were required to provide a breakdown of installation costs by the categories of labor, construction, materials, electric panel upgrades, overhead, and permitting.

Unfortunately, individual cost data was inconsistently reported. Fifteen participants (5.4 percent) reported no aggregated costs, 36 participants (13 percent) reported a cost for each category, and 112 (41 percent) reported a cost for every category except electrical panel costs. In every case in which participants reported disaggregated costs, the sum of those costs was equal to the reported total installed cost, suggesting either that (1) participants did not incur costs in that category or (2) different participants aggregated costs differently. While it is the case that not all installs would require electrical panel upgrades, it is unlikely that they did not incur overhead or permitting costs, suggesting that costs were not categorized consistently across projects. Quality issues make it impossible to draw strong specific conclusions from these data. However, they do provide some insight into what factors influence installation costs.

Table 4. Response Rate for Installation Cost Components

	Labor	Materials	Panel	Construction	Overhead	Permitting
Record Count	260	258	75	204	167	164
Share of Total	95%	93%	27%	74%	60%	60%

Labor costs are the largest contributor to cost accounting for over 49 percent of total costs per installation. Construction costs were the next largest cost category at 16 percent of average of total costs, followed by materials at 15 percent. Labor, construction, and material costs have the widest distribution over installations where those data are available, indicating that the most important drivers of cost variation are the amount of labor and site work needed, as well as the relative costs of those inputs, which can vary significantly by geography.

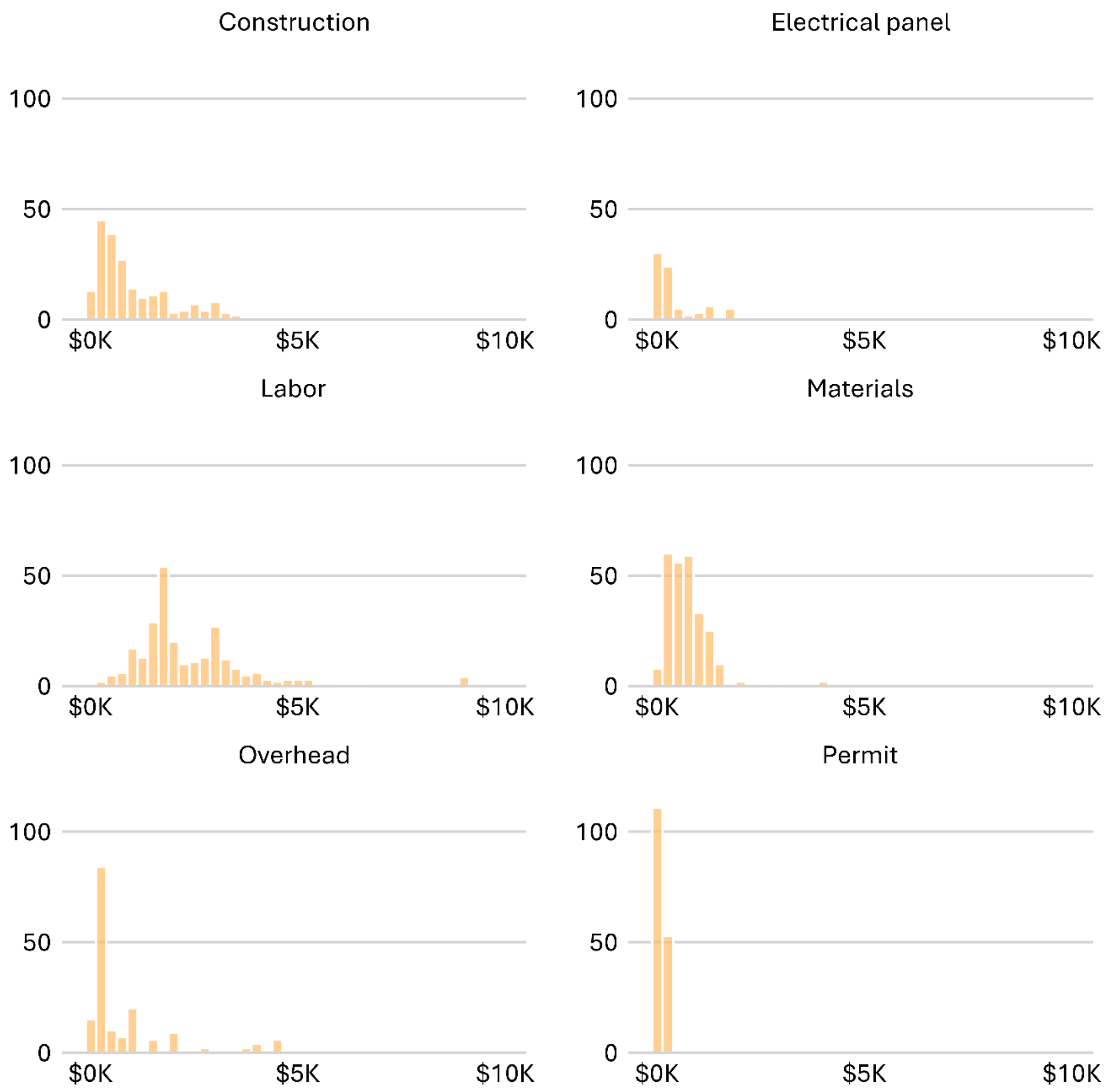
Permitting and electrical panel costs each made up about two percent of average project costs. The most common value for electrical panel upgrades is zero, suggesting that a large fraction of installs did not require significant upgrades to electrical service. However, upgrading electrical panels can substantially increase costs where upgrades are necessary. Permitting costs are low and do not vary much across installations. Overhead costs average about 11 percent of total costs, which is typical of construction projects. The distribution of overhead costs includes a large number of high outliers, although they might be simply reporting errors, given data quality issues.

Key takeaways:

- Disaggregated cost data were inconsistently reported by PON 2301 participants, making it difficult to draw strong conclusions about underlying installation cost components using those data.
- Labor accounted for the plurality of costs across installations and had the widest cost distribution among projects.
- Electrical panel upgrades were not always required but can add non-trivial costs to a project.

Figure 6. Distribution of Installation Cost Factors per Port at PON 2301 Deployments

Number of projects (y-axis) by per-port cost (x-axis). Cost widths are $750.

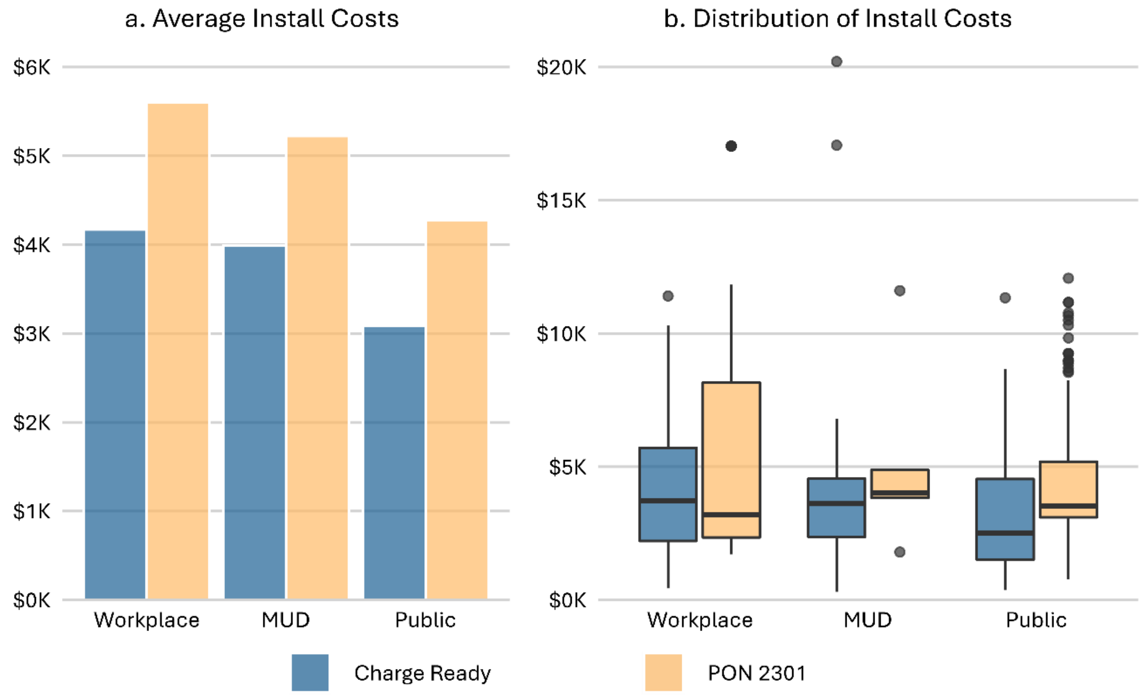


3.4 Installation Costs by Land Use and Geography

Figure 7.a shows the average installation costs between programs and land use,[6] and Figure 7.b is a box plot which shows the median (center line) and distribution of the same installation costs. Note that there are only two MUD deployments under the PON 2301 program.

Average installation costs vary by land use category for both programs. In both programs, workplace and MUD average installation costs are similar, with workplace costs slightly higher than MUDs. For the Charge Ready program, median costs for workplace and MUD chargers are very similar. However, the distribution of workplace chargers is wider and MUD installations had more high outliers. This means that installation costs between MUD and workplace installations are similar, but that they vary more for workplaces than for MUDs, suggesting that there is more variation in site configuration—and thus how much construction, labor, and materials are required—for workplace than MUD charger deployments.

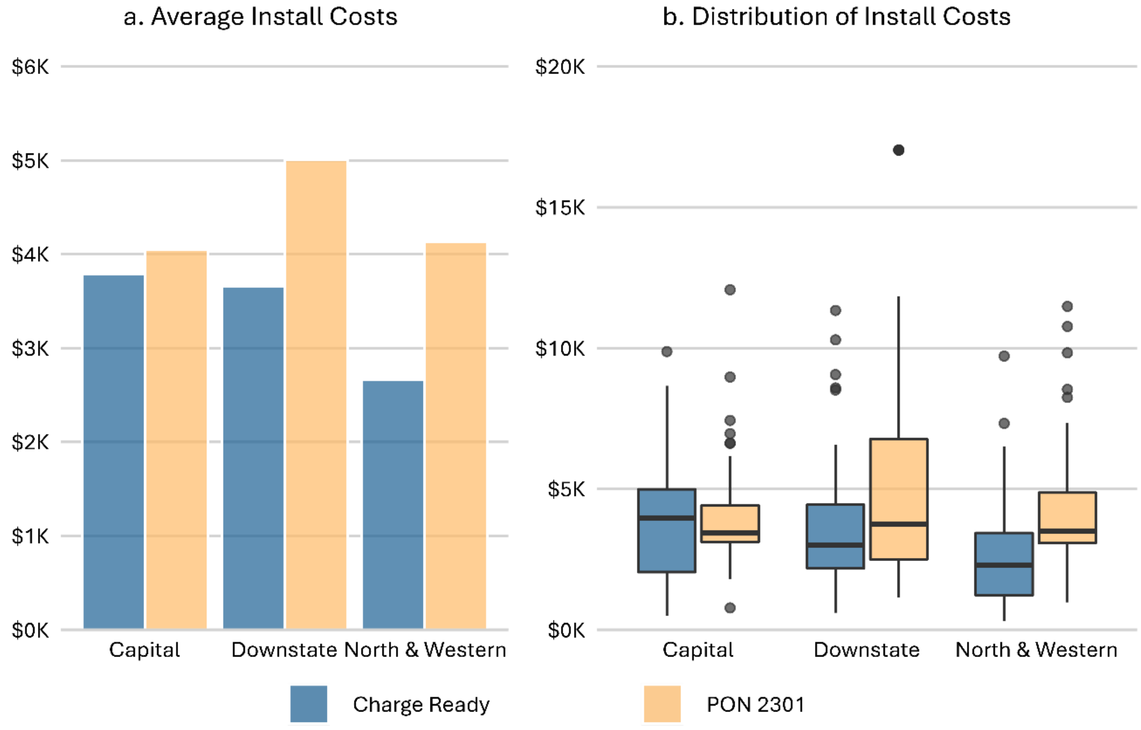
Figure 7. Average and Distribution of Install Costs by Land Use



Both the average and median charging installation costs were notably lower for public charging installs than for workplace and MUD charging. However, distribution of costs for public chargers is wider than MUD deployments and nearly as wide as workplace deployments. Lower average costs suggest that public charging deployments usually face more favorable site configurations than workplace or MUD deployments, although the wide variation in costs (especially at the upper end) indicates that projects at some public locations can be much more expensive than the typical case.

Unfortunately, there is not sufficient information about individual sites to further explore what might drive variation in project costs not associated with broad site type categories. Evidence from the PON 2301 program demonstrates that much of the variation has to do with how much site work is involved or whether electrical upgrades are necessary, things that will vary from site to site, even within the workplace, MUD, or public categories. However, the variability might also demonstrate that some installers have managed to better control costs than others.

Figure 8. Average and Distribution of Installation Costs by Region



Looking at geographic differences in charger installation costs, we divide New York State into downstate, which includes Mid-Hudson, New York City and Long Island, the Capitol Region (REDC that encompasses Albany), and any of the remaining REDCs that make up the northern and western portion of the State. The three regions have 211, 135, and 153 deployments, respectively. Figure 8.a shows the average per-port installation costs for the three regions, while Figure 8.b shows the median and distribution of costs.

While average costs differed between downstate and the other two regions in the PON 2301 program, median costs were very similar. In the Charge Ready program, distributions of costs in each program had similar widths, although the median cost for the Capitol Region was higher than that of downstate, which was in turn higher than installations in the north and west of the State. Even when only comparing New York City with the Capital Region, median costs were higher for the Capital Region.

The lower reported costs in the north and west of the State might be explained by lower construction wages in those areas and could also be driven by relatively less complicated parking configurations (surface lots instead of structures), which would reduce the complexity of construction work. However, why median costs in the Capitol Region were higher than the downstate region remains unclear.

Key takeaways:

- Installations at public locations are typically less costly on a per-port basis than those at workplaces or MUDs across both programs.
- Installation costs vary by geography, with notably lower costs in less populous north and western regions of the State. Projects in downstate were generally cheaper than those in the Capital Region, despite downstate including high-cost New York City.
- Future research with more detailed site information could better explore the relationship between cost, land use, and geography, which could in turn provide useful intelligence for more precisely predicting future installation costs based on site characteristics.

3.5 Costs by Number of Ports Deployed

Another important consideration is whether the per-unit costs of charging infrastructure decline as the size of the installation increases. These cost declines can occur when fixed costs like permitting are spread out among more individual chargers, where site work such as trenched conduit is shared between multiple chargers, or where installers are able to secure bulk discounts on materials or equipment.

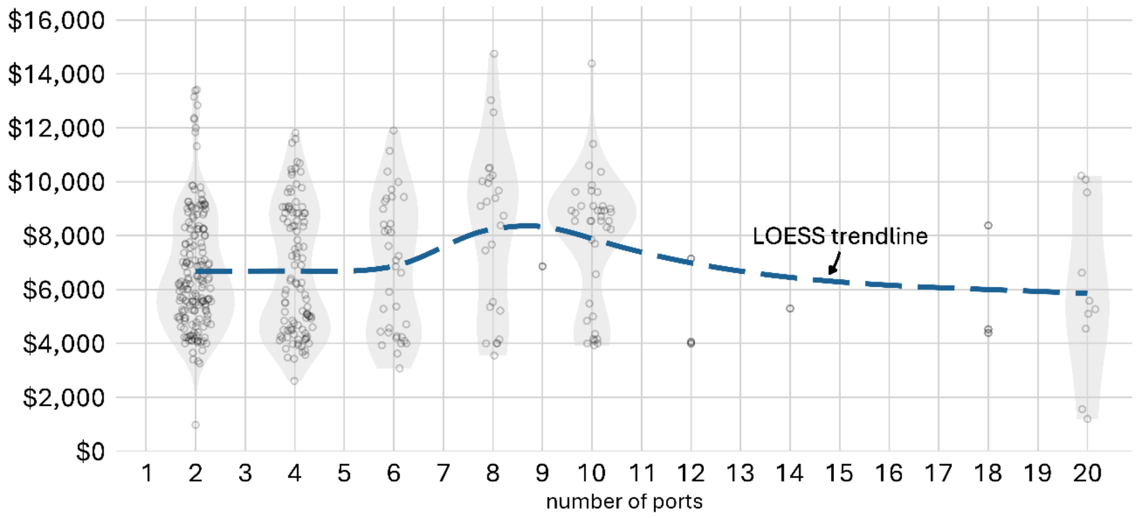
When modeling the association of cost and project size as a linear relationship, we find no significant relationship between project cost and project size, which we would expect to find if installing additional chargers decreased per-port costs in general. This means that there is no constant cost benefit from scale across projects in the program data.

When we model cost trends using a non-linear model[7] (Figure 9), we identify a trend where costs stay steady up to projects with six ports, increase for installations with eight or ten ports, and then slowly decline again out to projects with 20 ports. There is reason to think that mid-size installations might encounter cost-scaling factors such as electrical upgrades or site reconfiguration that are typically not necessary for smaller installations. Furthermore, it may be that it is only after reaching much larger-scale installations that cost benefits from scale are possible. If true, these conditions could explain the pattern we observe in installation costs with respect to project size.

However, it should also be noted that the design of the Charge Ready program caps per-port rebates, which would also tend to discourage participants from installing large quantities of charging equipment where installation costs are very high. With additional cost data, this potential relationship could be explored in more detail with more robust statistical methods.

Figure 9. Distribution of Per-Port Costs by Project Size and LOESS Fit Trendline for Charge Ready Program Installs

The distribution of costs for projects of each port size are shown graphically by the shaded area and the pattern of dots representing individual projects. The trendline illustrates a LOESS model fit to the data.



An important limitation of this analysis is that it only compares costs of single installations against each other which means it does not assess differences in per-port costs between one larger up-front installation or multiple smaller installations. In other words, the takeaway from this analysis should not be that it would be cheaper to do two four-port installations instead of one eight-port installation. In that case it is very likely that the step costs avoided in the first installation would be encountered in the second installation anyway, as cost scaling factors would still exist. Moreover, in that scenario, construction mobilization costs, permitting, site design, and demolition would need to be done twice instead of once, increasing the total fixed costs per charger.

Key takeaways:

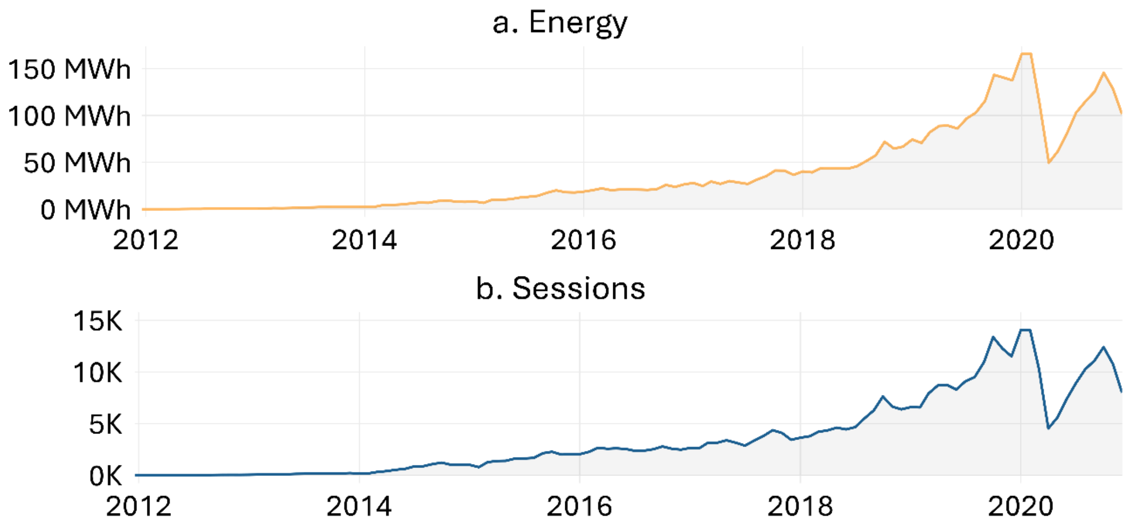
- We do not find evidence of reductions in average per-port costs as project sizes increase.
- The pattern of costs increasing for mid-sized installations before decreasing again for large installations suggests that mid-sized stations (above six ports) may encounter step-up costs not required of smaller installations and not yet compensated for by larger numbers of ports in larger projects.

4 Charging Use Trends

Throughout this section we measure the productivity of an individual or group of chargers by three core (and closely interrelated) metrics: (1) the amount of energy it delivered, (2) the number of sessions it served, and (3) the utilization rate or the ratio of in-use time relative to total time (represented as a percentage). Energy delivery is directly related to the number of electrically driven miles the charger supports and thus the direct environmental benefits[8] of the charger. Session counts describe the discrete usage of the charger irrespective of energy delivered, and utilization rates indicate the share of time that chargers are actively charging vehicles at either an individual or system level. Though not a productivity metric, we track idle time and idle utilization, which is defined as the time a vehicle is plugged in and occupying a charger, but not actively charging.

Figure 10. Monthly Trends in Energy (MWh) and Sessions (2012–2020)

Total energy delivery and sessions. Summarized by month, between 2012 and 2020.



Between the start of the PON 2301 program in 2012 and February of 2020 (prior to the COVID-19 pandemic and lockdown-related travel reductions), the amount of energy served, and individual sessions served by PON 2301 and Charge Ready-funded chargers increased in lock step and at a growing pace. At their peak in the month of February 2020, funded chargers delivered 166 megawatt-hours (MWh) of energy over 13,825 sessions, providing enough energy to power about half a million miles of electric driving at three miles per kilowatt-hour (kWh). Pandemic-related travel reductions dramatically reduced charger use in the early part of 2020. Energy delivery and session count had nearly rebounded to pre-pandemic levels by the fall of 2020, though had begun to fall again as the winter 2020 COVID-19 wave took hold.

4.1 Individual Charging Station Performance

We measure individual charging station performance by average energy delivery and session count productivity metrics. Overall, the average charger,[9] funded by the two programs delivered 3.25 kWh per day over 0.32 sessions—about two 10.5 kWh sessions per week. The median charger delivered 1.5 kWh per day and served 0.14 sessions—or about one per week.[10]

The large (doubling) difference between average and median productivity indicates a distribution where high outlier values are substantially pulling up the average. An analysis of the variation in charging productivity confirms a very unequal distribution of utilization across stations (see Figure 11). The disparity between the productivity of stations in the upper end of the productivity distribution and chargers that occupy the lower end is large. For example, the 90th percentile charging station's average energy delivery was three-and-a-half times and almost eight times more productive than the average and median station respectively. On session productivity, the 90th percentile station was about three-and-seven times more productive for the same metrics.

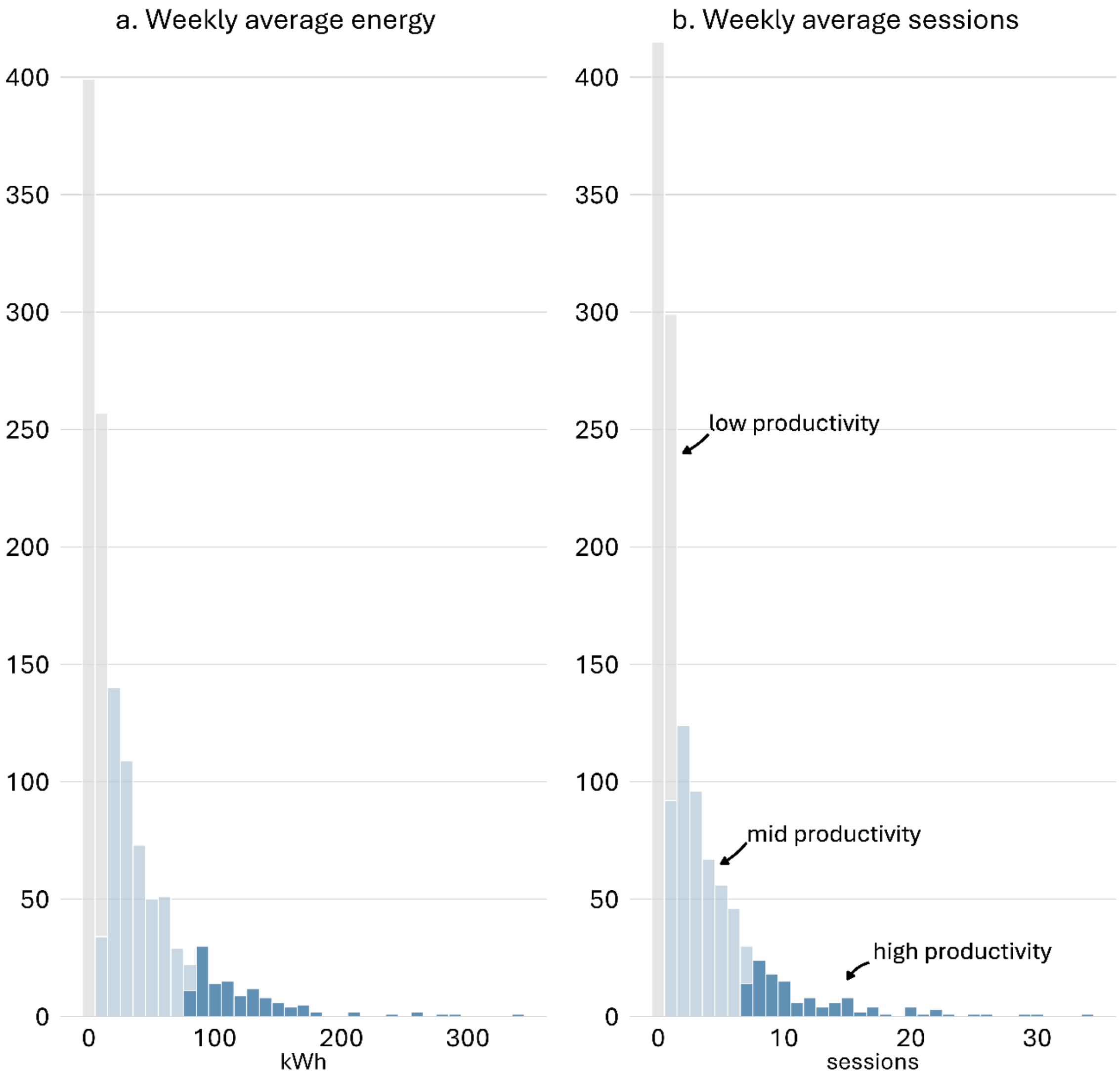
Moreover, stations above the 90th percentile in both metrics accounted for about half of all energy delivered and sessions served for all the chargers measured. On the opposite end, chargers in the bottom half of the productivity distribution accounted for only seven percent of sessions and eight percent of energy delivered.

Key takeaways:

- Average and median charging productivity metrics are indicative of infrequent overall use of charging stations funded by the programs in the study.
- Most charging occurs at a small number of high-productivity stations and most chargers are, comparatively, very unproductive.

Figure 11. Histograms of Weekly Charger Performance for Average Amount of Energy Delivered and Average Number of Sessions

Bar widths represent 10 kWh and one session. Low-productivity stations below the median (50th percentile). Mid-productivity stations are those above the 50th percentile and below the 90th percentile. High-productivity stations are 90th percentile and above.



4.2 Categorizing Station Performance

Because so much of overall charging station productivity is concentrated in a few high-performing stations, focusing solely on averages or medians might obscure important variation in the high end of the distribution. To counteract this possibility, we categorize stations into three performance categories (see labels in Figure 11). Where stations were split between the two performance metrics, they were assigned to the highest performance category option (e.g., a station with high performance on energy delivery but mid performance on sessions is categorized as high performing).

The three performance categories are:

- High-performing stations are above the 90th percentile of station performance.
- Mid-performing stations are between the 50th percentile and the 90th percentile.
- Low-performing stations are below the median or under the 50th percentile.

In this analysis, high-, mid-, and low-productivity categories are defined relative to other stations in the data set and are explicitly not meant to be a normative assessment of absolute charger performance. While more productive stations are certainly delivering more value than lower productivity stations and are thus a better investment, there is almost no publicly available data to benchmark the performance of the charging stations in NYSERDA's programs against the performance of stations in other geographic contexts, which would be necessary for a more robust evaluation of general station performance.

Table 5. Number of Stations by Performance Group

	High Productivity	**Mid Productivity**	**Low Productivity**
Station Count	207	516	521
Share of Total†	16.6%	41.5%	41.9%

† Percentages do not match percentiles due to categorization based on multiple metrics and per-port ranking.

Variability among station design complicates the categorization of individual charging stations. Stations have one or two ports each, and those that have two ports may either share an electrical circuit or not. Stations with multiple ports have twice the capacity to host sessions but dual-port stations that share a circuit can have the same energy delivery capacity as a single-port station. Sixty-eight percent of the charging stations within the charging use data have two ports, and the remaining 32 percent have one port. However, we do not have data on the power capacity of each port of the dual-port stations.

Unsurprisingly, when we compare performance categorization by station and by port, single-port stations make up a higher proportion of high-performing plugs than they do high-performing stations, especially when comparing by session count. To create the most usefully representative categories of charger performance, we categorize stations by the most productive port attached to the station.

Notably, even when categorizing on a per-port basis, single-port charging stations are underrepresented in the high-performing port category, relative to their prevalence in the wider data set. This indicates that all else equal, ports on single-port chargers get less use than ports on dual-port stations. It is unclear why this might be the case, but it is possible that there are systematic differences at locations where single-port stations were preferred compared to those which chose dual-port options.

4.3 Charging Station Performance and Land Use

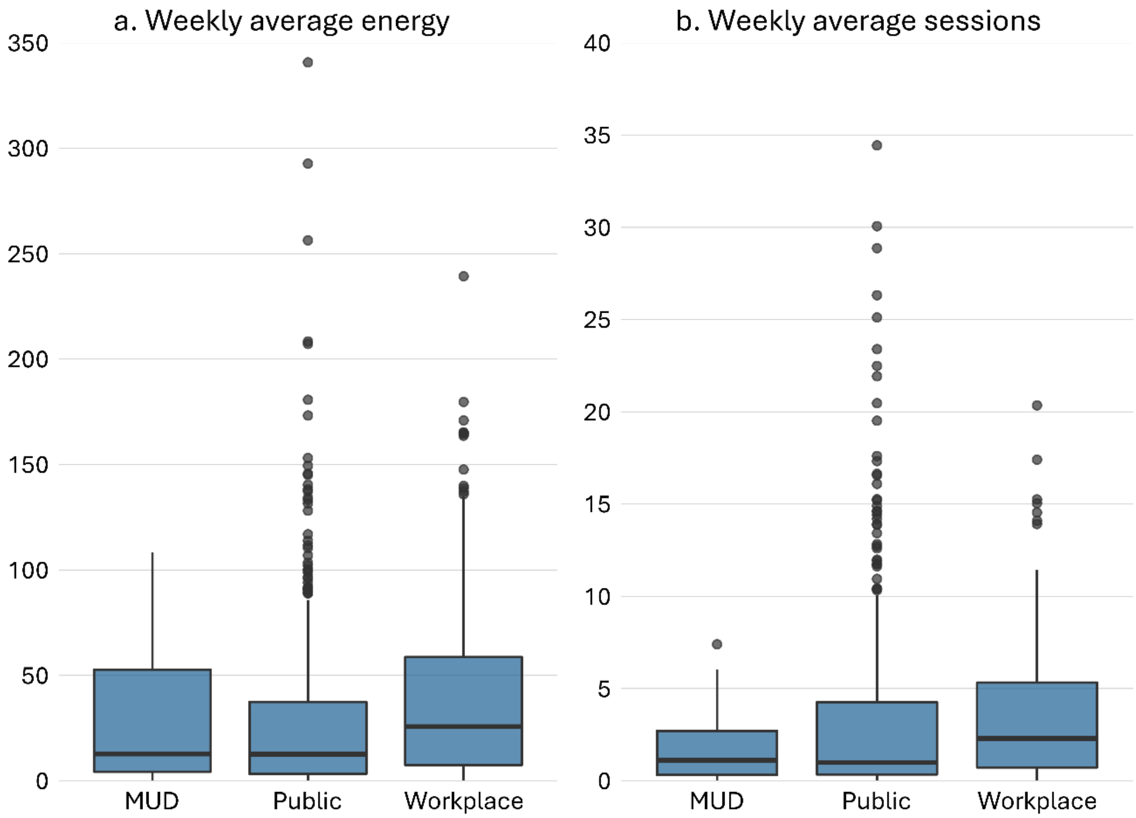
Because the chargers in this analysis are not fast chargers (which are more likely to attract drivers for the sole purpose of charging), we expect that charging is generally incidental or at least secondary to the primary behavior of the user visiting the location where a charger is sited. Thus, intuitively, we expect that the underlying land use where a charger is located will influence the frequency and intensity of charging station use, an expectation which is confirmed at a high level in the charging use data plotted in Figure 12.

The median workplace charger delivered more than twice the energy over twice the number of sessions compared to public and MUD charging stations, suggesting that chargers located at workplaces are typically more productive than those at public sites or at MUDs both in the amount of energy they deliver and the frequency of their use. This is consistent with expectations that workplaces, which are regular and repeat destinations to visitors that will park for long periods of time, are often good places to install charging infrastructure.

While having lower median use than workplaces, the stations with the absolute highest productivity are located at public sites—as indicated by the outliers shown in Figure 12. This is consistent with expectations that stations with more access have more potential for high-use frequency than the private or semi-private chargers at workplaces.

Stations at MUDs have similar median productivity metrics as public stations but also no high outlier stations, which indicates few locations where MUD stations are shared among many residents. That MUD stations have generally lower energy use is notable given that they are meant to provide a home charging option to MUD residents and home charging is usually the primary, and often the only, charging mode for EV drivers. The median station at a MUD delivers 12.75 kWh per week, meaning that half of MUD charging stations in the data set support no more than 44 to 57 miles[11] a week, far fewer than the typical New Yorker motorist drives. (Federal Highway Administration 2017) While it is possible that MUD resident EV drivers simply travel fewer miles than other drivers, it is reasonable to conclude that most of the MUD charging stations deployed to date are not currently supporting the majority of even one residents' EV charging energy demand.

Figure 12. Weekly Average Energy and Session Use by Land Use



Looking exclusively at the distribution of high-productivity chargers across land use types, we find that, again, workplace charging contains the highest share of high-productivity chargers. Most high-performing chargers are in the public category, yet on a percentage basis, public charging stations lag those at workplaces. MUD stations comprise a much smaller number of high-productivity chargers on an absolute and relative basis.

Table 6. High-Productivity Stations by Land Use

	MUD	Public	Workplace
High Productivity	4	81	54
Total	37	424	230
High-productivity percentage	10.8%	19.1%	23.5%

When comparing the subset of 699 chargers for which land use data exist to all stations in the session, we find that stations with more detailed location data are on average more productive and contain a higher proportion of high-productivity chargers. This indicates that there may be an unobserved link between a charger's productivity and whether detailed location data is available. If this is the case, that relationship could be biasing this comparison across land use types.

Key takeaways:

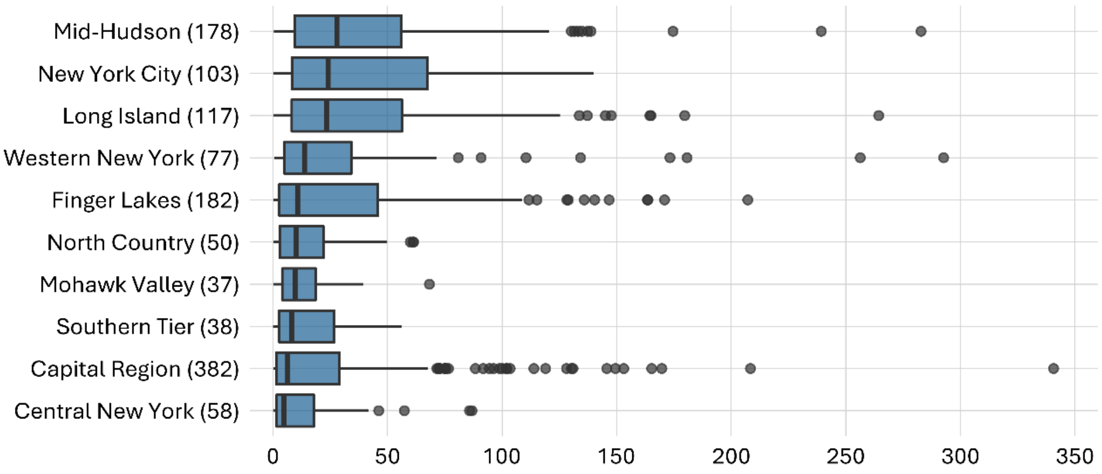
- General assumptions that workplaces are ideal locations for charging infrastructure appear to be borne out by usage data.
- Charging stations at most MUD-based stations receive less use than would be expected if they were providing the same support of vehicle travel that is typical for other *home charging* modes. This warrants further research, particularly because installing charging stations at MUDs is generally thought to be the most desirable way to enable EV adoption for that housing segment.
- While systemic differences in charger productivity across aggregated land use types typically aligns with expectations, the factors that drive the substantial productivity differences within broad land use categories remains unclear and should be the focus of future study.

4.4 Charger Productivity and Geography

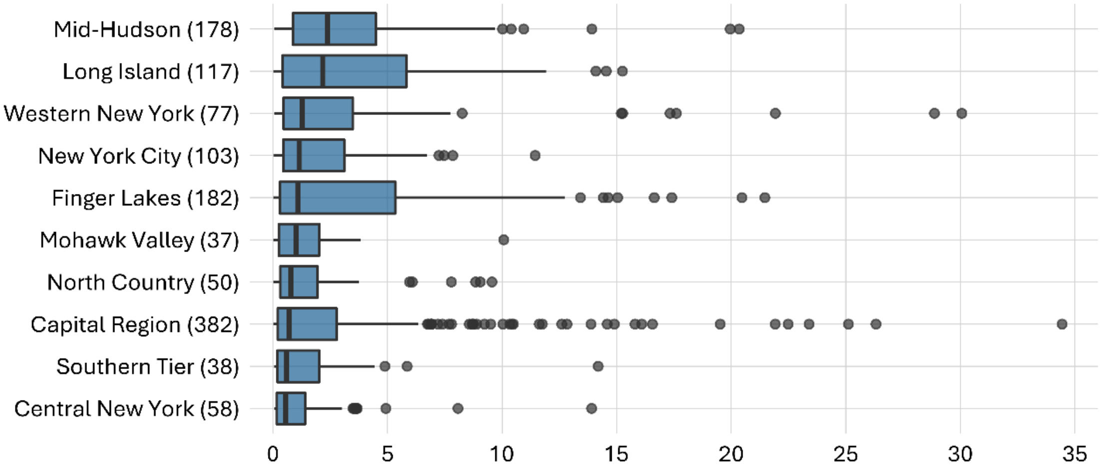
Unlike with land use detail, the session data set contains specific-enough location data to categorize all stations by region. Figure 13 shows the distribution of productivity metrics by region, as well as the number of stations in each region. The largest distinction of median station productivity is between the energy use of downstate regions and elsewhere in the State where the median downstate station outperforms other regions by at least double. Additionally, the third quartile (right side of the box) for those regions is substantially higher, indicating a flatter distribution of station performance than the norm for upstate stations.

Figure 13. Charging Productivity by REDC (Number of Chargers).

a. Weekly average energy



b. Weekly average sessions

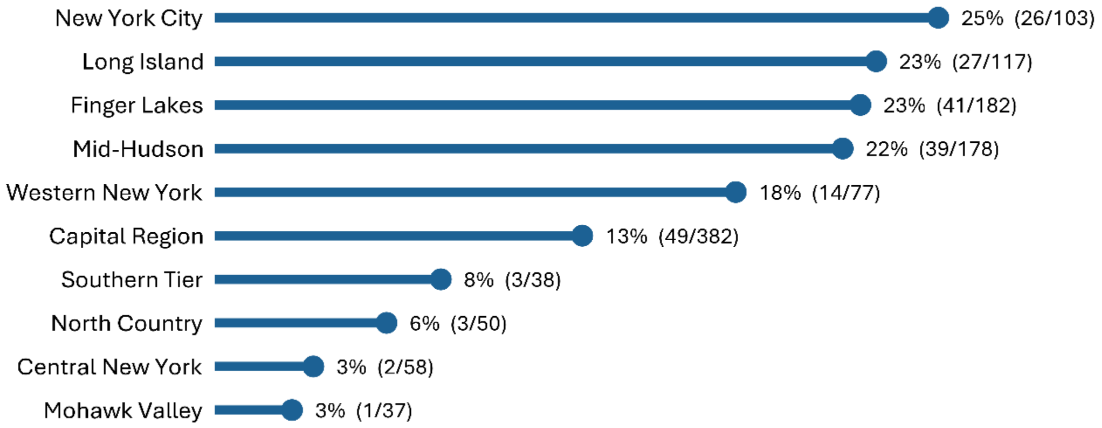


On a session basis, Mid-Hudson and Long Island repeat that pattern although New York City recedes closer to other regions in the State, meaning that stations in the City have uniquely high energy delivery per session.

Notably, the median charger in the Capitol Region (which has the most charging stations) is near the bottom of the ranking across regions in both productivity categories, although it also has a relatively high number of very high performing stations and contains the station with the most use across the entire usage data set.

Figure 14. Share of Regional Chargers in High Productivity Category

Figure shows the percentage (and fraction) of high-productivity charging stations in each region.



Key takeaways:

- Downstate regions have the most productive chargers on average and contain a high share of the most productive charging stations in the program.
- The Capital Region, which has the largest share of funded stations, is at the low end of average charger productivity and in the middle of the pack on share of high- productivity chargers, despite also containing the NYSERDA-funded charger in the program with the most use.
- It is likely that some regional variation can be explained by regional variation in EV adoption, something that should be explored in further research.

4.5 Charger Utilization Trends

Unlike session count and energy delivery metrics which are absolute values, charging utilization is relative—the ratio of charging port use to available capacity expressed as a percentage. This can be measured at a system (or site) level (e.g., if there are 10 ports and five are occupied at one time, that represents a utilization factor of 50 percent) or an individual level (e.g., if one station is used for six hours out of a day, its utilization rate is 25 percent). We track utilization on two separate metrics: charging, which is where a vehicle is actively charging; and occupied, which is where a vehicle is plugged in but may not be charging.

Figure 15. System Weekly Peak Utilization and Total Capacity Growth (2014–2020)

(a) the weekly peak utilization (highest level of utilization within a given week) trend
(b) trend in number of ports in service (or reporting data). 2012 and 2013 are excluded due to very low number of deployed chargers.

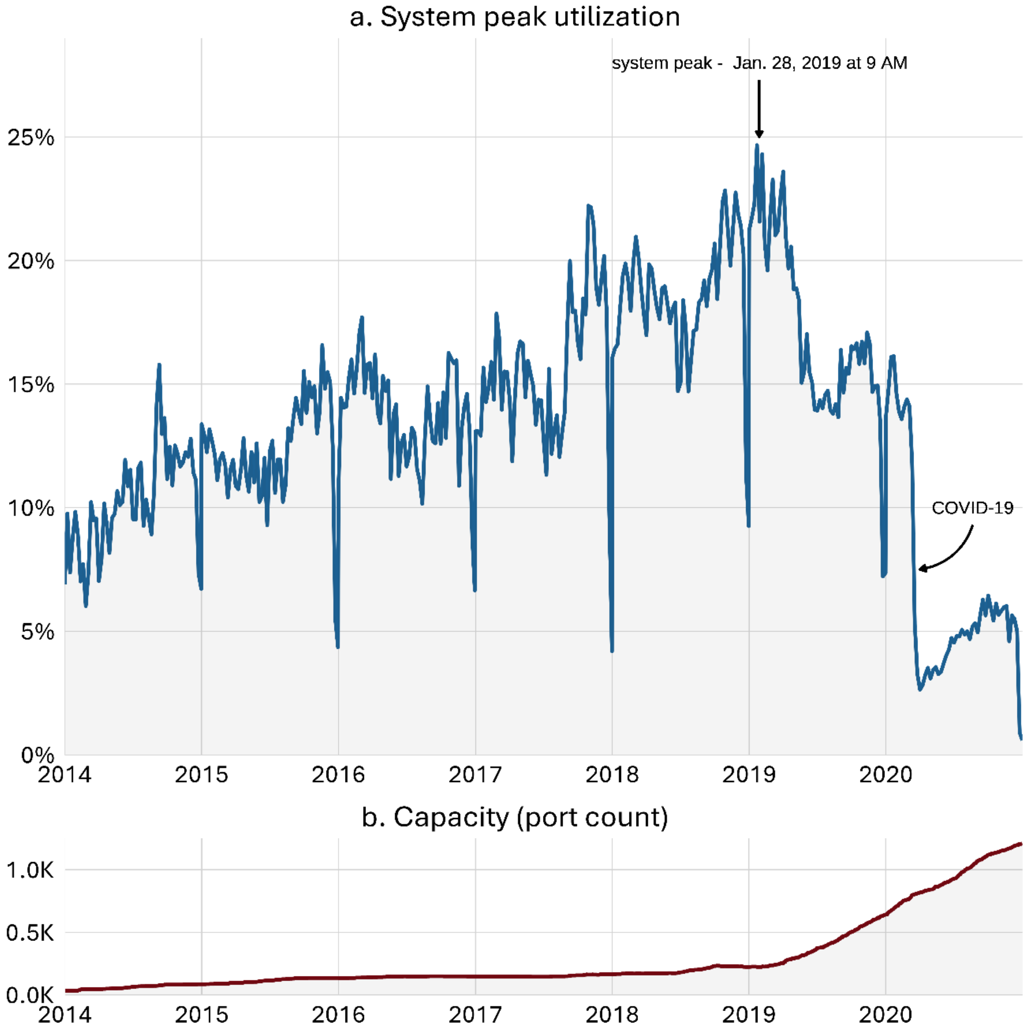


Figure 15.a plots the peak system utilization of funded chargers between the beginning of 2014 and 2020. Trends in utilization show significant seasonality with each year showing a summer trough and a deep decline at the end of the year which would coincide with dips in commuting that occur during winter holiday break. These cycles suggest system utilization is strongly tied to the commute patterns of workers, though summer dips in utilization may also be caused by the better efficiency EV drivers enjoy during warmer weather. There is also a notably sharp decline in utilization during COVID-19 pandemic induced travel reductions, which notably also strongly affected commuting.

The long-term trend of utilization increases between 2014 and early 2019 when the system experienced its historic peak utilization rate of just under one in four charging ports in use and charging at the same time. After this peak, in the second quarter of 2019, peak utilization rates fell from 25 to 15 percent over a few months, an unprecedented drop compared to historic trends. While utilization recovered slightly in the winter of 2019, it remained well below its historic peak and then fell again at the onset of the pandemic.

Looking at Figure 15.b, this decline in utilization occurred at the same time as system capacity (the denominator in the utilization equation) began to expand in earnest under the Charge Ready program. The fact that utilization decreased as capacity grew suggests the possibility that charging station deployment may have reached a saturation point, where new charging station availability began to crowd out usage at existing locations. However, across aggregate station utilization, we find that this drop is more likely to be caused by rapid capacity growth combined with low initial utilization at new stations.

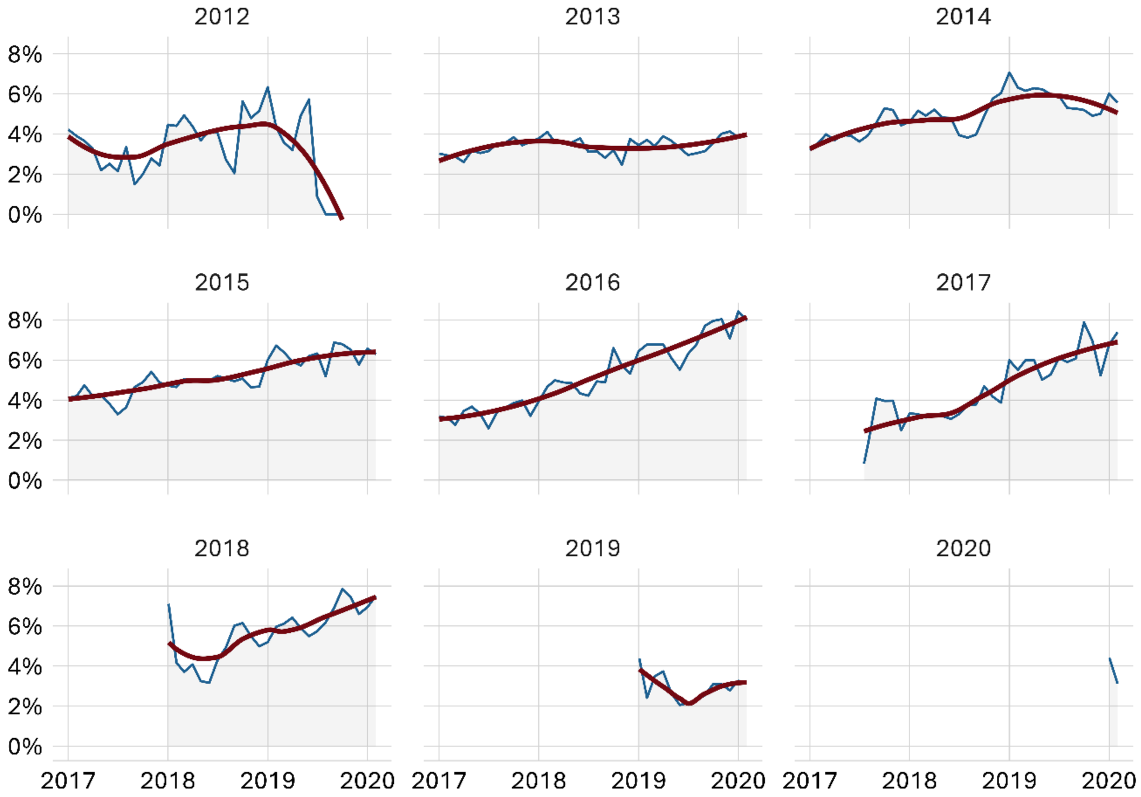
Figure 16 shows trends in charging utilization over time by the year-cohort in which the charger was deployed. If new stations competed with existing stations, then we would expect utilization to decline among chargers that were already deployed in 2019. While there does seem to be a dip that happens in the summer of 2019 across most charging station year-cohorts, it is not larger than prior fluctuations in use. Moreover, except for older chargers installed in 2012-2014, charging utilization among existing chargers continued to grow at a relatively even pace for all existing charging station cohorts. We also see utilization is comparatively low for the large quantity of chargers installed in 2019, suggesting that low early performance of those chargers (which is consistent with the starting utilization of past charging station cohorts) is depressing the system-wide utilization rate.

The decline in utilization for 2012 stations corresponds with the disappearance of those chargers from reporting data, which may be caused by them going offline or simply hitting the end of required reporting periods. Those chargers are removed from the overall capacity figure when they stop reporting and thus are not significantly impacting systemwide utilization rates.

There was a slight decline in utilization for the 2014 charging station cohort starting in 2019, which might reflect some competition from new stations coming online. More importantly, this aggregate analysis cannot capture potential effects at the individual station level that might occur if a new station is brought online near existing stations. We found inconclusive results when we explored whether new stations impact nearby existing stations.[12] This may indicate that there are no impacts of new station deployment on existing station utilization but could mean that any observable effect was masked by other factors, chiefly the effects of the COVID-19 pandemic on travel.

Figure 16. Average Charger Utilization by Annual Installation Cohort (2017–2020)

Trend data truncated after March 1, 2020 to exclude downward trends caused by the COVID-19 pandemic related reductions in travel demand.



Key takeaways:

- Charging utilization follows a seasonal pattern that suggests heavy influence from commuter travel patterns on station utilization.
- System utilization peaked in early 2019 prior to a decline that coincided with the expansion of the system capacity.
- Utilization factor declines do not appear to be driven by widespread competition between existing chargers and new chargers.

4.6 Charger Utilization by Time of Day

In addition to seasonal variation, utilization varies hour by hour and by day of the week. Figure 17 shows how hourly utilization has changed over the duration of the charging session data. Here, like in Figure 15, we see utilization growing year over year until 2019, and the effects of the COVID-19 pandemic in 2020. In addition, we see how the shape of daily utilization also changes over time.

In the first year of session data (2012), charging use patterns show a weekday trend that peaks in the late morning (as commuters arrive and plug in) and then rapidly declines into the early afternoon. At the same time, occupancy utilization (share of ports occupied) peaks with charging and then flattens, tapering off by the end of typical working hours. On weekends, system utilization does not even register on the graph. This is indicative of a system where utilization is driven almost exclusively by refueling commuters.

Over time, as the EV market matured and more of them were on the road, the daily usage pattern began to change. Weekend utilization picks up, though never as high as weekday use. The *commuter peak* pattern persists. However, it is softened by increased usage in the afternoons and evenings, suggesting that the dominance of commuter supporting charging (while still very significant) has waned over time. More weekend and afternoon charging indicates more users charging during non-work trips.

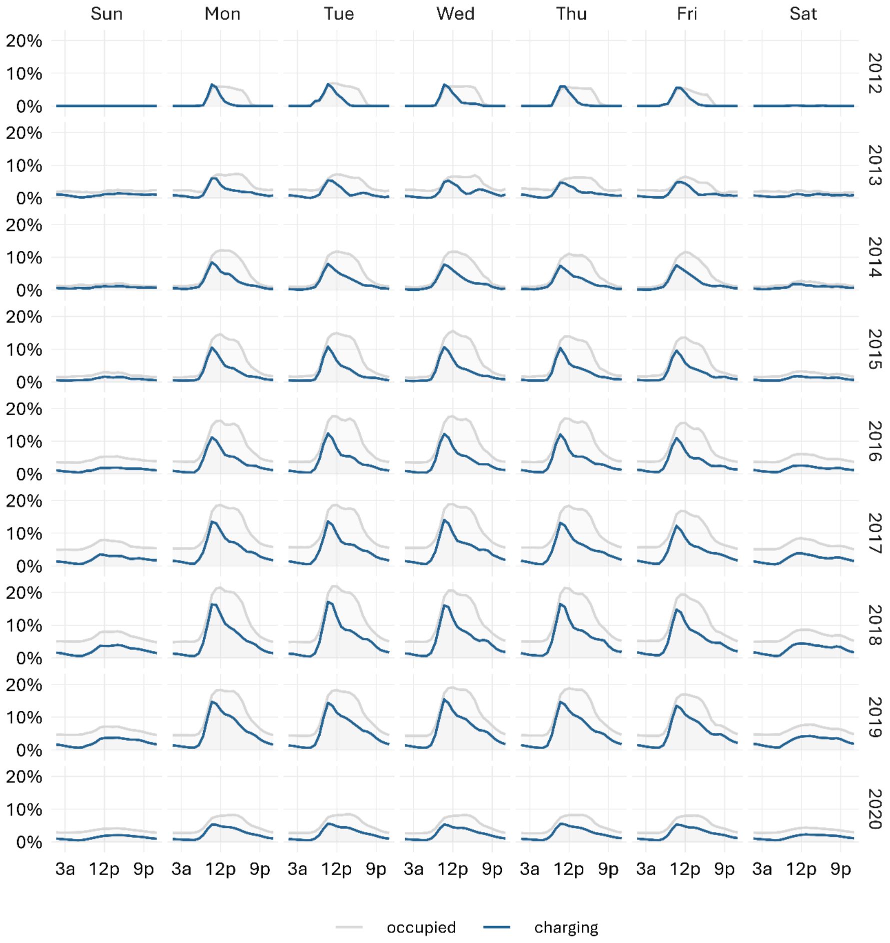
Starting in 2016 charging patterns start to show up, with charger utilization persisting through the evening and into the early hours of the following day. Across time, the lowest charging utilization continues to bottom out near zero in the early morning hours just before the morning ramp up. However, in later years occupancy utilization curves begins to develop a base occupancy rate above zero (about 5 percent at its peak in 2018-2019).

While the effect softens over time, the systemwide charging utilization is primarily driven by a commute-type pattern where most charging occurs in the mid-to-late morning and tapers off in the afternoon. Intuitively, we expect temporal usage pattens to be strongly related to the underlying land use where the charger is located, and the types of trips it attracts.

Figure 18 shows how hourly utilization varies by site type. Charging at MUDs generally conforms to expectations, showing a utilization curve that is approximately the opposite of public and workplace charging with an evening peak and daytime trough. However, as more stations were brought online, the ramp to the evening peak becomes more gradual, suggesting some increasing charging in late morning and early afternoon which does not fit expected profiles of home charging quite as neatly.

Figure 17. Hourly Utilization by Day of Week and Year

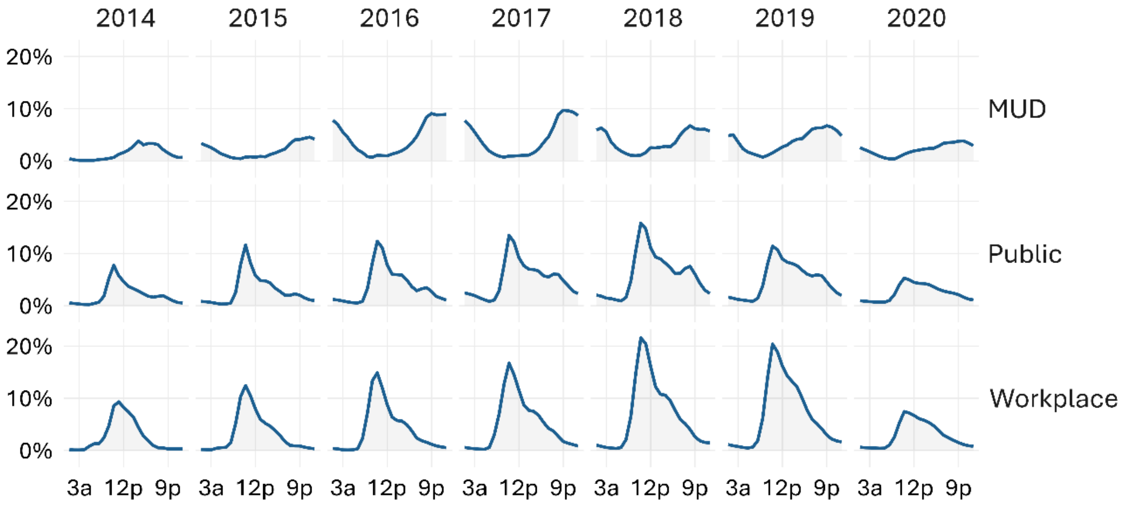
Summarized utilization rate of all chargers by hour, day of week, and year. Utilization shown as percentage of total plugs that are occupied and actively charging in a given hour.



Public and workplace charging stations are less distinct from each other. While public charging shows more late-afternoon and early-evening charging than workplace charging stations, public charger utilization is still predominantly driven by a commuter charging pattern. On the opposite side, workplace charging is more strongly oriented toward commuter charging, but also sees more significant charging in the late afternoon and evening than would be expected from solely commuter-oriented stations. Perhaps most interestingly, in later years, both public and workplace charging see small but appreciable amounts of overnight use.

Figure 18. Average Weekday Station Utilization by Year and Land Use

Summarized weekday utilization rate of chargers by hour, year, and land use. Utilization shown as percentage of total plugs that are actively charging in each hour.



Key takeaways:

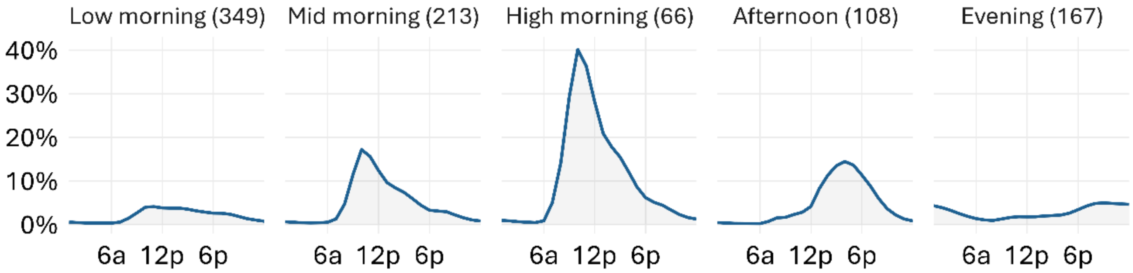
- Temporal patterns of charging use have changed over the course of time covered by the study period, with an early pattern of use focused almost exclusively on weekday commuter charging giving way to a more diverse pattern of use in later years.
- Despite growth in charging for other trip types, charging aligned with workday commuting remains the largest driver of system utilization, reinforcing conclusions drawn from seasonal use patterns.
- MUD-based chargers are generally used for overnight charging, but there is less distinction between workplace and public charging use, suggesting that those chargers are used for cross purposes.

4.7 Grouping Charging Stations by Use Pattern

The variation inside land use categories invites further evaluation of how individual chargers are used. The team grouped stations with similar usage patterns[13] and evaluated the utilization of stations within each group (see Figure 19), naming each group by the time of day when average usage peaked, as well as the magnitude of those peaks.

Figure 19. Average Charging Use Patterns by Cluster

Hourly average utilization rate of chargers in each charging-use cluster. Utilization shown as percentage of total plugs that are occupied and actively charging in a given hour.



Low morning (349 stations) This category is the largest and encompasses stations where combined utilization is, on average, low and relatively flatly distributed around a low 11:00 a.m. peak. Stations in this category do not exhibit a strong reoccurring daily use pattern in the morning, afternoon, or evening and are characterized by more mixed usage than other categories.

Mid morning (213 stations) The second-largest category, these stations collectively exhibit a stronger morning peak than low morning, but falloff is gentle for the remainder of the day indicating proportionally high afternoon use.

High morning (66 stations) The smallest grouping, stations in this category exhibit more frequent peak morning usage with a steeper falloff in the afternoon indicating a high concentration of use in peak commuter arrival hours, though usage in the afternoon remains high compared to some other station categories.

Afternoon (108 stations) Stations in the category are most frequently visited in the mid-afternoon, with a combined utilization pattern that displays an approximately symmetrical ramping up and down on either side. Notably these charging stations have no characteristic "commuter peak" in the morning.

Evening (167 stations) This category is approximately opposite of the low morning category, where usage instead generally peaks in the early evening and falls off into early-morning hours, but overall usage is more distributed. Stations in this category predominantly serve overnight charging sessions.

Remapping these charging-use patterns back to land use yields mostly unsurprising results such as: workplace locations dominating the *high morning* category, public stations falling mainly into the mixed *low morning* category, and MUD stations mostly falling within the *evening* category.

However, there are two interesting findings:

- While both were dominated by *morning* charging categories, there were proportionally more *afternoon* charging category stations among identified workplaces than in identified public locations.
- Sixteen (seven percent) identified workplace chargers had use characteristics that identified them with the mostly-overnight, *evening* charging category.

Table 7. Frequency and Share of High-Productivity Stations by Use Category

	Low Morning	Mid Morning	High Morning	Afternoon	Evening
Number of high-productivity stations	51	60	48	13	28
Percent of category	14.6%	28.2%	72.7%	12.0%	16.7%

Looking at usage pattern categories in the context of high-productivity stations defined earlier in the chapter yields additional insight (Table 7). *Afternoon* category chargers are the least likely to be high-productivity stations. Unsurprisingly, stations with a *high morning* usage pattern are the most likely to be high productivity, with nearly three out of four of those stations being highly productive. *Evening* charging stations are slightly more likely to be high productivity compared to low morning chargers which is somewhat surprising given the low representation MUD stations had in the high-productivity station category as shown in Table 6.

Key takeaways:

- The plurality of stations covered by the program do not display a well-defined temporal usage pattern.
- Stations with strong commuting driven patterns (mid and high morning) make up the second-largest set of stations.
- Stations that are used for afternoon charging sessions or for overnight charging are the smallest and second-smallest categories respectively.
- Stations' use patterns do not always match their land use type, further evidence of chargers used for cross purposes or even entirely unaligned with the typical trip-attracting characteristics of host land uses.
- Stations with consistent peak usage during commute times are most likely to be highly productive.

4.8 Station Idle Time and Congestion

Idle time is the time during which a station connector is plugged into a vehicle, but that vehicle is not charging. While this is sometimes the result of a fault in the charger or vehicle, with Level 2 chargers, it primarily occurs when vehicles finish charging prior to the driver returning to their vehicle. Sessions with idle time can represent an opportunity for managed charging or vehicle-to-grid integration. However, without those features, idle time is non-productive time that can prevent other drivers from using a charger thus causing congestion.

Congestion occurs when there is more demand for chargers than there are available chargers, meaning that those looking for a charge are not able to obtain one. In the case of Level 2 chargers where vehicles need to be parked for an extended time to obtain a meaningful charge, congestion will usually mean a potential user that arrives to find no unoccupied ports will simply not charge at that location.

On average, session charging times and session idle times are about equal, at about 2.4 and 2.3 hours respectively. However, median charging and idle times are quite different, at two hours for the former and half an hour for the latter. This is unsurprising given that battery capacity provides a practical upper limit to charging time, but vehicles can remain parked at a charger indefinitely. A small number of very long parking events have the effect of significantly increasing the average idle time, making median a better measure of typical idle times.

Figure 20 shows average and median charging and idle time by the hour when a session starts. In Figure 20.a, we see that sessions that begin in the late evening and overnight have the longest session length and the highest proportion of idle time to charging time generally, which aligns with expectations of a long-dwell charge while the driver is home and asleep. The second-longest group of sessions start between 5:00 and 9:00 a.m. which aligns with drivers arriving at work and plugging in, often for the entire workday. Average charging and idle time lengths are at their lowest in the midafternoon.

Looking at median charging and idle times (Figure 20.b), we see that idle times decrease dramatically for most periods of the day (relative to average). While the combined height of the bars is no longer interpretable, we do see some interesting patterns emerge. Idle times for the median charging session are longest during the commuting charging hour and the ratio of median charging time to session time is highest then as well. This result confirms general expectations that vehicles plugged in while drivers are at work, spend much of their time plugged in but not charging.

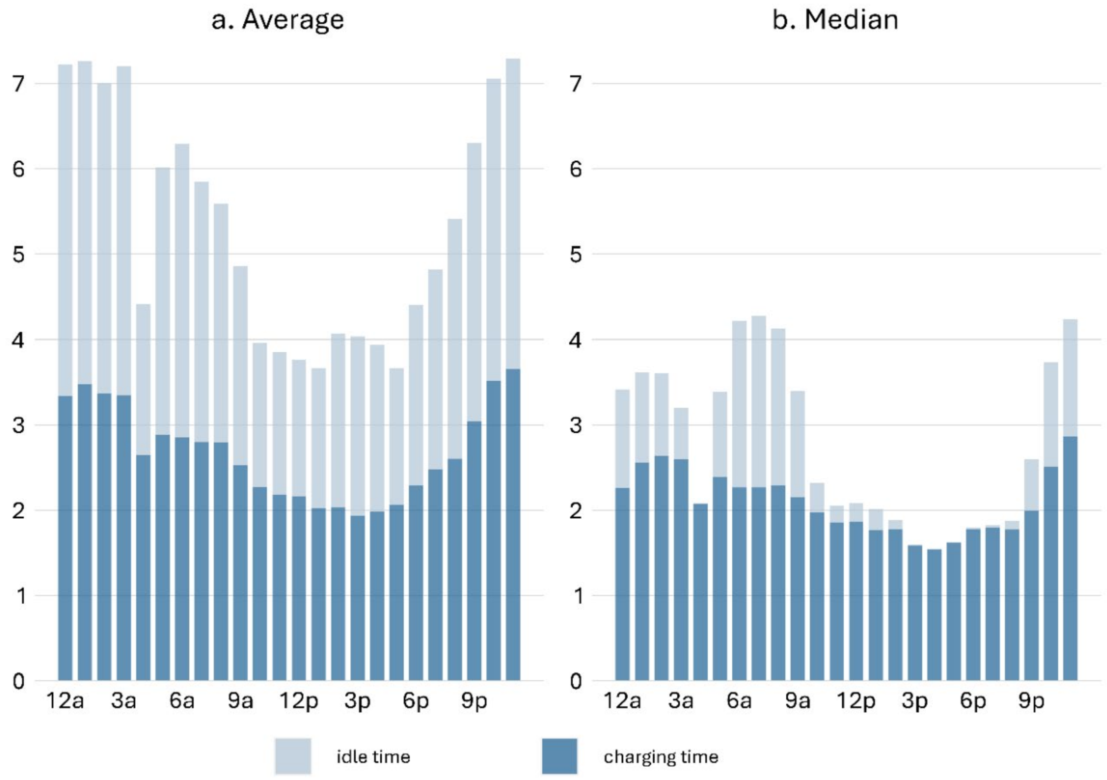
Idle time for the median vehicle charging in the early to late afternoon is significantly less than average, vanishing entirely between 3:00 and 6:00 p.m. From this we can infer that most vehicles that plug in during those time periods disconnect before they have reached a full charge, indicating charging sessions happening during shorter dwell periods. Interestingly, that same pattern is present for sessions that start between 4:00 and 5:00 a.m., perhaps indicating that most of the (relative few) charging sessions that occur during that time are last minute top-ups meant to supply users with charge to drive to work or elsewhere.

Idle times are a particular concern if they contribute to charger congestion and limit productivity, in which case it might be useful to employ charger use policies that limit idling on a charger. If long idle times were systematically interfering with charger productivity among the stations in our dataset, we would expect to see a negative association between idle time and charger productivity metrics. However, the data show a positive association between higher idle times and charger productivity metrics. This is because most stations get relatively little use overall, meaning that more idle time is positively correlated with more use, and thus more productivity.

However, even when we limit our analysis to only high-productivity stations, the association between idle time and productivity remains positive (though less strong). This suggests that idle time is not a limiting factor in station productivity even for highly utilized stations at current levels of EV adoption.

Figure 20. Charging and Idle Time by Hour of Session Start

Average and median charging and idle time by hour user plugs in. Total bar length indicates average total connection length in (a) but not median total connection length in (b).



4.8.1 Site-Level Charging Station Congestion

In general, congestion does not appear to be a significant concern for the charging stations under study. While this is self-evident for the low-performing stations, we conducted additional analysis to identify potential congestion at the site level[14] to determine hourly site-wide utilization rates for all co-located charging stations. Because a large majority of charging occurs during daytime hours, we limited this analysis to between the hours of 5:00 and 8:00 p.m., which provides a better sense of how frequently chargers are congested compared against all possible hours. Sites are congested when the utilization rate is 100 percent (all ports are in use) in any given hour. We find that congestion is relatively rare at the sites we were able to evaluate with available data.

Between 2017 and 2019:

- About 75 percent of dual-port locations were congested for less than five percent of daytime operating hours and only about 1.5 percent saw more than 50 percent congestion over that time.
- At sites with four ports, 78 percent of locations saw less than five percent congestion time and no locations were congested for more than 10 percent of hours.
- No sites with more than four ports were congested for more than 5 percent of daytime operating hours.
- No sites with more than eight ports have more than 10 congestion hours total per year, and no sites with more than 12 ports had any period where all ports were simultaneously in use.

Limiting the congestion analysis to an even narrower examination of just peak commuting charging hours does not significantly impact the observed incidence of congestion.

Key takeaways:

- As expected, charger idle time is highest during overnight and workday charging sessions.
- The median vehicle plugging in during afternoon hours unplugs before completing a full charge.
- Excess idle time does not appear to be an impediment to charger productivity given current charging demand, though it may become a limiting factor with future EV adoption growth.
- Except for a small number of sites with one dual-port station, congestion does not appear to be a significant concern among charger sites.
- Additional charging ports at a site appear to be an effective congestion mitigation strategy. However, larger installations appear to be overbuilt for current demand.

5 Discussion and Conclusion

The analyses of cost and use data contained in this report have served to better our general understanding of the trends in cost and use of Level 2 chargers funded by New York State programs. Moreover, they have revealed actionable information for both prospective site hosts of Level 2 stations and policymakers planning the development of next generation Level 2 funding programs. However, it is important to remember that the insights of this report are limited to Level 2 charging and that the discussion contained in this section should not be misconstrued as being applicable to DCFC which have significantly different cost and operating profiles.

5.1 Implications for Prospective Site Hosts

The median per-port cost to deploy Level 2 charging infrastructure funded by the recent Charge Ready NY program was about $6,500. Prospective site hosts in New York State should expect the full cost of installing infrastructure to be around that figure but, based on the wide distribution of install costs, they should also anticipate the possibility that costs might more than double depending on site-specific installation factors.

Site hosts at public sites should expect that typical install costs will be a bit lower than the overall average, whereas workplace and MUD site hosts should anticipate slightly higher costs. Likewise, site hosts in less populated areas of the State should anticipate slightly lower costs while those in more populated areas should expect to pay slightly more. Given the regional nature of labor costs and labor’s large contribution to project costs, site hosts located in lower labor-cost locations might expect to pay less for installations; however, equipment costs are likely to be similar.

The variability of costs, especially within site types where site conditions should be more similar, indicates that site hosts may have opportunities to make installation choices that control costs. Unfortunately, there is not sufficient data in this study to identify what those opportunities might be.

Looking forward, if trends continue, costs for charging equipment are likely to fall over time, though it is not clear when those declines might taper off. There is some indication that installation costs have also decreased over time, but the evidence of that is far less compelling, meaning site hosts should not necessarily anticipate lower install costs for this kind of charging infrastructure in the future.

Turning to charging station usage, most stations deployed to date have seen little regular usage. Site hosts that misjudge what demand will be for charging at their locations are likely to find that the stations they install are rarely used. While most site hosts elect to offer free charging, and thus install chargers for reasons other than earning revenue from charging, infrequent use likely means that a charger is not offering a meaningful amenity value to site hosts.

In addition to assessing the number of EV drivers that visit their locations, potential site hosts wanting to understand if their location is likely to attract significant charging use should consider whether they are likely to serve commuting drivers. Stations with charging patterns that are concentrated during early working hours are more likely to serve more sessions and deliver more energy. While the EV market is still relatively new, and lower initial use of charging stations is to be expected, more careful deployment of charging stations reduces the risk of stranding assets in consistently low-utilization locations.

Furthermore, there is little evidence to date that congestion at Level 2 chargers is a common problem, which has two implications for potential site hosts. First, idle time management, or efforts to reduce the amount of time that vehicles stay on chargers without actively charging are unnecessary for most site hosts at this time. Second, given the positive relationship between idle time and charger use, idle time management might result in less charging if drivers who want to stay parked for longer than they need to charge are dissuaded to plug in.

Second, while larger charging installations do seem to relieve congestion, congestion is not a significant factor, even at locations with few ports. For most sites, the reduction in congestion provided by an additional charging station is small relative to the marginal cost of an additional charging station. To date, large charging stations have not hit full utilization, indicating that they are overbuilt for current demand. Given that installation cost returns to scale are not guaranteed, caution is warranted when deciding the number of stations to deploy. However, those site hosts that have determined that demand for charging at their property is likely to grow in the future would do well to consider a deployment plan that includes both immediate station installation and additional make ready work for future station deployment. This will minimize disruption due to construction and will likely save money by avoiding doubling the incidence of fixed costs such as planning, permitting, and demolition.

5.2 Implications for Policymakers

While motivation of government investment in Level 2 charging infrastructure in service of expanding the EV market results in more speculative station development than the private sector may choose on its own, the efficiency of public investments is an important criterion for a successful program. Public capital can and should tolerate lower returns in the near term to support the wider build out of charging infrastructure. Moreover, public investment should also consider social returns such as equitable access to charging infrastructure, which are not likely to be adequately accounted for in private sector investment. Nevertheless, public expenditures per deployed charger and per-charger productivity are important metrics and should be considered by decisionmakers as they design the next generation of charging infrastructure incentive programs.

One key design decision for incentive programs is determining appropriate incentive amounts, a consideration that has considerable impact on program outcomes. Too-low incentive amounts can limit uptake, but too-generous incentives can encourage inefficiency and free riding.

In that vein, we find that the drop in average installation costs between the PON 2301 program and Charge Ready NY may be caused in part by the lower incentive amounts in the latter program enforcing greater cost discipline on program participants. Moreover, because of lower incentive values in the second program, the public spending per charger meaningfully decreased, increasing the cost effectiveness of the program, and allowing public funds to stretch further. Limiting the base amount of public funding per charger can also free up additional funding to be directed towards other social goals such as increased access to fast charging or equity—a feature that was implemented in the latter stage of the Charge Ready NY program through disadvantaged community incentive bonuses.

Low utilization rates for most charging stations could be the reason for future programs to be made less generous. PON 2301 and Charge Ready NY funded stations that have seen little use to date. Methods to shift more of the investment risk in charging infrastructure toward the site host could encourage them to more carefully consider whether charging infrastructure will be beneficial at their location. This would reduce the exposure of public capital to the risk of funding unproductive assets. However, this is a delicate balance to strike because the market for EV charging is still in early stages and too little public investment might lead to less-than-optimal charger deployment and impeded EV adoption.

Related to incentive funding amounts, project funding caps are also an important aspect of policy design. As mentioned in the discussion in the prior section, charger congestion at Level 2 sites does not appear to be a significant problem at this time. While charging station locations with more chargers experience less congestion, a low baseline amount of congestion combined with rapidly diminishing marginal congestion relief from additional stations make the public return on funding large station deployments minimal. Future program designs could account for this by either reducing incentive amounts based on the number of charging stations funded by a single project, reduce the cap on the number of funded stations per project, or both. A second strategy could be to provide a smaller incentive to fund make ready infrastructure so that site hosts are able to quickly scale capacity with demand in the future while minimizing the cost and inconvenience of a second round of construction.

Designing programs so that funding is explicitly targeted towards higher-productivity locations or complementary to other programs focused on fast charging is difficult and can conflict at times with other policy goals, like equity. Especially as the EV transition builds critical momentum, locations that can sustain high charger productivity are likely to require less public investment than places where infrastructure development can most easily be economically sustainable. At the same time, increased public investment might be more warranted in places where high productivity is not as assured, such as historically underinvested areas or places where there are structural barriers to charging access.

Much of the variation in utilization rates for charging stations remains unexplained. While further inquiry into the causes of that variation is warranted, underlying drivers of utilization may simply be too complex to be effectively factored into policy design. That said, there are some insights from the charging use data which could prove useful in guiding program development in the near term. In particular, workplace chargers are more likely to be highly productive than Level 2 chargers at other locations, making workplaces a worthwhile target for outreach efforts. Likewise, locations that would be categorized as *public* still attract more use if they can support incoming commuters.

A major takeaway of the analysis of use data is that there is a large disparity in utilization between a small number of high-productivity stations and the typical charger deployed by the programs. While this is indicative of a mismatch between deployment of stations and demand for charging, we find no evidence that the charging landscape is saturated—that is, additional chargers do not appear to be competing with or crowding out use at existing stations. Overall, except for pandemic-induced reductions in travel, demand at program funded chargers appears to be increasing with time and the growth of the EV market.

5.3 Future Research

The results of this report's analysis of charging station deployment costs and usage behavior point to several further research opportunities. Much of the variation in both deployment costs and utilization remains unexplained by the dimensions available to analyze the data in this report. Further study into what drives that variation is warranted. Better intelligence on what factors drive cost and utilization would serve both program administrators and site hosts. Such analysis would benefit from more complete geographic information and additional site-specific data on land use. Additional analyses that incorporate information about charging station users or the local penetration of electric vehicles may also provide additional insight.

Additionally, program data indicate that charging stations located at MUDs are generally not well utilized. Because deploying subsidized charging stations at MUD properties is considered a key strategy in enabling MUD residents to purchase EVs; low utilization for those chargers warrants further study.

Finally, because charging performance statistics are not commonly published, there is little information with which to compare or benchmark charger performance. Without data from other programs or jurisdictions on which to draw comparisons, it is difficult to make judgments about whether or not a given EV charging program is meeting or exceeding expectations. While assembling a broadly representative set of charging use data sets would be difficult, it would be invaluable for program managers as infrastructure programs proliferate to new jurisdictions.

5.4 Conclusion

Incentive programs that fund the deployment of charging infrastructure are an important policy tool used to support climate-mitigating transportation electrification goals. This report analyzed cost data for 2,641 ports and usage data for 2,175 ports deployed through NYSERDA's incentive programs between 2012 and 2020 and is meant to provide insight into trends of deployment cost and charging use for site hosts, program administrators, and other charging station investment program stakeholders.

Costs for charging station deployment varied widely with maximum per-port costs reaching into five figures. However, typical installation costs were lower, with most installations costing between $4,000–8,000. Variation in deployment costs is driven by the cost of installation which was usually about half the total cost but can vary widely depending on the amount of site work required, labor needs, and potential electrical upgrades. Installation costs varied by geography and land use, but unobserved intra-category differences accounted for much of the variation.

Costs for charging equipment have declined over time, but installation cost declines are less certain. There appears to be potential for cost reductions for very large installations, but per-port costs increase between small- and medium-sized deployments.

The defining characteristic of the charging use data is the highly unequal distribution of charger utilization between a small number of highly productive stations and the remainder of stations that see much less use. While overall charging use climbed over time, the median charger only delivered enough energy per day to support a handful of miles traveled. However, at the upper end of the distribution, the most productive chargers supported hundreds of miles of driving per week.

In early years, charging stations were almost exclusively used by commuters, but over time utilization in the afternoon, evenings, overnight, and on weekends has grown. Use data confirm that workplaces are generally good places to install chargers where they will see significant use. Moreover, charging stations that have usage patterns that indicate they are used primarily by commuters are more likely to be highly productive. However, much of the variation in charging station utilization remains unexplained.

Finally, while there is no evidence that the charging landscape is becoming saturated (at least when examining Level 2 chargers deployed by NYSERDA programs) there is also little evidence of congestion as a widespread problem, nor does excessive idle time appear to be interfering with charger productivity. The largest charging station deployments in the program never see full utilization, indicating that their size is mismatched to current demand. However, these stations may match future demand as EV adoption grows.

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Endnotes

[1] All cost data is pulled from these two programs. A small number of stations in the use data were funded by other New York programs.

[2] While cost data is limited to those two programs, a small portion of the session data was reported by stations funded by grants from the Recharge NY and Cleaner Greener Communities programs.

[3] No stations included in this report qualified for the disadvantaged community rebate.

[4] Some of the charging use data covers stations not deployed under either PON 2301 or Charge Ready programs.

[5] Recipients of Charge Ready program funds received $4,000 per port even if they spent less than $4,000 in project costs.

[6] The PON 2301 program categorized project locations by a wider set of land uses than the Charge Ready program which only breaks out land use by public, workplace, and MUD. For this analysis, PON 2301 land use categories are recategorized into the limited Charge Ready categories based on access and type.

[7] We used a locally estimated scatterplot smoothing (LOESS) model to examine trends in the data. LOESS is a non-parametric regression method used to identify and illustrate complex non-linear relationships between variables. Note that there is not a large enough sample size, nor enough data on larger project sizes, to draw any firm conclusions.

[8] Charging stations may have indirect environmental benefits by encouraging additional EV adoption. However, that effect is unmeasurable using these data.

[9] Due to the impacts of the COVID-19 pandemic on personal travel, charging use fell dramatically in the spring of 2020. To provide the most accurate picture of individual charger performance and not bias estimates downward, we base average and median statistics (but not distributions) on charger use that occurred before March 1, 2020. This filter removes the 429 stations that were built after March 1, 2020.

[10] Median values are individualized and may not reflect the same charger.

[11] Based on a 3.5 – 4.5 miles per kWh fuel economy

[12] We modeled the effects of nearby station deployment on existing station usage using spatially explicit difference-in-difference estimation but did not find statistically significant results across multiple model specifications and distance parameters.

[13] We use agglomerative hierarchical clustering to divide charging stations by typical usage patterns. Judgment is involved in choosing where to stop dividing clusters into subclusters. We chose the cluster number shown in this report because it balanced a smaller, more useful set of categories with enough diversity to capture the primary dominant charging modes. Stations with fewer than 10 recorded sessions were omitted from the clustering procedure.

[14] Site identifiers were not available in the charging session data. For this analysis we use geographic locations of the 699 stations for which that data exists to identify clusters of charging stations within 50 meters of each other and base this charging sites on those station clusters.

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