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Changing the World's Energy Future

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The Current State of Light-Duty Electric Vehicle Supply Equipment Costs: An Assessment of Contemporary Understanding

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Abstract: This study uses a hybrid meta-analysis and literature-review approach to understand the current state of knowledge regarding the costs of electric vehicle supply equipment (EVSE). We present a novel way to consider, categorize, and label measures of cost and show cost measure estimates from a sample of 13 recent studies. We find that in general, there is too much variation and too few commonly represented EVSE cost measures to reasonably provide aggregate figures for these measures. We propose a convention for presenting EVSE cost measures that includes the application (commercial or residential), the power level (Level 1, Level 2, DCFC [with further distinction based on rated power capacity]), and the type of cost measure (hardware, installation, operation, and total cost). We contend that providing researchers with standard cost measures will help to advance our knowledge of EVSE costs by ensuring that future work will use common metrics. Establishing common metrics will enable conventional meta-analyses that will make assessments of EVSE costs even more accessible. Additionally, common metrics will make tracking costs more reliable as the technology continues to evolve and become more ubiquitous.

Keywords: electric vehicles; charging equipment; cost; electric vehicle supply equipment; performance measurement

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1. Introduction

With climate change rapidly progressing and the ensuing climate crisis being a real and immediate threat, society is beginning to come to terms with the urgency of decarbonizing our economy. Transportation is a major contributor to global greenhouse gas emissions, constituting 29% of overall GHG emissions in the US [1]. Furthermore, the US is responsible for 45% of global transportation emissions, making the decarbonization of this sector a paramount priority. Low and zero emission transportation technologies have been in development and available to light-duty consumers for decades, with hybrid electric vehicles (HEVs) having been commercially available in the US for 25 years now [2]. Despite these innovations, there has not been a preeminent low or zero emission light-duty transportation technology that gained a significant market share until the recent proliferation of electric vehicles (EVs). In fact, global EV sales have tripled in the past three years, with a similar growth pattern observed in the US [3].

Although EV sales are not yet near those of their internal combustion counterparts, the sales trends are being met with optimism for this technology from key industry stakeholders. There is no stronger endorsement that signals confidence in EVs as a viable zero-emission technology than the massive levels of private industry investment in new manufacturing facilities. In early 2023, the National Resources Defense Council published an astonishing claim: at this point, US companies have committed or pledged USD 210 billion in investments in EV and battery manufacturing capabilities [3]. An interesting accompaniment to this announcement is that such a figure brings the United States to the forefront of the world in terms of announced investments from private industry. This can be attributed, at least in part, to major commitments to clean transportation and energy manufacturing from the Federal government that provide incentives and general confidence as industry makes the leap to new technologies.

Some state governments have led the charge toward promoting EVs through purchase incentives and public investment in charging infrastructure that is necessary for consumers to conveniently transition to EVs. Notably, California has been a leader in this transition, with the Low Carbon Fuel Standard driving a shift away from petroleum fuel in that state since its adoption in 2011 [4]. Arguably the most impactful public contributions to a transition to electrified transportation have come through the unprecedented investments from the Bipartisan Infrastructure Bill (BIL) of 2021 and the Inflation Reduction Act (IRA) of 2022. A recent report from the Chicago Policy Review predicts large increases in EV adoption, in large part, resulting from policies and incentives contained within the IRA [5]. In addition to IRA's supply side incentives contained in the direct investments and tax rebates to industry actors making commitments to clean transportation manufacturing, BIL provides demand-side incentives to consumers by investing in EV infrastructure. The National Electric Vehicle Infrastructure Formula Program provides USD 5 billion in the form of an 80% federal cost match for states and private developers to install electric vehicle supply equipment along interstates and alternative fuel corridors [6]. Additionally, the Charging and Fueling Infrastructure Discretionary Grant Program provides an additional USD 2.5 billion for high-speed and alternating current (AC) Level 2 charging equipment for communities and corridors [7]. This "once-in-a-generation investment" creates a profound opportunity to transform our transportation system, but this opportunity will also present challenges as we implement new infrastructure and technologies that have yet to be deployed on such a scale [8].

An important consideration for light-duty vehicle consumers and governments alike is the cost of ownership as well as the cost of operation of EVs. In fact, the high initial capital cost of EVs has been identified as a major impediment to more widespread adoption of the technology [9–12]. While recent progress on the price of new EVs compared to their internal combustion counterparts provides some hope on future cost parity between the technologies, lower operating costs have long been considered a competitive edge that EV owners enjoy [13,14]. These lower operating costs associated with EVs are a function of both less frequent maintenance requirements as well as lower fueling costs [15,16]. However, to enjoy lower fueling costs, or even be able to fuel an EV at all, EV drivers must have access to both private (at home) and public charging infrastructure. The cost of this infrastructure has been a topic of study since the advent of modern mass-produced EVs, and this paper seeks to synthesize and advance our understanding of light-duty EVSE costs so that consumers, industry, and government can track progress and assess the resources necessary to improve access to clean transportation.

With the rapid growth in EV adoption and associated commitment to decarbonization of the light-duty sector by both industry and government, there is a corresponding growing need for the expedient deployment of public EV supply equipment (EVSE). Transportation decarbonization is increasingly seen as a viable and even necessary element of the fight to limit the most drastic effects of climate change and avoid a climate catastrophe. Sustainable transportation strategies, such as electric light-duty passenger vehicles require investments in infrastructure to increase their viability as they compete with more mature technologies such as internal combustion-powered vehicles. Because of this need to facilitate more sustainable transportation options, state departments of transportation and other governmental entities are quickly deploying public EVSE, which is fueling a rapidly expanding demand for this infrastructure. The unprecedented levels of public investment seen with BIL and IRA require that governments ensure the prudent use of public funding by having an empirically based understanding of the current costs of EVSE. This study aims to establish such an understanding by examining the current state of knowledge regarding EVSE costs. This effort will help to make a somewhat disparate body of literature become more accessible by providing estimates of costs in a single place, by creating new systems for conceptualizing and categorizing costs, and by presenting a preferred method for reporting costs for future research.

2. Methods

To present a robust depiction of the state of the scientific understanding of EVSE costs, our study blends a meta-analysis methodology with a traditional literature review to present quantitative estimates from peer-reviewed articles and technical reports.

Eligibility for inclusion in our sample required articles and reports that satisfied the following criteria: (1) they are published in English, (2) they are focused on the U.S. market, (3) they identify at least one quantitative estimate of cost directly related to EVSE, (4) they appear in a peer-reviewed journal or are published by an industry respected institution or entity, and (5) they are available in full-text form. Articles that seemed to meet the inclusion criteria were analyzed in detail to ensure that criteria 2 was, in fact, met. Our ultimate sample included 13 articles and reports published between 2013 and 2023.

We used template analysis—a form of thematic text analysis that applies an inductive approach to data analysis and coding protocol—for labeling and categorizing the 51 cost measures that we encountered within our sample. Template analysis requires the identification of themes within given texts that are essential to the understanding or description of an otherwise more nebulous construct [17,18]. We developed labels and categories with respective codes using an iterative process that persisted throughout the analysis of abstracts and full texts. This iteration requires that as new themes (measures and categories) emerge, previously labeled and categorized measures are reconsidered. This process resulted in two final products: (1) a conceptual framework that describes our proposed system for considering and categorizing EVSE cost measures, and (2) a master table that includes all categorized measures with their respective estimates and corresponding study authors. This master table is included below as Appendix A.

Given that most cost measures identified in our sample were presented as a range of estimates, typically with a single low-end cost estimate and a single high-end cost estimate, we use box-and-whisker charts to present estimates from multiple studies of the same cost measure. Measures that were cited in multiple studies are displayed side-by-side in box and whisker charts for comparison. We converted all estimates to 2023 dollar amounts using the US Bureau of Labor Statistics' consumer price index inflation adjustment tool.

Finally, our results contain a discussion of textual findings from the studies in our sample that are not entirely evident from our analysis and presentation of cost estimates. Template analysis was also applied to the sample studies to identify common themes for presentation in the final narrative portion of the literature review.

3. Results

Our analysis of 13 peer-reviewed articles and technical reports that included original estimates of EVSE costs identified 51 unique measures of cost reported by those papers and reports [19–31]. We break these measures down into four cost categories that succinctly encompass their functions: (1) Hardware, (2) Installation, (3) Operation, and (4) Total costs. A quick analysis of these cost categories indicates that while all studies have multiple measures of cost, most studies have focused on total cost figures, with many studies also including figures on installation and hardware costs. Somewhat surprisingly, only three studies provided estimates that specify operational costs. Because of the vast array of cost figures supplied in the literature, we will report on only the most frequently cited cost measures that were used by multiple studies. We will break this reporting down into the overarching cost categories that we provided above. Below, we provide a conceptual framework to illustrate the ways in which these cost categories can be further parsed into additional constituent parts.

Figure 1 begins with the four main cost categories that we define: namely, Hardware, Installation, Operation and Maintenance, and Total costs. The second division includes charging levels of AC Level 1, AC Level 2, and direct current fast charging (DCFC). We have further broken down DCFC into three commonly reported maximum power supply levels of 50 kW, 150 kW, and 350 kW. Next, costs are differentiated between the end-use application of the charging equipment, whether that be in a commercial or residential context. Finally, we present a sample of specific cost measures that were identified in the literature.

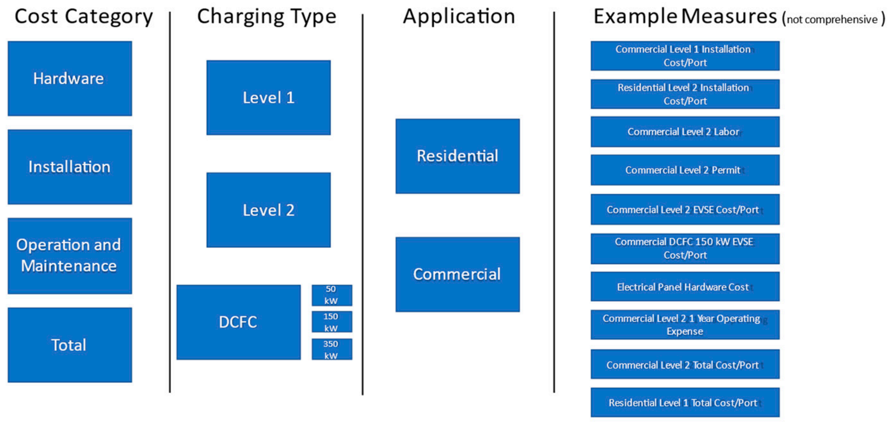

Figure 1. Conceptual framework for cost measure convention.

Figure 2 shows that total cost measures are the most frequently reported measures, followed by installation costs, then hardware costs. Operation and maintenance cost figures are the least commonly represented, with only 4 of the 51 measures identified from the sample we analyzed.

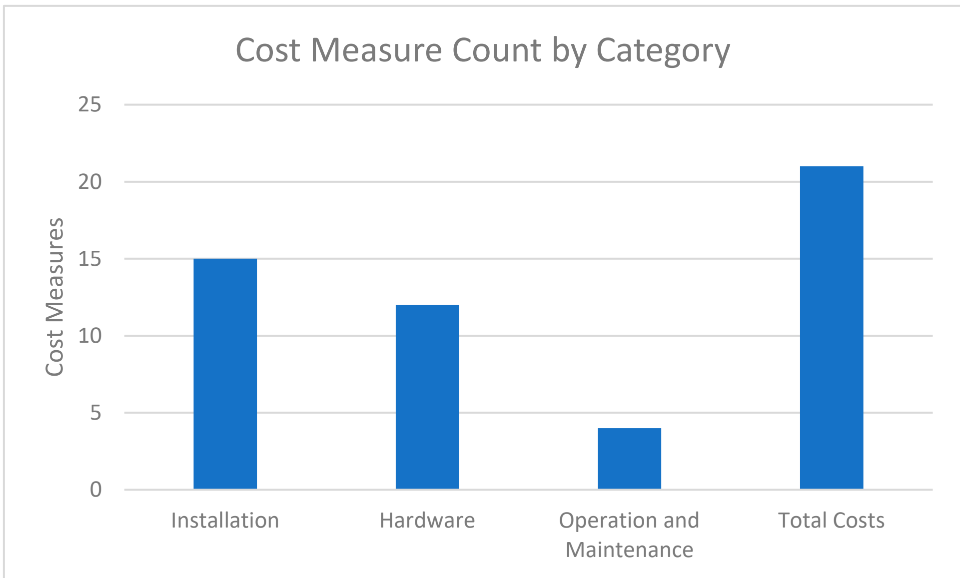

Figure 2. Cost measures by category.

3.1. Installation Costs

Installation costs include labor, materials, permits, taxes, construction, and total installation cost estimates. Installation cost measures were the second most frequently cited cost measures behind total cost measures, with 15 of the 51 measures identified in our analysis. Four of the thirteen papers in our study included cost measures in this category.

Generally, costs per charging port (i.e., the portion of the EVSE that provides power to a single EV, recognizing that some individual EVSE units contain multiple ports) is the most common way that researchers present cost estimates throughout all four cost categories.

With this in mind, we find that the installation cost per port was the most reported measure within the installation category. Below, Figures 3 and 4 present estimates for the installation cost per port for two types of chargers. We present these findings using box plots, as most studies utilized ranges to display cost estimates. Where there is clearly not a gap between low and high estimates of a box, this indicates that the study presented an average or a single-figure estimate.

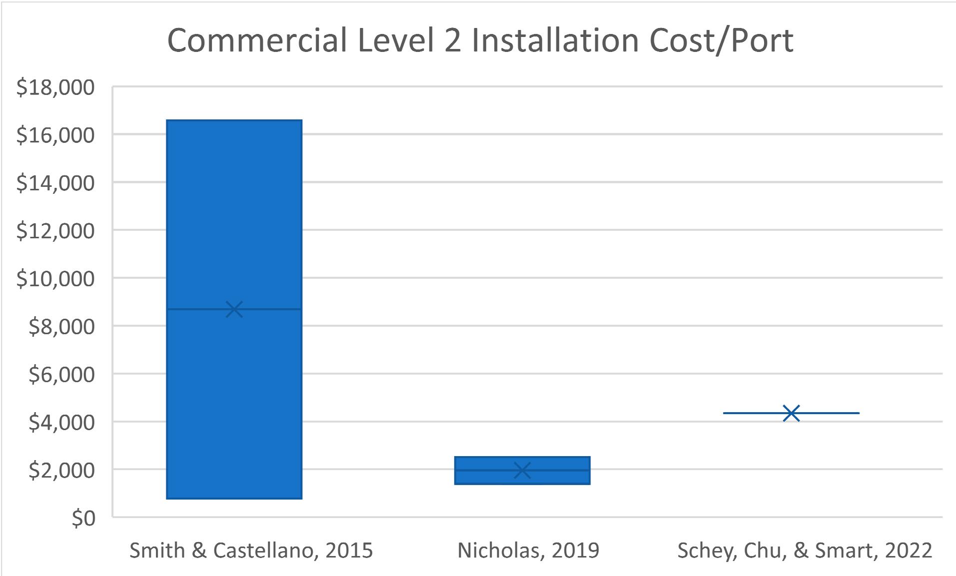

Figure 3. Commercial Level 2 installation cost per port [19–21].

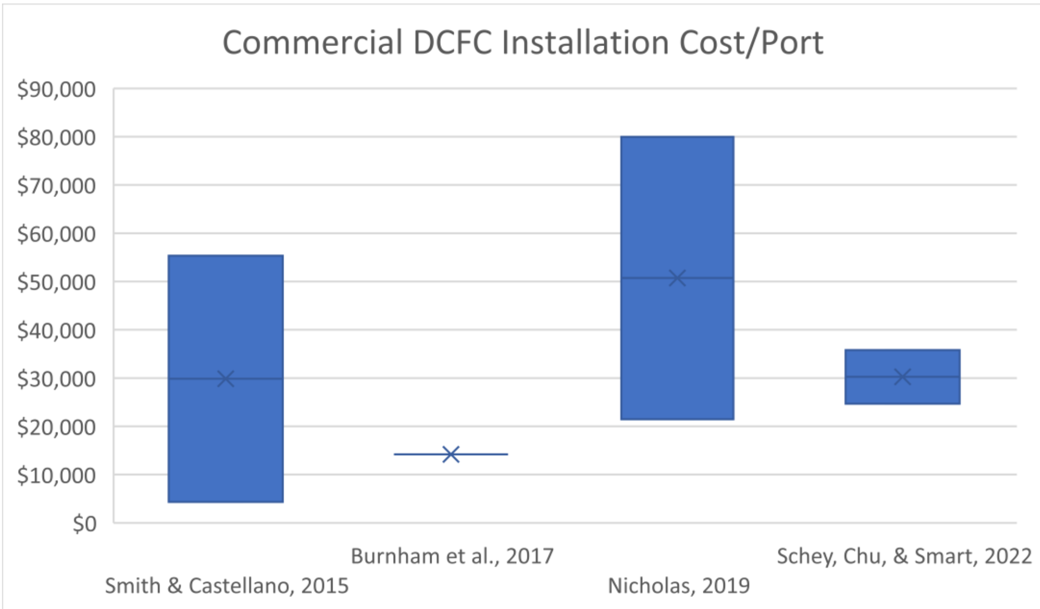

Figure 4. Commercial DCFC installation cost per port [19–22].

The lower value from Nicholas [20] represents workplace charging installation costs and the higher value represents multifamily housing developments. We consider multi-family housing developments to be a commercial installation, as the costs are more closely aligned with other commercial applications than they are with single-family residential applications.

Wherever possible, we report figures that specify the exact same measures used on the same charging equipment in the same application. However, some studies include more specificity regarding chargers' capabilities and applications. In the case of Figure 4, the cost ranges provided by Nicholas [20] represent 150 kW chargers with two chargers installed per site. The power level of the DCFC installation and the specification that there are two chargers per site is a level of detail not included in the estimates provided by Smith and Castellano [19] and Burnham et al. [22].

We observe some variation in the figures presented by the four studies presenting estimations for EVSE costs. For example, Nicholas [20] reports a median estimate of USD 1956 per port for the installation of Level 2 charging equipment in a commercial application, while Smith and Castellano's estimate for the installation of the same equipment in the same application presents a median value of USD 8682. Such variation is surprising given the fact that these studies were published only four years apart. A possible explanation for such variation is the fact that Smith and Castellano rely on data from very early installations of charging equipment "primarily from early installations of the technology that occurred between 2009 and 2013 because robust data sets of newer installations are not yet available [19]". These early installations likely occurred in a market with little competition for knowledgeable skilled labor, which would lead to higher prices, particularly when accounting for inflation. This explanation for the discrepancy in figures, particularly with a marked downward trend, comports with similar claims from the literature [19,21]. It should be noted, though, that this sample is far too small to presume an actual trend in the data from the included studies.

3.2. Hardware Costs

Hardware costs encompass the EVSE as well as some equipment and materials (like transformers) that are accepted as necessary for site preparation and some componentry that can often be sold separately from chargers themselves. Twelve of the fifty-one measures identified in our sample were categorized as hardware cost measures, found within 7 of the 13 studies.

Figures 5 and 6 show hardware costs per port for commercial applications of Level 1 and Level 2 EVSE. We see a relative agreement between most studies, with Nicholas (2019) [20] being an outlier on the lower end for both Level 1 and Level 2.

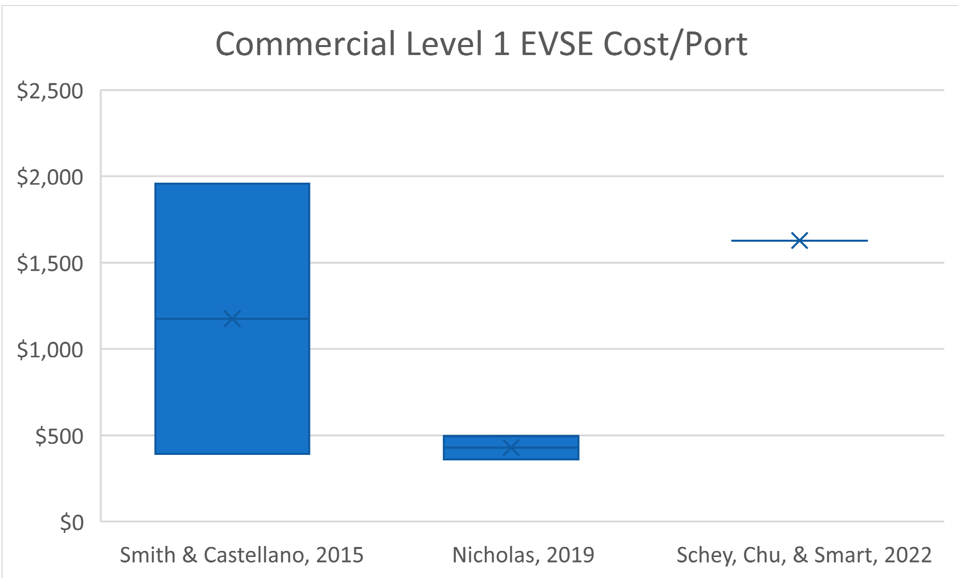

Figure 5. Commercial Level 1 EVSE cost per port [19–21].

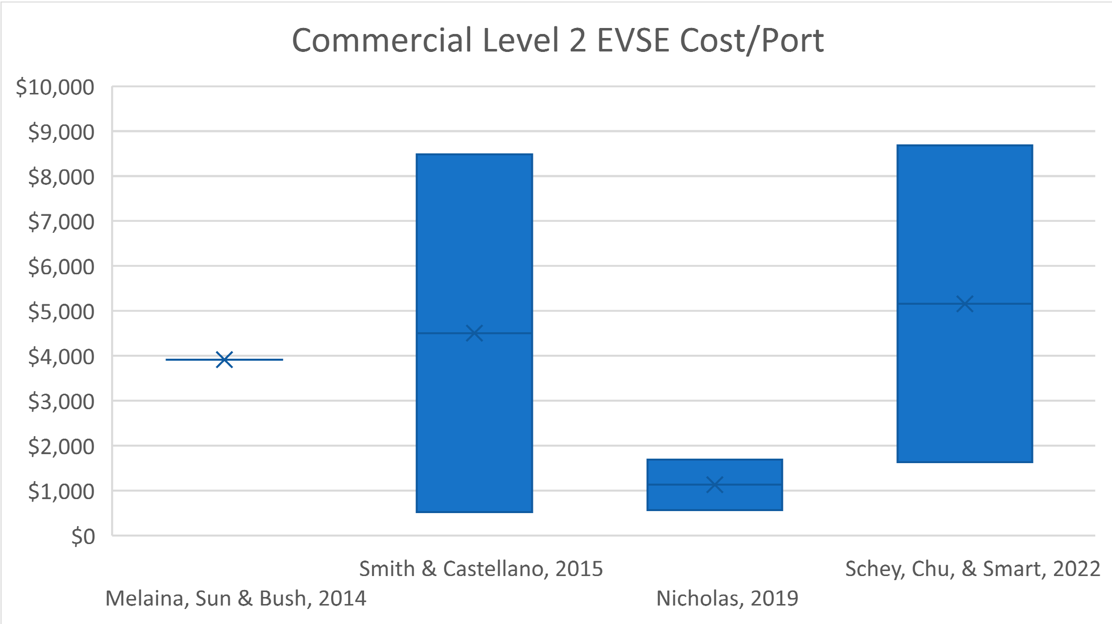

Figure 6. Commercial Level 2 EVSE cost per port [19–21,23].

Figures 7–9 show that for DCFC EVSE hardware cost estimates, there seems to be a slight downward trend in costs for all three power levels included in our analysis. Our assertion of a downward trend is supported by the observation that studies with later publication dates provide lower estimates for the same hardware than their older counterparts. This trend is stable for 50 kW, 150 kW, and 350 kW power specifications. It should be noted, however, that this observation is from a diminutive sample, from which we ascribe no statistical significance or predictive power.

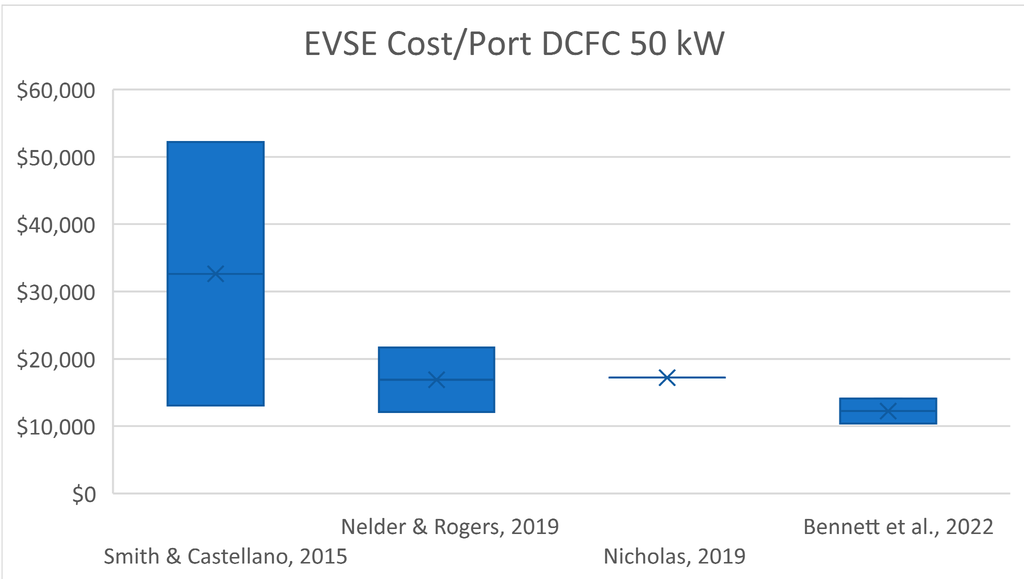

Figure 7. EVSE cost per port DCFC 50 kW [19,20,26,31].

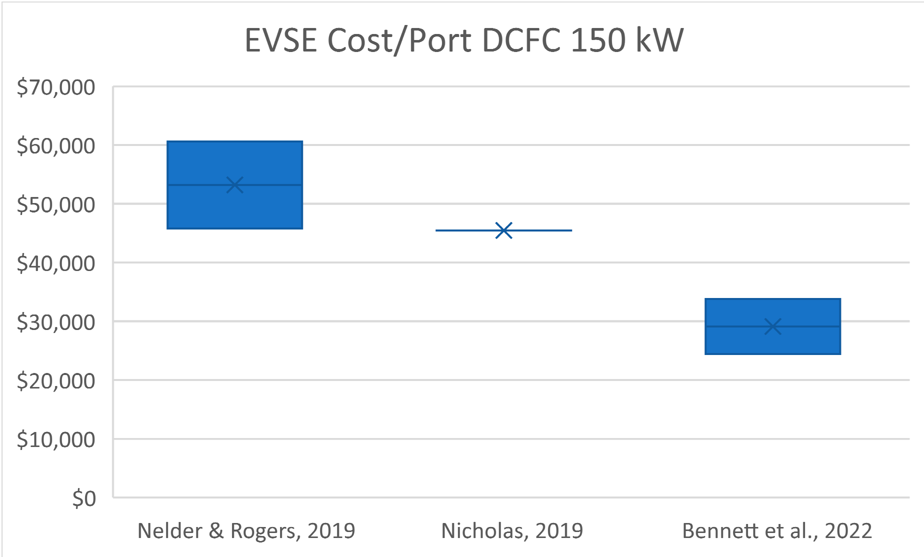

Figure 8. EVSE cost per port DCFC 150 kW [20,26,31].

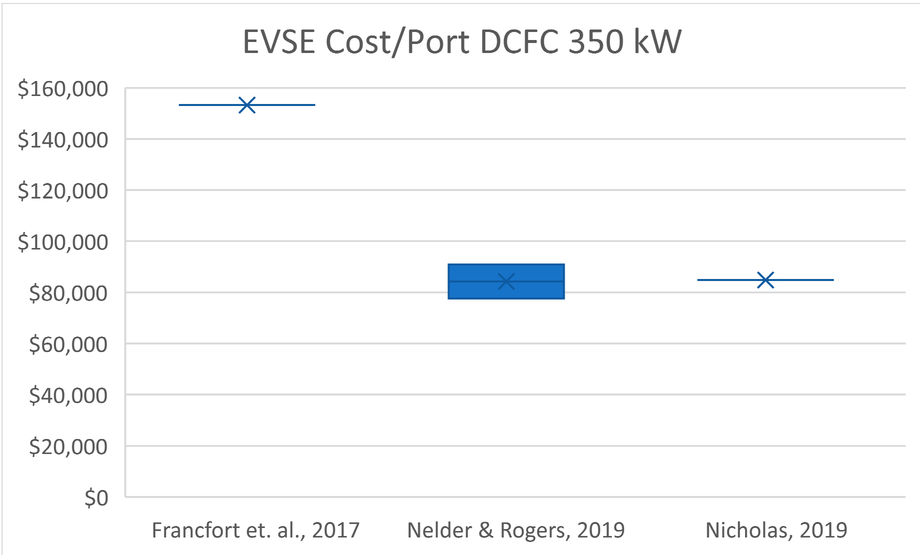

Figure 9. EVSE cost per port DCFC 350 kW [20,26,27].

3.3. Operation and Maintenance

We find that cost measures that can be categorized under operations and maintenance are the least commonly cited among our four cost categories. Of the 51 cost measures identified in the 13 studies we analyzed, only 4 were categorized under operations and maintenance, found within 3 different studies. These measures included overhead costs for commercial applications of two port Level 2 chargers, data contracts, network contracts, and yearly per charger operating costs.

Given the large number of cost measures that we have identified in this paper, we have thus far only reported on measures that were used by multiple studies. In this case, however, we will make an exception to briefly discuss the yearly per-charger operating costs estimated by Francfort et al. [27]. These authors estimate yearly operating costs to range from USD 27,167 to USD 82,427 per charger. These estimates are for hypothetical charging sites that contain six charging stations. The lower estimate is for a site that supplies six 50 kW DCFC chargers, and the upper estimate is for a site that supplies six 350 kW DCFC units.

3.4. Total Costs

Total cost measures include estimates of the cost of EVSE that includes hardware, installation, and sometimes operations and maintenance. We find that this cost category is the most represented in our sample of studies, with 20 of the 51 measures identified by our analysis. We also find that this category contains the highest number of measures that are cited by multiple studies. Eight of the thirteen studies in our sample provide measures from this category. For this study, we avoid computing total cost measures by aggregating constituent measures to create a new measure not reported within a given study from our sample. For example, Chu, Smart, and Schey [21] report estimates for EVSE (hardware) cost and installation costs, but they do not report total cost measures. For this example and others like it, we do not include a computed total cost measure.

Figure 10 shows that there is some evidence of declining total costs for residential applications of Level 1 charging infrastructure when comparing the estimates from the above papers. Melaina, Sun, and Bush [23] estimate a median cost (adjusted to 2023 dollars) of USD 988 in 2014, whereas Wood et al. estimate a median cost of USD 450.

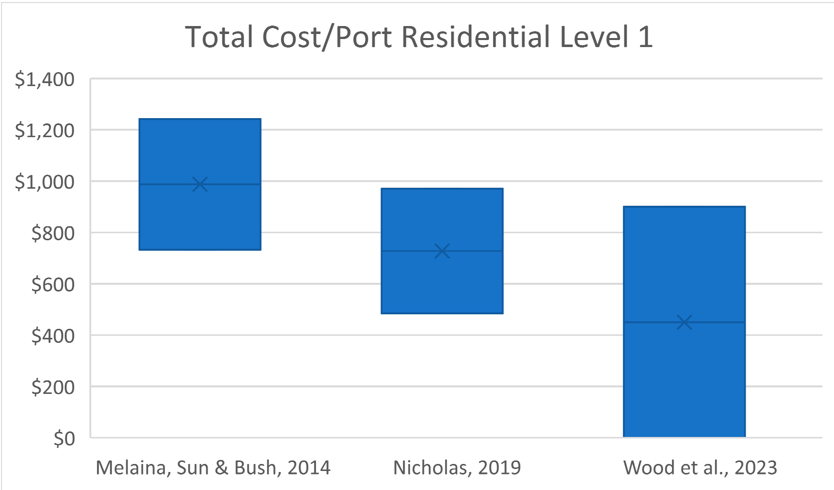

Figure 10. Total cost per port residential Level 1 [20,23,29].

Figure 11 demonstrates that for commercial applications of Level 2 charging infrastructure, there are consistent estimates of the total cost between the three studies that provided this measure.

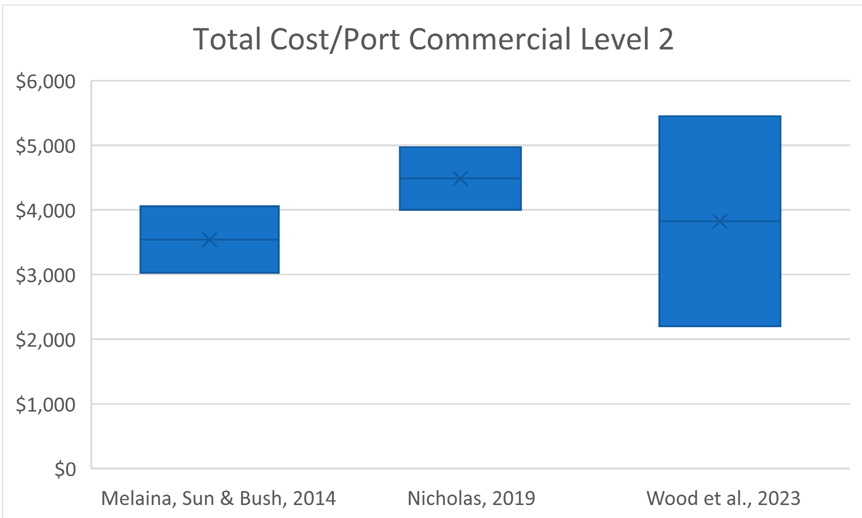

Figure 11. Total cost per port residential Level 2 [20,23,29].

3.5. Thematic Analysis

Our template analysis process identified three overarching topics commonly discussed among our sample of studies. The first theme is the overall trends in costs, for which there is a relative consensus that EVSE costs have and will continue to decline. Generally, most studies that speak of trends in EVSE costs suggest that costs have declined, based on data from the past [12,19,28]. Nicholas [20] and Nelder and Rogers [26] ascribe these reductions in overall cost to the decline in price of hardware, particularly chargers themselves. Some authors, however, indicated that past trends in costs might not predict the future cost trajectory. In referencing stakeholder interviews that they conducted, Wood et al. [29] suggest that costs could plausibly increase or decrease, depending on several factors such as economies of scale and supply chain constraints. Similarly, Burnham et al. [22] claim that with higher-powered DC fast charging installations, the technology is too nascent and ever-changing to reasonably predict cost trends going forward. Finally, when looking at the aggregate expense to taxpayers, both Wood et al. [29] and Nicholas [20] assert that costs have and will continue to rise in terms of total expenditure; however, Nicholas [20] contends that when examining such figures at the per vehicle scale, EVSE costs will decline along that same trend.

The next theme that was commonly addressed related to the factors influencing variation in EVSE costs. Our review of the studies in our sample identified 17 individual cost factors presented, which we have fit into four comprehensive categories: (1) site layout considerations, (2) hardware and futureproofing, (3) permitting and process considerations, and (4) operational factors. Site layout considerations was the category that contained the most factors influencing EVSE costs. Authors identified electrical upgrades, particularly the location of existing electrical infrastructure as it relates to the location of proposed charging infrastructure, as a common factor influencing EVSE costs [9,11,24,25]. The next most frequently cited factor related to the location of infrastructure on a charging site was trenching and concrete work [9,11,25]. Other site-specific considerations mentioned by studies in our sample included ventilation, lighting, shelter, and project engineering [25,26].

While hardware has been identified in other sections throughout this paper as a large component of total EVSE costs, this category contained only two factors identified by the studies in our sample as contributing to variation in EVSE costs. Alexander et al. [24] assert that particularly in areas with older building stock, the need for upstream capacity upgrades can have significant impacts on EVSE costs. Similarly, Nelder and Rogers [26] contend that utility interconnection costs can be an important factor in EVSE costs.

Permitting and process-oriented considerations was the second most cited category of factors affecting the variation in EVSE costs. Four studies cited permitting as a significant factor influencing costs, with an additional mention also given to other forms of regulatory compliance such as Americans with Disabilities Act compliance and inspection requirements [9,11,25,26]. From a higher-level, process-focused perspective, Alexander et al. [24] suggest that the nascent nature of government supported early EVSE installations is a significant factor affecting EVSE costs. They claim that factors specific to government-funded demonstration projects, including the administrative burden of such efforts, have artificially inflated the costs of early EVSE installations.

Operational cost factors were the most limited compared to the four cost categories, with vandalism being the sole named factor in this group [9].

Finally, many studies in our sample posited strategies for reducing EVSE costs. While this theme is logically similar to the factors influencing costs, we identified it as a unique category, largely because most authors did not directly link cost reduction strategies to cost drivers in their studies. The leading strategy for mitigating EVSE costs, in terms of the frequency with which it was mentioned in our sample, is locating EVSE in the optimal place within a site with respect to existing infrastructure. Costs can be reduced by citing EVSE in a place that minimizes the need for trenching, concrete work, and additional electrical hardware [9,25]. The next strategy that was mentioned by multiple studies was the need for "futureproofing" EVSE sites. Futureproofing is a somewhat broad concept that typically describes the provision of infrastructure for the expansion or improvement of an installation should such an upgrade be deemed necessary in the future. Futureproofing activities suggested by the studies in our sample included electrical improvements, such as 240 V panels, laying electrical wire and conduit to potential expansion areas, and selecting charging equipment with the potential to add ports or charge at higher rates than currently needed [9,25,27]. Francfort et al. [27] point out that elements of EVSE installation projects tend to be bottlenecks and "pulling them forward" to be addressed prior to the onset of construction rather than holding up construction can reduce construction time and cost. They identify engineering, permitting, and utility interconnection as fraught points in the EVSE installation process that can lead to delays, the avoidance of which can contribute to lower costs if these steps are addressed early on.

4. Discussion

The original intention of this study was to determine if, at a meta level (i.e., study), we could see trends in EVSE costs throughout the literature. While some cost measures demonstrated apparent trends, particularly those related to DCFC infrastructure, generally, we do not observe strong temporal trends in costs. We attribute this finding to two main factors. First, there are simply not enough data points when analyzing at the meta level. Our sample contained 13 studies that met our inclusion criteria, and making assertions about trends with such a sample was not feasible. Second, our analysis found that there is a great deal of variation in the way researchers are measuring EVSE costs. In our sample of 13 studies, we identified 51 unique cost measures. Such a high number of measures is less a function of a comprehensive understanding of EVSE costs, but rather a characteristic of a nascent area of study lacking convention in its metrics.

The lack of convention demonstrates a clear need for common metrics to set a baseline for future performance measurement and an advancement of a consensus. We present a conceptual framework that depicts a new standard for measuring EVSE costs based on cost categories (Hardware, Installation, Operation and Maintenance, and Total Costs), charging type (Level 1, Level 2, and DCFC [50 kW, 150 kW, and 350 kW]), and application (residential or commercial). We have presented cost measures taken from our sample studies using this convention; although, they were not usually presented in this fashion in their original representation in their respective studies. We also propose that whenever possible, cost measures should be computed using a normalized, cost-per-port measure. The purpose of this denomination is to reduce ambiguity around the unit being described. Applying this convention to future research and other presentations of EVSE cost measures will help policymakers and researchers compare like measures of cost, which will facilitate geographic and temporal variations. Understanding the existence of temporal variations, for example, would allow policymakers to determine the effects of government investments or incentives on EVSE costs. Additionally, a commonly accepted EVSE cost measure convention would increase the general visibility of EVSE costs for consumers. If consumers were able to access an estimate of EVSE costs from a trusted source, this could benefit them in decisions about which products to purchase and how much they can anticipate spending in total. A greater consumer understanding of EVSE costs might also, in the long run, force greater price competition in industry. Finally, a uniform and improved understanding of EVSE costs will help governments in their efforts to expand access to sustainable transportation options such as light-duty electric vehicles through the provision of public charging infrastructure. A more complete knowledge of EVSE costs will allow governments to better utilize limited public funds so that they can maximize the impact of those funds on zero emissions transportation infrastructure.

The Alternative Fuel Data Center (AFDC) provides a helpful illustration that demonstrates the potential confusion in just what a researcher might be describing when providing an estimate for charging equipment [32]. The illustration depicts a single station location with two chargers, three ports, and four connectors. Because of this somewhat complex taxonomy, we encourage future studies to clearly state EVSE costs in the denomination of cost per port to avoid any confusion. Note that cost per port can be affected by the total number of ports at a single charging station location, because fixed installation costs are divided across the number of ports at a single charging station. Therefore, it may also be advisable to separate cost-per-port figures by charging station size.

Given the immature status of research on EVSE costs, a standard convention for cost measurement will help researchers and officials better understand how costs are evolving with the changing landscape of EV charging. We encourage future studies to utilize the cost measurement convention that we have provided here, so that as more EVSE cost data emerges, they can be more easily compared against each other to support the reliability of cost measurement and help to produce robust benchmarks for ensuring the prudent expenditure of public resources. We contend that the use of our provided cost measurement convention will be accessible and beneficial to researchers, providing limited challenges in implementation. The only challenges that we foresee in utilizing this convention would arise from having data that do not indicate certain specifications, such as the number of ports contained by a given charger. However, we offer that if such specificity is not available in the data, cost measures will have limited use to researchers as ambiguity from what is included in the costs being presented will not contribute to a robust understanding of the current state of infrastructure costs or trends over time.

Author Contributions: The authors confirm their contributions to the paper as follows: study conception and design: J.S., K.-C.C. and T.L.; data collection: T.L.; analysis and interpretation of results: T.L.; draft manuscript preparation: T.L. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article. The data were collected from existing published resources that are publicly available and adapted for our analysis. All our data are contained within Appendix A and the sources from which they were collected and subsequently adapted are listed in the appendix item.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

This appendix item contains our working table that presents inflation-adjusted cost estimates adapted from our source studies.

Category	Measure	Figure	2023 $ Adjusted	Reference
Installation	Installation cost/port com 1	$0–3000; $600–900	$0–3924; $729–1093	[19,28]
	Installation cost/port com 2	$600–12,700; $1153–2074; $4000	$785–16,612; $1400–2519; $4349	[19,22,28]
	Installation cost/port com 3	$4000–51,000; $17,692–65,984; $11,300; $22,753–32,992	$5232–66,708; $21,486–80,134; $14,225; $24,739–35,872	[19,22,28,30]
	Installation cost/port XFC	$20,150–21,000	$25,365–26,435	[30]
	Installation cost/port res 1	$400–800	$485–972	[28]
	Installation cost/port res 2	$680–2800; $1100	$826–3400; $1196	[22,28]
	Labor (L2 Com)	$5000; $1786–1827 (2 chargers/site)	$6534; $2169–2219	[26,28]
	Labor (DCFC 150 KW)	$15,920 (2 chargers/site)	$19,334	[28]
	Materials (L2 Com)	$958–1039 (2 chargers/site)	$1163–1262	[28]
	Materials (DCFC 150 KW)	$21,840 (2 chargers/site)	$26,524	[28]
	Permit (L2 Com)	$200; $62–162 (2 chargers/site)	$261; $75–197	[26,28]
	Permit (DCFC 150 KW)	$158 (2 chargers/site)	$192	[28]
	Tax (L2 Com)	$89–121 (2 chargers/site)	$108–147	[28]
	Tax (DCFC 150 KW)	$89 (2 chargers/site)	$108	[28]
	Construction (L2 Com 2 Port)	$2000	$2614	[26]
Hardware	EVSE cost/port com 1	$300–1500; $1500; $298–408	$392–1962; $1631; $362–495	[19,22,28]
	EVSE cost/port com 2	$400–6500; $3000; $1,500–8000, $469–1397	$523–8500; $3921; $1631–8698; $570–1697	[19,22,26,28]
	EVSE cost/port 50 kW	$10,000–40,000; $10,000–17,900; $9,572–12,985; $14,201	$13,080–52,320; $12,144–21,739; $15,441	[19,23,28,31]
	EVSE cost/port 150 kW	$37,800–50,000; $22,479–31,176; $37,500	$45,906–60,722; $24,441–33,898; $45,542	[23,28,31]
	EVSE cost/port 350 kW	$64,000–75,000; $122,500; $70,000	$77,725–91,084; $154,206; $85,011	[23,24,28]
	EVSE cost/port XFC	$450,000	$489,283	[31]
	Transformer	$35,000–69,000	$42,506–83,797	[23]
	Credit Card Reader	$325–1000	$395–1214	[23]
	Cable	$1000–3500	$1214–4251	[23]
	Materials (L2 Com 2 Port)	$958–1039 (2 chargers/site)	$1163–1262	[28]
	Materials (DCFC 150 KW)	$21,840 (2 chargers/site)	$25,524	[28]
	Electrical Panel	$1000	$1307	[26]

Category	Measure	Figure	2023 $ Adjusted	Reference
Operation	Overhead (L2 Com 2 Port)	$1750	$2287	[26]
	Data Contracts	$84–240/charger/year	$102–291/charger/year	[23]
	Network Contracts	$200–250/charger/year	$243–304/charger/year	[23]
	Operating	$27,167–83,427/charger/year	$34,198–105,020/charger/year	[24]
Total	Total cost per/port residential 1	$562–952; $0–900, $400–800	$734–1244; $0–900; $486–972	[26–28]
	Total cost per/port residential 2	$380–689; $1496–3225; $900–3800; $680–2800	$461–837; $1955–4215; $900–3800; $826–3400	[23,26–28]
	Total cost/port com 2	$2319–3109; $2200–5450; $3300–4100	$3031–4063; $2200–5450; $4008–4979	[26–28]
	Total cost/port com 3	$8500–51,000	$11,108–66,689	[26]
	Total Cost/port DC 50	$64,250–95,750; $40,500–82,600	$80,879–120,532; $40,500–82,600	[24,27]
	Total Cost/port DC 150	$112,200–223,600	$112,200–223,600	[27]
	Total Cost/port DC 350	$180,100–309,900	$180,100–309,900	[27]
	$/kW Delivery Truck	$2280	$2664	[29]
	$/kW Shuttle Bus	$1937	$2264	[29]
	$/kW Forklift	$1933	$2259	[29]
	$/kW Light Duty Vehicle	$1635	$1911	[29]
	$/kW Transport Refrigeration Unit	$1301	$1520	[29]
	$/kW Transit Bus	$985	$1151	[29]
	$/kW Tractors	$739	$864	[29]
	$/kW Airport Ground Service Equipment	$647	$756	[29]
	$/kW Rubber Tire Gantry Crane	$569	$665	[29]
	$/kW School Bus	$490	$573	[29]
	Total cost/port non dif 1	$596–813	$724–987	[28]
	Total cost/port non dif 2 (non-networked)	$938–1182	$1139–1435	[28]
	Total cost/port non dif 2 (networked)	$6500–9250; $2793–3127	$7702–10,961; $3392–3798	[25,28]

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