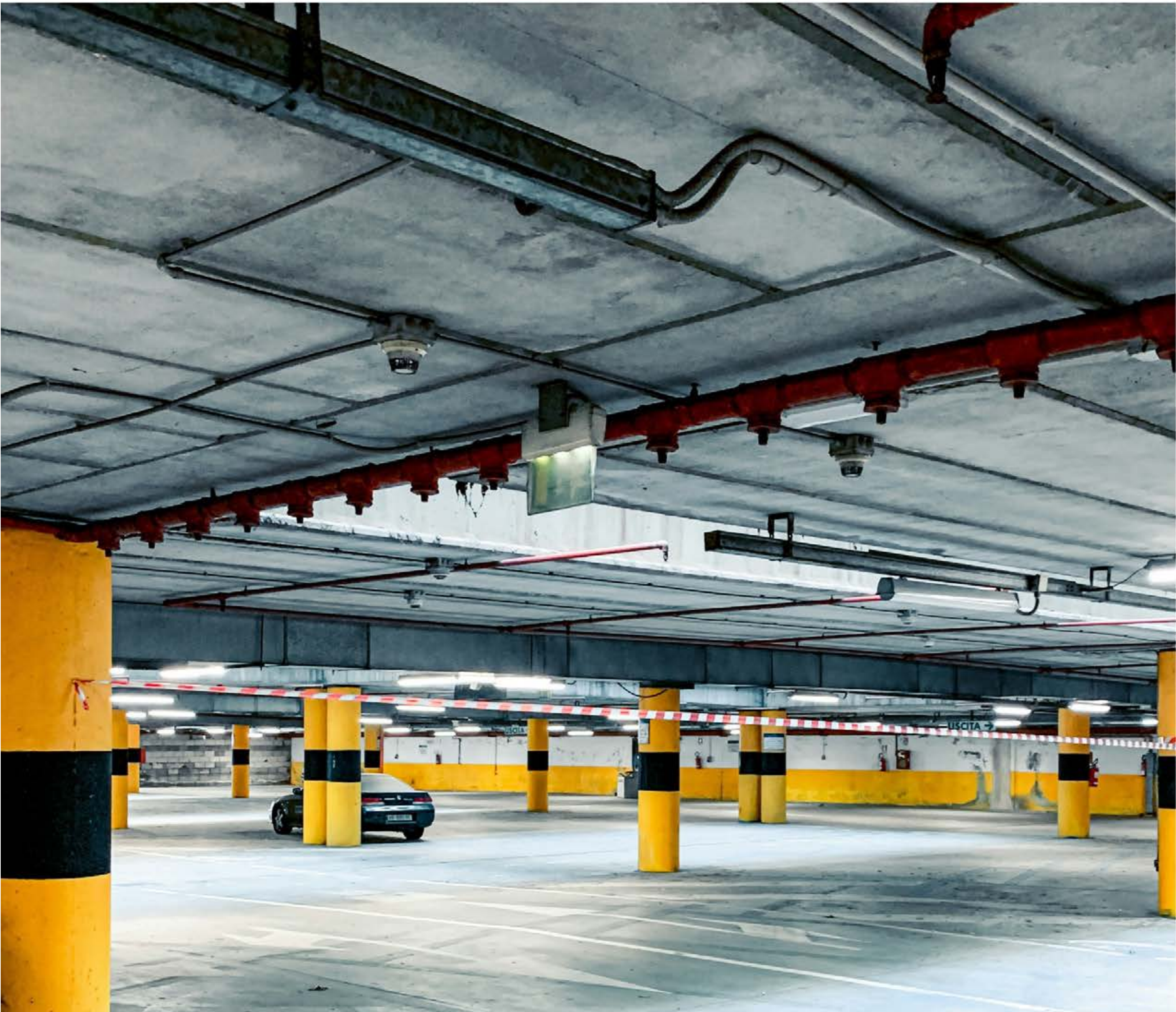

EVI-LOCATE User Manual

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National Renewable Energy Laboratory | November 2025
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Acknowledgments

We gratefully acknowledge the many people whose efforts contributed to this technical report and the associated work. This report is a user manual for the National Renewable Energy Laboratory's (NREL's) web tool, the Electric Vehicle Infrastructure – Locally Optimized Charging Assessment Tool and Estimator (EVI-LOCATE). EVI-LOCATE has received support from the U.S. Department of Energy's Federal Energy Management Program and Vehicle Technologies Office, U.S. Department of Defense Environmental Security Technology Certification Program, and the Joint Office of Energy and Transportation. In addition to the authors, the following colleagues have played primary roles in the development of EVI-LOCATE: Ohan Oumoudian, Katie O'Connell, and Karen Hammond-Smith with GFT Infrastructure Inc., Josh Gipper, Robin Christians, Kathryn DeForrest, Ben Rudolph, and Ehab Habib with WSP, Steve Ingracia and Walter Scheib with Felsburg Holt & Ullevig, and Loren Cogswell with NREL. We owe gratitude to our colleagues Mark Singer, Leidy Boyce, Emily Kotz, Erin Andrews-Sharer, Jesse Bennett, Fred Zietz, Heidi Blakley, Wes Maurer, and Nick Reinicke for their input along the way. We would also like to thank Jay Wrobel, Tim Tetreault, Mark Smith, Sonya Smith-Pickel, Kendall Kim, and Elizabeth Traut for their vision and leadership. Finally, we would like to extend our thanks to the many pilot tool users who provided us with feedback that led to tool refinements.

Acronyms and Abbreviations

A	ampere
AC	alternating current
DC	direct current
EV	electric vehicle
EVI-LOCATE	Electric Vehicle Infrastructure – Locally Optimized Charging Assessment Tool and Estimator
EVSE	electric vehicle supply equipment
kVA	kilovolt-ampere
kW	kilowatt
NEC	National Electrical Code
NREL	National Renewable Energy Laboratory
V	volt

Executive Summary

One of the longest stages in the deployment of electric vehicle supply equipment (EVSE) is the initial planning of the infrastructure itself. Engineers and fleet experts from the National Renewable Energy Laboratory (NREL) have supported dozens of charging infrastructure site plans over the past couple of decades, including generating site schematics, determining electric capacity, and estimating likely costs. As the market for electric vehicles has matured, this approach should no longer require a time- and personnel-intensive process. In order to shorten the time taken to develop site plans and cost estimates, NREL has developed a tool that fleet managers, facility managers, electricians, EVSE installers, and members of the public can use to develop initial schematics and ballpark pricing for charging station installations.

The Electric Vehicle Infrastructure – Locally Optimized Charging Assessment Tool and Estimator (EVI-LOCATE) provides a structured and consistent way for users to enter information about their planned EVSE project in a relatively simple web-based format. EVI-LOCATE then calculates electrical equipment capacity, wiring runs, and project costs. It produces a site diagram optimized around surface characteristics, with differential trenching costs for softscape such as grass compared to hardscape such as asphalt that can be adjusted by users in the tool. It also stores the resulting site plans and costs in a dashboard for access at a later date, including plan revisions if necessary.

This document guides users through the EVI-LOCATE screens and associated questions. It provides tips throughout on how best to interface with the tool and find additional information or context. The appendices contain the assumptions and calculations underpinning the tool. Much of the information for EVI-LOCATE was gathered through industry engagements with EVSE installers, invoices from completed EVSE installations, Gordian's RSMeans construction data, and the U.S. General Services Administration blanket purchase agreements for EVSE. For a visual tutorial of the tool, users can watch the "EVI-LOCATE Step by Step" video (www.youtube.com/watch?v=yOv_JY296TA). The tool itself is available at evi-locate.nrel.gov.

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Introduction

The Electric Vehicle Infrastructure – Locally Optimized Charging Assessment Tool and Estimator (EVI-LOCATE) is a web tool that enables charging station installation planning and cost estimation through a series of steps. It can be found at evi-locate.nrel.gov.

This guide reviews each screen where the user is required to enter information in the following order:

1. Create Project
2. Define Site
3. Manage EV Chargers
4. Manage Transformer
5. Manage Service Panel
6. Review Design
7. Estimate Cost
8. View Site Report and Cost Estimate

The appendices to this user guide explain how EVI-LOCATE completes the following functions:

1. Assesses the electrical capacity of the transformer and service panel based on electric vehicle (EV) infrastructure needs (Appendix B shows the calculation logic for the transformer and service panel).
2. Estimates total project costs by analyzing the site layout, wiring runs, electric vehicle supply equipment (EVSE) prices, local labor and material rates, and cost data gathered from real-world installations (Appendix C and Appendix D have the parameters used in the calculations and calculation equations, respectively).
3. Calculates optimal wiring runs using the deep-learning algorithm to identify surface type (Appendix E shows the deep-learning pixel classification).
4. Organizes projects by login information, stores data on the back end, and generates a dashboard for future reference.

The appendices also provide information about how the tool completes its calculations in the background and includes several assumptions and data sources that are critical to the tool functionality. For a visual tutorial on EVI-LOCATE, please visit the National Renewable Energy Laboratory (NREL) YouTube page's "EVI-LOCATE Step by Step" video: www.youtube.com/watch?v=yOv_JY296TA.

Required Information

Before starting an EV infrastructure project in EVI-LOCATE, the following information is required to generate an accurate site assessment and cost estimate.

Charging Stations

- Number of charging stations to be installed.
- Type of charging stations to be installed (e.g., alternating-current [AC] Level 1, AC Level 2, or direct-current [DC] fast chargers either in pedestal or wall-mounted configurations with one or two ports).

> **Tip:** Compile the following information before using EVI-LOCATE to streamline the experience.

Location

- Site location or address.
- Location of each infrastructure component to be installed within the site.
- **Note:** EVI-LOCATE assesses infrastructure at the parking lot level and incorporates localized labor and material costs.

Electrical Components

- Transformer power rating and peak load if assessing whether chargers will be powered by an existing transformer.
- Service panel voltage, current rating, and existing loads if assessing whether chargers will be powered from an existing panel.
- **Note:** EVI-LOCATE does not assess utility-level distribution feeder capacity; NREL's Distribution Integration Solution Cost Options (DISCO) tool can support that analysis (nrel.github.io/disco).

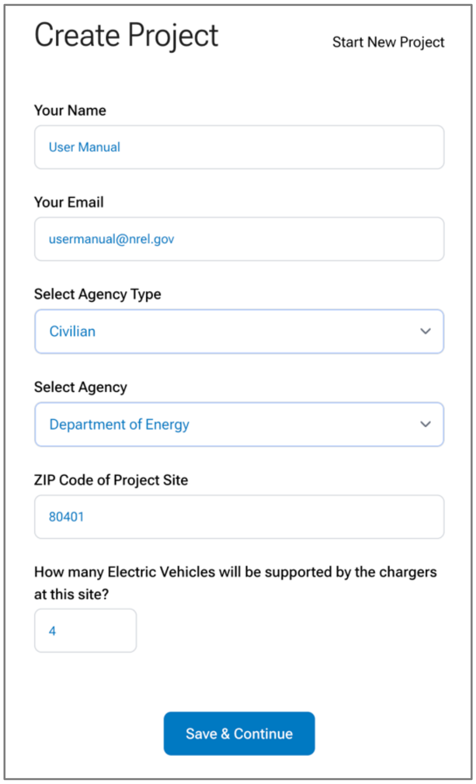
Login Information

Federal and state agency users should request access to their agency's EVI-LOCATE repository of site assessments by emailing evi-locate@nrel.gov. A username and password will be sent via email. Reset login credentials per the instructions.

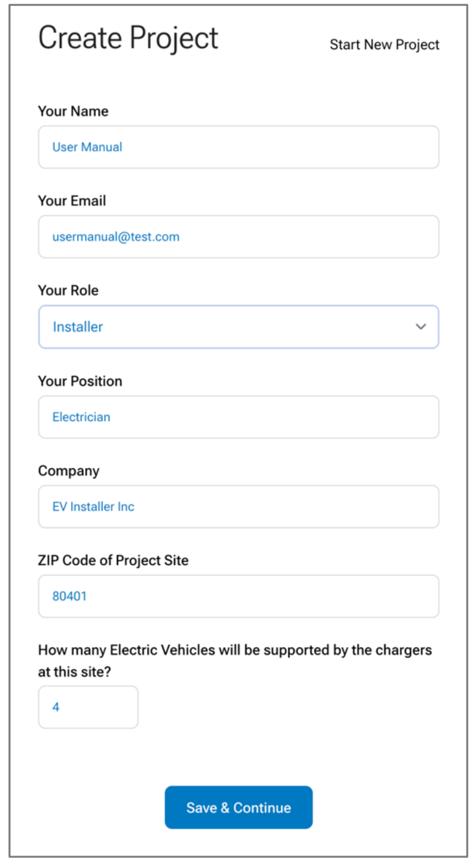
Public users can sign up using their ArcGIS, Google, GitHub, or Apple ID. They can create a free ArcGIS account if that is their preferred sign-up approach.

Step 1: Create Project

Enter your name and email address to create a project.



A. Create Project screen for federal and state agencies



B. Create Project screen for public users

Figure 1. Creating a project

> **Tip:** The ZIP code (for public users and civilian agencies) and the specific agency base (for U.S. Department of Energy bases) are critical to determine the city cost index or area cost factor that is determined using the location. Further, the weather conditions of the location are essential to navigate the National Electrical Code (NFPA 2024).

Step 2: Define Site

After choosing the location or base, select a new or existing site for installing EV charging.

Tip: Ensure that the site boundary is large enough to encompass all the required electrical components, including the existing or planned transformer and electrical service panel.

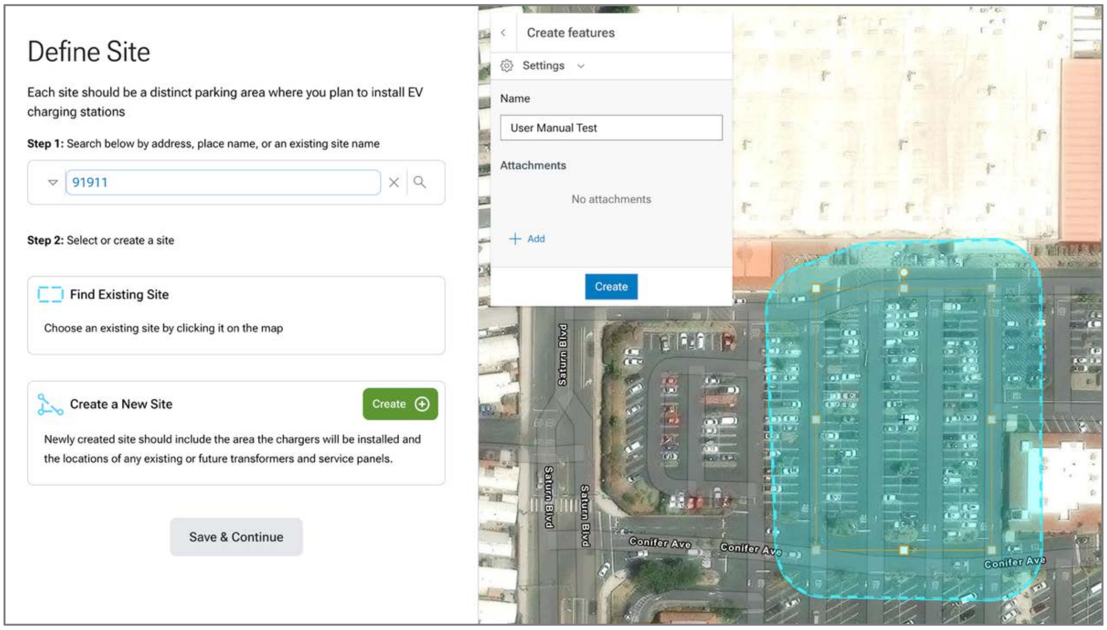


Figure 2. Defining a site boundary

Tip: Users can use the street address to find the specific location. This screen also contains an option to search for previous site assessments conducted by the same users. The old site assessments can then be modified.

Figure 3. Address field

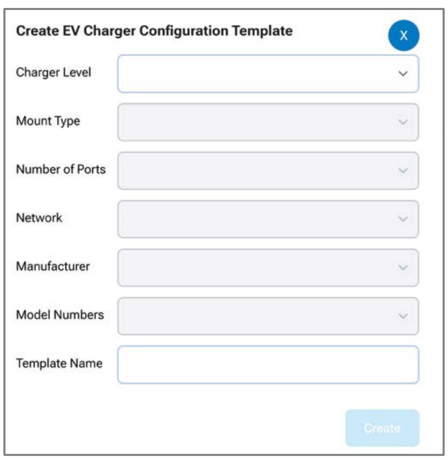
Step 3: Manage EV Chargers

Select the type(s) of EV charger(s) to be installed at the location. The selection table for chargers is assembled from the U.S. General Services Administration's blanket purchase agreement offerings (US GSA 2024). There is also an option to select generic EV charging types that include the median value of the unit price and ampere requirements from the blanket purchase agreement offerings. The generic EV charger types are presented in Table 1.

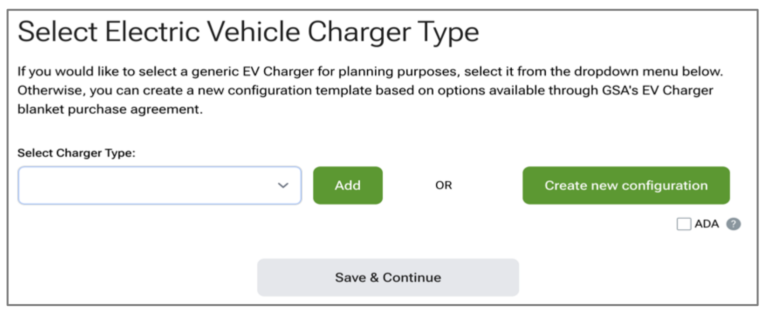
Select an EV charger configuration using the dropdown menus or select "Generic Profiles for Chargers."

The selected EV charger type or configuration dictates the electricity needs for each EV charger per the National Electrical Code (NEC) (NFPA 2024). The per-charger cost also affects the estimation of the project costs.

> **Tip:** The question mark icons include additional information about fields throughout EVI-LOCATE, such as what is meant by ADA-compatible chargers (i.e., Americans with Disabilities Act) in the screenshot below.



A. Creating an EV charger configuration



B. Selecting a generic profile for chargers

Figure 4. Creating the EV charger configurations

Table 1. Generic Charger Types

Power Level	Mount Type	Number of Ports	Unit Price ($)	Amps per Port (A)
Level 1	Pedestal	Dual	2,900	16
	Wall	Dual	2,900	16
	Wall	Single	1,100	18
Level 2	Pedestal	Dual	5,260	40
	Pedestal	Single	3,370	32
	Wall	Dual	4,020	40
	Wall	Single	1,990	32
DC fast charger	Pedestal	Single	52,000	200

Add EV Chargers to Map

Add the selected EV chargers to the map as shown in Figure 5. EVI-LOCATE displays aerial imagery of the site selected in Step 2. Point and click on the map location and mark where the EV chargers will be located.

> **Tip:** The top right corner of the image shows the number of chargers added to the map through the most recent action.

Figure 5. Adding EV chargers to the GIS map

Step 4: Manage Transformer

EVI-LOCATE provides a template and workflow that calculates whether an existing transformer can support new EV chargers, and then computes the associated costs. First determine whether the cost of a transformer should be included in the assessment. In some instances, electrical utilities will cover the cost and assessment of service transformers and panels. Go to afdc.energy.gov/utility-finder to learn more about local utility programs that support EV chargers.

If transformer costs are to be factored into the cost, there are two options:

1. Install a new transformer regardless of the capacity on the existing equipment.
2. Evaluate whether the existing transformer can handle the increased load from the EV charging stations.

Even if you do not want to include the cost of the transformer or already have a transformer ready to supply power, the transformer location must still be marked on the map to calculate the cost of wiring to the service panel.

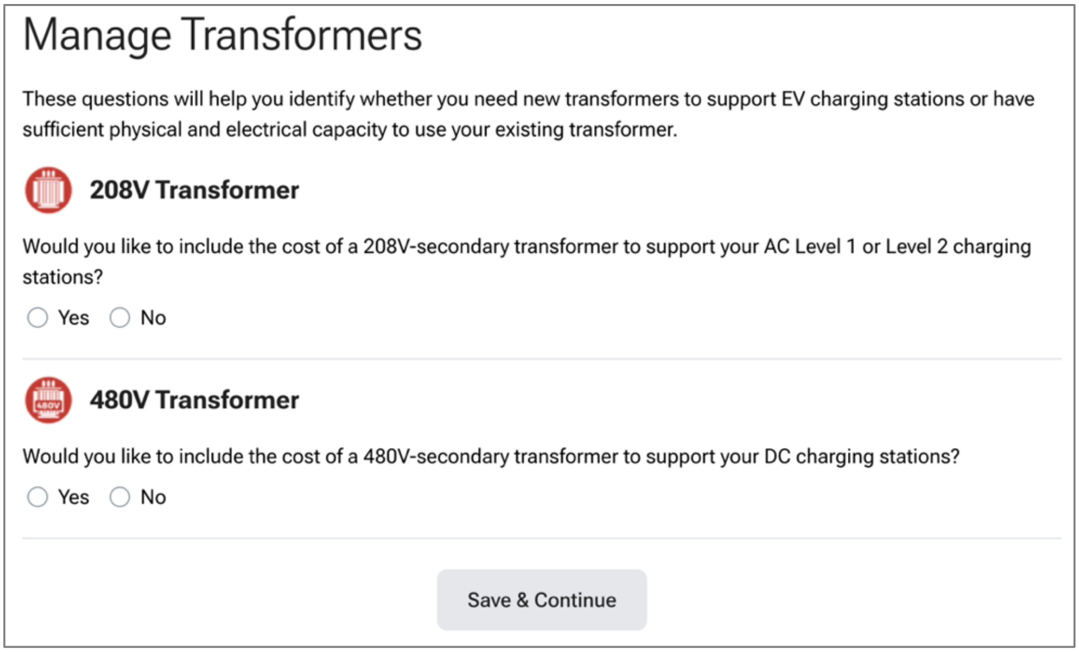
If an existing transformer will be used, certain equipment specifications will be required inputs, including the secondary-side voltage of the transformer, apparent power rating in kilovolt-amperes (kVA), existing peak load in kilowatts (kW), associated power factor,[1] and loading limit.[2]

The calculations for the transformer capacity are added in Appendix B.1: Transformer Logic.

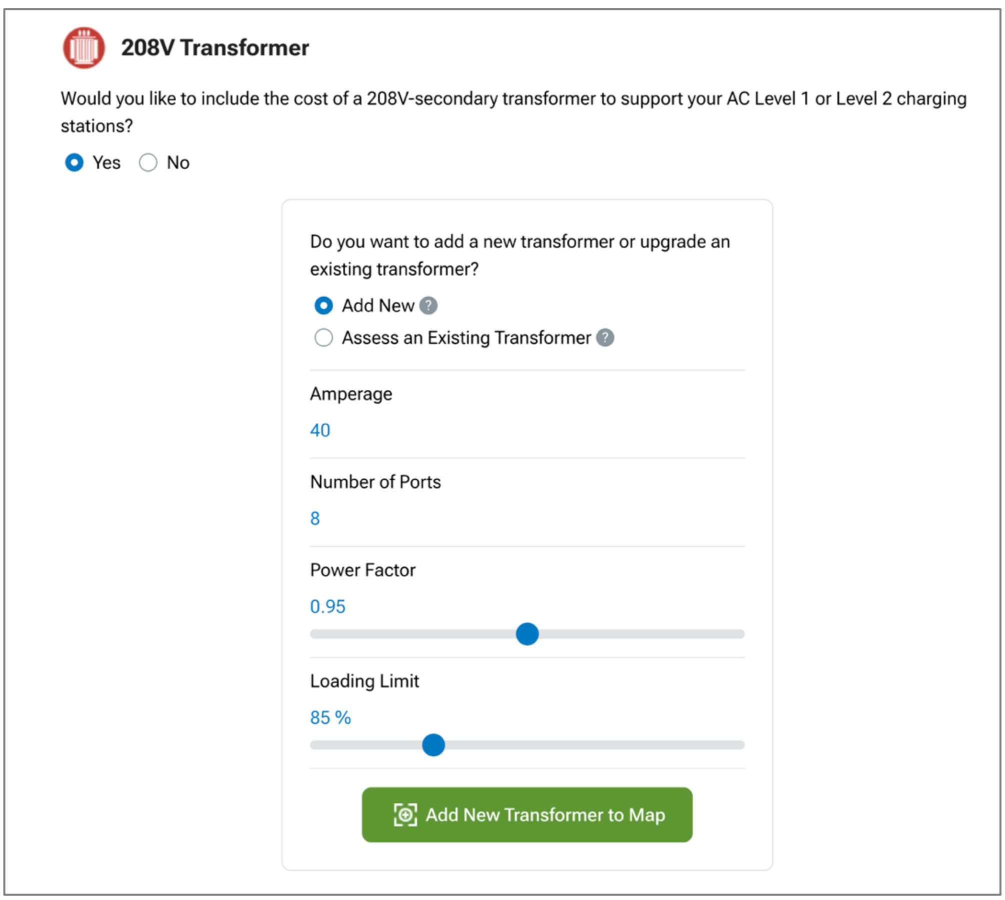
For EVI-LOCATE to calculate the costs of wiring from the service panel to the transformer, users need to mark the location of the existing transformer or where the new transformer will be located on the map.

Tip: Transformer markings typically include the secondary voltage and power rating, and meter data typically include peak load and power factor. Hover over the question mark icons in EVI-LOCATE for help finding this information.

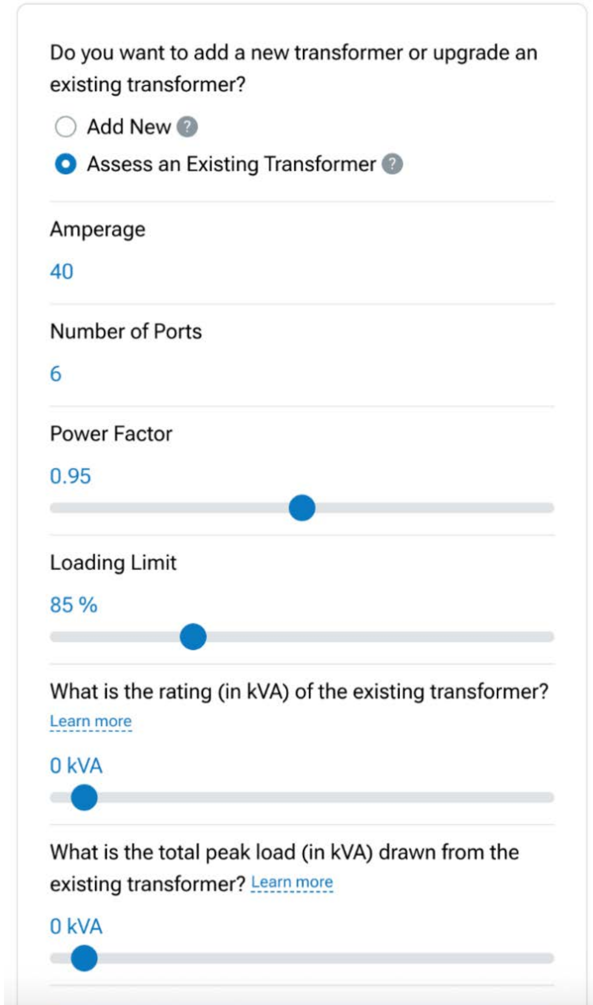
[1] Power factor is the ratio of real power (kW) to apparent power (kVA).
[2] Transformer capacity is limited by the maximum rating (kVA) of the transformer, and the loading limit is the maximum load capacity of a transformer.



A. Questions to decide whether the costs of the transformer should be included in the cost estimates



B. Option to add a new transformer without assessing an existing one



C. Option to assess whether the existing transformer is sufficient to support the additional EV charging load

Figure 6. Transformer questions

Step 5: Manage Service Panel

Questions in this step assess whether an existing service panel can support new EV chargers. Service panels or load centers host the circuit breakers that provide overcurrent protection for each charging port.

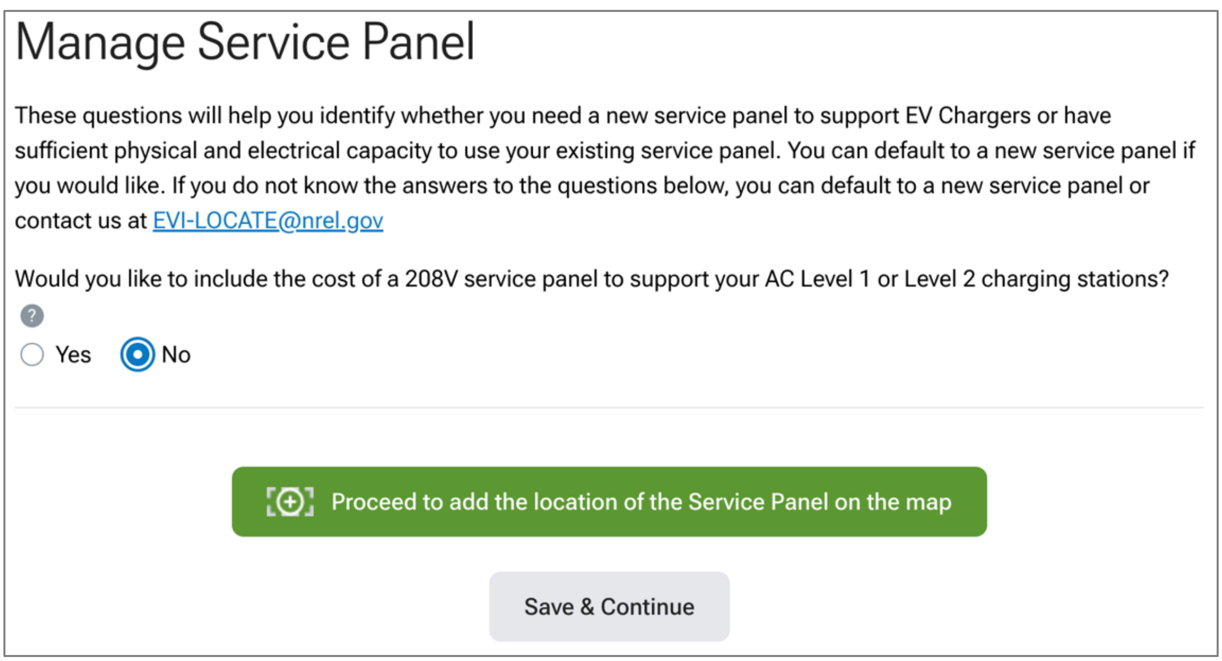
First determine whether the cost of a service panel should be included in the assessment. In some instances, electrical utilities will cover the cost and assessment of service transformers and panels. Go to afdc.energy.gov/utility-finder to learn more about local utility programs that support EV chargers.

If service panel costs are to be factored into the cost estimate, there are two options:

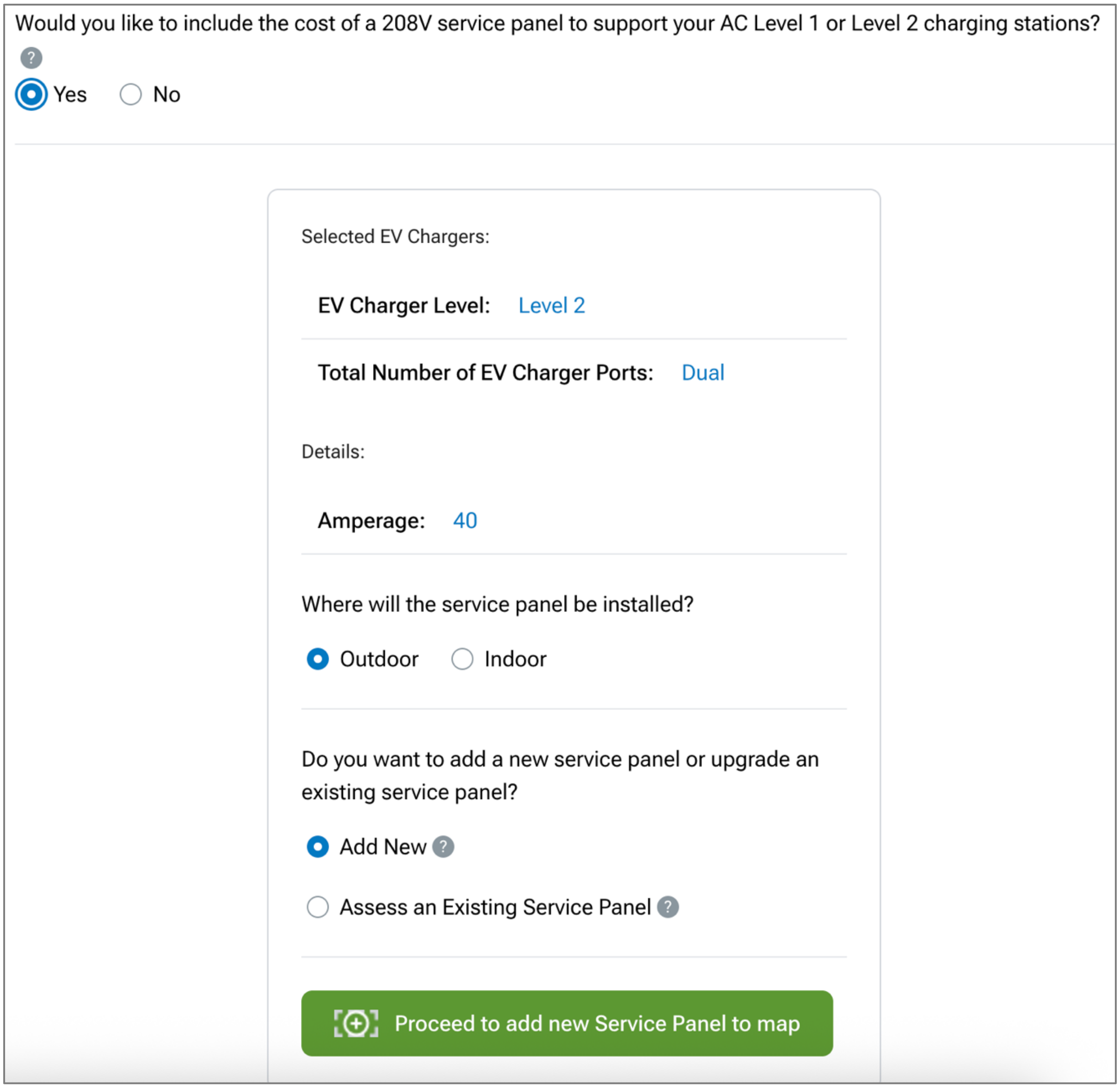
1. Install new service panel(s) regardless of capacity on the existing equipment.
2. Evaluate whether the existing service panel can handle the increased load from the EV charging stations.

For Option 2, provide equipment details like the voltage rating of the service panel, number of unused circuit breakers in the panel, main breaker rating of the panel in amps, and existing load. Service panel markings typically include the secondary voltage and the main breaker norm. Any meter data collected should include the existing load. The "Introduction to EVI-LOCATE" (www.youtube.com/watch?v=UtWZinurl-E&t=1s) and "EVI-LOCATE Step by Step" (www.youtube.com/watch?v=yOv_JY296TA) YouTube videos show you where to find this information.

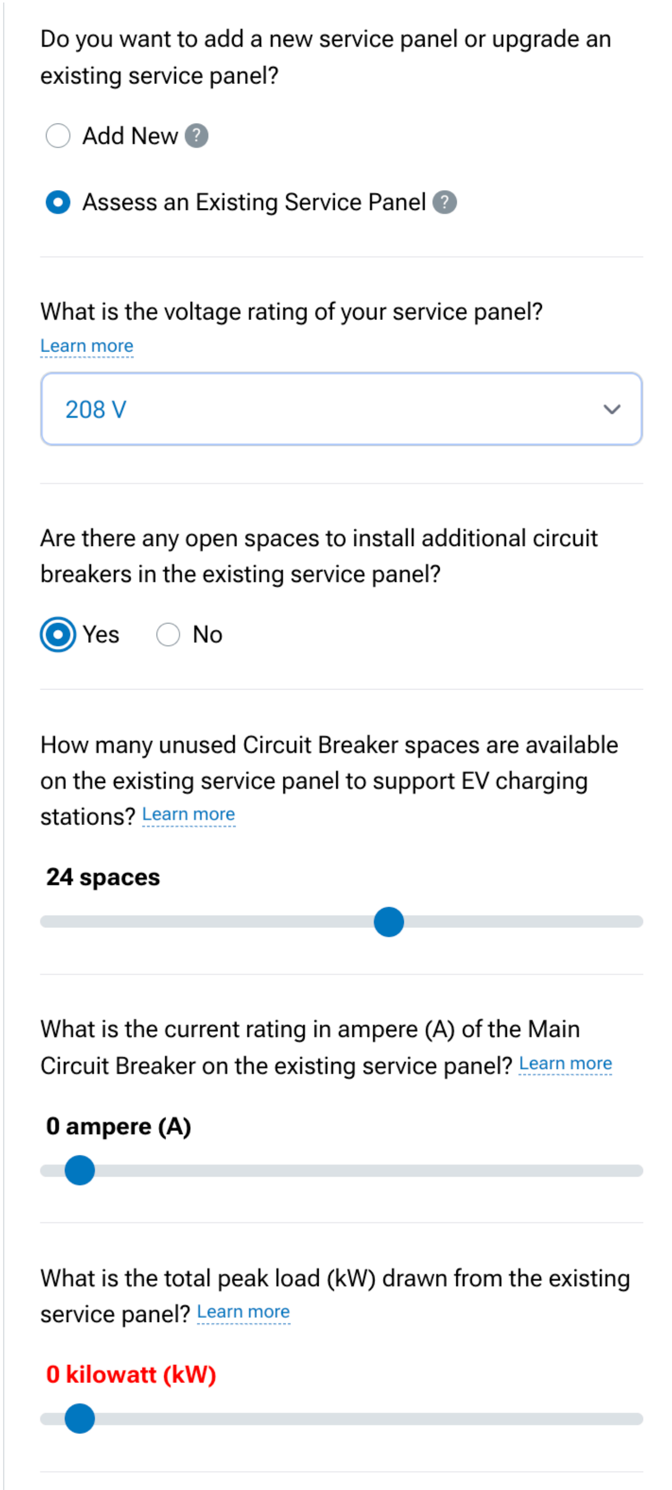
To calculate the costs of wiring from the panel to the EV charging stations, mark the location of the existing service panel or where the new service panel should be located on the map. The service panel calculations are shown in Appendix B.2: Service Panel Logic.



A. Question to decide whether the service panel costs should be included in the estimate



B. If a new service panel is to be added, answer only these questions



C. Additional questions for assessing remaining capacity of an existing service panel

Figure 7. Service panel questions

Step 6: Review Design

To estimate the distance for trenching and lengths of conduit and conductor, select “Generate Electric Lines.” EVI-LOCATE uses the Deep Learning Pixel Classification Image Analyst toolkit from ArcGIS Pro (ESRI 2023), which distinguishes hardscape (like asphalt) from softscape (like grass) to provide accurate estimates for trenching costs (Appendix D covers the details of the GIS process for the trenching costs).

The machine-learning algorithm processes the surface type and informs the tool if it is a hardscape, softscape, or combination. This identification allows the tool to generate the least-cost estimate.

The red line shows the direct path between the transformer and service panel, as well as the direct path between the service panel and chargers. However, the cost estimate leverages the least-cost path, including a preference for softscape over hardscape.

> **Tip:** The “Modify Electrical Lines” button allows users to move the electrical lines that were automatically generated by the tool.

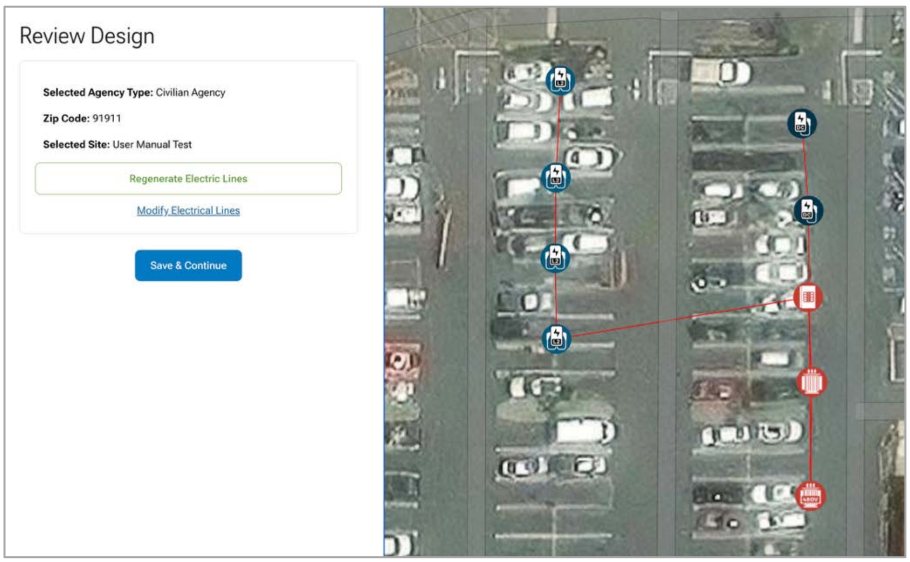


Figure 8. Generated electric lines that connect the transformer, service panel, and EV chargers

Step 7: Estimate Cost

Additional Construction Elements

Along with EV chargers and electrical components, the EV charging infrastructure may include optional inputs such as bollards or wheel stops to protect the chargers, and signage or painting to indicate charger access. Note that sometimes wheel stops and bollards are required by code to protect the charging stations. Figure 9 shows the construction cost components and assumptions for the project costs.

EVI-LOCATE defaults to specified project costs for the federal government; however, all inputs may be modified. The team conducted stakeholder engagement interviews with installers for the EVSE soft costs analysis. These interviews provided the default assumptions for the project costs. (Desai et al. 2024).

All percentages are a factor of the charging equipment, electrical infrastructure, and equipment costs. Contingency costs are calculated in addition to all other costs, including other project costs.

Tip: RSMeans (Gordian 2024) serves as the source for deriving the default construction assumptions. To understand how these assumptions can be used, please refer to the *Camp Lejeune Federal Fleet Tiger Team EVSE Site Assessment* (Hodge et al. 2022).

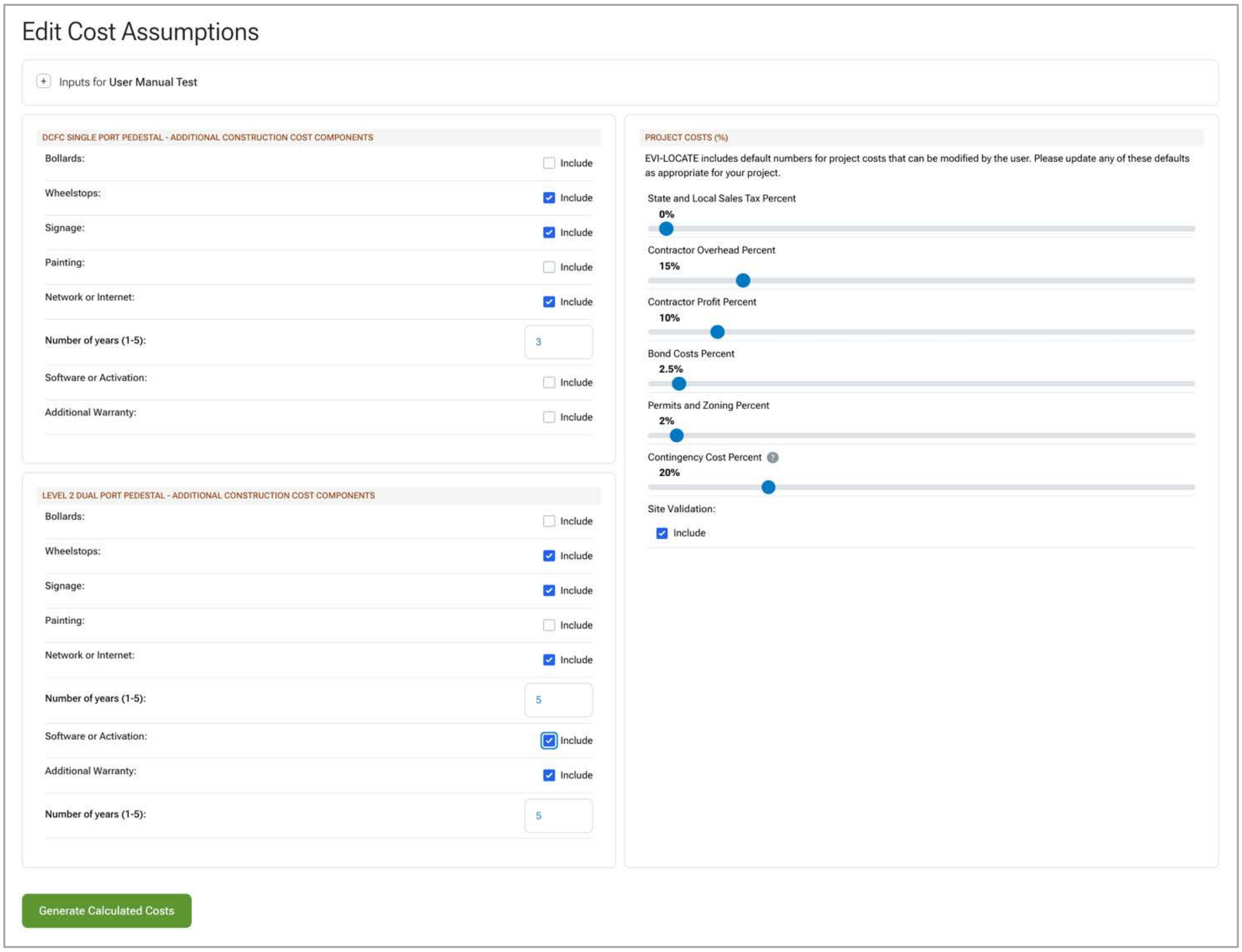


Figure 9. Options for inclusion and tuning of construction costs and project costs

Cost Calculations Algorithm

The tool's cost estimates are calculated by gathering the inputs from the users and datasets that are embedded in the tool. Appendix B.3: NEC Code shows the NEC logic used in the tool.

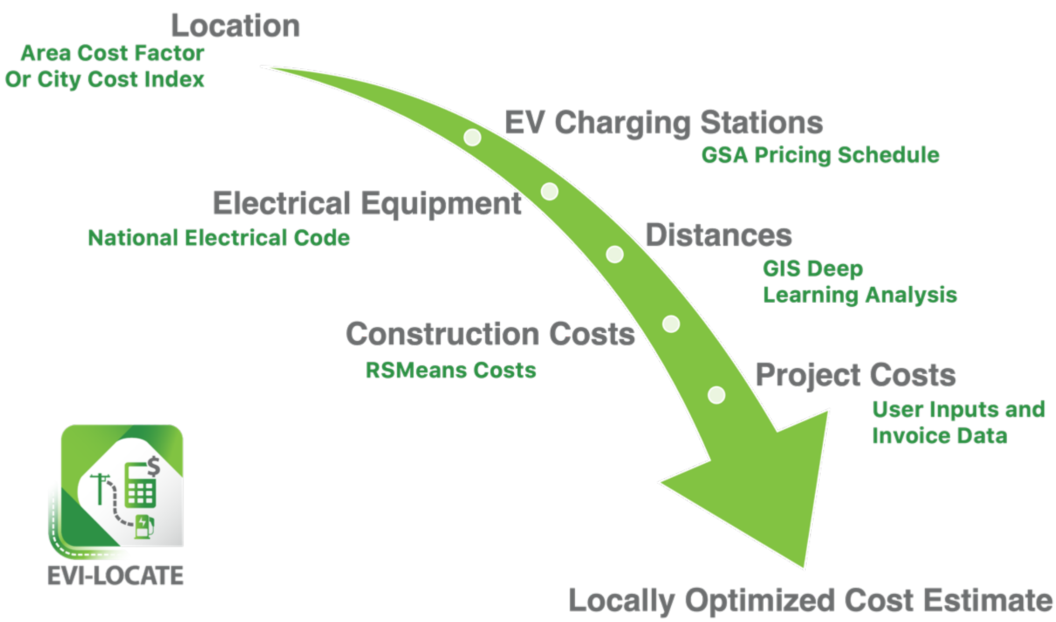


Figure 10. Architecture of the Python-based cost estimator

Step 8: View Site Report and Cost Estimate

EVI-LOCATE displays results based on inputs in Steps 1–7, including a high-level cost estimate, aerial image, and detailed cost estimate of the site design.

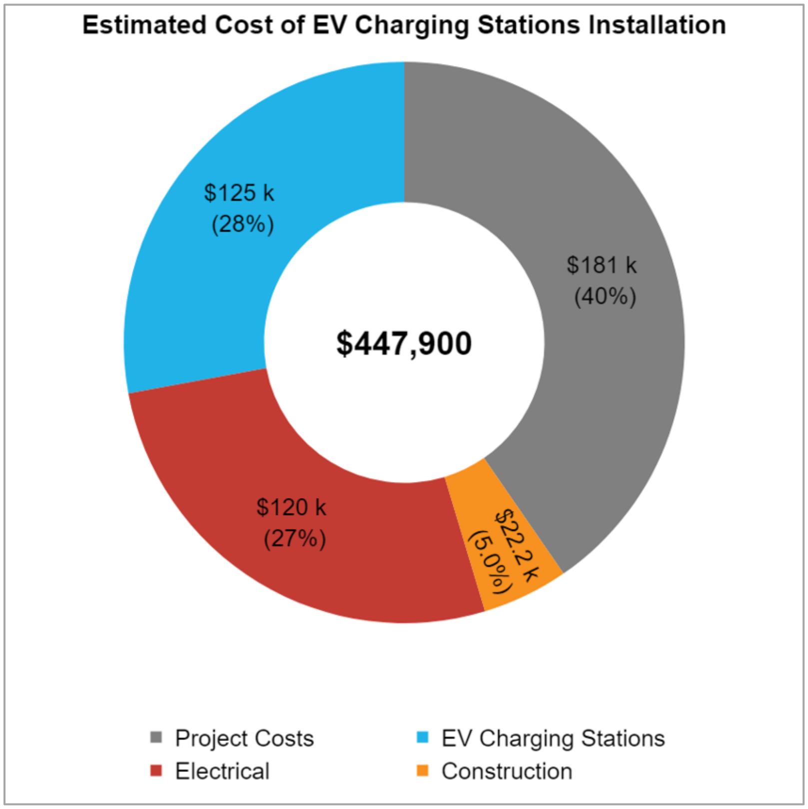


Figure 11**. An example pie chart shows the four main components (equipment, electrical, construction, and project costs) and the total costs of the installation.**

Tip: Zoom in on the aerial site map to view details more clearly.

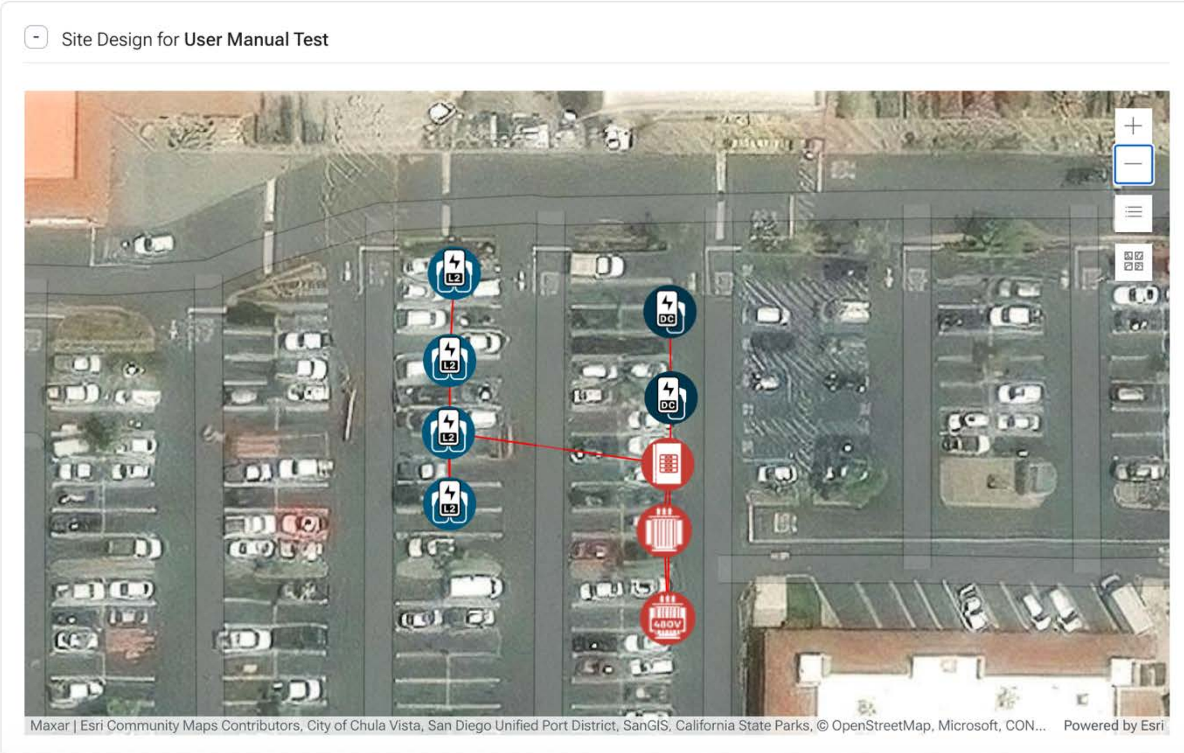


Figure 12. An example single-line site diagram shows the charging stations and essential electrical components—transformer(s), service panel, and electrical lines—generated by the GIS algorithm

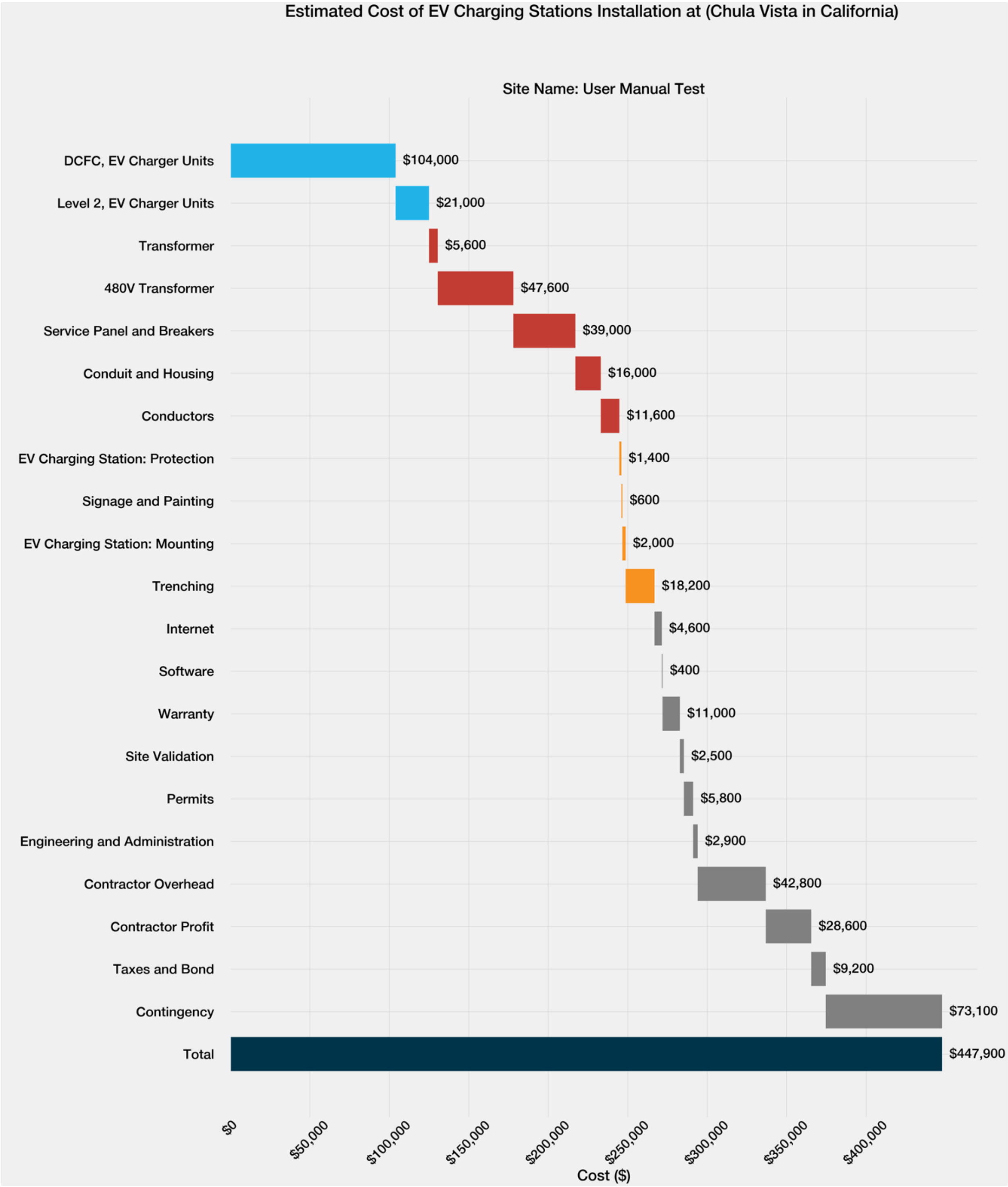


Figure 13. An example additive bar graph of cost components that build up the overall costs of the project

EVI-LOCATE Disclaimer

The following disclaimer appears as part of the narrative around the EVI-LOCATE outputs. It is important to note that EVI-LOCATE is a site planning and cost estimation tool. It cannot identify every factor that goes into an EV charging station site design. All assumptions and calculations used in EVI-LOCATE at the time of publication are shown in the appendices of this user manual.

> Design requirements, cost estimates, and parts lists generated by EVI-LOCATE include many inherent assumptions and do not reflect all site-specific characteristics except as represented by EVI-LOCATE inputs. For example, EVI-LOCATE cannot identify subsurface utilities that may impact feasibility locations for electrical equipment and wiring. The cost estimate was developed by the National Renewable Energy Laboratory ("NREL") using data from the General Services Administration schedules (gsa.gov/evse), RSMeans (https://www.rsmeans.com), charging station installation invoices provided by federal partners, the New York State Energy Research and Development Authority, and the Colorado Energy Office, as well as consultations with industry experts.
>
> Disclaimer: The EVI-LOCATE Model ("Model") is provided by the NREL, which is operated by the Alliance for Sustainable Energy, LLC ("Alliance") for the U.S. Department of Energy ("DOE") and may be used for any purpose. THE MODEL IS PROVIDED BY DOE/NREL/ALLIANCE 'AS IS' AND WITHOUT WARRANTY OF ANY KIND. DOE/NREL/ALLIANCE: (I) DISCLAIM ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, TITLE, OR FITNESS FOR A PARTICULAR PURPOSE, (II) DO NOT ASSUME ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS, OR USEFULNESS OF THE MODEL, (III) DO NOT REPRESENT THAT USE OF THE MODEL WOULD NOT INFRINGE PRIVATELY OWNED RATES, (IV) DO NOT WARRANT THAT THE OPERATION OF THE MODEL WILL BE UNINTERRUPTED, IS ERROR-FREE, OR THAT ANY ERRORS WILL BE CORRECTED.
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Appendix A. Assumptions for Cost Calculations

Entity	Assumptions	Reference (if any)
Overcurrent protection	125%	(NFPA 2024)
Scrap percentage for conduit and conductor material	10%	Expert stakeholder interview [a]
Additional material for conduit and conductor	1 ft on each side	Expert stakeholder interview
Trenching output	20 ft per day (for hardscape)	Expert stakeholder interview
Cleanup costs	1%	Expert stakeholder interview
Conduit per port	A separate conduit per port	Expert stakeholder interview and previous in-person site assessment
Number of pull boxes	2 per 200 feet of conduit Indoor: NEMA 1 Outdoor: NEMA 4	(NEMA Enclosures 2024)
Other Construction Elements		
Number of anchors	7 per single port 10 per dual port	Assumption in the tool
Hole drills	1 per 100 ft of conduit	Assumption in the tool
Size of the parking spot for one vehicle	Length: 20 ft Width: 15 ft	Expert stakeholder interview and measurements in previous in-person site assessments
Signage post	1 per charger port RSMeans line number: 10 14 53 20 0900	(Gordian 2024)
Bollards	1 per charger port RSMeans line number: 32 17 13 16 1600 Plastic parking bumpers, bollards, recycled plastic, 5 in. × 5 in. × 5 ft long	(Gordian 2024)
Wheel stops	1 per charger port RSMeans line number: 32 17 13 16 1610 Plastic parking bumpers, wheel stops, recycled plastic, yellow, 4 in. × 6 in. × 6 ft long	(Gordian 2024)
Concrete slab	1 per pedestal charger Cost: RSMeans line number: 03 30 53 40 3540	(Gordian 2024)
Painting	RSMeans line number: 32 17 23 13 0730	(Gordian 2024)

[a] The team conducted stakeholder engagement interviews with installers for the EVSE soft costs analysis. These interviews provided the default assumptions for the project costs (Desai et al. 2024).

Appendix B. Calculation Logics

B.1 Transformer Logic

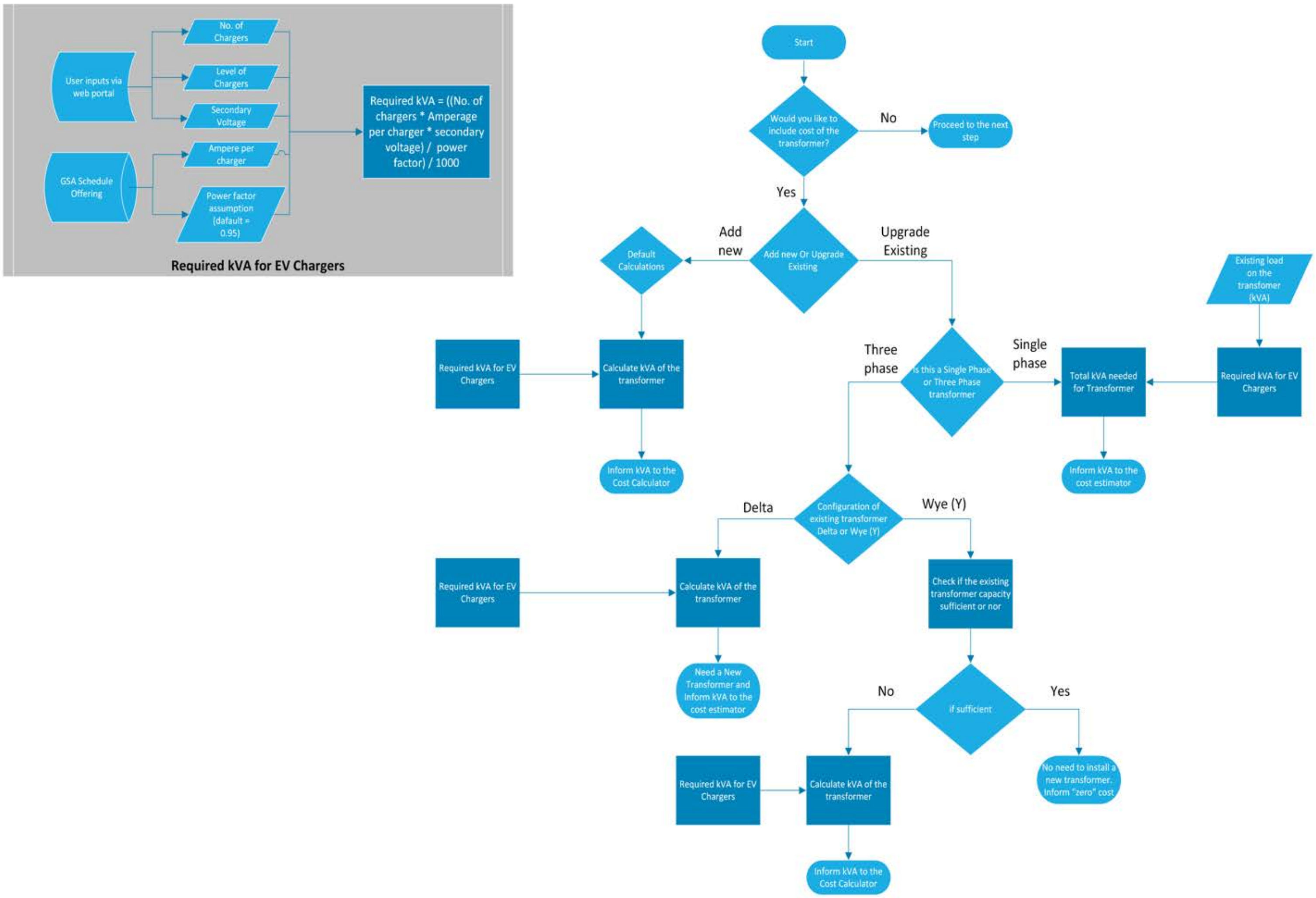


Figure B-1. Flowchart for deciding the required transformer capacity (kVA)

B.2 Service Panel Logic

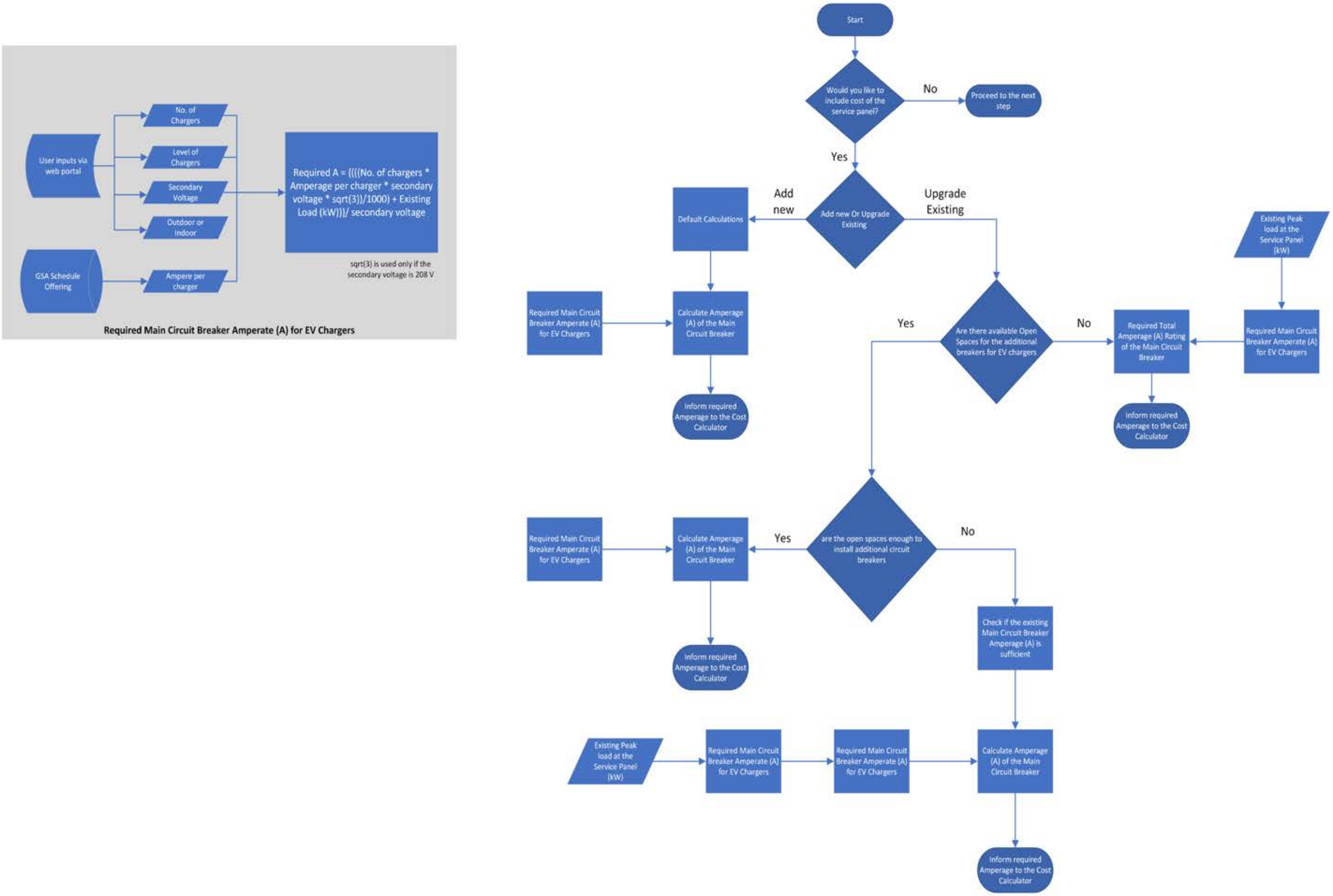
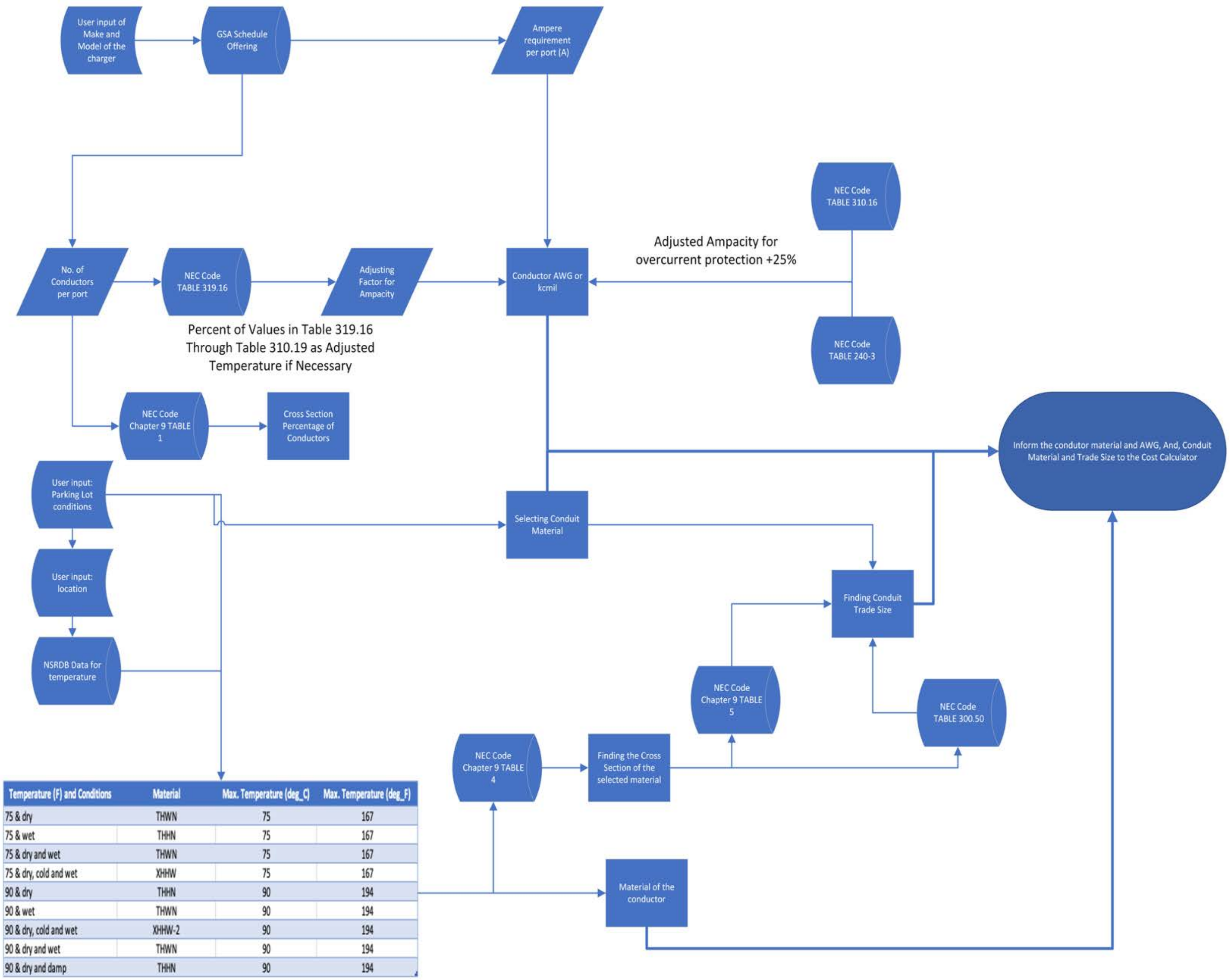


Figure B-2. Flowchart for deciding the required service panel capacity

B.3 NEC Code



Temperature (F) and Conditions	Material	Max. Temperature (deg_C)	Max. Temperature (deg_F)
75 & dry	THWN	75	167
75 & wet	THHN	75	167
75 & dry and wet	THWN	75	167
75 & dry, cold and wet	XHHW	75	167
90 & dry	THHN	90	194
90 & wet	THWN	90	194
90 & dry, cold and wet	XHHW-2	90	194
90 & dry and wet	THWN	90	194
90 & dry and damp	THHN	90	194

Figure B-3. NEC code algorithm

Appendix C. Parameters

Symbol	Meaning	Unit
$\boldsymbol{f}$	Function	
$\boldsymbol{A_{L2,C}}$	Level 2 charger amperage	$[A]$
$\boldsymbol{A_{L2,Total}}$	Total amperage of all Level 2 chargers	$[A]$
$\boldsymbol{AM_{Conductor}}$	Additional conductor material	$[m]$
$\boldsymbol{AM_{Conduit}}$	Additional conduit material	$[m]$
$\boldsymbol{AWG_{Conductor}}$	Conductor AWG	$[AWG]$
$\boldsymbol{B_{Parking}}$	Breadth of parking spot	$[m]$
$\boldsymbol{C_T}$	Cost of transformer	$[\$]$
$\boldsymbol{C_{T(208)}}$	Cost of 208-V transformer	$[\$]$
$\boldsymbol{C_{T(480)}}$	Cost of 480-V transformer	$[\$]$
$\boldsymbol{C_{SP}}$	Cost of service panel	$[\$]$
$\boldsymbol{C_{Conduit}}$	Cost of conduit	$[\$]$
$\boldsymbol{C_{Conductor}}$	Cost of conductor	$[\$]$
$\boldsymbol{C_{MCB}}$	Cost of main circuit breaker	$[\$]$
$\boldsymbol{C_{CB}}$	Cost of circuit breaker	$[\$]$
$\boldsymbol{C_{PB}}$	Cost of pull box	$[\$]$
$\boldsymbol{C_{Bollards,WS,Signage}}$	Cost of unit bollard, wheel stop, and signage	$[\$]$
$\boldsymbol{C_{Slab}}$	Cost of slab	$[\$]$
$\boldsymbol{C_{HD}}$	Cost of hole drilling	$[\$]$
$\boldsymbol{C_{Paint}}$	Cost of painting	$[\$]$
$\boldsymbol{C_{Internet}}$	Cost of internet connection	$[\$]$
$\boldsymbol{C_{Software}}$	Cost of charger software	$[\$]$
$\boldsymbol{C_{Warranty}}$	Cost of charger warranty	$[\$]$
$\boldsymbol{C_{Trenching,Softscape}}$	Cost of softscape trenching	$[\$]$
$\boldsymbol{C_{Trenching,Hardscape}}$	Cost of hardscape trenching	$[\$]$
$\boldsymbol{C_{Trenching}}$	Total cost of trenching	$[\$]$
$\mathbf{CL}$	Charger level	$[unitless]$
$\mathbf{CT}$	Conduit trade	$[unitless]$
$\mathbf{CM}$	Conductor material	$[unitless]$
$\boldsymbol{LL_{T(208)}}$	Loading limit of a 208-V transformer	$[unitless]$
$\boldsymbol{LL_{T(480)}}$	Loading limit of a 480-V transformer	$[unitless]$
$\boldsymbol{L_{Conductor}}$	Total length of conductor	$[m]$
$\boldsymbol{L_{Conduit}}$	Total length of conduit	$[m]$
$\boldsymbol{L_{Parking}}$	Length of parking spot	$[m]$
$\boldsymbol{Make_C}$	Manufacturer of the charger	$[unitless]$
$\boldsymbol{Model_C}$	Model number of the charger	$[unitless]$
$\boldsymbol{MountType_C}$	Mount type of charger	$[unitless]$
$\boldsymbol{MountType_T}$	Mount type of transformer	$[unitless]$
$\boldsymbol{N_{L2,C}}$	Number of Level 2 chargers	$[count]$
$\boldsymbol{N_{DC,C}}$	Number of DC fast chargers	$[count]$
$\boldsymbol{N_C}$	Number of chargers	$[count]$
$\boldsymbol{N_{CB}}$	Number of circuit breakers	$[count]$

Symbol	Meaning	Unit
$\boldsymbol{N_{PB}}$	Number of pull boxes	$[count]$
$\boldsymbol{N_{Conductor}}$	Number of conductors in each group	$[count]$
$\boldsymbol{N_{Parking}}$	Number of parking spots	$[count]$
$\boldsymbol{NP_C}$	Number of ports in the charger	$[count]$
$\boldsymbol{P_{L2,C}}$	Power of Level 2 charger	$[W]$
$\boldsymbol{P_{L2,Total}}$	Total power of Level 2 chargers	$[W]$
$\boldsymbol{P_{DC,C}}$	Power of DC charger	$[W]$
$\boldsymbol{P_{DC,Total}}$	Total power of DC chargers	$[W]$
$\boldsymbol{Pct_{Hardscape}}$	Percentage of hardscape trenching	$[unitless]$
$\boldsymbol{Pct_{Softscape}}$	Percentage of softscape trenching	$[unitless]$
$\boldsymbol{Pct_{Permit}}$	Percentage of permit cost	$[unitless]$
$\boldsymbol{Pct_{Cleanup}}$	Percentage of cleanup cost	$[unitless]$
$\boldsymbol{Pct_{Overhead}}$	Percentage of overhead cost	$[unitless]$
$\boldsymbol{Pct_{Profit}}$	Percentage of profit	$[unitless]$
$\boldsymbol{Pct_{Bonds}}$	Percentage of bond cost	$[unitless]$
$\boldsymbol{Pct_{Taxes}}$	Percentage of taxes	$[unitless]$
$\boldsymbol{Pct_{Contingency}}$	Percentage of contingency costs	$[unitless]$
$\boldsymbol{PC_{Subtotal}}$	Project subtotal cost before bonds taxes and contingency costs	[$]
$\boldsymbol{PC_{Total}}$	Total cost of the project	[$]
$\boldsymbol{PF_{T(208)}}$	Power factor of a 208-V transformer	$[unitless]$
$\boldsymbol{PF_{T(480)}}$	Power factor of a 480-V transformer	$[unitless]$
$\mathbf{PM}$	Pipe material	$[unitless]$
$\boldsymbol{S_{T(208)}}$	Total apparent power of a 208-V transformer	[kVA]
$\boldsymbol{S_{A(208)}}$	Additional user specified load of a 208-V transformer	[kW]
$\boldsymbol{S_{Rating,T(208)}}$	Rating of a 208V transformer	[kVA]
$\boldsymbol{S_{T(480)}}$	Total apparent power of a 480-V transformer	[kVA]
$\boldsymbol{S_{A(480)}}$	Additional user specified load of a 480-V transformer	[kW]
$\boldsymbol{S_{Rating,T(480)}}$	Rating of a 480-V transformer	[kVA]
$\boldsymbol{S_{Rating}}$	Rating of a transformer	[kVA]
$\boldsymbol{SP}$	Scrap percent	$[unitless]$
$\boldsymbol{TC_C}$	Total cost of chargers	[$]
$\boldsymbol{TC_{CB}}$	Total cost of circuit breakers	[$]
$\boldsymbol{TC_{PB}}$	Total cost of pull boxes	[$]
$\boldsymbol{TNP_C}$	Total number of ports	$[count]$
$\boldsymbol{TC_{Bollards,WS,Signage}}$	Total cost of wheel stop, bollard, and signage	[$]
$\boldsymbol{TC_{Slab}}$	Total cost of slab	[$]
$\boldsymbol{TC_{mtrl,equip,labor}}$	Total cost of material, equipment, and labor	[$]
$\boldsymbol{TL_{Paint}}$	Total length to paint	$[m]$
$\boldsymbol{TL_{Trenching}}$	Total length to trench	$[m]$
$\boldsymbol{V_{T(208)}}$	Secondary voltage of a 208-V transformer	[V]

Appendix D. Calculations

Power Load Calculations

A typical circuit is shown in Figure D-1.

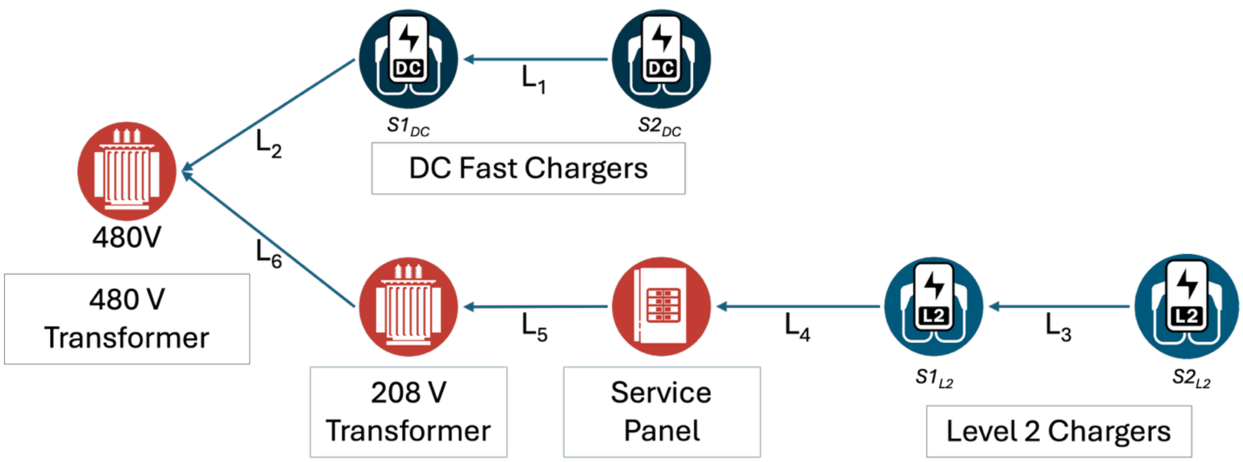


Figure D-1. A typical circuit connection in EVI-LOCATE

Chargers

The user inputs for the number of chargers ($N_{L2,c}$) and their required ampere ratings ($A_{L2,c}$) are used to calculate the total amperes ($A_{L2,Total}$) required for the installation. Similarly, the total power required (P_{Total}) is calculated from the number of chargers and power required per charger (P_c):

$$Total\ Ampere\ for\ L2 = A_{L2,Total} = \left(A_{L2,C} \times N_{L2,C}\right)$$ Equation 1

$$Total\ Power\ (load)\ for\ L2 = P_{L2,Total} = \left(P_{L2,C} \times N_{L2,C}\right)$$ Equation 2

In the case of DC fast chargers:

$$Total\ Power\ (load)\ for\ DC = P_{DC,Total} = \left(P_{DC,C} \times N_{DC,C}\right)$$ Equation 3

208/240-V Secondary Transformers

In the EVSE installations, transformers with a 208- or 240-V secondary voltage are typically used to support the load of AC Level 2 chargers. The required load capacity is calculated using Equation 4. The user provides the existing load (S_A) in kilowatts at the transformer, the power factor of the secondary transformer (PF), and the secondary voltage of the transformer.

$$S_{T(208)} = \left[\frac{V_{T(208)} * A_{L2,Total}}{PF_{T(208)} * 1000}\right] + \frac{S_{A(208)}}{PF_{T(208)}}$$ Equation 4

The user can evaluate whether the existing transformer is sufficient for the additional load using Step 4: Manage Transformer.

If:

$$S_{Rating,T(208)}\,(in\;kVA) \;\geq\; \left(S_{T(208)} \;\times\; LL_{T(208)} \right) \tag{Equation 5}$$

Then the existing transformer is sufficient to support the EVSE load; otherwise, the tool suggests a new transformer of higher capacity. The $Loading\ limit$ is a user input; if users are unsure, the default assumption is 85%. $Loading\ limit$ is the maximum power a transformer can handle without overheating or damage.

480-V Secondary-Side Transformers

For DC chargers, the required power to support only the DC charger load is calculated using Equation 6:

$$S_{Rating,T(480)}\,(in\;kVA) = \left(\frac{P_{DC,Total} + S_{A(480)}}{PF_{T(480)}} \right) \times LL_{T(480)} \tag{Equation 6}$$

However, if the installation includes both Level 2 and DC chargers, the three-phase transformer needs to support loads of both Level 2 (i.e., the total rating of the single-phase transformer) and DC chargers, in addition to the existing load on each of the transformer.

$$S_{T(480)} = \left[\left(\frac{P_{DC,Total} + S_{A(480)}}{PF_{T(480)}} \right) + S_{Rating,T(208)} \right] \tag{Equation 7}$$

The rating of the 480-V three-phase transformer is calculated using Equation 8:

$$S_{Rating,T(480)}\,(in\;kVA) \;\geq\; S_{T(480)} \times LL_{T(480)} \tag{Equation 8}$$

Appendix E. Cost Calculations

Equipment Costs

The users select the charging stations to install, and the tool uses charger level ($ChargerLevel$), mount type of the charger ($MountType_C$), make ($Make_C$), and model ($Model_C$) of the selected charger to look up the per-charger cost.

$$Cost\ per\ Charging\ Station = C_C = f(CL, MountType_C, Make_C, Model_C) \quad \text{Equation 9}$$

$$Total\ Cost\ of\ Charging\ Stations = TC_C = (C_C \times N_C) \quad \text{Equation 10}$$

Electrical Costs

The total electrical costs are calculated using the component-level costs from RSMeans (Gordian 2024). The technical specifications of each component are determined using NEC guidelines and the original equipment manufacturer recommendations.

Circuit Breaker Costs

The unit cost of a circuit breaker comes from RSMeans (Gordian 2024). For Level 2 chargers, the ampere rating for the circuit breaker is decided per the NEC, and the tool identifies two-pole circuit breakers and one breaker per each port. For the DC chargers, the breaker ratings are recommended by the original equipment manufacturers. The tool selects a three-pole circuit breaker of the required rating for a DC charger.

The total cost of circuit breakers is calculated as following, where A_C is the charger ampere rating:

$$Cost\ per\ Circuit\ Breaker = C_{CB} = f\left(CL, A_{L2,C}\right) \quad \text{Equation 11}$$

$$Total\ Cost\ of\ Circuit\ Breaker = TC_{CB} = (C_{CB} \times N_{CB}) \quad \text{Equation 12}$$

Transformer Costs

The user decides whether the transformer costs are to be included in the site assessment. However, if the costs are to be included, the transformer rating is decided as shown in Equation 5 and Equation 8.

$$Transformer\ Cost = C_T = f\left(S_{Rating}, MountType_T\right) \quad \text{Equation 13}$$

For the single-phase transformer, the tool chooses a dry-type, ventilated, primary voltage 480-V and secondary voltage 120/208-V. Similarly for the three-phase transformer, the tool chooses pad-mounted, oil-filled, primary 15 kV, and secondary voltage 480 V.

Service Panel Costs

For Level 2 chargers, a service panel can be included in the cost estimates. The total ampere rating of the main circuit breaker in the service panel is calculated using $A_{L2,Total}$—i.e., the total ampere of Level 2 chargers and total number of circuit breakers. Note that the tool estimates the required number of service panels in the cost estimate; however, the site diagram in the site report shows only one service panel.

$$C_{SP} = f\left(A_{L2,Total}, N_{CB}\right) \qquad \text{Equation 14}$$

However, for DC chargers, the two circuit breakers—one on each live wire—are used, but a service panel is not included.

Conductor and Conduit Costs

The technical specifications for the conductor (AWG and material) and conduit (trade and material) are determined as per the NEC requirements as shown in Appendix B.3: NEC Code. These specifications are used to find the component-level costs.

$$C_{Conductor} = f(AWG_{Conductor}, CM) \qquad \text{Equation 15}$$

Length of the Conduit

The tool assumes there would be a separate conduit connecting each port at each charging station. For example, referring to Figure D-1, for the dual-port charger *S1* the length of the conduit until the service panel would be $2 \times L_4$. Similarly, for the charger *S2* the length of the conduit would be $2 \times (L_3 + L_4)$. In addition, scrap percentage and extra material are needed for the conductor and conduit. Consequently, the total length of the conduit (Equation 16) for the Level 2 stations and DC chargers to the 480-V transformer is needed. Note that the technical specifications for the conduit would be different as per the NEC.

$$L_{Conduit} = \big((2 \times (L_3 + L_4 + AM_{Conduit}) + L_5 + L_6) + 2 \times (L_1 + L_2 + AM_{Conduit})\big) \times (1 + SP) \qquad \text{Equation 16}$$

Length of the Conductor

For Level 2 port, the tool considers four conductors as per the installation guides (e.g., SemaConnect 2021b; 2021a; BlinkSeries 2025; BreezeEV 2025; Eaton 2025). Therefore, the length of the conductor for the charger $S1_{L2}$ would be $4 \times L_4$ until the service panel. Similarly, typical DC chargers require a dedicated three-phase AC power source with at least three conductors for the phases and one for the ground, for a minimum of four conductors (NYSERDA 2025). Therefore, the length of the conductor to the 480-V transformer via the main breakers for the DC charger, $S1_{DC}$, would be $4 \times L_2$. Therefore, the total length of the conductor is as follows:

$$L_{Conductor} = \big((4 \times 2 \times (L_3 + L_4 + AM_{Conductor.}) + L_5 + L_6) + 4 \times 2 \times (L_1 + L_2 + AM_{Conductor})\big) \times (1 + SP) \qquad \text{Equation 17}$$

Pull Boxes

The number of pull boxes is estimated as two per 200 feet of conduit, and the cost per pull box is determined by the parking conditions (i.e., indoor or outdoor parking) that determine the NEMA rating for the pull boxes (NEMA Enclosures 2024).

$$Total\ Cost\ of\ Pull\ Boxes = TC_{PB} = (C_{PB} \times N_{PB}) \quad \text{Equation 18}$$

Construction Costs

The construction costs include material, labor, and equipment.

Bollards, Wheel Stops, and Signage

The additional construction costs such as bollards, wheel stops, and signage are dependent on the user's decision to include these costs in the estimate or not. However, if they are to be included, the number is estimated from the number of charging ports, per-item costs are extracted from RSMeans, and the respective line numbers are included in Appendix A. The total costs are calculated as a multiplication of the number of items and the per-item costs.

$$TC_{Bollards,WS,Signage} = TNP_C \times C_{Bollards,WS,Signage} \quad \text{Equation 19}$$

Painting, Hole Drilling, and Concrete Slab

The painting and hole drilling costs are estimated using the assumptions in Appendix A and the costs from RSMeans.

$$C_{Paint} = f\left(N_{Parking}, L_{Parking}, B_{Parking}\right) \quad \text{Equation 20}$$

The costs for hole drilling are also included in the cost estimates and are a function of the conduit trade (CT), estimated using the RSMeans line numbers 26 05 33 95 0500 to 26 05 33 95 0630.

$$C_{HD} = f(CT) \quad \text{Equation 21}$$

The concrete slab costs are included for pedestal chargers and the respective RSMeans line numbers in Appendix A.

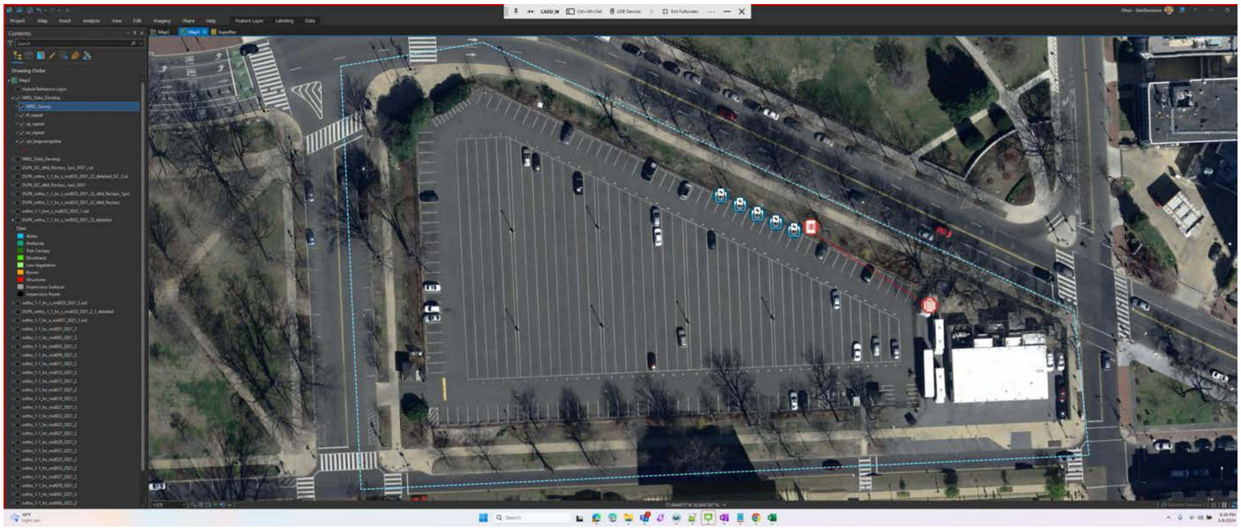
$$TC_{Slab} = N_{C,if\ Pedestal} \times C_{Slab} \quad \text{Equation 22}$$

Trenching

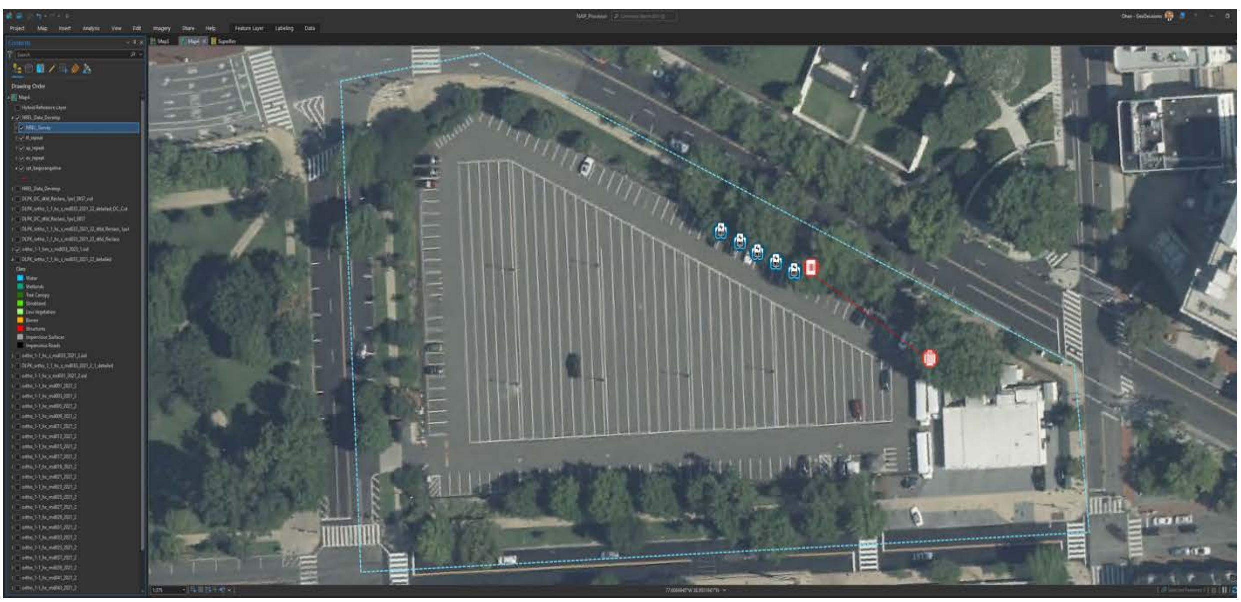
The total trenching costs are composed of trencher chain (RSMeans line number: 01 54 33 20 4900), concrete saw (renting, RSMeans line number: 01 54 33 10 2600), sawing (RSMeans line numbers: 03 81 13 50 0500 and 03 81 13 50 0520), and the refilling costs (refer to Appendix A). The ArcGIS deep-learning surface interpretations algorithm determines the length of softscape (e.g., grass, gravel) and hardscape (e.g., concrete, asphalt) trenching. The following section demonstrates the implementation of the deep-learning pixel classification algorithm.

ArcGIS Surface Interpretation

The EVI-LOCATE tool utilizes the Deep Learning Pixel Classification Image Analyst toolkit of ArcGIS Pro Field (ESRI 2023). The web portal enables user access to the site's GIS data, and the tool uses the captured imagery to perform the GIS analysis. The function of the classification algorithm is depicted in Figure E-1, which shows four screenshots from the same parking lot imagery.

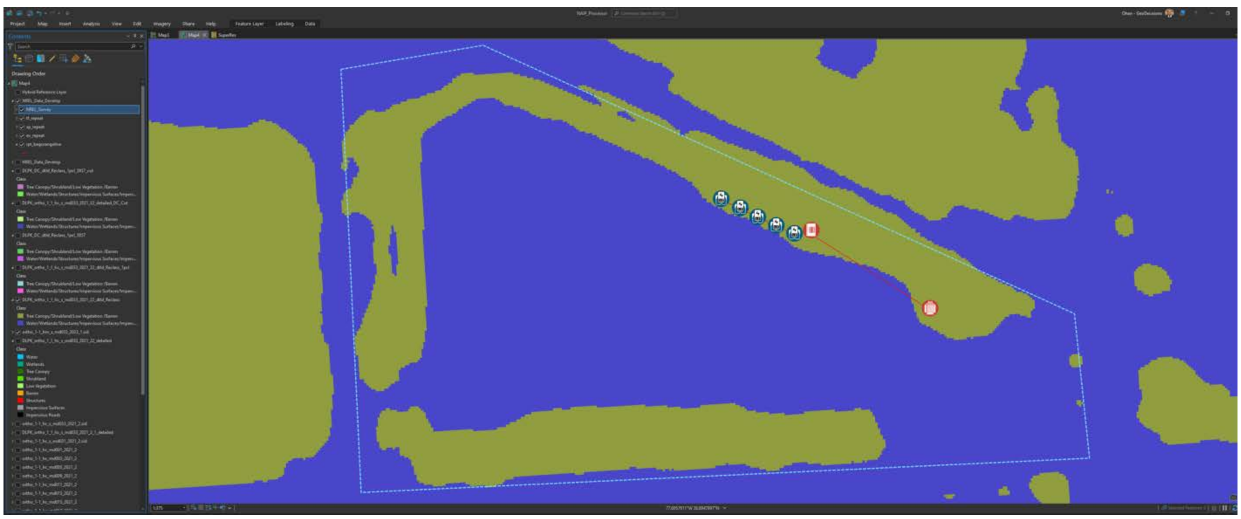


A. A site layout with the icons of five Level 2 dual-port pedestal charging stations with a service panel and transformer with the site/parking lot boundary.



B. A site layout with the red line representing the electric lines connecting the electrical system.

C. Deep pixel classification machine-learning algorithm showing different classifications of the surface. The image shows five different classifications of the surface.



D. Deep pixel classification shows the final classification of permeable and impermeable surfaces at the end.

Figure E-1. GIS analysis and deep pixel classification

$$TL_{Trenching} = f(C_{Trenching,SoftScape}) \times Pct_{SoftScape} \times (L_1 + L_2 + L_3 + L_4 + L_5 + L_6) + f(C_{Trenching,HardScape}) \times Pct_{HardScape} \times (L_1 + L_2 + L_3 + L_4 + L_5 + L_6) \quad \text{Equation 23}$$

$$C_{Trenching} = TrenchingCosts = f(Trenching\ Chain, Concrete\ Saw, Concrete\ Sawing) \quad \text{Equation 24}$$

Project Costs

Network (or Internet), Software or Activation, and Additional Warranty

The network, software, and additional warranty costs are some key costs that are part of EV charging installation projects. These costs are informed from the EVSE soft costs analysis (Desai et al. 2024) and are incorporated per charger port. In the following equations, $years$ is the number of years the services are intended, as per user input.

$$C_{Internet} = C_{internet\ per\ port\ per\ year} \times TNP_C \times years \quad \text{Equation 25}$$

$$C_{Software} = C_{software\ per\ port} \times TNP_C \quad \text{Equation 26}$$

$$C_{Warranty} = C_{warranty\ per\ port\ per\ year} \times TNP_C \times years \quad \text{Equation 27}$$

Taxes, Contractor Overhead and Profit, Bonds, Permits and Zoning, Contingency, and Site Validation

The soft costs of taxes (Pct_{Taxes}), contractor overhead ($Pct_{Overhead}$) and profit (Pct_{Profit}), bonds (Pct_{Bonds}), permits (Pct_{Permit}), and contingency ($Pct_{Contingency}$) are users' inputs as a percentage of the material, equipment, and labor costs. However, the cleanup costs ($Pct_{Cleanup}$) are assumed to be 1% (Appendix A).

Total Costs

$$\begin{aligned} Total\ Costs\ of\ Material, Equipment\ and\ Labor &= TC_{mtrl,equip,labor} \\ &= TC_C + C_T + C_{SP} + TC_{CB} + C_{MCB} + TC_{PB} \\ &+ C_{Conduit} + C_{Conductor} + C_{Bollards,WS,Signage} \\ &+ TC_{Slab} + C_{Paint} + C_{HD} + C_{Trenching} + C_{Internet} \\ &+ C_{Software} + C_{Warranty} \end{aligned} \quad \text{Equation 28}$$

$$\begin{aligned} PC_{Subtotal} = {} & TC_{mtrl,equip,labor} \\ & + \left(TC_{mtrl,equip,labor} \times Pct_{Permit}\right) \\ & + \left(TC_{mtrl,equip,labor} \times Pct_{Cleanup}\right) \\ & + \left(TC_{mtrl,equip,labor} \times Pct_{Overhead}\right) \\ & + \left(TC_{mtrl,equip,labor} \times Pct_{Profit}\right) \end{aligned} \quad \text{Equation 29}$$

$$\begin{aligned} Total\ Project\ Costs = PC_{Total} &= PC_{Subtotal} \\ &+ (PC_{Subtotal} \times Pct_{Bonds}) \\ &+ (PC_{Subtotal} \times Pct_{Taxes}) \\ &+ \left(PC_{Subtotal} \times Pct_{Contingency}\right) \end{aligned} \quad \text{Equation 30}$$

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