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Using Mapping Tools to Prioritize Electric Vehicle Charger Benefits to Underserved Communities

Energy Systems and Infrastructure Analysis Division

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ACRONYMS AND ABBREVIATIONS

AADT	Average annual daily traffic
AFC	Alternative fuel corridor
AFDC	Alternative Fuel Data Center
ANL	Argonne National Laboratory
BIL	Bipartisan Infrastructure Law
BIPOC	Black, Indigenous, and people of color
CCS	Combined charging system
DAC	Disadvantaged community
DCFC	Direct current fast charger
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EEJ	Energy and Environmental Justice
EERE	Office of Energy Efficiency & Renewable Energy
EPA	Environmental Protection Agency
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FHWA	Federal Highway Administration
GDP	Gross domestic product
GGE	Gasoline gallons equivalent
GHG	Greenhouse gas
HBCUs	Historically black colleges and universities
IOU	Investor-owned utilities
LGBT	Lesbian, gay, bisexual, and transgender
kW	kilowatt(s)
kWh	kilowatt hour(s)
MFH	Multi-family housing
MSIs	Minority serving institutions
NCES	National Center for Education Statistics
NEPA	National Environmental Policy Act
NEVI	National Electric Vehicle Infrastructure

NOx	Nitrogen oxides
PM2.5	Particulate matter (particles 2.5 micrometers and smaller)
POC	People of color
STEM	Science, technology, engineering, and mathematics
TCU	Tribal colleges and universities
VMT	Vehicle miles traveled
VTO	Vehicle Technologies Office (DOE)

USING MAPPING TOOLS TO PRIORITIZE ELECTRIC VEHICLE CHARGER BENEFITS TO UNDERSERVED COMMUNITIES

ABSTRACT

Mapping tools can play an important role in incorporating equity into planning, implementing, and evaluating investments in electric vehicle (EV) charging stations, also referred to as EV chargers or electric vehicle supply equipment (EVSE). Federal, state, and local organizations need methodologies for using mapping tools as they pursue equity-focused goals to ensure that the benefits of investments in EV chargers flow to energy and environmental justice (EEJ) underserved communities. This report provides examples of how to apply mapping tools to identify priority locations for installing EV chargers that may benefit EEJ underserved communities through four EV charger planning approaches: corridor charging, community charging, fleet electrification, and diversity in STEM and workforce development. It also explores various methodologies for calculating low-public EVSE density.

Ensuring that the benefits of EV charger investments flow to underserved communities involves prioritizing locally identified needs and incorporating community input when choosing charging station locations. Installing EV chargers in a census tract identified as an EEJ underserved community does not inherently mean that those EV chargers provide benefits to residents of that community. In addition, representatives of historically disadvantaged communities or environmental justice communities have concerns that installing EV chargers in their communities could potentially exacerbate or propagate existing inequities. While the methodologies described in this report may help identify priority census tracts for equity-focused EV charger investment, additional community engagement and site evaluation are necessary to determine whether EV chargers are accessible, affordable, and convenient to EEJ underserved community residents and what benefits the local community is looking to realize with EV charger installations.

This report is the culmination of many discussions with project leaders from DOE-funded projects deploying EV chargers in communities across the nation, organizations representing EEJ underserved communities, state agencies developing EV investment plans, utilities making major EV investments, and DOE national laboratory experts working in transportation electrification. The authors distributed a draft report for peer review, and reviewer comments are summarized in this report. These methodologies are likely to evolve as more EV charger funding programs are implemented and more real-world data is available to measure the effectiveness of strategies for incorporating equity in EV charger deployment projects. Continued efforts to document best practices and critically evaluate whether equity-focused programs achieve their goals are needed as transportation electrification proceeds at the local, regional, and national levels.

1. INTRODUCTION

As the United States (U.S.) sees growing commitment to transportation electrification from government agencies, automakers, public and private sector fleets, utilities, and environmental justice advocates, the conversation on incorporating equity into transportation electrification investments is a pressing priority. The electric vehicle (EV) market has been growing, with EV sales making up 6.1 percent of light-duty[1] sales in November 2021 and 5.8 percent in the fourth quarter of 2021. Automakers continue to announce major investments in EVs, with Toyota, Ford, GM, and Stellantis each announcing plans to invest at least $30 billion to develop EV models by 2030.[2] The U.S. Department of Energy has funded numerous projects over the past decade that deploy electric vehicles and electric vehicle charging stations.

The Bipartisan Infrastructure Law (BIL)[3] passed in November 2021 includes $7.5 billion in funding for vehicle fueling infrastructure, including $5 billion specifically for EV chargers that will put the U.S. on a path to a nationwide network of 500,000 EV chargers. This funding will accelerate equitable adoption of EVs, even by those who cannot reliably charge at home, reduce transportation-related greenhouse gas emissions, and help put the U.S. on a path to net-zero emissions by no later than 2050.[4] Across all programs in the BIL, $8 billion in funding supports zero-emission vehicle-related investments,[5] an additional $32 billion is included for zero-emission vehicles but could also go to other fuel types, and $10.5 billion is available for electric grid technology and battery development, recycling and research.[6] This is more funding for transportation electrification than has previously been announced by federal, state, and local governments and investor-owned utilities (IOUs) combined.

The Justice40 Initiative, established in January 2021 by Presidential Executive Order 14008 on Tackling the Climate Crisis at Home and Abroad,[7] states as a goal that at least *40 percent of the overall benefits of certain federal investments flow to disadvantaged communities (DACs).* The Interim Implementation Guidance for the Justice40 Initiative,[8] released in July 2021, identifies clean transportation as a Justice40 Covered Program and identifies access to EV charging stations as a benefit of a covered program. The interim guidance also identifies this paper's sponsor, the U.S. Department of Energy (DOE) Vehicle Technologies Office (VTO), as a Justice40 Covered Program Pilot to Maximize Benefits to DACs. VTO's

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1 Light-duty vehicles includes passenger cars, like sedans and coupes, as well as other light-duty vehicles, like pickups, minivans, utility vans, and SUVs.

2 United States Electric Vehicle Market Summary: Q3 and Q4 2021, Atlas, 2022, https://atlaspolicy.com/united-states-electric-vehicle-market-summary-q3-and-q4-2021/.

3 President Biden's Bipartisan Infrastructure Law: https://www.whitehouse.gov/bipartisan-infrastructure-law/.

4 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/.

5 This includes the $5 billion National Electric Vehicle Formula Program (Division J), $2.5 billion for zero emission school buses (section 71101), and $0.5 billion for State Energy Programs (section 40109).

6 United States Electric Vehicle Market Summary: Q3 and Q4 2021, Atlas, 2022, https://atlaspolicy.com/united-states-electric-vehicle-market-summary-q3-and-q4-2021/.

7 https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/.

8 https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf.

Justice40 Pilot includes addressing barriers to DACs benefitting from its competitive funding opportunities, improving program investment reporting metrics to enable better measurement of benefits that flow to DACs, and implementing a Clean Cities Energy and Environmental Justice Initiative. While the term DAC is used in Justice40 metrics for measuring benefits, the interim guidance acknowledged that some community members and advocates prefer alternative terminology, such as "overburdened and underserved communities." The DOE Justice40 website[9] and the U.S. Department of Transportation (DOT) Justice40 website[10] were both launched in spring 2022 and detail how each agency is implementing the Justice40 Initiative.

To date, electric vehicle charging investments have historically been deployed in well-resourced, higher-income census tracts with many early adopters. These new investments and the transition from early adopters to broader market adoption bring an opportunity to prioritize equity considerations and ensure that transportation electrification benefits all Americans. Existing EV charger deployment strategies may not prioritize rural, underserved, and disadvantaged communities as primary locations for installing EV chargers. However, those communities often experience high transportation energy costs, high exposure to air pollution with corresponding public health issues, and lack of access to clean and reliable transportation, and they are affected first and worst by climate impacts.

New government and utility investments in transportation electrification can help remedy historical injustices and inequities by prioritizing the benefits of investing in EV charging stations for *environmental and energy justice* (EEJ) underserved communities, which may include rural, underserved, overburdened, disadvantaged, or environmental justice communities. According to the Initiative for Energy Justice, *energy justice* is the "goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those disproportionately harmed by the energy system."[11] According to the Environmental Protection Agency (EPA) *environmental justice* is the "fair treatment and meaningful involvement of all people, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[12] *EEJ* refers to the combined goals of energy justice and environmental justice. This report uses a working definition of *EEJ underserved communities* as "communities at the front line of pollution and climate change, communities with high energy expense or fossil dependence, indigenous communities, and those historically overburdened by racial and social inequity."[13] This is a variation of the energy justice definition provided by the Initiative for Energy Justice.[14]

In this report, we explore four EV charger planning approaches: corridor charging, community charging, fleet electrification, and diversity in STEM and workforce development. We document these approaches to prioritizing EV charging station benefits to EEJ underserved communities using mapping tools developed through robust stakeholder engagement with

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9 https://www.energy.gov/diversity/justice40-initiative.

10 https://www.transportation.gov/equity-Justice40.

11 https://iejusa.org/.

12 https://www.epa.gov/environmentaljustice/learn-about-environmental-justice.

13 Working definition of EEJ underserved communities was developed by Erin Nobler, NREL, in support of the DOE Vehicle Technologies Office.

14 https://iejusa.org/.

industry leaders. The objectives used in the four approaches intersect and can be customized to meet specific energy and environmental justice goals. Approach objectives include:

- Build a nationwide network of FHWA-designated EV corridors;
- Accelerate equitable adoption of EVs, including for those who cannot reliably charge at home;
- Implement the Justice40 goal that 40% of overall benefits of Federal investment in EV charging flow to DACs;
- Identify priority census tracts for DCFC placement within 1 mile of EV corridors that benefit nearby EEJ underserved communities;
- Identify priority census tracts for community EV charging (Level 2 and/or DCFC) that benefit nearby EEJ underserved communities;
- Decarbonize the transportation sector including fleet vehicles that operate in EEJ underserved communities;
- Increase diversity in science, technology, engineering, and mathematics (STEM) jobs through EV charger placement; and
- Increase workforce development opportunities for EEJ underserved communities through EV charger placement.

This report is the culmination of many discussions with project leaders from DOE-funded projects deploying EV chargers in communities across the nation, organizations representing EEJ underserved communities, state agencies developing EV investment plans, utilities making major EV investments, and DOE national laboratory experts working in transportation electrification. In addition to stakeholder discussions, the authors distributed a draft report for peer review, and reviewer comments are summarized in several places in this report. The authors use "stakeholders" to refer to the discussion participants, advisors, and reviewers whose input has informed the report content and use "reviewers" to refer more narrowly to the people who have reviewed and provided comments during the peer review process.

A screening map can be a powerful tool for visualizing where EEJ underserved communities are located, targeting communities for EV outreach and education efforts, developing funding program eligibility requirements, and evaluating which communities are benefiting from funding program investments. Each of these approaches may be relevant at a different stage of planning and implementing an EV charger funding program. There is no one-size-fits-all approach to prioritizing EV charger benefits for EEJ underserved communities. Each state or local region is composed of distinct communities with unique individuals who have their own set of needs and priorities. This report seeks to offer various customizable ways in which a state or local government can define EEJ underserved communities and identify where EV chargers will benefit those EEJ underserved communities that will best suit their particular geographic area.

While there are significant barriers to requiring that funding should benefit certain EEJ underserved communities when developing a funding program, many organizations are working to create innovative approaches to incorporating equity considerations into funding programs. It is challenging to define EEJ underserved community boundaries, quantifiably measure benefits of EV charger installations to EEJ underserved communities, collect information needed to calculate those benefits before selecting funding recipients or EV charger sites, and navigate conflicting perspectives on if or how equity can be a part of an EV charger funding program. Organizations managing funding programs could require equity-related data tracking and metrics reporting for funded projects, even if equity considerations are not part of an application selection criteria. Requiring data collection at the beginning of a funding program can enable future program evaluation, potentially reveal bias in a program structure, and inform revisions to how a funding program is structured.

2. AN OPPORTUNITY TO PRIORITIZE EQUITY AS PART OF GOVERNMENT INVESTMENT IN EV CHARGING STATIONS

Equity can serve as a priority consideration for government investment in public EV charging stations to help remedy historical inequities of benefits and burdens from the transportation and energy systems for EEJ underserved communities. An effort to incorporate equity from the beginning of a new government funding program can intentionally align investments to address current injustices and avoid future potential injustices in the transportation system. Developing an EV charger funding program that prioritizes benefits to EEJ underserved communities can lead to complex and difficult-to-answer questions about identifying underserved communities and EV charger locations that most benefit those communities. While this paper does not address all these difficult questions, it does provide examples of mapping data layers for visualizing EEJ underserved communities, public EVSE density, and other relevant data that could be used to identify priority census tracts for EV charger investments.

Difficult EV charger equity questions might include the following:

a) How is an EEJ underserved community defined and prioritized?

b) What is the spatial granularity for identifying an EEJ underserved community (e.g., county, zip code, census tract, census block)?

c) What is the methodology for determining whether a public EV charger is accessible, affordable, and convenient to residents from EEJ underserved communities?

d) What is the methodology for determining whether a particular business that hosts a public EV charger represents an EEJ underserved community?

e) Where will the emissions benefits from increased EV adoption be found based upon a proposed group of EV charger sites?

The BIL appropriated $5 billion for the National Electric Vehicle Infrastructure (NEVI) Formula program, which provides dedicated funding to states to strategically deploy EV charging infrastructure. In February 2022, the Federal Highway Administration (FHWA) released The NEVI Formula Program Guidance,[15] which states that the NEVI Formula program will support the Justice40 Initiative. The NEVI Program Guidance uses the DOE and DOT joint interim definition of DACs and the interactive EV Charging Justice40 Map hosted on the EV Charging Equity Considerations webpage by Argonne National Laboratory.[16] The joint interim definition uses publicly available data sets that capture vulnerable populations, health issues, transportation access and burden, energy burden, fossil dependence, resilience, and

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15 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf.

16 https://www.anl.gov/es/electric-vehicle-charging-equity-considerations.

environmental and climate hazards. The joint interim definition for the NEVI program includes three components:

1. Combined census tracts from DOT's working DAC definition and DOE's working DAC definition
2. Tribal lands
3. U.S. territories

In February 2022, the White House Council on Environmental Quality (CEQ) released a beta version of the Climate and Economic Justice Screening Tool (CEJST) for public feedback.[17] The CEJST is designed to help agencies identify DACs for the Justice40 Initiative goal to ensure that everyone is receiving the benefits intended from federal programs.

17 https://www.whitehouse.gov/ceq/news-updates/2022/02/18/ceq-publishes-draft-climate-and-economic-justice-screening-tool-key-component-in-the-implementation-of-president-bidens-justice40-initiative/.

3. IDENTIFYING, MEASURING, AND MAXIMIZING BENEFITS OF EV CHARGER DEPLOYMENT TO EEJ UNDERSERVED COMMUNITIES

Identifying, measuring, and maximizing benefits to EEJ underserved communities from government investments in EV chargers is challenging. While placing EV chargers in or near an EEJ underserved community can result in benefits to community residents, it does not inherently do so. Throughout EEJ stakeholder engagement efforts, numerous stakeholders recounted examples where an EV charger was placed in a census tract identified as a DAC in a screening tool, yet the EV charger was not accessible, affordable, and/or convenient to community residents and did not benefit those residents. For example, placing an EV charger in an industrial complex, hotel, or workplace that is in a DAC, but not accessible to DAC residents does provide EV charging opportunities to those residents. Additionally, a DCFC that has a high cost to for charging a vehicle may not be an affordable EV charging solution for low-income residents who do not have access to home charging. Community engagement and incorporating input from underserved communities when identifying EV charger locations and determining charging payment structures can ensure that EV chargers placed in DACs are accessible, affordable, and convenient to community residents or convey other benefits to DAC residents (e.g., economic, public health). Funding programs can maximize the benefits and minimize the negative impacts of deploying EV chargers in EEJ underserved communities by requiring entities applying for or managing project funding to consider the benefits and impacts to EEJ underserved communities at the beginning of their planning efforts, throughout community engagement efforts, during the EV charger site selection process, when reporting EV charger utilization data, and as part of project evaluation expectations.

A recurring theme during discussions with EEJ stakeholders is the importance of taking time to engage with communities, understand a community's priorities, and include the community in identifying goals for how a project or program can benefit that community. Applying this approach to EV charger funding programs involves educating a community about the possible benefits and drawbacks to installing EV chargers and choosing a local plan for EV charger investment based on community input. It may also involve general outreach and education about EV adoption, such as available EV models, EV charging basics, current and planned public EV charger locations, EV total cost of ownership, and financial incentives. A primary reason a community may not benefit from EV chargers is that most residents who drive may not currently be driving EVs. Closing this gap requires a parallel effort, with appropriate funds, to address community vehicle and mobility needs (e.g., EV purchase incentives, low interest loans, EV car sharing, rebates for trading in old gasoline-powered vehicles, encouraging community purchase of used EVs, etc.). Community engagement could also include recruiting participants for electrician training programs, such as the Electric Vehicle Infrastructure Training Program (EVITP), so that community members can benefit from job opportunities related to installing or maintaining EV chargers.[18]

Authentic community engagement requires spending time building community trust and developing relationships. It is difficult to effectively incorporate that process into typical

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[18] https://evitp.org/training/.

government funding program structures and may require innovative approaches. One example of an innovative approach is California Air Resource Board's Sustainable Transportation Equity Project (STEP).[19] This pilot takes a community-based approach to overcoming barriers to clean transportation. STEP incorporated equity in its mission, process, outcomes, and evaluation by using Greenlining Institute's Mobility Equity Framework.[20] See Appendix A for more information about the STEP structure. The FHWA guide, Public Involvement Techniques for Transportation Decisionmaking[21] outlines that meaningful community engagement entails not just simply holding events, but also acting on public comments and feedback and that community engagement should be planned with respect to the ability for community members to attend and participate in public events. The list below describes guiding principles for meaningful engagement with underserved communities developed through stakeholder discussions.

Guiding Principles for Meaningful Engagement with Underserved Communities

1. Take into account the barriers specific communities might face in participating in the EV charging planning and implementation process.
2. Receive input on how to design effective community engagement efforts with disadvantaged communities in the state.
3. Provide foundational information to disadvantaged community members that will equip them to actively provide feedback for EV charging decisions (e.g., EV outreach and education).
4. Learn about which benefits of EV charging deployment community members prioritize in the state.
5. Receive feedback on EV charging siting, workforce development and contracting efforts from communities.
6. Reflect to community members how the feedback and input is being used to make decisions.
7. Make decisions in concert with community members.
8. Communicate progress on EV charging plan design and deployment efforts.
9. Evaluate how community members are receiving benefits as plans are being implemented.
10. Mitigate potential negative impacts of greatest concern to communities.
11. Update EV charging plans based on initial experiences and feedback from communities on EV charging implementation efforts.
12. Publicly summarize input received from community engagement efforts.

Public-facing reports describing community engagement efforts ideally include the following components:

- Summarize input received from stakeholders,
- Describe how input is being used to inform decision making on siting or program design regarding contracting, job training and hiring,

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19 https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program-1.

20 http://greenlining.org/publications/2018/mobility-equity-framework/.

21 https://www.fhwa.dot.gov/planning/public_involvement/publications/pi_techniques/index.cfm

- Report out how the funding program was evaluated and if benefits are being received by communities, both self-reported and community-reported, and
- Describe how the funding program will be course-corrected based on the assessment of equitable distribution of benefits.

Benefits to EEJ Underserved Communities from EV Charger Deployment

Examples of benefits to EEJ underserved communities from government investments in EV chargers identified through stakeholder discussions and drawing upon the DOE Justice40 policy priorities[22] are described below. There may be other priority benefits identified through community engagement that are not included in this list. While this list encompasses general EV charger benefits, there may be a distinction between the benefits from EV chargers designed primarily for personally owned light-duty vehicle charging (e.g., sedans, pickup trucks), light- and medium-duty fleet vehicle charging (e.g., taxi, shuttle bus, delivery van), or heavy-duty fleet vehicle charging (e.g., transit bus, long-haul truck).

A. **Enabling EV ownership and corresponding operating cost savings** by installing EV chargers in current charging deserts (geographic areas with no or insufficient access to public EV charging), especially for residents who do not have access to home EV charging
    i. Accessible for evening or overnight charging to residents without access to home EV charging (e.g., multi-family housing (MFH) EV charging, public curbside/right-of-way charging, community charging hubs, other overnight charging locations)
    ii. Convenient opportunity charging at locations frequented by community members within a reasonable distance from home, work, or shopping (e.g., grocery store, recreation attractions, parks, libraries, community spaces)
    iii. Workplace charging for people who live in or work in EEJ underserved communities (can be public access, private access, or a combination)
B. **Providing clean transportation mobility systems** and **transportation access** through EV chargers installed for public transportation, first/last mile solutions, and EV car sharing, which may also **increase community EV awareness**
C. **Improving public health** by **reducing local transportation emissions** (i.e., electrifying vehicle fleets that contribute to poor air quality, thereby mitigating harmful effects on public health from poor air quality)
D. **Fostering business opportunities and clean energy enterprise creation** through attracting customers to locally owned businesses while their vehicle charges, increasing product demand for EV and EV charger manufacturers, creating opportunities for local start-up businesses in the EV or EV charger space, revenue generation from charging sessions, EV ride-hailing, etc.

[22] https://www.energy.gov/diversity/justice40-initiative

E. **Increasing the clean energy job pipeline** and creating workforce opportunities in conjunction with job training for EV technicians, electricians installing or maintaining EV chargers, etc.

F. **Enhancing community energy resiliency, decarbonization, and diversification** by investing in electrical service upgrades and incorporating distributed energy resources (e.g., solar, batteries) when developing EV charger projects to provide broad community benefits that may align with energy resiliency, decarbonization, and diversification goals.

Table 1 shows example metrics that could be used when considering how to quantify the benefits of government investments in EV chargers that flow to DACs for the Justice40 initiative. Some of these metrics may be more relevant or less relevant based on community priorities, the EV charging deployment approach (e.g., corridor charging or community charging) and equity objectives.

TABLE 1 Example metrics for measuring benefits of investments in EV chargers for the Justice40 Initiative

Example Benefits	Example Metrics for Measuring Benefit[23]
A. Enabling EV ownership and corresponding operating cost savings	• Net petroleum fuel reduced displaced by electric transportation in DACs [GGe] • Dollars saved [$] in transportation petroleum fuel costs for DACs.
B. Providing clean transportation mobility systems and transportation access	• Number of EV charging infrastructure installed in or near DACs or the increase in density of EV chargers.
C. Improving public health by reducing local transportation emissions	• Reduce environmental exposures to transportation emissions in DACs based on EV registration data (modeling tools may need to be developed to calculate this metric) • Reduce environmental exposures to transportation emissions in DACs from EVSE deployment (modeling tools may need to be developed to calculate this metric)
D. Fostering business opportunities and clean energy enterprise creation	• Dollars spent [$] on EV charging infrastructure owned by or providing revenue to organizations located in DACs • Number of and % of EV charging infrastructure owned by organizations located in DACs • Number of and % of EV charging infrastructure owned that provide revenue to organizations located in DACs

[23] These example metrics were developed in collaboration with NREL staff including Monisha Shah, Alana Wilson, and Erin Nobler.

E. Increasing the clean energy job pipeline	• Dollars spent [$] on job training programs for participants from DACs • Number of participants from DACs in job training, apprenticeship, and STEM education programs. • Number of hires or jobs created resulting from DAC installation or related job growth opportunities. • Number of contracts and/or dollar value [$] awarded to small businesses that are principally owned by women, minorities, disabled veterans, and/or LGBT persons such as charging station service providers.
F. Enhancing community energy resiliency, decarbonization, and diversification	• Number and size (in megawatt hour) of community resilience infrastructure deployed in DACs (e.g., potentially pairing EV charging infrastructure with distributed solar and/or battery energy storage or as part of a microgrid). • Stakeholder investments in increased electrical service to DACs to prepare sites for NEVI investments in EV charging infrastructure (e.g., dollars spent [$], # of EV charging infrastructure locations affected, utility filings to increase electrical service in DACs) • Stakeholder investments in electrified transportation hubs in DACs co-located with NEVI investments in EV charging infrastructure such as shared electric micromobility devices (e.g., dollars spent [$], # of EV charging infrastructure locations affected)

Disbenefits to EEJ Underserved Communities from EV Charger Deployment

Installing EV chargers in EEJ underserved communities can also result in various disbenefits or negative impacts. Incorporating equity in EV charging projects includes minimizing disbenefits and ensuring that communities that will be affected by the EV chargers are able to participate in decisions that affect potential disbenefits. Communities may have concerns over EV chargers impacting traffic congestion, safety, or transportation access. An additional potential disbenefit is increased electricity rates to pay for upgrades to electrical service to accommodate the EV charger load on the grid. Installing EV chargers and restricting nearby parking spaces to EVs can reduce the available parking spaces for other vehicles. There could be community concerns regarding negative environmental impacts from installing EV chargers in specific locations, such as disturbing an ecologically sensitive area when installing underground electrical conduit connecting an EV charger to the electrical service. Local permitting or National Environmental Policy Act (NEPA) review can screen for environmental issues but talking with community members during the planning process and avoiding these areas can minimize the need for complex environmental assessments. Another potential disbenefit is gentrification-induced displacement in which residents can no longer afford to live in their neighborhood due to rising housing costs.[24]

Community engagement with members of or organizations representing underserved communities early in the process is necessary to understand community concerns and plan EV charger locations with a focus on minimizing the potential disbenefits. EV charging projects can be designed such that the overall benefits of making EV charging more convenient, accessible, affordable, reliable, and equitable vastly outweigh potential disbenefits.

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[24] https://sites.utexas.edu/gentrificationproject/understanding-gentrification-and-displacement/.

4. MAPPING TOOLS TO MEASURE/ASSESS EV CHARGING EQUITY

Government agencies and other planning entities can use mapping tools to incorporate equity when planning investments in EV charging. Various federal, state, and local government agencies may have different equity metrics, and each geographic area has a unique landscape for how historical transportation and energy injustices affect local EEJ underserved communities, so there is no single approach or step-by-step guide for incorporating equity into a government EV charger funding program that will work best for every community.

Mapping tools are critical for achieving EV equity. (The Energy Zones Mapping Tool, https://ezmt.anl.gov/, was used for this report, but multiple mapping tools are available). This report describes approaches to prioritizing benefits to EEJ underserved communities from government investments in EV chargers as well as specific scenarios. The authors based these approaches and scenarios on findings from VTO-funded projects deploying EV chargers that benefit EEJ underserved communities and subsequent stakeholder engagement. The authors also conducted a series of discussions with leading experts on transportation electrification equity and using mapping tools for EV charging equity. Input from these exchanges and written comments from reviewers helped make this report a summary of many perspectives on how to incorporate equity into EV charger funding programs. This is not an exhaustive review of the possible approaches for using mapping tools for EV charging equity, nor is it formal guidance for how to manage government funding. Appendix B provides a list of additional resources that stakeholders recommended for considering equity in transportation electrification.

Equity Guiding Principles for Developing a Government EV Charger Funding Program

1. Determine the targeted EEJ underserved communities for EV charger benefits.
2. Incorporate community education, outreach, engagement, and capacity building into the program.
3. Empower communities to co-create the process for community engagement, identify which EV charger benefits they want, voice their concerns about disbenefits, and express their preferences for potential EV charger locations.
4. Identify an equity goal(s) and metrics for measuring progress toward that goal, incorporating community engagement findings.
5. Actively avoid causing disbenefits that would exacerbate existing injustices or cause new injustices in EEJ underserved communities (e.g., increased traffic congestion, gentrification-induced displacement, decreased access to transportation services).
6. Identify synergistic funding sources or programs that could provide comprehensive solutions that meet community needs and maximize community benefits beyond the traditional scope of an EV charger funding program (e.g., making EVs available more broadly, providing electrician training, establishing electrified multi-modal transportation hubs).
7. Require equity-related data tracking and metrics reporting for funded projects. Implement annual program evaluations by measuring equity metrics and tracking progress towards equity goals. Make adjustments to the funding program as needed to ensure planned benefits are realized and disbenefits are mitigated.

5. PUBLIC EVSE DENSITY CALCULATION OPTIONS

Public EV charger density is an often-used metric to quantify community EV charger accessibility and identify which communities would most benefit from EV charger investments. EV chargers are also referred to as electric vehicle supply equipment (EVSE), especially when referring to the quantity of ports for vehicle charging at a single EV charging station. Measuring **public EVSE density** and identifying a threshold for low public EVSE density can provide a definition for a "**charging desert**." Showing low public EVSE density on a mapping tool with layers that identify underserved communities can provide meaningful information for EV charger planning and siting efforts.

However, there are several ways to quantify EV charger density for a given census tract. This section describes multiple methodologies for measuring EVSE density while taking into consideration the differences between urban and rural settings. EVSE density calculations are based on **the quantity of EVSE ports**, not the quantity of EV charger station locations or EV charger connectors. An EVSE port provides power to charge only one vehicle at a time even though it may have multiple connectors. Locations and quantities of EVSE ports used in this analysis are from the Alternative Fuel Data Center (AFDC).[25] Since Tesla chargers use an EVSE connector standard that is only compatible with Tesla vehicles and therefore not accessible to all EV drivers, these methodologies exclude Tesla chargers.[26] This document uses the term *EVSE* when referring specifically to quantities of EVSE *ports* or metrics based on quantities of EVSE ports (public EVSE density). Otherwise, it uses *EV charger(s)* and *EV charging*.

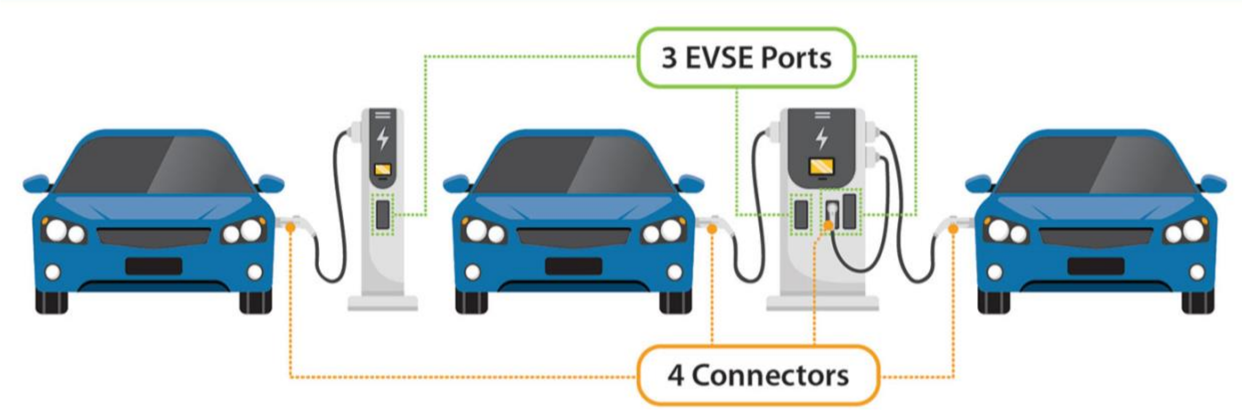

FIGURE 1 EVSE Ports vs connectors vs station location. At one EV charging station location, there can be multiple EVSE ports that provide power to charge a vehicle. Multiple connectors can be available on one EVSE port (e.g., offering two different connector standards), but only one vehicle will charge at a time. (Image Source: Alternative Fuels Data Center[27])

25 Data used in this analysis were downloaded from https://afdc.energy.gov/stations/ on January 31, 2022.

26 Throughout this report, measurements of public EVSE ports exclude Tesla chargers unless stated otherwise.

27 https://afdc.energy.gov/fuels/electricity_infrastructure.html.

Overview of Public EVSE Density Calculation Methodologies

This report presents multiple ways to calculate public EVSE density, each of which has strengths and weaknesses. Different methodologies may be more or less appropriate based on the specific analysis goals and the current state of EV charging deployment (Table 2).

TABLE 2 EVSE density methodology, data required, and key takeaway.

Method	Data Required	Key Takeaway
Number of EVSE ports within a given distance	EV charger locations and counts	Prioritizes convenient walking distance but uses a radius measurement and is limited by natural barriers
EVSE ports per traffic activity or roadway length	EV charger locations and counts, traffic volume, roadway	Prioritizes high traffic locations and communities that can benefit from transportation emission reduction
EVSE ports/vehicle stock	EV charger locations and counts, vehicle registration	Prioritizes the locations that have higher residential charging potential with increasing EV penetration
Areas with or without access to EVSE ports	EV charger locations and counts, roadway network	Best applicable for urban areas where the expectation is walking to at least one public EVSE
Number of public EVSE ports within 15 driving minutes	EV charger locations and counts, roadway network	Best applicable for rural or suburban areas where the expectation is driving to public EVSE
Number of public EVSE ports within 15 walking minutes	EV charger locations and counts, roadway network	Best applicable for urban areas where the expectation is walking to public EVSE
EVSE ports/population	EV charger locations and counts, population	Not recommended since it may lead to overestimation of charger availability/access
EVSE ports/area	EV charger locations and counts, area	Not recommended since it may lead to underestimation of charger availability/access

Calculating Public EVSE Density

Here we suggest several public EVSE density methodologies for different deployment priorities, using publicly available data. The number of public EVSEs within 15 driving and walking minutes by census tract can be downloaded from the Argonne website.[28]

1. **Number of EVSE ports within a given distance:** From each public EVSE port, we first identify the census tracts falling within a 0.3-mile straight-line distance (not walking distance).[29] Then we estimate the number of chargers that are reachable in each census tract. A simplified version of the isochrone-based approach described below is to use a fixed distance. Like that metric, this metric prioritizes locations for improving the convenience of accessing charging stations in urban areas. Each census tract will be considered able to access the EVSE port if the population centroid falls within a given distance range, 0.3 miles in Figure 2. This is computationally simple to quantify for anywhere in the United States. However, natural barriers (e.g., rivers) or roads not accessible to pedestrians could block actual EV charger accessibility, and this would not be captured in this metric.

[28] https://www.anl.gov/es/transportation-energy-equity-analysis-and-resources.

[29] The census tract is included if the population centroid falls into the 0.3 miles range.

2. **EVSE ports per traffic activity or roadway length:** Normalizing EVSE ports by the total traffic activity or roadway length can help identify the communities that can benefit from emission reduction due to transportation electrification. Tailpipe vehicle emissions from existing gasoline vehicles are highly correlated with the geospatial distribution of vehicle miles traveled (VMT). Therefore, these communities would benefit from switching the vehicle fuel to electricity. If the VMT at the census tract level are difficult to quantify, then traffic volume could be used instead.

3. **EVSE ports/vehicle stock:** Normalizing EVSE ports within a given driving distance by the total number of vehicles (all passenger vehicles, not just EVs) registered in or near the census tract, shown in Figure 2, may present a problem similar to that produced by normalizing by population (see page 23 and Figure 6). However, if the objective is to deploy EV chargers for future EV growth based on where passenger vehicles are registered, this metric prioritizes the locations that have higher residential charging potential with increasing EV penetration. Although vehicle stock is highly correlated with the population, urban areas have lower vehicle stock per capita while the equivalent figures in rural areas are higher. Note that vehicle stock does not include the vehicles coming from communities different from the one they are operating in, such as ride-sharing vehicles or through traffic.

4. **Areas with or without access to EVSE ports:** Mapping the area within a given walk/drive from each EVSE port identifies locations that have access to at least one EVSE port and those that do not. Figure 3 shows the locations in the Washington D.C. area within an 8-minute walk of at least one publicly accessible EVSE port (Level 2 or DCFC). For a rigorous quantitative analysis of the population that could be served by these charging stations, a detailed population assessment at the census block level would probably be necessary.

5. **Number of public EVSE ports within 15 driving minutes:** Quantify the public EVSE density for a rural area by calculating the number of public EVSE ports within a 15-minute *drive* of the population centroid of the census tract,[30] shown in Figure 2. For rural analysis, stakeholders suggested focusing on high-power direct current (DC) fast chargers (DCFCs), which can charge a vehicle in under an hour. The analysis shown in this report quantifies the number of public EVSE ports (both L2 and DCFC) within a 15-minute drive of census tract population centroids across the country. Future analysis should separate the EVSE ports by charging level and speed depending on the objective.

   The 15-minute threshold was chosen because it provides reliable accuracy for a range of census tract geographic sizes (described further below). Additionally, using the U.S. Department of Transportation's 2017 National Household Travel Survey (NHTS),[31] the

[30] The center of population (centroid) is the point at which an imaginary, weightless, rigid, and flat (no elevation effects) surface representation of the 50 states (or 48 conterminous states for calculations made prior to 1960) and the District of Columbia would balance if weights of identical size were placed on it so that each weight represented the location of one person. This concept as used by the U.S. Census Bureau is that of a balance point.

[31] https://nhts.ornl.gov/.

average driving time to go to/from buying goods was 16 minutes each way[32]. However, other thresholds can be considered. The 15-minute travel radius was determined by generating fixed-travel-time isochrones[33] using the API from TravelTime.com, assuming travel at non-peak traffic hours. The number of EVSE ports within each isochrone was determined for each census tract in the United States, using the population-weighted centroid location.

6. **Number of public EVSE ports within 15 walking minutes:** Quantify the public EVSE ports within a 15-minute *walk* [34] of the centroid of the census tract for urban areas, shown in Figure 2. For urban analysis, we consider that residents can park their cars and walk to their homes, returning to a fully charged vehicle. The analysis shown in this report quantifies the number of public EVSE ports (both L2 and DCFC) within a 15-minute walk of the population-weighted centroid of each census tract in the United States. A 15-minute threshold was chosen because the corresponding average walking time to go to/from buying goods (from the 2017 NHTS) was 11-12 minutes each way. The average time to walk to change transportation mode was 12-14 minutes each way. Again, a different threshold could be considered to ensure comfortable walking distance. Similarly, stakeholders suggest separating the EVSE ports by charging level (e.g., Level 2 and DCFC) depending on the objective.

[32] This is not a gas-station-specific analysis. Trips include all shopping.

[33] Isochrone maps typically depict the area accessible from a point within a certain time or distance threshold. Driving rate of travel is restricted by the speed limit and traffic conditions of the road network.

[34] Walking rate of travel is walking speed.

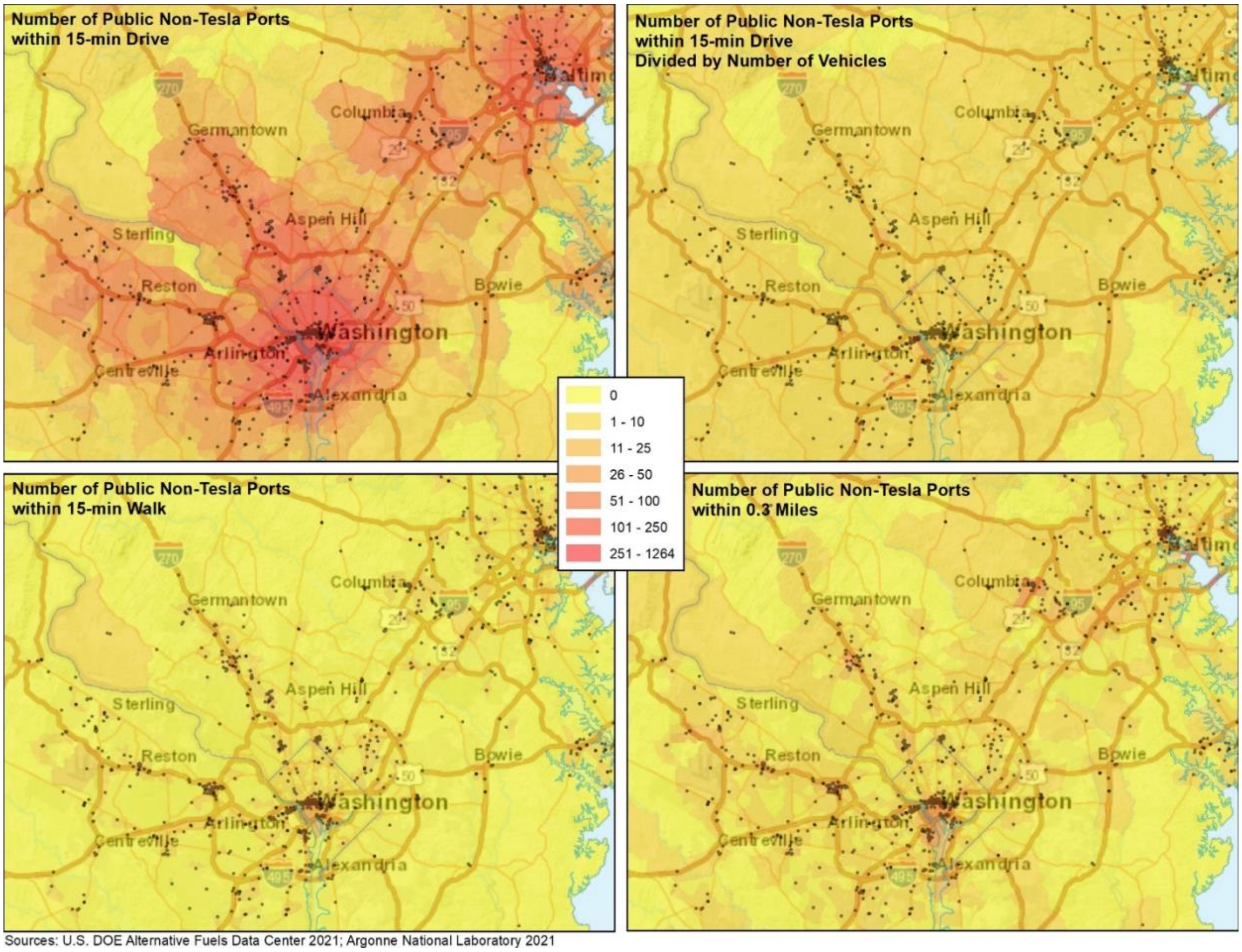

FIGURE 2 Applying density calculation methodologies to public EVSE density in the Washington D.C.–Maryland–Virginia region (dots indicate EV charger locations). Upper left: Number of public EVSE ports within 15 driving minutes. Upper right: Number of public EVSE ports within 15 driving minutes divided by number of vehicles registered (all passenger vehicles, not just EVs). Bottom left: Number of public EVSE ports within 15 walking minutes. Bottom right: Number of public EVSE ports within 0.3 miles.

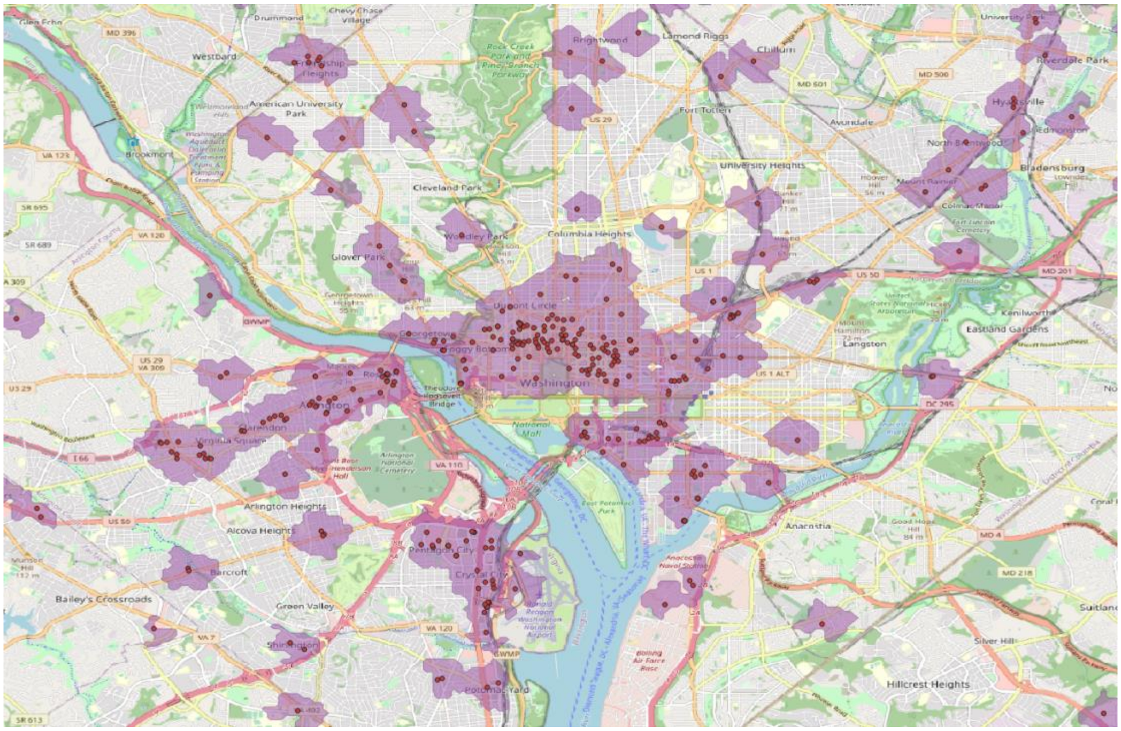

FIGURE 3 Areas within an 8-minute walk of each public EVSE in Washington D.C. metropolitan area (dots indicate EV charger locations).

Take the Washington D.C. region as an example. As shown in the top left section of Figure 2, the number of public EV chargers within 15 driving minutes in this urban area is high. Accessibility does not seem to be an issue in the city, so improving convenience might be a better focus to ensure that EVSE ports are within *walking* distance of drivers' homes or preferred destinations. Therefore, the number of public EVSE ports within 15 walking minutes is more suitable for an urban area, while the number of public EVSE ports within 15 driving minutes is better for non-urban areas. Figure 4 gives a closer look of the number of public EVSE ports within 15 walking minutes in Washington D.C.

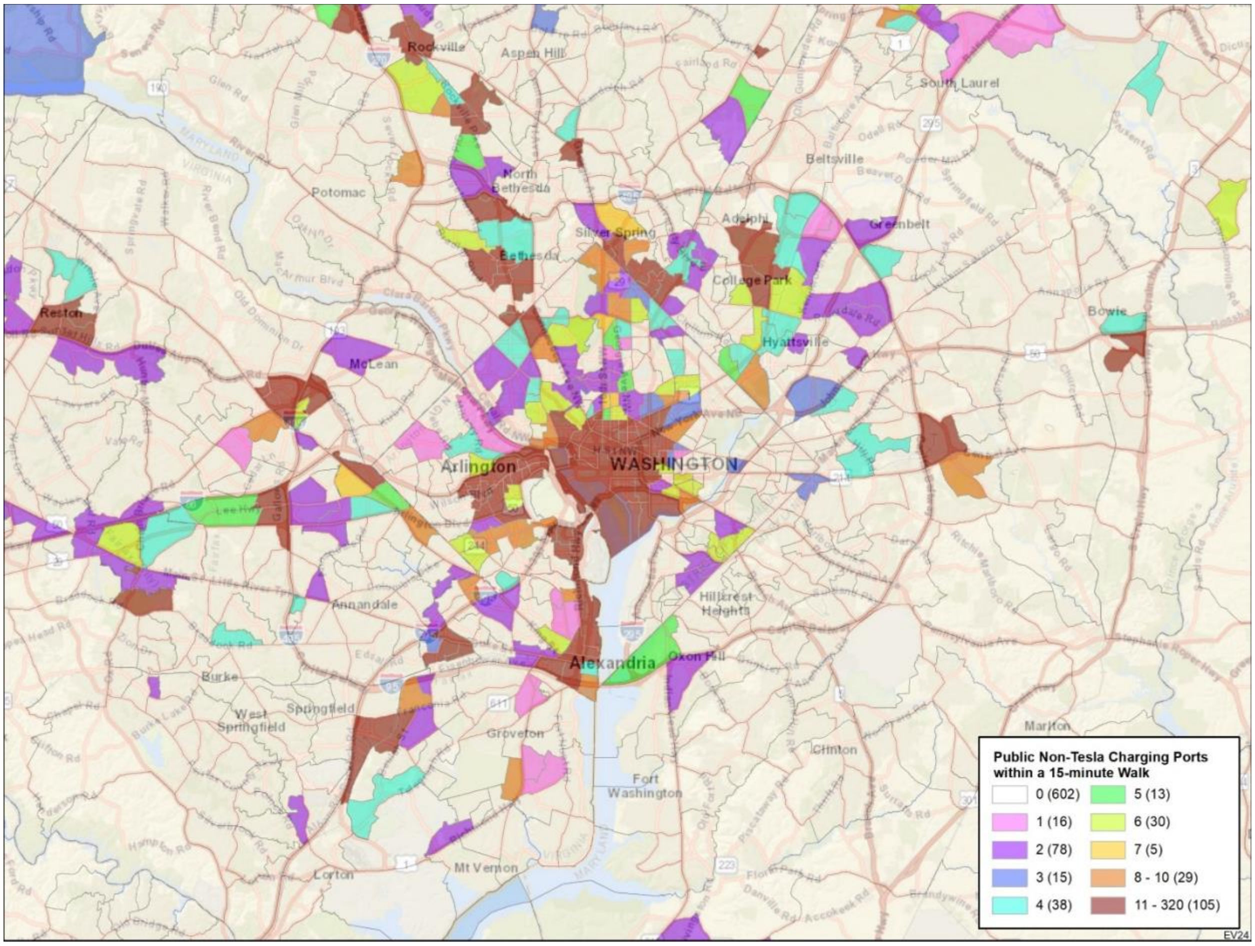

FIGURE 4 Number of public EV chargers within 15 walking minutes in Washington D.C., starting from the population center of the census tract.

The authors are not suggesting 15 minutes is always a convenient or preferred amount of time to walk or drive to reach EV charging, but we instead use it as a comparative metric. We used the population centroid of the census tract as the representative point to quantify the accessible number of EVSE ports. However, some census tracts might be large enough to take 15 minutes to travel from one side to the other. We used 15 minutes as the example for this analysis since it is the smallest unit of time that can be used with reliable accuracy across the country to provide a comparable measurement for the quantity of EVSE ports accessible to residents in a census tract. Choosing a smaller unit of time, such as five minutes, could reduce the accuracy or consistency of the EVSE density measurement. For example, Figure 5 below represents a census tract that requires 15 minutes to travel from one end to the other. The EV charger is a 5-minute travel time from Home A and a 15-minute travel time from Home B. However, since the EV charger is seven minutes from the centroid, it would not be counted when measuring the number of EV chargers within a 5-minute travel time of the centroid. A shorter travel time could be used in geographic areas where the census tracts require a shorter time to travel from one end to the other.

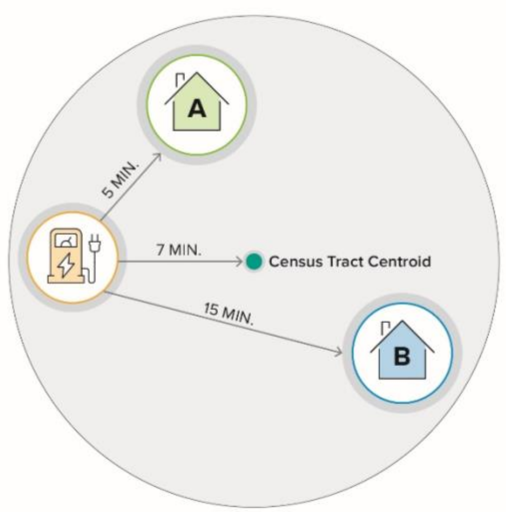

FIGURE 5 Travel time from census tract centroid. Using a 15-minute travel time from the population centroid of the census tract identifies one EV charger in this census tract, while choosing a 5-minute travel time would identify no EV chargers.

Calculation Methods Resulting in Underestimation or Overestimation

- **EVSE ports/population:** Locations with tiny populations will have high normalized numbers, which may lead to **overestimation** of charging availabilities/access and result in benefits not going to the target community. For example, as shown in Figure 6, Kiowa County in Kansas has a population of less than 2,500 residents and several EVSE ports at a single location, a museum. This makes the EVSE ports per 100,000 people relatively high. However, it does not represent how EV chargers are distributed geographically and communities nearby may not have convenient access to that location and the chargers.

- **EVSE ports/area:** When dividing the total number of EVSE ports by the area (square mile), then the variation in the normalized value becomes small, which may lead to **underestimation** of charging availabilities/access (i.e., most communities will have close to zero EVSE density except a few metropolitan areas). Figure 7 shows large areas that have close to zero EVSE density in the U.S.

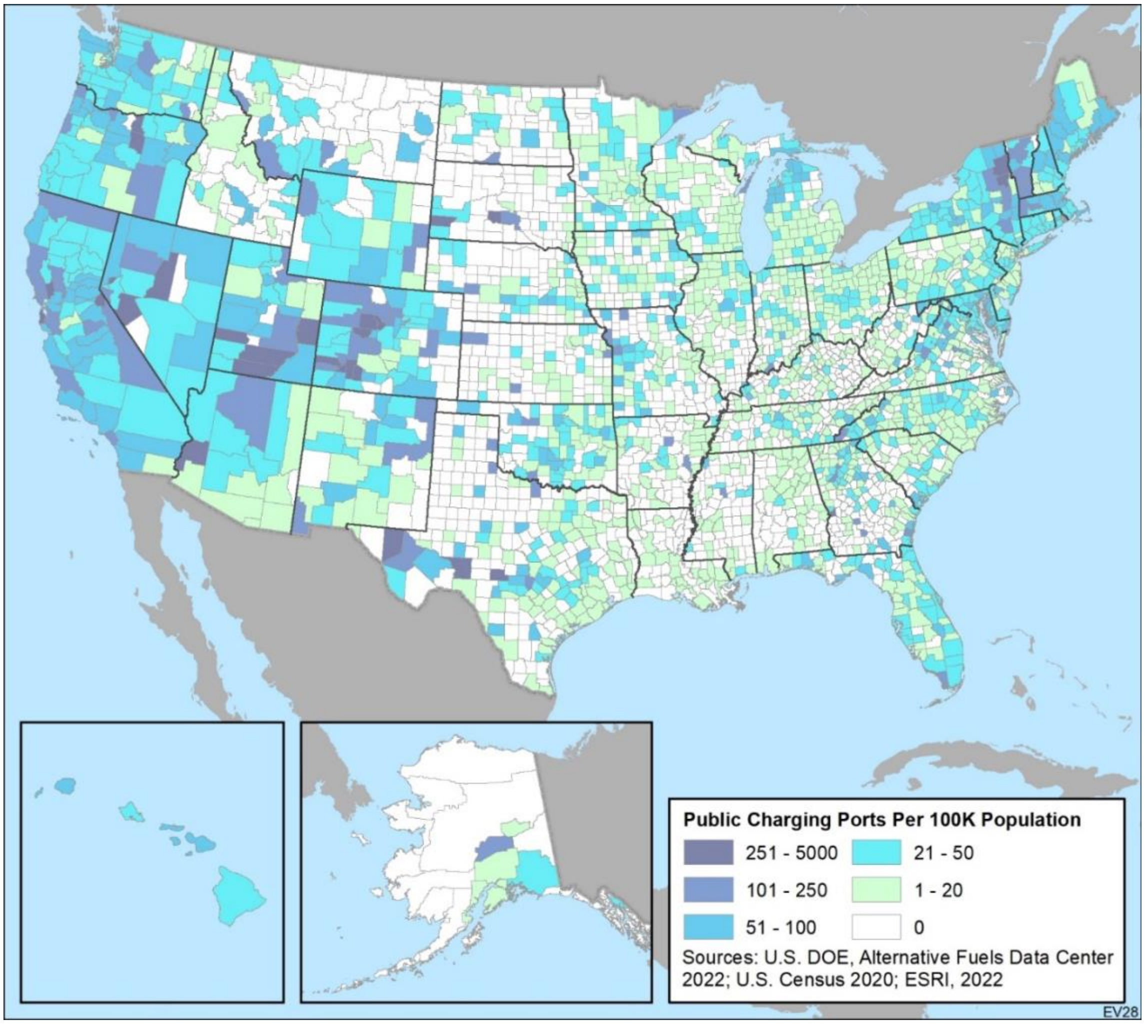

FIGURE 6 Number of public EVSE ports per 100,000 population in each U.S. county (Tesla ports are included).

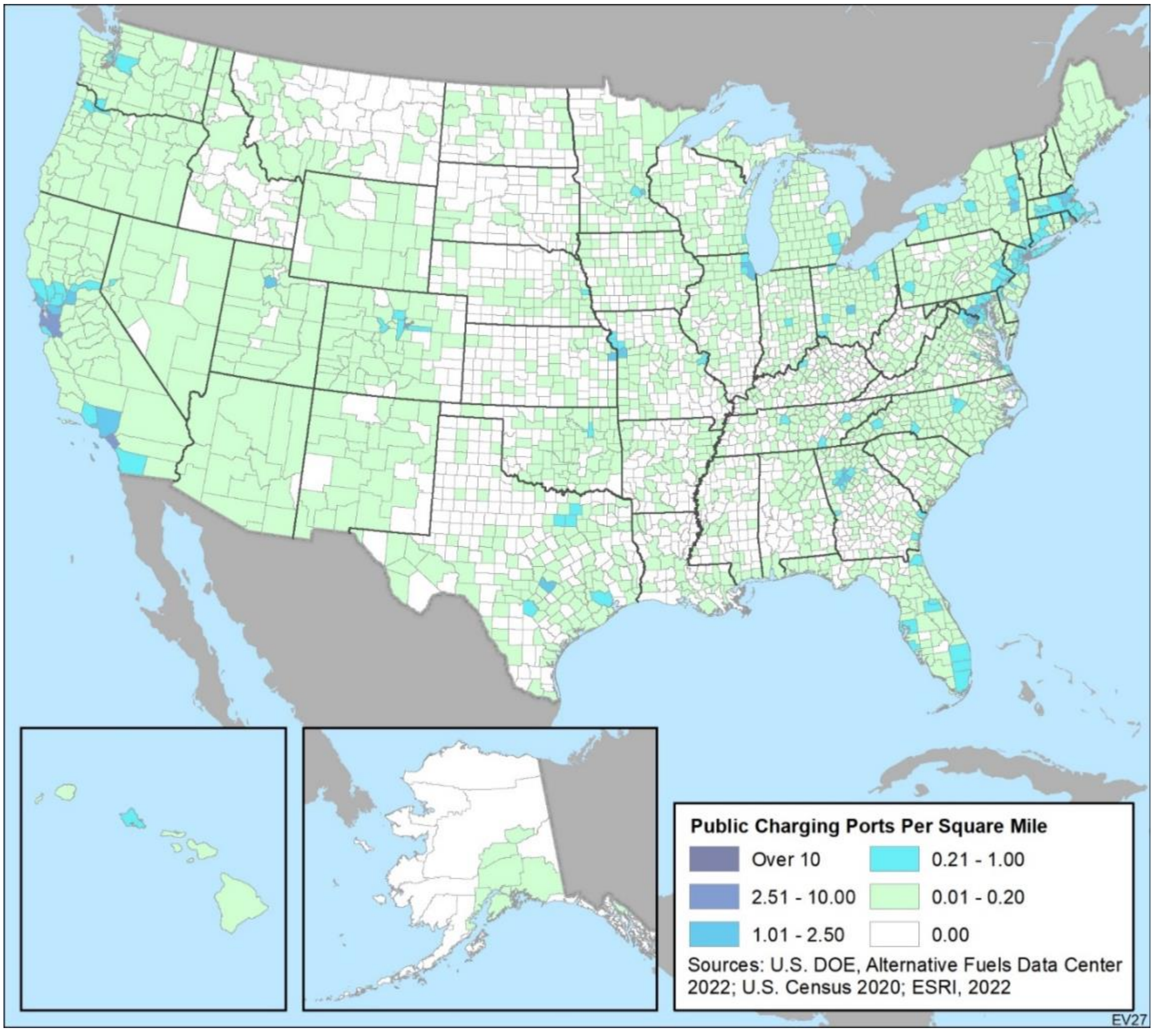

FIGURE 7 Number of public EVSE ports by area in each U.S. county (Tesla ports are included).

Peer Review Input for Public EVSE Density Methodology

Choosing the methodology that fits the community: A reviewer commented that different methodologies will be a better fit based on the characteristics of a particular community, such as density, demographics, and other factors. Areas with high concentrations of multi-family residents without dedicated parking lots could prioritize walkability and overnight or long-dwell parking times. Communities with less-dense neighborhoods and low walkability scores, or that are otherwise more car-dependent, may need faster recharge times along popular travel routes or at destinations.

Convenient distance or travel time: Reviewers provided input on convenient distances or travel times to EV chargers. One reviewer suggested a travel distance of 2.5 miles for DCFC and 0.25 miles for Level 2 EV chargers as reasonable distances to consider the EV charger accessible to a particular location or neighborhood. Another reviewer recommended including a condition that EV chargers in rural and urban areas should be within a reasonable walking distance (no more than 5-10 minutes) of a common parking destination (e.g., home, work, shopping, recreation, community spaces) to be considered convenient. Another reviewer commented that EV chargers within 15 walking minutes may become an issue for older adults and people with disabilities. *The authors agree that these distances and travel times are important considerations when siting EV charging stations. The use of a 15-minute travel time for EVSE density calculations is not meant to imply 15 minutes is a convenient travel time, but rather it is a metric that can be utilized uniformly across census tracts of varying characteristics as a basis for initial charging desert analysis.*

Using quantity of EVSE ports vs EV charging station locations: A reviewer commented that using EVSE ports (which represents the quantity vehicles that can charge at the EVSE at the same time) rather than EV charger station locations (which identifies distinct locations where EV charging is available to drivers) for calculating EVSE density is problematic. It may not adequately measure equitable EV charger distribution and the necessary EV charger access for rural and underserved communities. This approach is potentially problematic for the same reasons that gross domestic product (GDP) can hide massive wealth inequality when looking at countries at the national scale. GDP per capita by itself does not indicate how that money is distributed; similarly, the number of EVSE ports does not necessarily reflect the distribution of charging station access. If there were a room full of ten people and we took the GDP per capita, then a billionaire walks in the room and we measure the GDP per capita again, the GDP would have gone up significantly even though the individual wealth of the other ten people did not change.

Counting EVSE ports by power level: Reviewers noted the need to specify whether an EVSE density methodology is counting DCFC only or includes Level 2 EVSE ports. A reviewer agreed that future analysis should separate the EVSE ports by charging level and speed depending on the objective for both driving and walking distance. This reviewer recommends further identifying DCFC charging stations based on power output (e.g., 50 kW, 100 kW, 150 kW).

Number of EVSE ports within a given distance: A reviewer agreed that this methodology is less useful, since natural or constructed barriers may limit straight-line access to EV chargers.

EVSE ports per traffic activity or roadway length: One reviewer commented that this methodology is a good strategy for reducing the distributional inequities of climate change, such as air pollution, but does not change the structural disparity in EV ownership alone. Another reviewer noted that this method may over-value areas without significant population (e.g., along an inter-city highway) where EV chargers may not be needed.

EVSE ports/vehicle stock: For this methodology, a reviewer commented that it is crucial to consider that urban areas have high vehicle density but low vehicle stock per capita. This reviewer suggested considering the ratio of EVSE ports to vehicles driven in a given area rather than vehicle ownership. Another reviewer stated this methodology should consider the fact that a high percentage of EV owners can charge their EVs at home and do not need public charging. The reviewer suggested using the equation below:

$$\frac{EVSE}{X\%\ vehicle\ stock\ with\ access\ to\ EVSE\ +\ vehicle\ stock\ without\ access\ to\ EVSE}$$

where X% can be selected as 10%. Ideally, a mapping tool for prioritizing public EV charger locations would reflect the estimated need for *public* EV chargers.

Another reviewer commented that this methodology would favor rural and suburban areas, which are more suitable for residential charging. The reviewer recommended this methodology be combined with an additional metric related to percentage of multi-unit dwellings or some proxy for homes without dedicated parking spaces.

A different reviewer pointed out the importance of not using this methodology specifically for the vehicle stock of registered EVs. Using a methodology based on registered EVs perpetuates placing EV chargers where EVs are or where they are expected to be is the reason for unequitable EV charging investments. Current EV deployment strategies have placed chargers in places where EV drivers already frequent or are projected to be, which overlooks Black, Indigenous, and people of color (BIPOC) communities who lag in adoption but are still poised to uptake EVs at similar levels to early adopters. These deployment strategies do not take into consideration that the early adopter profile is only a subsection of the total potential EV market and placing chargers only where there are investment opportunities disqualifies communities that are posed to uptake more EVs but have a need for infrastructure to stimulate adoption first.

Areas with or without access to EVSE ports: A reviewer noted that assuming walkability based on a specified distance or an "8-minute walk" overlooks the challenge that BIPOC communities are significantly more likely to have low walkability.

Number of public EVSE ports within 15 driving minutes: A reviewer noted that rural households have a higher average daily VMT than urban households and therefore a metric with a longer driving time than 15 minutes may be more appropriate for public EVSE density in rural communities. "In 2009, the average urban household in North Carolina drove 32.7 miles per day while rural North Carolina households drove 74 percent more miles, or 56.8 miles per day. Similarly, urban North Carolina households averaged 4.4 automobile trips per day while rural North Carolina households averaged 23 percent more, or 5.4 trips per day."[35]

Number of public EVSE ports within 15 walking minutes: A reviewer commented that there is a higher incidence of traffic fatalities in BIPOC communities[36] and stretches of road with high incidents of pedestrian deaths are commonly bordered by lower-income neighborhoods[37]. A walkability metric and a pedestrian safety metric need to be paired with this methodology for it to represent EVSE within a safe 15-minute walk of the centroid of the census tract.

[35] https://www.ncdot.gov/initiatives-policies/environmental/climate-change/Documents/vehicle-miles-traveled-reduction-study.pdf

[36] https://www.ghsa.org/resources/news-releases/Equity-Report21

[37] https://jtlu.org/index.php/jtlu/article/view/1825

6. IDENTIFYING PRIORITY CENSUS TRACTS FOR EV CHARGER PLACEMENT FROM AN EQUITY PERSPECTIVE

This report describes approaches to EV charger planning based on a set of defined objectives and example mapping scenarios for identifying priority census tracts for EV charger placement from an equity perspective. Each mapping scenario uses assumptions to identify EEJ underserved communities, such as public EVSE density thresholds and other relevant data layers for visualizing census tracts that may be priority locations for investments in EV chargers (or priority locations for future community engagement). The report identifies the advantages and potential biases of different methodologies and summarizes reviewer responses to the approach examples. As state and local EV charging planners define objectives and specific equity goals, they may find it beneficial to use a combination of these mapping scenarios and additional map layers to identify priority locations for EV charger placement. There is no one size fits all approach to incorporating equity in EV charger planning and best practices will continue to emerge as various communities implement EV charger funding programs.

The map scenarios display results at the census tract level based on the granularity of the available datasets. State or local EV charging planners (e.g., metropolitan planning organizations) may have access to more granular data sets to display results at a block group or lot/parcel granularity. It should be noted that the social-demographic characteristics of communities are often non-homogeneous within census tracts. Table 3 shows the map layers used in the following scenarios in addition to the public EVSE density.

Approach A: Corridor Charging

- Scenario A1: Disadvantaged communities + EV Corridors
- Scenario A2: High transportation energy burden + low public EVSE density + EV Corridors

Approach B: Community Charging

- Scenario B1: Disadvantaged communities (national) + public EVSE density ranges
- Scenario B2: Low income and/or community of color + low public EVSE density
- Scenario B3: High MFH density and/or high rental density + low public EVSE density
- Scenario B4: High transportation energy burden + low public EVSE density

Approach C: Fleet Charging

- Scenario C1: Disadvantaged communities + high traffic volume
- Scenario C2: High PM2.5 + high traffic volume

Approach D: Diversity in STEM and Workforce Development

- Scenario D1: Community colleges and vocational schools in DACs
- Scenario D2: Historically black colleges and universities (HBCUs), minority serving institutions (MSIs), and Tribal colleges and universities (TCUs) + EV Corridors

TABLE 3 Map layers used in scenarios in addition to public EVSE density

Scenarios	Map Layer	Data Source
A1, B1, C1, D1	Joint DOE/DOT Interim Guidance DAC definition	DOE and DOT[38]
A1, A2, C2, D2	FHWA designated EV Corridors	FHWA[39]
A1, A2, C2, D2	Public DCFC locations	AFDC[40]
A2, B4	High transportation energy burden	Argonne[41]
B2	People of color percentage 80%-100%	EPA EJScreen[42]
B2	Low-income percentage 80%-100%	EPA EJScreen
B3	Percentage MFH ≥80th percentile	U.S. Census[43]
B3	Percentage rental housing ≥80th percentile	U.S. Census[44]
C1	Traffic proximity and volume	EPA EJScreen
C2	Distance-normalized traffic volume ≥80th percentile	EPA EJScreen
C2	High particulate matter (PM2.5) levels in air ≥80th percentile	EPA EJScreen
D1	Community colleges	NCES[45]
D1	Vocational schools	NCES
D2	HBCUs	ArcGIS[46]
D2	TCUs	ArcGIS
D2	MSIs	MSI[47]

Approach A: Corridor Charging

The objectives of Approach A are to:

- Build a nationwide network of FHWA-designated EV Corridors
- Accelerate equitable adoption of EVs, including for those who cannot reliably charge at home
- Implement the Justice40 goal that 40% of overall benefits of federal investment in EV charging flow to DACs
- Identify priority census tracts for DCFC placement within one mile of EV Corridors that benefit nearby EEJ underserved communities

38 https://www.anl.gov/es/electric-vehicle-charging-equity-considerations.

39 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/.

40 https://afdc.energy.gov/fuels/electricity_infrastructure.html.

41 https://doi.org/10.2172/1760477.

42 https://www.epa.gov/ejscreen.

43 https://data.census.gov/cedsci/table?q=Single%20Unit%2FMulti-Unit%20housing&tid=ACSDT5Y2018.B25024.

44 https://data.census.gov/cedsci/table?q=C25033&tid=ACSDT1Y2019.C25033.

45 https://nces.ed.gov/ipeds/.

46 https://www.arcgis.com/home/item.html?id=385d5b830acc4d4ba9572fd885844cc6.

47 https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

FHWA manages the Alternative Fuel Corridor (AFC) designation program established by the Fixing America's Surface Transportation Act of 2015. Initial NEVI funding is directed to designated AFCs for electric vehicles to build out the national network.[48] NEVI program guidance also requires that EV charging infrastructure (at least four 150 kW DCFCs) should be installed every 50 miles along a state's portions of the interstate highway system, within one travel mile of the interstate, for a designated AFC to be considered "fully built out." This approach is illustrated by map scenarios that visualize two combinations of map layers, including FHWA-designated EV Corridors, DCFC locations, the DOE/DOT Justice40 DAC definition, communities with high transportation energy burden, and low public EVSE density.

Scenario A1—Disadvantaged Communities + EV Corridors

Scenario A1 uses the EV Charging Justice40 Map that displays the joint DOE and DOT interim definition of DACs available on Argonne's EV Charging Equity Considerations webpage[49] (screenshot shown in Figure 8) and relevant EV Corridor layers (EV Corridors and public DCFC stations, shown in Figure 9). This scenario can be used to identify geographic areas where EV Corridor Pending highways, which presently have an insufficient number of EV charging stations to achieve full corridor designation, overlap with DACs. Community engagement and inclusive planning efforts could potentially result in choosing priority locations for future DCFC that upgrade an EV Corridor Pending stretch of highway to EV Corridor Ready while also producing benefits for a nearby DAC. Simply placing a charger along a highway in a DAC may only be conveniently accessible to highway travelers and not reasonably accessible to members of that community. However, there may be other strategies for ensuring that benefits flow to community members such as placing chargers in locations near the highway that attract customers to locally owned businesses.

Scenario A1 Map Layers

- Joint DOE and DOT interim definition of DACs for Justice40, one of the following:
    - Combined census tracts from DOT's and DOE's working DAC definitions
    - Tribal lands
    - U.S. territories
- FHWA designated EV Corridors (both EV Corridor Ready and EV Corridor Pending)
- Public DCFC locations

48 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf.

49 https://www.anl.gov/es/electric-vehicle-charging-equity-considerations.

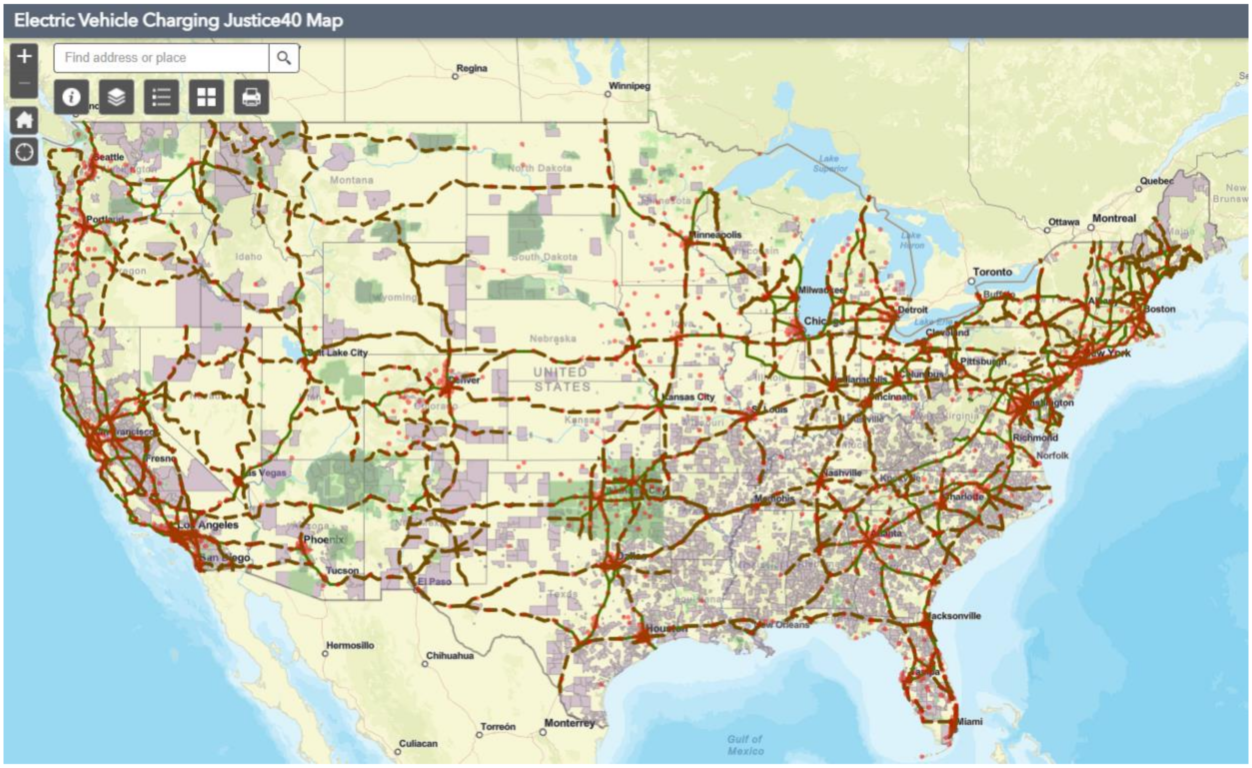

FIGURE 8 Scenario A1: Electric vehicle charging Justice40 map displays DOE/DOT Interim Guidance DACs.

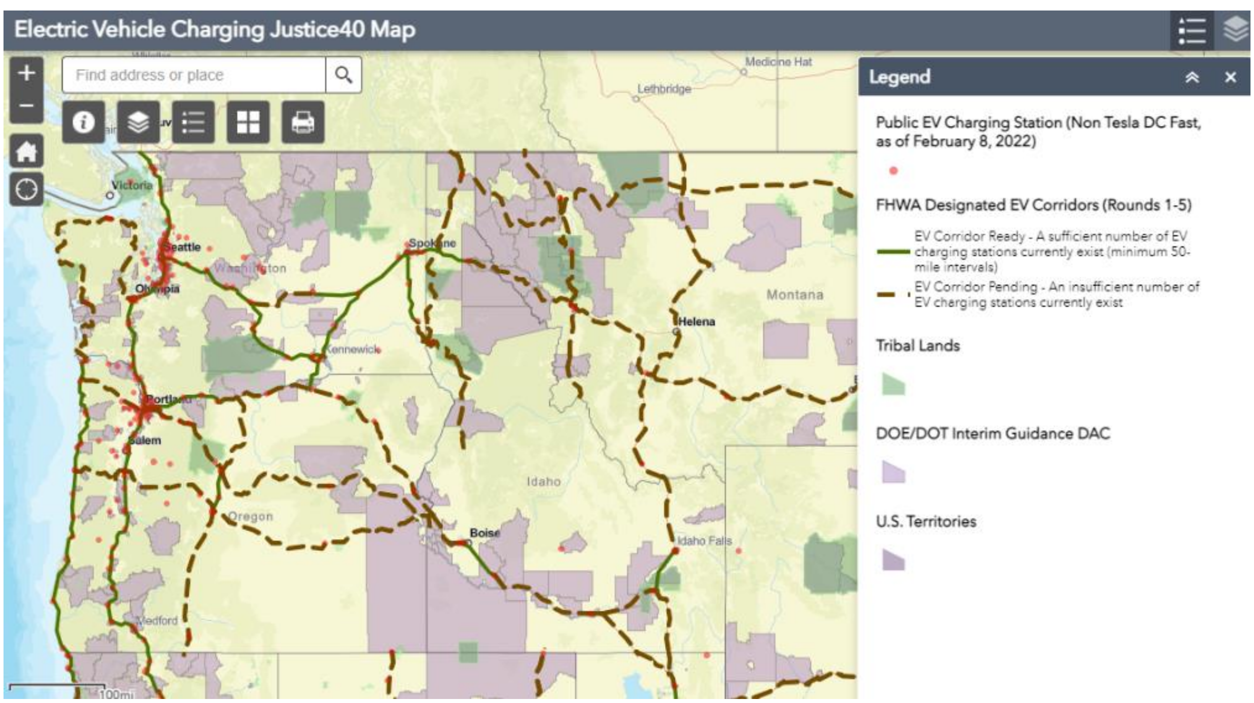

FIGURE 9 Scenario A1: Mapping layers in the electric vehicle charging Justice40 map.

Scenario A2—High Transportation Energy Burden + Low Public EVSE Density + EV Corridors

Scenario A2 identifies EEJ underserved communities that have high transportation energy burdens and currently limited access to public EV charging. Transitioning from a gasoline vehicle to an EV can reduce the transportation energy burden through decreased fuel cost and maintenance costs. People with the highest energy burden have the most to gain by drastically reducing transportation energy costs. This example may be particularly relevant when considering locations for EV Corridor charging, since EV charger installations for corridor charging could potentially be designed to also provide benefits to communities, particularly rural communities, that have a high transportation energy burden.

Transportation energy burden in this report is defined as the percentage of household annual income spent on vehicle fuel.[50] While the national average household transportation energy burden is about 3.4%, households in some census tracts spend more than 20% of their income on vehicle fuel. For a nationwide analysis of high transportation energy burden, we set the threshold at 5% as an example. *When focusing on a smaller geographic region or a particular state, a higher or lower threshold may be a better assumption.* For example, setting the threshold for high transportation energy burden at 4% would be so restrictive that less than 20% of the census tracts in DC, CO, CT, DE, FL, MA, MD, NH, NJ, NY, RI, TX, UT, and VA would qualify as high transportation energy burden. For those geographic areas, a lower threshold may be needed.

Figure 10 and Figure 11 identify (in purple) the census tracts that: (1) have a transportation energy burden equal to or greater than 5%, and (2) have only 0-10 public EVSEs (DCFC or Level 2) within a 15-minute drive. These figures also show FHWA designated EV Corridors (blue for Corridor Ready and yellow for Corridor Pending) and public DCFC (black dots). As states install EV chargers to complete EV Corridors, this methodology can help prioritize locations that will benefit communities with high transportation energy burdens and low public EVSE density. Note that 0-10 public EVSEs is an example threshold; a different range may be a better threshold for "low public EVSE density" based on the geographic area and existing public EVSE density in that area.

Scenario A2 Map Layers

- High transportation energy burden and low public EVSE density
  - High transportation energy burden >5%
  - Public EVSE density (DCFC only) of 0-10 public EVSE ports within 15 driving minutes
- FHWA designated EV Corridors (both EV Corridor Ready and EV Corridor Pending)
- Public DCFC

[50] https://doi.org/10.2172/1760477.

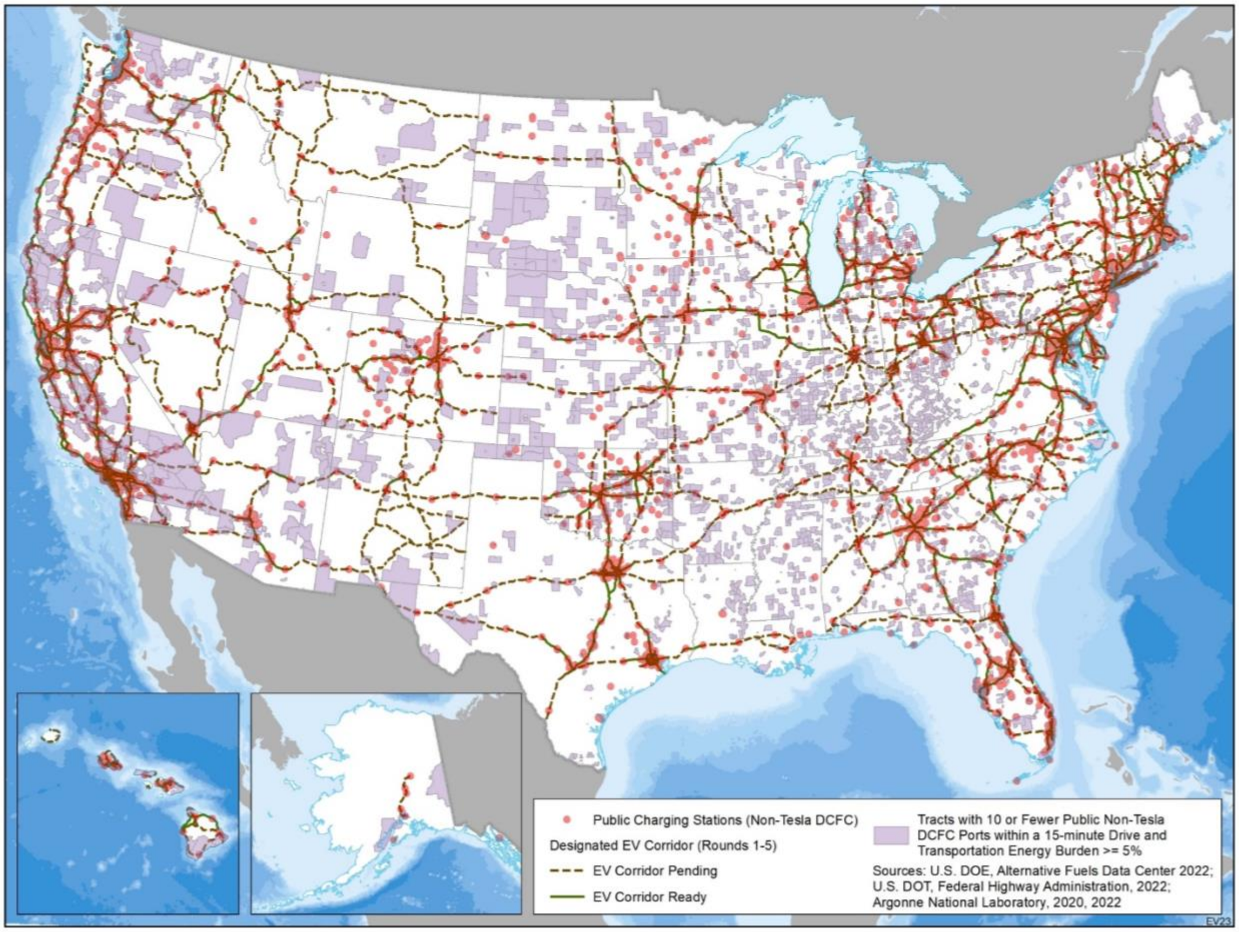

FIGURE 10 Scenario A2: Census tracts with high transportation energy burden (≥ 5%) and low public EVSE density (0-10 DCFC ports within a 15-minute drive).

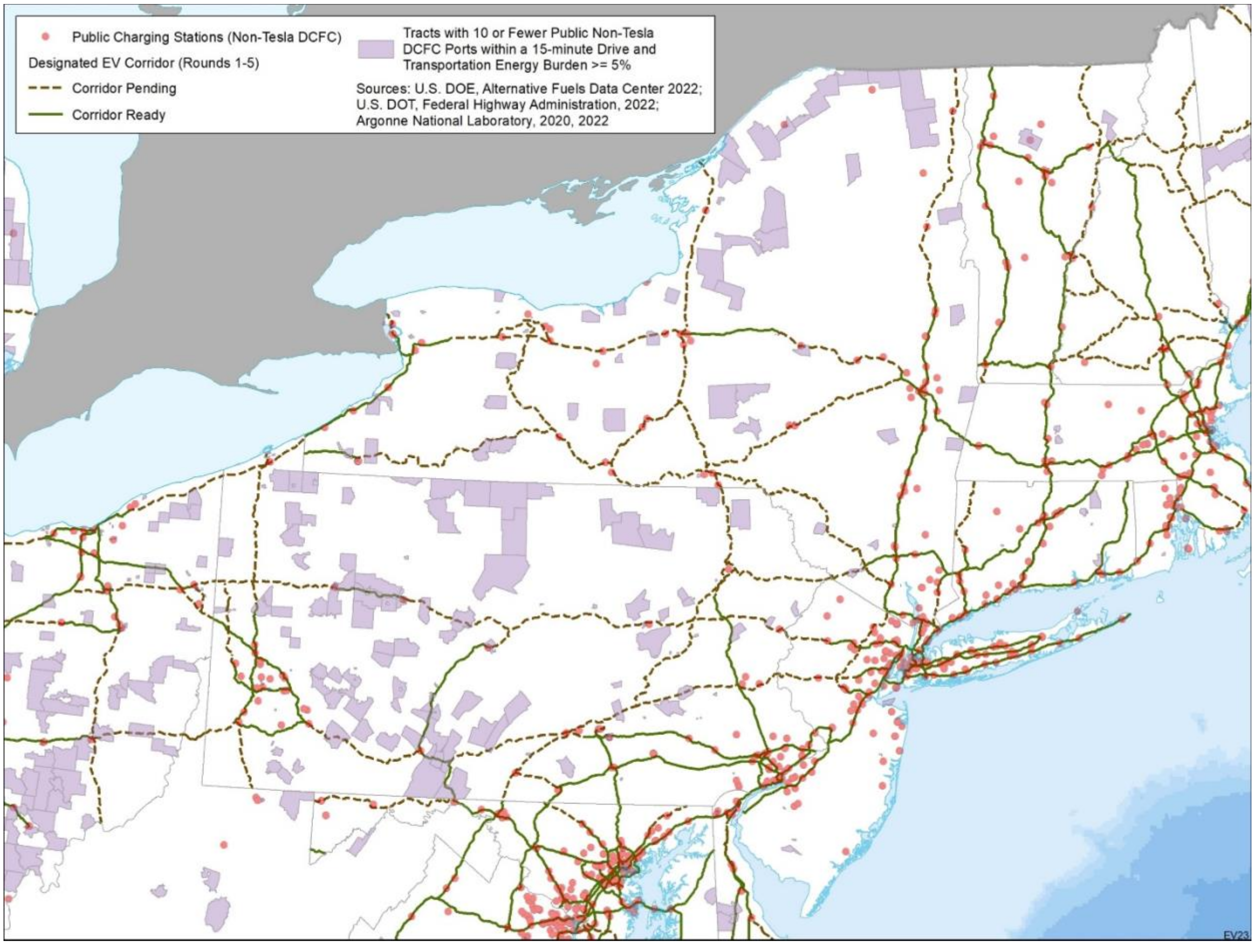

FIGURE 11 Scenario A2: Northeast communities with high transportation energy burden (≥5%) and low public EVSE density (0-10 DCFC ports within a 15-minute drive).

Peer Review Input for Approach A: Corridor Charging

Install Level 2 EVSE ports with corridor DCFC: Reviewers commented that when installing DCFCs along a highway, adding Level 2 EVSE ports adds only a small incremental cost but can provide a significant increase in benefits that flow to nearby community residents. Generally, the charging session cost to the driver from a DCFC is higher than for Level 2 chargers. Locating the charging station at sites that attract visitors to locally owned businesses or common destinations for nearby community residents can also maximize the benefits that flow to nearby community residents. One reviewer commented that while there is an auxiliary benefit of co-locating Level 2 chargers for community use, the quantity of Level 2 EVSE ports should not be considered when calculating the public EVSE density if the purpose is planning future corridor charging locations.

A different reviewer commented that adding Level 2 EVSE ports would help support a broader range of electric vehicle types, including those without DCFC connectors, but does necessitate the selection of a location suitable for a vehicle to remain for longer dwell times (2+ hours). Multiple reviewers noted that a DCFC seems more likely to come with higher demand charges which often translates as higher flat connection fees/cost regardless of kWh consumed in a particular charging session. That may make it less suitable to serve a DAC's everyday needs, or at least influences when electric vehicles cost less per mile to operate compared to gasoline vehicles.

Corridor charging public EVSE density methodology: A reviewer recommended incorporating the latest FHWA AFC criteria for designated EV Corridors when calculating the public EVSE density (four 150 kW ports using the combined charging system [CCS] standard). A public EVSE density threshold could consider 0-3 EVSE ports that have a minimum of 150 kW charging output and use a CCS standard or include CHAdeMO standard as well. That would identify gaps in charging stations which meet the FHWA standard and can be overlaid with disadvantaged community census tracts. Another potential change is modifying the EVSE port counting methodology to identify EVSE ports within a 50-mile range to align with the FHWA standard of spacing EV charging infrastructure at 50-mile intervals along designated corridors.

Multiple reviewers recommended using 0-10 public charging station locations instead of 0-10 public EVSE ports. Particularly in rural areas, both EVSE ports and the number of charging station locations matter. For example, two charging ports at two sites may serve a rural community better than one charging station with two ports at one site.

Displaying DCFCs on a map: One reviewer agreed with displaying only DCFCs for corridor charging scenarios rather than including Level 2 EV chargers. The reviewer also recommended further identifying DCFCs based on the number of EVSE ports at particular power output levels (e.g., 50 kW, 100 kW, 150 kW) and charging standards (e.g., CCS, CHAdeMo). This reviewer recommended visually scaling the "public charging stations" to number of ports or total power availability (number of ports x average port power).

Additional map layers: Multiple reviewers recommended incorporating areas prioritized for economic development (e.g., Qualified Opportunity Zones) when evaluating corridor charging locations. Reviewers also suggested considering internet access in rural areas, which can have significant impact on EV charger operation. A third reviewer noted that electric utility service territory boundaries may be a beneficial additional mapping layer, as different locations in a given area will determine who provides electricity to the EV charger and thus the rates charged.

Scenario A1—Justice40 DACs + EV Corridors: A reviewer acknowledged the value of including this approach, given the connection to the NEVI and Alternative Fuel Corridor programs. The reviewer also communicated that while this is a very straightforward approach, there is a challenge that some census tracts included as DACs under the interim DOE/DOT definition may be communities that would not benefit from corridor charging (i.e., ones that may instead prioritize community charging or other transportation options). The reviewer noted that because a relatively high percentage of census tracts in the U.S. were included as DACs under the interim DOE/DOT definition (as compared to some state definitions of defined communities), there may be a need to select a narrower range of DAC identification metrics for specific investment cases.

Scenario A2—Communities with High Transportation Energy Burden + Low Public EVSE Density + EV Corridors: A reviewer commented that in general, transportation energy burden (perhaps in conjunction with demographic metrics) is a good metric for corridor charging investments. This reviewer agrees with the importance of setting the threshold for high transportation energy burden on a state-by-state basis (assuming data is available), given that individual states will implement the NEVI program. The reviewer did not think Level 2 chargers are relevant for measuring the status of corridor charging, and should not be included (also, it will not help states and communities achieve "fully built out" corridors per NEVI guidance). The authors therefore revised Approach A scenarios to only reflect DCFC when calculating pubic EVSE density.

Corridor DCFCs unlikely to be used by DACs residents: Multiple reviewers commented that in many cases, EV chargers along highways that go through census tracts identified as DACs will not be accessible or convenient to DAC residents.

- One reviewer described a geographic area where the current designated EV Corridors include limited-access highways and do not include heavily traveled state highways more likely used by local DAC residents. This is especially true when the corridors are along toll roads. Installing EV chargers along roads that are heavily used by DAC residents would increase the likelihood that they will provide benefits to that community.
- A second reviewer commented that many rural commuters are more likely to take county roads and state highways than interstate highways. Therefore, DCFC locations on interstate corridors may be more likely to benefit travelers than rural DACs. This is especially true in more remote, rural, or mountainous regions which may have a large concentration of DACs (e.g., Ozark Mountains).
- A third reviewer also expressed doubt that corridor charging will be used by nearby communities. Corridor DCFCs located within one mile of the interstate are not convenient or accessible to nearby communities identified as DACs or with a high transportation energy burden. The corridor DCFC also has the risk of being occupied by corridor travelers. Serving corridor travelers and serving community residents/workers seem like truly different use cases or business cases. There might be specific communities in which corridor charging sites would be convenient and accessible to communities, but not many.
- A fourth reviewer commented that corridor charging used as a replacement for at home charging for rural residents makes them compete for charging with through travelers to these areas. If there are no through travelers to that area, there will be no business case to build the DCFC with affordable charging rates.

Approach B: Community Charging

The objectives of Approach B are:

- Accelerate equitable adoption of EVs, including for those who cannot reliably charge at home

- Implement the Justice40 goal that 40% of overall benefits of federal investment in EV charging flow to DACs

- Identify priority census tracts for community EV charging (Level 2 and/or DCFC) that benefit nearby EEJ underserved communities

There is not a uniform set of best practices for incorporating equity considerations in community charging planning efforts. Various federal, state, and local government agencies may have different methodologies for identifying EEJ underserved communities (e.g., Justice40 DACs, environmental justice communities, tribal communities, MFH and rental residents, communities of color) and each geographic area has a unique landscape for how historical transportation and energy injustices affect local EEJ underserved communities. A government agency may or may not have a predetermined methodology for identifying census tracts that qualify as EEJ underserved communities. The map scenarios in Approach B explore various methodologies for identifying EEJ underserved communities and potential priority census tracts for community EV charger deployment. Additionally, a state or local government organization may be interested in developing a methodology for identifying EEJ underserved communities based on the historical environmental justice considerations of a specific geographic area and the public EVSE density.

Methodologies for Identifying EEJ Underserved Communities

For Approach B, we considered methodologies for identifying EEJ underserved communities using the existing data sets listed below. These indicators could be used individually or as a group to identify priority communities for investment in EV chargers.

- Joint DOE and DOT interim definition of DACs for Justice40, described in an earlier section, for one of the following:
  - Combined census tracts from DOT's working DAC definition and DOE's working DAC definition
  - Tribal lands[51]
  - U.S. territories
- Low-income population—EPA EJScreen[52]
- People of color (POC) population—EPA EJScreen

[51] https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-geodatabase-file.2020.html.

[52] EJScreen uses twice the federal poverty level as determined by the U.S. Census for low-income population https://www.epa.gov/ejscreen.

- MFH residents—U.S. Census[53]
- Renters—U.S. Census[54]
- High transportation energy burden—Argonne National Lab[55]
- Low public EVSE density—Data source and method described in earlier section

Scenario B1 – Disadvantaged Communities + Public EVSE Density Ranges

One component of prioritizing EV charger benefits to EEJ underserved communities is placing EV chargers in communities identified as DACs by screening tools. When paired with community engagement and meaningful equity considerations, EV charger deployments located in DACs can be designed to provide both EV charging access and economic opportunities for members of DACs. Installing an EV charger that is not accessible, convenient, and affordable does not improve community access to EV charging. Strategies such as using the local workforce for EV charger installation and maintenance, installing the EV charger in a location that attracts customers to local businesses, or other innovative approaches to foster entrepreneurial opportunities can be used to bring economic opportunities to DACs.

Multiple DAC screening tools are available for consideration. For this scenario, the authors are using the joint DOE and DOT interim definition of DACs as an example of a federal screening tool. Other potential scenarios could use state-specific screening tools such as the California CalEnviroScreen[56] or the New York DAC map.[57]

Scenario B1 Map Layers

Joint DOE and DOT interim definition of DACs for Justice40, using one of the following:

- Combined census tracts from DOT's working DAC definition and DOE's working DAC definition
- Tribal lands
- Public EVSE density (both DCFC and L2)
    - Number of public EVSE ports within a 15-minute *drive* using a national map (Figure 12)
    - Number of public EVSE ports within a 15-minute *walk* for urban zoomed-in map (Figure 13)

53 https://data.census.gov/cedsci/table?q=Single%20Unit%2FMulti-Unit%20housing&tid=ACSDT5Y2018.B25024.

54 https://data.census.gov/cedsci/table?q=C25033&tid=ACSDT1Y2019.C25033.

55 https://doi.org/10.2172/1760477.

56 https://oehha.ca.gov/calenviroscreen.

57 https://climate.ny.gov/Our-Climate-Act/Disadvantaged-Communities-Criteria/Disadvantaged-Communities-Map.

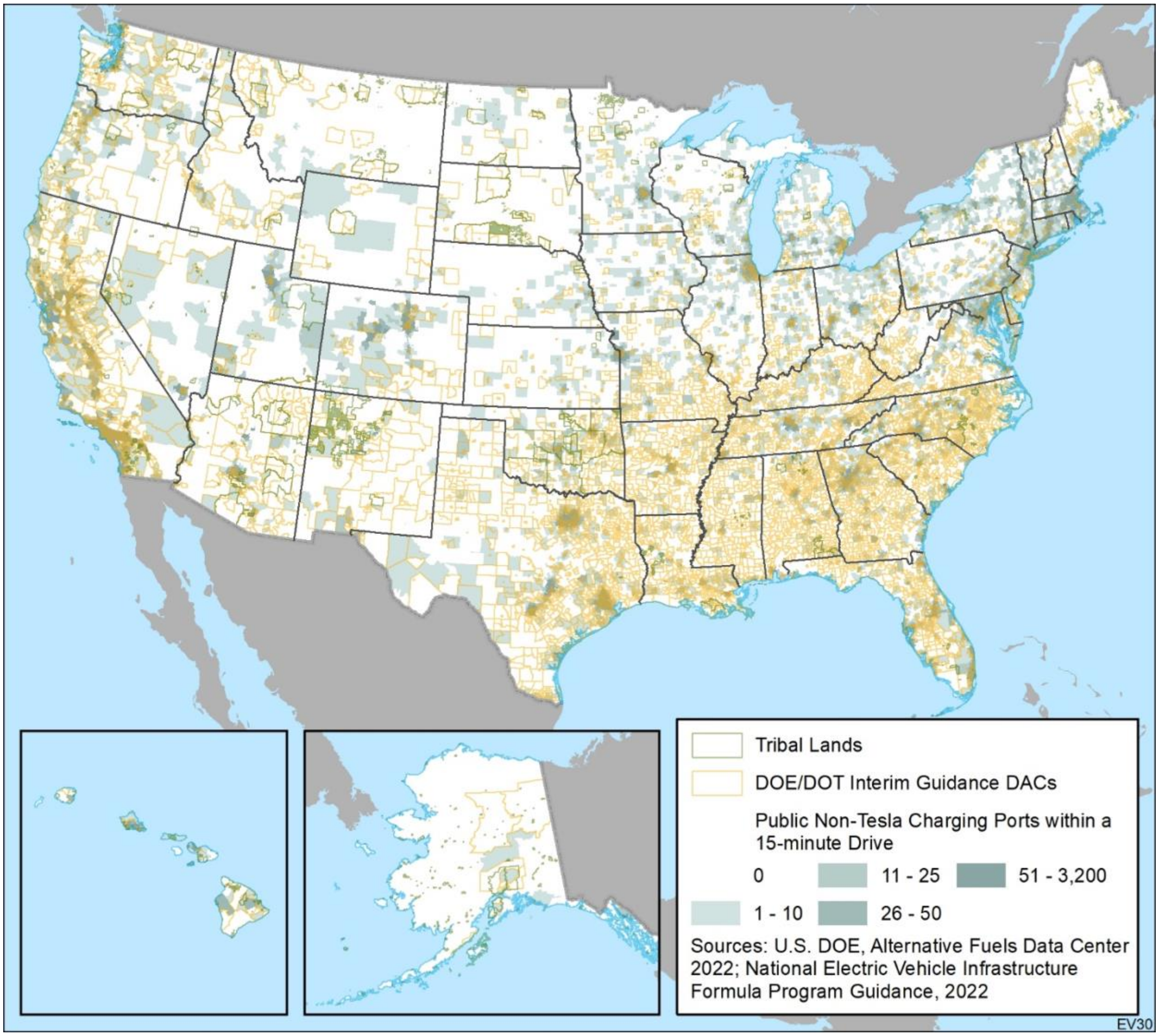

FIGURE 12 Scenario B1: Joint DOE and DOT interim definition of DACs for Justice40 and number of public EVSE ports within a 15-minute drive (by census tract). (Note that the U.S. territories are included in the DOE/DOT Interim Guidance DACs although not shown in this screen shot.)

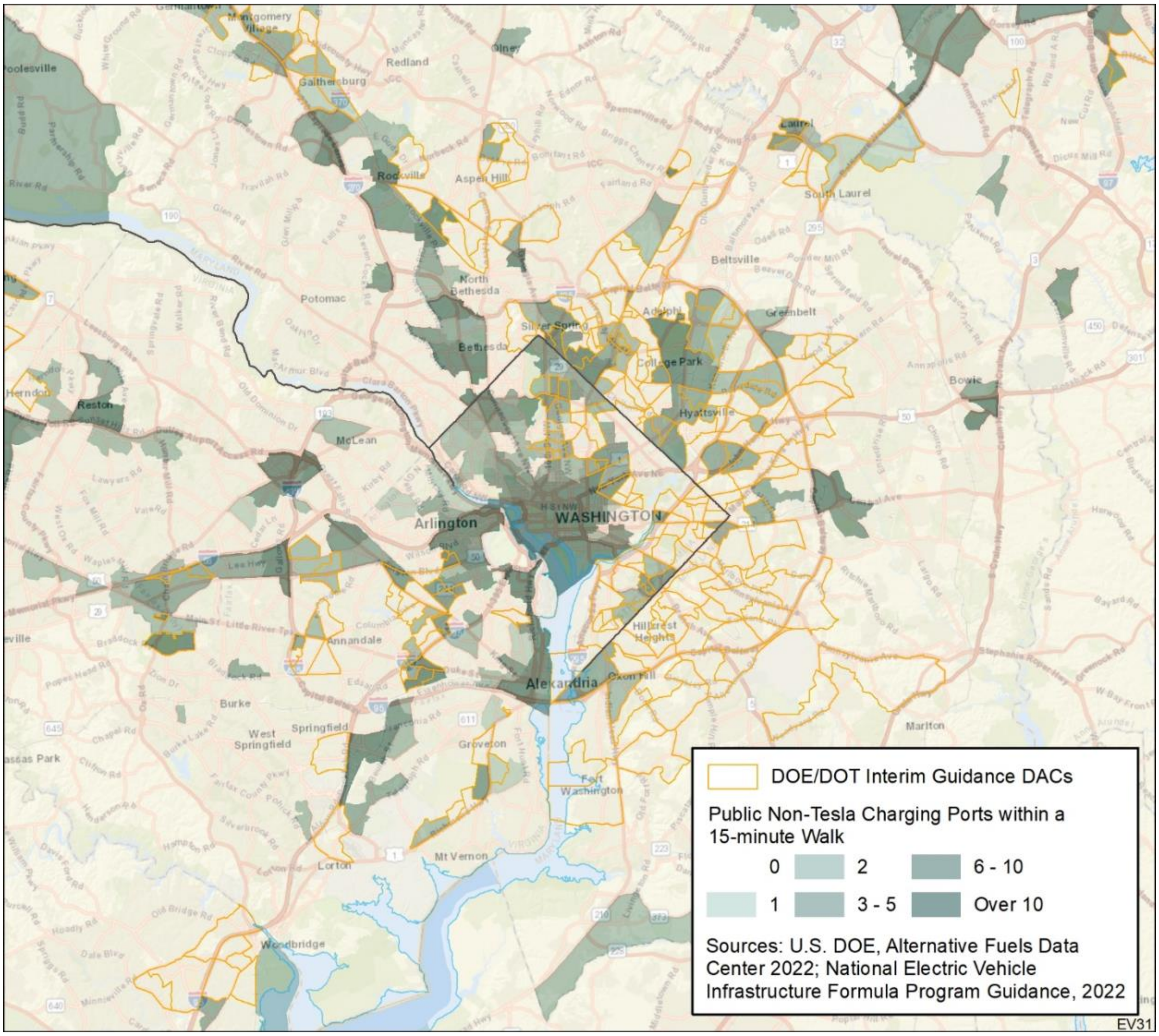

FIGURE 13 Scenario B1: Joint DOE and DOT interim definition of DACs for Justice40 and number of public EVSE ports within a 15-minute walk (by census tract).

Scenario B2 – Low Income and/or Community of Color + Low Public EVSE Density

Scenario B2 identifies EEJ underserved communities that currently have limited convenient access to public EV chargers. While publicly available EV charging stations are growing rapidly in majority-white communities, majority black or Latino census tracts have fewer public EV charging stations.[58] This scenario uses EPA EJScreen demographic layers for low income, people of color, and both. These are paired with an urban threshold for public EVSE density based on walking distance from the center of the census tract (see pages 16-17 for method). This approach can be modified with a rural public EVSE density based on driving distance from the center of the census tract. This approach uses demographic data from EPA EJScreen for people of color percentile to represent "community of color."

Scenario B2 Map Layers

- Low-income community + low public EVSE density using both of the following:
  - Low-income percentage 80%-100%
  - Public EVSE density (DCFC and L2): 0-10 public EVSE ports within a 15-minute walk
- Community of color + low public EVSE density using both of the following:
  - People of color percentage 80%-100%
  - Public EVSE density (DCFC and L2): 0-10 public EVSE ports within a 15-minute walk
- Both low income and community of color + low public EVSE density using all of the following:
  - Low-income percentage 80%-100%
  - People of color percentage 80%-100%
  - Public EVSE density (DCFC and L2): 0-10 public EVSE ports within a 15-minute walk

[58] https://www.washingtonpost.com/business/2021/12/09/charging-deserts-evs/.

Take the Washington D.C.–Baltimore (MD) metropolitan area as an example. Figure 14 shows the census tracts (1) with the low-income percentage and/or people of color percentage ≥80% by each state,[59] and (2) with only 0-10 public EVSE ports within a 15-minute walk. We use state-level rather than national percentages because every state has a different threshold for its low-income percentile and people of color percentile.

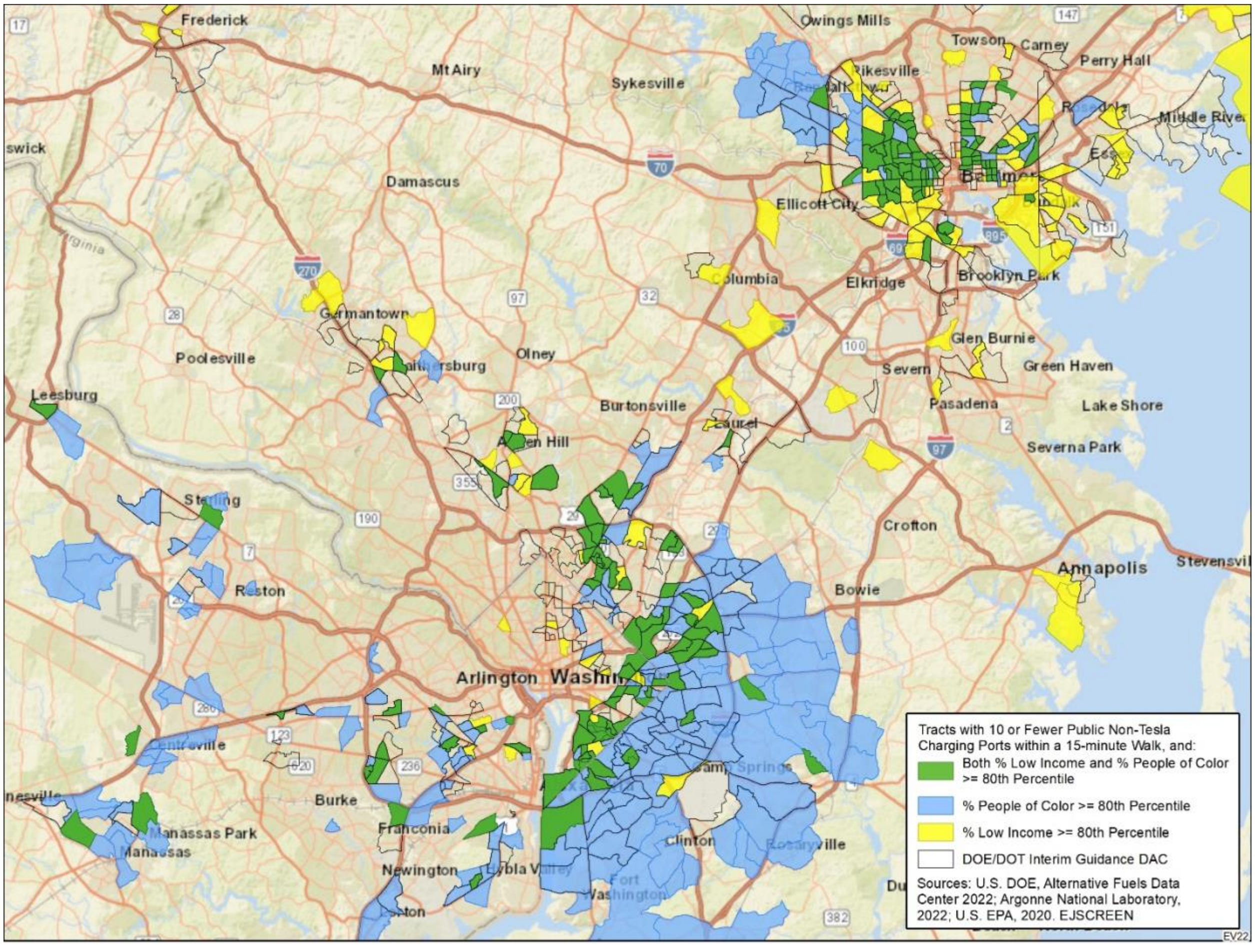

FIGURE 14 Scenario B2: Urban low-income community and/or community of color and low public EVSE density. (Blue: people of color ≥80th percentile in each state, yellow: low-income ≥80th percentile in each state, green: both.)

59 https://www.epa.gov/ejscreen.

Scenario B3—High MFH Density and/or High Rental Density + Low Public EVSE Density

Scenario B3 identifies census tracts with a high percentage of residents that do not have the option of charging at home and would benefit from public EV charging that is within walking distance of home or at a convenient destination. We use the MFH share of all housing types and rental share of all housing ownership types as the indicators, based on the data collected in the American Community Survey.[60] This scenario considered MFH residents and rental property residents as "underserved" since they typically would not have the option to install home EV charging and would therefore need to rely on public or workplace charging to own an EV. The scenario could be further refined by adding in other indicators, such as low income.

As in Scenario B2, we include public EVSE density as the convenience indicator. Figure 15 shows the census tracts with (1) MFH (five units or more) density ≥80th percentile by state, and/or with the rental housing density ≥80th percentile by state, and 2) only 0-10 public EVSE ports within a 15-minute of walk. Parking availability by housing type is a better metric for identifying communities that lack spaces for residential charging,[61] and regional travel and community surveys may have that information. For example, the Chicago Metropolitan Agency for Planning (CMAP) periodically surveys households throughout northeastern Illinois about their travel habits and household parking availability.[62]

Scenario B3 Map Layers

- High MFH density and low public EVSE density (yellow) using both of the following:
  - Percentage MFH (three units or more) ≥80th percentile
  - Public EVSE density: 0-10 public EVSE ports within a 15-minute walk
- High rental housing density and low public EVSE density (blue)
  - Percentage of renter-occupied ≥80th percentile in structures
  - Public EVSE density: 0-10 public EVSE ports within a 15-minute walk
- Both high MFH density and high rental housing density and low public EVSE density (green)
  - Percentage MFH (three units or more) ≥80th percentile
  - Percentage of renter-occupied ≥80th percentile in structures
  - Public EVSE density: 0-10 public EVSE ports within a 15-minute walk

[60] https://www.census.gov/programs-surveys/acs/about.html.

[61] https://www.nrel.gov/docs/fy22osti/81065.pdf.

[62] https://www.cmap.illinois.gov/data/transportation/travel-survey.

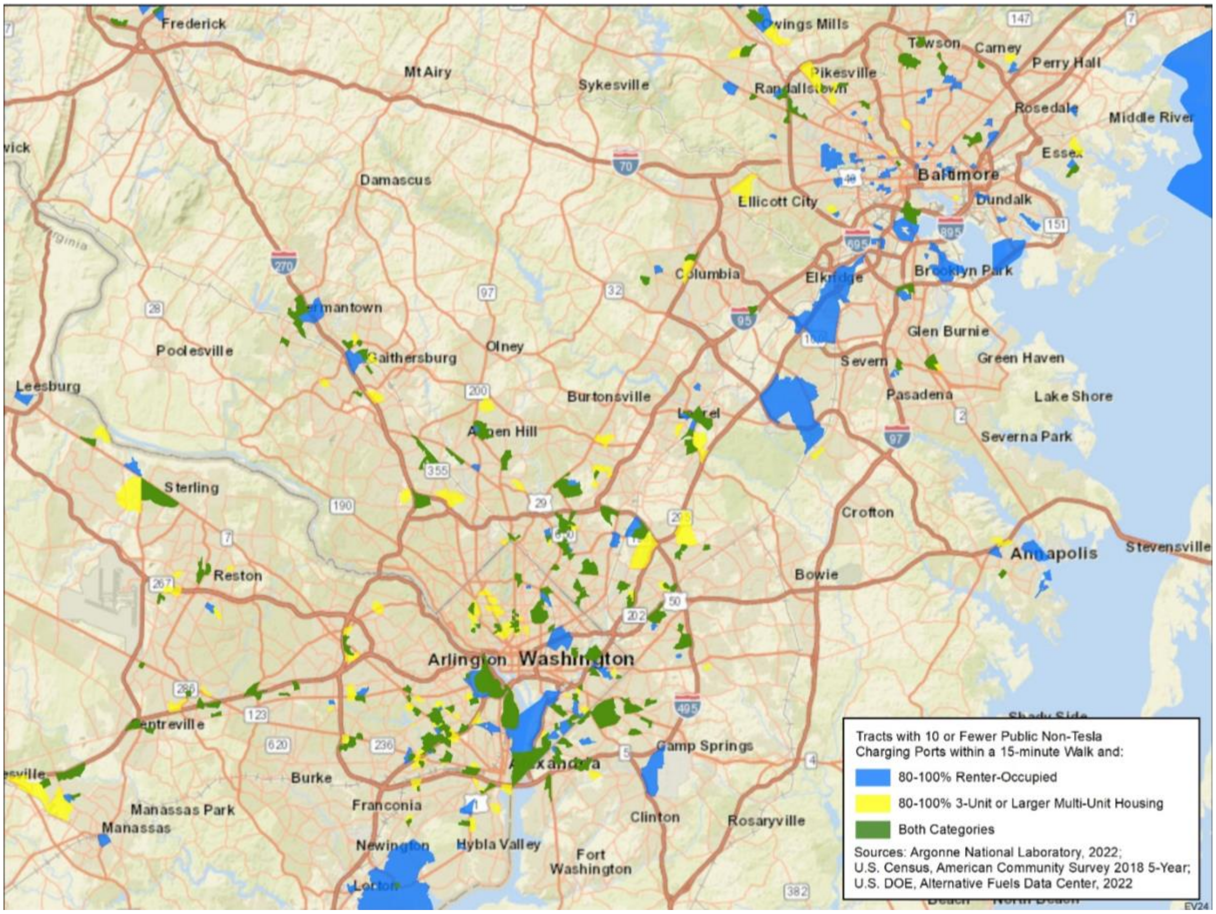

FIGURE 15 Scenario B3: Communities with high MFH density, high rental density, and low public EVSE density. (Yellow: MFH density ≥80th percentile in each state, blue: high rental density≥80th percentile in each state, green: both.)

Scenario B4 – High Transportation Energy Burden + Low Public EVSE Density

Scenario B4 identifies EEJ underserved communities that have **high transportation energy burdens** and currently have limited accessibility to public EV charging. Switching from a gasoline vehicle to an EV can reduce transportation energy burden through decreased fuel cost and maintenance costs. People with the highest energy burden have the most to gain from drastically reducing transportation energy costs. A detailed description of transportation energy burden can be found in Scenario A2. For a nationwide analysis of high transportation energy burden, we set the threshold at 5%. The specific threshold for "high" transportation energy burden should be targeted to a specific geographic area based on local transportation energy burden analysis and percentage of population the threshold seeks to include.

Scenario B4 Map Layers

- High transportation energy burden and low public EVSE density using both of the following:
    - Transportation energy burden ≥5%
    - Public EVSE density (DCFC or L2): 0-10 public EVSE ports within 15 minutes' travel time (driving for rural example shown in Figure 16, and walking for urban example shown in Figure 17).

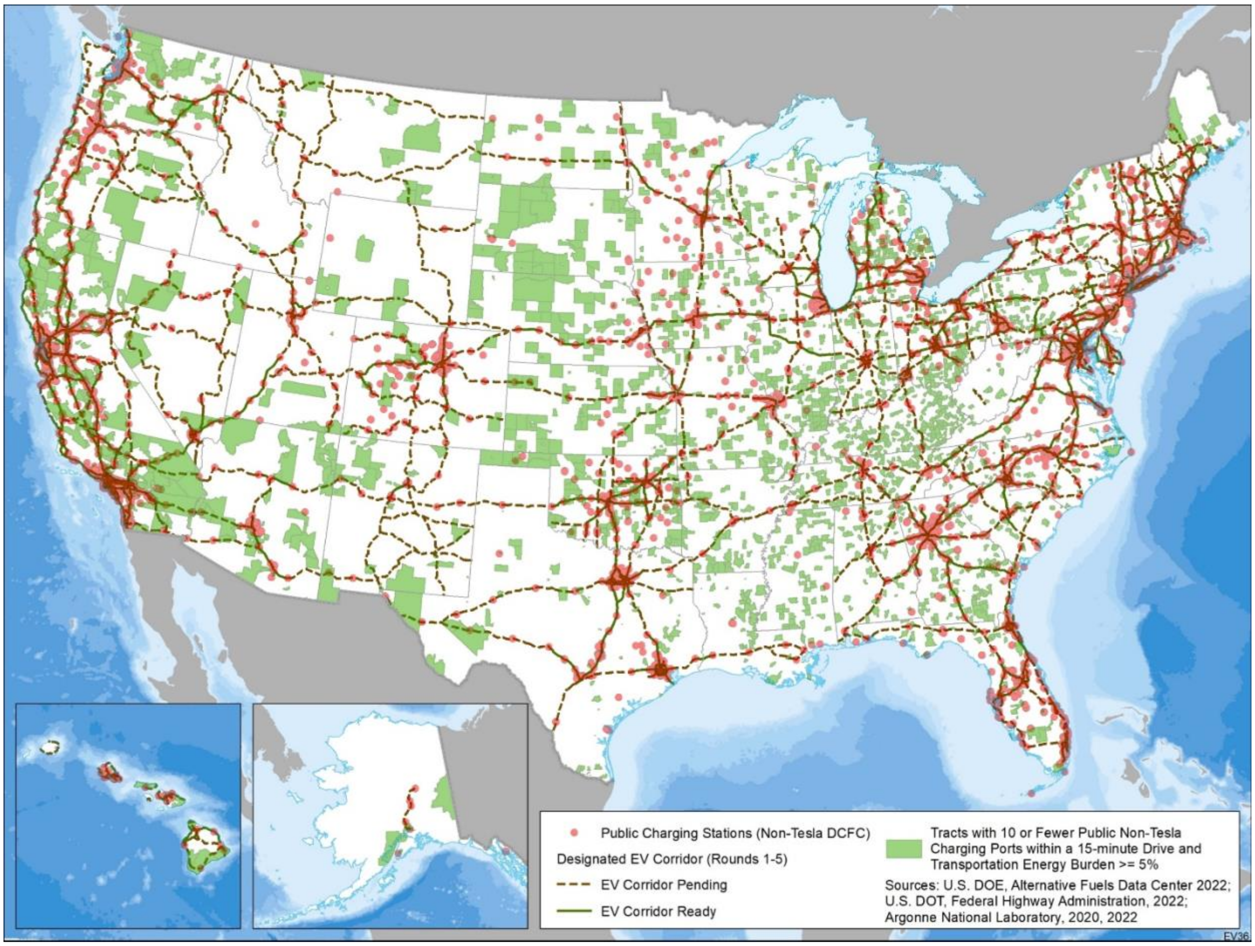

FIGURE 16 Scenario B4: Census tracts (in green) that have (1) transportation energy burden ≥ 5%, and (2) only 0-10 public EVSE ports (including DCFC or Level 2) within a 15-minute drive.

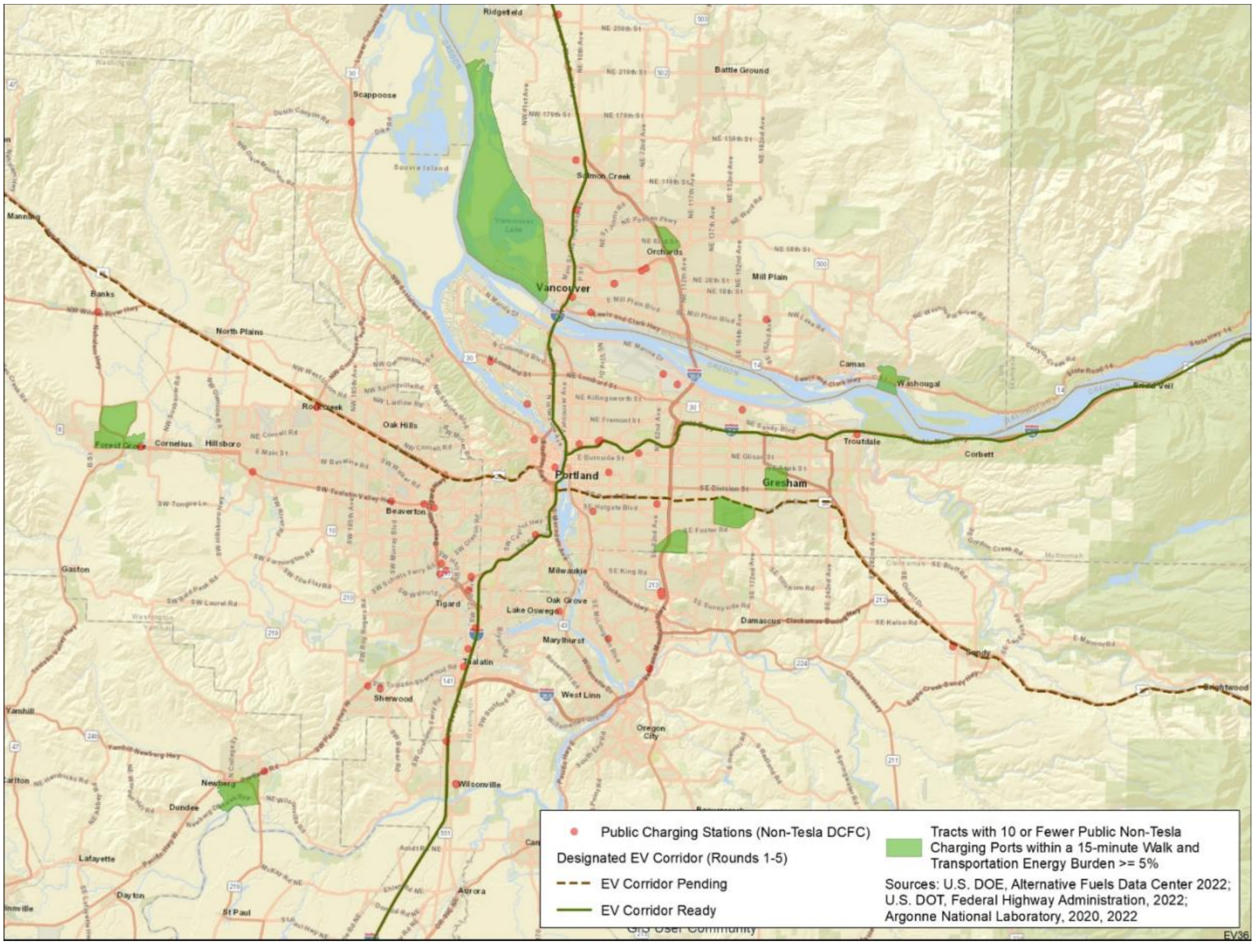

FIGURE 17 Scenario B4: Census tracts (in green) that have (1) transportation energy burden ≥ 5%, and (2) have only 0-10 public EVSE ports (DCFC or Level 2) within a 15-minute walk.

Peer Review Input for Approach B: Community Charging

Rural access community considerations: Reviewers had varying input on whether it is reasonable to assume rural communities have access to residential charging and would therefore primarily use public EV chargers to supplement residential charging. One reviewer stated that it is not reasonable to assume rural communities have residential charging and that making such assumptions can exclude disadvantaged communities from needed investments in EV charging. Rural homes may lack the electrical capacity to install home EV charging and may not have a driveway, garage, or dedicated parking location suitable for EV charging. Rural residents may also have limitations to their ability to install home EV charging due to challenges related to living in a MFH or rental property. Another reviewer stated it is reasonable to assume rural communities have access to residential charging if they own a house and do not live in multi-family housing. One reviewer suggested that addressing challenges preventing rural residents from having access to residential charging (e.g., upgrading electrical infrastructure in rural communities) may be a wiser investment than accessible public EV charging since it is less expensive and more convenient to charge an EV at home than using public chargers. Another reviewer recommended incorporating a community charging objective to ensure all rural communities have a DCFC within 50 miles of their home.

Incorporating race in a definition of underserved communities: Many reviewers commented that racial inequity is an important consideration when defining or mapping underserved communities. However, there isn't a clear best practice for how to incorporate race when creating a map for prioritizing EV charger locations.

- Scenario B2 uses EPA EJScreen demographic layers for low income, people of color, and both. These map layers have been used in previous project efforts to identify environmental justice communities. Some reviewers found these maps to be a useful visualization tool for identifying communities that have been historically disadvantaged due to racial segregation and discriminatory policies such as redlining. One reviewer commented that it would be better to show low-income communities on a separate map from communities of color and expressed concerns that showing them both on the same map can result in conflating low income and community of color to imply they are always interrelated. Another reviewer commented that there is precedent for displaying low income and community of color populations on the same map when identifying environmental justice communities. Those maps are most meaningful when assessed relative to state or region-specific averages as opposed to national averages. *This divergence in perspectives demonstrates that continued stakeholder engagement is needed to determine inclusive language and methodologies for representing communities that experience racial injustice.*
- One reviewer emphasized that it is important to include race as an indicator of disadvantage when prioritizing equity since communities of color are hit first and worst by poverty and pollution. This reviewer pointed out that race is the most important social determinant of health and serves as the most accurate data point for predicting a variety of public health injustices.
- One reviewer noted that using EJScreen "people of color percentage 80%-100%" seems like a high threshold and may exclude some EEJ underserved communities. This reviewer noted that identifying majority community of color census tracts is a priority for identifying underserved communities given the evidence of unequal access to EV chargers in communities of color even when accounting for such factors as income.

- Reviewers commented that further analysis may show that inequities in current public EV charger distribution are not universal across all communities of color but rather more prevalent for specific races or ethnicities. One suggestion was to use mapping tools to specifically look at the public EVSE density for Black communities and/or Latinx communities rather than or compared to the more generalized people of color EJScreen dataset, which encompasses all people other than non-Hispanic white-only individuals.[63] The approach of putting all communities of color in one category assumes that their experiences are universally alike. In the same way that there is no "one size fits all" approach to electrification, there is no one size fits all approach to various demographic groups.
- Similarly, reviewers emphasized that grouping all people of color into one category has limitations and may not effectively identify communities that are historically disadvantaged due to the variable in the J40 interim guidance described as "racial and ethnic residential segregation, particularly where the segregation stems from discrimination by government entities."
- Another comment that came from reviewer discussion on race as an indicator of "historically disadvantaged communities" is to be aware that there is not always substantial written history on discriminatory policy. Engaging with local communities who know the neighborhoods or towns in their region that are historically disadvantaged is often more effective than relying on mapping tools. It is also important to avoid putting too much burden on communities to show proof of disadvantage to qualify for funding opportunities.

High transportation spending: A reviewer commented that transportation spending in the high range (10-30% of income) is most common for residents in apartments and residents employed part time. Therefore, high cost burden for transportation is a relevant consideration for community charging in addition to corridor charging.

Difference between EV chargers located in a DAC and benefiting a DAC: Many reviewers emphasized the difference between locating EV chargers in a census tract identified as a DAC by a screening tool and considering that EV charger to be accessible to or somehow providing benefits to underserved and overburdened communities that environmental justice, equity, or Justice40 policies are seeking to benefit. Reviewers described scenarios where the geographic deployment of EV chargers may be perceived as equitable due to their locations but may not be serving priority populations due to the census tract's zoning (industrial, commercial, etc.) where the EV charger may be hard to reach. In other cases, the deployment may be aimed at DAC census tracts where high income populations have the most access due to the proximity of these census tracts to job centers.

Additional map layers to consider: Reviewers provided recommendations for additional map layers that can be used when prioritizing EV charger benefits for underserved communities.

- **Multi-modal transit.** Mapping data on the density of or existence of inter-modal connections (e.g., bus stops, transit stations, park-and-ride facilities) to create transit hubs.
- **Walkability.** Walkability is especially important to consider when using a public EVSE density methodology that assumes walking distances.
- **Public health**. Public health indicators such as particulate matter (PM2.5) could be used to identify communities with the greatest needs for public health improvement regardless of whether their exposure is attributable to transportation.

[63] https://www.epa.gov/ejscreen/overview-demographic-indicators-ejscreen.

- **COVID-19.** The Covid-19 pandemic has reached unprecedented and disproportionate infection and death rates as well as rippling consequences to our economic and social establishments. Transportation electrification efforts can lead to much needed air quality improvement in communities that have suffered the worst from this public health crisis. COVID-19 data could be used to identify communities most vulnerable to the effects of respiratory illness.
- **Public and affordable housing.** The National Housing Preservation Database (NHPD) is an address-level inventory of federally assisted rental housing in the U.S.[64] This data can be used to identify residents who may benefit most from affordable, convenient public EV charging.
- **Land use.** Land use and zoning maps could be used to better apply a cost–benefit analysis to charging infrastructure deployment.
- **Climate change.** Embedding current and projected climate induced landscape changes into state, regional, and national transportation electrification plans can mitigate and delay the effects of climate change. Using sea level rise data and flood maps that determine where land will be submerged can be analyzed along with fire risk data to assess where to deploy EV infrastructure, where to allocate resources, and which populations are most at risk and therefore in need of targeted investment that includes climate mitigation efforts along with transportation electrification deployment.
- **Gentrification**. Many communities have expressed concerns that installing EV chargers in an underserved community could contribute to gentrification-induced displacement. Entities identifying priority neighborhoods for public EV chargers that benefit underserved communities have expressed concern about making siting decisions expecting a particular EV charging site will be accessible to low-income residents, but by the time that EV charger is installed and ready for use, gentrification factors have forced low-income residents to move out of that neighborhood. Consideration of displacement risk could be incorporated in the process of determining whether an EV charger will likely benefit the targeted underserved community demographic or potentially have an adverse effect. Data-Smart City Solutions identifies multiple gentrification displacement risk methodologies.[65]
- **Utility investments.** There may be a need for a standard geospatial analysis of where investor-owned utilities (IOUs) have invested in deploying transportation electrification and infrastructure across the U.S. That data could be used to fill gaps more specifically targeting communities impacted by both poverty and pollution.

Combining layers: One reviewer suggested combining layers showing high transportation energy burden, which identifies people who would benefit most from transitioning from a gasoline vehicle to EV, with MFH/rental density, which identifies people who theoretically are most in need of public EV charging.

Charging level: A reviewer commented that EV charging analysis and planning efforts should separate EVSE ports by charging level and speed depending upon the objective. The length of anticipated vehicle dwell time in a particular location and the charger speed will have a significant impact on EV charger convenience and utilization.

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64 https://preservationdatabase.org/.

65 https://datasmart.ash.harvard.edu/news/article/where-is-gentrification-happening-in-your-city-1055.

Approach C: Fleet Electrification Based on Underserved Community Indicators

The objectives of Approach C are to:

- Decarbonize the transportation sector, including fleet vehicles that operate in EEJ underserved communities

- Implement the Justice40 goal that 40% of overall benefits of federal investment in EV chargers flow to DACs

Approach C identifies priority EEJ underserved communities for fleet vehicle electrification given their high levels of transportation-related emissions. The following scenarios could help communities prioritize fleet outreach efforts to gain the benefits of transportation electrification and/or prioritize funding for fleet EVs and EV chargers. It is important to note that many fleets use private refueling or charging strategies, so these approaches may not align with investments in public EV charging. However, investing in fleet EVs and private EV charging can have significant benefits for EEJ underserved communities in which these fleets operate, such as air quality improvement, increased access to clean transit, and reduced noise pollution.

Indicators of Transportation-Related Emissions

While transportation emissions contribute to air pollution and have an influence on public health, attribution of public health metrics to the transportation sector is very difficult and complicated. Local metropolitan planning organizations (MPOs) are a good source of community-specific link-based vehicle miles travelled (VMT) and/or emissions analysis.

In Approach C, traffic volume, air quality, and emission data are indicators that could be used individually or as a group to identify priority communities that could benefit from fleet electrification. The EPA Office of Air and Radiation (OAR) compiles data on the level of pollutants in the air. We use particulate matter (PM2.5) as an example here. The EPA National Emissions Inventory (NEI) data, which separates emissions by sector, might be a better alternative to identify transportation-related emissions. However, NEI data is only available at the county level. Future work needs to integrate OAR and NEI in order to develop geospatially granular data (e.g., by census tract) with national coverage. Also note that using distance-normalized traffic volume (annual average daily traffic, or AADT) is a better metric than AADT itself, which highlights the road network but not the communities. *Distance* in this case is from "major road segments" to census block centroids. "Major road segments" was defined as interstates, expressways, principal arterials, and minor arterials in urban areas.

- Traffic proximity and volume
  - Distance-normalized traffic volume (EPA EJScreen): Count of vehicles and average annual daily traffic (AADT) at major roads within 500 meters, divided by distance.[66]

- Air quality: PM2.5 levels in air in µg/m3 annual average
  - EPA OAR fusion of model and monitor data (used in Scenarios C1 and C2).

- Emissions
  - EPA NEI data separates emissions by sector and vehicle class. However, the data is only available by county.

- Location of industrial centers and transportation hubs (e.g., ports, rail yards, warehousing, distribution centers, etc.). Reliable national-scale data is lacking, so this factor is not included in this analysis.

Scenario C1—Disadvantaged Communities + High Traffic Volume

Scenario C1 uses the EV Charging Justice40 Map that displays the DOE and DOT joint interim definition of DACs available on the Argonne EV Charging Equity Considerations web page to identify communities for priority investment in fleet EVs and EV charging. We overlaid the DOE/DOT Interim Guidance DACs with traffic volume, as shown in Figure 18.

Scenario C1 Mapping Layers

- Joint DOE and DOT interim definition of DACs for Justice40 using one of the following:
  - Combined census tracts from DOT's working DAC definition and DOE's working DAC definition
  - Tribal lands
  - U.S. territories
- Traffic proximity and volume

[66] https://www.epa.gov/ejscreen/overview-environmental-indicators-ejscreen.

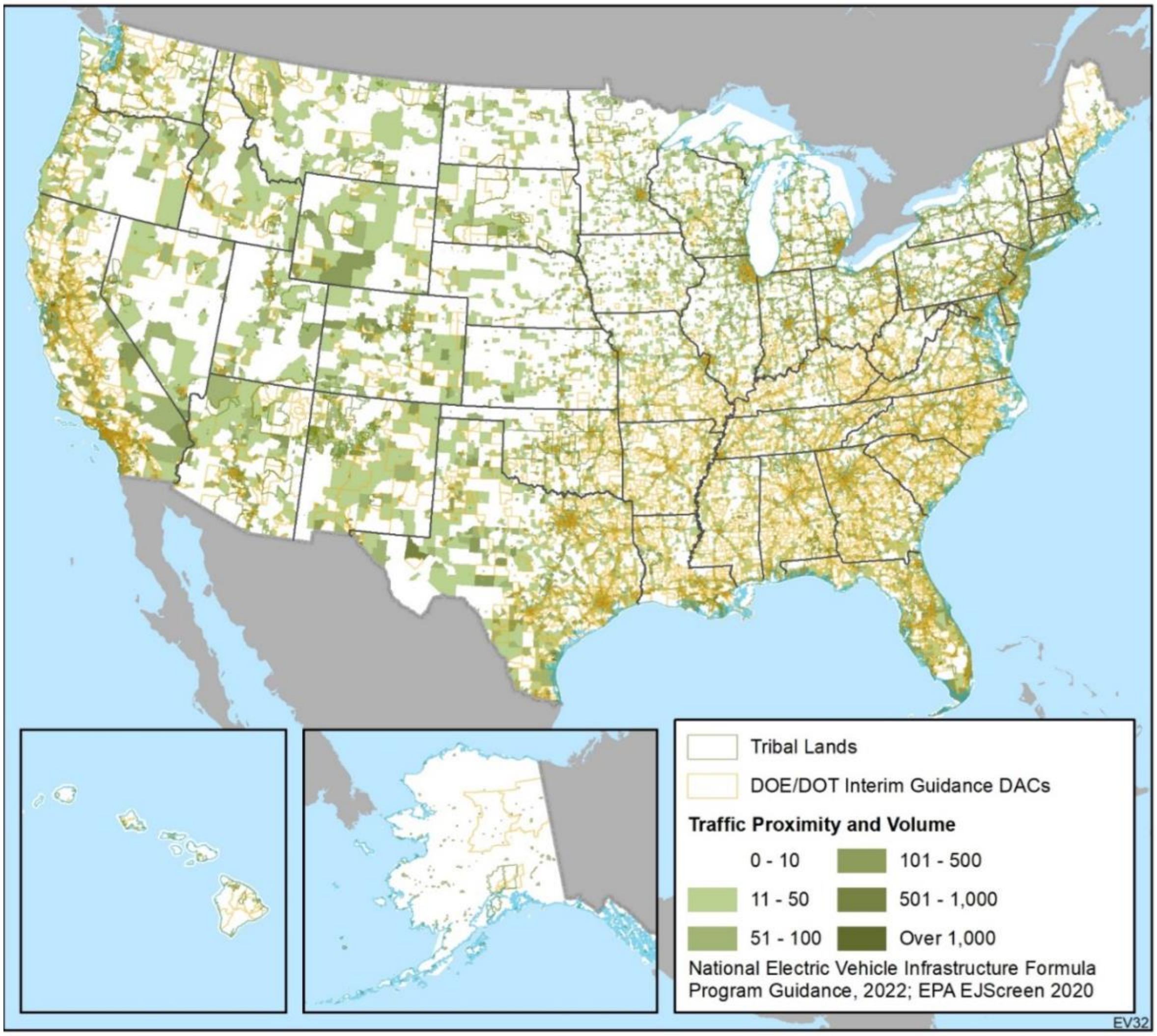

FIGURE 18 Scenario C1: Joint DOE and DOT interim definition of DACs for Justice40 + Traffic Proximity and Volume AADT at major roads within 500 meters, divided by roadway distance.

Scenario C2 – High PM2.5 + High Traffic Volume

Scenario C2 identifies the EEJ underserved communities that suffer poor air quality that could potentially be attributed to transportation-related emissions. We overlaid traffic volume data with the PM2.5 levels in air (µg/m3 annual average) reported by EPA. While it is difficult to attribute the source of the PM2.5 to transportation emissions, this map scenario could provide meaningful data visualization. Figure 19 shows census tracts with distance-weighted traffic volume and PM2.5 ≥80th percentiles in each state. It is difficult, however, to see individual census tracts at this scale. Using the Washington D.C.–Baltimore and Chicago metropolitan areas as examples, Figure 20 shows the communities in these regions that could benefit from the reduced PM2.5 levels—and reduced negative health impacts—associated with electrification. Future work could use freight traffic volume to target medium-duty/heavy-duty fleet electrification.

Scenario C2 Map Layers

- Distance-normalized traffic volume ≥80th percentile
- High particulate matter (PM2.5) levels in air ≥80th percentile
- FHWA Designated EV Corridors (both EV Corridor Ready and EV Corridor Pending)
- Public DCFC locations

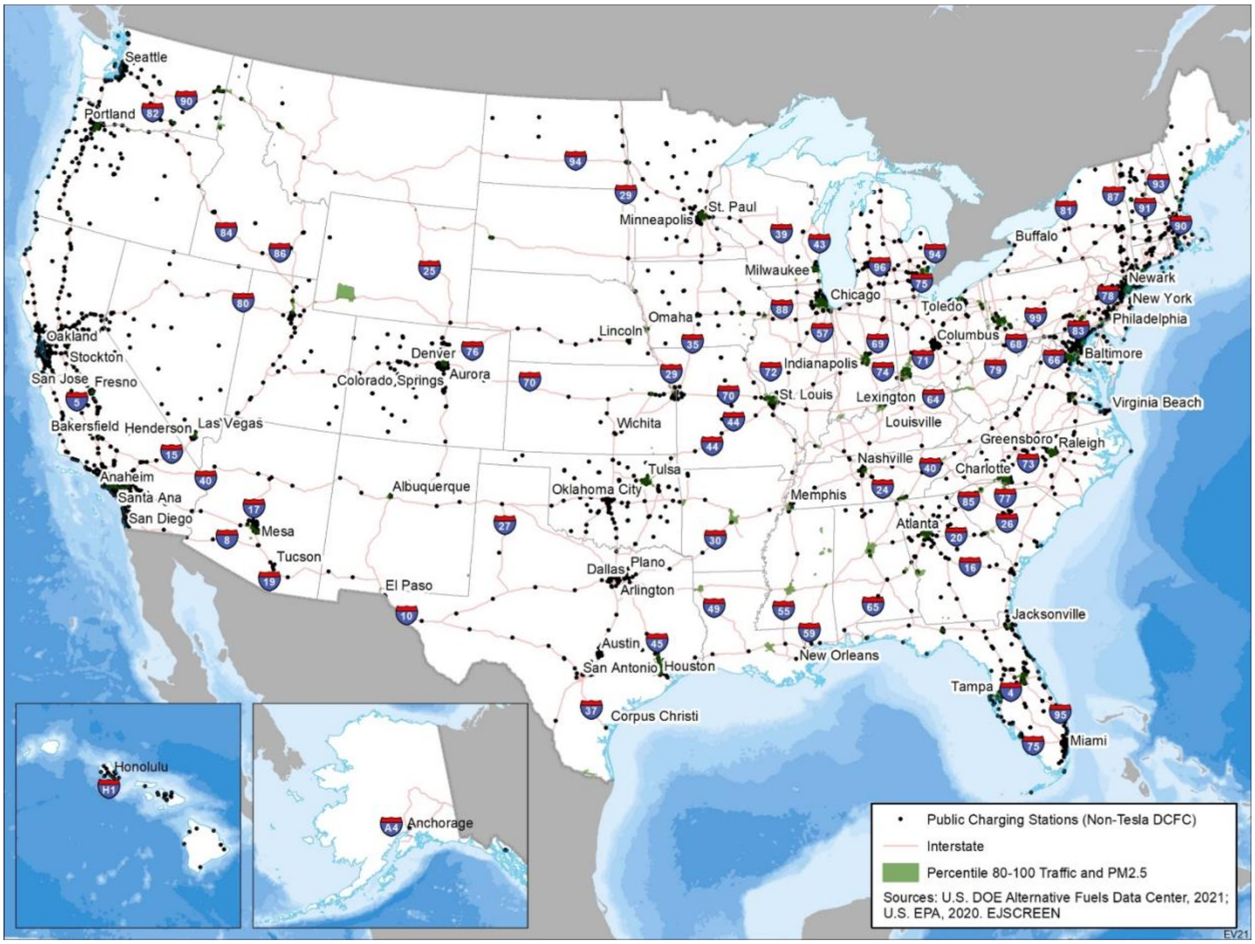

FIGURE 19 Scenario C2: Census tracts with high levels of transportation-related emissions (distance-weighted traffic volume and PM2.5 ≥80th percentile in each state).

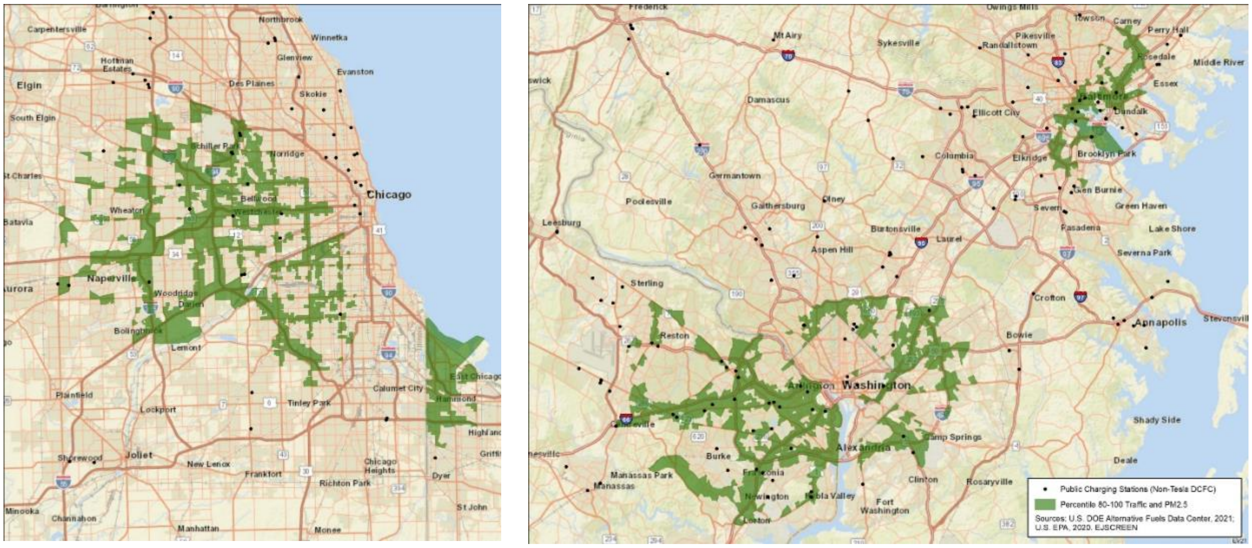

FIGURE 20 Scenario C2: Chicago (left) and Washington D.C.–Baltimore (right): Census tracts with high levels of transportation-related emissions (distance-weighted traffic volume and PM2.5 ≥80th percentile in each state).

Peer Review Input for Approach C: Fleet Charging

Heavy-duty vehicles: One reviewer commented that instead of total traffic, heavy-duty vehicle traffic volumes should be used when deploying EV charging for electrifying trucks. Another reviewer noted that heavy-duty vehicles account for more emissions, but the availability of vehicles is quite low and many of them do not use public charging infrastructure. Transit buses and school buses with depot charging are going to be one of the most widespread sectors, as well as medium-duty delivery vans.

Combining layers: Multiple reviewers suggested displaying both layers from C1 and C2 on the same map. Including multiple scenario maps and identifying overlapping areas between several map layers can be used to identify the high-priority area for EV charger investment, which is the overlapping area among several scenarios. The same principle can be applied to Approach A and B.

Aligning emissions and fleet application: One reviewer recommends developing scenarios that align metrics for particular pollutants with vehicles that predominantly emit that pollutant to accelerate the deployment of EVs in the vehicle class or application relevant to the particular pollutant type. For example, light-duty vehicles contribute NOx pollution, while medium- and heavy-duty vehicles produce PM2.5. To better reflect this, the analysis could include a scenario that looks at heavy-duty truck traffic (rather than AADT for all vehicles) combined with data for census tracts that have high PM2.5 levels and only include EV chargers that can serve the charging needs for heavy-duty trucks. A second scenario could look at AADT levels, EV chargers that can serve the charging needs for light-duty vehicles, and census tracts that have high NOx pollution levels.

Emissions exposure: A reviewer noted that overall PM2.5 exposure can come from various sources, such as adjacent agriculture property that is kicking up dust during plowing, asphalt plants, and a variety of other sources. Whether EVs reduce PM2.5 is also debatable, since heavier tire wear has the potential to increase PM2.5. NOx can be a key indicator of transportation impact, as it is a diesel combustion byproduct, so assessing NOx in addition to (or maybe even instead of) PM2.5 may be helpful. This is especially applicable to assessing medium-duty/heavy-duty electrification benefits.

Public health metrics: In general, it is easier to map public health metrics than to attribute public health metrics to the transportation sector. Reviewers recommended using public health metrics for prioritizing communities to electrify fleets. Reviewers noted the following:

- The Minnesota Department of Health and Minnesota Pollution Control Agency studied health impacts related to air quality, using hospital admissions and emergency room visit rates for asthma and chronic obstructive pulmonary disease episodes, as well as other health issues based on hospital discharge records.[67]
- It might be possible to use EPA's Benefits Mapping and Analysis Program (BenMAP) to create a mapping layer reflecting health impact costs of vehicle pollution from the current baseline.
- It could be beneficial to incorporate screening tools, such as the Risk-Screening Environmental Indicators (RSEI) toxic release/chemical release model, to identify areas currently at greatest risk for chronic health impacts and those that suffer from emissions that are indirectly related to transportation.[68]

Air quality monitoring: A reviewer commented on the importance of expanded air quality monitoring, including community-based air quality monitoring systems in addition to the regulatory monitors.

Traffic density: A reviewer commented that DACs in urban areas have less traffic, especially commuter cities that have most traffic traveling to and from work. DACs may not see benefits if the focus is on traffic density. Another reviewer suggested it would be valuable to look at high-volume traffic but remove commuter traffic, which may or may not be feasible.

Rural emissions exposure: A reviewer commented that in rural communities, emissions levels and emissions exposure may tell two different stories.

Freight corridors: A reviewer commented that once FHWA designates EV Freight corridors, that will probably be the preferred map to include for this approach.

67 https://www.pca.state.mn.us/air/life-and-breath-report.

68 https://edap.epa.gov/public/extensions/EasyRSEI/EasyRSEI.html.

Approach D—Diversity in STEM and Workforce Development

The objectives of Approach D are:

- Increase diversity in science, technology, engineering, and mathematics (STEM) jobs through EV charger placement
- Increase workforce development opportunities for EEJ underserved communities through EV charger placement
- Implement the Justice40 goal that 40% of overall benefits of federal investment in EV chargers flow to DACs

A diverse workforce is key to a successful transition to electric vehicles in the automotive industry. The current workforce does not have enough highly skilled people to meet the industry's needs. Approach D incorporates DOE's Office of Energy Efficiency and Renewable Energy (EERE) crosscutting principles to foster a diverse STEM workforce and develop more workforce training opportunities with the broader goal of deploying EV chargers that benefit EEJ underserved communities.

EERE's crosscutting principles include: "Fostering a diverse STEM workforce. We need to increase awareness of clean energy job opportunities at minority-serving institutions and ensure that organizations receiving EERE funding are thinking through diversity and equity in their own work. Developing more robust workforce training opportunities to build a pipeline for permanent, good-paying jobs for the clean energy workforce."[69]

Scenario D1 – Community Colleges and Vocational Schools in DACs

Prioritizing the EV charging benefits to EEJ underserved communities can mean offering job training to those communities so they can participate in the economic opportunities in transportation electrification. A growing EV market and investments in EV chargers will lead to many workforce opportunities, such as technicians trained to perform EV maintenance and repair or electricians trained to install and maintain EV chargers. Building partnerships with high schools, community colleges, and vocational schools located in or primarily serving DACs when developing EV infrastructure plans can engage students from DACs in the transportation electrification job pipeline and facilitate their participation in the clean energy economy.

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[69] https://www.energy.gov/eere/mission.

Scenario D1 Map Layers

- Community colleges
- Vocational schools
- Joint DOE and DOT interim definition of DACs for Justice40 using one of the following:
  - Combined census tracts from DOT's working DAC definition and DOE's working DAC definition
  - Tribal lands
  - U.S. territories

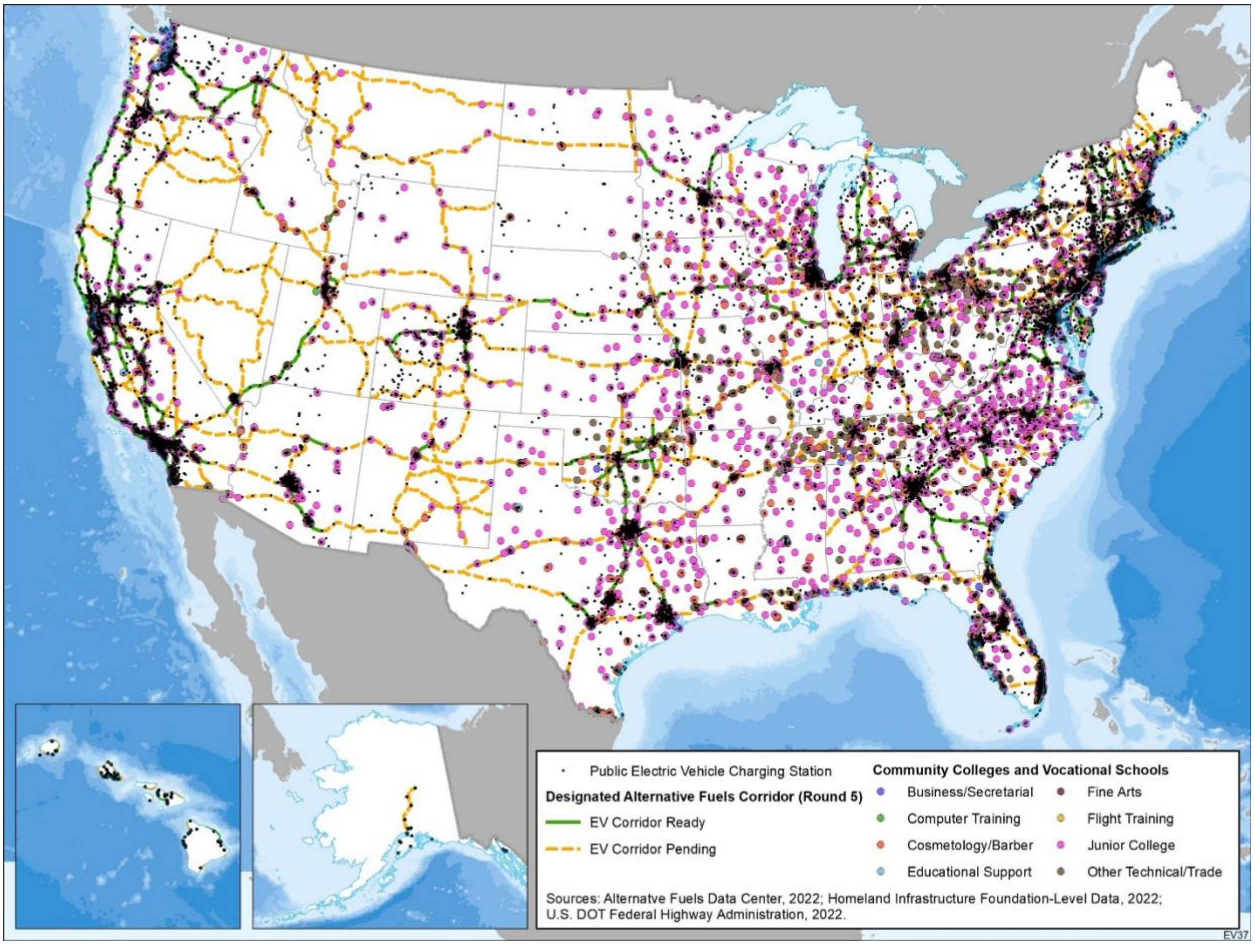

FIGURE 21 Scenario D1: Locations of community colleges and vocational schools.

Scenario D2 – HBCUs, MSIs, and TCUs + EV Corridors

Building partnerships with HBCUs, MSIs, and TCUs when developing EV infrastructure plans can engage underrepresented minorities in STEM in the transportation electrification job pipeline. An HBCU, MSI, or TCU could host a public EV charging hub and integrate it into its educational curriculum. In addition to deploying EV chargers at these educational institutions as a component of student exposure and workforce development, they can also lead to EV ride-share services at these institutions that would reduce emissions in those local areas.

The U.S. Department of Interior Office of Civil Rights provides a definition of MSI programs,[70] and the U.S. Department of Education provides a list of HBCUs and MSIs.[71] Figure 22 shows the locations of these educational institutions and public DCFCs in the United States, while Figure 23 shows HBCUs within one mile of an FHWA EV Pending Corridor.

Scenario D2 Map Layers

- HBCUs
- TCUs
- MSIs
- FHWA designated EV corridors (both EV Corridor Ready and EV Corridor Pending)
- Public DCFC stations

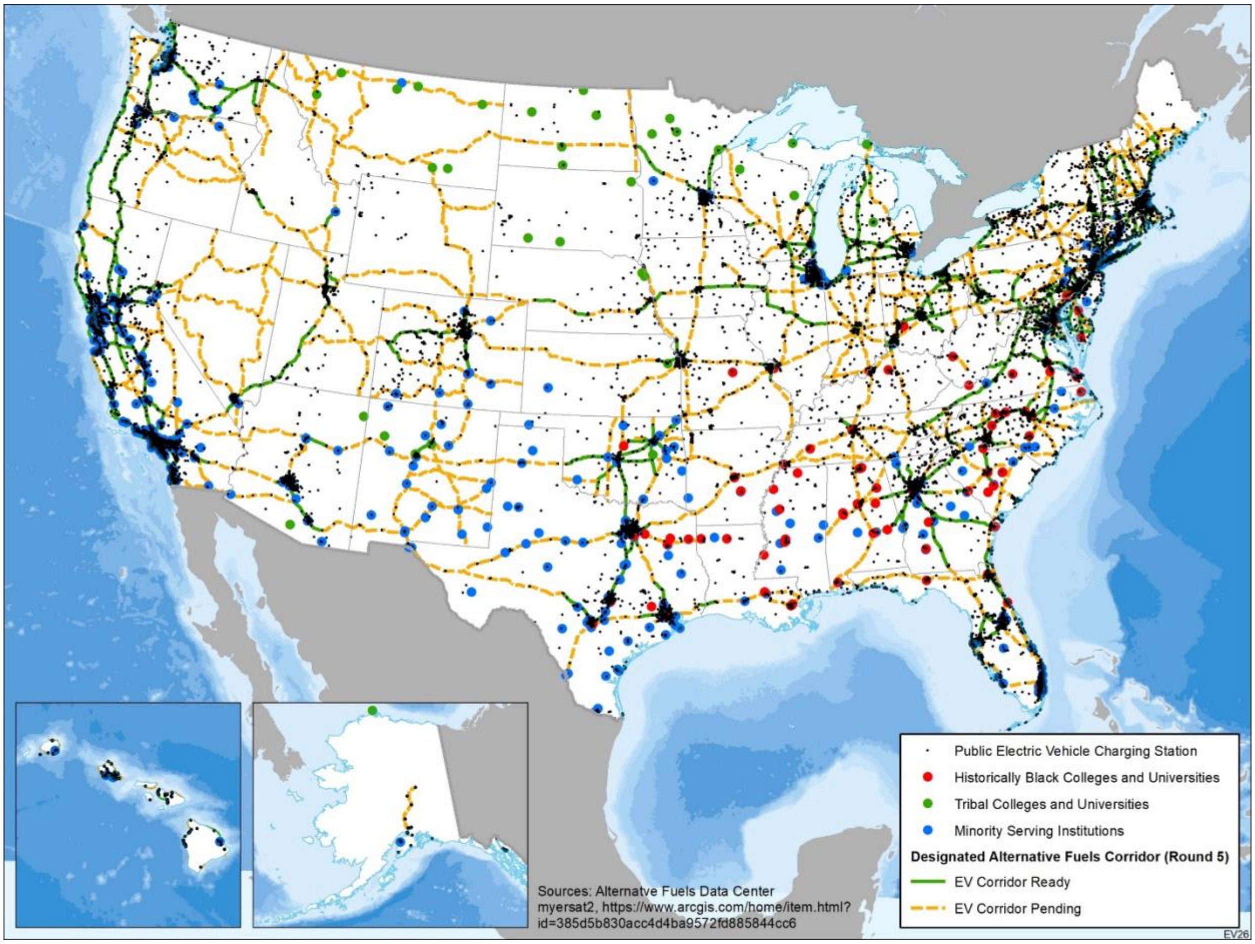

FIGURE 22 Scenario D2: Locations of HBCUs, MSIs, and public DCFCs.

[70] https://www.doi.gov/pmb/eeo/doi-minority-serving-institutions-program.

[71] https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

FIGURE 23 Scenario D2: HBCUs within one mile of FHWA EV Corridor Pending (New Orleans, LA).

Peer Review Input for Approach D: Diversity in STEM and Workforce Development

Corridor or community charging: Many reviewers commented that they had not previously thought of placing EV Corridor charging stations in locations that also contribute to diversity in STEM and workforce development, but that the idea could be an innovative approach to considering the benefits of EV charger investments. Considering the requirements to place corridor charging within one mile of a highway and the many other requirements for FHWA designated corridor charging, there will be a limited number of geographic areas where those options align with an HBCU, MSI, or TCU. This approach may be most applicable when considering investments in community charging stations.

Engaging high schools: A reviewer emphasized the importance of engaging high schools as part of diversity in STEM and workforce development efforts when planning for EV charging locations. High schools could be identified based on enrollment demographics or by leveraging the definitions of "high need local education agency" provided in the BIL for the EPA Clean School Bus Program.[72] School districts that take advantage of the EPA Clean School Bus program could also be key targets for pursuing these objectives, in programs in which students could learn about and perhaps even support their own districts' technologies in a hands-on manner.

Additional considerations:

- One reviewer suggested including federally funded job training programs in a map layer.
- Another reviewer noted that while partnerships with HBCUs and MSIs are important, EEJ underserved communities may benefit by partnering with STEM-focused universities or community colleges that are serving rural and low-income communities.
- This approach could be expanded beyond engaging underrepresented minorities in STEM to other underrepresented groups and/or workforce transition training (e.g., under-employed, formerly incarcerated, low income, etc.).
- A reviewer commented that this is a good approach, but substantial work needs to be done with academic institutions to create an accredited program around these training skills for this to be a useful strategy. Installing EV chargers to increase workforce development opportunities for underserved communities won't have the desired impact without a curriculum to train people for those jobs.

[72] See page 894 of the legislation: https://www.congress.gov/117/bills/hr3684/BILLS-117hr3684enr.pdf.

7. CONCLUSION

With growing commitments to transportation electrification investments in the U.S., the conversation about incorporating equity in transportation electrification investments is a pressing priority. The NEVI Formula Program supports the Justice40 Initiative, and states will be implementing strategies to demonstrate that 40% of the overall benefits of federal investments in EV charging benefit disadvantaged communities. However, there are many perspectives on how to define disadvantaged or underserved communities within federal and state government agencies. Specific methodologies for measuring EV charger benefits to EEJ underserved communities are needed as well as best practices for identifying EV charger locations that benefit EEJ underserved communities.

Mapping tools can serve an important role as federal, state, and local organizations seek to incorporate equity considerations in EV charger planning, implementation, and evaluation. The EV deployment objectives, geographic area, and definition of underserved communities determine which mapping layers are most relevant when identifying priority census tracts for potential EV charger locations that benefit underserved communities.

This report provides examples of objectives and map layers for four EV charger planning approaches: corridor charging, community charging, fleet electrification, and diversity in STEM and workforce development. The objectives used in the four approaches intersect and can be customized to meet specific energy and environmental justice goals. These objectives include the following:

- Build a nationwide network of FHWA-designated EV Corridors
- Accelerate equitable adoption of EVs, even by those who cannot reliably charge at home
- Implement the Justice40 goal that 40% of overall benefits of federal investment in EV charging flow to DACs
- Identify priority census tracts for DCFC placement, within one mile of EV Corridors, that benefits nearby EEJ underserved communities
- Identify priority census tracts for community EV charging (Level 2 and/or DCFC) that benefits nearby EEJ underserved communities
- Decarbonize the transportation sector, including fleet vehicles that operate in EEJ underserved communities
- Increase diversity in science, technology, engineering, and mathematics (STEM) jobs through EV charger placement
- Increase workforce development opportunities for EEJ underserved communities through EV charger placement

While some state and local government agencies have GIS analysts that can create customized scenarios based on preferred map layers and various data sources, many communities do not have access to GIS expertise or the capacity to dedicate staff time to complex analysis work. Stakeholders would benefit from a user-friendly mapping tool that provides many layer options with the ability to set customized thresholds and requirements to integrate the map layers—an on-line tool that provides optional layers such as those shown in Table 4.

Whatever the method of identifying locations for equity-focused EV charger investment, additional community engagement, and site evaluation are necessary to determine whether EV chargers are accessible, affordable, and convenient to EEJ underserved community residents as well as the benefits the local community is looking for with EV charger installations. Installing EV chargers in a census tract identified as an EEJ underserved community does not necessarily mean those EV chargers provides benefits to residents of that community.

While this report provides examples of mapping layers for visualizing underserved communities, public EVSE density, and other relevant data layers, more work is needed to develop best practices for using mapping tools in real-world EV planning scenarios. These are likely to evolve as more EV charger funding programs are implemented and more real-world data is available to measure the effectiveness of strategies for incorporating equity into EV charger deployment projects. Continued efforts to document best practices and critically evaluate whether equity-focused programs achieve their goals are broadly needed as transportation electrification proceeds at the local, regional, and national levels.

To provide feedback on this report or suggestions for map scenarios, contact the report's lead authors at yzhou@anl.gov and margaret.smith@ee.doe.gov.

TABLE 4 Potential map layers for future interactive mapping tool development.

Example Map in Report?	Map Layer	Data Source
Yes	Public EVSE density: Number of public EVSE ports within a 15-minute drive	AFDC + ANL[73]
Yes	Public EVSE density: Number of public EVSE ports within a 15-minute drive divided by number of vehicles	AFDC + ANL
Yes	Public EVSE density: Number of public EVSE ports within a 15-minute walk	AFDC + ANL
Yes	Public EVSE density: Number of EVSE ports within a given distance (e.g., 0.3 mile)	AFDC + ANL
Yes	Public EVSE density: Areas with/without access to EVSE ports	AFDC + ANL
Yes	Joint DOE/DOT Interim Guidance DAC Definition. Combined census tracts from DOT's working DAC definition and DOE's working DAC definition, Tribal lands, and U.S. territories.	DOE and DOT[74]

[73] https://www.anl.gov/es/transportation-energy-equity-analysis-and-resources.

[74] https://www.anl.gov/es/electric-vehicle-charging-equity-considerations.

TABLE 4 (Cont.).

Map Example in Report?	Map Layer	Data Source
Yes	FHWA designated EV Corridors	FHWA[75]
Yes	Public DCFC locations	AFDC[76]
Yes	High transportation energy burden	ANL[77]
Yes	People of color percentage 80%-100%	EPA EJScreen[78]
Yes	Low-income percentage 80%-100%	EPA EJScreen
Yes	Percentage of multi-unit dwellings ≥80th percentile	U.S. Census[79]
Yes	Percentage of rental housing ≥80th percentile	U.S. Census[80]
Yes	Traffic proximity and volume	EPA EJScreen
Yes	Distance-normalized traffic volume ≥80th percentile	EPA EJScreen
Yes	High particulate matter (PM2.5) levels in air ≥80th percentile	EPA EJScreen
Yes	Community colleges	NCES[81]
Yes	Vocational schools	NCES
Yes	HBCUs	ArcGIS[82]
Yes	TCUs	ArcGIS
Yes	MSIs	MSI[83]
Yes*	DOE interim guidance DAC definition	DOE[84]
Yes*	DOT interim guidance DAC definition	DOT[85]
Yes*	Tribal Lands	U.S. Census[86]
No	Climate and Economic Justice Screening Tool (CEJST)	CEQ[87]
No	New York State's draft DAC definition	New York State[88]
No	CalEnviroScreen	CalEPA[89]
No	Public health indicators, such as particulate matter (PM2.5, diesel particulate matter, etc.)	EJScreen
No	Electric Vehicle registration as a proportion of total registered vehicles – for example, BEVs + PHEVs per 1k registered vehicles (Reviewer suggestion)	Experian Automotive,[90] and IHS-Polk[91]
No	Public EVSE density: Number of public EVSE ports within 50 miles (Reviewer suggestion)	Further research/ consideration needed

75 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors.

76 https://afdc.energy.gov/fuels/electricity_infrastructure.html.

77 https://doi.org/10.2172/1760477.

78 https://www.epa.gov/ejscreen.

79 https://data.census.gov/cedsci/table?q=Single%20Unit%2FMulti-Unit%20housing&tid=ACSDT5Y2018.B25024.

80 https://data.census.gov/cedsci/table?q=C25033&tid=ACSDT1Y2019.C25033.

81 https://nces.ed.gov/ipeds/.

82 https://www.arcgis.com/home/item.html?id=385d5b830acc4d4ba9572fd885844cc6.

83 https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

84 https://www.energy.gov/diversity/justice40-initiative.

85 https://www.transportation.gov/equity-Justice40.

86 https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-geodatabase-file.2020.html.

87 https://screeningtool.geoplatform.gov/.

88 https://climate.ny.gov/Our-Climate-Act/Disadvantaged-Communities-Criteria/Disadvantaged-Communities-Map

89 https://oehha.ca.gov/calenviroscreen/about-calenviroscreen.

90 https://www.experian.com/automotive/auto-data.

91 https://ihsmarkit.com/products/polk-automotive-solutions.html

TABLE 4 (Cont.).

Map Example in Report?	Map Layer	Data Source
No	Public EVSE density: EVSE / (X% vehicle stock with access to EVSE + vehicle stock without access to EVSE)	Further research/ consideration needed
No	Qualified opportunity zones	HUD[92]
No	Electric utility service territory boundaries and electricity rates (Reviewer suggestion)	Further research/ consideration needed
No	Health impact costs of vehicle pollution from the current baseline (Benefits Mapping and Analysis Program [BenMAP] used to create mapping layer) (Reviewer suggestion)	EPA
No	Walkability scores for block groups using the National Walkability Index, which was developed using variables on density, diversity of land uses, and proximity to transit from the Smart Location Database. (Reviewer suggestion)	National Walkability Index[93]
No	Areas with access to high-speed internet/broadband (Reviewer suggestion)	Further research/ consideration needed
No	Risk-Screening Environmental Indicators (RSEI) model toxic release inventory chemical release data (Reviewer suggestion)	Further research/ consideration needed
No	Density of or existence of inter-modal connections (e.g., bus stops, transit stations, park-and-ride facilities) to create transit hubs. (Reviewer suggestion)	Further research/ consideration needed
No	Percent of public transit fleet that operates on alternative fuels including battery electric or fuel-cell electric (Reviewer suggestion)	Further research/ consideration needed
No	National Housing Preservation Database (NHPD) address-level inventory of federally assisted rental housing in the U.S. (Reviewer suggestion)	NHPD[94]
No	Covid-19 hospitalization rates or other indicators of increased vulnerability to the effects of respiratory illness (Reviewer suggestion)	Further research/ consideration needed
No	Land use and zoning maps to be used for cost–benefit analysis of charging infrastructure deployment (Reviewer suggestion)	Further research/ consideration needed
No	Indicators of populations at risk for climate change: sea level rise data and flood maps (Reviewer suggestion)	Further research/ consideration needed
No	Gentrification displacement risk (Reviewer suggestion)	Further research/ consideration needed
No	Geospatial analysis of where investor-owned utilities (IOUs) have invested in deploying transportation electrification and infrastructure (Reviewer suggestion)	Further research/ consideration needed
No	High schools, in addition to community colleges, trade schools (Reviewer suggestion)	Further research/ consideration needed
No	Housing density data that will allow analysis of EVSE density by urban, suburban, and rural areas (Reviewer suggestion)	American Community Survey
No	Streetlight locations and/or streetlight density to identify potential sites for installing EV chargers on streetlight poles (Used in a VTO-funded project)	Further research/ consideration needed
No	Points of Interest could identify potential high-usage-rate destinations for siting EV chargers (e.g., church, grocery store, library)	ANL[95]

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92 https://opportunityzones.hud.gov/

93 https://www.epa.gov/smartgrowth/smart-location-mapping

94 https://preservationdatabase.org/.

95 https://www.anl.gov/es/transportation-energy-equity-analysis-and-resources.

TABLE 4 (Cont.).

Map Example in Report?	Map Layer	Data Source
No	Cadastral data/land use parcel data, which provides housing type (single family, multi-family, condo, etc) for each housing parcel in a specific geographic area. (Used in a VTO-funded project)	Further research/ consideration needed
No	Median household income from the 2017 Census block-group level data (Used in a VTO-funded project)	U.S. Census
No	Housing tenure from the 2017 Census block-group level data, which provides the count of households in each block group that were rented and the count of households that were owned. (Used in a VTO-funded project)	U.S. Census
No	EV Registration data providing all vehicle registrations at the zip code level (Used in a VTO-funded project)	Experian Automotive, IHS-Polk

* The Joint DOE/DOT interim guidance DAC definition included a combination of the DOE interim guidance DAC definition and the DOT interim guidance DAC definition. They could be included as separate layers in a future mapping tool.

APPENDIX A: CALIFORNIA AIR RESOURCES BOARD STEP HANDOUT,[96] MAY 2021

MOVING CALIFORNIA

cleaner transportation for all communities

Sustainable Transportation Equity Project (STEP)

STEP is a new pilot that takes a community-based approach to overcoming barriers to clean transportation. STEP aims to reduce greenhouse gas emissions, increase access to key destinations, and address community residents' transportation needs by funding planning, clean transportation, and supporting projects.

Grant Types	Planning & Capacity Building Grants	Implementation Grants
Goals	Identify community residents' transportation needs and prepare to implement clean transportation projects	Increase community residents' access to key destinations without a personal vehicle
Funding	$1.75 million for 8 grantees	$17.75 million for 3 grantees
Eligible Project Types	• Community transportation needs assessments • Community engagement activities • Land use and mobility plans • Other	• Set of clean transportation and supporting projects • May include infrastructure, capital, operations, planning, policy-making, and outreach projects
Eligible Applicants	Community-based organizations, federally-recognized tribes, and local governments as lead applicants (representing a broader coalition of community, public agency, and private partners as sub-applicants)	Community-based organizations, federally-recognized tribes, and local governments as lead applicants (representing a broader coalition of community, public agency, and private partners as sub-applicants)
Priority Populations	Disadvantaged or low-income communities	Disadvantaged communities
Example Proposal	• Applicant identifies that a specific community was not well represented when conducting community engagement for a recent Transportation Plan. • Applicant applies for STEP funds to conduct a community transportation needs assessment and prioritize projects in identified under-represented community.	• Applicant identifies (through a community engagement process) seven projects for STEP funding. • These projects could include (but are not limited to) a new bus-rapid transit service, a new vanpool service, bike and pedestrian infrastructure, transit passes, a land use and mobility plan, a parking pricing program, and an outreach and education campaign to encourage active transportation.

For more information, contact STEP staff at step@arb.ca.gov or (916) 440-8284.

96 https://ww2.arb.ca.gov/lcti-step.

APPENDIX B: EQUITY CONSIDERATIONS IN TRANSPORTATION ELECTRIFICATION RESOURCES

These resources related to equity considerations in transportation electrification were compiled from peer reviewer recommendations. Argonne and DOE do not endorse any one of these studies.

- Baldwin. S., et al. 2020. *Increasing Electric Vehicle Charging Access at Multi-Unit Dwellings: Workshop Summary Report.* https://energyinnovation.org/publication/increasing-electric-vehicle-charging-access-at-multi-unit-dwellings-workshop-summary-report/.

- *Greenlining's Mobility Equity Framework*. http://greenlining.org/publications/2018/mobility-equity-framework/.

- Goetz, M. 2021. *Towards Equitable and Transformative Investments in Electric Vehicle Charging Infrastructure*. https://www.georgetownclimate.org/files/report/Towards%20Equitable%20and%20Transformative%20Investments%20in%20EV%20Charging%20Infrastructure.pdf.

- Huether, P. 2021. *Siting Electric Vehicle Supply Equipment (EVSE) with Equity in* Mind. https://www.aceee.org/sites/default/files/pdfs/siting_evse_with_equity_final_3-30-21.pdf.

- Hsu, C. W., and P. Slowik. 2021. *Electric ride-hailing charging infrastructure: Needs assessment and equitable siting in Houston*. https://theicct.org/wp-content/uploads/2021/12/ride-hail-evs-infrastructure-houston-us-oct21.pdf.

- Hsu, C. W., and K. Fingerman. 2021. "Public electric vehicle charger access disparities across race and income in California." *Transport Policy* 100: 59-67. https://doi.org/10.1016/j.tranpol.2020.10.003.

- Tolbert, J. 2021. Beyond Cities: Breaking Through Barriers to Rural Electric Vehicle Adoption. https://www.eesi.org/articles/view/beyond-cities-breaking-through-barriers-to-rural-electric-vehicle-adoption.

- Kneeland. K. et al. 2020. *Electric Vehicle Charging Access for Renters: A Guide to Questions, Strategies, and Possible Next Steps*. https://www.usdn.org/uploads/cms/documents/usdn_evchargingaccess_updatedreport_final_11.18.20.pdf.

- *Advancing Transportation Electrification in Diverse Communities: A Public Policy Toolkit for Policymakers*. https://evhybridnoire.com/wp-content/uploads/2022/01/EVHybridNoire-Public-Policy-Toolkit-1.25.22.pdf.

- California Air Resource Board's Sustainable Transportation Equity Project. https://ww2.arb.ca.gov/lcti-step

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