Equity and Energy Justice-Related Metric Development for Evaluation of State-Level Electric Vehicle Charging Infrastructure Programs

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<td>AFLEET</td>
<td>Alternative Fuel Life-Cycle Environmental and Economic Transportation (Modeling tool)</td>
</tr>
<tr>
<td>ANL</td>
<td>Argonne National Laboratory</td>
</tr>
<tr>
<td>BILD-AQ</td>
<td>Benefits of Infrastructure in Large-Scale Deployment: Air Quality (Modeling tool)</td>
</tr>
<tr>
<td>CFI</td>
<td>Charging and Fueling Infrastructure</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CO₂e</td>
<td>Carbon Dioxide Equivalent</td>
</tr>
<tr>
<td>DAC</td>
<td>Disadvantaged Community</td>
</tr>
<tr>
<td>DBE</td>
<td>Disadvantaged Business Enterprise</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>EV</td>
<td>Electric Vehicle</td>
</tr>
<tr>
<td>EVSE</td>
<td>Electric Vehicle Supply Equipment</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>Joint Office</td>
<td>Joint Office of Energy and Transportation</td>
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<tr>
<td>JUST</td>
<td>Joint Office United Support for Transportation</td>
</tr>
<tr>
<td>MBE</td>
<td>Minority Business Enterprise</td>
</tr>
<tr>
<td>NEVI</td>
<td>National Electric Vehicle Infrastructure</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulfur Oxides</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering, and Mathematics</td>
</tr>
<tr>
<td>WBE</td>
<td>Women Business Enterprise</td>
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Preface

The Joint Office of Energy and Transportation (Joint Office) established the Joint Office United Support for Transportation (JUST) Lab Consortium to conduct actionable research on integrating equity into federally funded electric vehicle infrastructure deployment efforts. As part of this effort, the JUST Lab Consortium provides this resource to key evaluation stakeholders as a starting point for planning, outreach, data collection, and data quantification efforts for equitable deployment of multibillion-dollar investments in clean transportation infrastructure. This report is a preliminary perspective and not exhaustive in scope, and the relevance and usefulness of the information provided is dependent on the project, project phase, and location. The approach to quantifying outcomes of projects will also vary by access to data and tools and the scope of measurement. Many example metrics are provided and for each project, there will be a range from accessible to aspirational measurement, and we recommend that project planners aim to address many community and policy priorities and continually refine the measurement of program performance and outcomes. Thus, this process of prioritization and refinement should be developed with community stakeholders in order to guarantee a more equitable approach and to achieve greater procedural justice. We also identify metrics that might be a good starting point for each of the policy priority areas. We selected those metrics, referred to as "starter metrics," based on accessibility criteria such as data availability, existing tools, and resourcing requirements. With current publicly available data, these metrics should be attainable with minimal resources and are thus a good place to start. To support the achievement of more equitable outcomes in the deployment of EV infrastructure, technical guidance to recipients of electric vehicle supply equipment investment programs — such as the National Electric Vehicle Infrastructure (NEVI) Formula Program—will be ongoing with other resources made available in the future.

Executive Summary

As part of the Justice 40 Initiative, the White House developed eight key policy priorities. Spanning four of the policy areas and multiple dimensions of justice: distributive, procedural, recognition, and restorative, this report provides examples of metrics within an equity-oriented framework to help maximize benefits for disadvantaged communities (DACs), “historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure, and healthcare” (Exec. Order No. 14,008, 2021).

<table>
<thead>
<tr>
<th>Four Key Justice40 Policy Priorities for underserved communities</th>
<th>As covered in this paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the clean energy job pipeline and job training for individuals from DACs</td>
<td>Economic opportunity and jobs</td>
</tr>
<tr>
<td>Decrease environmental exposure and burdens for DACs</td>
<td>Environmental benefits</td>
</tr>
<tr>
<td>Increase parity in clean energy technology</td>
<td>Access to electric vehicles and charging</td>
</tr>
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Quantifying these metrics that result in just and equitable outcomes for national project planning and implementation is challenging. The authors consulted emerging best practices and current research in the equitable planning and deployment of clean energy infrastructure for each of the four policy goals above. For each of the four policy priorities above, the report discusses the following:

- Key considerations and limitations.
- Examples of equity-related metrics.
- Data sources.
- Available tools/modeling.
- Case studies of metrics.
- Metric limitations and data gaps.

Some takeaways for each of the four key policy areas are as follows:

- **For economic impacts**, a number of data sources exist such as job statistics and reporting requirements for the Davis-Bacon Act, but no formal data channels or reporting systems are in place for worker training programs and outcomes. Similarly, the JOBS tool from ANL can be a useful starting point to estimate employment impacts, but analogous tools for worker training are not available. State agencies will need sufficient resources to set up processes to collect more data on jobs and worker training and to analyze and interpret the data.

- **For environmental impacts**, the metrics discussed here are all measured against a counterfactual scenario (i.e., reductions, savings, or changes against a counterfactual or baseline scenario). This type of quantification thus requires dedicated, complex analysis and modeling to accurately determine air quality and health outcomes. It is essential to comprehend the available tools, recognizing their strengths and limitations (e.g., modeling tools excel in simulating investment planning, while sensors and monitors prove valuable for program evaluation). State agencies can use existing resources (e.g., regulatory monitors, the BILD-AQ tool, the AFLEET tool) to help quantify air quality and health outcomes.

- **For access to EVs and charging**, mapping tools such as ANL’s Energy Zones Mapping Tool help to provide insights on access across many domains, including corridor and community charging, fleets, and associated co-benefits of workforce development. Analysis of access metrics can help policymakers and transportation planners determine where barriers remain for both EV purchase and EVSE access gaps. By layering EVSE metrics and demographic data on visualizations, planners have the ability to make informed decisions to meet strategic goals.

- **For energy democracy**, community participation early and throughout all project stages is critical for a just and resilient clean energy transition. Community participants—individuals and advocacy organizations—should fully represent the social composition of the community, especially those who have been historically marginalized and burdened by pollution and underinvestment. Empowering communities with decision-making, long-term governance, and asset ownership increases equity in energy policies and implementation and narrows the divide between community and governance.
1. Introduction: The Justice40 Initiative, Joint Office of Energy and Transportation, and JUST Consortium

1.1 Justice40 Initiative

The Justice40 Initiative, announced by President Biden in 2022, highlights the importance of achieving equitable outcomes in federal investments. Specifically, the federal government has made it a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities (DACs). The categories of investment within the Justice40 Initiative include climate change, clean energy and energy efficiency, clean transit, affordable and sustainable housing, training and workforce development, remediation and reduction of legacy pollution, and the development of critical clean water and wastewater infrastructure.

Programs covered by the Inflation Reduction Act (The White House 2022), the bipartisan Infrastructure Investment and Jobs Act (The White House 2023b), and the American Rescue Plan (The White House 2023a) with investments in any of the above categories can also be considered covered by the Justice40 Initiative. All Justice40 covered programs are required to engage in stakeholder consultation and ensure that community stakeholders are meaningfully involved in determining program benefits. Covered programs are also required to report data on the benefits directed to DACs.

Clean transportation is a key pillar for equity-focused infrastructure investments. In particular, the Infrastructure Investment and Jobs Act is the largest investment in infrastructure since the New Deal and contains several provisions for electric transportation, including $7.5 billion in funding for electric vehicle (EV) charging infrastructure, $5 billion for electric school buses, and $5.6 billion for electric transit buses (JO site; Satterfield and Shefter 2022). The Inflation Reduction Act adds and expands tax credits for purchases of new and used EVs, provides incentives to electrify heavy-duty vehicles like school buses, and includes support for the installation of residential, commercial, and municipal EV charging infrastructure (The White House 2022).

1.2 Joint Office and the JUST Lab Consortium

The Joint Office of Energy and Transportation (Joint Office) supports the deployment of zero-emission, convenient, accessible, and equitable transportation infrastructure. The Joint Office was created through the Infrastructure Investment and Jobs Act and facilitates collaboration between the U.S. Department of Energy and U.S. Department of Transportation. This collaboration will support the buildout of a nationwide network of EV chargers, zero-emission fueling infrastructure, and zero-emission transit and school buses by aligning resources and expertise to achieve this strategic goal. This alignment will include unifying guidance, technical assistance, and analysis for multibillion-dollar clean transportation deployment programs in charging infrastructure and low- to zero-emission transit and school buses. Key Joint Office stakeholders include states and communities, tribal nations, school districts, and transit agencies.

The Joint Office established the Joint Office United Support for Transportation (JUST) Lab Consortium to conduct actionable research on integrating equity into federally funded EV infrastructure deployment.
efforts. The JUST Lab Consortium provides technical support to Joint Office staff and its constituents with a focus on an equitable and clean transportation transition. This includes state-of-the-art analysis capabilities to inform the planning and implementation of clean transportation policies and programs that maximize benefits for underserved communities.

**Overarching Policy Priorities for the JUST Lab Consortium**

1. Decrease energy burden in DACs
2. Decrease environmental exposure and burdens for DACs
3. Increase access to low-cost capital in DACs
4. Increase the clean energy job pipeline and job training for individuals from DACs
5. Increase clean energy enterprise creation (minority-owned or diverse business enterprises) in DACs
6. Increase energy democracy, including community ownership in DACs
7. Increase parity in clean energy technology access and adoption in DACs
8. Increase energy resiliency in DACs

2. Assessment Framework

An important component for meeting the Justice40 goals is a well-defined framework and methodology for identifying, measuring, and reporting equity-related benefits and burdens experienced by DACs. Metrics and indicators are essential to identify opportunities, barriers, and progress toward achieving a more equitable and just energy transition.\(^1\) Metrics are measures that aim to quantify, approximate, or even translate aspects of social, economic, or environmental conditions; assess and evaluate a program; allocate resources; estimate the availability of public/private goods and services in a given location; and/or provide goods and services by institutions and organizations (United Nations 1989). These metrics can be developed by combining demographic indicators related to education, gender, race, family, or institutional safety nets with indicators that measure accessibility and affordability of energy resources (Romero-Lankao and Nobler 2021). Calculating specific metrics of energy justice and equity can be challenging; and often begins with understanding historical and systemic injustice, identifying ways to remedy harm and do so in a way that recognizes what is essential to the people affected (restorative and recognition justice). That provides a starting point for the metrics offered here which are mostly based in distributive and procedural justice\(^2\), and make defining equitable outcomes for EV charging infrastructure a little clearer.

While different sectors—federal, state, and local governments; regulators; industry; private sector;

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1 Here we use the term “metrics” to describe a quantitative measurement for a qualitative phenomenon that can help measure a specific equity outcome. However, in certain literature (Blanco and Rosner 2023; Januzzi 2021), “indicators” are used as “a representation of a relevant equity outcome that can be used to establish the state of equity at a given point in time and is useful in collecting baseline equity measurements” (Januzzi 2021). As we acknowledge why those terms are used interchangeably in this analysis and most of the Justice40 documents and resources, we also want to highlight that understanding their differences can help in assessing and evaluating energy equity outcomes in a set of programs.

2 Distribute justice seeks to ensure the fair distribution of benefits and burdens associated with, in this context, energy and transportation systems. Procedural justice aims to achieve equity by including individuals and communities impacted by energy and transportation systems to a fair process to determine relevant aspects of those systems (Romero-Lankao and Nobler 2021).
nonprofits; and community-based organizations, among others—use various metrics to measure benefits and programs (mainly in terms of affordability), it is necessary to include other groups of indicators to assess the achievement of Justice40 goals and priorities of equitable outcomes in the deployment of EV infrastructure. This can be achieved by building a more robust equity measurement methodology with a set of indicators that assess equitable outcomes in a broader way, incorporating not only economic benefits and burdens, but also environmental benefits, accessibility, and energy democracy metrics.

Because equitable transportation electrification is contingent on meaningful, community-derived metrics (Carreon et al. 2022), the framework we offer begins with an overarching community engagement goal. It then identifies metrics that help policymakers and investors understand the role of electric vehicle supply equipment (EVSE) investments and their effects in communities. Until recently, EVSE investments came from the private sector where commercial viability was the key factor, rather than equity. Some analysis of recent trends indicates that looking at EVSE from a commercial perspective alone will not guarantee social and equity goals for EV adoption (Hopkins et al. 2023). Similarly, using optimization models that focus exclusively on vehicle miles electrified will not create an even playing field to reduce barriers for access to EVSE. Hopkins et al. (2023) highlight the need for metrics that show change occurring equally across an area or population (e.g., per-capita share of EV resources), as well as metrics that show equality (e.g., location of EVSE placement). In the latter, variation of needs of different people such as income and cost burdens are considered.

Our framework helps planners and practitioners identify what information and data are needed to determine progress, evaluate outcomes, and siting to achieve more equitable outcomes in EV investments and infrastructure—especially in DACs. To measure benefits of any intervention, investment, policy, or procedure, our framework must first ask fundamental questions. In order to measure benefits, we developed a framework that first addressed the following considerations:

- **Metric quantification.** There is a wide range in the ability to quantify the impact of EVSE investments on the equity-related metrics described here (economic opportunities and jobs, environmental benefits, access to EVs and charging, and energy democracy). Some metrics can be obtained more readily from existing data sources and/or modeling tools (e.g., jobs), but other categories are more difficult to quantify due to multiple confounding factors (e.g., environmental benefits, affordability, housing displacement) and/or lack of data (e.g., number of decision-making roles held by community advisors). In addition to benefits such as jobs and training sessions, burdens such as unwelcome gentrification or housing displacement are important to keep in mind, although metrics for these burdens are not fully captured here.

- **Check metric assumption.** When quantifying key metrics with a given approach or tool, it is important to understand the key assumptions and limitations underpinning that quantification approach or tool to ensure the greatest applicability and accuracy.

- **Resource requirements.** The Joint Office recognizes that individual state offices may require additional staff to develop or identify assessment approaches, collect data, analyze data with in-house capability or publicly available modeling tools, and quantify these metrics. Each of these tasks may also entail further staff training, multi-office coordination and communication, and
development or establishment of new business practices. To that end, the Joint Office plans to provide more support in the form of additional training guides, tools, and models in the future.

- **Metric reporting and terminology.** When reporting key metrics, it is important to be precise in reporting the context and terminology of that metric to convey the most meaningful information. For example, stating that “the project generated 50 jobs” is not particularly helpful because 50 jobs with a duration of 2 days each is very different from 50 jobs with a duration of 4 years each. A description such as “50 jobs, each with a span of 4 years” would be preferred; “200 job-years for project development and construction” would be more even more informative.

- **Community engagement.** Because the exact quantification of some of these metrics is quite challenging, the Joint Office also sees the value of community partnership and outreach in the form of community meetings, focus groups, and/or surveys to gain a qualitative understanding and better awareness of community impacts of EVSE investments.

Accounting for those considerations allows for fine-tuned performance measurements targeting specific equity priorities, as well as the assessment of project success. In the process diagram shown in Figure 1, the starting point is to prioritize benefits—articulate what should be achieved and for whom by defining goals and outcomes. For each of the policy areas presented in this report, goals and outcomes are defined at the start. As an example, an environmental policy goal is to improve air quality. If that is achieved, outcomes of community health and quality of life improvements are likely to follow. The next step in the process is to get situated at a baseline by finding the information available for metrics that can define actions and drive goals toward outcomes. From there, program design is bolstered by defining those metrics that are attainable, reliable, and credible. With those in place—goals, metrics, and outcomes—the project can be actioned with agility to adjust and recalibrate as planning or project phases come to their end.

![Figure 1 Equitable Performance Measurement Process](image)

The process chart in Figure 1 and the example equity metrics in Table 1 offer a framework to develop a...
strategy and assess outputs and outcomes that allow for the understanding of how clean transportation projects impact communities. Accompanying goals and outcomes in Table 1 are a few example metrics related to EV charging for each of the four Justice40 policy areas presented in this report. The effectiveness of these metrics in driving equitable outcomes is furthered by incorporating community engagement strategies at the beginning of the process. Therefore, economic opportunities, environmental benefits, access to EVSE, and energy democracy are achieved more equitably when the community is represented and participating in ways that are driving processes and decisions throughout the life cycle of the project.

Some of the listed example metrics in Table 1 can be more challenging to gather than the others. Considering the state of knowledge, data availability and resource demands, the authors have indicated a set of more accessible metrics, referred as “starter metrics”, in bold throughout this document. The authors recommend starting with these metrics as they offer a practical and accessible starting point. The required tools, considerations and demonstration for these starter metrics are available in each Policy Priority section.

**Table 1 Equity Goals, Outcomes, and Example Metrics across Four Priority Policy Areas**

<table>
<thead>
<tr>
<th>Community Engagement Goal</th>
<th>Policy Area</th>
<th>Economic Opportunities</th>
<th>Environmental Benefits</th>
<th>Access to EV Charging</th>
<th>Energy Democracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determining benefits and burdens from clean transportation infrastructure will be made through meaningful community engagement that (1) ensures representation aiming to mirror the composition of the community, including those denied systematic fair, just, and impartial treatment; and (2) ensures direct participation with the community early and often to the level of consultation, collaboration, and enablement of community-driven processes and decisions.</td>
<td>Policy Goals</td>
<td>Increase job training, good jobs, and wealth</td>
<td>Improve air quality and reduce negative health impacts</td>
<td>Reduce costs and increase access to EV charging</td>
<td>Increase equity, governance and ownership in energy assets and systems</td>
</tr>
<tr>
<td>Example Metrics</td>
<td></td>
<td>• Number of people hired with addresses in DACs</td>
<td>• Air quality improvements in DACs</td>
<td>• Number and percent of EVSE installed in DACs</td>
<td>• Percentage of community members in roles of governance and decision-making that span the project life cycle and represent DACs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Number of jobs offered in DACs</td>
<td>• Decrease in indirect greenhouse gas (GHG) emissions (from electric grid) in DACs</td>
<td>• Number of charging ports normalized by DAC population</td>
<td>• Completion of a community needs assessment that (1) determines current travel behaviors, (2) measures community understanding and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Number of jobs offered in DACs vs. total number of people or jobs offered</td>
<td>• Decrease in direct GHG emissions (from tailpipes) in DACs</td>
<td>• Percentage of DAC population that lack access to EVSE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Number of clean-energy-related job trainings for DACs</td>
<td>• The shift in disparity in asthma among citizens inside and outside the DAC</td>
<td>• The number or percentage of EVSE in DACs with alternative payment options such as non-credit card payment options</td>
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<tr>
<td></td>
<td></td>
<td>• Number of people trained from DACs</td>
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<tr>
<td></td>
<td></td>
<td>• Number of training events in DACs</td>
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</tbody>
</table>
• Number of certifications or completed trainings for DAC residents
• Number of trainees that received jobs for DAC residents
• Dollars spent on job training programs for participants from DACs
• Number of participants from DACs in job training, apprenticeship, and science, technology, engineering, and mathematics (STEM) education programs

• Rate of asthma emergency room visits and cardiovascular disease vs. average non-DAC residents
• The rate of pediatric asthma morbidity inside and outside of DACs
• Monetized savings from improved health outcomes in DACs
• Increase in the number of “healthy days” reported in DACs
• Change in the number of school loss days for children with asthma

• The availability of charging ports in DACs (uptime)
• The adoption rate of EV/PEVs in DACs delineated by proximity to EVSE
• EVSE electricity rate compared to residential rate
• Count of free charging incentives offered by carmakers and consumer willingness to purchase based on free charging incentives

| Equitable Outcomes | Improved livelihood and basic well-being | Improved health and quality of life | EV charging is widely accessible, available (functioning equipment), and affordable | Communities gain governance and ownership in the energy transition |

2.1 Unique Considerations

There are three unique considerations to developing just and equitable deployment of clean transportation infrastructure: how to consider historical bearing, define communities, and define meaningful engagement.

2.1.1 Considering Historical Bearing

To address the embedded systemic inequities of injustice in federal infrastructure projects, we must consider historic underinvestment and environmental burden due to racial segregation and other marginalization. For equitable implementation of current and future transportation investments, considerations such as race, wealth, and health gaps must be addressed. Success will rely on the meaningful engagement of communities, especially communities who have been historically marginalized.
2.1.2 Defining Communities

Communities can be people within geographic boundaries such as what is defined by census tracts. Communities can also define groups dispersed geographically who share a common identifier such as migrant workers. Specific to Justice40, 40% of the overall benefits of federal investments from covered programs should flow to DACs, defined as having been “historically marginalized and overburdened by pollution and underinvestment in housing, transportation, water and wastewater infrastructure, and health care” (Exec. Order No. 14,008, 2021). Census tracts identified as DACs are available through the Climate and Economic Justice Screening Tool (Council on Environmental Quality 2023). In addition, federally recognized tribal lands and U.S. territories, in their entirety, are categorized as DACs. A fair and just deployment of clean transportation infrastructure should consider all communities who have been denied systematic fair, just, and impartial treatment, including Black, Latino, Indigenous, Native American, Asian American, Pacific Islander, and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; women; immigrants; veterans; individuals with disabilities; individuals in rural communities; individuals without a college degree; individuals with or recovering from a substance abuse disorder; justice-involved individuals; and individuals otherwise adversely affected by persistent poverty or inequality (U.S. Department of Energy 2023). Further identification and inclusion of specific stakeholders and organizations may include project developers/owners, labor unions, neighborhood associations, community-based organizations, faith-based organizations, or environmental groups.

2.1.3 Defining Meaningful Engagement

Best practices for engaging community in ways that are meaningful and effective for equitable and just impact are based in representation and decision-making roles. Meaningful engagement requires maximum representation of the social composition of a community, as well as providing access and ability to decision-making roles from the beginning in an “intentional, dynamic process that continues throughout all stages of project development” (U.S. Department of Transportation 2022b). Meaningful engagement is critical for efficient adoption and viability of clean transportation infrastructure, and including communities impacted by previous harm avoids exacerbating inequity. Early engagement leads to understanding and inclusion of community concerns and priorities. Further, such proactive engagement brings focus to minimizing potential disbenefits (Zhou et al. 2022).

The U.S. Department of Energy urges project teams to build trust, ongoing relationships, and partnerships with impacted communities, and to apply community input in key project decisions such as siting, design, implementation, and continuous improvement. A current resource used by government agencies, including the Joint Office, is The Spectrum of Community Engagement to Ownership (González 2019), which outlines a pathway to increase meaningful citizen participation: from merely informing the public to consulting, involving, collaborating, and empowering them to bridge the divide between community and governance.

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3 Requirements to meet meaningful public engagement and participation are further established under Title VI of the Civil Rights Act of 1964, the National Environmental Policy Act of 1969, Executive Order 13175 “Consultation and Coordination with Indian Tribal Governments,” and other existing requirements.
3. Policy Goals, Metrics, and Outcomes

Historically, transportation metrics generally provide a one-dimensional perspective of mobility, environmental, and economic issues. These metrics do not help us fully understand complex topics with overlapping implications and may not provide accurate insights in rapidly changing communities. For example, environmental effects, positive (e.g., air quality improvement due to EV fleet increase in a neighboring community) and negative (e.g., air pollutants leakage across geological boundaries), can be challenging to monitor even with appropriate resources and cross-border collaborations accurately. The primary objective of this section is to help states understand the resources available to measure the impact of NEVI investments in their communities, at a local level. The metrics and outcomes provided in this area are not exhaustive; instead, they provide some starting examples to assist with equitable planning and deployment of clean transportation infrastructure.

3.1 Policy Priority: Economic Opportunities and Jobs

Here we focus on metrics and considerations for job creation and workforce development including related discussions on contracting, economic activity, and wealth creation.

DACs generally have high unemployment and historical lack of public and private investment. This can lead to a lack of good jobs with living wages. This fundamental shortfall in economic opportunity leads to a negative cycle of higher precarity and higher stress, contributing to loss in well-being and more adverse health outcomes. Other employment barriers may include a lack of education, training, employable skills, and access to locations with higher job densities (due to lack of either private or public transportation).

A major policy goal is to improve economic outcomes in DACs by investing in these communities in support of the transition to a zero-net-GHG economy, thereby providing more economic opportunities to improve livelihoods and basic well-being. Improved economic outcomes can take the form of direct hiring, education, and training programs in specific areas such as electrical work and construction, apprenticeships, and STEM education programs. Such hiring and training programs can also lead to more career opportunities and higher incomes. As residents receive more training and experience, they may find their expertise in greater demand and will be in a better position for further installation and business development opportunities.

Specific aspects and considerations for several topics related to economic outcomes are described below.

- **For contracting**, businesses located within DACs can also be awarded contracts to deploy chargers through the NEVI Formula Program and the Charging and Fueling Infrastructure (CFI) Discretionary Grant Program. Tracking these contracts provides insight into how funding opportunities are flowing directly into businesses located within DACs, such as the number of contracts to Justice40-determined businesses (women-owned, minority-owned, veteran-owned, and/or economically disadvantaged businesses).
- **Certification of DBEs** is included within the notice of proposed rulemaking.\(^4\)

\(^4\) Certification of DBEs is not expected to change in the final rule (U.S. Department of Transportation 2022a).
• **For economic activity**, the presence of additional EV chargers can increase activity at local businesses (e.g., restaurants, stores). An example metric is the proportion of EVSE investments in DACs. The increase in local revenue can represent a substantial boon to businesses—analagous to gas stations, where most profits originate from concessions rather than the sale of gasoline. While some revenue and profit will flow to site hosts through the sale of electricity from chargers, the indirect economic activity associated with charging vehicles may outstrip these revenues.

• **Potential metrics for economic activity** can be tracked using empirical data (such as the count of businesses within DACs that are also within proximity of a charger). However, any metrics tracking changes in revenue or profit to businesses located with DACs will require an economic analysis to gauge the counterfactual scenario in which chargers were not deployed within those communities. Proper accounting will require a vetting of the methodology used to determine the metric.

• **For wealth creation**, metrics should establish long-term economic benefits for DACs. Rather than a direct tracking of revenue or investments, this metric is intended to capture measures of growth activity or potential, such as the number of chargers owned by entities with addresses in DACs. Similar to the economic activity category, data for these metrics are likely directly available through a combination of NEVI-captured data and census/business data sets.

3.1.1 Key Considerations and Limitations within Policy Goal

It is important to clarify some commonly accepted definitions for what we mean by “jobs” in terms of job types, job duration, and net vs. gross jobs (Wei, Patadia, and Kammen 2010). At the very least, it is important to keep these distinctions in mind when the term “jobs” is referred to because the quoted numbers of jobs may be referring to different things, and two different estimates for job impacts may not be commensurable.

First, the “total jobs number” often includes three job types: the number of direct, indirect, and induced jobs:

1. A direct job is a job created by the actual government expenditure, and the wages are paid for from the funds for the project. (Note that the location of the job is more localized for discrete localized projects.)

2. An indirect job is a job created by the expenditures the suppliers make to produce the materials used for the project. The cost of this would be included in the cost of the materials. (Note here that the location of the jobs could be geographically diverse or even span international boundaries.)

3. An induced job is a job created elsewhere in the economy as increases in income from the direct government spending lead to additional increases in spending by workers and firms. (Here again, the location of jobs could be very dispersed if energy and cost savings accrue widely across a large regional area.)

Second, it is important to specify a job’s duration or job-years, where 1 job-year is equivalent to one full-time job for a duration of 1 year. For example, construction jobs associated with discrete projects are of limited duration, whereas operations and maintenance work can be ongoing (and actually vary) over the lifetime of the project. A statement like “5,000 jobs were created” is not so meaningful if the job duration for these jobs is only a few months or less.
Third, it is important to keep in mind net vs. gross jobs. For example, massive increases in solar and wind will definitely increase the jobs in those industries (increase in gross jobs) but may result in some job losses in those industries that are being displaced (e.g., coal, natural gas). Ideally, this should be accounted for to estimate an overall or net jobs impact (gross jobs created less those that are eliminated). This is important because some of those job losses may occur in the area where the new investment is occurring (e.g., a gas station may close and its employees lose their jobs if there are far more EVs and several new charging stations nearby). Full economic models such as input/output economywide models can capture net job impacts, but often what is quoted for large infrastructure projects is impact to gross jobs. Another important consideration is the job quality—for example, minimum wage jobs with limited opportunities for career advancement and income growth vs. jobs that provide a living wage and pathways to more opportunities and higher incomes.

3.1.2 Example Metrics (starter metrics in bold)

Primary metrics for job creation associated with large infrastructure investments include the total number of jobs supported and the duration of those jobs (or job-years). For example, the most recent official estimate of the impacts of infrastructure investment on employment was generated by the Executive Office of the President’s Council of Economic Advisers, who estimated that every $1 billion in federal highway and transit investment funded by the American Jobs Act would support 13,000 jobs for 1 year, or 13,000 job-years (U.S. Department of Transportation Federal Highway Administration 2023). Note that this estimate includes direct, indirect, and induced jobs; 64% of the job-years are direct and indirect jobs, while 36% are induced jobs. In this case, it is not clear if the jobs estimate refers to net or gross jobs, but it is generally advisable to assume that quoted job impacts are gross job impacts rather than net job impacts unless otherwise noted.

This type of rule of thumb is helpful to give general estimates for total number of jobs supported for a given amount of infrastructure investment, but in the equity and environmental justice context, an additional challenge is to estimate or quantify how many of those jobs are in DACs. In other words:

1. Number of people hired with addresses in DACs.
2. Number of jobs offered in DACs.
3. Number of jobs offered in DACs vs. total number of people or jobs offered.

Similar to the creation of jobs, the deployment and maintenance of infrastructure will require a workforce with specialized skill sets. This workforce will likely undergo specific training, and by presenting training opportunities to DACs, the opportunities associated with workforce development will flow to communities supported under the Justice40 Initiative.

Some job training metrics include (starter metrics in bold):

1. Number of clean-energy-related job trainings for DACs.
2. Number of people trained from DACs.

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5 Here, when “job location” is referred to, for convenience we mean where the employee resides. In other words, “50 jobs located in the DAC of interest” means the 50 employees live in the DAC. The actual place of work in this usage can be in the DAC of interest but does not have to be.
3. **Number of training events in DACs.**
4. Number of certifications or completed trainings for DAC residents.
5. Number of trainees that received jobs for DAC residents.
6. Dollars spent on job training programs for participants from DACs.
7. Number of participants from DACs in job training, apprenticeship, and STEM education programs.

In general, the total number of jobs is more readily estimated than the number of jobs for residents in DACs because state and federal labor offices do not typically track job locations at the spatial granularity needed for estimating the fraction of jobs located in DACs. The total number of jobs can be estimated from past official sensitivities (e.g., U.S. Department of Transportation Federal Highway Administration 2023) or by using the publicly available JOBS EVSE tool from Argonne National Laboratory (ANL). For the number or fraction of jobs located in DACs, other data sources would need to be compiled from more local sources as described below (e.g., union membership/apprenticeship data or employer Davis-Bacon payroll data coupled to employee demographic information).

Similarly, overall job training programs are generally easier to track (metrics for all attendees), but additional data collection is needed to determine the number of attendees or trainees from DACs, or the job training programs need to be targeted for DAC residents only.

Economic impacts such as well-being can also be qualitative. Assessment of economic impacts can be an area for community outreach to seek neighborhood-level inputs over time on the impacts of major investment projects on their neighborhood and their lived experience.

### 3.1.3 Example Data Sources

The U.S. Bureau of Labor Statistics tracks job by geography ([bls.gov/guide/geography/employment.htm](http://bls.gov/guide/geography/employment.htm)). Some jobs data are available down to the city or town level, but detailed industry job tracking is only available by county. They also have “labor force status” data (e.g., unemployment) down to city or town resolution; these data are available for some large metropolitan areas (U.S. Bureau of Labor Statistics 2023) but not to the DAC level.

The U.S. Census Bureau is another source of data through the Longitudinal Employer-Household Dynamics program under the Local Employment Dynamics Partnership (U.S. Census Bureau 2023). Limitations for these data are that it may be hard to discern the impact of a particular program among all the other factors that contribute to labor and workforce statistics and that the spatial resolution of these data sources does not typically reach down to the DAC level, which may be at the resolution of several census tracts.

Specific aspects and considerations for several topics related data sources are described below.

- **To track job locations**, some cities (e.g., Seattle, San Francisco, Los Angeles) track employee demographics together with Davis-Bacon certified payroll associated with specified projects (Paige Shevlin, personal communication, May 10, 2023). This approach allows the mapping of job impacts to the DAC and neighborhood level. This approach could be employed by state departments of transportation to quantify the aforementioned DAC job metrics.
- **Other data sources on jobs and workforce** can potentially be found at the local (city or county) level, including:
- Labor statistics, sometimes divided by occupations from the county.
- Local union chapters that have data in the growth of licensed workers or laborers.
- Other information or data from city or county economic departments.
- Local chambers of commerce.

- **For EVSE equipment installation**, a good data source on employment impact is union data on registered apprentices (Paige Shevlin, personal communication, May 10, 2023). This is because trainees for the Electric Vehicle Infrastructure Training Program, which provides training and certification for electricians to install EVSE, either need to be certified electricians or registered apprentices. Thus, an increase in registered apprentices is a proxy data source for employment and/or training impacts. Again, this source of data would provide an overall impact for EVSE-related investments on the pipeline of trained installation personnel, but additional data collection would be needed to track the demographic information and job status for registered apprentices.

- **Workforce development metrics** will probably require direct data sources, as we are currently unaware of any models that estimate any of the listed workforce metrics. Potential data sources include state departments of labor, as well as other organizations that typically collect these data.

- **For job training programs**, classes held, and students certified, overall numbers should be tracked through the agencies providing the training. For tracking purposes and to quote the metrics above, the place of residence for all participants, attendees, or trainees should be collected to determine what fraction of residents reside in DACs, or in some cases, a requirement could be set up that the training is only open to DAC residents.

- **Additional examples on tracking employment and training**

  - Illinois has a new $25-million-per-year program for re-apprenticeship training and a good tracking system of beneficiary groups and evaluation of long-term outcomes. New Jersey is another leading state in this area with a score card for all community colleges and salary tracking (Paige Shevlin, personal communication, May 10, 2023).

  - The city of San Francisco tracks underrepresented demographic groups by employment category (officials and administrators, professionals, technicians, and protective services) compared to benchmark demographic data from the American Community Survey (Simon 2019).

  - Seattle’s Priority Hire program aims to put people living in economically distressed communities to work on the city’s construction projects and beyond by recruiting diverse workers, training workers, helping workers get hired, and giving workers ongoing support (Seattle Finance & Administrative Services 2021). Some tracked metrics include:

    - Additional wages earned due to Priority Hire.
    - Share of overall project hours by workers of color.
    - Average annual income for Priority Hire worker compared to average annual income by demographic.
    - Hourly wages by race/ethnicity.
    - Share of hours worked by women.
    - Spending on program recruitment, training, and support services.
    - Tracking which Priority Hire projects are anticipated to start.
- The percentage of contractors that are women- and minority-owned businesses.
- The percentage of workers who live in economically distressed ZIP codes.
- The number of people who were placed into construction.
- Program participant retention rates in the construction industry.

3.1.4 Tools/Modeling Available
The JOBS EVSE tool from ANL is free and available for download (https://www.anl.gov/esia/jobs-evse). The tool is a good starting point for overall gross job impacts at the state level but does not track location of jobs to the DAC level (Ke, Mintz, and Zhou 2022).

3.1.5 Case Study of a Metric: West Virginia’s NEVI Plan Using ANL’s JOBS Tool
In West Virginia’s NEVI plan, all EVSE is deployed between 2023 and 2026. The buildout consists of 48 150-kW chargers, 480 50-kW chargers, and 384 Level 2 chargers. Through 2033, this investment is estimated to produce 975 in-state job-years (direct, indirect, and induced). Initially, most jobs are associated with 50- and 150-kW charger construction and electrical installation, with 358 such jobs through 2026 (Figure 2). Starting in 2027, most jobs are induced jobs associated with additional retail and advertising revenues (Figure 3), which continue over time. (Vehicle owners are assumed to make retail purchases during charging, and advertising display screens are assumed to be shown on the chargers—like some gas stations today—with the resulting revenue supporting jobs in the retail and advertising sectors.)

The construction and installation jobs from 2023 to 2026 are those most readily tracked by the state department of transportation, and the equity-related metrics to be collected by the state (and not available from the JOBS tool) could include the number of those jobs held by residents in DACs and the total wage income that accrues to residents in DACs.

![Figure 2. Estimated EVSE-related jobs by charger type. Each bar represents the quantity of job-years, or the number of jobs supported in 1 year, for each category of charger.](source)

Source: Personal communication, Yue Ke, ANL, May 10, 2023.
3.1.6 Metrics Limitations and Data Gaps

These employment tracking approaches have several limitations; economic impacts can certainly go beyond the job and job training metrics described here. These are starting points, and a fuller characterization could be done with more comprehensive data and/or survey data collection tracking items such as the number and growth of DAC-owned businesses/wealth creation, additional private investment in the community, some quantification of changes in job mobility, and housing and real estate valuation.

There may also be disbenefits such as unwelcome gentrification or housing displacement that are not captured here but discussed further in this report in “Policy Priority: Energy Democracy.” Moreover, the job location metric or fraction of total jobs supported in DACs is an imperfect metric because spending from the resultant income may or may not occur within the DAC, especially if there is a lack of commercial entities in the DAC.

From a practical standpoint, state departments of transportation may not be adequately resourced to either quantitatively or qualitatively estimate job, job training, or general economic impacts. For example, trained staff or contractor resources would be needed for data specifications, tracking, collection, analysis, and interpretation, and to do this across an entire state would not be a small undertaking. Additional resources for qualitative assessment of impacts would also be needed for any community outreach and/or surveys. Tracking job outcomes for individuals as a result of job training programs would also require more longitudinal data collection.

3.2 Policy Priority: Environmental Benefits

Here we introduce metrics and considerations to validate the decrease of environmental exposure and burdens for DACs. Black and Latinx communities in the United States are exposed to up to 64% more air...
pollution than they produce (Tessum et al. 2019). NEVI and other Justice40 programs have the potential to reduce environmental impacts for DACs such as local criteria pollutants (e.g., particulate matter [PM$_{2.5}$], sulfur oxides [SO$_x$], nitrogen oxides [NO$_x$]) and global GHG emissions (e.g., carbon dioxide [CO$_2$], CO$_2$ equivalent [CO$_2$e]). EVs can provide a direct improvement in local air quality by replacing emissions associated with the combustion of gasoline and diesel fuel with a zero-emissions vehicle. To the extent that public EV chargers within DACs can induce a switch from gasoline to electric vehicles or a change in the timing and location of charging to reduce upstream emissions, the benefits of lowering air pollution and associated negative health outcomes can be identified and quantified.

Validating and quantifying environmental benefits in the context of pollution and emissions reduction initiatives come with significant challenges and uncertainties. These initiatives often have spillover effects that extend beyond geographical boundaries, making it difficult to fully trace all sources of air pollution. Furthermore, identifying the causal effects of a specific project becomes complex when multiple decarbonization activities and changes in energy mix are happening simultaneously. For instance, investments made in one state can have far-reaching impacts on the air quality of neighboring states through various avenues, including but not limited to EV adoption, direct on-road emissions, and indirect grid emissions.

### 3.2.1 Key Considerations and Limitations within Policy Goal

Assessing the impact of Justice40 activities on criteria pollutants in DACs can be complex due to intricate and confounding factors. A change in energy use or fuel source in one neighborhood may not result in emissions reductions in the same neighborhood. For example, if an EV owner charges the EV in a DAC but does most driving outside of the DAC, the air quality benefits may not accrue to the DAC. Air quality impacts are not a result of where the charging station is sited directly, but rather of where EVs are adopted and operated. We also need to recognize other decarbonization activities happening in parallel. Investments made in one state will affect the net air quality impacts in neighboring states through multiple avenues including EV adoption, direct (on-road) emissions, and indirect (grid) emissions (so-called spillover effect). Moreover, it is essential to consider that air quality may be further influenced by other local and/or regional activities such as road and agricultural dust, industrial processes, and the heavy-duty fleet, which are subject to constant changes. Therefore, evaluating the infrastructural investment requires careful considerations of methods and understanding of the limitations that come with the measuring methods. As a starting point, we identify three major factors to consider: (1) confounding factors, (2) selecting the right measurement tools, and (3) differences in indoor and outdoor air quality.

#### 3.2.1.1 Confounding Factors

Metrics identifying the direct concentration of pollutants (e.g., ozone, PM$_{2.5}$, PM$_{10}$, NO$_x$) can be directly monitored via sensors. However, it would not be immediately clear what baseline of comparison would be used to establish the benefit associated with a specific pollutant concentration. For example, an improvement in air quality in one DAC might be due to an increase in the EV fleet or another decarbonization activity such as a reduction in diesel trucking activities. Similarly, environmental benefits can come from pollutant and emission leakage. These metrics measure impact in respective
DACs, while pollutant and GHG emissions such as wind-borne fine particulate matter disperse across wide areas. The metrics are all measured against a counterfactual scenario (reductions, savings, or changes against a counterfactual or baseline scenario). All of these efforts will thus require dedicated, complex analysis and modeling to accurately determine air quality and health outcomes.

3.2.1.2 Selecting the Right Measurement Tools: Models vs. Sensors and Monitors

With the challenges of confounding factors in mind, there are two common options to measure or estimate the concentration of pollutants and emission levels: (1) physical monitors and sensors and (2) modeling tools. The effectiveness of initiatives aimed at improving air quality heavily relies on the accuracy of the chosen measurement methods. Consequently, it becomes imperative to grasp the merits and constraints of these tools within the context of project management stages and the specific metrics under consideration. Each method—modeling tools or physical sensors and monitors—comes with both potential advantages and limitations. For example, while physical sensors are suitable to track the actual change in air quality, they are also time- and resource-intensive as a means to measure the benefits (e.g., cost of sensors, deployment, data collection, data analysis). In contrast, modeling tools only produce estimates. They might not track physical changes in air quality, but they are an economical and resource-efficient choice that facilitates a wide range of simulations. Modeling tools are practical methods to try out several scenarios in decision-making processes. Models can estimate cost, time frames, and/or other factors for targeted benefits and outcomes. Modeling tools are most useful in the project planning stage when deciding where to deploy charging stations (more details in “Tools/Modeling Available”), but not as accurate to validate the actual environmental benefit physically experienced in DACs.

Brief descriptions and characteristics of modeling tools and sensors follow.

3.2.1.2.1 Modeling Tools

Modeling tools enable us to estimate the concentration of pollutants with a set of assumptions and emissions factors. An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant, such as CO\textsubscript{2} and NO\textsubscript{x} (EPA 2022). Combinations of modeling tools can then derive benefit metrics such as change in air quality and health outcomes in neighborhoods near infrastructural change. Some national labs have developed modeling capabilities to quantify such metrics (more details in “Tools/Modeling Available”).

3.2.1.2.2 Physical Monitors and Sensors

Physical monitors include regulatory monitors, air sensors, and remote sensing. Today, the most accurate monitoring instruments are regulatory monitors used to determine compliance with the National Ambient Air Quality Standards. These monitors are operated by federally designated experts and meet strict operation and performance requirements\textsuperscript{6}. Alternatively, air sensors are a class of technology that are lower in cost, more portable, and generally easier to operate than reference

\textsuperscript{6} The operation and performance requirements are outlined in the U.S. Code of Federal Regulations (40 CFR Parts 50, 53, and 58) (Clements et al. 2022).
monitors or research instruments. Unlike regulatory monitors, the accuracy, lifetime, and reliability of sensors vary due to the underlying measurement technology, quality of different air sensor components, environmental conditions, and methods of operation. Finally, remote sensing is a method for measuring pollutants at a distance without physical contact by measuring reflected or emitted light. Because remote sensing can be deployed aboard aircraft, satellite-based platforms in orbit, or at ground-based sites, it provides more spatial coverage. However, because it is not directly monitoring the air quality, accuracy can vary (Clements et al. 2022). Figure 4 compares most common monitors and sensors in critical criteria discussed here. Overall, monitoring via air sensors or remote sensing is a less resource-intensive means than regulatory monitors to observe changes in air quality with broader geospatial access, yet careful consideration on their accuracy is needed.

Figure 4. Common types of air monitoring instruments and their characteristics. Source: Clements et al. (2022)

3.2.1.3 Indoor vs. Outdoor Air Quality
Finally, it is important to consider the difference between indoor and outdoor air quality. The concentration of many pollutants varies over long or even short distances. The location of where pollutants are measured determines what is measured. As shown in Figure 5, air monitoring can occur in different locations and represent different conditions (Clements et al. 2022).
Figure 5. Different air monitoring locations for outdoor air (near source, mobile, ambient, and background) and indoor air (occupational and residential).
Source: Clements et al. (2022)

Concentrations for most pollutants tend to be highest near the source, decreasing rapidly within the first few hundred feet away from the source. If multiple sources are widely distributed within a given area, pollutant concentrations may be more similar, but will still be different from location to location. Other factors, including geography and local atmospheric conditions, will also influence concentrations (Clements et al. 2022).

Americans, on average, spend approximately 90% of their time indoors, where the concentrations of some combustion pollutants are often 2 to 5 times higher than typical outdoor concentrations (EPA 2023a). While the length of exposure to indoor or outdoor air may vary per person, the location of communities is also an important factor to consider. DACs tend to have more proximity to highways or busy roads than non-DACs. DAC indoor air quality may be worse than measured/estimated outdoor air quality.

3.2.2 Example Metrics (starter metrics in bold)

Here we introduce common metrics that quantify the environmental benefit to DACs caused by air quality improvement (starter metrics in bold):

- **Air quality monitoring in DACs**: The concentration of pollutants (e.g., ozone, PM$_{2.5}$, PM$_{10}$, NO$_x$) can be directly measured by physical sensors and monitors, remote sensing, or estimated by modeling tools (such as AFLEET below).

- **Emissions reduction estimates in DACs**: Simple emission factors enables assessments of how changes in energy use or sources would affect local and/or global emissions at the point of source.
  - Change in indirect (grid) emissions: These refer to GHG emissions from electricity grid generation units for EV charging. Each state can estimate the emissions from displaced fossil fuel power generations. The U.S. Environmental Protection Agency (EPA) publishes a comprehensive inventory of environmental attributes of electric power systems called the Emissions & Generation Resource Integrated Database (eGRID), which provides average and marginal emissions factors that can be used to estimate emissions reductions.
  - Change in direct (on-road) emissions: Increases in EV adoption can be used to estimate net change in tailpipe pollutants and GHGs using emissions factors for displaced gas and diesel vehicles. Indicators (inputs) to derive EV adoption rate include:
    - EV adoption rate estimated by fuel cost (liquid fuel for internal combustion engine vehicles and grid electricity), average charging time, and location of charging station in a model (e.g., BILD-AQ).
    - Tracking the market share (e.g., sales data) of EVs and internal combustion engine vehicles.

- **Health benefits in DACs**: The assessment of health benefits linked to changes in pollutant exposure and improvements in air quality can be approached through two methods: direct measurement of health outcomes or calculations based on measured changes in pollutant concentrations. Each method has its strengths and limitations, often necessitating a
combination of both approaches to achieve a comprehensive understanding of the health outcomes associated with infrastructure investments.

- **Direct measurements:**
  - The shift in disparity in asthma among citizens inside and outside the DAC.
  - Rate of asthma emergency room visits and cardiovascular disease vs. average non-DAC residents.
  - Rate of pediatric asthma morbidity inside and outside of DACs.
  - Increase in the number of “healthy days” reported in DACs.
  - Change in the number of school loss days for children with asthma.

- **Estimates:**
  - Rate change in health risk (e.g., cancer, asthma) in DACs derived by the change in measured concentration of pollutants.
  - Monetized savings from improved health outcomes in DACs.

### 3.2.3 Example Data Sources

#### 3.2.3.1 Air Quality Tracking

- Regulatory monitors: There are over 4,000 monitoring stations across the United States, typically sited in high-population and high-pollution areas (EPA 2023b). Daily data are available to download: [https://www.epa.gov/outdoor-air-quality-data/download-daily-data](https://www.epa.gov/outdoor-air-quality-data/download-daily-data).
- Satellite data: NASA provides real-time satellite air quality data per aerosol or chemical compound (e.g., carbon monoxide, nitric acid, nitrous oxide, ozone) (NASA 2023): [https://www.earthdata.nasa.gov/learn/find-data/near-real-time/hazards-and-disasters/air-quality](https://www.earthdata.nasa.gov/learn/find-data/near-real-time/hazards-and-disasters/air-quality).

#### 3.2.3.2 Emissions Reduction Estimates

- eGRID provides emissions estimates per power generation plant registered in the United States: [https://www.epa.gov/egrid](https://www.epa.gov/egrid).
- EPA published *The Enhanced Air Sensor Guidebook* to provide basic foundational knowledge on topics including background information, selecting appropriate sensors for different applications, data quality considerations, and sensor performance (Clements et al. 2022).
- EPA’s Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE): [https://www.epa.gov/benmap](https://www.epa.gov/benmap); estimates the health impact (and economic value) of changes in air quality.
3.2.4 Tools/Modeling Available

- **BILD-AQ**: The Joint Office, through the U.S. Department of Energy’s national labs, is supporting the creation of tools to provide useful environmental indicators by utilizing some of the metrics introduced above. Benefits of Infrastructure in Large-scale Deployment: Air Quality (BILD-AQ) is a workflow linking several models. Scenarios of EV charging infrastructure deployment can be input into BILD-AQ, which will then generate the resulting EV adoption, on-road emissions, grid emissions, air quality concentration, and resulting mortality impacts of that infrastructure deployment. As the outputs are at the census tract level, analysts can compare the estimated outcomes for DACs and non-DACs of charging infrastructure investment scenarios. For example, BILD-AQ calculates the change in PM$_{2.5}$ concentration per census tract based on the number and locations of charging stations a state plans. The main input to BILD-AQ is planned charging infrastructure installation locations (Figure 6). BILD-AQ can take in various state plans (various scenarios on locations and numbers of charging stations) and provide emissions changes and health outcomes for each scenario. BILD-AQ promises to be an important modeling tool to evaluate environmental benefits at the community level. Although BILD-AQ is currently not an open-source tool, you can contact sustainabletransportation@lbl.gov to request more information or to use the tool.

![Figure 6. BILD-AQ workflow](image)

- **AFLEET**: The Joint Office, together with ANL, created the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) CFI Emissions Tool to estimate well-to-wheel GHG emissions and vehicle operation air pollutant emissions (ANL 2023). This tool focuses on emissions reduction estimates (i.e., no estimates on associated health outcomes) and is free and available online. It calculates emissions reduction estimates for criteria air pollutants (CO, NO$_x$, PM$_{10}$, PM$_{2.5}$, and SO$_x$) and volatile organic compounds per annual fuel consumption per fuel unit and some displacement of baseline vehicle assumptions per charging and fueling infrastructure location (state level). States can input the number of chargers or stations by type and utilization category (i.e., low, moderate, high) in the Excel spreadsheet to obtain estimated emissions production. States can also customize the electric generation mix (residual oil, natural gas, coal, nuclear power, biomass, and other renewables) to obtain more accurate estimates on long-tailpipe emissions reductions.

For example, as of 2021, the electric generation mix in California was natural gas (37.9%), coal (3.0%), nuclear power (9.3%), biomass (2.3%), and other renewables (47.5%) (California Energy Commission 2023). The energy mix can be updated in the “Intro” worksheet (Figure 7):
As of February 2022, California has 1,581 public DC fast charging stations (6,764 DC fast chargers) and 12,568 public Level 2 stations (28,877 Level 2 chargers). Assuming these charger types are at low utilization, the state can input them under the “utilization” column. Estimated emissions reductions per pollutant are then shown in Section 4 as in Figure 8:

- **Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE):** This is EPA’s open-source program that estimates the health impact (and economic value) of changes in air quality. BenMAP-CE has pre-loaded dataset (e.g. air quality, demographic, concentration-response relationships), but users can also upload their own data to derive outcomes that more specific to the region. Users can access from here: [https://www.epa.gov/benmap](https://www.epa.gov/benmap).

### 3.2.5 Case Study of a Metric: California’s Community Air Protection Program

The Community Air Protection Program was launched in response to California’s Assembly Bill 617, which requires that the California Air Resources Board and air districts to implement emissions reporting, monitoring, reduction plans, and measures. These measures must reduce air pollution exposure specifically in 14 selected communities with higher rates of unemployment, lower educational attainment, and higher rates of asthma and cardiovascular disease, among other criteria (California Air
Resources Board 2022, 2023a). This case study serves as a compelling example of how the benefits of each infrastructure investment are determined and assessed by the respective communities. The process involves a meticulous selection of appropriate methods with considerations mentioned in the previous section.

The program addresses air pollution disparities at the neighborhood level by establishing a community focus target. Community-level expertise through steering committee meetings and input from a broad range of stakeholders supported the district’s development of this plan. The monitoring is led by both districts and community-based organizations (e.g., fence-line monitoring near station source).

![Diagram](image.png)

**Figure 9. Community emissions reduction program required elements.**

Source: California Air Resources Board (2018)

Although a variety of metrics are used to meet each respective district’s targets, the following is a list of example metrics used in selected communities in this program (California Air Resources Board 2018):

- **Change in concentration of pollutants** (e.g., tons of PM$_{2.5}$/year reduced in a DAC) monitored by both states/districts and community-based organizations.
- Rate change in health risk (e.g., cancer, asthma) of residents derived by the change in measured concentration of pollutants.
- Number of zero-emission trucks driving through selected communities.
- Number of plug-in hybrid or battery-electric vehicles driving though or by a DAC.
- **Number of diesel buses replaced by electric public** and school buses that have routes in a DAC (to derive emission reduction estimates in DAC: a starter metric).

For example, under the program, San Joaquin Valley Air Pollution Control District in Stockton, California, has the Heavy Duty Truck Replacement Program as one of their many community emissions reduction programs (California Air Resources Board 2023b; San Joaquin Valley Air Pollution Control District 2023). The strategy of this program is to provide incentives (via state investment) to replace existing heavy-duty diesel trucks with new zero- or near-zero-emission trucks. With a budget of $10 million and
expected cost of up to $200,000 per truck (50 trucks to be replaced), Stockton estimates the emissions reduction associated with this measure includes up to 4 tons of PM (including toxic diesel PM), 191 tons of NO\textsubscript{x}, and 14 tons of volatile organic compounds using emission factors (San Joaquin Valley Air Pollution Control District 2021).

While health benefits were not explicitly used as part of benefit metrics in this particular case, the estimated pollutant reduction (i.e., 191 tons of NO\textsubscript{x} and 14 tons of volatile organic compounds) can subsequently be employed in other modeling tools like the Intervention Model for Air Pollution (InMAP) to derive health benefits (e.g., percent change in asthma risk) for targeted communities (Tessum, Hill, and Marshall 2023).

### 3.2.6 Metrics Limitations and Data Gaps

The Community Air Protection Program relies heavily on inputs from local communities. The districts require communication routes to ensure the quality of measurements. It is important to note that a variety of air monitoring approaches may be utilized, as each community has different objectives, tools, and stakeholders involved. In this program, the California Air Resources Board offers support and assistance to ensure robust community-operated air quality sensor systems. For example, air districts may require fence-line monitoring (i.e., air monitoring at or adjacent to a known stationary source) to determine where and when emissions are occurring, at what rate emissions are leaving the source, and what chemicals are released when fugitive emissions are present (California Air Resources Board 2018, Appendix E).

The benefits of the Heavy Duty Truck Replacement Program are estimates. In order to claim the true benefits associated with the investment, the district can consider confounding factors to adjust the benefits and improve accuracy.

### 3.3 Policy Priority: Access to Electric Vehicles and Charging

Justice40 programs focus on reducing barriers to entry for purchasing EVs and improving access to EVSE for all Americans. JO recognizes the existing “uneven opportunity for individuals or groups to benefit from electric vehicles are due to the lack of provision, affordability or useability of charging infrastructure (Hopkins et al. 2023)”. Various policy incentives have sought to increase access to purchase and use of EVs, including tax credits, rebates, and grants. Such incentives have historically been disproportionately distributed; 90% of incentive programs are distributed among the top income quintile (Roberson et al. 2022). Home charging is still the norm; as of 2021, government estimates indicate that 80% of EV charging take place at home (Jackman et al. 2023). Home charging has not been a widely available option however, particularly for residents of multifamily dwellings where EVSE has yet to be installed. While EVSE has expanded to public and commercial sites, the location choices have not always included DACs. The current distribution of public charging stations across the U.S. is highly uneven, in terms of both charging stations per capita and total charging stations by state. Charging infrastructure remains sparse across much of the landmass of the US. (e.g., Idaho, Montana, Alaska, and number of other states have fewer than 10 chargers per 100,000 residents) (Jackman et al. 2023).

The policy goal is indeed to eliminate this uneven access to electric vehicle charging and to ensure cleaner modes of transportation are accessible for DACs. Enhancing EV adoption require a simultaneous
Effort of making EVs more affordable and making EVSE accessible and available. In this section, we discuss a few examples of metrics to track EV adoption rate and EVSE accessibility in DACs. Our implicit assumption is that making EVSE more widely available in DACs will at the least help to remove one barrier to EV/PEV adoption, and in conjunction with more attractive vehicle rebates to DAC residents, increase the rate of EV/PEV adoption.

As a starting point to developing EVSE related access metrics for greater equity, we begin with a set of access-related requirements for all EVSE as mandated by the Department of Transportation’s NEVI Standards and Requirements (DOT 2023b):

- **Availability.** Charging stations located along and designed to serve users of designated Alternative Fuel Corridors must be available for use and sited at locations physically accessible to the public 24 hours per day, 7 days per week, year-round.

- **Cybersecurity.** Suitable strategies for cybersecurity should include the following topics: user identity and access management; cryptographic agility and support of multiple PKIs; monitoring and detection; and incident prevention and handling.

- **Accessibility of payment methods.** Unless charging is permanently provided free of charge to customers, charging stations must: (1) Provide for secure payment methods, accessible to persons with disabilities, which at a minimum shall include a contactless payment method and provide access for users that are limited English proficient and accessibility for people with disabilities. To customer service must also be ensured via suitable platforms and sufficient multilingual access.

- **Charging Station Information.** Information on charging stations must be publicly available through online mapping tools and provide information such as locations, pricing, real time availability, and accessibility.

- **Accessibility.** The American with Disabilities Act of 1990 (ADA), and implementing regulations, apply to EV charging stations by prohibiting discrimination on the basis of disability by public and private entities. EV charging stations must comply with applicable accessibility standards adopted by the Department of Transportation.7

With these general requirements in mind, key access-related EVSE metrics in DACs can include (the starter metrics in bold):

- **Number and percent of EVSE installed in DACs**
- **Number of charging ports by type (i.e., Level 3) normalized by DAC population and within some distance of the charging stations, e.g., within 15 miles.**
- Percentage of DAC population that lack access to EVSE, e.g., those DAC tracts or DAC population beyond 15 miles from a charging station
- The availability of charging ports in DACs, i.e., the percentage of uptime per year for each charging port.
- The number or percentage of EVSE in DACs with alternative payment options such as non-credit card payment options.

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7 Department of Transportation ADA regulations (49 CFR part 37) adopted in 2006, and Department of Justice ADA regulations (28 CFR parts 35 and 36), adopted in 2010.
• The price level of electricity from EVSE chargers in DACs in dollar per kWh as a multiple compared to the average price level of residential electricity in the DAC, e.g., 1.5X or 50% higher average price.
• The adoption rate of EV/PEVs in DACs delineated by proximity to EVSE, e.g., the adoption rate of EV/PEVs in DACs within 15 miles of EVSE and the adoption rate that are more than 15 miles from EVSE.

### 3.3.1 Key Considerations and Limitations within Policy Goal

Access policy focuses on acceleration of transport electrification for DACs, and monitoring the increase in EV adoption and EVSE locations in DACs. Similar to other policy we have discussed so far, it is critical to be aware of confounding factors in access as well. For example, EV adoption could increase due to sharply dropping prices and increased competitiveness with ICE vehicles, or it could also increase in some DAC areas where both EV and home charging is made more affordable. Similarly, a lack of EV adoption even with much greater and access to affordable EVSE could be driven by a lack of awareness and/or high-profile EV accidents or fires.

Creating successful EV infrastructure in DACs requires a symbiotic balance of three critical components: EV adoption increase, charging port accessibility increase for DACs, and effective utilization of charging stations within DACs. These factors are interconnected, with each relying on the others in a mutually reinforcing cycle for sustainable development. Here we discuss considerations and limitation in each factor to develop metrics to best evaluate the progress.

**Access in terms of EV adoption**

Access to EV rental or EV ownership in DACs could be dependent on supply availability (i.e., the distance to dealerships that carry EVs and a lack of supply of more affordable used EVs). If DAC residents are wholly dependent on commercial for-profit EVSE providers, they would pay more for fueling than residents who pay residential electric rates and who have greater flexibility to charge when rates are lowest. This would be another factor making EV ownership less attractive for DAC residents.

In terms of data collection, vehicle registration records can be great resource to track the EV adoption rate as it contains owners’ address and vehicle models. However, data would be lagging in time and data analysis could be resource intensive.

**Access in terms of Charging Ports**

Counting ports in conjunction with the population provides insights on normalized numbers. For example, if there is a small population in an area, the count alone may lead to overestimation of availability/access. Looking to the number of EVSE ports installed in/near DACs is vital. Considering the ports and populations together does not provide insights on optimal location. In sum, there may be “enough” ports, but in inconvenient locations. Just because EVSE is in or near a DAC does not necessarily mean that the residents of that community utilize the EVSE.

Regarding the metric for percentage of DAC residents that are further than 15 miles from EVSE, the 15-mile benchmarks does not fully characterize EVSE access in rural and tribal communities. This metric could be combined with other metrics or mappings to determine if residents have to drive out of their way to access EVSE.

Finer grain data on charging access can be found from along two axes: the types of establishments in
which DAC EVSE are available (e.g., the percent of charging ports that are government owned, vs commercially owned locations; the percentage of those sited at mobility hubs, and the percentage at residential locations and/or other site) and second, the number of charging ports in proximity to affordable housing units and/or multifamily units.

**EVSE utilization**

A desirable metric would be the percentage of EVSE utilization by EV owners or EV renters in DACs. This would be difficult to collect but perhaps possible if license plate data is collected for each charging session and linked to vehicle registration data from a state’s Department of Motor Vehicles.

Types of location EVSE is placed (e.g., parking lots in a shopping center, in gas stations, in highway rest plaza, etc) can be useful indicators for future analysis. It can identify the most popular/convenient locations to charge especially for owners who do not have home charging access.

### 3.3.2 Example Metrics (starter metrics in bold)

Table 2 provides a starting point for considering EVSE metrics to help policymakers and planners understand access; example metrics for EV access are included in Table A-1.

<table>
<thead>
<tr>
<th>Metric</th>
<th>As It Applies to Access</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number and percent of EVSE installed in DACs</strong></td>
<td>First order metric for equity and accessibility to EVSE</td>
<td>The metric does not take into account population density. See metric below (Ports per population)</td>
</tr>
<tr>
<td><strong>Ports per population</strong></td>
<td>Counting ports in conjunction with the population provides insights on normalized numbers. For example, if there is a small population in an area, the count alone may lead to overestimation of availability/access. Looking to the EVSE ports installed in/near DACs is vital</td>
<td>Considering the ports and populations together does not provide insights on optimal location. In sum, there may be “enough” ports, but in inconvenient locations. Just because EVSE is in or near a DAC does not mean that the residents of that community utilize the EVSE.</td>
</tr>
<tr>
<td><strong>Transportation energy cost burden</strong></td>
<td>Enhancing access to affordable charging will reduce energy burden</td>
<td>Barriers to entry for vehicle purchase will still be at play</td>
</tr>
<tr>
<td><strong>Number of EVSE locations requiring parking fees in a census tract</strong></td>
<td>While EVSE location may be technically accessible to the public, the requirement to pay parking fees may serve as an obstacle to many.</td>
<td>Collecting data on this metric may be time-consuming and difficult to determine with a high level of confidence.</td>
</tr>
<tr>
<td><strong>Count of census tracts without access to EVSE within 15 miles, weighted for population density</strong></td>
<td>Transportation planners indicate the 15-mile distance as a standard consideration</td>
<td>The 15-mile benchmarks does not fully recognize EVSE access in rural and tribal communities. This metric should be combined with others to determine if residents have to drive out of their way to access EVSE.</td>
</tr>
</tbody>
</table>
### Metric Development for Evaluation of State-Level Electric Vehicle Charging Infrastructure Programs

<table>
<thead>
<tr>
<th>Metric</th>
<th>As It Applies to Access</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of smartphone applications/digital platforms developed to help consumers/drivers access EVSE</td>
<td>Public information on location and cost of EVSE can help reduce range anxiety and encourage adoption of EVs. Creating counts of innovative apps to help consumers locate EVSE can shed insights on the nexus between information and adoption</td>
<td>Not all members of society are tech savvy or use cellphones. This metric does not shed light on this demographic.</td>
</tr>
</tbody>
</table>

#### 3.3.3 Example Data Sources

These datasets can be combined to develop example metrics that introduced above.

- U.S. Department of Energy Alternative Fuels Data Center: [https://afdc.energy.gov/data](https://afdc.energy.gov/data).
- The American Community Survey and Alternative Fuel Station Locator were common data sets utilized in U.S. studies: [https://afdc.energy.gov/stations/](https://afdc.energy.gov/stations/).
- U.S. Census Bureau: [https://data.census.gov/](https://data.census.gov/).
- EPA’s Environmental Justice Screening and Mapping Tool: [https://www.epa.gov/ejscreen](https://www.epa.gov/ejscreen).

#### 3.3.4 Tools/Modeling Available

- **Energy Zones Mapping Tool (EZMT):** This is a free online mapping tool to enable users to generate and analyze potential corridor routes. Users can create a scenario with available indicators such as location of power plants with nine resources (i.e., biomass, coal, geothermal, natural gas, nuclear, solar, storage, water, and wind), corridor siting factors (e.g., slope and land protections), population density, minority population, and traffic density to identify high suitability locations for clusters of charging ports. More details and tutorial videos are available here: [https://ezmt.anl.gov/](https://ezmt.anl.gov/).

#### 3.3.5 Case Study of a Metric: EV Charging Infrastructure Deployment Assessment in California

California enacted Senate Bill 1000 (SB1000) as an effort to enhance transportation equity. SB1000 directs California Energy Commission (CEC), in consultation with CARB, to assess whether charging station infrastructure is proportionately deployed by population density, geographical area or population income levels (low, middle and high). SB1000 report demonstrates many useful metrics that are introduced here. Some metrics used in this SB1000 report are:

- **The number of public level 2 and DC fast charging stations by county**
- **Public level 2 and DC fast chargers by census tract population density or by county**
- The number of public chargers per 100,000 people by community income level
- Per-capita public level 2 and DC fast chargers by census tract median household income
- Chargers per square mile by county broken out by power level.
As an example of density analysis, CEC collected population, PEV registrations and the number of chargers per charger types (i.e., Level 2 and DC Fast charger) per county. Together with spatial size, CEC derived the population density and PEV density and chargers’ density as in Figure 10. These simple metrics visualize the current state of charging station availability against populations. As mentioned in challenge and limitation section, we still need to look at other factors to evaluate whether charging stations are addressing DAC access sufficiently, but looking at the density per regional level is an important first step to track the progress of more equitable transition.

![Image: Figure 10 Population Density, Plug-In Electric Vehicle Density, and Public Level 2 and DC Fast Charger Density by County](source)


Another example of charger density analysis is presented in Figure 11. CEC assesses charger accessibility based on population by income level (i.e., low, middle and high). Chargers within the same country for a given population are counted. It is vital to carefully determine the definition of income level, for example average, median or a specific percentile, that accurately portray the community when conducting this type of evaluation.
3.3.6 Metrics Limitations and Data Gaps

One limitation is whether these metrics fully capture the spatial distribution of DAC residents. For example, if there are pockets of underserved residents within a city or region that are not well captured by existing DAC maps, these residents might be missed. To track the spatial dependence of access to EV charging within DAC areas and related statistics, e.g., to estimate the number of DAC residents within 15 miles of a given charging location also requires some analytical capability to do geospatial analysis. In addition, this case study does not track the demographics of consumers using the charging stations. Gathering information about charger users’ characteristics (e.g., address, demographic) requires additional effort and resources. It involves a separate initiative to determine if access benefits extend to the non-DAC population.

3.4 Policy Priority: Energy Democracy

We now look at processes and practices that provide agency to communities in the deployment of clean transportation infrastructure—especially DACs—and why their involvement is critical for a just and resilient clean energy transition. Active participation in the provision and governance of energy is foundational in developing energy democracy among communities (Becker and Naumann 2017). Energy democracy is important in institutionalizing justice and rights in energy systems and ensuring the equitable distribution of benefits across communities.

3.4.1 Key Considerations and Limitations within Policy Goal

A key limitation to community involvement with energy sources is the complexity and geography of systems. The planning and deployment of energy projects impacts communities from a broad scale, from local to larger, including regional, national, and even global. Considerations of energy democracy
in this report focus on localized areas such as municipalities or ZIP codes rather than larger geographical systems such as interstate corridors. Therefore, the more localized considerations in transportation planning center on neighborhood composition including noise, congestion, and affordability. Site placement of EV chargers will result in both benefits and disbenefits—benefits can increase neighborhood value and lead to gentrification and displacement. Alternatively, communities not enhanced in the clean transportation transition are at risk of decline as resources such as businesses and jobs relocate and tax base diminishes.

Energy democracy is rooted in giving communities long-term governance and decision-making in the planning considerations of energy projects—from how, where, and when investments are made to the actual ownership of energy assets. Key considerations regarding the decision-making roles include diversity in leadership and active bureaucratic representation. Limitations of energy democracy can be reduced when administrators share in the social composition (e.g., race, ethnicity, gender) of the community they represent, improving the equity in policy outputs and implementation (Liang, Park, and Zhao 2020).

3.4.2 Example Metrics (starter metrics in bold):

- **Percentage of community members in roles of governance and decision-making that span the project life cycle and represent DACs**
- Completion of a community needs assessments that (1) partners with the community; (2) identifies and measures inequities of prior transportation projects; (3) determines current travel behaviors; (4) measures community understanding, interest, and concerns; and (5) centers community need on community input.
- Completion of an anti-displacement assessment and strategy with the state or metro housing agency to avoid the displacement of DAC members.
- Number of community liaison positions funded for the entire project life cycle to identify, develop, measure, and institutionalize effective community engagement.
- Dollars spent to compensate community members for participating at an advisory capacity including listening sessions, focus groups, and serving on committees.
- Number of workforce and community agreements including the provision of good-paying jobs and career pathways in the clean energy economy for people in DACs.
- Number of clean energy contractual opportunities for DBE, MBE, and WBE programs.
- Number of energy assets owned by the municipality, tribal government, or local business enterprises, especially DBEs, MBES, and WBES.

Tracking energy democracy is important across all communities and should equitably represent disadvantaged community members including those denied systematic fair, just, and impartial treatment.

Although some metrics are quantitative, qualitative focused metrics are helpful. Impact on neighborhood composition and the satisfaction of community members specifically can be qualitative. Therefore, results from community engagement such as listening sessions, interviews, surveys, and other narrative content should be included.

In terms of jobs and career pathways, as mentioned under “Policy Priority: Economic Opportunities and
Jobs,” the total number of jobs is more readily estimated than the number of jobs for residents in DACs. In this set of metrics, however, the job focus is building community wealth by engraining signed community agreements that guarantee jobs for people in DACs as part of the energy transition.

3.4.3 Example Data Sources
- U.S. Department of Transportation Disadvantaged Business Directories by State.
- U.S. Census Bureau American Community Survey.

3.4.4 Tools/Modeling Available
- Climate and Economic Justice Screening Tool: Census tract tool to define and identify DACs.
- U.S. Census Bureau Application Programming Interface.
- ANL’s Electric Vehicle Charging Justice40 Map.
- U.S. Department of Transportation’s Transportation Disadvantaged Census Tracts (arcgis.com) tool.

3.4.5 Case Study of a Metric: King County Metro’s Transit Mobility Framework
A case study that demonstrates multiple energy democracy metrics is King County Metro’s Transit Mobility Framework. In response to accelerated growth in the most populous county of Washington, which includes Seattle, and to address disparities by race and place, King County Metro Transit convened a Mobility Equity Cabinet of 23 community members to co-create a mobility framework to center equity and sustainability in future investments. The mobility framework, guided policy updates, including Metro’s long-range vision, Metro Connect, which includes goals for a 70% increase in transit service by 2050, ensuring 84% of BIPOC residents and 86% of low-income residents have access to frequent transit service within half a mile, and GHG emissions reduction of 1.9 million metric tons each year (King County Metro 2021).

Addressing decades of disproportionate impacts from mobility systems and anticipating both benefits and disbenefits from transportation planning, an equity framework was established that guided Metro’s updated strategic plan with the following energy democracy metrics:
- **The number of partnerships established with, and dollars invested in, community-based organizations to gather feedback on needs and priorities.**
- The percentage of services, programs, plans and policies developed through co-creation or shared decision-making with community members.
- The percentage of community members who felt that engagement processes was accessible and welcoming, that they had sufficient time to participate, and they see how public feedback was used in decision-making.
• The number of policies established to prioritize working with communities of highest need first.
• The proportion of priority populations and the general public with convenient access to the transit network
• Customer satisfaction (by priority populations and the general public)

King County Metro Transit uses equitable community engagement best practices to ensure that priority population communities have an opportunity to influence the services, programs, and plans that impact them. Metro focuses on building long-term relationships, partnering with community-based organizations to design welcoming and culturally relevant engagement opportunities, demonstrating how community input shaped engagement outcomes, and compensating community members and organizations for their time and expertise. A new community liaison program was developed to provide a conduit between planning and community, a language equity program is developing standard best practices for communications for linguistically diverse riders, and metrics are designed to measure continual improvement to institutionalize the role of community in mobility planning.

3.4.6 Metrics Limitations and Data Gaps

Social dimensions of communities are complex, overlapping, and can change rapidly. Distribution of funds and number of compensated positions in community engagement alone are not sufficient to indicate energy democracy, especially when measured for brief amounts of time. Because long-term institutional procedures and policies are needed to advance energy democracy, further analysis will be required to gauge the resulting benefits and burdens from efforts taken compared to counterfactual scenarios. Further vetting will be required to validate the methodology and metrics for long-term performance of institutionalizing justice and community roles. Another gap to consider is between what the public expects from their roles and impact of engagement, and what that turns out to be. To the extent this gap is closed is important for the validity and effectiveness of public engagement in terms of energy democracy. Without having any meaningful authority or impact, the process is not democratic. A partnership in shared learning is proposed to identify and close these gaps and increase community trust and satisfaction (Grossardt, Bancroft, and Wormald 2019).

4. Common Challenges

Here we discuss some recurring issues and challenges that are seen across all four policy areas in the prior discussion of metrics.

One underlying question that arises is the debate on prioritizing EV access vs. EVSE. Some views indicate that investments in creating greater access to EVSE in DACs is not merited until there is greater adoption of EVs from community members. In reality, community members are hesitant to own EVs while reliable and affordable charging is uncertain. There is concern that lack of access to EVSE may create a self-perpetuating scenario where access problems today will cause hesitance to purchase EVs in the future and will continue to reinforce DAC reliance on internal combustion engine vehicles. Although several example data sources are provided in this report across the four policy areas, a main
challenge for sustained and consistent tracking of metrics is staffing. State agencies will need sufficient resources to collect, analyze, and interpret equity data sources. Additional resources are needed to set up processes to collect data where there is a lack of existing data sources. For more specialized data, such as that used for air quality, additional training or equipment may be required. Additional data challenges include disaggregation or delay, which can be the case with job data. Lastly, it can be challenging to obtain or establish baseline data, and at times data may not be available, both of which are barriers to measuring equity in outcomes.

Many confounding factors make attribution and causation of benefits and outcomes from EVSE programs extremely difficult to discern. Examples within the four policy priorities covered here include:

- the relationship between economic activity, jobs, and the inclusion of DAC-owned businesses in EVSE projects.
- confounding factors extend beyond local investment to broader decarbonization efforts and/or activities. Air quality is not a result of where charging stations are sited directly, but rather where EVs are adopted and operated.
- “chicken-and-egg” debate of charging infrastructure vs. EVs.
- the role of community involvement and the resulting outcomes toward achieving more democratic, inclusive approaches to clean energy projects.
- complications of attribution and causation in the intersections of the four priorities. For example, environmental conditions are related to economic activity. Greater economic activity leads to greater transport activity and more air pollution, while access to EVSE intersects with energy democracy and historical burdens of pollution and underinvestment.

Overall impacts and outcomes are more readily quantified than those that accrue specifically to DACs. For example, a $1-billion investment for construction projects can have an overall job and economic impact that is relatively straightforward to quantify, but tracking the benefits to DACs is more challenging and requires additional data collection approaches and systems. Similarly, a pollution reduction measure such as the imputed increase in EV driving miles due to greater buildout and availability of EVSE can give a global reduction in air pollutants across a certain region, but the benefits to a geographically specified DAC can only be roughly estimated unless local air quality monitors or other direct measurements are utilized, and direct air quality measurements would still have attributional issues.

5. Conclusion

The JUST Lab Consortium presents this report on developing metrics and methods to track equitable outcomes from federal investments in EV charging programs and projects, including approaches that could be utilized for Justice40 implementation. The intended audience includes state departments of transportation, cities and local agencies, tribal nations, and community organizations.

This report covers metrics and methods for tracking equitable outcomes in four key policy areas: economic opportunities and jobs, environmental benefits, access to EVs and charging, and energy democracy. Each of the four policy areas includes a discussion on key considerations, example metrics and data sources, available modeling tools, a case study, and metric limitations and data gaps.

Some takeaways for each of the four key policy areas are as follows:
• For **economic impacts**, a number of data sources exist such as job statistics and reporting requirements for the Davis-Bacon Act, but no formal data channels or reporting systems are in place for worker training programs and outcomes. Similarly, the JOBS tool from ANL can be a useful starting point to estimate employment impacts, but analogous tools for worker training are not available. State agencies will need sufficient resources to set up processes to collect more data on jobs and worker training and to analyze and interpret the data.

• For **environmental impacts**, the metrics discussed here are all measured against a counterfactual scenario (i.e., reductions, savings, or changes against a counterfactual or baseline scenario). This type of quantification thus requires dedicated, complex analysis and modeling to accurately determine air quality and health outcomes. It is essential to comprehend the available tools, recognizing their strengths and limitations (e.g., modeling tools excel in simulating investment planning, while sensors and monitors prove valuable for program evaluation). State agencies can use existing resources (e.g., regulatory monitors, BILD-AQ, AFLEET) to help quantify air quality and health outcomes.

• For **access to EVs and charging**, mapping tools such as ANL’s Energy Zones Mapping Tool help to provide insights on access across many domains, including corridor and community charging, fleets, and associated co-benefits of workforce development. Analysis of access metrics can help policymakers and transportation planners determine where barriers remain for both EV purchase and EVSE access gaps. By layering EVSE metrics and demographic data on visualizations, planners have the ability to make informed decisions to meet strategic goals.

• For **energy democracy**, community participation early and throughout all project stages is critical for a just and resilient clean energy transition. Community participants—individuals and advocacy organizations—should fully represent the social composition of the community, especially those who have been historically marginalized and burdened by pollution and underinvestment. Empowering communities with decision-making, long-term governance, and asset ownership increases equity in energy policies and implementation and narrows the divide between community and governance.

Overall, equity-related metrics are often difficult to quantify due to multiple confounding factors. Some starting points and strategies are presented here to derive initial estimates, as state agencies may lack the resources to collect more detailed data. Further work is needed to provide more standardized definitions for equity metrics and community indicators, data collection protocols, and supporting tools for metric quantification. Community member participation is essential to the whole process, including developing metrics, identifying DAC benefits, and providing program feedback, evaluation, and suggestions for process improvements.
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### 7. Appendix.

#### Table A-1. Example Metrics to Analyze EV Access

<table>
<thead>
<tr>
<th>Metric for Access to EVs</th>
<th>As it Applies to Access</th>
<th>Limitation of Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial incentives</td>
<td>Governmental, manufacturer, and other allocations to reduce barriers to entry</td>
<td>Even with financial incentives, higher cost of EVs has put purchases out of reach recently</td>
</tr>
<tr>
<td>Access to low-cost capital to increase equitable adoption of EVs or purchase of used EVs</td>
<td>Reduction in initial barriers to entry. Existing and new low-interest or zero-interest loans for EV purchase have the potential to increase access for many consumers.</td>
<td>Does not inform on how concern over access to charging infrastructure may influence purchase</td>
</tr>
<tr>
<td>Count of federal, state, and local policies to make EV purchases affordable, to include tax credits, rebates, and/or grants</td>
<td>While the cost of purchase of EVs has fallen in recent years, incentives have also made EVs more affordable for some buyers. Understanding the relationship between incentives and consumer behavior helps determine if these options extend benefits across all communities, or simply reward those who are already well positioned to make an EV purchase.</td>
<td>Different tax and financial incentives have played a part in reducing access barriers, but these financial incentives have often benefitted wealthier buyers and not low-income earners.</td>
</tr>
<tr>
<td>Count of EV car-sharing projects in DACs</td>
<td>EV-sharing programs have provided an opportunity for the public to gain an understanding of how EVs function, thus leading to a greater willingness to purchase an EV.</td>
<td>Many EV-sharing initiatives have launched across the United States, but sustaining them from a commercial standpoint has been difficult in the long run.</td>
</tr>
<tr>
<td>Count of car rental companies offering EVs</td>
<td>Exposure to EVs for consumers that rent can provide education and influence purchase</td>
<td>Consumer behavior with regard to rental choices may not have a complete carryover to personal purchases</td>
</tr>
<tr>
<td>Count of automaker partnerships with community-based organizations</td>
<td>Automakers have played a role in helping community-based organizations in DACs access EVs for ride-share/car-share programs. These initiatives have helped to provide education on the role of EVs and brought about economic, environmental, and social benefits. Collecting data and trends on corporate support at a local level sheds insights on reducing initial barriers to entry.</td>
<td>These data may not be readily available and may not inform the direct study question of U.S. Department of Transportation teams wanting to learn more about access; perhaps an interesting metric, but may not be the most vital.</td>
</tr>
<tr>
<td>Count of free charging incentives offered by carmakers and consumer willingness to purchase based on free charging incentives</td>
<td>Home charging offers both convenience and cost benefits, but for consumers who lack this option, cost for public charging is a consideration for those purchasing an EV. Some car companies offer free charging for a set period to incentivize EV purchases.</td>
<td>Corporate incentives for free charging are constantly evolving; thus, collecting and updating the data for this metric would require time and expertise</td>
</tr>
<tr>
<td>Metric for Access to EVs</td>
<td>As it Applies to Access</td>
<td>Limitation of Metric</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Count of other financial or social incentives to purchase EVs</td>
<td>Free charging at the workplace, subsidized charging in DACs, and other favorable pricing structures can provide insights on the interplay between economic factors and consumer willingness to purchase an EV</td>
<td>Collecting data in a systematic way on the financial and social incentive packages may take time and investment into new studies and data collection methodologies</td>
</tr>
<tr>
<td>Count of registration and/or road tax breaks for consumers who purchase EVs</td>
<td>Identifying the number of state and local financial incentives for EV purchases can help policymakers gain insight on what is influencing consumer behavior and what works to reduce initial barriers to access.</td>
<td>If the price point for an EV is still out of reach for many, waiving registration and road tax fees may not be an adequate focus for increasing access.</td>
</tr>
<tr>
<td>Count of localities allowing EVs to use high-occupancy vehicle (HOV) lanes or offer reduced registration/taxes for EV owners</td>
<td>One of the first incentives to encourage more consumers to purchase EVs was allowing use of HOV lanes. Counting the number of communities allowing EVs to use HOV lanes may provide some understanding on consumer behavior with regard to EVs and how residents of DACs that face long commutes may see this as an incentive as compared to an internal combustion engine vehicle</td>
<td>Transportation planners indicate that encouraging access to privately owned EVs through subsidies can have unintended impact of putting more cars on the street and reducing tax base available funds to invest in public transportation.</td>
</tr>
<tr>
<td>Count and reach of public education programs on EV adoption</td>
<td>Many consumers remain hesitant about the benefits of EVs. Public education is considered an enabling factor to reducing anxiety over a new technology and reducing the initial barriers to purchase.</td>
<td>Education alone will not solve the issue of cost and lack of affordability for privately owned EVs.</td>
</tr>
</tbody>
</table>