Arizona Public Service and Tucson Electric Power

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Arizona Statewide Transportation Electrification Plan

Phase II DRAFT

Energy+Environmental Economics

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Executive Summary

The transportation sector is undergoing a transformation due to the rapid advancements made on electric vehicle (EV) technology in recent years. Momentum will build as EV costs decline and increasing numbers of consumers begin to adopt these vehicles. Transportation electrification (TE) can provide significant benefits not only to EV purchasers but also to electric utility customers generally. Arizonans overall also stand to benefit from TE due to the significant reductions in emissions of both greenhouse gases and local air pollutants, leading to improved health outcomes and allowing for expanded economic development in the state.

Arizona needs to plan for the large-scale changes that TE represents for both the transportation and electric power sectors. Without proper planning and coordination, new electricity demand from EVs could result in expensive upgrades to the electric grid and missed opportunities to utilize the battery storage capacity within the growing EV fleet. Lack of collaboration in the development of the TE sector could also lead to inequitable outcomes with underserved communities largely excluded from the benefits EVs can bring to Arizona. This is a very real risk given EV purchases have historically skewed towards relatively affluent early adopters. Alternatively, proper planning and collaboration between electric utilities, regulatory agencies, policymakers, advocates for underserved communities, automakers, third-party charging service providers, and other stakeholders can unlock the significant benefits offered by TE for all Arizonans.

Recognizing the need to plan for TE the Arizona Corporation Commission (ACC), in Decision No. 77289, ordered the state's Public Service Corporations (PSCs) to develop a long-term, comprehensive Statewide Transportation Electrification Plan for Arizona. In December 2019 Arizona Public Service (APS) and Tucson Electric Power (TEP)[1], with the help of Energy and Environmental Economics, Inc. (E3), filed a Phase I TE Plan with the ACC, which provided a conceptual framework for TE planning in the state.[2] Phase II builds upon the Phase I report to put forth a comprehensive and actionable roadmap for TE in Arizona, including analysis of promising EV opportunities and significant engagement with the state's TE stakeholder community. APS and TEP intend to update this plan periodically, and this Phase II report should be seen as the first iteration of a guiding document for development and expansion of TE in Arizona.

The Phase II process focused largely on two parallel efforts: 1) rigorous analysis of the costs and benefits of several near-term electrification opportunities, specifically assessing five promising vehicle segments; and 2) stakeholder engagement, to provide a forum for knowledge sharing and the discussion of critical issues for different groups, and to leverage the expertise of a diverse set of Arizonans interested in TE.

Transportation Electrification Provides Net Benefits to Arizona

E3 conducted a Cost Benefit Analysis (CBA) and a related Air Quality Potential Analysis for electrification of five promising vehicle segments, including personal light-duty vehicles (LDVs), rideshare LDVs, medium duty (MD) parcel delivery trucks, school buses, and transit buses. As outlined in the Phase I report, these vehicle segments represent some of the most promising near-term opportunities for electrification. However, they do not reflect the entirety of the on-road transportation fleet in Arizona, and other, non-modeled MD and

[1] For the purposes of this TE Plan, TEP also represents sister utility UNS Electric.

[2] The Phase I report is available at: https://docket.images.azcc.gov/E000004250.pdf.

heavy-duty (HD) vehicles also provide significant potential benefits from electrification, especially with respect to reductions in greenhouse gas and local air pollutants.[3]

E3 found that the EVs modeled for this analysis collectively provide net benefits to not only EV adopters (participant cost test), but also to utility ratepayers generally (ratepayer impact measure) and Arizonans overall (societal cost test). Table 1 describes the estimated net present benefits over the lifetime of all modeled EVs adopted between 2020 and 2040 across several different adoption scenarios, broken out by the two utilities' service territories as well as the extrapolated results at the statewide level.[4] Note that the Low adoption scenario assumes unmanaged charging of EVs, while the Low + Managed, Medium, and High adoption scenarios alternatively assume that all vehicle charging is managed based on time of use (TOU) electricity rates.

Table 1. Net Present Benefits, Total EV Population, All Vehicle Segments Modeled ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	556	106	1,297	766	307	2,103	1,732	509	4,392
Low + Managed	640	117	1,484	786	313	2,153	1,749	567	4,530
Medium	4,030	689	9,248	4,540	1,620	12,074	11,467	2,948	28,254
High	5,592	969	12,859	6,265	2,239	16,667	15,851	4,092	39,090

These results are consistent with E3's findings in other jurisdictions and indicate that supporting TE can provide significant benefits to Arizonans. APS and TEP plan to continue assessing these costs and benefits over time as EV costs decline and the utilities' electricity supply sources evolve in line with commitments to reduce the carbon intensity of their generation resources. As an initial assessment, however, these promising results suggest that TE can provide substantial benefits for Arizona. Achieving these benefits will require engagement and supporting initiatives from not only the electric utilities, but also from other actors and TE stakeholders.

Actions Recommended by Transportation Electrification Stakeholders

A key component of the Phase II process has been the ongoing involvement of a diverse stakeholder group representing state and local government agencies, transit agencies, environmental organizations, EV advocates, representatives of underserved communities, academic institutions, automakers, charging service providers, fleet operators, and others, who have collectively provided valuable insights and perspectives on TE. With facilitation support from ILLUME Advising (ILLUME), the working groups focused on five distinct topical areas: *EV Infrastructure*, *Programs & Partnerships*, *Equity*, *Goods Movement & Transit*, and *Vehicle Grid Integration*. Each group was tasked with discussing TE barriers and opportunities

[3] See section 4.3.3.1 for an estimate of emissions reduction potential from these non-modeled vehicles.

[4] It is important to note that statewide results based on the APS and TEP modeling are directional and not precise. As many inputs vary by utility – for example, electricity supply costs and retail electricity rates, these scaled results are not a precise depiction of the costs and benefits of TE in other Arizona electric utilities and should be interpreted with this caveat in mind.

relative to their topical focus, as well as recommended actions for the electric utilities and other involved parties to help overcome these barriers and unlock the benefits of TE.

Table 2 provides a summary of the high-priority, near- and medium-term actions the working groups recommend be taken by different actors in Arizona to support TE. Additional detail on recommendations and the barriers they help to overcome is included in Chapter 5.

69 *Table 2. Stakeholder Working Group Recommended Near- and Medium-term Actions to Support TE in Arizona*

Actor	Priority	Action
Electric Utilities	Near	Continue stakeholder coordination meetings; prioritize inclusion of diverse voices
		Develop new and expand existing education & outreach programs
		Establish dedicated electrification teams
	Medium	Develop incentive programs for EVs and/or EV charging infrastructure
		Develop EV rates
		Implement pilot charging programs and begin to deploy additional charging infrastructure; emphasize deployment in underserved communities
		Electrify fleet vehicles
State and/or Local Government	Near	Support and participate in TE Collaborative process; focus on inclusive planning model and diversity of voices
	Medium	Enact Zero Emissions Vehicle (ZEV) legislation
		Develop and/or support Group Purchase programs and EV funding mechanisms such as loan-loss reserves
		Develop incentive programs for EV and/or charging infrastructure purchase (state)
		Implement EV Ready building codes (local)
		Develop rideshare programs for underserved communities
Representatives of Underserved Communities	Near	Engage in collaborative TE planning processes
	Medium	Partner with utilities and public agencies on education & outreach, rideshare / micromobility, and training programs
Transit Agencies and/or Fleet Operators	Medium	Initiate and scale existing pilot electrification programs
		Purchase diverse model types to explore capabilities and limitations; share knowledge
Third-Party EV Service Providers (EVSPs)	Near	Engage in collaborative TE planning processes
		Collaborate with utilities on improving interconnection processes
	Medium	Develop additional public and workplace charging infrastructure; prioritize service coverage in underserved communities

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APS and TEP Initiatives to Support Transportation Electrification

APS and TEP believe they have a key role to play in helping to support the development of a robust TE sector in Arizona. The utilities are committed to supporting TE through their ongoing programs as well as planned initiatives informed in part by the recommendations of the TE stakeholder group through the Phase II process.

Table 3 summarizes their TE initiatives (additional detail is provided in Chapter 6).

Table 3. Summary of Ongoing or Planned APS and TEP TE Initiatives

Barrier	APS Initiatives	TEP Initiatives
Lack of Collaboration	+ Continued engagement in industry events and collaborative working groups + Planned hosting of regular TE Collaborative meetings with stakeholders	+ Continued engagement in industry events and collaborative working groups + Planned hosting regular TE Collaborative meetings with stakeholders
Inequity in TE Planning	+ Planned hosting of regular TE Collaborative meetings with stakeholders	+ Planned hosting of regular TE Collaborative meetings with stakeholders
Education & Outreach	+ Participation in events throughout Arizona + Planning additional events for post-COVID timeframe + APS Marketplace; Improving APS EV website + Take Charge AZ (L2 & DCFC installation & ownership)	+ EV marketing plan + Customer Toolbox + Residential EV Calculator + Fleet Conversion Planning Tool + EV Infrastructure Cost Estimation Tool + Employee EV program and fleet electrification
Access for Underserved Communities	+ Take Charge AZ (L2 & DCFC installation & ownership)	+ TEP Owned Public DCFC + Smart EV Charging pilot
Insufficient Charging Infrastructure	+ Take Charge AZ (L2 & DCFC installation & ownership) + Proposed EV pre-wire incentive + TRU & electric forklift incentive	+ Smart Home EV pilot + Smart School EV & EE pilot + Smart EV Charging pilot + EV-readiness incentive
Grid Planning & Capacity Needs	+ EV adoption forecasting + Charging analysis + DCFC screening + Load forecasting using residential EV charging data	+ 5-yr Strategic EV Roadmap + EV penetration study + Charging siting forecasts + System cost benefit analysis + Load management platform
Electricity Rate Design	+ EV rate evaluation for APS- or EVSP-operated charging sites + Saver Choice Max rate for residential customers	+ TOU rates & EV rate discount + Stand Alone EV & Submeter EV rates

Establishing a Statewide EV Goal

APS and TEP support establishing a statewide goal, which most of the working groups have recommended as a key outcome of this process. Specifically, APS and TEP propose a goal aligned with the Medium scenario modeled in the CBA, composed of the following statewide targets for 2030:

- 1,076,000 electric LDVs
- 3,831 electric MD parcel delivery trucks
- 785 electric transit buses
- 1,422 electric school buses

In order to assess progress towards the proposed statewide goal, APS and TEP plan to track various metrics and share this information with stakeholders through regular TE Collaborative meetings that the utilities plan to host. Example metrics could include:

- Public EV charging stations and plug counts, both statewide and within APS and TEP service territories
- Customers enrolled in EV or TOU rates.
- Customers enrolled in residential and commercial EV programs.
- Ratio of DCFC stations to battery electric vehicle adoption.
- EV models available to Arizona residents compared to total EVs available in the United States.
- Individuals and organizations attending and engaging in ongoing TE Collaborative meetings.
- Number of municipalities that have incorporated TE into their fleet(s).

Gathering and reporting on these types of metrics will be part of the ongoing collaboration between Arizona's TE stakeholders. The structure for collecting, reporting and distributing updates will need to be developed, and APS and TEP anticipate that this will be one of the topics of discussion at the initial TE Collaborative meetings.

Tracking progress across these key indicators will allow APS and TEP – and by extension, the engaged TE stakeholder community – to ensure that progress towards the 2030 goal is occurring at the required pace. Future iterations of this TE plan will consider progress towards the 2030 goal in prioritizing the different opportunities that exist to further promote EVs, ensuring that the utilities and other stakeholders remain on track to meet the desired goal.

Through ongoing collaboration with other TE stakeholders, APS and TEP will continue to work towards unlocking the benefits of TE for all Arizonans. Revisiting progress towards this goal on a regular basis – both through ongoing collaborative meetings and more formally as part of the future iterations of the statewide TE plan – will constitute an important part of enabling robust TE in Arizona.

1. Introduction: Our Process

Transportation electrification (TE) can provide significant benefits to EV purchasers as well as utility customers generally. Adoption of EVs also improves air quality and aids in the growth of the Arizona economy, providing benefits for all Arizonans. To unlock this value, Arizona's TE stakeholders – including electric utilities, regulatory agencies, policymakers, advocates for underserved communities, automakers, transit agencies, fleet operators, third-party charging service providers, and others – must work together to support EV adoption while also integrating this new load into the existing electricity system, ideally in the most cost-effective manner possible.

Recognizing this, in Decision No. 77289, the ACC ordered the state's PSCs to develop a long-term, comprehensive Statewide Transportation Electrification Plan (TE Plan) for Arizona. This report constitutes Phase II of a two-part process to develop such a statewide plan. Phase I – filed in December 2019 – provided a conceptual framework for the plan, and Phase II builds upon that starting point to put forth a comprehensive and actionable roadmap for TE in Arizona. APS and TEP intend to update this plan periodically, and this Phase II report should be seen as the first iteration of a guiding document informed by a broad and diverse group of engaged stakeholders.

1.1 Phase II Focus and Structure of the Statewide TE Plan

As envisioned in Phase I, the Phase II process focused largely on two parallel efforts: 1) rigorous analysis of the costs and benefits of several near-term electrification opportunities, specifically assessing five promising vehicle segments, and 2) stakeholder engagement, to both provide a forum for knowledge sharing and the discussion of critical issues for different groups, and to leverage the expertise of a diverse set of Arizonans interested in TE.

This report documents the findings and key learnings from the Phase II process, and is organized as follows:

- Chapter 2 provides a detailed **Transportation Electrification Market and Technology Assessment**, including an inventory of vehicle types and counts in Arizona.
- Chapter 3 discusses key **Transportation Electrification Policies and Institutions** at the federal, state, and local levels.
- Chapter 4 describes E3's analysis conducted for APS and TEP as part of the Phase II process, including a **Cost Benefit Analysis** as well as an **Air Quality Potential Analysis** focused on the health co-benefits of TE.
- Chapter 5 summarizes the barriers and recommendations provided by stakeholders involved in the Phase II process, structured as a **Gaps Analysis** to identify areas for further TE support.
- Chapter 6 proposes a **Statewide Transportation Electrification Goal for 2030** and discusses **APS and TEP Initiatives** planned to support achieving this goal.
- Chapter 0 concludes the report.
- Appendix A includes additional results and assumptions for the analyses described in Chapter 4.
- Appendix B provides the final reports of the five stakeholder working groups, describing their findings and recommendations.
- Appendix C provides a list of organizations involved in the Phase II TE Plan process.
- Appendix D includes stakeholder comments received on the draft version of this report.

1.2 Stakeholder Input to the Phase II TE Plan

A key component of the Phase II process has been the ongoing involvement of a diverse stakeholder group of over 400 individuals representing over 200 organizations including state and local government agencies, transit agencies, environmental organizations, EV advocates, representatives of underserved communities, academic institutions, automakers, charging service providers, fleet operators, and others, who have collectively provided valuable insights and perspectives on TE.[5] With the assistance of E3 and ILLUME, APS and TEP organized three stakeholder workshops and dozens of meetings across five stakeholder working groups. This process began in earnest in July 2020 with an informative TE Industry Update presentation for the stakeholder group and culminated in February 2021 with E3's presentation of this report to stakeholders. APS and TEP anticipate continued collaboration with this diverse group of TE stakeholders and welcome ongoing input and coordination with this group.

The working groups focused on five distinct topical areas: *EV Infrastructure*, *Programs & Partnerships*, *Equity*, *Goods Movement & Transit*, and *Vehicle Grid Integration*. Each group was tasked with discussing TE barriers and opportunities relative to their topical focus, as well as recommended actions for the electric utilities and other involved parties to help overcome these barriers and unlock the benefits of TE in Arizona. Chapter 5 includes a summary of the groups' recommended actions, and Appendix B includes the final reports each group compiled to formalize their findings and recommendations. Insights and comments from the working groups are also included where appropriate throughout this report. APS, TEP, E3 and ILLUME greatly appreciate the time and effort this large and diverse group of stakeholders has dedicated to the Phase II TE Plan process and extend our gratitude to all participants for their contributions.

1.3 Utility and Other Transportation Electrification Stakeholder Roles

Supporting TE requires collaboration and effort from a variety of different stakeholders. Electric utilities have a critical and unique role to play in helping to enable the charging infrastructure required to power increasing numbers of EVs, through either direct ownership of the infrastructure, preparing the connection to the grid (known as "make ready"), or facilitation of the interconnection process. Utilities can also leverage their relationship with electricity customers to promote EV programs and, for example, provide education on TE options or available incentives. Chapter 6 details the ongoing and planned APS and TEP initiatives to support TE.

However, electric utilities cannot single-handedly support the development of a robust transportation electrification sector. Other stakeholders have distinct roles to play, and achieving the significant benefits offered by TE for all Arizonans will require the contribution of many actors, including but not limited to APS and TEP. Accordingly, APS and TEP have structured this report to encompass the various initiatives that will be required from different stakeholders to support TE in Arizona in a meaningful way, both through the discussion of barriers by vehicle segment in Chapter 2 and through the Gaps Analysis and Recommended Actions developed by stakeholders and summarized in Chapter 5.

[5] Please see Appendix C for a list of organizations involved in the Phase II TE Plan process.

Examples of the roles other actors can play in supporting TE in Arizona include development of additional charging infrastructure by third-party EV service providers; implementation of "EV Ready" building codes by municipalities to facilitate expanded, lower-cost charging infrastructure deployment; procurement and piloting of electric models by transit agencies and other fleet operators; and supportive policies from the state of Arizona, such as incentives to lower the cost of EVs or legislation to increase EV model availability within the state. This non-exhaustive list provides a sampling of the different support initiatives that TE stakeholders can engage in. As described by stakeholders in the Recommended Actions portion of Chapter 5, there are many ways to promote TE and achieving the ambitious statewide goal proposed in this plan will require effort from all parties involved.

1.4 Ongoing Collaboration and Future Updates to the Statewide TE Plan

As EV technology continues to progress and the utilities and other stakeholders develop further competencies with TE, the statewide TE plan will need to be updated to reflect the latest information and evolving best practices in supporting an electrified transportation system. Accordingly, APS and TEP anticipate revisiting this plan on a regular basis – likely every three years – to document progress on existing TE initiatives as well as noteworthy developments and opportunities for the utilities and other Arizona TE stakeholders to consider.

Periodic updates to the plan will benefit from the continued engagement of the stakeholder group. One outcome of the Phase II process is a commitment from APS and TEP to continue regular meetings and collaboration with TE stakeholders. This ongoing collaboration will allow for future revisions to the statewide TE plan that include the input of engaged stakeholders, continuing the collaborative relationships that this Phase II process has developed. Regular meetings and collaboration will provide stakeholders with the opportunity to remain engaged with the TE initiatives APS and TEP plan and implement and will in turn provide valuable insights for the utilities as they accelerate their TE programming.

1.5 Establishing a Statewide Transportation Electrification Goal

Reaching the ambitious statewide goal of 1.076 million electric LDVs by 2030 – represented by the Medium adoption scenario in the Cost Benefit Analysis (see Chapter 4) – will require accelerated action on the part of all TE stakeholders. In contrast to the Low adoption scenario, the state is unlikely to reach 1.076 million electric LDVs without a significant increase in supportive policy, funding, and programs, including a large scale-up of charging infrastructure and expanded education and outreach initiatives to increase awareness of TE options. Discussion of the statewide goal in Chapter 6 provides an overview of the level of effort which will be required to meet this goal, in contrast to lower adoption trajectories that might be expected in the absence of increased supporting initiatives.

Importantly, special consideration needs to be given to TE planning with respect to inclusion and equity to ensure that this transition of the transportation sector and attainment of the statewide goal provides opportunities for all Arizonans to share in the benefits of electrification. This includes historically underserved communities, Native American communities, rural populations, and other groups that are at risk of being neglected without the active solicitation of representative voices in TE discussions.

2. Transportation Electrification Market and Technology Assessment

2.1 Introduction

The first step in determining how to best support transportation electrification in Arizona and deliver its benefits is to take an inventory of the current transportation landscape in order to establish a baseline. Next, assessing the state of TE technologies and their market potential in Arizona – including identifying and categorizing the barriers to adoption and grid integration that these vehicles face – allows for development of priority focus areas and actionable next steps for different TE stakeholders. This chapter builds upon the initial assessment completed for the Phase I report, incorporating additional data and information on current market and technology status, a considerably more robust investigation of the current transportation landscape in Arizona, and input from the five working groups convened throughout the Phase II TE Plan process.

To provide a baseline for assessing market potential we begin by characterizing the current composition of Arizona's vehicle population, as well as the attributable carbon emissions given the opportunity for emissions reductions offered by TE. Today Arizona's vehicle fleet consists almost entirely of gasoline- and diesel-powered internal combustion engine vehicles, with relatively low penetration of EVs. However, for every vehicle category an electric drive version is either under development or already commercially available.

Accordingly, the bulk of this chapter surveys the state of electric drive technology for each category and, where appropriate, market segment. This survey begins with the smallest EV technologies for personal transport ("micromobility") and progresses sequentially through the primary vehicle types that compose our transportation sector. For each vehicle segment, EV technology readiness and commercialization is described, followed by a discussion of the primary barriers facing further development of TE for that segment. E3's assessment of barriers by vehicle segment was augmented by the identification and description of barriers by the five stakeholder working groups (the groups' recommended actions to overcome these barriers are discussed in detail in Chapter 5, beginning on page 84).

This TE assessment affirms the conclusions from the Phase I report, that opportunities for TE with significant near-term market potential in Arizona include: personal light-duty vehicles, transportation network company (TNC, or "rideshare") fleets, medium-duty parcel delivery vans, truck stop electrification, transport refrigeration units and several types of non-road vehicles or equipment. Accordingly, the utilities recommend their actions and those of other TE stakeholders focus on these opportunities in the near term, while continuing to assess the potential of other electrified technologies for additional focus in the medium and longer term.

2.2 Arizona's Vehicle Fleet Today: Composition and Emissions Profile

As of January 2020, Arizona had approximately 6.3 million registered on-road vehicles powered by gasoline or diesel. 91 percent of these were passenger cars or light-duty trucks (< 8,500 lbs.), three percent motorcycles, and five percent medium- and heavy-duty vehicles (≥8,500 lbs.). An additional 55,876

registered vehicles were fully battery electric or powered by alternative fuels (including electric golf carts as well as battery electric passenger vehicles). See Figure 1, below for the major on-road vehicle categories.

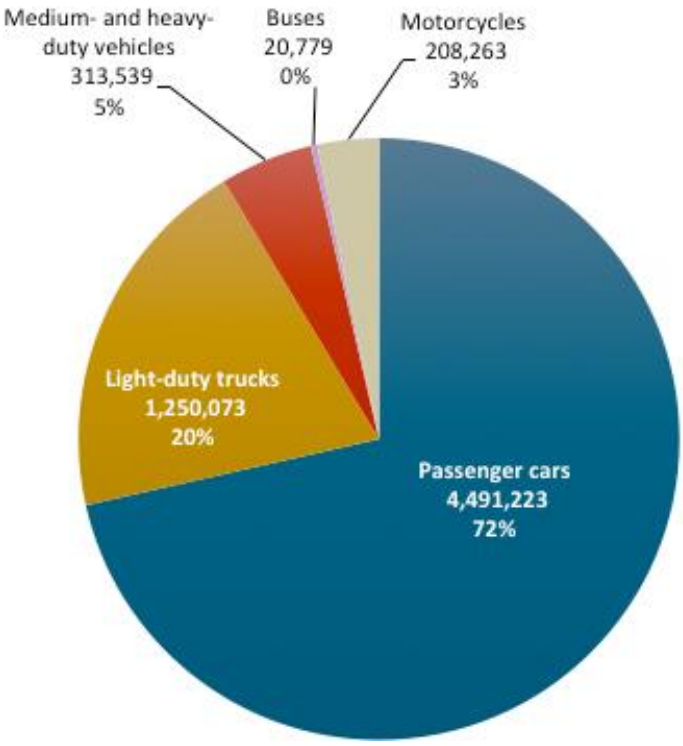

Figure 1. On-road gasoline or diesel vehicles registered in Arizona as of January 2020[6]

As of 2017 (the most recent year available), transportation as a whole comprised 38 percent of Arizona's energy-related carbon dioxide emissions[7] (see Figure 2Error! Reference source not found.).

[6] Arizona Department of Transportation (ADOT), MVD Report generated/retrieved on 1/4/2020. These counts include plug-in hybrid vehicles.

[7] Energy-related emissions exclude those resulting from agriculture, industrial processes and product use (IPPU) and waste.

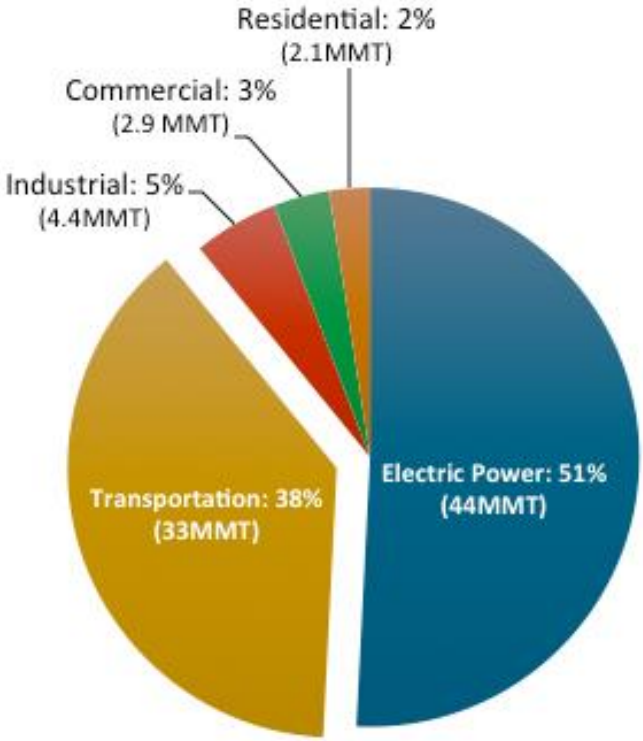

Figure 2. Arizona's energy-related carbon dioxide emissions, 2017[8]

E3's cost-benefit analysis (detailed further in Chapter 4) finds that today personal electric LDVs reduce annual emissions by 70 percent in APS service territory and 53 percent in TEP service territory, relative to ICE vehicles. These emissions reductions will grow as electric power sector emissions continue to decline with the addition of increasing amounts of renewable energy, especially if vehicles participate in managed charging to maximize utilization of these renewable sources.

A breakdown of Arizona's emissions by vehicle type is not available. However, *national* data suggests that passenger cars and light-duty trucks are the leading causes of carbon dioxide emissions from transportation (see Figure 3), with medium- and heavy-duty trucks also a significant contributor.

[8] U.S. Energy Information Administration, Energy-Related CO2 Emission Data Tables, Table 4, available at https://www.eia.gov/environment/emissions/state/

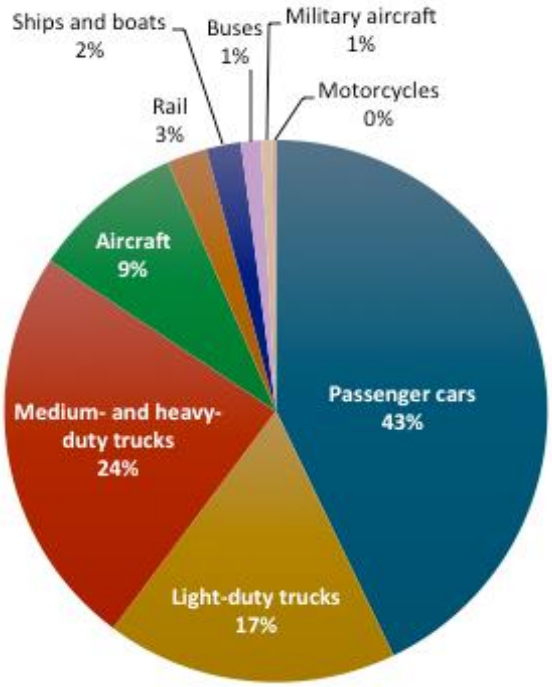

Figure 3. Breakdown of United States carbon dioxide emissions from transportation, 2018[9,10]

The following section details the status of TE technology by vehicle segment, as well as the primary barriers and grid integration challenges facing each vehicle type. Many of these barriers are shared across vehicle segments – for example, upfront cost premium or insufficient charging infrastructure – however, as described below these challenges manifest distinctly by segment, requiring distinct actions to address them.

2.3 Technology Assessment Approach

Our assessment of the maturity of electrified technologies relies primarily on analysis prepared by the California Air Resource Board (CARB), whose transportation experts regularly review progress toward commercialization of low- and zero-emission vehicle technologies. They assign a Technology Readiness Level (TRL) using a methodology originally developed by NASA.[11]

[9] U.S. Environmental Protection Agency, "Inventory of Greenhouse Gas Emissions and Sinks, 1990 - 2018," available at https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018.

[10] Medium- and heavy-duty trucks are defined as vehicles weighing ≥ 8,500 lbs.

[11] CARB, "Proposed Fiscal Year 2020-21 Funding Plan for Clean Transportation Incentives, Appendix D," November 6, 2020. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-11/appd_hd_invest_strat.pdf

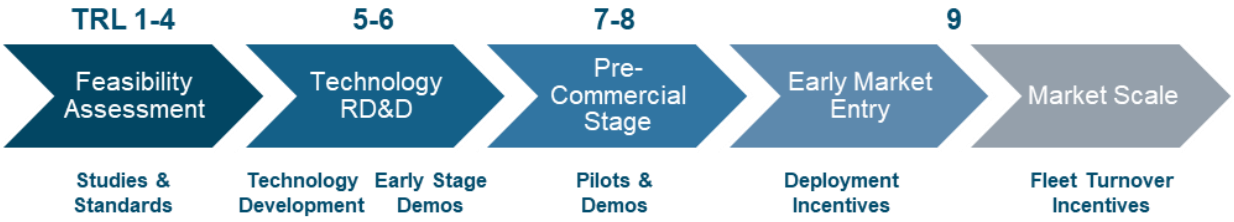

Figure 4. CARB Commercialization Pathways and Technology Readiness Levels

The utilities will be most effective at supporting TE technologies in the early market entry phase (TRL 9) once vehicles have become commercially available and customers begin utilizing these new technologies. There is also opportunity to provide technical support to commercial and industrial customers interested in demonstrating or piloting medium-duty (MD) and heavy-duty vehicle (HD) technologies or smart charging technologies at earlier levels of development (TRL 6-8). These demonstration projects will help to identify potential grid impacts of MD and HD technologies and allow for investigation of potential solutions to manage and/or mitigate these impacts.

Light-duty electric cars are clearly in the early market entry phase and some progress is evident for light-duty trucks.[12] As shown in Figure 5 below, many MD and HD battery electric vehicles (BEVs) are not as far along in their commercialization. However, several of these vehicle technologies are mature and have significant potential market penetration in Arizona including airport ground support equipment (GSE) and last-mile MD parcel delivery trucks and vans. Electrified MD delivery trucks, potentially a significant market in the Tucson and Phoenix metro areas, have recently transitioned from pilots to early market entry, while HD delivery trucks are still being demonstrated. Electrified transport refrigeration units (TRUs or eTRUs) also have potential applications transporting produce and other perishables.

[12] Light-duty trucks encompass Classes 1-3, weighing up to 14,000 lbs., including pickup trucks and large SUVs.

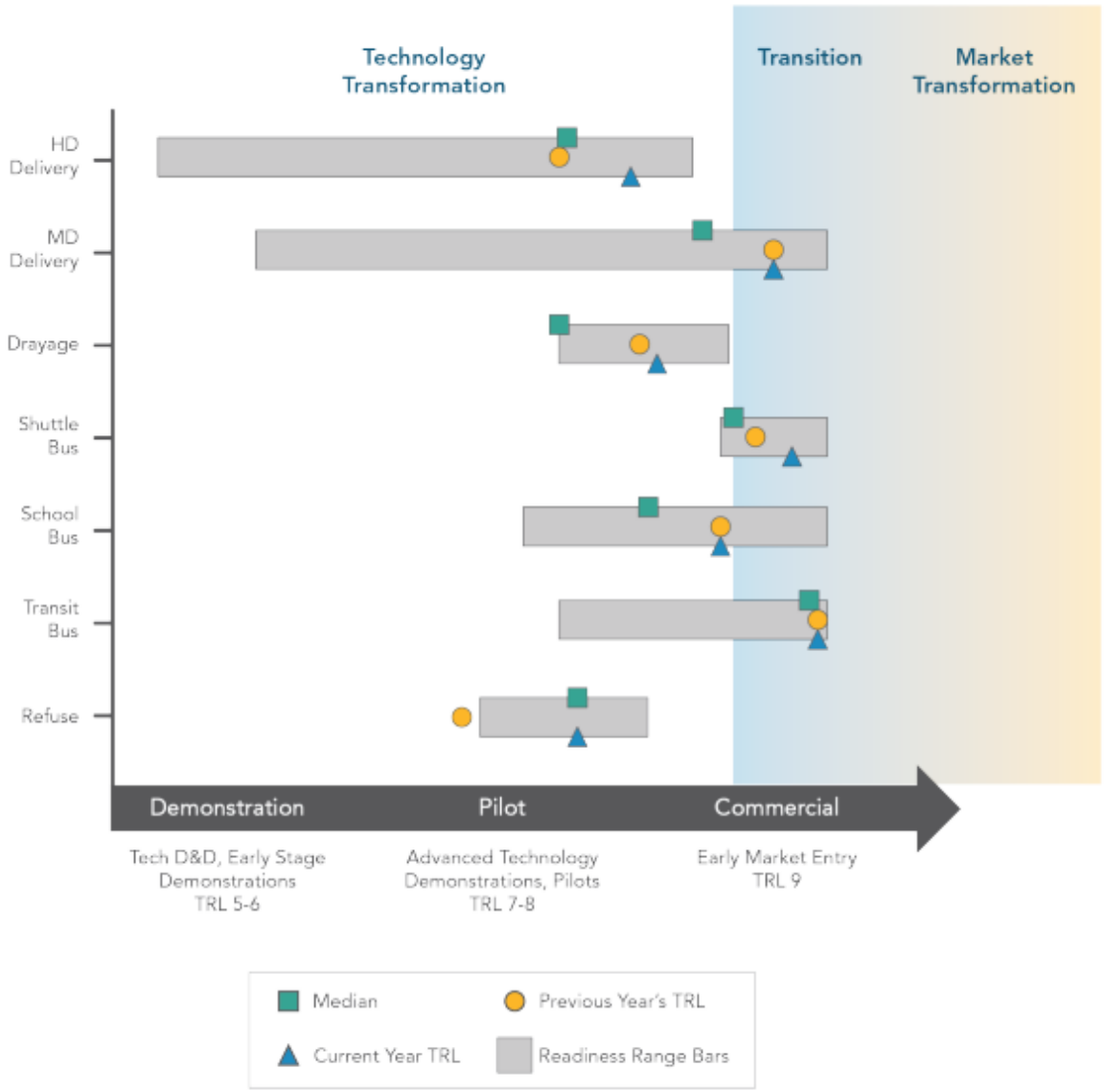

Figure 5. On-Road Battery Electric Vehicle Technology Status Snapshot, CARB[13,14]

2.4 Key Barriers

As identified by the stakeholder working groups, many of the common barriers to further EV adoption are shared not only across vehicle segments, but also across the topical areas discussed by the groups. For

[13] CARB, "Proposed Fiscal Year 2020-21 Funding Plan for Clean Transportation Incentives, Appendix D," November 6, 2020. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-11/appd_hd_invest_strat.pdf.

[14] The "Readiness Range Bars" in this figure indicate the range of readiness levels of individual vehicles that fall within a platform and collectively make up the median (green square) and weighted average (blue diamond) TRL.

example, one primary barrier to address is the lack of charging infrastructure. This is the core focus of the *EV Infrastructure* working group and is an impediment to electrification of all vehicle segments, including the MD and HD vehicles necessary for *Goods Movement and Transit*, a separate working group. Lack of charging infrastructure and how / where new infrastructure is deployed also highlights potential equity challenges, as discussed by the *Equity* working group, and overcoming these challenges will require strategic *Programs and Partnerships* (another working group). Finally, the deployment of additional charging infrastructure will be most durable and will provide the greatest benefits if it considers current and future *Vehicle Grid Integration* opportunities, the focus of the fifth and final working group.

To illustrate the interconnected nature of these challenges (and opportunities), Table 4 below summarizes the primary barriers identified by the different working groups.

Table 4. Common Barrier Categories Identified Across Working Groups

Barrier Category	EV Infrastructure	Equity	Programs & Partnerships	Goods Movement & Transit	Vehicle Grid Integration
Lack of Collaboration	X	X	X	X	
Inequity in TE Planning	X	X	X		
Education & Outreach	X	X	X	X	X
Model Availability & Technology Readiness		X	X	X	X
Upfront Cost		X	X	X	X
Access for Underserved Communities	X	X	X		
Insufficient Charging Infrastructure	X	X	X	X	X
Grid Planning & Capacity Needs	X		X	X	X
Electricity Rate Design	X	X	X	X	X

Table 5 briefly summarizes the nature of each of these barrier categories. As these barriers manifest differently for different vehicle segments, they are discussed in further detail in the following, segment-specific sections along with descriptions of technology status and market potential in Arizona.

326 *Table 5. Barriers and challenges facing TE adoption*

Barriers to Adoption	
Education & Outreach	Awareness of and enthusiasm for electric vehicles and related technology remains very low outside of environmentally motivated early adopters.
EV Model Availability	Though increasing, the number and types of EV models have historically been relatively small. SUV and light-duty truck models remain limited, as do MD and HD technologies.
Upfront Cost Premium	Total cost of ownership can be lower for EVs relative to their internal-combustion engine counterparts, but higher upfront costs, even with available incentives, remain a barrier.
Funding Mechanisms	Funding remains a challenge. Development of funding mechanisms and/or funding partnerships to enable the required investments will be critical to unlocking the capital required to promote TE.
Access for Underserved Communities	Without direct intervention and coordinated planning, EVs, charging stations, jobs in TE, and other EV-related opportunities are unlikely to be uniformly available or accessible across socioeconomic groups and/or geographic areas.
Technology Readiness & Performance	While EV technology has progressed substantially in recent years, viable commercially available options are not yet prevalent for all vehicle segments or use cases; this is a larger issue for MD and HD applications.
Lack of Charging Infrastructure	Despite numerous studies showing that 80 percent or more of regular trips can be accomplished with an EV, consumers remain anxious about the ability to take long trips and recharge if their battery is unexpectedly low. Fleet operators often require that every vehicle they own is capable of completing any route, which can limit use of EVs.
Charging Infrastructure Costs	Cost remains an impediment to the deployment of sufficient charging infrastructure to support anticipated levels of TE. This includes initial equipment procurement costs, ongoing operations and maintenance costs, and additional soft costs such as permitting.
Interconnection Costs & Process	Related to charging infrastructure costs above, the cost and inefficiencies in the interconnection process impedes more rapid and complete deployment of charging stations.
Grid Planning & Capacity Needs	Growth in EVs entails growth in electricity demand, requiring additional generation and potentially additional capacity resources. Additionally, charging loads for EVs are fundamentally different than other end-use load types for which the distribution system has been designed and built. Left unmanaged, these loads are likely to have high peak load coincidence factors.[15]
Electricity Rate Design	Electricity rates that are not conducive to EV charging raise the cost of EVs, presenting a less compelling value proposition. Electricity rates must also be designed to promote full cost recovery for the utility to avoid shifting costs onto other, non-EV customers, requiring a balance between at-times competing objectives.

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[15] Utility Dive, Walton, R., "Uncoordinated trouble? Electric vehicles can be a grid asset, but only with planning and investments," January 31, 2018. Available at: https://www.utilitydive.com/news/uncoordinated-trouble-electric-vehicles-can-be-a-grid-asset-but-only-with/515787/.

2.5 Individual Vehicle Segments

2.5.1 Micromobility

2.5.1.1 Maturity, Adoption and Market Size

Currently, over 75 percent of Arizona commuters drive alone to work, while roughly 1 percent bike.[16] However, electrification of small personal mobility devices is rapidly advancing, providing an alternative option for workers with shorter commutes. Benefits of these devices (e-bikes, e-scooters and e-mopeds) include reductions in carbon emissions, noise pollution and local air pollution. E-scooters in particular have provoked controversy and have been subject to a range of policy measures in cities where they have been introduced. Tempe, Scottsdale, Peoria and Mesa have welcomed them, while Phoenix has been more hesitant to allow them, and Tucson is exploring their impact on mobility and public safety. The Phoenix City Council approved a pilot program for three scooter vendors to offer their services within a specific area of the city, which began in September 2019 and was extended for an additional six months in October 2020.[17] The pilot will be evaluated by the City Council once it concludes. Tucson also recently ran a six-month pilot program with two scooter vendors, including discounted pricing for low-income residents.[18] The city decided to extend its pilot for an additional six months and also released a detailed evaluation of the initial period, concluding that this form of micromobility showed promise and merited additional exploration. Scottsdale incorporated scooters into its bicycle ordinance and has placed limits on where they may be parked.[19] Tempe requires these e-mobility companies to sign a licensing agreement in order to operate within its city limits, which details certain operational and safety standards that must be met.[20]

Additionally, as highlighted by the *Equity* working group, along with improvements in electrified public transit options micromobility technologies can help to provide access to clean transportation for Arizonans who do not own an automobile and do not desire to. The micromobility pathway is not a replacement for equitably providing access to all clean transportation options (including ownership of an EV) but can serve a useful purpose in providing additional or alternative TE options for individuals who do not want or need a personal vehicle.

2.5.1.2 Barriers to Adoption

The primary barriers to adoption of these personal mobility devices are customer awareness (education and outreach), avoiding nuisance parking, and safety concerns. Access to electrified micromobility options may also represent a barrier for some groups or communities, as noted by the *Equity* working group.

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[16] Arizona Department of Transportation, "Transportation in Arizona," January 2016. Available at: https://azdot.gov/sites/default/files/2019/08/final-transportation-in-arizona-working-paper-1_15_2016.pdf.

[17] City of Phoenix, "E-Scooter Pilot Program." Available at: https://www.phoenix.gov/streets/scooters.

[18] City of Tucson, "E-Scooter Pilot Program Evaluation." Available at: https://www.tucsonaz.gov/files/bicycle/documents/E-Scooter_Pilot_Evaluation.pdf.

[19] AZFamily.com, "Scottsdale releases strict rules for electric scooters," December 13, 2018. Available at: https://www.azfamily.com/news/scottsdale-releases-strict-rules-for-electric-scooters/article_1b07e0ce-ff12-11e8-ba8d-1f3887acdbf3.html.

[20] City of Tempe, "Tempe passes license to regulate scooter and dockless bike companies," January 11, 2019. Available at: https://www.tempe.gov/Home/Components/News/News/13258/.

2.5.1.3 Grid Integration Challenges and Opportunities

These devices charge at Level 1 and do not require specialized charging equipment. Like personal LDVs, this charging load likely has significant flexibility that can be harnessed to enable cost-effective grid integration and support renewable energy.

2.5.2 Light-Duty Vehicles

2.5.2.1 Maturity, Adoption and Market Size

As suggested by the portion of total vehicles they represent (see Figure 1 on page 11), electrification of LDVs is by far the largest opportunity for TE in Arizona. In 2019, BEVs and plug-in hybrid electric vehicles (PHEVs) collectively represented a small percentage of new LDV sales in the state.[21] However, EV sales grew every year from 2011 through 2019, as shown in Figure 6 below. The EV adoption forecasts APS and TEP conducted with Guidehouse Consulting in 2019 anticipate a statewide EV population of nearly 600,000 by 2038 (APS study) and approximately 700,000 by 2040 (TEP study) in the base business-as-usual case.[22,23] Under strong market transformation policies – for example, major marketing campaigns, strong consumer preference shift towards EVs, increased light truck model availability – this population could, alternatively, reach 1.5 million by 2038.

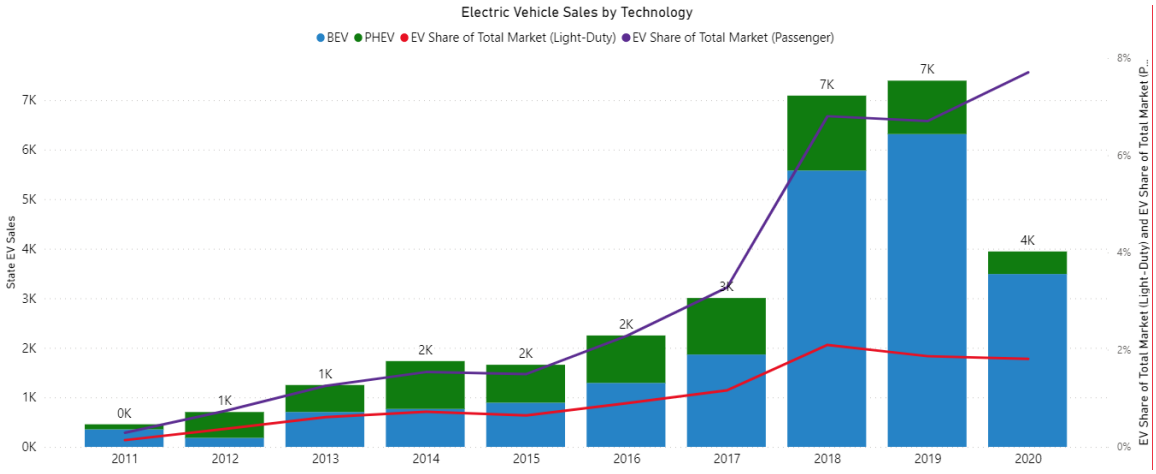

Figure 6. Annual Battery Electric Vehicle and Plug-in Hybrid Electric Vehicle Sales in Arizona[24]

Light-duty EV technology is already in the early market entry stage and is maturing steadily. The market for EVs remains largely policy-driven rather than purely market-driven, so small manufacturing volumes and ongoing technology development translate into higher costs relative to conventional vehicles. Aggressive

[21] Alliance of Automobile Manufacturers, "Advanced Technology Vehicle Sales Dashboard," 2020. Available at: https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/. 2019 data through October, 2019. Retrieved December 5, 2020.

[22] Guidehouse Consulting, "Electric Vehicle Adoption Forecast and Charging Station Siting Analysis: Arizona Public Service," October 2, 2019.

[23] Guidehouse Consulting, "Electric Vehicle Forecasting: Tucson Electric Power," January 27, 2020.

[24] Atlas EV Hub, "Automakers Dashboard," Available at: https://www.atlasevhub.com/materials/automakers-dashboard/.

public policies in China, Europe, and the Zero Emission Vehicle (ZEV) states[25] are delivering the expected market transformation. The value proposition of EVs is improving as rapidly declining battery prices reduce component costs and the increasing energy density of battery packs extends driving range. EV adoption forecasts continue to be revised upward:[26] both Bloomberg New Energy Finance and McKinsey project that light-duty EVs will reach price parity with internal combustion engine vehicles by the mid-2020s (see Figure 7 below).[27,28] Bloomberg has recently reported that certain EV models will be competitive on an upfront price basis as soon as 2022.[29] Less optimistic forecasts estimate price parity will be reached around 2030.

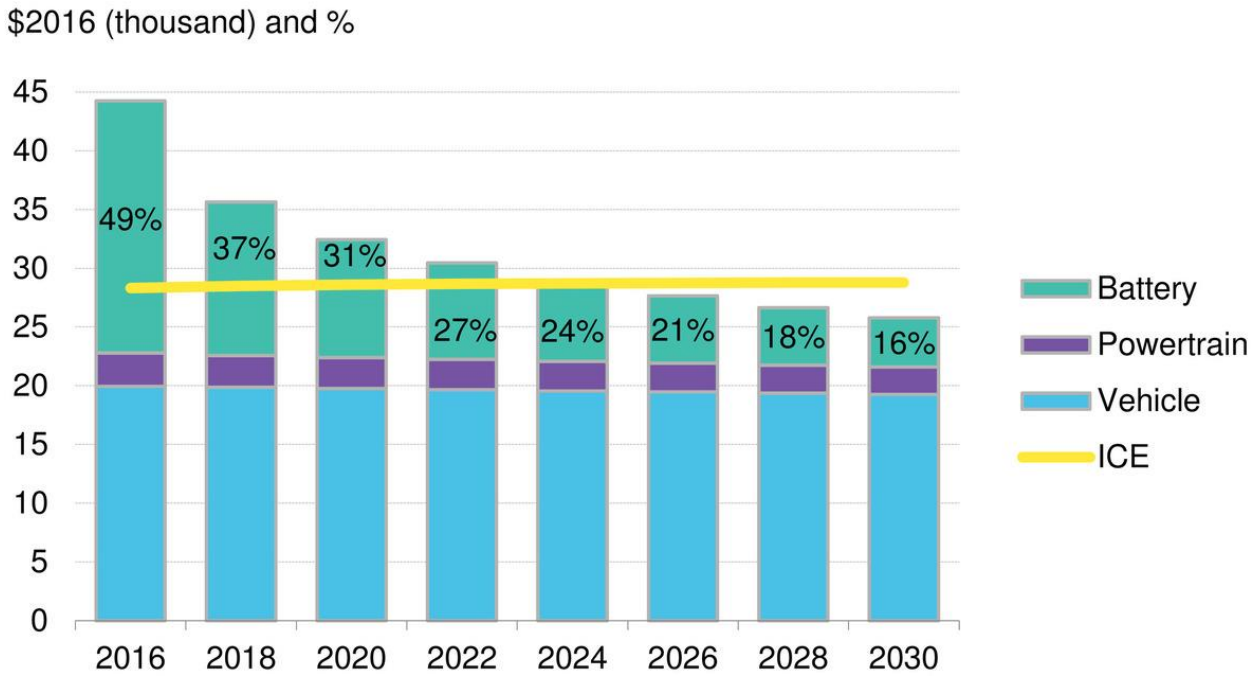

Figure 7: BNEF forecast of upfront EV prices, before incentives, suggests price parity with ICE vehicles by 2025

2.5.2.2 Customer Uses for Light-Duty Vehicles

There are four primary customer uses for LDVs, described below. Adoption barriers and grid integration challenges for each use case are identified and discussed.

[25] Section 177 of the federal Clean Air Act (42 U.S.C. Sec. 7507) permits states to adopt California's tailpipe emissions standards instead of the less stringent federal standards. Current ZEV States in addition to California are Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Oregon, and Colorado.

[26] Bloomberg New Energy Finance, (2017). "All Forecasts Signal Accelerating Demand for Electric Cars" Available at: https://about.bnef.com/blog/forecasts-signal-accelerating-demand-electric-cars/.

[27] Bloomberg New Energy Finance, "Electric Vehicle Outlook 2019," Available at: https://about.bnef.com/electric-vehicle-outlook/.

[28] McKinsey & Company, "Making electric vehicles profitable," March 2019. Available at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/making-electric-vehicles-profitable.

[29] Bloomberg, "Electric Car Price Tag Shrinks Along with Battery Cost," April 12, 2019. Available at: https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost.

Personal vehicles are owned by individuals or families and account for most LDV sales and vehicle miles travelled (VMT) today. These vehicles are typically used for commuting, errands, and occasional longer trips.

Networked service vehicles include taxis, limousines and vehicles affiliated with TNCs like Lyft and Uber. These service vehicles generally have high VMT, increasing the savings from EVs' lower maintenance and refueling costs.

Shared vehicles include those in car-share and rental fleets. Trips taken in these shared vehicles are typically local and short. The brief uses of these vehicles by a large number of individuals provides an opportunity to increase EV awareness.

Fleet vehicles include numerous public and private vehicle fleets that operate in Arizona, which vary widely in annual VMT and range of operation. High-mileage fleets are strong candidates for electrification as the total cost of ownership declines with increased VMT.

2.5.2.3 Charging Infrastructure for Light-Duty Vehicles

All light-duty EVs can charge at AC power using J1772 connectors, which have been standardized in the U.S. market. Most BEVs today are also equipped with a DC fast charging (DCFC) port. There are three main standards for DC charging — CHAdeMo (used by Japanese automakers), Combined Charging System (CCS, used by European and U.S. automakers) and Tesla's proprietary supercharger technology.[30] Note that Tesla owners may also purchase a CHAdeMO adapter. Across Arizona there are currently 154 public Level 2 charging stations hosting 1,376 plugs and 68 DCFC stations hosting 383 plugs.[31] Of these, over 100 stations hosting nearly 400 plugs are operated by Tesla and are therefore not accessible to non-Tesla EVs.[32]

2.5.2.4 Barriers to Adoption

LDVs used in the four customer applications share similar adoption barriers, although they manifest in different ways.

Education & Outreach: Lack of Awareness, Knowledge, and Enthusiasm for EVs

National surveys have found widespread lack of knowledge of the commercial availability of EVs, purchase incentives, fuel, and maintenance cost savings, charging options, and their ability to meet most people's daily driving needs.[33,34] The five working groups independently identified education and outreach as one of the primary barriers to TE in Arizona (both for LDVs and other vehicle segments). Additionally, as highlighted by the *Equity* working group, this barrier can be especially significant for underserved populations, as educational campaigns and outreach activities often do not fully consider the importance of communicating

[30] Driven largely by Nissan's recent decision to switch over to CCS, CHAdeMo appears to be phasing out.

[31] Atlas Public Policy, "EV Charging Deployment." Updated October 2020.

[32] This includes 83 Tesla Level 2 stations hosting 184 plugs and 20 Tesla Supercharger DCFC stations hosting 194 plugs.

[33] National Renewable Energy Laboratory, Singer, M., "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update," NREL Technical Report: NREL/TP-5400-70371. Available at: https://www.nrel.gov/docs/fy18osti/70371.pdf.

[34] International Council on Clean Transportation, Jin, L. and Peter, S., "Literature of electric vehicle consumer awareness and outreach activities," March 21, 2017. Available at: https://www.theicct.org/sites/default/files/publications/Consumer-EV-Awareness_ICCT_Working-Paper_23032017_vF.pdf.

specifically to these communities. Appropriate messaging might include, for example, might include the use of different media or multi-lingual messages that resonate more directly with specific underserved communities. Additionally, while appropriate messaging to these communities about EVs (and TE more broadly) is important, using appropriate *messengers* is also critical to ensure that education and outreach activities reach all Arizonans, including and especially those who might not otherwise receive such information.

It is also worth highlighting that the lack of awareness of EVs goes beyond the vehicles themselves. As described by the *EV Infrastructure* working group, the supporting technologies and components which make up a TE system, such as different types of charging plugs or electricity pricing structures, are also foreign to many consumers, creating an additional hurdle to broad adoption of EVs.

Lack of Suitable Models

Most of the light-duty EVs on the market today are sedans, which meet the needs of many drivers but are ill-suited for others. For instance, some LDV drivers are only willing to consider purchasing an all-electric vehicle if it is able to drive 300 miles on a single charge.[35] Additionally, those who prefer trucks or SUVs currently have limited options. However, automakers plan to begin selling approximately 130 EV models by 2023, with an average BEV range of over 250 miles[36], and 200 new EV models in the next five years (many of which are anticipated to be SUVs).[37] Notably, the new offerings will include a number of SUVs and crossovers from both luxury *and* more affordable brands, as well as several pickup trucks. These are important developments since SUVs and pickup trucks made up 49 percent of light-duty vehicle registrations in Arizona in 2018.[38] Additionally, as flagged by the *Equity* working group, making *affordable* EVs available to Arizonans will be critical in enabling TE for a broad range of the state's residents that wish to participate in TE through ownership of their own EV.

Model availability in Arizona may lag that of the ZEV states, however, as automakers have an incentive to concentrate vehicles and marketing resources in the areas where they face regulatory obligations to greatly increase EV sales. This ZEV state concern was flagged by multiple working groups, leading to a common recommendation that Arizona consider becoming a ZEV state to increase model availability and customer choice.

Insufficient Charging Infrastructure

Insufficient availability of suitable and reliable charging infrastructure is a significant barrier to adoption across all four applications of light-duty EVs. As highlighted by several of the working group (*EV Infrastructure*, *Equity*), this is especially true for residents of multi-unit dwellings, including many historically

[35] National Renewable Energy Laboratory, Singer, M., "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update," NREL Technical Report: NREL/TP-5400-70371. Available at: https://www.nrel.gov/docs/fy18osti/70371.pdf.

[36] Electric Power Research Institute, "Overview of EV Market and PHEV Technology," July 8, 2019.

[37] International Energy Agency, "Global EV Outlook 2020," June 2020. Available at: https://www.iea.org/reports/global-ev-outlook-2020.

[38] Alliance of Automobile Manufacturers, "Autos Drive Arizona Forward," 2020. Available at: https://autoalliance.org/in-your-state/AZ/.

underserved communities, who often do not have the ability to install charging infrastructure at their residence.

The *EV Infrastructure* working group focused largely upon this issue in their discussion. The group identified four primary barrier categories to the further deployment of charging infrastructure in Arizona: procurement costs, operational costs, soft costs, and utility engagement and information. Procurement costs include hardware costs (the equipment itself) and the costs of installation. Operational costs include software and networking fees, ongoing maintenance, and the cost of electricity through utility electric rates. Soft costs include permitting, securing the required right-of-way and any parking restrictions, and various compliance costs related to, for example, programmatic requirements or fees related to required equipment inspections. Finally, the barrier of utility engagement and information includes siting and interconnection processes as well as a lack of clarity regarding the roles and responsibilities for different parties in developing publicly funded EV infrastructure projects.

Personal vehicles*:* To date, most EV purchasers live in single-family residences and do the majority of their charging at home. A recent FleetCarma study commissioned by Salt River Project (SRP) found that roughly 75 percent of personal LDV charging takes place at home. However, as pointed out by the *Equity* and *EV Infrastructure* working groups, home charging is an elusive option for residents of multi-unit dwellings (MUDs), which are estimated to comprise 30 percent of Phoenix area housing units and 31 percent of housing units statewide.[39,40] It is costly and complex to install Level 1/Level 2 in MUDs.[41] Challenges include the cost of upgrades to wiring and electrical capacity and for construction to accommodate chargers (e.g., trenching if parking is not close enough to electric infrastructure). Other concerns for building owners are the potential loss of parking spots for other vehicles and how to allocate ongoing maintenance costs. Limited availability of charging at workplaces (Level 1 or Level 2) and scarce public DCFC leave both MUD residents and other EV owners without a dependable non-home charging solution.

Even for customers who can charge at home, a robust and reliable network of public chargers, especially DCFC, is essential to building range confidence and enabling EVs to serve the same needs as provided by conventional personal vehicles. Beyond Tesla's private network, EVgo, Blink and Electrify America currently have the largest populations of DCFCs in Arizona.[42] While the DCFC network in Arizona has been growing, this system will need to expand significantly to meet forecast EV growth. For example, the recent Navigant EV adoption study found that the number of DCFC ports in APS territory will need to increase four-fold by 2038 in the base adoption scenario, and by more than ten-

[39] U.S. Census Bureau, "Household Type by Units in Structure - American Community Survey 1-year estimates," 2018. Available at: https://censusreporter.org/data/table/?table=B11011&geo_ids=31000US38060&primary_geo_id=31000US38060.

[40] Ibid.

[41] California Air Resources Board, Waters, D., "Electric Vehicle (EV) Charging Infrastructure: Multifamily Building Standards," April 13, 2018. Available at: https://arb.ca.gov/cc/greenbuildings/pdf/tcac2018.pdf.

[42] U.S. Department of Energy, "Electric Vehicle Charging Station Locations." Available at: https://afdc.energy.gov/fuels/electricity_locations.html.

fold in the market transformation scenario.[43] Elsewhere, utilities and/or governments have stepped in to help fill the gap.

Electric taxis and TNC vehicles*:* Electric taxis and TNC vehicles need access to a reliable and relatively uncongested network of public DCFC so they can recharge swiftly and return to service. TNCs report that their EV growth strategy is to first move into markets with existing DCFC infrastructure that is sufficiently available to their drivers before potentially investing in or partnering to develop more dedicated charging stations.

Shared vehicles for personal use*:* Car-share vehicles are typically used for short-duration, short-distance trips, creating opportunities to recharge at a depot. Rental cars need to be able to recharge quickly at or near the depot in order to return to service quickly. They also require a sufficiently robust charging network at destination points (e.g., tourist attractions, resorts, restaurants, retail establishments) for rental car companies to put them in their fleets and for customers to be willing to drive them.

Fleet vehicles*:* These vehicles mainly need to be able to charge at their depot. Overnight charging is likely suited for most fleets, although driving patterns vary widely. There may be a need for public DCFC to extend the range of vehicles that routinely drive long distances.

Cost Premium Versus Conventional Vehicles

Numerous EV cost-benefit analyses, including the analysis conducted for the Phase II TE Plan and described in Chapter 4, reveal net economic benefits to the average EV driver. However, this is based on total cost of ownership (TCO) over the vehicle's life rather than on upfront cost. The upfront cost premium remains a barrier even for EVs with lower TCO than their conventional counterparts, given that TCO requires consumers to factor in charger costs, tax credits, gasoline savings and electricity prices, which can be a challenging sales pitch versus the more familiar calculations for ICE vehicles. Additionally, many currently available EVs are costly luxury makes and models, a point highlighted by the *Equity* working group in its discussions of equitable access to EVs. Declining upfront EV costs could help overcome this barrier. Online calculators that showcase the lifetime savings which can be provided by EVs can also help customers to look beyond only upfront costs. Both TEP and Salt River Project provide such calculators for their customers.[44]

[43] Navigant Consulting, "Electric Vehicle Adoption Forecast and Charging Station Siting Analysis: Arizona Public Service," October 2, 2019.

[44] Available at the following URLs, TEP: https://tep.wattplan.com/ev/; SRP: https://srp.wattplan.com/ev/.

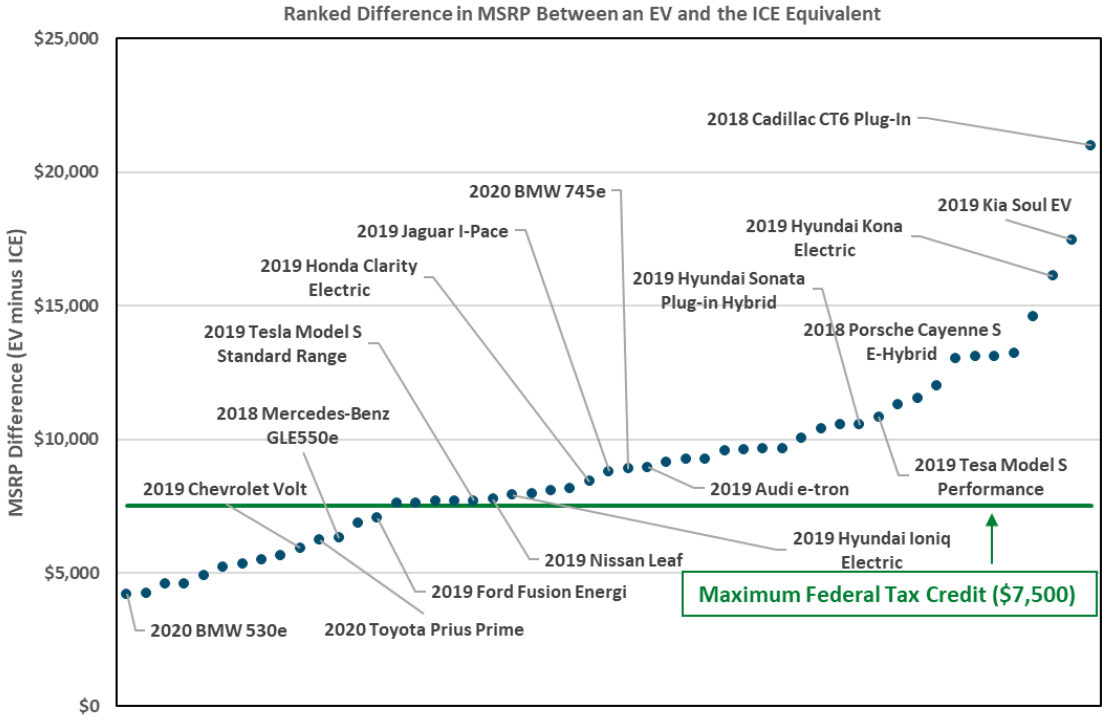

Figure 8. Differences in MSRP between EV models and their standard internal combustion engine counterparts[45]

Introducing EVs into shared and TNC fleets will accelerate availability of relatively inexpensive secondhand EVs and provide more Arizona residents the opportunity to own one, potentially helping to address the issue of inequitable access to EV models discussed in detail by the *Equity* working group. These vehicles are generally re-sold once they reach a certain mileage, which occurs more quickly for these heavily utilized fleets than for most private vehicles. This opportunity will expand once automakers begin producing stripped-down basic models of EVs for such fleets, an option currently available only for conventional models.

Lack of Dealer Incentives to Sell EVs

Vehicle shoppers' experiences at the dealership may deter them from choosing an EV, especially if they are not already aware of their availability and advantages. Research shows that car dealerships may perceive a lack of business case viability relative to conventional vehicles, leading to dealers being dismissive of EVs, misinforming shoppers on vehicle specifications, and/or omitting EVs from the conversation entirely.[46,47] As described by the *Programs & Partnerships* working group there is also a perception that dealers may be

[45] Developed using data from PG&E, "Compare Electric Vehicles," 2019. Available at: https://ev.pge.com/vehicles.

[46] Nature Energy, de Rubens, G., Noel, L., and Sovacool, B., "Dismissive and deceptive car dealerships create barriers to electric vehicle adoption at the point of sale," May 21, 2018.

[47] Sierra Club, "Rev Up Electric Vehicles: Multi-State Study of the Electric Vehicle Shopping Experience," 2016. Available at: https://content.sierraclub.org/evguide/rev-up-evs.

reluctant to sell EVs as their lower maintenance costs mean less business and profit for their repair shops. These issues mainly affect purchasers of personal vehicles.

Additionally, as discussed by the *Equity* and *EV Infrastructure* working groups, auto dealerships often do not currently provide sufficient training on the specifics of EVs to their staff, limiting their ability to communicate with prospective customers about the benefits of EV ownership.

2.5.2.5 Grid Integration Challenges and Opportunities

As more EVs come online, utilities face the challenge of integrating them proactively and cost-effectively onto their distribution systems. Both the *EV Infrastructure* and the *Vehicle Grid Integration* working groups have discussed that while integration of new EV loads could pose an impediment to more rapid EV adoption it also provides significant opportunities to shift these loads to lower cost, off-peak times of the day including times of high renewable energy generation.

Personal EVs have so far been largely charged at home. Absent incentives and educational campaigns for drivers to shift their charging behavior, the average driver is likely to plug into a Level 1 or Level 2 charging port when returning home from work or school. This means that without incentives and customer education, residential EV charging will likely coincide with evening distribution system peak loads. In addition, power levels for public DC fast charging are steadily rising with EV service providers (EVSPs) beginning to install EV supply equipment (EVSE) with capacities up to 350 kW. Arizona's first 350 kW charging station went online in March 2019 at the Target in Yuma. Especially if grouped together in charging plazas, these large-capacity chargers can trigger distribution system upgrades.[48,49]

Incentivizing "smart" charging of EVs using TOU rates, telematics devices like Geotab / FleetCarma, or traditional demand response programs can avoid or delay the need for distribution upgrades, lowering utility costs and customers' bills. EVs can also provide grid services that increase the reliability of the grid and assist with renewable integration. For example, workplace charging could provide the ability to absorb low-cost peak solar generation from the Energy Imbalance Market (EIM), providing cost savings for utilities that are passed along to customers. Automakers, charging providers and technology companies are developing technologies to aggregate individual EVs and fleets to be able to provide grid services, including system capacity, replacement reserves, regulating reserves and fast frequency response.

2.5.2.6 Fleet Composition and Market Potential for ZEVs

As of January 2020, Arizona had approximately 4.5 million registered passenger cars, 1.3 million light-duty trucks, and 200,000 motorcycles (see Figure 1 on page 11).[50] Prior to the COVID-19 pandemic, over 75

[48] UtilityDive, "Uncoordinated trouble? Electric vehicles can be a grid asset, but only with planning and investments," January 31, 2018. Available at: https://www.utilitydive.com/news/uncoordinated-trouble-electric-vehicles-can-be-a-grid-asset-but-only-with/515787/.

[49] Electrify America, "National ZEV Investment Plan: Cycle 2," February 4, 2019. Available at: https://www.epa.gov/sites/production/files/2019-02/documents/cycle2-nationalzevinvestmentplan.pdf.

[50] ADOT, January 2020, "MVD Report." These counts include plug-in hybrid vehicles.

553 percent of Arizona commuters were driving alone to work.[51] With increased remote workforce growth in
554 2020 due to the pandemic this number could change significantly in the coming years.

555 Approximately 70,000 of these vehicles are registered as rental vehicles.[52] A number are also commercial,
556 government or institutional fleets. The City of Phoenix, for example, has approximately 2,500 sedans in its
557 fleet. Northern Arizona University (NAU) has 330 light-duty vehicles and vans,[53] and Arizona State University
558 (ASU) has approximately 680 vehicles in its non-bus fleets.[54] The University of Arizona has 1,401 vehicles in
559 its fleet, including light duty vehicles, carts, motorcycles, and other non-bus vehicles. All three universities
560 are currently investigating the potential for fleet electrification.

561 In addition, a significant number of Arizona's light-duty vehicles are used to provide rideshare services for
562 TNCs such as Lyft and Uber. Since TNC drivers do not have to register their vehicles as being used for this
563 purpose, there is no publicly available information on the number of TNC drivers in the state. A very rough
564 back of the envelope calculation based on publicly available inputs suggests Arizona's TNC drivers could
565 number around 34,000.[55] This includes drivers that drive full-time for TNCs as well as those driving part-
566 time around other employment and commitments. It also includes those using their own vehicles for this
567 purpose as well as those who lease vehicles through rental services. Although TNC drivers represent a tiny
568 fraction of the total light-duty vehicles on Arizona's roads, they are promising candidates for electrification.
569 Lyft recently announced a commitment to 100-percent electrification of vehicles on its network by 2030,[56]
570 and Uber has committed to 100-percent electric rides in the U.S., Canada, and Europe by 2030.[57] Analysis
571 by E3 and by Lyft also suggests that Arizona's full-time TNC drivers could save money by purchasing EVs,[58]
572 as lower fueling and maintenance costs across their high daily mileage offsets the upfront cost premium of
573 an EV.

574 Of the approximately 5.7 million passenger cars and light-duty trucks in the state, only 31,572, or 0.55
575 percent, are plug-in electric (20,637 full battery electric vehicles and 10,935 plug-in hybrids). As described
576 in the remainder of this Phase II TE Plan, the future trajectory of electrification is dependent on the ability

[51] ADOT, January 2016, "What Moves You Arizona," available at https://azdot.gov/sites/default/files/2019/08/final-transportation-in-arizona-working-paper-1_15_2016.pdf

[52] ADOT, 2019, "Point-in-Time Registered Vehicles By Category," available at https://apps.azdot.gov/files/mvd/statistics/registered-vehicles-fy19.pdf

[53] Data received from NAU, September 4, 2020.

[54] Interview with ASU, August 25, 2020

[55] This rough calculation takes account of the 1.25 million national Uber drivers, Uber's claimed 65 percent share of national TNC rides, the 20 percent of TNC drivers that drive for both Lyft and Uber, and Arizona's 2.22 percent of the U.S. population. Sources: Uber, August 2020, "Working Together Priorities to enhance the quality and security of independent work in the United States," available at https://ubernewsroomapi.10upcdn.com/wp-content/uploads/2020/08/Working-Together-Priorities.pdf. Uber, February 2020, "2020 Investor Presentation," available at https://s23.q4cdn.com/407969754/files/doc_financials/2019/sr/InvestorPresentation_2020_Feb13.pdf.

[56] Lyft, June 2020, "Leading the Transition to Zero Emissions: Our Commitment to 100 percent Electric Vehicles by 2030," available at https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions

[57] Uber, September 2020, "Driving a Green Recovery," https://www.uber.com/us/en/about/sustainability/

[58] Lyft, June 2020, "Leading the Transition to Zero Emissions: Our Commitment to 100 percent Electric Vehicles by 2030," available at https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions

of stakeholders and policymakers across the state to support EV adoption. E3 modeled a number of potential light-duty EV adoption forecasts, as described in further detail in Chapter 4.

2.5.3 Buses

Bus electrification represents an important medium-term opportunity in Arizona. These vehicles present distinct challenges from those of the LDV segment given differences in size, usage, and technology maturity, yet nonetheless represent a market segment which is increasingly ripe for electrification. Discussion of the opportunities presented by bus electrification was one of the primary topics of the *Goods Movement & Transit* working group.

2.5.3.1 Maturity, Adoption and Market Size

Buses come in many shapes and sizes but fall generally into four categories: *Transit*, *Tourist*, *School* and *Shuttle*. Both transit and shuttle e-buses have reached the commercial stage.

China has led with aggressive electrification of its transit fleets. For example, Shenzhen has electrified its entire fleet of over 16,000 buses.[59] Transit e-bus manufacturing has also been historically dominated by Chinese firms, but competition from U.S. and European manufacturers is growing: All major North American bus makers are producing full-sized battery-electric transit buses, and over 25 different models are now available in the U.S.[60] Almost every state has a transit agency that owns an e-bus thanks to federal grants and VW settlement funds. California has mandated that all transit bus fleets become zero emissions by 2040 and will require all transit buses purchased in 2029 and after are BEVs or fuel cell vehicles (FCVs).[61] As transit agencies across the country increasingly adopt electric buses, Arizona will be able to learn from their experiences with new technologies.[62] Pilots within Arizona will also provide valuable information given the state's unique climate and the associated impact on electric bus operation.

In many parts of the country electrified transit buses already offer TCO savings over diesel and compressed natural gas (CNG) buses. Bloomberg New Energy Finance predicts electric buses will reach upfront price parity with diesel buses by 2030,[63] and Guidehouse expects electric buses to comprise 27 percent of new

[59] World Resources Institute, "How Did Shenzhen, China Build World's Largest Electric Bus Fleet?" April 4, 2018. Available at: https://www.wri.org/blog/2018/04/how-did-shenzhen-china-build-world-s-largest-electric-bus-fleet.

[60] CARB, "Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives," Appendix D, September 20, 2019. Available at: https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low-1.

[61] CARB, "California transitioning to all-electric public bus fleet by 2040," December 14, 2018. Available at: https://ww2.arb.ca.gov/news/california-transitioning-all-electric-public-bus-fleet-2040.

[62] For example, in late 2018 CARB approved a regulation mandating that California's transit agencies transition to 100 percent zero-emission bus fleets by 2040. Other cities and transit agencies have also committed to zero-emission transit bus fleets, including New York City and King County Metro (Seattle).

[63] Bloomberg New Energy Finance, "Electric Buses in Cities: Driving Towards Cleaner Air and Lower CO2," April 10, 2018. Available at: https://about.bnef.com/blog/electric-buses-cities-driving-towards-cleaner-air-lower-co2/.

U.S. bus sales by 2027.[64] Recent reports from communities piloting electric transit or school bus programs have also been promising, with the buses largely meeting or exceeding expectations.[65]

Buses may charge at a depot or, to maintain continuous operation, stop briefly at ultra-fast overhead chargers (pantographs) situated along their route. Wireless or inductive charging allows vehicles to charge while driving a short, fixed route or while parked.

Electrified school buses are also beginning to reach the market[66] and are already being implemented in several communities in the U.S. and Canada.[67,68,69,70,71] The more mature electric school bus manufacturers include Lion, Blue Bird, Green Power, Starcraft and Trans Tech. Several states are using NO_X mitigation funds allocated to them from the Volkswagen Environmental Mitigation Trust to replace diesel school buses with electric buses to capture the added benefit of reducing children's exposure to toxic air contamination from emissions of diesel particulate matter.[72] In Arizona, however, school systems have primarily used these funds to upgrade to new diesel buses.[73]

2.5.3.2 Barriers to Adoption

Arizona presents a challenging environment for bus electrification. Some pilots have found that in hot climates e-buses require larger-capacity batteries than are currently available to serve their high air-conditioning requirements while also delivering the mileages needed to cover their routes.

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[64] Guidehouse Research, "Market Data: Electric Trucks and Buses," 2018. Available at: https://www.Guidehouseresearch.com/reports/market-data-electric-drive-buses.

[65] U.S. Public Interest Research Group, "Electric Buses in America: Lessons from Cities Pioneering Clean Transportation," October 2019. Available at: https://uspirg.org/feature/usp/electric-buses-america#.

[66] CARB, "Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives" Appendix E, September 20, 2019. Available at: https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low-1.

[67] Acadia Center, "No. 1 on Our List of Back to School Supplies: Electric School Buses," September 6, 2017. Available at: http://acadiacenter.org/no-1-on-our-list-of-back-to-school-supplies-electric-school-buses/.

[68] School Transportation News, "Largest US Electric School Bus Pilot Comes to California," May 12, 2017. Available at: https://stnonline.com/news/largest-us-electric-school-bus-pilot-comes-to-california/.

[69] Energy New Network, "Minnesota district to get Midwest's first electric school bus this fall," July 11,2017. Available at: https://midwestenergynews.com/2017/07/11/minnesota-district-to-get-midwests-first-electric-school-bus-this-fall/.

[70] Ontario Ministry of Transportation, "Electric School Bus Pilot Program," August 28, 2017. Available at: http://www.mto.gov.on.ca/english/vehicles/pdf/electric-school-bus-webinar-deck.pdf.

[71] Vermont Energy Investment Corporation, "Bring electric school buses to your district." Available at: https://www.veic.org/electric-school-buses.

[72] California Air Resources Board, "Overview: Diesel Exhaust and Health." Available at: https://www.arb.ca.gov/research/diesel/diesel-health.htm.

[73] AZ.gov, "Volkswagen Settlement." Available at: https://vwsettlement.az.gov/.

Recent trials of electric buses in regions with hills or high AC demands demonstrate that the electric bus technology still needs improvement.[74,75,76] A local example comes from the Phoenix area's Valley Metro, which reported that its 2016 pilot with a BYD electric bus proved unsuccessful due to the limited range of the vehicle in Arizona's hot climate. The bus was unable to surpass a 90-mile range (less than two-thirds of the bus's advertised range), making it unfit for most of the agency's current routes. Valley Metro remains optimistic about future electric bus technologies and is willing to reconsider them after they are further proven in other regions.[77] A recent pilot by Sun Tran in Tucson has shown more promise, with the electric bus generally performing to specifications and proving suitable for a number of routes.

Despite these challenges, however, the *Goods Movement and Transit* working group decided to categorize this barrier as medium rather than high priority after discussing the issue several times. The group's general consensus is that technology will continue to improve, and that this impediment need not delay more rapid scale-up of electric buses in Arizona, despite its unique climate.

Other common barriers cited are knowledge of and/or enthusiasm about electric models among bus operators, the capital cost premium over conventional alternatives (CNG and diesel), and the existing electricity rate structures available today. The *Goods Movement and Transit* working group further identified the medium priority barriers of additional planning requirements for transit routes, including consideration of battery life relative to route length, placement of chargers, and maintaining route flexibility; planning and development fees for installing charging infrastructure; and training of existing staff on new technologies. The working group also identified a number of lower priority barriers including a lack of planning to remove or replace existing, non-electric buses; lack of expertise with upgrading infrastructure for charging needs; resistance to being a "first-mover" when technology is likely to improve (and costs to decline); scalability of pilot programs, especially without additional grants or incentives; and lack of standardization for vehicles and charging types.

Additional barriers include:[78]

- Flexibility and operational experience.
- Low load factor during early bus deployment, leading to high customer demand charges per bus.
- Interconnection issues and need for grid upgrades.

[74] Reuters, Groom, N., "U.S. transit agencies cautious on electric buses despite bold forecasts," December 11, 2017. Available at: https://www.reuters.com/article/us-transportation-buses-electric-analysi/u-s-transit-agencies-cautious-on-electric-buses-despite-bold-forecasts-idUSKBN1E60GS.

[75] South Florida Sun Sentinel, "Electric buses: Can they take the (South Florida) heat?" November 2, 2018. Available at: https://www.sun-sentinel.com/news/transportation/fl-ne-electric-buses-will-they-hold-up-20181025-story.html.

[76] Los Angeles Times, "Stalls, stops and breakdowns: Problems plague push for electric buses," May 20, 2018. Available at: https://www.latimes.com/local/lanow/la-me-electric-buses-20180520-story.html.

[77] Based on conversations with Valley Metro on 1/9/19 and 2/1/19.

[78] Bloomberg New Energy Finance, "Electric Buses in Cities: Driving Towards Cleaner Air and Lower CO2," April 10, 2018. Available at: https://about.bnef.com/blog/electric-buses-cities-driving-towards-cleaner-air-lower-co2/.

2.5.3.3 Grid Integration Challenges and Opportunities

Integrating e-buses into the grid presents both challenges and opportunities, which vary across the four bus categories. The *Goods Movement & Transit* working group found that the opportunities afforded by management of bus charging loads are substantial and provide the potential to "soak up" additional renewable energy generation that would otherwise be curtailed (not used). School buses in particular could present a unique opportunity to create a new daytime load as they are usually idle during school hours and could charge mostly or entirely on solar power. Their large batteries of 150-200 kWh are also potential sources of ancillary services. A number of school districts across the country are currently conducting vehicle-to-grid (V2G) pilots for school e-buses.[79,80,81,82]

Typical e-bus loads are currently as much as 500 kW using an overhead charger and 100 kW using a depot charger.[83] A recent E3 analysis found bus depot loads ranged from 0.5 MW to 40 MW depending on assumptions regarding bus fleet electrification levels, charging schedules, bus-to-charger ratios, and charger sizes. This wide load range is comparable to anywhere from 200 to 16,000 typical homes in the U.S. As it is unlikely that depots can be relocated to uncongested parts of the grid, it will be necessary to coordinate distribution system upgrades with bus operators' plans to electrify their fleets.

Demand charges for bus electrification stem from the poor load factor that comes from inconsistent charging times, charging during peak periods, and brief but high levels of charging. Due to the need to design rates based on cost of service, this particular type of load can impose additional system costs if bus charging loads are not managed by the bus depot or the utility.

2.5.3.4 Fleet Composition and Market Potential for ZEVs

ADOT data shows 20,779 buses registered in Arizona as of January 2020: 62 percent diesel and 38 percent gasoline. Approximately 7,200 of these are yellow school buses.[84] Prior to COVID-19, almost 300,000 Arizona students rode school buses every day, making it the number-one mode of public transportation in

[79] CleanTechnica, "Massachusetts Puts $1.4 Million Into Electric School Bus Pilot," August 16, 2016. Available at: https://cleantechnica.com/2016/08/16/massachusetts-puts-1-4-million-electric-school-bus-pilot-project/.

[80] PJM Inside Lines, "V2G Hits the Big Time with Dominion Electric School Bus Project," October 10, 2019. Available at: https://insidelines.pjm.com/dominion-to-roll-out-largest-electric-school-bus-deployment-in-u-s/.

[81] Electrek, "Electric V2G school bus pilots grow, but schools asleep at the wheel," August 23, 2019. Available at: https://electrek.co/2019/08/23/electric-v2g-school-bus-pilots-grow/.

[82] Greentech Media, "School Districts Rolling Out Electric Buses as Economics Improve: 'It's Time to Switch'," November 15, 2018. Available at: https://www.greentechmedia.com/articles/read/school-districts-rolling-out-electric-buses.

[83] CALSTART, Gallo, J., Bloch-Rubin, T., and Tomic, J., "Peak Demand Charges and Electric Transit Buses: White Paper," October 1, 2014. Available at: https://calstart.org/wp-content/uploads/2018/10/Peak-Demand-Charges-and-Electric-Transit-Buses.pdf.

[84] School Bus Fleet Magazine, "School Transportation: 2017-18 School Year," https://www.schoolbusfleet.com/download?id=10117405&dl=1.

Arizona,[85] and these buses completed over 8 million miles annually[86] Arizona saw its first electric school bus hit the road in January 2020, in Phoenix Union High School District.[87]

Arizona's transit agencies also operate significant bus fleets. Transit agencies in the state's four largest cities – Phoenix, Tucson, Flagstaff and Yuma – operate approximately 1,200 full-size (≥35ft) buses, along with paratransit and other vehicles (See Table 6). Valley Metro is currently trialing one of their routes with electric buses from three manufacturers to assess performance. Tucson Mayor Regina Romero has made bus electrification a priority. The city launched its first battery electric bus route in May 2020,[88] and has received federal Low or No Emission Vehicle (Low-No) Program funding to take receipt of five fully electric buses in 2021 and an additional five in 2022.[89] TEP has provided charging infrastructure for the initial bus and also committed to providing in-kind funding for chargers and associated infrastructure as part of the Low-No grant. Mountain Line has adopted an ambitious electrification plan that seeks to purchase fully electric buses on replacement of the agency's existing vehicles, with full electrification of its 29 buses in 2032.[90]

[85] Chispa Arizona, January 2020, "The Future is Electric – Phoenix Celebrates First Electric School Bus!," https://chispaaz.medium.com/the-future-is-electric-phoenix-celebrates-first-electric-school-bus-b21472e02f5b.

[86] School Bus Fleet Magazine, "School Transportation: 2017-18 School Year," https://www.schoolbusfleet.com/download?id=10117405&dl=1.

[87] Chispa Arizona, January 2020, "The Future is Electric – Phoenix Celebrates First Electric School Bus!," https://chispaaz.medium.com/the-future-is-electric-phoenix-celebrates-first-electric-school-bus-b21472e02f5b.

[88] "Sun Tran's first all-battery electric bus hits Tucson streets," May 2020, available at https://kvoa.com/news/2020/05/18/sun-trans-first-all-battery-electric-bus-hits-tucson-streets/#:~:text=On percent20Monday percent2C percent20Tucson percent20Mayor percent20Regina,city's percent20vehicle percent20and percent20transit percent20fleet. percent22.

[89] Interview with Sun Tran, August 21, 2020.

[90] Interview with City of Tucson and Northern Arizona Intergovernmental Public Transportation Authority, July 22, 2020.

Center for Transportation and the Environment, "Mountain Line On-Route Charging Overview"

Table 6. Full-size buses (≥35 ft.) operated by transit agencies in Arizona's four most populous cities[91]

City	Agency	Count of full-size buses currently in fleet
Phoenix[92]	Valley Metro & City of Phoenix	939
Tucson	Sun Tran	253
Flagstaff	Mountain Line	29
Yuma	Yuma County Area Transit	24
Total		**1,245**

Arizona's universities operate or contract smaller bus fleets: Northern Arizona University runs 26 buses, Arizona State University contracts approximately 10, and the University of Arizona has 22.[93] All three universities are currently investigating the potential for electrification of their buses. For example, prior to the COVID-19 pandemic the University of Arizona was beginning initial discussions with TEP about a financial partnership to enable the campus' first electric bus; the university is interested in re-engaging on this front.

The National Park Service also operates 33 shuttle buses in Grand Canyon National Park.[94] They have recently completed a fleet analysis which provided an overview of the different feasible fuel options for their operations at the South Rim, concluding that they will remain with CNG buses for their next bus replacement cycle while also likely piloting other technologies that hold future potential in the coming decade, such as battery electric buses.[95]

ADOT's count of 20,779 registered buses suggests that there are also a large number of privately owned and operated tour, shuttle, and event buses in the state. The travel patterns and routes of these buses vary widely, and their charging needs, and rate of electric vehicle adoption will likely vary accordingly.

[91] Sources: Interviews with named organizations, July - August 2020;

"Valley Metro, Phoenix award 396-CNG-bus order to New Flyer." http://www.metro-magazine.com/bus/news/726231/valley-metro-phoenix-award-396-cng-bus-order-to-new-flyer; "About Sun Tran," https://suntran.com/about_trivia.php#:~:text=Currently percent20Sun percent20Tran percent20has percent20more percent20than percent20253 percent20buses percent20in percent20its percent20fleet;

"RATP Dev USA Selected to Manage Yuma County, Arizona's Transit Service," https://www.masstransitmag.com/home/press-release/12415574/ratp-dev-usa-ratp-dev-usa-selected-to-manage-yuma-county-arizonas-transit-service

[92] Including Glendale & Scottsdale shuttles & Regional Connectors.

[93] Interviews with named organizations, July - August 2020.

[94] Interview with the National Park Service, August 24, 2020.

[95] Email correspondence with the National Park Service, January 11, 2021.

2.6 Goods Movement

Arizona's economy relies heavily on freight. The Arizona Department of Transportation (ADOT) reports that freight-dependent sectors account for 30 percent of state GDP and 32 percent of jobs.[96] Of the state's freight tonnage, over 65 percent is carried by truck. The majority of this freight value is moving *through* the state, largely due to traffic between the Ports of Long Beach and Los Angeles and inland markets via I-10 and I-40. Passing through both Phoenix and Tucson, I-10 is a critical component of Arizona's freight system. Additionally, two of the nation's four transcontinental freight rail corridors traverse Arizona, and most of the non-trucking freight is transported by rail (again with the majority of rail tonnage moving *through* the state). Intermodal transfer facilities in Phoenix and Tucson provide the capability to transfer freight between trucks and rail cars.

With six of the 29 land crossings between the U.S. and Mexico in Arizona, a significant portion of trading value passes through the state. Of the $437 billion worth of goods moving across land borders between the two countries in 2014, $30 billion (7 percent) was processed by Arizona border crossings. Of the value crossing Arizona's borders, $20 billion was handled by trucks, with the majority of the remainder transported by rail. Land-based border flows are heavily concentrated at two crossings: over 85 percent of both imports and exports flow through Nogales-Nogales, while over 10 percent of both imports and exports flow through Douglas-Agua Prieta.[97]

ADOT anticipates freight flows in Arizona increasing in the coming years.[98] Population growth and the increasing popularity of e-commerce are generating more local truck trips to deliver parcels. Meanwhile, local economic growth and complex supply chains are leading to more movement of final and intermediate goods in and out of the region, especially to Mexico. This increased freight traffic – from both trucks and trains – will result in increased diesel emissions. With the Phoenix/Mesa area already in *Serious* and *Moderate* nonattainment of the federal National Ambient Air Quality Standards (NAAQS) for PM_{10} and ozone, respectively, reducing diesel emissions from goods movement is becoming a priority, especially given that recent data shows ozone concentrations in the area have continued to rise in recent years.[99] While efforts to date have focused on idling limits and voluntary replacement of older diesel vehicles,[100,101] electrified options are increasingly available and approaching commercialization for many of the types of vehicles and equipment involved in freight handling, and therefore may provide additional mitigation pathways.

The remainder of this section summarizes the current state of electrified goods movement technologies and describes the barriers to deployment and grid integration challenges and opportunities. Trucks are discussed in the greatest detail, with less focus on other technologies. Consideration of rail transportation

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[96] Arizona Department of Transportation, "Arizona State Freight Plan A to Z," 2017. Available at: https://azdot.gov/sites/default/files/2019/08/arizona-state-freight-plan-110917.pdf.

[97] Ibid.

[98] Ibid.

[99] Arizona Department of Environmental Quality, "RE: Possible Modifications to ACC's Energy Rules," May 20, 2019.

[100] Maricopa County, "Diesel Idling," May 30, 2019. Available at: https://www.maricopa.gov/1762/Diesel-Idling.

[101] City of Phoenix, "Environmental Sustainability Goals." Available at: https://www.phoenix.gov/sustainability/air.

is limited to non-road vehicles and equipment at stationary facilities as there are significant challenges to electrifying diesel trains at this time.

2.6.1 Medium-Duty Trucks / Vans

2.6.1.1 Maturity, Adoption and Market Size

Medium-duty (MD) trucks, especially last-mile delivery vehicles, are the most advanced electric-drive truck technology. MD trucks (Classes 4-6) range from 14,001 to 26,000 lbs., and their uses include various delivery services as well as utility service or "bucket" trucks. The relatively short, set routes of most delivery vehicles are well within the 100-mile range of current offerings. These vehicles use conductive plug-in L2 and DCFC charging infrastructure and are equipped with batteries ranging in size from 60-120 kWh.

Private companies operating sizeable fleets are increasingly making commitments to electrification of their vehicles, especially among delivery companies, and early deployments of EVs in these vehicle classes are proliferating. UPS has established partnerships with several EV startups to develop electric trucks and is beginning to deploy them in its global fleet of 125,000 vehicles.[102] The company's largest order to date has been for 10,000 electric delivery vehicles from British company Arrival. In 2018 FedEx announced that it would be acquiring 1,000 Chanje V8100 electric delivery vans, while DHL, which bought an electric van company called StreetScooter in 2014, has thousands of electric delivery vans and is producing 2,500 more this year. Most recently, Amazon ordered 100,000 electric delivery vehicles from Rivian, of which it expects to have 10,000 on the road by 2022.[103] Amazon also recently ordered 1,800 electric delivery vans from Daimler's Mercedes-Benz, in August 2020.[104] Based on these commitments and the increasingly large orders, electrification of large distribution companies appears to be accelerating rapidly.

2.6.1.2 Barriers to Adoption

The *Goods Movement & Transit* identified high priority barriers to the adoption of electric-drive MD trucks as lack of awareness and technical expertise with these new technologies, the cost and lead times associated with dedicated depot chargers, the upfront vehicle price premium relative to diesel alternatives, and existing utility rate structures. The group categorized planning, development and permitting fees for installation of charging infrastructure as well as capacity for training staff on new technologies as medium-priority barriers, and a number of additional barriers as lower priority, including inventory availability (both OEM production capacity and model diversity for different applications); scaling investments beyond initial pilot programs; lack of standards or protocols; and limited technical understanding or familiarity with new, electric technologies.

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[102] New York Times, "Soon, the Kitty Litter Will Come by Electric Truck," August 27, 2020. Available at: https://www.nytimes.com/2020/08/27/business/electric-delivery-vehicles-ups-fedex-amazon.html.

[103] The Verge, "Amazon unveils its new electric delivery vans built by Rivian," October 8, 2020. Available at: https://www.theverge.com/2020/10/8/21507495/amazon-electric-delivery-van-rivian-date-specs.

[104] CNBC, "Amazon debuts electric delivery vans created with Rivian," October 8, 2020. Available at: https://www.cnbc.com/2020/10/08/amazon-new-electric-delivery-vans-created-with-rivian-unveiled.html.

Highly visible early deployments by fleet giants like FedEx, UPS, Amazon, Ryder and Pepsi-FritoLay are raising awareness of the availability of e-trucks. The price premium will continue to decline as battery technology improves and manufacturers realize scale economies, lowering the TCO.[105] Even with TCO lower than conventional vehicles, smaller fleet operators may still face issues in absorbing the initial capital cost of the vehicle price premium and charging infrastructure. One manner to address upfront costs is through available Volkswagen Settlement funds: New Jersey recently awarded $825,000 to IKEA for purchase of electric delivery trucks at several locations.[106] As described in section 3.1.3, however, in Arizona these funds have largely been spent on replacing older diesel school buses with newer diesel models.

2.6.1.3 Grid Integration Challenges and Opportunities

The duty cycles for these vehicles vary widely: Delivery of parcels often starts in the very early morning hours and concludes by 2 or 3 p.m., while produce delivery is often complete by 6 a.m. A number of these vehicles could be available to charge using solar energy for their full six- to eight-hour charging time. Additionally, some vehicles with appropriate duty cycles could provide battery capacity for vehicle-to-building or eventually vehicle-to-grid services. As highlighted by the *Vehicle Grid Integration* working group, program designs tailored to specific customer types and end uses (e.g., duty cycles) may be required to realize these opportunities.

2.6.2 Heavy-Duty Trucks

2.6.2.1 Maturity, Adoption and Market Size

Heavy-duty (HD) trucks (Classes 7 and 8) weigh over 26,000 lbs. and include long-haul, regional freight delivery, and drayage trucks (which transfer containers from ports to warehouses). Although this segment is further from commercialization than MD trucks, recent announcements by Tesla[107], BYD[108], Cummins[109] and Volvo[110] suggest that development of electrified HD technologies is accelerating. CARB funding for demonstration projects in California is also helping to further develop these technologies. CARB also announced the Advanced Clean Trucks regulation in June 2020, which creates an increasing ZEV sales requirement for truck manufacturers from 2024 to 2035. By 2035, zero-emission trucks will need to make up 40-75 percent of truck sales, depending on the truck class.[111] California Governor Newsom also

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[105] CARB, "Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives – Appendix D" September 20, 2019. Available at: https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low-1.

[106] New Jersey Department of Environmental Protection, "Overview of Distribution of Mitigation Funds," November 19, 2019. Available at: https://www.state.nj.us/dep/vw/project.html.

[107] Trucks.com, "Here's Everything We Know About the Tesla Semi," September 5, 2019. Available at: https://www.trucks.com/2019/09/05/everything-we-know-about-the-tesla-semi-truck/.

[108] InsideEVs, "See the BYD Class 8 Electric Truck in Motion: Video," October 11, 2019. Available at: https://insideevs.com/news/375749/byd-class-8-electric-truck-in-motion/.

[109] Cummins, "PowerDrive for Electric Trucks." Available at: https://www.cummins.com/electrification/powerdrive-for-electric-trucks.

[110] Trucks.com, "Volvo Trucks Unveils Electric Truck, Readies Commercialization," September 13, 2019. Available at: https://www.trucks.com/2019/09/13/volvo-unveils-vnr-electric-truck/.

[111] CARB, "Advanced Clean Trucks Fact Sheet," June 2020. Available at: https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet.

announced Executive Order N-79-20 in September 2020, which requires medium- and heavy-duty vehicles to be 100 percent zero emissions by 2045 (with drayage trucks required to meet 100 percent zero-emissions by 2035).[112]

2.6.2.2 Barriers to Adoption

One of the main barriers to HD truck electrification is the high cost resulting from low production volumes, high battery cost, and the electric powertrain. Lower range limits for fully electric trucks and the associated need for frequent recharging present a barrier although they have been steadily improving with advances in battery technology. The availability of suppliers and vendors is currently limited but also increasing. Finally, as highlighted by the *Goods Movement & Transit* working group, demand charges in commercial and industrial electricity rates can significantly increase bills. Given these barriers, regional freight delivery and drayage services have duty cycles that are a better fit for the introduction of electric trucks. Electrifying freight transport for longer routes is likely a longer-term opportunity.

2.6.2.3 Grid Integration Challenges and Opportunities

HD e-truck chargers draw very large loads and may require major infrastructure upgrades at depots. Power supply upgrades may be necessary as well.[113] Anecdotally, fleet operators and EVSE installers operating in California note that they have encountered lengthy delays in interconnection when grid upgrades are required. The *Goods Movement & Transit* working group also highlighted a lack of understanding of infrastructure upgrade requirements as an impediment to MD and HD vehicle electrification.

2.6.2.4 Fleet Composition and Electrification Potential: Medium-Duty and Heavy-Duty Trucks

ADOT shows 313,539 on-road medium- and heavy-duty vehicles (≥8,500 lbs.) registered in Arizona as of January 2020: 228,580 gasoline-powered and 84,959 diesel-powered.[114] In addition to trucks registered in the state, many travel through Arizona as they complete trips that start and end in other states or Mexico. These "through trips" accounted for 61 percent of Arizona's truck tonnage, and 62 percent of its truck cargo value as of 2013.[115] As of 2014, trucks handled $20 billion worth of goods moving across the Arizona-Mexico border, mostly at Nogales-Nogales and Douglas-Agua Prieta.[116] Governor Ducey seeks to increase these Arizona-Mexico flows, announcing in 2018 the funding of $134 million to build out the highway from the Mariposa Port of Entry to I-19.[117]

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[112] "Executive Order N-79-20," September 2020. Available at: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-text.pdf.

[113] Rocky Mountain Institute, "Seattle City Light: Transportation Electrification Strategy," 2019.

[114] ADOT, January 2020, "MVD Report."

[115] CPCS, July 2019, "Arizona Truck Parking Study," https://azdot.gov/sites/default/files/2019/08/final-report-arizona-truck-parking-study.pdf

[116] Arizona Department of Transportation, "Arizona State Freight Plan A to Z," 2017. Available at: https://azdot.gov/sites/default/files/2019/08/arizona-state-freight-plan-110917.pdf.

[117] "Ducey Announces Major Funding For Border Shipping Route At Arizona-Mexico Commission Summit," June 2018, https://fronterasdesk.org/content/658498/ducey-announces-major-funding-border-shipping-route-arizona-mexico-commission-summit

The number of medium- and heavy-duty trucks on the state's roads is increasing over time. Population growth and the increasing popularity of e-commerce are generating more local truck trips to deliver parcels. Meanwhile, local economic growth and complex supply chains are leading to more movement of final and intermediate goods in and out of the region, especially to Mexico. Thirty-five million square feet of warehouse and distribution space was built in Arizona between 2000 and 2014.[118] Data from IHS Markit suggests that truck tonnage is expected to nearly double between 2013 and 2040 (see Figure 9).

Measure	Outbound from AZ	Inbound to AZ	AZ to AZ	Through AZ	Total
Tonnage	89%	114%	75%	119%	99%
Value	247%	200%	130%	149%	161%

Source: HDR analysis of Transearch data, received in November 2015,

Figure 9. Arizona's forecasted increase in freight moved by trucks between 2013 and 2040[119]

Data on the size of fleets held by individual freight, shipping and delivery companies is not publicly available. However, a number of the largest private trucking fleets in the country are headquartered in Arizona, as shown in Table 7.

Table 7. Large Private Truck Fleets Headquartered in Arizona[120]

National Fleet Size Rank	Company	Industry	Headquarters	Total Trucks, Trailers & Tractors
8	Republic Services, Inc.	Sanitation	Phoenix	18,652
184	Nuverra Environmental Services	Sanitation	Scottsdale	1,853
200	NPL/Northern Pipeline Construction Co.	Construction	Phoenix	1,640
201	Sunstate Equipment Co. LLC	Business Services	Phoenix	1,626
208	Salt River Project	Utilities	Tempe	1,539
221	Arizona Public Service Co.	Utilities	Phoenix	1,423
376	Services Group of America	Food Products	Scottsdale	750
386	Shamrock Foods Co,	Food Products	Phoenix	714
415	Truly Nolen	Business Services	Tucson	637
441	Mobile Mini Inc.	Manufacturing/Processing	Tempe	576

[118] CPCS, July 2019, "Arizona Truck Parking Study," https://azdot.gov/sites/default/files/2019/08/final-report-arizona-truck-parking-study.pdf

[119] HDR analysis of IHS data in CPCS, July 2019, "Arizona Truck Parking Study," https://azdot.gov/sites/default/files/2019/08/final-report-arizona-truck-parking-study.pdf.

[120] Fleet Owner, "FleetOwner 500: Top private fleets of 2019," April 15, 2019. Available at: https://www.fleetowner.com/truck-stats/fleet-owner-500/article/21703705/fleet-owner-500-top-private-fleets-of-2019.

2.6.3 Electrified Parking and Transport Refrigeration Units

Initiatives to reduce idling of conventional diesel trucks have stimulated development of systems to enable trucks to use electricity instead of running their engines while parked. Electrified parking spaces (EPS), also known as truck stop and truck terminal electrification, can provide the necessary heating, cooling, Wi-Fi, television, and power for onboard appliances so that they do not have to idle. Single-system electrification relies on offboard equipment, with a hose connected by a window adapter delivering HVAC services. Dual-system electrification, or "shore power," requires both onboard and offboard equipment so that trucks can plug directly into electrical outlets. Trucks must be equipped with AC equipment or an inverter to convert 120-volt power. Truck stops offering this technology have so far generally installed 6-12 electrified parking spaces at each location.[121] Using grid-connected electric power for these services improves air quality through reduced emissions and can save trucking companies an estimated 40 percent to 70 percent on operating costs during these waiting periods.[122] These air quality improvements can be especially significant around truck stops, which are often located in communities that are financially and environmentally disadvantaged.

Electrified transport refrigeration units (TRUs) also offer opportunities to reduce vehicle idling. One pathway uses "shore power" to cool units while docked at facilities. Another pathway is through on-board battery technology, which is improving and is in the early stages of deployment. For example, Thermo King, a large supplier of transport refrigeration technologies, recently announced a partnership with electric MDV company Chanje and the two companies are currently testing an all-electric refrigerated delivery van.[123] CARB is currently developing regulation for TRUs in California. Components of the proposed regulation include transitioning to zero-emissions truck TRUs, imposing a stricter diesel PM emission standard for new TRUs, and requiring the use of refrigerants with lower global warming potentials.[124] These regulations, while outside of Arizona's jurisdiction, may reduce emissions from TRUs due to the large amount of freight traffic shared between the two states.

Both of these technologies present near-term, non-LDV TE opportunities in Arizona given the state's sizeable trucking industry. APS has recently received approval for a shore power program in its 2020 Demand Side Management (DSM) plan, while TEP has also proposed a shore power TRU program in its 2021 own DSM plan.

2.6.3.1 Market Size and Electrification Potential

Arizona has 129 truck parking locations open to the public, providing over 7,030 truck parking spaces statewide. Approximately 93 percent of these truck spaces are provided by the private sector, with the remaining seven percent (523) being provided by ADOT. The top three private companies -- Pilot/Flying J,

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[121] Electric Power Research Institute. April 28, 2015. "Truck Stop Electrification." Available at: https://www.epri.com/#/pages/product/000000003002005924/?lang=en-US

[122] Ibid.

[123] Thermo King, "Driving Innovation: 100 percent Electric. 100 percent Cool," April 5, 2019. Available at: https://www.thermoking.com/na/en/newsroom/2019/04/driving-innovation--100--electric--100--cool--.html.

[124] CARB, "New Transport Refrigeration Unit Regulation in Development," October 23, 2020. Available at: https://ww2.arb.ca.gov/our-work/programs/transport-refrigeration-unit/new-transport-refrigeration-unit-regulation.

TA-Petro, and Love's -- provide over 65 percent of privately-owned, publicly available truck parking spaces in the state (See Figure 10), while operating just one-third of truck parking *locations*. This indicates that the average size of these operators is fairly large (many parking spaces per location). ADOT has identified a current shortage of publicly-accessible truck parking in the state, and its 2019 "Arizona Truck Parking Study" will be used to help prioritize the $10 million in National Highway Freight Program (NHFP) funding allocated in the Arizona State Freight Plan to improve truck parking.[125] As noted in ADOT's study, significant forecasted increases in trucking (see again Table 6) are likely to cause further truck parking shortages.

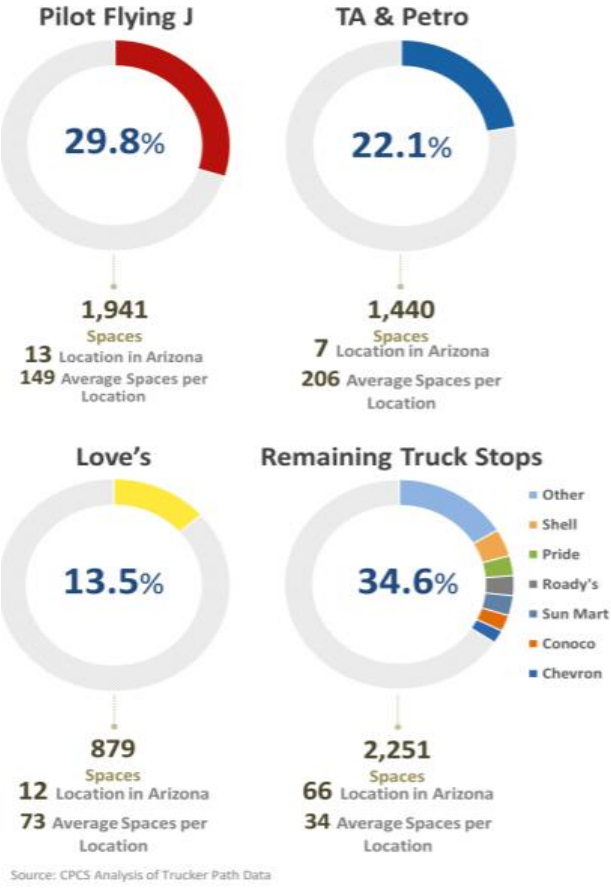


Figure 10. Publicly accessible truck parking spaces provided by the private sector, by company[126]

Public data on the number of parking spaces at truck *terminals* (private parking facilities that are not open to the public) is not available.

Electrified parking spaces are a near-term opportunity for the state. The National Renewable Energy Laboratory (NREL) has implemented a pilot to electrify 50 truck stops across the country using funding from

[125] CPCS, July 2019, "Arizona Truck Parking Study," https://azdot.gov/sites/default/files/2019/08/final-report-arizona-truck-parking-study.pdf

[126] CPCS, July 2019, "Arizona Truck Parking Study," https://azdot.gov/sites/default/files/2019/08/final-report-arizona-truck-parking-study.pdf

872 the American Recovery and Reinvestment Act. This effort included one truck stop in western Arizona on I-
873 40.[127] IdleAir and Shorepower provide electrified parking spaces within Arizona on I-10 and I-40,
874 respectively, and American Idle, EnviroDock and IdleAir also provide this technology in other states.[128] Salt
875 River Project currently offers a $1,000 rebate for eligible customers to install electrified parking spaces, and
876 this rebate has been used to support an EPS demonstration project with IdleAir at the Schneider Trucking
877 Terminal in Phoenix. Through its administration of the U.S. EPA's Diesel Emissions Reduction State Clean
878 Diesel Program, Maricopa County Air Quality Department also provides funds for a variety of projects,
879 including covering up to 30 percent of the cost of TSE.[129]

880 ### 2.6.4 Off-Road Vehicles

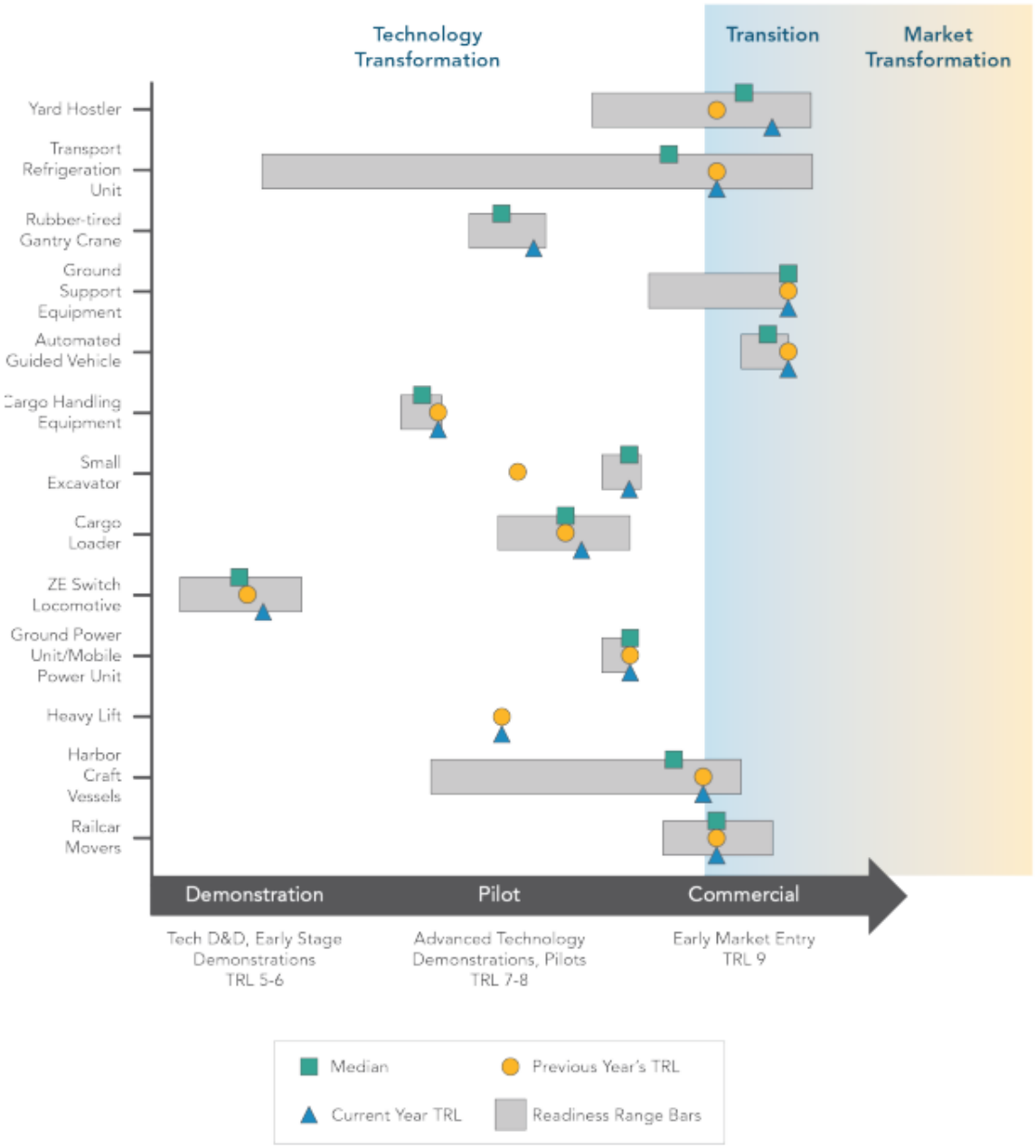
881 Electrified alternatives are available to replace most types of diesel-powered cargo-handling vehicles and
882 equipment. Equipment for handling cargo containers includes yard hostlers that move containers within
883 the terminal, gantry cranes that are used in intermodal operations to ground or stack containers, top
884 handlers, side handlers, and Automated Guided Vehicles (AGVs) that move materials around a warehouse.
885 Several electrified cargo-handling technologies are at TRL 7-9.[130] Electrified cargo-handling technologies
886 would be particularly helpful for freight clusters along the I-10 corridor in Phoenix and Tucson.

[127] NREL, 2015, "Shorepower Truck Electrification Project (STEP) – Cumulative," https://www.nrel.gov/docs/fy15osti/64635.pdf

[128] U.S. Department of Energy, "Truck stop electrification sites by company as of March 30, 2017," https://www.energy.gov/eere/vehicles/fact-973-april-17-2017-truck-stop-electrification-services-reduce-idling-are-available

[129] Maricopa County Air Quality Department. May 7, 2018. 'FY 18 DERA Sub Grantee Letter." Available at: https://www.maricopa.gov/DocumentCenter/View/38018/FY18-DERA-Sub-Grantee-Letter.

[130] CARB, "Proposed Fiscal Year 2020-21 Funding Plan for Clean Transportation Incentives, Appendix D," November 6, 2020. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-11/appd_hd_invest_strat.pdf.



887

888 *Figure 11. Off-Road Battery Electric Vehicle Technology Status Snapshot*[131,132]

889 Light-duty electric forklifts used in warehouses have achieved commercialization and are widely used.
890 Because they have no emissions, electric forklifts are attractive for indoor use. These forklifts are estimated

[131] CARB, "Proposed Fiscal Year 2020-21 Funding Plan for Clean Transportation Incentives, Appendix D," November 6, 2020. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-11/appd_hd_invest_strat.pdf

[132] The "Readiness Range Bars" in this figure indicate the range of readiness levels of individual vehicles that fall within a platform and collectively make up the median (green square) and weighted average (blue diamond) TRL.

to have a typical payback in less than two years, largely through reducing fuel costs by up to 75 percent but also by reducing maintenance costs.

While FedEx Freight awaits production of the Tesla Class 8 trucks, electric hostlers are being evaluated. Hostlers have an advantage in that they are used only on FedEx premises and therefore avoid the challenges associated with range limitations. In addition, the limited number of hostlers at FedEx facilities makes charging requirements manageable. During FY19, FedEx Freight began pilot testing an electric hostler with positive results.[133] Drivers appreciate the quiet and efficient operation, as well as the zero emissions. Future plans call for integrating the electric hostler with the FedEx Freight Yard Management System for seamless operation.

2.6.4.1 Airports

In addition to freight vehicles, there is also opportunity for electrifying Ground-Support Equipment (GSE) and other vehicles at airports. The two largest airports in Arizona are the Phoenix Sky Harbor International Airport and the Tucson International Airport, which had approximately 46 million and 3.8 million passengers in 2019, respectively.[134,135] They have a wide range of vehicles including shuttle buses, off road equipment, heavy duty trucks, light duty trucks, and Aircraft Rescue and Firefighting Trucks (ARFFs).

Both airports have explored paths towards vehicle electrification and are in the process of drafting more defined electrification goals for their respective operations.[136,137] Phoenix Sky Harbor International Airport is working on a Sustainability Management Plan and exploring various options on how to electrify their fleet, such as the Federal Aviation Administration's Voluntary Airport Low Emissions (VALE) grant, or other funding opportunities. Similarly, Tucson International Airport is assessing their electrification potential, and exploring opportunities to take advantage of their solar resources. Both airports are also interested in providing chargers for the public parking spaces. Sky Harbor already has 13 L1 Chargers and 20 L2 Chargers ready for public use. While electrification of the airports' light-duty vehicles and heavy-duty trucks is somewhat more straightforward given their use by other sectors (i.e., beyond the airports), some of the off-road equipment requires more research before reaching the electrification stage.

One challenge with electrification of GSE at these airports is that the airlines – rather than the airport directly – supply a large portion of the vehicles. A transition to electrified GSE therefore requires input and consideration not only from airport management and planning teams, but from a distributed group of representatives for the different airlines who are focused on their own operations rather than the holistic operations of the airport. While several airlines, including American Airlines and Delta, have begun the

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[133] FedEx, "2020 FedEx Global Citizenship Report," Available at: https://sustainability.fedex.com/FedEx_2020_Global_Citizenship_Report.pdf.

[134] Phoenix Sky Harbor International Airport, "Airport Statistics," https://www.skyharbor.com/about/Information/AirportStatistics

[135] Tucson International Airport, "2019 TUS Passenger Numbers Grow To Make it Airport's 5th Biggest Year," Available at: https://www.flytucson.com/articles/2019-tus-passenger-numbers-grow-to-make-it-airports-5th-biggest-year/.

[136] Interview with the Tucson International Airport, August 17, 2020.

[137] Interview with the Phoenix Sky Harbor International Airport, September 17, 2020.

transition from diesel-powered GSE to electric GSE,[138] many other operators have not. Additionally, while some airlines are further along than others, electrification initiatives are primarily being targeted at larger airports and airports in cities with air quality issues,[139] implying that electrification driven by the airlines may not accelerate quickly in smaller airports such as Tucson.

2.6.4.2 Additional Off-Road Use Cases

Tactical fleets at military bases are also prime candidates for electrification, and such investments align well with the military's dedication to energy efficiency. The Los Angeles Air Force Base was the first to experiment with V2G in collaboration with the Microgrids Group at Lawrence Berkeley National Laboratory. [140] The seven military bases in Arizona provide a number of potential electrification opportunities, including Luke Air Force Base and the Arizona Air National Guard. Figure 12 provides a map of major military locations within the state.

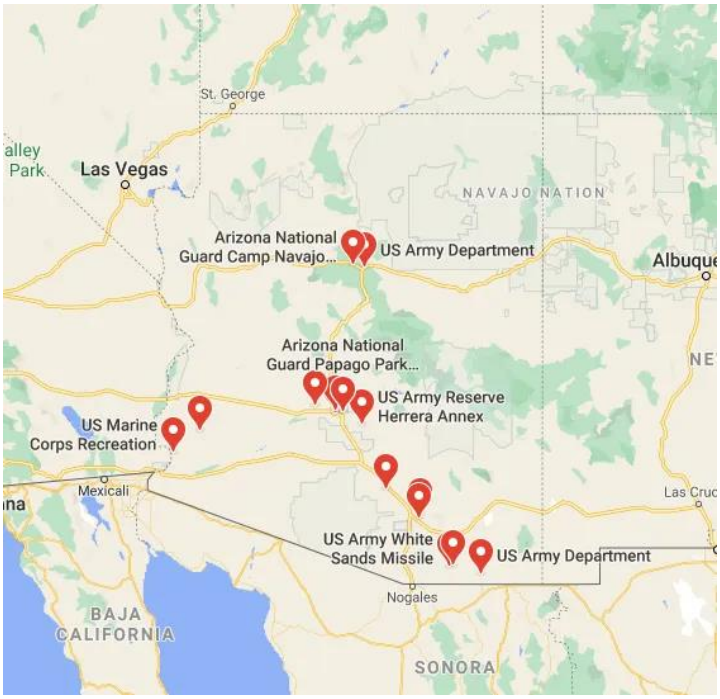

Figure 12. Military Bases in Arizona[141]

While still nascent, electrified mining equipment also represents an opportunity in Arizona, and can help to improve health and safety at mining operations. Swedish manufacturer Epiroc recently launched a new line of battery-electric mining equipment and is receiving orders from customers in Australia, Canada, and

[138] Delta News Hub, "Airlines' 'other fleet:' Science behind ground equipment," https://news.delta.com/airlines-other-fleet-science-behind-ground-equipment

[139] Automotive Fleet, "American Airlines switches to Electric GSE Fleet," https://www.automotive-fleet.com/9176/american-airlines-switches-to-electric-gse-fleet.

[140] Lawrence Berkeley National Laboratory, "Los Angeles Air Force Base Vehicle to Grid Pilot Project," 2013. Available at: http://eta-publications.lbl.gov/sites/default/files/lbnl-6154e.pdf.

[141] OMK, "Military Bases in Arizona," Available at: https://www.operationmilitarykids.org/military-bases-in-arizona/.

Finland.[142] Electrification of mining equipment is particularly useful for underground options, which typically require substantial investments in ventilation due to the use of diesel-powered equipment.

The higher cost for electrified goods handling equipment makes it challenging to develop a compelling business case for electric conversions, especially outside of nonattainment areas or without a local or corporate greenhouse gas (GHG) reduction target. Finally, payloads may be lower for some technologies due to the size and weight of the battery.

2.7 Hydrogen Fuel Cell Vehicles

Fuel cell vehicles (FCVs) and equipment are a zero-emissions alternative to EVs. FCVs also employ electric drive for propulsion, but their electricity is produced onboard via a chemical reaction between hydrogen and oxygen. Fuel cell models have been developed for light-, medium-, heavy-duty and some non-road vehicles, all of which currently lag behind their battery-electric counterparts in technological maturity and adoption. While FCVs do have a range advantage over EVs, hydrogen refueling infrastructure development is considerably more challenging than EVSE infrastructure development. Additionally, the range gap is closing with advances in battery technology and declining costs. Currently neither battery-electric nor fuel cell vehicles are truly zero-emission, as both technologies result in upstream emissions from electricity generation and hydrogen production, respectively. Both technologies offer zero-emissions opportunities, however: Electricity can be generated from renewable sources, and hydrogen can also be produced using renewable energy.

Thus far FCVs have proven a successful alternative to internal combustion forklifts. FCVs are also seen as promising for long-haul trucking, which could represent an opportunity for Arizona: Fuel cell electric freight truck maker Nikola Motors, which reports over 13,000 pre-orders for its vehicles, broke ground on a large manufacturing facility in Coolidge in July 2020[143] and is starting to develop a national network of hydrogen refueling stations. Nikola has also partnered with Anheuser-Busch, who has placed an order for up to 800 of Nikola's hydrogen-electric semi-trucks as part of the brewing company's commitment to power its entire fleet renewably by 2025.[144]

Major impediments to adoption across FCVs technologies are their high cost relative to conventional models, scarce public hydrogen dispensing infrastructure, and the high cost of hydrogen compared to gasoline. Other barriers include lack of understanding of the business case for FCVs (other than forklifts), limited choice of vendors and models, and an undeveloped service and support network.[145]

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[142] Mining Metal News, "Epiroc wins several battery electric mining equipment orders," September 19, 2019. Available at: https://www.miningmetalnews.com/20190919/1302/epiroc-wins-several-battery-electric-mining-equipment-orders.

[143] InsideEVs, "Nikola's Coolidge Site In Arizona: They Are Finally Building!," December 20, 2020. Available at: https://insideevs.com/news/461276/nikola-coolidge-site-arizona-they-building/.

[144] Anheuser-Busch, "Anheuser-Busch Continues Leadership in Clean Energy, Places Order for 800 Hydrogen-Electric Powered Semi-Trucks with Nikola Motor Company," May 3, 2018. Available at: https://www.anheuser-busch.com/newsroom/20071/05/anheuser-busch-continues-leadership-in-clean-energy---places-ord.html.

[145] CARB, "Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives – Appendix D" September 20, 2019. Available at: https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low-1.

2.8 Automated Driving Technologies

Automated driving technologies are advancing rapidly and are already being deployed in all transportation sectors. Electrification will likely hasten deployment of automated driving technologies because connected, electric-drive vehicles are best suited for automation. Additionally, automation of EVs can provide improved efficiency and therefore greater range without additional battery capacity. Mass deployment of fully automated vehicles could radically transform personal mobility, mass transit and goods movement, reshaping urban landscapes — for better or worse.

Development and deployment of automatic driving technologies are proceeding incrementally. To map the pathway to full automation, the Society of Automotive Engineers created the classification system illustrated in Figure 13. Automakers and fleet owners are keenly interested in testing Level 4 (High Automation) as they strive to reach Level 5 (Full Automation). At Level 4, the vehicle can operate without human oversight under select conditions (e.g., on highways or in clear weather) or in specific geographic areas (e.g., on campuses or military bases). At Level 5 the AV can operate on any road under any condition without human oversight or input. Only at this stage is a vehicle truly driverless, making it possible to eliminate costly components such as the steering wheel, accelerator, and brake pedals.

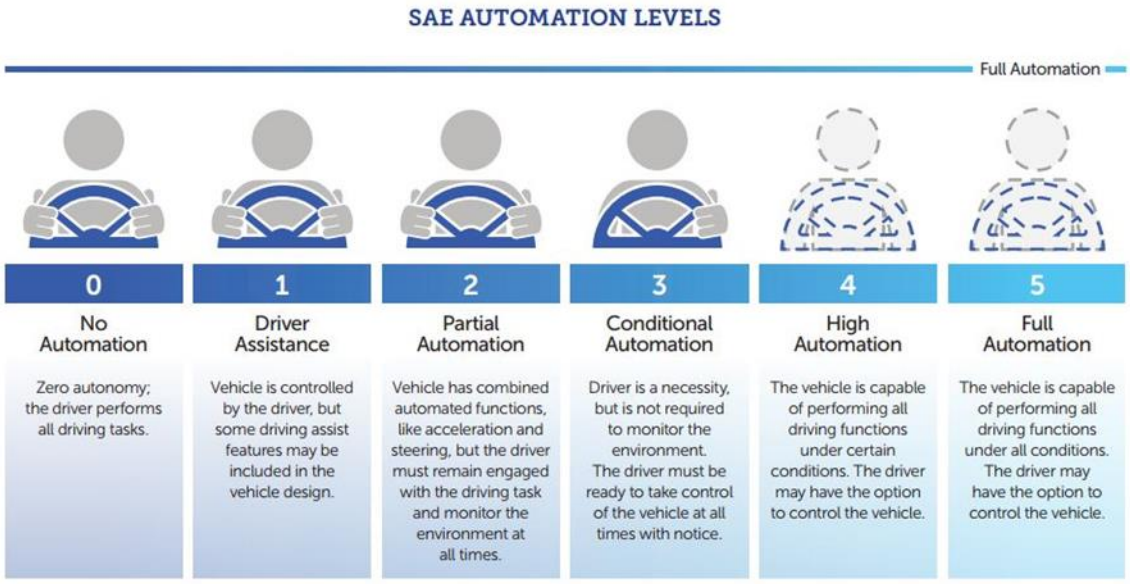

Figure 13. Levels of Vehicle Automation[146]

Automation is expected to yield many benefits, including increased safety and productivity; decreased fatalities; efficiency improvements from smoother traffic flows; and wider access to mobility.[147] Fixed route applications offer opportunities for automation, such as transit and shuttle services, bus depots, and non-

[146] National Highway Traffic Safety Administration, "Automated Vehicles for Safety," 2019. Available at: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety.

[147] Ibid.

road use cases such as mines, freight handling facilities and rail yards. However, lack of standardization for charging non-road EVs makes it challenging for utilities to anticipate their power needs.

In the LDV segment taxi and TNC fleets are attractive early targets for automation, with significant investments being made by automakers and TNC companies alike, including Lyft, Uber, Cruise Automation, General Motors, Ford, Volvo, Honda, and others. In Arizona, Google's self-driving car program, Waymo One, is available for hailing and has been reportedly moving closer to Level 5 automation.[148]

Progress on vehicle automation is also taking place beyond the LDV segment. Automated trucking company TuSimple has been testing its vehicles – with human operators onboard for safety – on I-10 between Phoenix and Tucson, as well as between three destinations in Texas.[149] The company plans to develop an autonomous freight network, eventually intended to span the nation, but initially featuring service between Phoenix, Tucson, El Paso, Dallas, Houston, and San Antonio. This initial phase is intended to take place through 2021, with additional expansions beyond Arizona and Texas to follow.

Public policy will play a key role in enabling AV testing on public roads, and Arizona is well positioned to remain at the forefront in this area. Governor Ducey's executive orders on AVs have drawn companies developing this technology to the state, and the recently created Institute of Automated Mobility will continue to drive collaboration on AVs between the public sector, private enterprises and academia.

2.9 Potential impacts of COVID-19 on transportation electrification trajectory

The COVID-19 pandemic has had significant impacts on the LDV and EV market. Auto sales plunged in the immediate aftermath of the pandemic, with Q2 2020 auto sales down 33 percent. Sales rebounded slightly by Q3 when they were down 9 percent from 2019.[150]

EV sales as well as share of total vehicle sales decreased in April and May 2020, as shown in Figure 8. EV sales are projected to stay below 2019 levels over the next few months to years, yet the EV *share* of total sales is projected to rebound and ultimately increase above its pre-COVID values by 2023. While EV sales have declined they are not expected to be hit as hard as conventional vehicles; total passenger vehicle sales are expected to drop by 23 percent in 2020, but EV sales are expected to drop by only 18 percent.[151] Monthly EV sales share had increased above pre-COVID levels by July 2020, despite total sales being below the same period in 2019.[152]

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[148] The Verge, "Waymo tells riders that 'completely driverless' vehicles are on the way," October 10, 2019. Available at: https://www.theverge.com/2019/10/10/20907901/waymo-driverless-cars-email-customers-arizona.

[149] Arizona Republic, "Self-driving trucking service launched from Phoenix, other Southwest cities," July 2, 2020. Available at: https://www.azcentral.com/story/money/business/tech/2020/07/02/tusimple-launches-self-driving-trucking-routes-phoenix-southwest-cities/3281064001/.

[150] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-auto-sales-down-9-in-q3-as-coronavirus-continues-to-curb-demand-60696734

[151] Bloomberg New Energy Finance, "Electric Vehicle Outlook 2020,"Available at: https://about.bnef.com/electric-vehicle-outlook/

[152] Atlas EV Hub, "Automakers Dashboard," Available at: https://www.atlasevhub.com/materials/automakers-dashboard/.

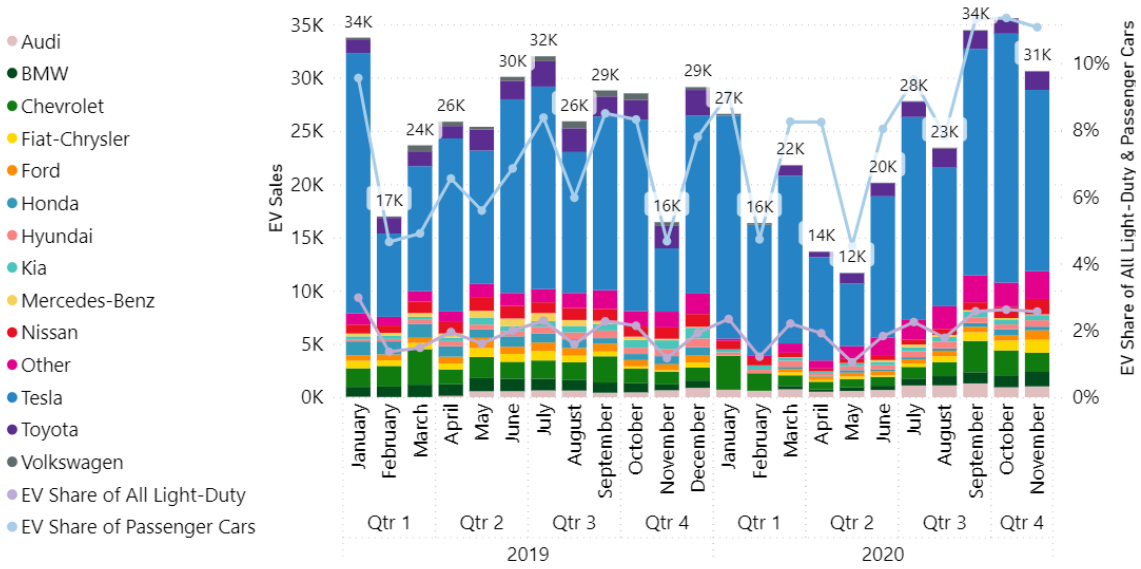

Figure 14. Monthly EV sales in 2019 and 2020 by EV manufacturer[153]

Bloomberg New Energy Finance has predicted that the impact on COVID-19 vehicle sales will last several years, but the long-term trajectory will be unchanged, as shown in Figure 15 below.[154]

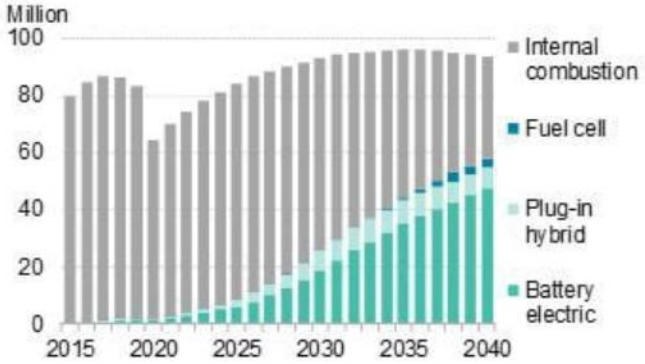

Figure 15. Global annual passenger vehicle sales by drivetrain.

Commercial vehicle sales are expected to reach normal levels sooner than personal vehicle sales due to the increasing reliance on e-commerce. While some automakers have experienced project delays in EV model launches, the impact of COVID-19 on model availability is not expected to be large or long-lasting.

COVID-19 presents an existential crisis for public transit, however. Public health concerns and increased hesitancy around proximity to others in shared spaces have risen, while commuting has decreased. The long-term implications of these trends remain unclear. A return to pre-COVID patterns and social norms –

[153] Atlas EV Hub, "Automakers Dashboard," Available at: https://www.atlasevhub.com/materials/automakers-dashboard/.

[154] Bloomberg New Energy Finance, "Electric Vehicle Outlook 2020," Available at: https://about.bnef.com/electric-vehicle-outlook/

which may be feasible through the widespread availability of the vaccines currently beginning to be distributed – could result in utilization of public transit services at prior levels. However, as with many aspects of the current global health crisis, both the timing and the specifics of such a "return to normalcy" are highly uncertain.

3. Transportation Electrification Policies and Institutions

While technological improvements and cost reductions have driven a large part of the increase in TE in recent years, supportive policies at the national and state level have also played a role. However, continued and expanded policy support will be critical to unlocking the benefits afforded by the opportunity to electrify the transportation sector.

3.1 Federal Policies, Regulations and Programs

Federal initiatives and policies to increase EV adoption and support can help Arizona to maximize its efforts to electrify the state's transportation sector.

3.1.1 Federal Electric Vehicle Tax Credit

The federal tax credit for plug-in EVs (PEVs) was established through the Energy Improvement and Extension Act of 2008 and was updated to its current format by the American Recovery and Reinvestment Act of 2009.[155] Credits for individual EVs range from $2,500 to $7,500, depending on battery capacity, and are subject to a 200,000-vehicle limit per manufacturer (after which credit amounts phase out over several quarters). The tax credit is not available for vehicles with a gross vehicle weight rating exceeding 14,000 lbs., and therefore excludes the majority of medium-duty and all heavy-duty vehicles.[156]

Tesla reached its 200,000-vehicle limit in June of 2018, while General Motors passed this mark in December of 2018. Both of these automakers' tax credits subsequently began to phase out in 2019. While no other automaker has yet surpassed the 200,000-vehicle cap, as of June 2020 Nissan, Ford, and Toyota had each passed the halfway-mark of 100,000 sales, while BMW had sold just under 100,000 qualified vehicles.[157] Figure 16 details qualified PEV sales by manufacturer, relative to the 200,000-vehicle limit on the federal tax credit, using data current through June 2020.

[155] Congressional Research Service, "The Plug-In Electric Vehicle Tax Credit," May 14, 2019. Available at: https://fas.org/sgp/crs/misc/IF11017.pdf.

[156] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, "Qualified Plug-In Electric Vehicle (PEV) Tax Credit." Available at: https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives.

[157] EVAdoption, "Federal EV Tax Credit Phase Out Tracker by Automaker," 2020. Available at: https://evadoption.com/ev-sales/federal-ev-tax-credit-phase-out-tracker-by-automaker/.

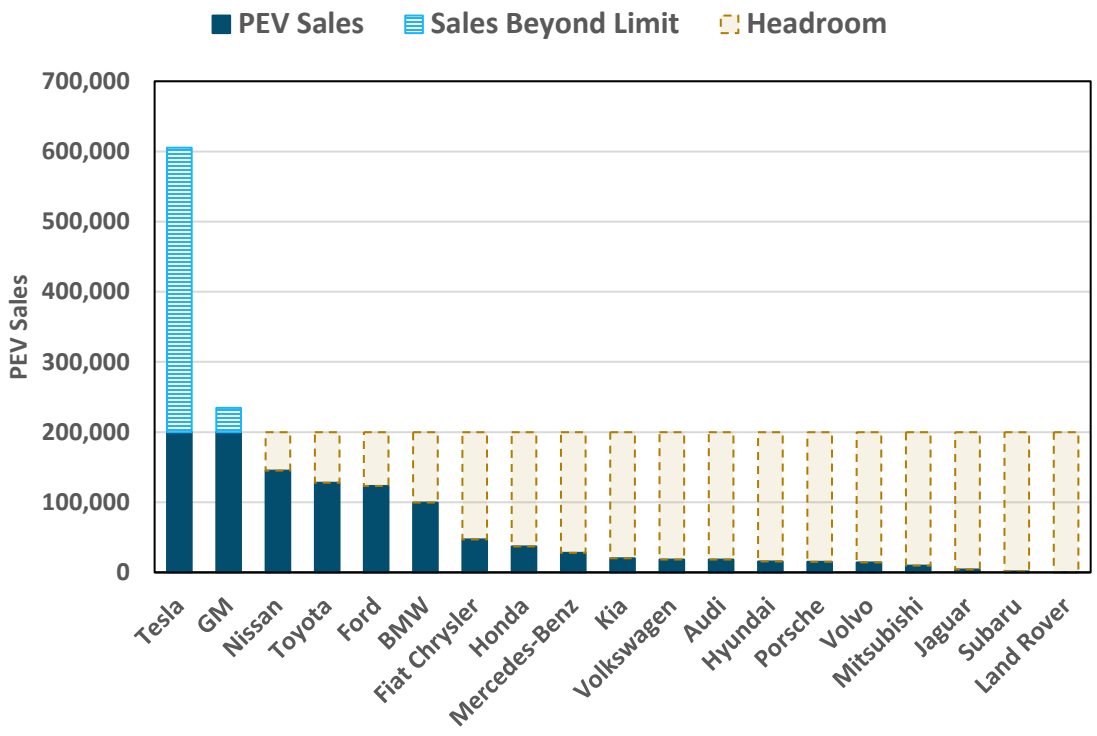

Figure 16. Federal EV Tax Credit Tracking by Automaker (through June 2020) [158]

Competing legislative proposals have been put forth, to either expand or repeal the EV tax credit.

- The Electric CARS Act of 2019 proposes to extend the credit through 2029 and repeal the per-manufacturer cap.[159]
- The Driving America Forward Act would increase the cap, providing tax credits of up to $7,000 for vehicles from manufacturers exceeding the 200,000-vehicle limit; these additional credits would be available for an additional 400,000 vehicles per-manufacturer.[160]
- The Fairness for Every Driver Act proposes to repeal the federal EV tax credit and to impose an annual fee on alternative fuel vehicles to contribute to the Highway Trust Fund.[161]

The Congressional Research Service reports that the federal EV tax credit is disproportionately claimed by higher-income taxpayers, with 78 percent of credits claimed by filers with annual adjusted gross income of $100,000 or more.[162] As Arizona develops and expands upon its own EV initiatives, it will be critical to ensure programs and incentives are available for Arizonans of all income classes. This has been one of the

[158] Adapted from EVAdoption, "Federal EV Tax Credit Phase Out Tracker by Automaker," 2020. Available at: https://evadoption.com/ev-sales/federal-ev-tax-credit-phase-out-tracker-by-automaker/.

[159] H.R. 2042, 116th Congress (2019-2020).

[160] S. 1094, 116th Congress (2019-2020).

[161] S. 343, 116th Congress (2019-2020).

[162] Congressional Research Service, "The Plug-In Electric Vehicle Tax Credit," May 14, 2019. Available at: https://fas.org/sgp/crs/misc/IF11017.pdf.

primary topics of discussion for the *Equity* working group, which has proposed a number of recommended actions and initiatives for different TE stakeholders to improve the affordability and availability of EV models for underrepresented communities.

3.1.2 National Ambient Air Quality Standards

The federal Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment.[163] The EPA in turn requires states to develop Infrastructure State Implementation Plans (SIPs) detailing how areas will attain and maintain the mandatory local air quality standards.[164] Arizona Revised Statutes (ARS), Title 49, divides responsibility and encourages cooperation for meeting the requirements of the CAA among the state, county agencies, and regional planning organizations. Currently, the state and three county agencies operate air quality control programs under direct or delegated authority. These air pollution control agencies are the Arizona Department of Environmental Quality, Maricopa County Air Quality Department, Pima County Department of Environmental Quality, and the Pinal County Air Quality Control District.[165]

As of October 2020, parts of Arizona were in nonattainment of five of the six criteria air pollutants regulated under NAAQS, as detailed in Table 8 and Figure 17 below. The majority of the nonattainment areas are within Maricopa and Pinal counties.

[163] U.S. Environmental Protection Agency, "NAAQS Table." Available at: https://www.epa.gov/criteria-air-pollutants/naaqs-table#3.

[164] U.S. Environmental Protection Agency, "NAAQS Implementation Process." Available at: https://www.epa.gov/criteria-air-pollutants/naaqs-implementation-process.

[165] Arizona Department of Environmental Quality, "Arizona State Implementation Plan Revision under Clean Air Act Sections 110(a)(1) and 110(a)(2) for the 2015 Ozone National Ambient Air Quality Standards," September 24, 2018. Available at: https://static.azdeq.gov/aqd/sip/2015_o3_isip.pdf.

1083 *Table 8. NAAQS Nonattainment Areas in Arizona*[166]

County	Nonattainment Area	Criteria Pollutant(s)
Cochise	Paul Spur/Douglas	PM_{10}
Gila	Miami	PM_{10}, SO_2
	Hayden	SO_2, Lead
Maricopa	Phoenix	PM_{10}, Ozone
Pinal	Hayden	PM_{10}, SO_2, Lead
	West Pinal	PM_{10}
	Miami	PM_{10}
Pima	Rillito	PM_{10}
Santa Cruz	Nogales	PM_{10}, $PM_{2.5}$
Yuma	Yuma	PM_{10}, Ozone

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[166] Arizona Department of Environmental Quality, "Air Quality | Nonattainment Areas," revised on October 29, 2020. Available at: https://azdeq.gov/nonattainment_areas.

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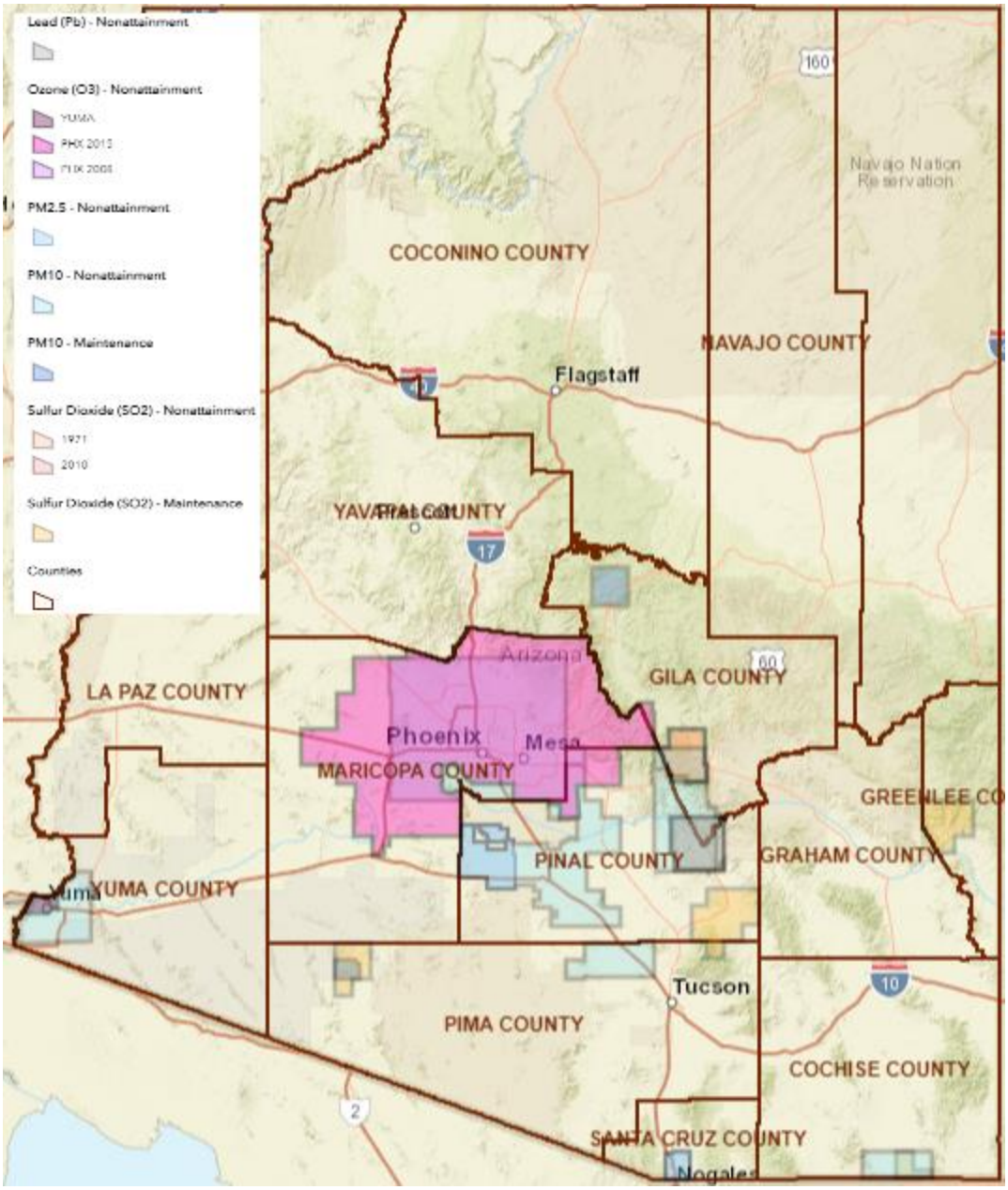

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1087 *Figure 17: NAAQS Nonattainment Areas in Arizona*[167]

[167] Arizona Department of Environmental Quality, "Nonattainment Areas." Available at: http://www.azdeq.gov/emaps. Retrieved December 6, 2020.

Ozone Nonattainment

There are currently two ozone nonattainment areas in Arizona: Maricopa County and Yuma County. Ground-level ozone is regulated through nonattainment areas under the CAA because it can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma.[168] Additionally, there are potentially large financial impacts that accompany ozone nonattainment status: ADEQ estimates annual expenditures on ozone mitigation activities due to nonattainment status for the Phoenix metropolitan area alone of $89 million to $296 million.[169]

Reducing ozone emissions is a critical element of the Phase II TE Plan given the manner in which this pollutant is formed. Ground-level ozone is not emitted directly into the air by human activities but is instead created by a chemical reaction between nitrogen oxides (NO_X), volatile organic compounds (VOCs) and sunlight.[170] Of the NO_X emissions in Maricopa County, 83 percent are the direct result of internal combustion engines.[171] Point sources such as power plants and industrial operations account for only 5 percent of NO_X emissions in the nonattainment area. To reduce ground-level ozone pollution, it is essential to reduce NO_X and VOC emissions. Accordingly, as internal combustion-powered engines are the largest contributor to NO_X emissions,[172] TE offers an important pathway to improving air quality, minimizing adverse health effects and reducing NAAQS nonattainment costs.

3.1.3 Volkswagen Settlement: Environmental Mitigation Funds

Arizona will receive approximately $57 million from the Volkswagen Diesel Settlement over the next ten years. The state's Beneficiary Mitigation Plan proposes to use this funding for projects that reduce NO_X emissions in areas of the state significantly affected by diesel emissions: 67 percent of the funds is proposed for school bus replacement, 24 percent for on-road freight replacement projects, and 9 percent for administrative costs.[173] As of June 30, 2020, 319 school buses and 47 on-road fleet vehicles have been scrapped, with funds for reimbursement distributed or in the process of being distributed to school districts and state agencies, respectively.[174] While electric vehicles – especially electric buses – are an option under this funding, the majority of these older diesel replacements have been with newer diesel vehicles. Additional EV charging infrastructure or other utility support could help to make school bus electrification

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[168] Environmental Protection Agency, "Ground-Level Ozone Pollution." Available at: https://www.epa.gov/ground-level-ozone-pollution.

[169] Arizona Department of Environmental Quality, "RE: Possible Modifications to ACC's Energy Rules," May 20, 2019.

[170] Environmental Protection Agency, "Ground-Level Ozone Pollution Basics." Available at: https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#effects.

[171] Maricopa County Air Quality Department, "2017 Periodic Emissions Inventory for Ozone Precursors," November 2019. Available at: https://www.maricopa.gov/DocumentCenter/View/52917/2017-Periodic-Emission-Inventory-Ozone-PDF.

[172] Arizona Department of Environmental Quality, "Electric Vehicle Project." Available at: https://azdeq.gov/electric-vehicle-project.

[173] Arizona Department of Administration, "Beneficiary Mitigation Plan for the State of Arizona," June 8, 2018. Available at: https://vwsettlement.az.gov/sites/default/files/media/VWBeneficiary-Mitigation-Plan.pdf.

[174] Arizona Governor's Office of Strategic Planning and Budget, "Beneficiary Mitigation Plan for the State of Arizona - Semiannual Report #4," July 30, 2020. Available at: https://vwsettlement.az.gov/sites/default/files/media/Semiannual percent20Report percent20 percent234.pdf.

a viable option in Arizona, although as discussed in Chapter 2, the state's hot climate has thus far proven challenging for e-bus technology at its current level of development.

3.1.4 Volkswagen Settlement: Electrify America

As part of its diesel emissions settlement, Volkswagen has also capitalized the $2 billion Electrify America initiative to expand zero-emission vehicle infrastructure and awareness over the ten-year period ending 2027. Approximately $800 million will be spent in California, and the remaining $1.2 billion will be used to develop a long-distance highway charger network, support community-based local charging networks, and implement a nationwide, brand-neutral public EV education campaign. This $1.2 billion will be disbursed in four 30-month investment cycles of $300 million each. Table 9 below lists the funding allocations to different categories for Cycle 1 and Cycle 2 of the initiative. The funding allocations for Cycles 3 and 4, which will take place from 2022 to 2026, have not yet been announced.

Table 9: Electrify America Investments, Cycles 1 and 2

Investment Category	Cycle 1 ($ million)	Cycle 2 ($ million)
Highway Charging Infrastructure	$190	$65 - $85
Community Charging Networks	$60	$145 - $165
Autonomous Vehicle Infrastructure		$2 - $4
Public EV Education and Admin Costs	$50	$25
Branded Marketing		$10
Business Operation & Organization		$30
Total	**$300**	**$300**

Phoenix was one of 18 metro areas in the U.S. selected to receive Cycle 2 funding. Figure 18 details the planned geographic distribution of Cycle 1 and Cycle 2 DCFC infrastructure investments. Additionally, the national education campaign should provide general EV awareness support to the state.

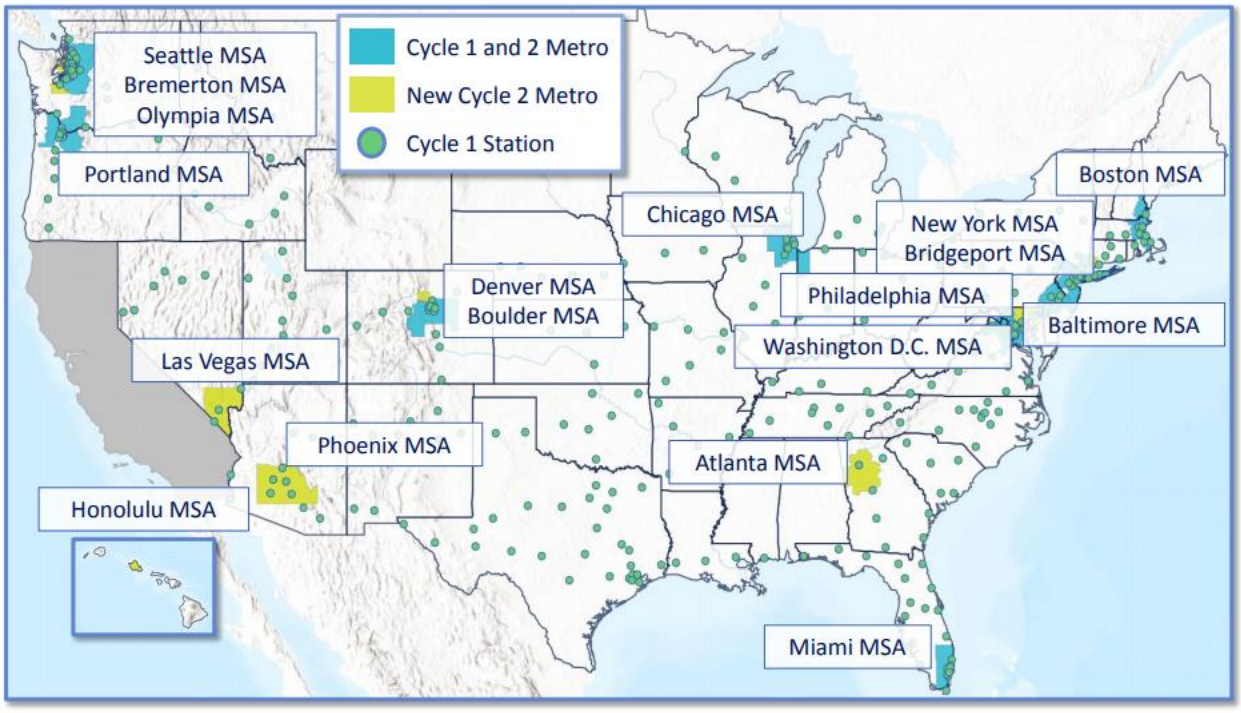

Figure 18. Electrify America's planned national DCFC charging network, plus metropolitan areas targeted for local charging infrastructure support[175]

Chargers installed in Cycle 2 range from maximum levels of 150 kW to 350 kW. On average, stations installed as part of Cycle 2 will consist of five 150 kW chargers per site. As of the end of 2020, eight DCFC sites had been commissioned in Arizona. Figure 19 below details the status of DCFC sites throughout the U.S. as of the end of 2019.

[175] Electrify America, "National ZEV Investment Plan: Cycle 2," February 4, 2019. Available at: https://www.epa.gov/sites/production/files/2019-02/documents/cycle2-nationalzevinvestmentplan.pdf.

Figure 19. Electrify America's national DCFC site construction status as of the end of 2019[176]

As a result of the COVID-19 pandemic, Electrify America's investment in 2020 has been "substantially delayed," with estimates of about 70 percent of permitted sites throughout the country being impacted. Electrify America is still aiming to incur all Cycle 2 costs by the end of December 2021 but may incur some investments during Cycle 3.[177]

3.1.5 Federal Highway Administration Alternative Fuel Corridors

As of 2017, the U.S. Department of Transportation Federal Highway Administration (FHWA) has designated I-10 between Phoenix and Tucson as a "signage ready" alternative fuel corridor for EVs. These corridors will have clear signs that indicate where EV chargers are located. The designation is also meant to encourage further EV infrastructure development along the routes. Other segments of I-10, as well as a portion of I-17, are considered "signage pending," indicating that sufficient alternative fueling infrastructure to merit signage has yet to be installed. A collaborative effort led by the Pima Association of Governments in partnership with ADOT and the Valley of the Sun Clean Cities Coalition, with funding from the FHA, recently released a report on the deployment plan for the I-10 alternative fuel corridor.[178] Relative to EV charging, the report found that DCFC stations are required in Salome and Tonopah to meet the "corridor ready"

[176] Electrify America, "Locate a Charger," Accessed February 1, 2021. Available at: https://www.electrifyamerica.com/locate-charger/.

[177] Electrify America, "2019 Annual Report to the U.S. EPA," April 30, 2020. Available at: https://newspress-electrifyamerica.s3.amazonaws.com/documents percent2Foriginal percent2F419-2019ElectrifyAmericaNationalAnnualReport.pdf.

[178] Pima Association of Governments, "Arizona Interstate 10 Alternative Fuels Corridor Deployment Plan," November 2020. Available at: https://mk0pagrtahost21swg12.kinstacdn.com/wp-content/docs/pag/2020/12/AFCDP_113020-FINAL.pdf.

designation from FHWA by closing gaps in charging coverage. The report proposes several truck stop travel centers for consideration as potential site hosts for EV charging.

3.1.6 Additional Federal Funding

Several additional federal programs provide funding for TE technology:

- The Voluntary Airport Low Emissions (VALE) program incentivizes the purchase of alternative fuel vehicles at airports by funding the incremental cost of these models over conventional options; support infrastructure is also eligible for funding.[179]
- The Airport ZEV Infrastructure Pilot program provides funding for up to 50 percent of the total costs of zero-emissions vehicles and associated infrastructure at airports.[180]
- The Low or No Emissions Competitive Program administered by the Federal Transit Administration provides funding to state and local governments to assist with the purchase or lease of zero-emission and low-emission transit buses and supporting infrastructure.
- The Clean Diesel Program administered by the U.S. Environmental Protection Agency provides rebates and grants to replace diesel buses, trucks and non-road vehicles or equipment with low-emitting alternatives. The grant funding under this program has been used by some jurisdictions to replace diesel vehicles with electric alternatives. In November 2018, the EPA awarded $414,000 to the Maricopa County Air Quality Department to retrofit and replace older, polluting diesel vehicles and equipment, including both school buses and heavy-duty trucks.[181,182] While these replacement vehicles are not scheduled to be electric, this program may nonetheless be a useful target for EV funding in the future.

3.2 Regional Transportation Electrification Initiative

Arizona is a founding member of a multi-state effort to promote TE in the western U.S. In October 2017 Governor Ducey signed the Regional Electric Vehicle (REV) memorandum of understanding (MOU) with seven other Western states to create an Intermountain West Electric Vehicle Corridor, laying the groundwork for coordinating state actions on electric vehicles across the region and supporting "the successful implementation of a robust EV charging station network."[183] This initiative aims to "make it possible to seamlessly drive an EV across the western states' major transportation corridors," and is enabling this goal through activities such as coordinating the signatory states on EV charging station

[179] Federal Aviation Administration, "Voluntary Airport Low Emissions Program." Available at: https://www.faa.gov/airports/environmental/vale/media/VALE-brochure-2017.pdf.

[180] Federal Aviation Administration, "Airport Zero Emissions Vehicle and Infrastructure Pilot Program." Available at: https://www.faa.gov/airports/environmental/zero_emissions_vehicles/.

[181] U.S. Environmental Protection Agency, "EPA awards Diesel Emissions Reduction Act grant for clean air projects in Arizona," November 20, 2018. Available at: https://www.epa.gov/cleandiesel/state-allocations.

[182] Maricopa County, "Arizona State Clean Diesel Program." Available at: https://www.maricopa.gov/4509/Clean-Diesel-Program.

[183] Arizona Office of the Governor, "Arizona Joins Agreement to Promote Electric Vehicle Corridor," October 12, 2017. Available at: https://azgovernor.gov/sites/default/files/rev_west_plan_mou_10_3_17_final.pdf.

locations and identifying opportunities to incorporate charging station infrastructure into planning and development processes.[184]

While the REV MOU is a recognition of the value in coordinating the actions of the signatory states, it does not commit the states to any specific timing or implementation goals and does not yet appear to have resulted in significant action toward the build-out of the charging corridor. It may serve as a useful framework through which Arizona's public agencies and utilities can further collaborate on how best to build out the infrastructure required to support TE along key interstates but will require active engagement from these entities given the voluntary nature of the MOU.

3.3 Arizona State Policies Supporting Transportation Electrification

Arizona has enacted a number of statutes and policies that aim to support transportation electrification in the state, as well as the increased use of alternative fuel vehicles (AFVs)[185] more broadly:

- ARS 28-876: Authorizing fines for parking conventional vehicles in spaces reserved for EVs.
- ARS 28-877: Permitting individuals driving AFVs and using alternative fuels to park without penalty in parking areas designated for carpool operators.
- ARS 28-2416, 23-2416.01 and 28-2511: Granting registered AFVs unrestricted access to high-occupancy vehicle (HOV) lanes, regardless of time of day or number of passengers. Requires registered AFVs to display an AFV license plate; plug-in hybrid electric vehicles receive a distinct license plate granting the same HOV access, although the PHEV-specific program has reached its 10,000-vehicle limit.
- ARS 49-573: Requiring federal fleets based in Arizona which operate primarily in counties with a population greater than 1.2 million people be composed of at least 90 percent AFVs. Relative to this regulation, alternative fuels include qualified diesel fuel substitutes and E85 in addition to the AFV-eligible fuels noted above.
- ARS 28-4414: Requiring new motor vehicle dealers to make information on AFVs and Arizona-based incentives available to consumers.
- ARS 41-803: Establishing AFV purchasing requirements for Arizona state agencies, boards and commissions. Relative to this regulation, alternative fuels include qualified diesel fuel substitutes and E85 in addition to the AFV-eligible fuels noted above. Requires the appointment of a state motor vehicle fleet alternative fuel and clean burning fuel coordinator, who shall develop, implement, document and monitor a statewide alternative fuels plan.
- ARS 9-500.04, 49-474.01, 49-541 and 49-571: Establishing requirements for local governments to encourage and increase the use of alternative fuels in municipal fleets. Requirements vary based on size and location of municipality.

[184] National Association of State Energy Officials, "REV West: Electric vehicle Policy Baseline for the Intermountain States," October 2018. Available at: https://www.naseo.org/data/sites/1/documents/publications/REVWest_Baseline_Final_Combined.pdf.

[185] AFVs are defined in most Arizona Revised Statutes as vehicles fueled by propane, natural gas, electricity, hydrogen, or a blend of hydrogen with propane or natural gas.

- ARS 49-542: Exempting all-electric vehicles registered for the first time in Arizona from emissions testing.
- ARS 49-572: Requiring Arizona state agencies and political subdivisions operating alternative fueling stations to allow vehicles owned or operated by other state agencies of political subdivisions to fuel at that station, to the extent practical.
- ARS 43-1090 and 43-1176 (repealed in May 2017): Granting Arizona taxpayers a $75 tax credit for installing an electric vehicle charging outlet (i.e., a 240V outlet capable of hosting a Level 2 charger) at their home.
- ARS 28-5801: Providing reduction in annual vehicle license taxes for AFVs.

These supportive policies serve as an important starting point for larger-scale TE, but on their own are unlikely to catalyze significant uptake of EVs. Many of the policies are focused on government fleets specifically, and also cover a broader category of AFVs than solely EVs. Given the charging infrastructure needed and the higher upfront costs of plug-in electric vehicles relative to some other AFVs, these policies are unlikely to spur significant adoption of EVs within government fleets. These policies also do not directly address key barriers to EV adoption in the private sector, namely model availability, lack of information/education, upfront vehicle cost, availability of charging infrastructure, and lack of dealer incentives to sell EVs (see Chapter 2 for further discussion of these barriers).

3.3.1 State Freight Plan

A further noteworthy state initiative is Arizona's five-year State Freight Plan produced by the Arizona Department of Transportation (ADOT).[186] The plan was most recently updated and published in November 2017 and includes significant detail on ADOT's vision, goals, and guiding principles for the state's freight movement and related systems.

The development of these plans every five years presents an important opportunity for partnerships with ADOT on freight and/or trucking related TE initiatives. The primary focus areas of the plan include economic development, increasing system performance and improving system management. These focal areas provide a potential linkage to TE efforts, which present significant opportunity to create new jobs (economic development), reduce air pollution and increase the efficiency of freight transport (increasing system performance), and allow for a modernized approach to the transportation sector overall (improving system management).

3.3.2 Autonomous Vehicle Policies

A discussed in Chapter 2, the development of autonomous vehicles (AVs) is closely linked to the growth of the EV market. Arizona is a national leader in enabling AV technology due its supportive regulatory environment. As a result, leading AV companies — including both traditional auto manufacturers and newer technology firms — have established a significant presence in Arizona and base much of their on-road research in the state.

[186] Arizona Department of Transportation, "Arizona State Freight Plan," November 15, 2017. Available at: https://azdot.gov/sites/default/files/2019/08/arizona-state-freight-plan-110917.pdf.

The development of Arizona's AV-friendly regulatory environment has been driven largely by Governor Ducey through several executive orders:

- Executive Order 2018-09 (October 2018): Establishing the Institute for Automated Mobility, a collaboration between state agencies, universities and private firms to conduct research on AV technology, safety and policy. Intel is the founding private sector partner.
- Executive Order 2018-04 (March 2018): Updating Governor Ducey's original 2015 executive order (2015-09) with additional requirements for AV licensing and registration and defining key terms for use in laws and regulations pertaining to AVs.
- Executive Order 2015-09 (August 2015): Requiring various public agencies to support the testing and operation of self-driving vehicles on public roads in Arizona and enabling pilot programs on university campuses.

The focus on AV development in Arizona will likely increase the demand for EV infrastructure. Many transportation experts believe that electric AVs offer a variety of operational advantages over automating internal combustion vehicles, and therefore that the development of automated transportation will be intimately connected to EV technology. For example, the dramatically fewer components involved in EV motors compared with internal combustion engines allow for easier automation and control. The maturation of the AV market in Arizona will further catalyze the EV market and the demand for EV-supportive policies, incentives and infrastructure.

3.4 Local Programs, Initiatives and Commitments

Cities and counties in Arizona have made different commitments to reducing emissions in the coming years. As transportation is the leading sector contributing to GHG emissions in these cities and counties, transportation electrification provides a method of achieving these long-term emission reduction goals.

At the local level, a variety of TE initiatives exist, although most remain in a nascent phase.

- The Phoenix City Council unanimously adopted a goal of reducing GHG emissions 80 percent below 2012 levels by 2050 and 30 percent below 2012 levels by 2025. The city has also committed to carbon neutrality by 2060.[187] In October 2020 the City Council adopted a Memorandum of Understanding with APS, which outlines the shared mission and goals of the City and APS related to sustainability and promoting a clean energy future for Phoenix, the state of Arizona, and the Clean Energy Arizona Partnership, including a particular focus on actions related to EVs as well as renewable energy, tree planting and local air quality.[188] Additionally, the City's draft Climate Action Plan includes goals for TE, including launching an EV public education and awareness campaign

[187] AZ Big Media, "Phoenix sets goal to reduce greenhouse gas emissions by 30 percent," January 10, 2018. Available at: https://azbigmedia.com/phoenix-sets-goal-reduce-greenhouse-gas-emissions-30/.

[188] City of Phoenix, "Results: City Council Formal Meeting," October 21, 2020. Available at: https://www.phoenix.gov/cityclerksite/City%20Council%20Meeting%20Files/10-21-20%20Formal%20Results.pdf

and incentive program in partnership with electric utilities by 2022 and achieving carbon-neutral transportation by 2050 in part through electrification.[189]

- The City of Tucson has committed to creating a "2030 District" by adopting sustainable building goals inclusive of water conservation and energy and transportation-related emissions reductions.[190] The City has also formed a Sustainability Working Group which will work with relevant stakeholders and City staff to develop the framework for a Climate Action Plan.[191] The Tucson City Council also recently declared a climate emergency, announcing plans to achieve carbon neutrality by 2030,[192] including a goal of electrifying the city's public transit system.
- The City of Flagstaff also recently declared a climate emergency and is now aiming for carbon neutrality by 2030.[193] The City had previously set a goal of reducing greenhouse gas emissions 80 percent below 2016 levels by 2050, with interim targets of 15 percent emissions reduction by 2025 and a 30 percent reduction by 2030. The city's Climate Action and Adaptation Plan discusses the importance of encouraging EVs by providing a sufficient number of charging ports within the city, along with promoting alternative modes of transportation such as walking, biking, and public transportation. City staff are updating this plan to be based on the more aggressive goals laid out in the climate emergency declaration and aim to add a Carbon Neutrality Plan by April 2021. Separately, Flagstaff has also adopted requirements for EV pre-wiring in new construction.[194]
- The City of Tempe has joined the Global Covenant of Mayors for Climate and Energy and is currently working through a stakeholder process for the city council to approve its Climate Action Plan.[195] The plan lists methods of reducing GHG emissions from the transportation sector such as providing solar EV charging stations and encouraging community members to use public transportation.
- The City of Avondale adopted standards for EV charging stations for new developments, effective January 6, 2021. The new standards require installation of Level 2 charging stations as a percentage of parking spaces (based on land use type) as well as additional requirements for EV Capable wiring, aimed at enabling future expansion of charging infrastructure without the cost of retrofits.[196] The City has also taken a number of other actions related to EVs in the past three years, including: Beginning to electrify its municipal fleet; leveraging incentives provided by APS and SRP to install

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[189] City of Phoenix, "Climate Action Plan Framework for Public Input," November 2020. Available at: https://www.phoenix.gov/oepsite/Documents/Climate%20Action%20Plan%20Framework%2011182020.pdf.

[190] The Daily Wildcat, "Seeing green: Tucson looks towards a sustainable future after becoming a 2030 district," February 7, 2019. Available at: https://www.wildcat.arizona.edu/article/2019/02/n-tucson-2030.

[191] City of Tucson, "Sustainability Report and Recommendations from the Commission on Climate, Energy, and Sustainability," September 17, 2019. Available at: https://www.tucsonaz.gov/sirepub/mtgviewer.aspx?meetid=1908&doctype=SUMMARY.

[192] Tucson.com, "Tucson declares climate emergency; council commits to 10-year plan for change," September 10, 2020. Available at: https://www.kold.com/2020/09/10/tucson-declares-climate-emergency-council-commits-implementing-ten-year-plan-change/.

[193] City of Flagstaff, "Climate Action & Adaptation Plan," November 2018. Available at: https://www.flagstaff.az.gov/ClimatePlan.

[194] City of Flagstaff, "Building Safety," June 18, 2019. Available at: https://www.flagstaff.az.gov/494/Building-Safety.

[195] City of Tempe, "Climate Action Plan" November 2019. Available at: https://www.tempe.gov/home/showdocument?id=76425

[196] City of Avondale, "Amendments to City of Avondale Zoning Ordinance," December 7, 2020. Available at: https://www.avondaleaz.gov/home/showpublisheddocument?id=15123.

charging stations for fleet vehicles; enabling and incentivizing workplace charging for city staff through an Administrative Policy; building a website to share information on EVs with the public; launching a Drive Electric Campaign in the community; installing EV charging stations for the public at city facilities; and developing strategies to further accelerate TE.[197]

- The City of Scottsdale plans to be carbon neutral by 2040. The City is working to adopt the 2021 International Energy Conservation Code (IECC) later this year, which will reduce energy use by close to 15 percent over the 2015 IECC and by 55 percent compared to the 2000 IECC. Scottsdale's 2021 IECC amendments will also include EV Ready and EV Capable building infrastructure requirements to accommodate future EV charging needs for new buildings including single-family, multifamily and commercial sites. EV Ready will require a dedicated circuit from electrical service panel to location of EV charging. EV Capable will require electrical capacity in the service panel for future EV charging capability. Scottsdale will be installing its first City-owned EV charging stations this year, both for staff and public use, but also as a first step to electrifying its fleet. Scottsdale currently uses compressed natural gas instead of gasoline for the vast majority of its fleet given the lower emissions.[198]
- Both the cities of Phoenix and Tucson are recognized as members of the Clean Cities Coalition Network, where they work with vehicle fleets, fuel providers, and community leaders to promote the use of EVs and domestic fuels in order to reduce emissions from the transportation sector.[199]
- Pima County aims to reduce carbon emissions in line with the 2015 Paris Climate Agreement,[200] as the local governments within the county have set varying intermittent targets. As part of this effort the County will replace 120 conventional passenger sedans with EVs by FY 2023.

While reducing transportation-related emissions will no doubt be a key component of reaching these goals, these jurisdictions are just beginning to plan for TE. The City of Phoenix's "Transportation 2050" plan does not feature electrification[201] although the draft climate action plan does lay out TE goals. Pima County plans to replace up to 120 county vehicles with EVs, but additional components of its transportation decarbonization plan have not been articulated. The City of Flagstaff's "Blueprint 2040 Regional Transportation Plan," published in March 2017, lists a number of future initiatives on vehicle electrification, but the city cited challenges to implementation posed by resource constraints and has made statements indicating it is likely to take a less proactive approach to TE in the near term.[202] The recent climate emergency declarations may drive renewed interest and engagement on planning for TE given the importance of this pathway for reducing greenhouse gas emissions.

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[197] Email correspondence between APS and City of Avondale, January 11, 2021.

[198] Email correspondence between APS and City of Scottsdale, January 14, 2021.

[199] Clean Cities Coalition Network, "Valley of the Sun Clean Cities Coalition (Phoenix)," Available at: https://cleancities.energy.gov/coalitions/phoenix.

[200] Pima County, "Sustainable Action Plan for County Operations 2018-2025," October 2018.

[201] City of Phoenix, "Plan Elements." Available at: https://www.phoenix.gov/T2050/Elements.

[202] Arizona Daily Sun, "City council passes climate change adaptation plan, but will it be implemented?" November 24, 2018. Available at: https://azdailysun.com/news/city-council-passes-climate-change-adaptation-plan-but-will-it/article_e02d5890-7299-5aa6-8635-0ddec22d4979.html.

4. Transportation Electrification Provides Net Benefits for Arizonans

As described throughout this report, transportation electrification presents an opportunity for significant economic and social benefits relative to conventional internal combustion engine vehicles that predominate today. As part of the Phase II TE Plan E3 conducted a detailed analysis of five distinct vehicle segments within the APS and TEP service territories to estimate the benefits and costs of TE in Arizona. These vehicle segments do not represent the entirety of the vehicle fleet in the state, and instead were selected based on their near-term potential for electrification, consistent with the Phase I report published in December 2019.

4.1 Scoping the Phase II Transportation Electrification Analysis

Given the scope of this project E3 has not conducted a detailed analysis for all electric utilities in the state, instead focusing on in-depth analysis of TE in the service territories of the state's two largest investor-owned electric utilities. In the interest of conveying directional results for the state as a whole, however, we present results both for APS and TEP separately, as well as an extrapolation of these findings to a statewide level. These statewide results are not intended to be determinative or precise, but rather to convey an approximation of the benefits and costs of TE across the many other electric utilities in Arizona by using APS and TEP data inputs as a proxy for the other utilities.

E3 has conducted the analysis described in this chapter for five specific vehicle segments: personal light-duty vehicles, rideshare or Transportation Network Company (TNC) light-duty vehicles, medium-duty parcel delivery vans, transit buses, and school buses. In consultation with APS and TEP, these vehicle segments were selected for analysis given their relatively large share of the total vehicle population, the particular electrification opportunity they offer, and/or their potential for significantly reducing criteria pollutant emissions. TE will not be limited to these vehicle types, and accordingly the benefits and costs of electrifying the transportation sector overall will be distinct from the estimates provided through E3's analysis for the Phase II TE Plan. Recognizing that electrification of other vehicle segments presents additional opportunities – especially relative to GHG reductions – E3 has also conducted a high-level assessment of the emissions reduction potential of the portion of the state's vehicle fleet not modeled in our cost benefit analysis; see section 4.3.3.1 for details.

4.2 The Case for Transportation Electrification: Economic and Health Benefits

E3 conducted two separate analyses of the five vehicle segments detailed above, a Cost Benefit Analysis (CBA) and an Air Quality Impact analysis focused on the health co-benefits of TE. The connection between these analyses is twofold: net emissions changes modeled for the CBA serve as one of the primary inputs for the Air Quality Potential analysis; in turn, the health co-benefits estimated in the Air Quality Potential analysis are included as part of the societal benefits that are included in the CBA results.

4.2.1 Cost Test Perspectives

To perform the CBA of transportation electrification in APS and TEP service territories, E3 compared the costs and benefits accrued over the lifetime of each EV adopted relative to the alternative of an equivalent ICE vehicle. As is common practice in CBA, E3 utilized several different "cost test perspectives" to assess the lifetime costs and benefits of TE.[203] These perspectives allow for consideration of the lifetime economics of TE separately for Arizonans adopting EVs, non-participating utility customers, and to Arizona overall. This distinction in perspective is important because different costs and benefits are relevant for these different groups, and a cost-effective option for one group does not necessarily imply overall cost-effectiveness.

Each perspective offers distinct insights that help describe the impact of EV adoption in APS and TEP service territories for different parties, which can in turn help to inform the development of TE programs and policy. The three perspectives analyzed are as follows:

- The **Participant Cost Test (PCT)** measures the costs and benefits to the individual or company adopting an EV; answering the question: *Is the total cost of ownership of an EV higher or lower than a similar ICE option?*
- The **Ratepayer Impact Measure (RIM)** measures the costs and benefits to all APS or TEP ratepayers, answering the question: *Will average electricity rates increase or decrease?*
- The **Societal Cost Test (SCT)** measures the costs and benefits to all Arizona citizens, answering the question: *Do EVs provide net benefits for the state overall?* This perspective includes the estimated value of environmental externalities such as carbon emissions or criteria pollutants.

Table 10 provides an overview of the different costs and benefits relevant for each perspective:

Table 10. Costs and benefits associated with each cost test perspective

Cost/Benefit Component	PCT	RIM	SCT
Incremental EV cost	Cost		Cost
Federal EV tax credit	Benefit		
EV O&M savings	Benefit		Benefit
Fuel savings	Benefit		Benefit
Electricity supply costs for EV charging		Cost	Cost
Charging infrastructure cost	Cost		Cost
Electricity bill for EV charging	Cost	Benefit	
CO_2 savings			Benefit

[203] The cost test perspectives originate from the California Public Utilities Commission's Standard Practice Manual, available at: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf.

4.2.2 Vehicle Segments and Adoption Trajectories Modeled

Each of the cost test perspectives was used to assess the costs and benefits across five different vehicle types, two charge management scenarios, and three adoption scenarios, which are listed below.

- **Five vehicle segments**: Personal light-duty vehicles, rideshare light-duty vehicles, medium-duty parcel delivery vans, transit buses, and school buses.
- **Two charge management assumptions**: Unmanaged charging, managed charging (with the assumption that 100 percent of EVs charge based on time of use electricity rates from each utility).
- **Three adoption scenarios** for EVs adopted over the period 2020-2040: Low, Medium, and High.
    - The Low adoption scenario assumes that the current trajectory of vehicle electrification continues over the adoption period.
    - The Medium adoption scenario assumes more rapid vehicle electrification, with total statewide electrified LDVs reaching 1.076 million by 2030. Non-LDV electrification is based on the simple average of the Low and High adoption scenarios.
    - The High adoption scenario assumes that 20 percent of the state's total LDVs are electrified by 2030 (equal to approximately 1.479 million electric LDVs). Non-LDV adoption is based on NREL forecasts for a high adoption scenario.

4.2.2.1 Low Adoption

Low vehicle adoption trajectories were developed primarily using forecasting recently completed for APS and TEP by Guidehouse Consulting (formerly Navigant Consulting). Guidehouse provided a 20-year (2020-2039) plug-in electric vehicle adoption forecast for LDVs, MDVs, and HDVs within the TEP service area. The Guidehouse base case assumes a business as usual (BAU) scenario where the current market trajectory for these vehicles persists. E3 has directly leveraged these figures for four of the five vehicle segments of interest in the CBA (all besides rideshare LDVs, which are discussed separately below).

Guidehouse separately developed LDV forecasts for APS, at both the utility service territory and statewide level. As the Guidehouse work for APS did not include non-LDV forecasts, E3 developed MD parcel delivery truck and school bus forecasts for the APS service territory based on the forecast for these vehicle types completed for TEP and scaled for differences in population between the two utilities' service territories. Transit buses, alternatively, were scaled according to the ratio of buses in TEP and APS service territories, with the assumption that adoption of these vehicles in the APS service territory occurs at the same rate as the Guidehouse base case forecast for transit buses in TEP service territory.

The rideshare or TNC LDV forecast was developed separately. For the Low adoption scenario, the penetration of rideshare LDVs was held constant over time at current levels (based on proportion of total VMT by all LDVs), effectively scaling directly with the assumed population growth underlying the total LDV forecast from Guidehouse. A portion of the rideshare EV adoption is forecasted to follow Lyft's corporate

goal of 100 percent electrification by 2030.[204] For other TNC providers (Uber), the remaining portion of the forecast in the base case follows Guidehouse's rate of electrification for LDVs.

4.2.2.2 Medium Adoption Scenario

The Medium adoption scenario for LDVs is based on a Rocky Mountain Institute (RMI) nationwide goal of 50 million electric LDVs by 2030. RMI scaled this goal down to state-specific targets using 2017 vehicle registration data, with the resulting Arizona goal of 1.076 million electric LDVs by 2030. This scenario is based on RMI's estimates of the emissions reductions required from the transportation sector to maintain global climate change below 2° C. RMI assumed that by 2030 the LDV population grows by three percent from current levels. To align the APS and TEP forecasts with this statewide goal of 1.076 million E3 used the proportions of the total statewide LDV population represented by vehicles within the utilities' service territories, assigning the pro rata share accordingly. Beyond the 2030 goal, E3 extrapolated the EV counts using an assumption that by 2050 Arizona would reach 100 percent electrification of LDVs, connecting these points using a logistic curve (although this study only considers vehicle adoption through 2040).

The Medium adoption scenario for MD delivery vans, transit buses, and school buses is based on the simple average of the Low adoption scenario (described above) and the High adoption scenario (described below).

Total rideshare or TNC LDV *counts* in the Medium adoption scenario were developed using assumptions from Bloomberg New Energy Finance's (BNEF) 2019 and 2020 EV Outlook,[205] and represent a world where shared mobility plays a large role in personal transportation. In the Medium adoption scenario, it is assumed that Lyft's 100 percent-by-2030 goal applies to the full TNC population (rather than only to the portion represented by Lyft, as is the case in the "Base Case" adoption forecast).

4.2.2.3 High Adoption Scenario

The High adoption scenario is a variation on the Medium scenario, which explores higher levels of LDV adoption, specifically. The RMI goal of 1.076 million electric LDVs in Arizona by 2030 assumed 20 percent of *total* LDVs in the state being electrified by 2030. However, RMI also assumed relatively low population growth (three percent), whereas the Guidehouse forecast upon which the Low adoption scenario is based assumes LDV population growth of 31 percent by 2030, reflecting a combination of both population growth and growth in GDP (which spurs additional vehicle purchases). Accordingly, when modeling electrification of 20 percent of the total LDV population using the Guidehouse forecast employed in the Low adoption scenario the statewide electric LDV figure for 2030 is 1.479 million, considerably higher than the 1.076 million goal in the Medium scenario. E3 considered this alternative as a distinct scenario for purposes of exploring a higher level of LDV adoption. This difference applies to both the personal and rideshare LDV forecasts. As with the Medium adoption scenario, E3 also assumed that Arizona reaches 100 percent electrification by 2050 and used a logistic curve to extrapolate adoption beyond 2030.

Non-LDV adoption in the High scenario is based on the high adoption scenario in the National Renewable Energy Laboratory's (NREL) *Electrification Future Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States.* [206] NREL's high adoption scenario reflects technology

[204] https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions

[205] https://www.eenews.net/assets/2019/05/15/document_ew_02.pdf

[206] https://www.nrel.gov/docs/fy18osti/71500.pdf

advancement, policy support, and consumer enthusiasm for electrification. NREL's high adoption scenario projections for the share of electric MD trucks, HD trucks, and transit buses for the U.S. were applied to the total number of MDVs, HDVs, transit buses, and school buses in each of the service territories, which in turn were taken from the base case forecasts from Guidehouse used in the Low adoption scenario. For this scenario E3 assumed that electric school bus adoption rates would be equivalent to electric transit bus adoption rates. Additionally, NREL's projected bus adoption rates were applied to both MD and HD transit and school bus counts in each service territory.

Figure 20 shows the statewide level of LDV adoption, by scenario. Under the Low adoption trajectory, EVs in Arizona reach approximately 250,000 by 2030. Under the Medium and High scenarios EVs on the road in 2030 reach 1.076 million and 1.479 million, respectively. Additional adoption figures for the other vehicle segments, as well as segmentation by APS and TEP service territory, are included in Appendix A.

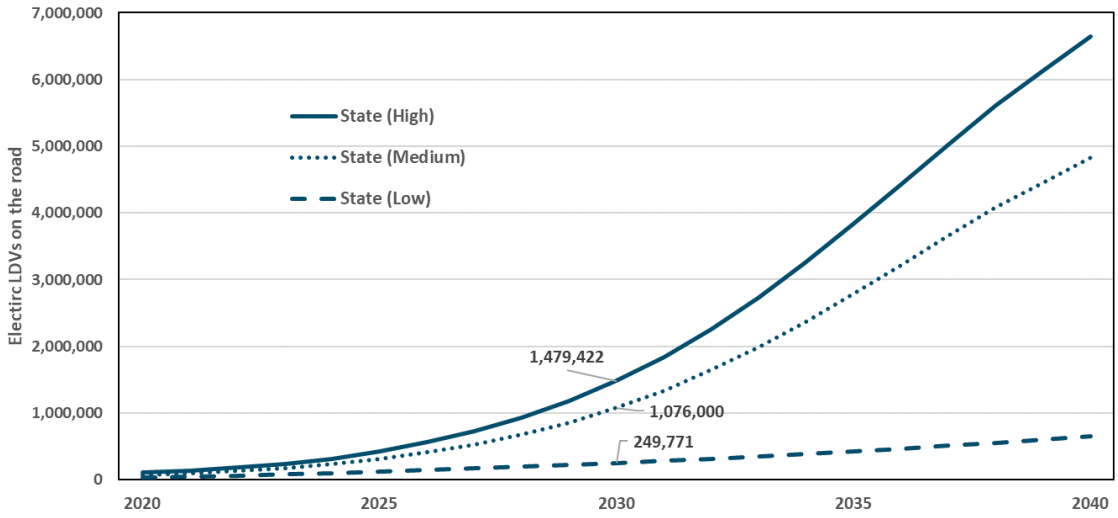

Figure 20. Statewide Electric LDV Adoption by Scenario

4.2.3 Cost Benefit Analysis

The CBA is conducted in several steps, detailed further in the following sections.

1. Generating **driving and charging profiles** for each vehicle segment;
2. Developing **cost projections** including electricity supply costs (separately or each utility);
3. Modeling of **costs and benefits** of operating each vehicle over its lifetime;
4. **Scaling** of per-vehicle costs and benefits to the total forecast population of EVs.

4.2.3.1 Driving and Charging Profiles

The first step in conducting the CBA is the development of EV driving and charging load profiles for each vehicle segment. To model charging behavior E3 has developed a bottoms-up approach that simulates driving and charging of thousands of EV drivers to reflect a population of drivers more accurately (rather than modeling the same individual driver multiple times over). First, historical driving behavior is captured

using travel survey data from either the National Household Travel Survey[207] (personal LDVs), the NREL Fleet DNA Database[208] (non-LDVs), or the City of Chicago's survey of Transportation Network Company trip data[209]. Next a statistical process using a Markov-Chain Monte Carlo algorithm is used to simulate driving profiles for the vehicle population based on this data. This process effectively simulates the probability of a driver going between their current location and one of a number of potential destinations (e.g., going from work to home) using the survey data noted above as the basis.

Once driving profiles are created, unmanaged charging profiles are developed using data on drivers' access to different charging types (home, workplace). Charging access assumptions are developed using U.S. Census Bureau data from the American Community Survey[210] to characterize driver populations by housing type, vehicle ownership and commute patterns. This data is paired with charging access data from UC Davis research[211] and the California Clean Vehicle Rebate Program[212] to develop a population segmentation by home and workplace charging access as well as housing area type (urban, suburban or rural).

The key assumption underlying the resulting unmanaged charging profiles is that EV drivers charge immediately upon arrival at the location where charging is available. Figure 21 provides an example of the driving and charging pattern for the population of personal LDVs over a one-week period. The x-axis represents a sample one-week period, while the y-axis represents the probability a driver will be either driving, at work, at home, at a public location without charging available, or at a public location that provides charging services.

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

[208] https://www.nrel.gov/transportation/fleettest-fleet-dna.html

[209] https://data.cityofchicago.org/Transportation/Transportation-Network-Providers-Trips/m6dm-c72p

[210] https://www.census.gov/programs-surveys/acs/data/pums.html

[211] https://its.ucdavis.edu/research/publications/?frame=https percent3A percent2F percent2Fitspubs.ucdavis.edu percent2Findex.php percent2Fresearch percent2Fpublications percent2Fpublication-detail percent2F percent3Fpub_id percent3D2799

[212] https://cleanvehiclerebate.org/sites/default/files/attachments/CVRPConsumerSurvey2013-15Reference.pdf

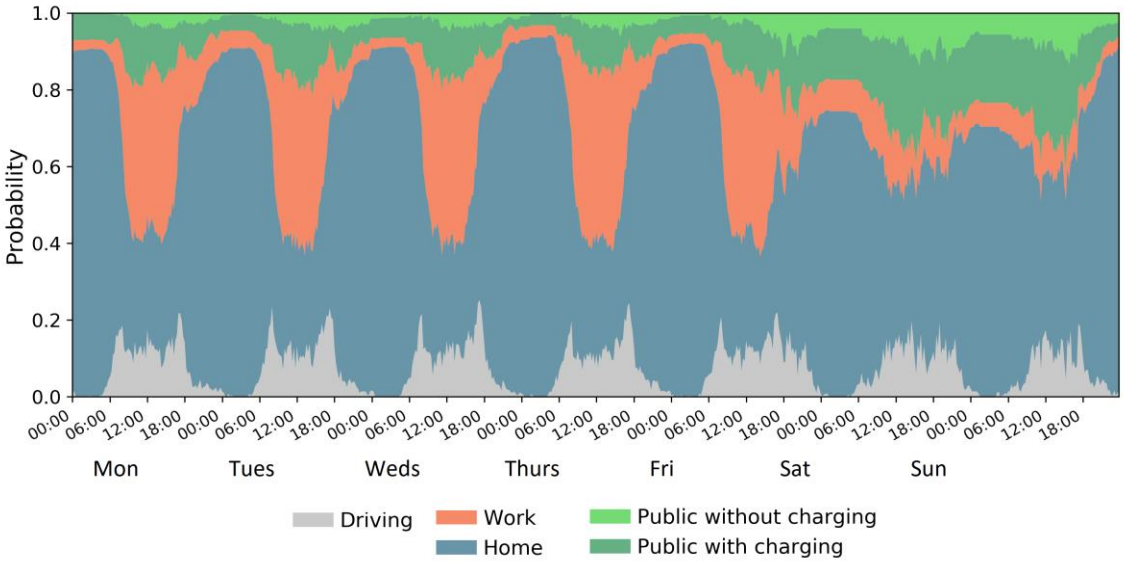

Figure 21. Personal LDV weekly driving pattern from Markov-Chain simulation

Once unmanaged charging profiles are developed, managed charging profiles are subsequently generated by shifting load from the unmanaged profile. These load shifts are based on reducing driver charging costs (through charging at lower-priced times of day), while also maintaining enough battery state of charge (SOC) to fulfill all driving requirements (with driving requirements based on the driving profiles described above).

Figure 22 and Figure 23 below provide an example of the contrast between unmanaged and managed charging profiles, respectively. These figures show the charging profile of a transit bus in APS territory over a one-week period. In the first example, the bus is charged based solely on when it arrives at the depot, where it has access to vehicle charging. In the second example, the bus charging is instead optimized to reduce costs (by charging during low-cost, off-peak times) while also meeting minimum SOC requirements based on its driving profile. The flat "blocks" of charging in the second figure represent periods of low-cost charging during the nighttime off-peak hours (unlike the higher charging levels shown in the first figure, which trigger additional costs for the customer due to demand charges assessed on the "peaky" unmanaged shape).

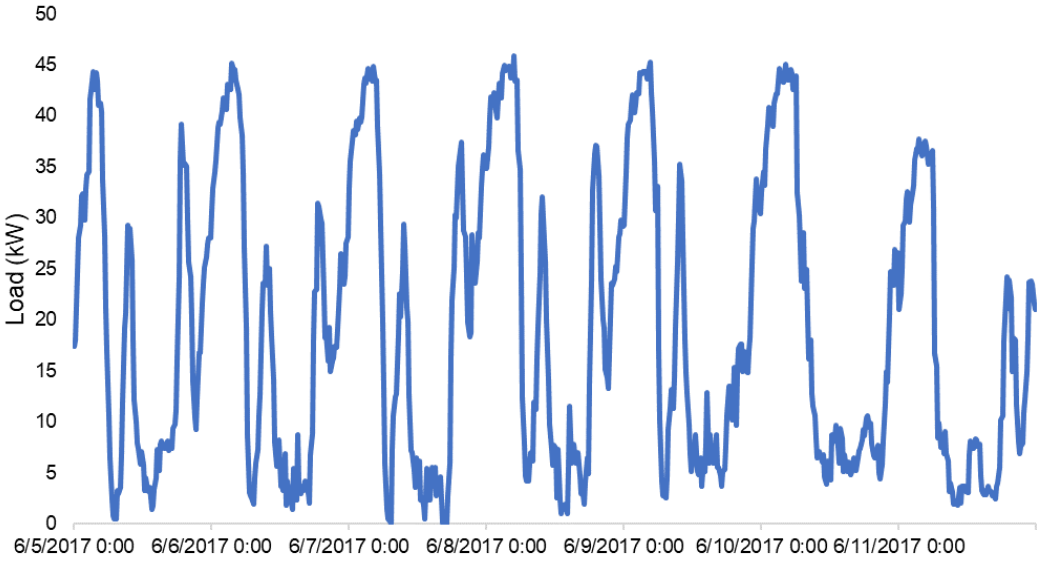

Figure 22. Transit Bus Unmanaged Charging Load (Summer Week)

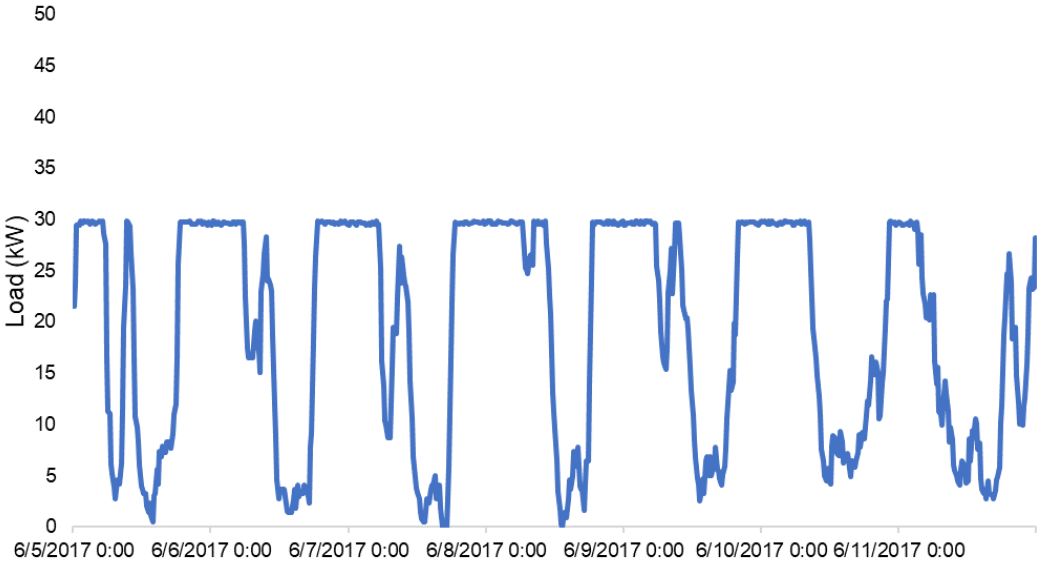

Figure 23. Transit Bus Managed Charging Load (Summer Week)

The driving and charging profiles generated for different vehicle segments vary depending on historic driving pattern data, charging access and requirements (i.e., level, battery size) and electricity rate (for managed charging). E3 developed these patterns for the five vehicle segments noted above, in both utility service territories, resulting in both unmanaged and managed charging profiles for each vehicle type and within each service territory.

4.2.3.2 Cost Projections

Conducting the CBA requires defining numerous costs and benefits for each vehicle segment, which are relevant for the different cost test perspectives over the lifetime of the EV. The following table details a number of the primary costs as well as E3's source for these assumptions.

Table 11. Primary Cost Inputs

Input	Source
Incremental Vehicle Costs	International Council on Clean Transportation[213]
Make Ready and EVSE Infrastructure Costs[214]	International Council on Clean Transportation[215] and Idaho National Lab[216]
Gasoline Price Forecast	Energy Information Administration (EIA) mid forecast
Electricity Marginal Costs	Marginal energy and capacity costs (generation, transmission and distribution capacity) and loss factors were provided by APS and TEP, and sourced from data and analysis supporting their most recent Integrated Resource Plans
Retail Electricity Rates	APS and TEP retail rates for residential and commercial customers
Tax Credits and Incentives	Department of Energy[217]

While many of these inputs are upfront costs (e.g., incremental vehicle costs), to correctly calculate the electricity supply costs and EV driver electricity bills requires using the hourly load shapes generated through the driving and charging profile development process. This is critical for isolating the additional benefits of managed charging, which takes advantage of lower cost (and lower emission) hours to charge EVs. Using the load shapes generated earlier in the process E3 calculates the estimated cost of supplying electricity to power the adopted EVs – accounting for the marginal cost of energy, generation capacity, transmission and distribution capacity, and line losses – as well as the incremental utility bills that EV customers pay for this electricity.

4.2.3.3 Modeling of Lifetime Costs and Benefits

Once all costs and benefits relevant across the three different cost test perspectives have been calculated the final cost-benefit comparison can be made. E3's analysis compares the lifetime costs and benefits for vehicles adopted in each year of the study period (2020-2040), accounting for both upfront costs and the ongoing operations and maintenance costs (and cost savings) for each year of the vehicle's life.[218] These

[213] https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf.

[214] EVSE = Electric Vehicle Supply Equipment

[215] https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

[216] https://www.osti.gov/servlets/purl/1459664

[217] https://www.fueleconomy.gov/feg/taxevb.shtml

[218] In this analysis E3 has assumed that all vehicles have a lifetime of 14 years.

costs and benefits compare the value of an EV to the value of an alternative, hypothetical (or "counterfactual") ICE vehicle that would otherwise have been purchased and operated.

The lifetime results of this comparison are then reported on a per-vehicle basis, with the costs and benefits for each vehicle segment presented as a net present value. For example, a vehicle segment with $5,000 in net present benefits per vehicle indicates that across all vehicles of that type adopted from 2020-2040, the lifetime benefits are $5,000 greater than the lifetime costs, per-vehicle. Displaying results in this fashion allows for consideration of all vehicles adopted over the study horizon, regardless of the year they are adopted (given that the costs and benefits are discounted back to the present).

4.2.3.4 Scaling of Results

The final step in the CBA is to scale the per-vehicle results up to the total vehicle population level. As described earlier in this section, E3 modeled several different adoption trajectories. For each adoption and charge management scenario, the appropriate per-vehicle results (unmanaged vs. managed charging) are scaled up using total vehicle counts to produce distinct net present value results for the entire vehicle population.

4.2.4 Air Quality Potential Analysis

To assess the health co-benefits offered by transportation electrification through improvements in air quality, E3 used the Co–Benefits Risk Assessment (COBRA) screening model developed by the EPA. COBRA is a simplified dispersion model that determines the impact of changes in criteria pollutants on ambient air quality and subsequently human health.

There are four steps to the air quality analysis undertaken for this study.

- First, the change in criteria pollutant emissions resulting from each transportation electrification scenario is estimated based on emission factors from the 2018 Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model from Argonne National Laboratory[219] (for vehicle emissions) and from APS and TEP (for power plant emissions). The change in pollutant emissions includes both avoided emissions from fossil fueled vehicles displaced, and increased emissions from power plants.
- Second, the impact of these changes in emissions on ambient air quality is determined, using the COBRA model, for three "snapshot" years of 2023, 2028, and 2040 (to capture the trends of changing relative power plant vs avoided ICE emissions over time). COBRA uses a simplified 2D dispersion model to determine where the emitted pollutants flow, and how they react with sunlight and other pollutants in the atmosphere to form pollutants such as ozone and secondary $PM_{2.5}$.
- Third, the calculated changes in ambient air quality are combined with statistical health and economic metrics to determine the monetized human health benefits of the air quality scenarios modeled. The result of this analysis is an estimate of the monetized air quality co-benefits for each transportation electrification adoption scenario and vehicle type.

[219] See documentation at https://greet.es.anl.gov.

- Fourth, the air quality benefits in the three modeled snapshot years are interpolated to the intermediate years based on the net NOx emissions savings in each year. These benefits are then converted to an NPV benefit per vehicle, for inclusion in the Societal Cost Test in the CBA.

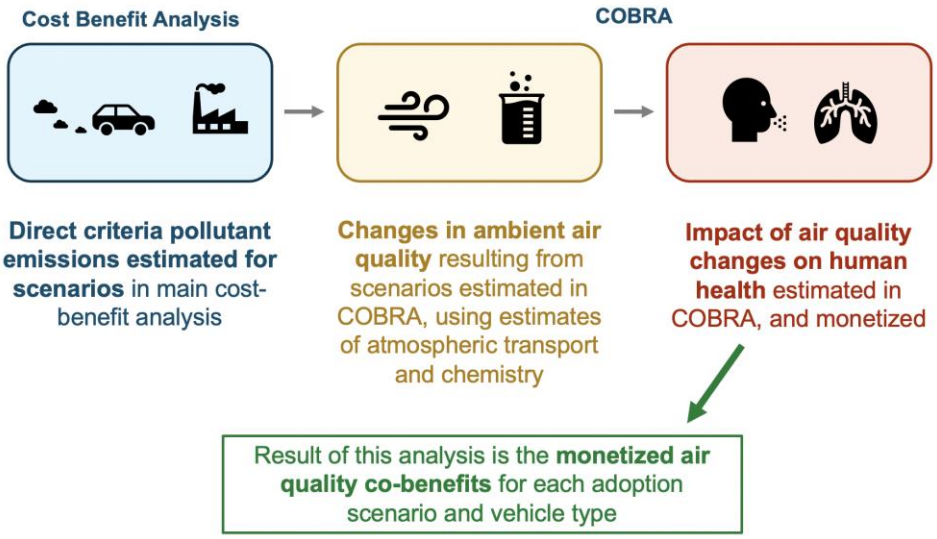

Figure 24. Air quality modeling methodology used in this study.

E3 conducted the health co-benefits analysis described above for each of the five vehicle segments detailed previously. Below we provide a summary of the resulting monetized health co-benefits.

4.3 Results

4.3.1 Air Quality Results

Table 12 shows a sample (for 2028) of the criteria pollutant emissions impacts of transportation electrification, that are used in the Air Quality Potential Analysis. These emissions figures serve as the input to the COBRA model. All numbers modeled in COBRA are statewide (rather than utility-specific) estimates, although CBA results are shown in the following section both at the statewide level and for the APS and TEP service territories, respectively.

Table 12: Statewide criteria pollutant emissions in 2028 for the Low adoption scenario (metric tons)

Source	Pollutant	Personal LDV, Unmanaged	Personal LDV, Managed	Rideshare LDV (TNC)	MD Delivery Van	School Bus	Transit Bus
Additional Emissions from Electricity Generation	NOx	49.3	45.8	12.7	0.6	0.1	0.2
	PM_{10}	3.1	3.0	0.6	0.0	0.0	0.0
	SO_2	29.9	29.0	8.8	0.4	0.0	0.2
	VOC	0.5	0.5	0.1	0.0	0.0	0.0
Avoided ICE Emissions	NOx	107.9	107.9	27.4	3.0	0.2	0.3
	PM_{10}	8.7	8.7	2.2	0.5	0.0	0.1
	SO_2	3.8	3.8	1.0	0.0	0.0	0.0
	VOC	215.8	215.8	54.9	2.8	0.2	0.4

Figure 25 shows the results of the Air Quality Potential Analysis from COBRA. This analysis shows the net air quality benefits of LDV electrification in the Low adoption scenario increasing to ~$15 million annually by 2040.

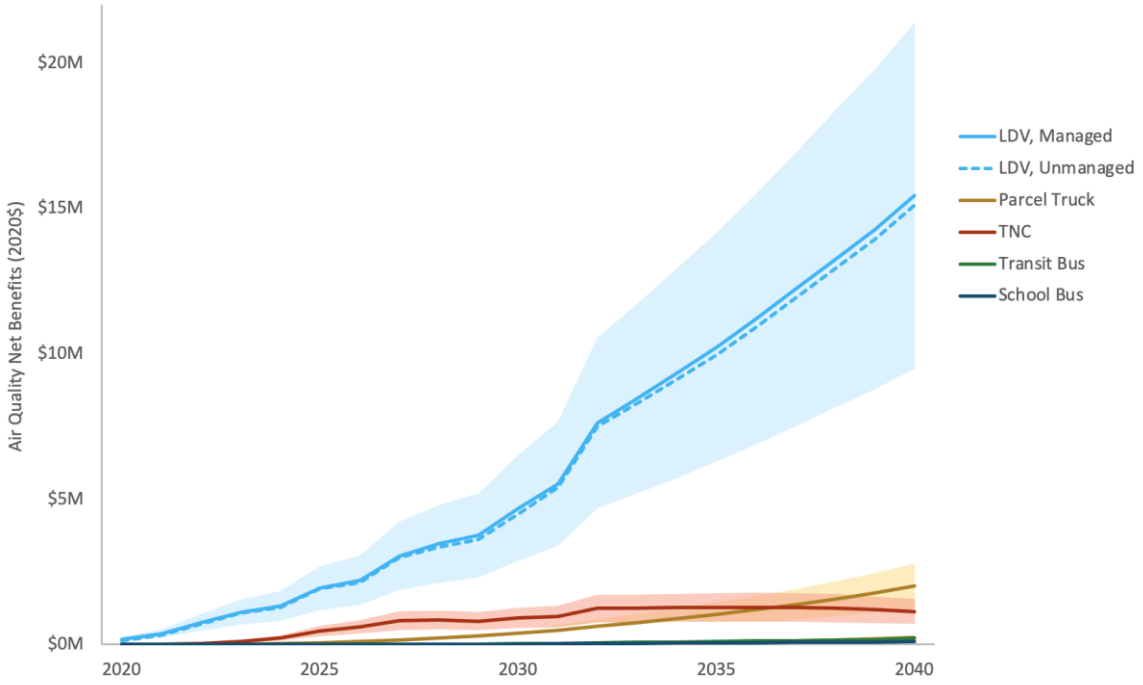

Figure 25. Statewide Air Quality Net Benefits of EV Adoption by Vehicle Segment for the Low Adoption Scenario. Uncertainty ranges reflect the high and low estimates from COBRA.

The air quality co-benefits of transportation electrification are significant. In particular, among the vehicle segments modeled, LDV electrification is likely to have the highest positive impact on air quality due to the large number of vehicles anticipated to be adopted, relative to other vehicle segments.

As noted above, the COBRA outputs displayed here are subsequently converted into NPV per-vehicle benefits, for inclusion in the main CBA results and scaling to the Medium and High adoption scenarios.

4.3.2 Cost Benefit Analysis Results

E3 found that there are large net present benefits from transportation electrification in Arizona across all three cost test perspectives. Below we provide two detailed examples of lifetime costs and benefits across the three cost test perspectives, followed by summary tables of the total net present benefits for personal LDVs and, separately, for the entire EV population, across the different adoption scenarios.

4.3.2.1 Per-Vehicle Results

As an example, Figure 26 depicts the lifetime costs and benefits for personal LDVs adopted in APS service territory over the adoption period of 2020-2040. The three separate groups of clustered columns represent the Participant Cost Test (PCT), Ratepayer Impact Measure (RIM), and Societal Cost Test (SCT). While personal LDV results here are shown for APS in particular, the analogous results for TEP are very similar. Similarly, for the transit bus results shown in Figure 28 are for TEP specifically, although APS results are quite similar. See Appendix A for results from all vehicle segments modeled, separately for APS and TEP.

As shown by the net benefits labels, from all three perspectives there are greater lifetime benefits than lifetime costs, indicating that adoption of personal LDVs over the study period provides is beneficial to not only EV drivers but also utility ratepayers more broadly as well as all Arizonans. These per-vehicle net benefits equate to approximately $3,600 for participants, $4,500 for utility ratepayers, and $11,500 for Arizonans overall.

- For the participant (PCT), the benefits of avoided spending on gasoline, operations and maintenance (O&M) savings, and tax credits outweigh the costs of additional electric utility bills, incremental upfront vehicle price, and charging infrastructure.
- For utility ratepayers (RIM), the benefits of additional utility electric bills paid by EV drivers outweigh the costs of supplying the additional electricity required to power the EVs.[220]
- For Arizonans overall (SCT), the benefits of avoided spending on gasoline, O&M savings, avoided GHG emissions and additional health co-benefits outweigh the incremental upfront vehicle price, additional electricity supply costs and charging infrastructure costs.

[220] Note that the electric utility bill (dark blue bar) which is a cost for participants and a benefit for utility ratepayers differs in size due to a portion of the incremental utility bill going to third-party charging service providers, rather than directly to the utility.

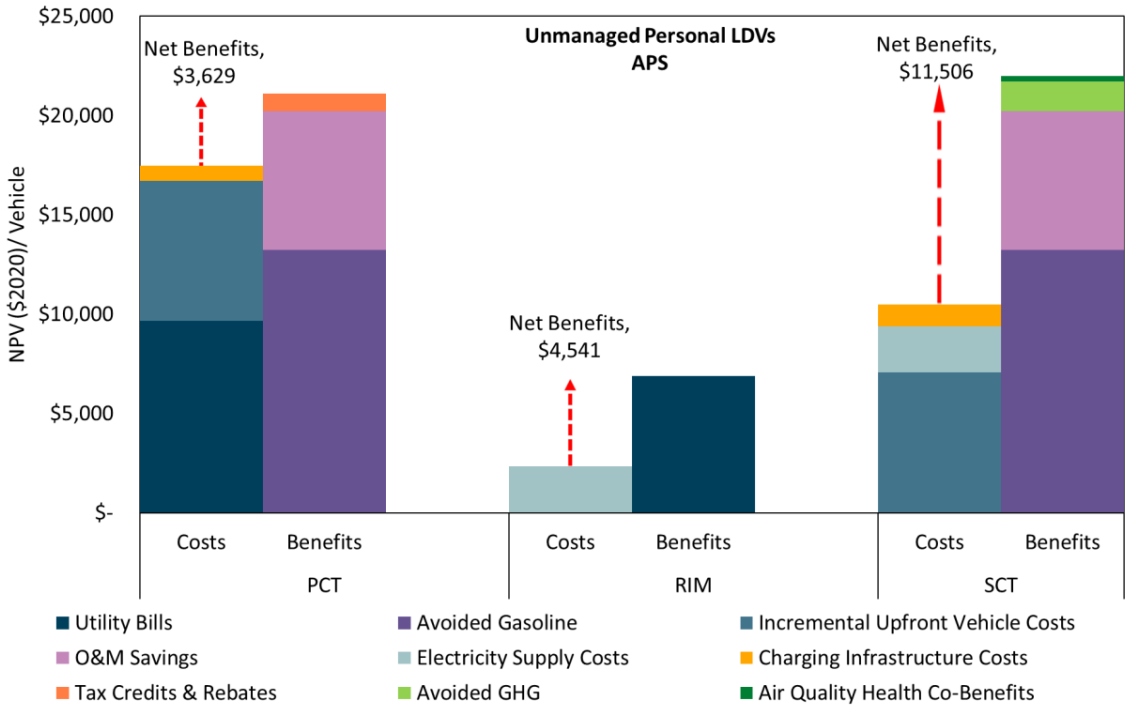

Figure 26. Lifetime Costs and Benefits, Unmanaged Personal LDVs (APS)

Net benefits increase across the three cost tests when these EVs are assumed to participate in managed charging, as shown in Figure 27 below.

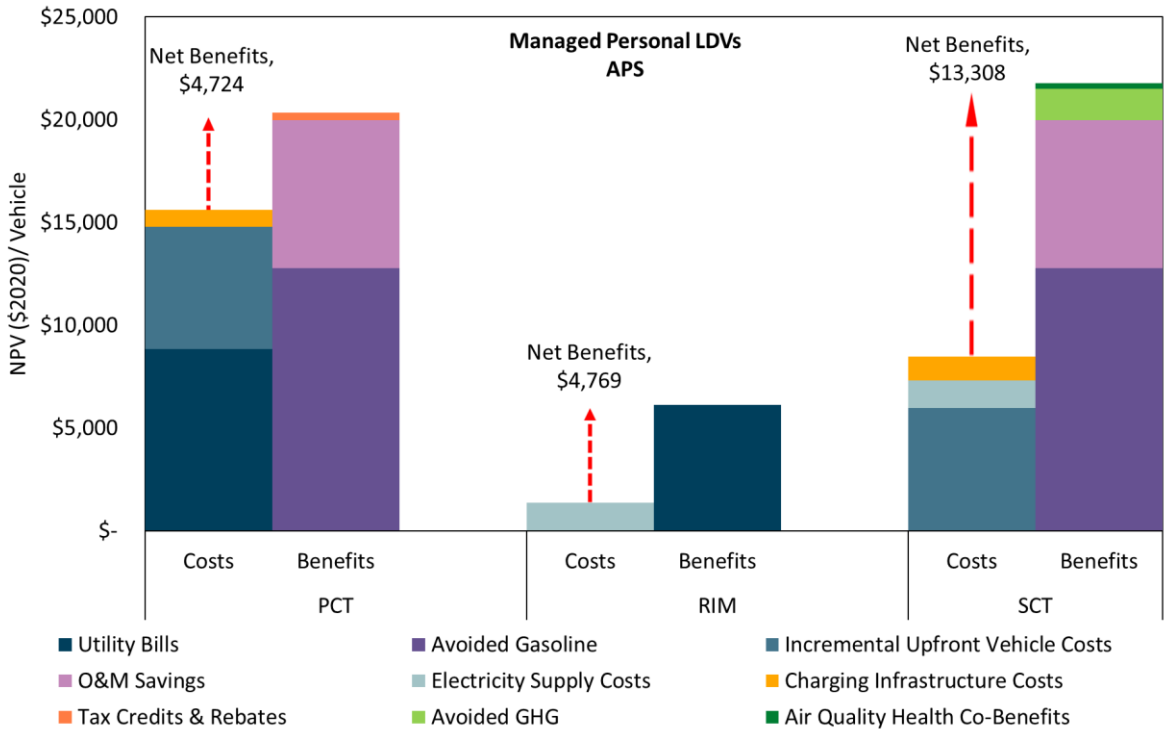

Figure 27. Lifetime Costs and Benefits, Managed Personal LDVs (APS)

Figure 28 below provides the same comparison of lifetime costs and benefits for unmanaged transit buses in TEP service territory (note that APS results are similar, see Appendix A). As with the personal LDV example shown above, transit bus electrification provides net benefits across all three perspectives.

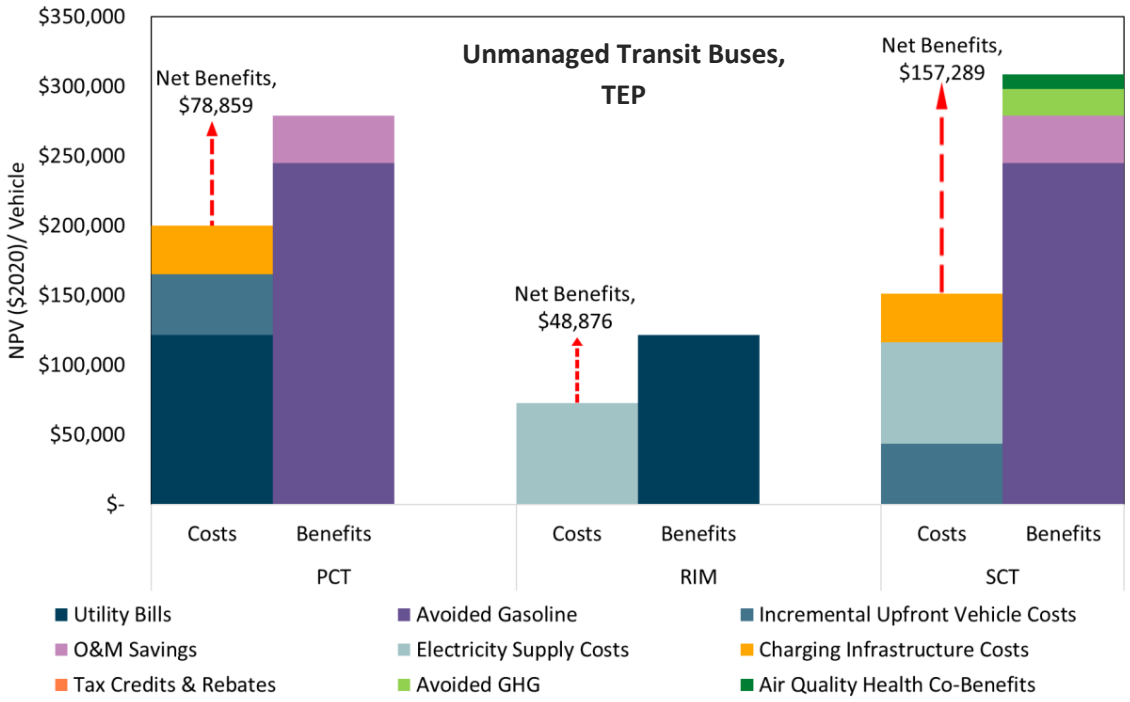

Figure 28. Lifetime Costs and Benefits, Unmanaged Transit Buses (TEP)

Appendix A contains detailed per-vehicle cost benefit results for all segments modeled.

4.3.2.2 Total EV Population Results, Net Present Benefits

The following tables present the net present benefits over the lifetime of all EVs adopted between 2020 and 2040 across the different adoption scenarios, broken out by the two utility service territories and the extrapolated results at the statewide level.[221] Table 13 presents these results for Personal LDVs, while Table 14 presents the combined lifetime net benefits for the five vehicle segments modeled. Note that the APS figures are considerably larger than those of TEP due to the larger service territory covered and the accordingly larger number of EVs assumed to be adopted. Analogous tables with NPV results for all vehicle segments are included in Appendix A.

[221] It is important to note that statewide results based on the APS and TEP modeling are directional and not precise. As many inputs vary by utility – for example, electricity supply costs and retail electricity rates – these scaled results are not a precise depiction of the costs and benefits of TE in other Arizona electric utilities and should be interpreted with this caveat in mind.

Table 13. Net Present Benefits, Personal LDVs ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	453	70	1,026	567	216	1,535	1,402	372	3,476
Low + Managed	561	82	1,259	625	232	1,680	1,663	441	4,123
Medium	3,722	581	8,434	3,757	1,271	9,855	10,263	2,444	24,906
High	5,119	799	11,601	5,168	1,748	13,555	14,117	3,361	34,258

As evidenced by the values in these tables, TE presents the opportunity for large net benefits in both APS and TEP service territory, and by extension for the state of Arizona. For example, Table 13 (above) indicates that LDVs alone in the Low adoption scenario present adopting EV customers throughout the state with a combined lifetime net present benefit of over $1 billion. In the High adoption scenario, this figure grows to over $11 billion.

From the perspective of other ratepayers, TE offers even greater net benefits at scale. As more EVs are adopted, utility infrastructure is increasingly utilized to provide the electricity needed to power these vehicles. This additional throughput on the electricity system decreases the average $/kWh rate and should drive down the electricity rates paid by all customers in the absence of other expenses incurred to serve the new EV load. While some level of infrastructure upgrades will be required to accommodate this additional electricity load – including investment by the utilities in make-ready and charging infrastructure – that value is likely to be outweighed by the benefits ratepayers receive in the form of reduced rates due to increased electricity sales once EV adoption accelerates sufficiently.

Finally, TE offers the largest net benefits from a societal perspective. In the Low adoption scenario, statewide societal net benefits from personal electric LDVs are nearly $3.5 billion; in the High adoption scenario this increases ten-fold to nearly $35 billion in net present benefits.

When including the other vehicle segments modeled (Table 14, below), the statewide net present benefits range from a low end of $1.3 billion to nearly $13 billion for EV adopters; from $2.1 billion to nearly $17 billion for utility ratepayers; and from $4.4 billion to over $39 billion from the societal perspective of all Arizonans.

Table 14. Net Present Benefits, Total EV Population, All Vehicle Segments Modeled ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	556	106	1,297	766	307	2,103	1,732	509	4,392
Low + Managed	640	117	1,484	786	313	2,153	1,749	567	4,530
Medium	4,030	689	9,248	4,540	1,620	12,074	11,467	2,948	28,254
High	5,592	969	12,859	6,265	2,239	16,667	15,851	4,092	39,090

This analysis strongly suggests that TE in Arizona can provide significant net benefits to all parties, as shown by the large figures included in the summary tables above. What level of TE adoption Arizona reaches over this time period will be determined by a combination of market and technology developments (e.g., EV costs), federal and state policy (e.g., incentives), consumer preferences, and the relative cost of electricity and gasoline, among other factors. However, what the analysis described in this chapter makes clear is that EV adoption is likely to result in large benefits for a range of parties – adopting individuals, utility ratepayers, and Arizona overall – and is accordingly a compelling opportunity for the state to pursue.

4.3.3 Additional Benefits & Greenhouse Gas Reduction Potential

This analysis has estimated the lifetime costs and benefits of TE to different groups. However, it is important to note that additional, non-quantified benefits of TE exist, including, for example, increased customer choice, reduced noise pollution, and economic growth opportunities. While this assessment has not attempted to quantify and monetize the value of these additional components, we note that the growth of TE in Arizona will provide a broader range of benefits than the subset explored through this analysis.

Furthermore, while the cost-benefit and air quality analyses have provided a detailed estimate of the lifetime value of five distinct vehicle segments in Arizona, these estimates do not cover the entirety of the on-road transportation sector in the state. Notably, beyond medium-duty parcel delivery trucks, school buses, and transit buses, the electrification potential of other MD and HD vehicles have not been modeled due both to the scope of this analysis and the current level of market maturity for electric versions of other vehicles (see section 2.6). Nonetheless, electrification of other MD and HD vehicles in Arizona presents the potential for significant reductions in GHG and criteria pollutant emissions in the coming years. In order to acknowledge this potential and the role overall transportation sector emissions play in Arizona's emissions inventory (recall Figure 2 on page 12, depicting the state's total emissions), E3 has conducted a high-level assessment of the GHG emissions reduction potential of the remaining MD and HD vehicles not captured in the cost-benefit and air quality analyses described above.

4.3.3.1 GHG Reduction Potential of Non-modeled MD and HD Vehicles

To estimate the GHG reduction potential from electrifying MD and HD vehicles other than the MD parcel delivery trucks and buses modeled in the cost benefit and air quality analyses, E3 undertook the following analytical steps:

- Estimate baseline emissions (i.e., with no electrification) over time based on a Guidehouse vehicle population forecast and data from the Federal Highway Administration on fuel consumption per vehicle;
- Estimate direct GHG emissions reductions from TE levels modeled in the High adoption scenario described above, based on the percentage of vehicle stock electrified (note that this particular analysis does not include indirect emissions from electric generation, which become less significant by 2040 under a highly decarbonized grid);
- Estimate additional potential for GHG emissions reductions based on electrifying 15 percent of MDV and HDV vehicle stocks by 2030, and 60 percent by 2040. These levels are consistent with electrification goals and mandates in other jurisdictions such as California and Colorado, such as the Advanced Clean Trucks regulation in California.

Figure 29 and Figure 30 show the results of this analysis, depicting the emissions reduction potential from non-modeled MD and HD vehicle electrification, respectively. Note that buses are included under HDVs for the purposes of this analysis.

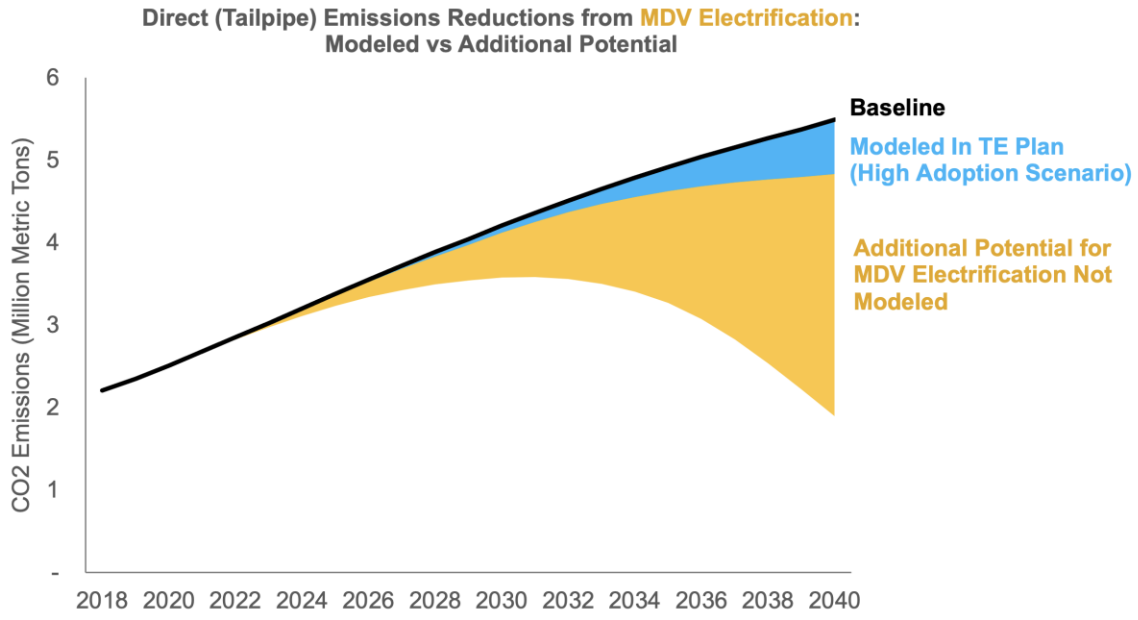

Figure 29: GHG reduction potential from electrifying non-modeled MDV vehicles.

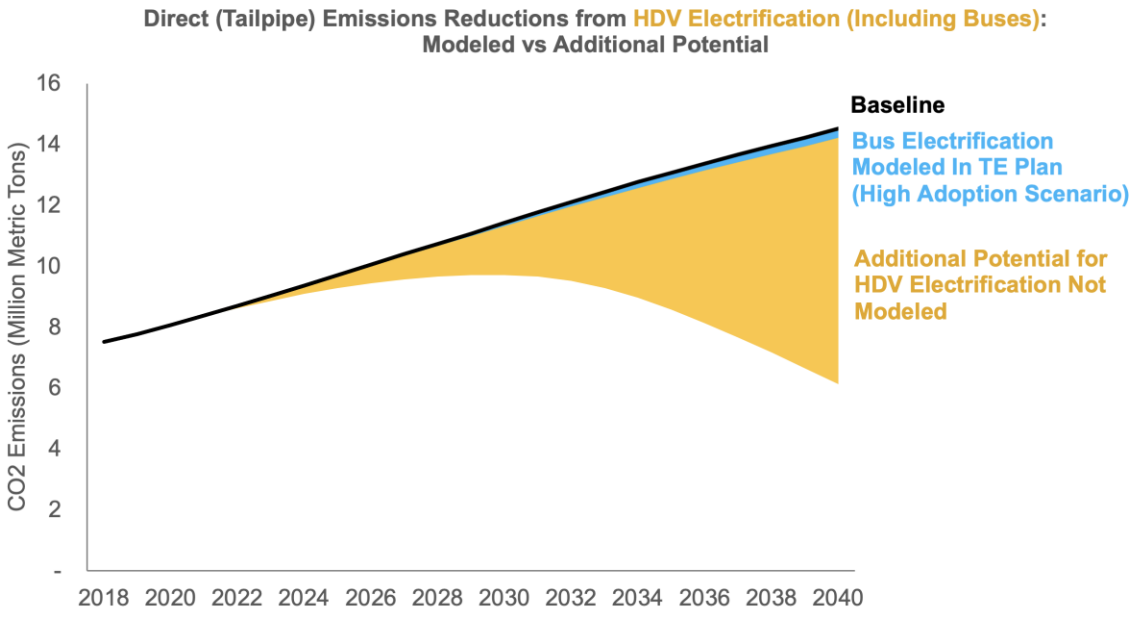

Figure 30: GHG reduction potential from electrifying non-modeled HDV vehicles.

5. Gaps Analysis and Recommended Actions

At both a global level and locally in Arizona many barriers to widespread transportation electrification exist, as detailed by vehicle segment in Chapter 2. Some of these barriers are being addressed through initiatives by different actors including policymakers, education and advocacy organizations, electric utilities, automakers, and others. However, many barriers are not being addressed sufficiently to unlock the significant net benefits to all Arizonans described in Chapter 4, highlighting gaps which must be filled to enable accelerated development of TE. This chapter describes the various gaps which exist and provides potential enabling actions which can be taken to address them.

Discussing barriers to transportation electrification and identifying recommended actions to overcome them was one of the primary focus areas of the five stakeholder working groups that met periodically throughout the Phase II TE Plan process. Barriers identified by these groups have been incorporated directly into the Transportation Electrification Market and Technology Assessment (Chapter 2). This chapter, alternatively, leverages the key findings and recommended initiatives from the working groups, building upon the barriers detailed in Chapter 2 to describe and assess the primary gaps that must be addressed to enable broad TE in Arizona.

5.1 Summary of Barriers to Transportation Electrification

As a starting point for developing recommended actions and initiatives to promote TE in Arizona, each working group identified the primary barriers relevant to their focus area. As shown in the following summary table, many types of barriers cut across the focus areas discussed by the different working groups.

Table 15. Common Barrier Categories Identified Across Working Groups

Barrier Category	EV Infrastructure	Equity	Programs & Partnerships	Goods Movement & Transit	Vehicle Grid Integration
Lack of Collaboration	X	X	X	X	
Inequity in TE Planning	X	X	X		
Education & Outreach	X	X	X	X	X
Model Availability & Technology Readiness		X	X	X	X
Upfront Cost		X	X	X	X
Access for Underserved Communities	X	X	X		
Insufficient Charging Infrastructure	X	X	X	X	X
Grid Planning & Capacity Needs	X		X	X	X
Electricity Rate Design	X	X	X	X	X

5.2 Summary of Recommended Actions by Actor

Table 16 provides a summary of the working group recommended TE support initiatives, by actor and timeframe. Additional detail is provided in the following section (5.3). For the purposes of this summary, near- and medium-term are defined as within one year and one to four years, respectively. Given the focus of the working groups' recommendations, this table does not cover long-term initiatives (five or more years).

Table 16. Recommended Actions by Actor, Near- and Medium-term

Actor	Priority	Action	Barrier(s) Addressed
Electric Utilities	Near	Continue stakeholder coordination meetings; prioritize inclusion of diverse voices	+ Lack of Collaboration + Inequity in TE Planning
		Develop new and expand existing education & outreach programs	+ Education & Outreach
		Establish dedicated electrification teams	+ Insufficient Charging Infrastructure
	Medium	Develop incentive programs for EVs and/or EV charging infrastructure	+ Upfront Cost + Insufficient Charging Infrastructure
		Develop EV rates	+ Electricity Rate Design + Insufficient Charging Infrastructure
		Implement pilot charging programs and begin to deploy additional charging infrastructure; emphasize deployment in underserved communities	+ Insufficient Charging Infrastructure + Grid Planning & Capacity Needs + Access for Underserved Communities + Education & Outreach
		Electrify fleet vehicles	+ Education & Outreach + Grid Planning & Capacity Needs
State and/or Local Government	Near	Support and participate in TE Collaborative process; focus on inclusive planning model and diversity of voices	+ Lack of Collaboration + Access for Underserved Communities + Inequity in TE Planning
	Medium	Enact ZEV legislation (state)	+ Model Availability
		Develop and/or support Group Purchase programs and EV funding mechanisms such as loan-loss reserves	+ Upfront Cost + Access for Underserved Communities + Inequity in TE Planning
		Develop incentive programs for EV and/or charging infrastructure purchase (state)	+ Upfront Cost + Insufficient Charging Infrastructure
		Implement EV Ready building codes (local)	+ Insufficient Charging Infrastructure
		Develop rideshare programs for underserved communities	+ Access for Underserved Communities + Education & Outreach

Actor	Priority	Action	Barrier(s) Addressed
Representatives of Underserved Communities	Near	Engage in collaborative TE planning processes and promote inclusive planning model	+ Access for Underserved Communities + Inequity in TE Planning + Lack of Collaboration
	Medium	Partner with utilities and public agencies on education & outreach, rideshare / micromobility, and training programs	+ Education & Outreach + Access for Underserved Communities + Inequity in TE Planning
Transit Agencies and/or Fleet Operators	Medium	Initiate pilot electrification programs	+ Technology Readiness + Grid Planning & Capacity Needs
		Purchase diverse model types to explore capabilities and limitations; share knowledge	+ Technology Readiness
Third-Party EV Service Providers (EVSPs)	Near	Engage in collaborative TE planning processes	+ Lack of Collaboration
		Collaborate with utilities on improving interconnection processes	+ Insufficient Charging Infrastructure
	Medium	Develop additional public and workplace charging infrastructure; prioritize service coverage in underserved communities	+ Insufficient Charging Infrastructure + Education & Outreach + Access for Underserved Communities + Inequity in TE Planning

5.3 Addressing the Gaps: Recommended Initiatives to Promote Transportation Electrification in Arizona

This section provides recommended initiatives to address barriers to TE in Arizona which are not currently being addressed sufficiently by existing programs or policies. Recommendations are organized by the primary barrier they address, with additional barriers addressed discussed as well.

5.3.1 Lack of Collaboration

Addressable Gap: Lack of comprehensive coordination between TE decision makers and stakeholders, including lack of broadly adopted processes and standards, limiting efficiency and effectiveness of TE-focused initiatives.

Potential Actors: State and local government; utilities; transit agencies; representatives of underserved communities.

As described by the *EV Infrastructure*, *Equity*, *Programs & Partnerships*, and *Goods Movement & Transit* working groups, an important form of cross-cutting initiative that can support TE is increased collaboration among different actors in Arizona. This type of initiative helps to address multiple gaps including lack of engagement on TE from the state, insufficient awareness and education around EVs and TE planning requirements, and, if successful, the lack of charging infrastructure. One approach would be a task force or working group that meets regularly to ensure coordination of efforts, including policy implementation, incentive and other support programs, dissemination of knowledge and learnings, ensuring diverse representation in planning and programmatic decisions to avoid inequitable outcomes, bulk purchasing programs, and approved vendor lists, among others.

The *EV Infrastructure* working group recommends a combination of bottoms up (local and regional) and top down (state and regional) cooperation and partnerships to ensure that sufficient charging infrastructure is developed to meet the needs of local areas, larger regions and the state overall.

The *Programs & Partnerships* working group specifically recommends the "reinstatement of a statewide office that participates in regional collaboration, funding, and program coordination on transportation electrification" to address the lack of engagement and coordination on TE issues. Additionally, the group recommends that the electric utilities host "Transportation Electrification Collaborative" meetings on a quarterly basis, focused on updating stakeholders on TE progress and developments as well as enabling collaboration with other entities pursuing EV goals.

One of the *Equity* working group's five priority recommendations for the near-term (within the next year) focuses directly on collaboration: centering the voices and experiences of underserved communities in the development of TE plans, programs, and policies. Specifically, the group recommends that a leadership group be established for TE equity efforts in Arizona, and proposes that a non-profit, academic, public, or industry group lead this effort. The working group proposes that the electric utilities support this group through funding and resources, as well as through the quarterly TE Collaborative meetings described above as part of the *Programs & Partnerships* working group recommendation on collaboration.

Relative to MD and HD vehicles, coordination between utilities and other stakeholders can help to determine charging needs, cost-effective locations for installing large capacity charging stations, and potential rate structures that better support TE for fleets of larger vehicles. Collaboration across regions will also help to disseminate best practices: for example, as highlighted by the *Goods Movement & Transit* working group "detailed planning and communication between regions" can enable the sharing of strategies to mitigate the impacts of Arizona's extreme climate on vehicle battery life and performance.

5.3.2 Inequity in TE Planning

Addressable Gap: Insufficient consideration of equity issues within TE planning, creating potential for inequitable outcomes across communities, populations, and/or geographies.

Potential Actors: State and local government; utilities; representatives of underserved communities; transit agencies.

As highlighted by the *Equity* working group, the Phase II TE Plan process attempted to include a broad range of stakeholders, yet participation required internet access, invitation to workshops and meetings, proficiency in English, and the ability to participate without direct compensation (other than as provided by the groups represented by stakeholders). To further promote true equity in Arizona through TE, additional

outreach and accommodations to involve an even broader and more representative group of stakeholders in upfront planning decisions will be essential.

Related to the "Lack of Collaboration" section above, convening a leadership group on equity issues in TE is one important way that diverse voices and perspectives can be involved in collaborative efforts from inception. Additionally, the *Equity* working group provided the overarching recommendation of creating structures to prioritize equity and track progress throughout development and implementation of the TE Plan.

5.3.3 Education & Outreach

Addressable Gap: Lack of awareness about TE technologies, limiting potential adoption of EVs.

Potential Actors: State and local government; utilities; automakers; transit agencies.

Lack of education and outreach is a fundamental barrier to TE across all vehicle segments and technologies. Despite growth of the sector in recent years TE technology remains foreign to many consumers, from individual residents considering their personal LDV options to fleet managers and transit operators making procurement and operational decisions. Notably, lack of education and outreach was the most universally referenced impediment to TE discussed by the five working groups, clearly highlighting a gap which needs to be addressed. Further promoting awareness of TE technology – including the benefits associated with EV options – will therefore be a critical component of enabling accelerated uptake of these vehicles in Arizona.

Importantly, as described by the *Equity* working group, increasing awareness of TE options and technologies cannot be structured in a one-size-fits-all manner, and instead education and outreach initiatives should be tailored to the audience and/or use case, attempting to raise awareness using "appropriate messages and trusted messengers."

The *Programs & Partnerships* working group recommends a number of TE awareness-focused initiatives. Many of these are captured in the following subsections, while others are described as part of recommendations to address other barriers, such as workplace charging programs – which address the lack of charging infrastructure, but also support awareness. For the full list of recommended actions please see the working group's final report in Appendix B.

5.3.3.1 Outreach Campaigns

Outreach campaigns and programs have the explicit goal of providing information on EVs to increase awareness of the technology. As highlighted by the *Programs & Partnerships* working group these programs can be run by the electric utilities, state or local agencies, or third parties, and can be targeted at residential and commercial customers, auto dealerships, state or local agencies (including legislative audiences), or other groups that would benefit from increased familiarity with TE options.

Successful campaigns improve awareness of EV technology and options and provide resources for consumers to continue learning more about EVs and/or find available options. These programs also help to address other gaps. For example, the *Vehicle Grid Integration* working group anticipates that achieving a majority of EV charging taking place via some form of managed charging, large-scale consumer education campaigns will be critical – including specific outreach to low-income communities.

5.3.3.2 Training and Technical Assistance

In addition to a lack of awareness of options from the perspective of potential EV adopters, there is also a lack of familiarity with TE technology on the part of mechanics, auto dealers, and others who support the transportation sector. Furthermore, entities such as local governments or businesses that might host charging stations lack familiarity with the considerations inherent in installing such infrastructure, highlighting a gap in the dissemination of technical experience.

The *Equity* working group identified that training for current and future mechanics, auto dealers, and other transportation-related roles will be an important part of both enabling further EV adoption and of promoting equity in TE. Specifically, programs focused on underserved and/or disadvantaged communities can provide new pathways and opportunities for residents to participate in the transportation sector. The group recommends several specific actions be taken in the medium-term (1- to 4-year timeframe) to support equitable TE training opportunities, including training programs to support a transition from internal combustion engine (ICE) to EV repair services; development of Career and Technical Education programs and funding for trade-focused R&D in high schools and community colleges; and creation of pipelines and training programs in prisons.

The *Goods Movement & Transit* working group provided similar recommendations, with a focus on enabling MD and HD fleet operators to learn about TE more easily. Medium-term recommendations include coordinated training from automakers, as well as online courses and resources from entities such as the Vehicle Innovation Center and the Center for Transportation and the Environment. Longer-term recommendations from the group focus on developing fleet management plans that consider the operating characteristics of EVs rather than ICE vehicles, as well as pilot programs for fleet electrification to help provide valuable experience and serve to limit risk exposure by identifying pitfalls early, prior to rollout of TE technology for broader MD and HD uses.

5.3.3.3 Marketing Through Demonstration

Electrification of fleet vehicles can serve the dual purpose of promoting awareness of EVs and providing valuable first-hand experience in managing EVs for operators. The presence of branded EVs can help to showcase that this technology is becoming increasingly reliable and mainstream, promoting confidence in electric options. As described by the *Programs & Partnerships* working group this "marketing through demonstration" can be undertaken by both utilities and other actors including commercial businesses (for example, delivery trucks "wrapped" in promotional content about the vehicle being electric). For utilities, using EVs for their own operations (including installing charging capacity) provides an opportunity to gain experience with the infrastructure and drivetrains of EVs, which can help to build competencies that are useful in supporting other adopting customers, for example, through technical assistance.

5.3.4 Model Availability & Technology Readiness

Addressable Gap: Insufficient availability of EV models in Arizona hampers adoption.

Potential Actors: State and local governments; automakers; transit agencies and fleet operators.

As described in Chapter 2, EV model availability across different vehicle segments has been increasing in recent years, and many automakers have announced plans to deliver a wider diversity of electric models in the early 2020s. However, relative to conventional ICE vehicles there are still relatively few EV options; this

is true both for LDVs and for larger MDV and HDV applications. For the larger vehicles, technology readiness and performance remain an issue in addition to model availability, as TE technology is more developed and available for a broader range of use cases for LDVs than it is for MD and HD vehicles, although rapid progress is being made on these latter segments.

Furthermore, while model availability is an issue broadly for TE, it is especially relevant for Arizona given it is bordered by two zero emission vehicle (ZEV) states, California and Colorado. Requirements in these states for automakers to sell increasing numbers of ZEVs over time create a strong incentive for allocating EV stock to those states, which can make it more challenging to find EV options in Arizona where that requirement does not exist.

While not detailed here, upfront incentives (discussed below in section 5.3.5.1) can also help to improve model availability by creating more demand for automakers to respond to.

5.3.4.1 Enact ZEV Legislation

To address the lack of model availability several of the working groups (*Programs & Partnerships*, *Equity*) recommend that Arizona enact legislation to become a ZEV state, or adopt a similar policy, in the interest of increasing the number and availability of EVs. By requiring a certain portion of vehicles to be ZEVs the state would create a stronger signal for automakers to invest in the Arizona market, increasing model availability. This has proven to be an effective policy in other jurisdictions.

5.3.4.2 Purchase Diverse Model Types

The *Goods Movement & Transit* working group recommends that in the near-term, Arizona stakeholders support a diverse group of bus manufacturers entering the market to simultaneously develop better knowledge of different options and avoid the potential for investing too heavily in a particular provider prior to the technology having been fully vetted by bus operators. This recommendation is also valuable for other (non-bus) fleet operators as it will allow for comparison of the benefits and limitations of different products and OEMs. Sharing learnings through regular collaborative meetings (see section 5.3.1) can help to disseminate this valuable information broadly across fleet operators from around the state.

5.3.5 Upfront Cost

Addressable Gap: Insufficient market and policy support to make most EV options competitive on an upfront cost basis today, despite many models offering lifetime savings.

Potential Actors: State and local government; electric utilities; automakers; auto dealerships.

The upfront price premium of EVs remains a significant barrier to further adoption. Policies such as the federal EV tax credit help to address this barrier but do not fully equalize upfront costs with ICE alternatives for many EV models. Despite the lifetime savings that many EVs offer, the remaining upfront price premium after accounting for the federal tax credit represents an important gap to be addressed. A number of actions can be taken to further reduce upfront costs.

5.3.5.1 Incentive Programs for EV Purchases

Incentives are the most direct and arguably the most effective mechanism to spur EV adoption. The *Programs & Partnerships* working group identified this as one key intervention strategy to address the current gap in EV support in Arizona, while the *Equity* working group put upfront cost reductions as a priority

for the 1- to 4-year timeframe. Incentives can be offered by various entities, with programs most commonly funded and/or administered by state or local governments or by electric utilities. The most common forms of incentives are generally rebates or grants at the time of purchase, tax credits, and sales tax exemptions.

The *Programs & Partnerships* working group specifically recommends that incentive programs aimed at expanding the *used* EV market in Arizona be prioritized, a development that has the potential to improve and expand access to TE for different groups and improve equity outcomes.

The *EV Infrastructure* working group notes that upfront incentives which help to spur adoption of EVs also indirectly help to promote development of charging infrastructure, both through increasing demand for charging services and also through increased utilization of infrastructure, which lowers the operational costs for EV service providers.

5.3.5.2 Group Purchase Programs

Group purchase programs take advantage of the cost savings afforded by bulk purchases to reduce the price premium of EVs. As highlighted by the *Programs & Partnerships* working group, there are currently 48 group purchase programs across 20 states, demonstrating significant precedent for this type of support initiative. Such programs are generally run by state or local governments and can benefit personal EV adopters, businesses and fleet operators, and transit agencies depending on program structure and available partnerships with automakers willing to provide discounts for these bulk purchases.

The *Goods Movement & Transit* working group highlighted these group purchase programs for fleets as a promising near-term action, recommending that the Arizona Department of Administration facilitate such a program for government fleets, and that the Arizona Department of Transportation facilitate a program for other, private vehicle purchases.

5.3.5.3 Funding Mechanisms

The *Equity* working group highlighted the importance of not only securing availability of affordable EV models, but also availability of funding mechanisms to enable a broader range of Arizonans to adopt these vehicles. The group specifically recommends that equitable funding mechanisms be developed with underserved communities considered and prioritized. Such mechanisms can include loans for EV purchases (or for charging equipment), which the state could make more available through the creation of a loan-loss reserve to reduce default risk for participating financial institutions. The *Goods Movement & Transit* working group recommends that in the near-term the state institute a revolving loan fund to help schools and transit agencies with EV purchases.

5.3.5.4 Fair Registration Fees

As a part of making EVs affordable to encourage adoption the *Programs & Partnerships* working group recommends that Arizona implement fair and supportive EV registration fees. The group acknowledges that consideration of sustainable long-term funding options for transportation infrastructure will be required, but stresses that high upfront registration fees will impede uptake of EVs.

5.3.6 Access for Underserved Communities

Addressable Gap: Inequitable access to TE options for different communities, resulting in a lack of opportunities for underserved populations.

Potential Actors: state and local government; electric utilities; automakers; auto dealerships.

Without distinct consideration of underserved communities, equitable participation in TE in Arizona will not be attainable.

5.3.6.1 Inclusive Planning Model

As noted above in the "Inequity in TE Planning" section (5.3.2), the *Equity* working group has highlighted the importance of including a diversity of voices and perspectives in TE planning discussions *from the beginning* of such processes. Maintaining this perspective across TE initiatives – whether they are utility pilots or programs, local government actions, state planning activities, or other processes – will be critical in ensuring the benefits of TE are shared by all Arizonans. One effective starting point would be through the regular TE Collaborative meetings recommended by the *Programs & Partnerships* working group.

5.3.6.2 Charging Infrastructure in "Hard to Reach" Markets

The *EV Infrastructure* and *Equity* working groups recommend sector-specific programs based on income-qualification, geography (e.g., Native American or rural communities), or other equity measures to promote the development of needed charging infrastructure in areas that might not otherwise receive it. This could be provided by electric utilities or by third parties. A commonly referenced argument for utility ownership is that the private market (i.e., third-party providers) will not develop sufficient infrastructure in areas with low EV penetration, while, conversely, EV penetration will not increase without sufficient charging infrastructure. Utilities can help to address this issue by developing charging infrastructure in these areas and recovering costs from all utility customers, a model which is not available to private charging service providers. While these investments may take some time to recoup their value, as EV penetration grows the assets will become increasingly utilized and eventually can provide a net benefit to all utility ratepayers, while also having supported TE equity.

5.3.6.3 Public Transit, Rideshare/Carshare Programs, & Micromobility

The *Equity* working group highlighted that ensuring access to TE consider not only personal ownership of EVs – which may not be desired by all Arizonans – but also public transit, rideshare, and micromobility options. Supporting electrified public transit can spread the benefits of TE to a broader range of Arizonans – including, importantly, reductions in local air pollutants that cause serious harm to human health (see section 4.2.4 for a discussion of the air quality impacts of TE). Expanding the availability of and access to micromobility options such as e-bikes and e-scooters is another effective way to provide TE options to a larger group. It is important to note, however, that these options should not be considered as complete replacements for access to either shared or personal EVs for those who desire it.

As a further way to provide broader and more equitable access to TE options, the *Programs & Partnerships* and *Equity* working groups recommend the development of electrified rideshare and/or carshare programs for low-income residents. These programs provide rental access to publicly owned fleets of EVs for qualified low-income residents. This intervention can also help to promote awareness of EVs.

Separately, a recommended near-term initiative from the *Goods Movement & Transit* working group is to encourage development of Bus Rapid Transit (BRT) routes, including incorporation of e-buses in the early stages. BRT generally includes dedicated bus lanes to improve the efficiency and speed of bus trips; it also often includes off-board fare collection for further time efficiency.

5.3.7 Insufficient Charging Infrastructure

Addressable Gap: Insufficient charging infrastructure to support anticipated growth of EVs in Arizona, including complex interconnection processes.

Potential Actors: Utilities; third-party EVSPs; state and local government; residential and commercial customers.

Lack of charging infrastructure is a challenge for all vehicle segments. This contributes both to the physical challenge of providing charging capacity for EVs as well as to concerns over range anxiety which would be alleviated by a more robust network of available charging ports. While there is opportunity for more comprehensive and coordinated support to further develop this market, the current environment dampens interest and confidence in EV options and highlights a critical gap to be filled. Additionally, the development of charging infrastructure must include consideration of access for underserved communities, as highlighted by the *Equity* working group in their recommendation that over the next several years charging stations be distributed equitably and with fair pricing models.

The following intervention strategies draw largely upon the recommendation of the *EV Infrastructure* working group, which aim to address the four barrier categories it identified: procurement costs, operational costs, soft costs, and utility engagement and information (discussed further in section 2.5.2.4).

5.3.7.1 Utility Electrification Programs for EV Infrastructure

There are numerous forms of utility programs that support development of EV charging infrastructure, either through direct ownership of the infrastructure or other means. As highlighted by the *EV Infrastructure* working group, program types generally include make-ready programs, upfront rebates for charging hardware, direct ownership of charging hardware, on-bill financing, EV-specific electricity rates and load management programs, and dedicated electrification teams.

Ownership of Infrastructure: Electric utilities hold a unique position in their ability to provide EV charging infrastructure, both in terms of their technical competency in developing electricity infrastructure projects and their ability to fund such investments through electricity rates. This form of funding is especially compelling for EVs that represent additional electricity sales, which over time puts downward pressure on electricity rates by spreading the cost of the electric grid across a larger number of kWhs. In short, more efficient use of grid infrastructure drives down electricity rates, and as long as this effect outweighs investments in new infrastructure to meet this new demand, rates will decrease (especially if charging largely takes place in lower-cost, off-peak hours). As noted by the *EV Infrastructure* working group, this ownership could encompass only the make-ready (infrastructure connecting the electric grid to the charging hardware) or direct ownership of the charging hardware itself.

Charging as a Service: A specific type of utility charging infrastructure ownership recommended by the *Goods Movement & Transit* working group as a longer-term action is the development of "Charging as a Service" programs. Utilities – potentially in partnership with third-party EVSPs – would provide building owners with charging services at their site without requiring the site host to own or install the infrastructure.

Electrification Teams: Another initiative the utilities can undertake is to develop dedicated electrification teams, enabling increased collaboration with third-party EVSPs to address numerous barriers including

challenges related to interconnection, soft costs, permitting, and siting. The *EV Infrastructure* working group highlighted interconnection costs and process as a significant barrier to further deployment of EV charging stations and recommended a utility best practice of dedicating "specific staff members to provide assistance to EV charging developers, entities looking to electrify their vehicles, and site hosts, in particular during the siting and interconnection phase of development."

Shared Infrastructure Programs: The *Vehicle Grid Integration* working group recommends limiting infrastructure upgrade costs using a layered approach and shared infrastructure programs. Beginning at a localized level, first individual buildings and then the local distribution grid / node would be considered for load sharing EV chargers, enabling increased charging ports through the maximum use of existing infrastructure without triggering upgrades (where possible).[222]

5.3.7.2 Incentive Programs for Charging Infrastructure

An effective initiative to spur deployment of charging infrastructure – at private residences, multi-unit dwellings, workplaces, and other commercial locations – is to provide upfront incentives to reduce the cost of charging hardware, as recommended by the *EV Infrastructure* and *Programs & Partnerships* working groups. The *Vehicle Grid Integration* working group specifically recommends incentivizing "smart" Level 2 chargers for customers installing these devices at their residences, given the benefits offered by off-peak TOU charging and participation in demand response programs. Furthermore, creation of demand response programs that complement TOU rates will help to avoid demand spikes that can otherwise occur at the times of day when electricity rates switch to off-peak prices.

Separately, the *Goods Movement & Transit* working group recommends that the utilities host competitive grant funding solicitations to support the purchase and installation of charging equipment for MD and HD vehicles, which could be tied to managed charging requirements to mitigate electric grid impacts and upgrade costs.

Government or utility financial support for charging infrastructure can take a number of forms, including upfront grant or rebate programs to reduce equipment and installation costs, tax credits, or the use of Volkswagen Settlement funds.[223] See the more detailed discussion and case studies of different government incentive programs included as part of the *EV Infrastructure* working group's final report in Appendix B.

5.3.7.3 Workplace Charging Programs

Workplace charging programs provide employees with EV charging at their place of employment. These programs expand the number of charging ports available, addressing the current lack of infrastructure and encouraging employees to consider EVs as a transportation option by helping to address range anxiety. The *Programs & Partnerships* working group notes that workplace charging programs are also an effective way to increase awareness of TE. Many programs provide charging at no cost to present a further incentive for employees to adopt EVs, further supporting adoption by reducing operating costs. Workplace charging also

[222] Load sharing chargers allow site hosts to install a greater number of charging ports than would otherwise be permitted based on the site's capacity (e.g., the service panel or transformer) by automatically sharing power across charging ports. This can reduce the maximum power available to any one charger (when necessary) but enables a greater total number of charging ports.

[223] See sections 3.1.3 and 3.1.4 for a discussion of the VW settlement funds and related Electrify America charging infrastructure program, respectively.

provides the opportunity to better integrate renewable energy given the alignment between solar generation and common work schedules. Additionally, enabling widespread managed workplace charging will allow for significant EV load without driving peak demands.

Installing EV charging at workplaces can also provide credits towards green building certifications such as the Leadership in Energy & Environmental Design (LEED) program. The U.S. Department of Energy's Alternative Fuels Data Center provides detailed information on workplace charging program design considerations.[224]

As discussed in section 2.9, the long-term effects the ongoing COVID-19 pandemic may have on transportation patterns remains unclear. This pandemic has drastically altered the commute and work patterns for many, and to the extent that remote work becomes a lasting pattern for many, workplace charging programs may have less potential than previously believed. However, utilization of such programs will likely remain valuable for the reasons discussed above.

5.3.7.4 EV Ready Building Codes

The *EV Infrastructure* and *Programs & Partnerships* working groups identified EV Ready building codes as an important state and/or local government initiative which can support further deployment of charging stations. Typically structured as a requirement that new construction (residential, commercial, or both) include service panel capacity or, at times, charging stations themselves, this initiative takes advantage of the cost savings from planning for EV charging at the point of construction, rather than through retrofits at a later date. As noted by the *Programs & Partnerships* working group, at least one jurisdiction in Arizona, the City of Flagstaff, already requires this (see brief description in section 3.4).

5.3.7.5 State and Local Guidance and Mandates

There are a variety of initiatives that the state of Arizona and/or local governments can undertake to support further deployment of charging infrastructure. The *EV Infrastructure* working group documented state (or local) TE plans, state guidance for local permitting authorities (e.g., through a permitting handbook), EV ready building codes (discussed above in section 5.3.7.2), regulatory and policy workshops, and setting TE goals.[225] At a regional level, the group recommends that Arizona join other states in creating an EV charging corridor by expanding the REV West MOU[226] and, importantly, ensuring that the state's Native American communities are included in this process.

The *Programs & Partnerships* working group recommends the state enact open access and interoperability legislation to support both uniformity in charging types and straightforward payment processes that together ensure a seamless charging experience. The group also recommends that Arizona enact right-to-charge legislation to ensure that homeowners and businesses cannot be prohibited from installing additional charging infrastructure at their properties.

5.3.8 Grid Planning & Capacity Needs

Addressable Gap: Insufficient planning for EV load growth and impacts this will have on the electric grid.

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[224] https://afdc.energy.gov/fuels/electricity_charging_workplace.html

[225] A statewide TE goal for Arizona is discussed in the following chapter, beginning on page 79.

[226] See section 3.2 for discussion of the Regional Electric Vehicle (REV) memorandum of understanding (MOU).

Potential Actors: Utilities; third-party EVSPs; transit agencies and fleet operators.

Without advance planning the growth of TE in Arizona will drive up electric grid costs by requiring significant grid upgrades. This barrier is also an opportunity, however, as both managed charging and proactive siting of EV charging infrastructure can mitigate these costs while also enabling further integration of renewable energy.

5.3.8.1 Utility Pilot Programs to Understand Grid Impacts

Pilot programs are critical to gaining a better understanding of the impacts that growing EV load will have on utility systems. APS and TEP are already engaging in such programs, which will provide valuable data on customer charging patterns, utilization rates and distribution system impacts. EV charging will be provided across a variety of different locations (e.g., workplaces, multifamily dwellings, etc.) at both Level 2 and DCFC sites. Future programs will be informed by the learnings from these pilots. Additionally, pilot programs could be expanded to include partnership with third-party EVSPs, transit agencies, and fleet operators, allowing for shared learnings between the participants.

5.3.8.2 Vehicle to Grid Pilot Programs

The *Vehicle Grid Integration* working group identified vehicle to grid technology as a "nascent area that could evolve into a key part of a clean energy future for Arizona," without clearly viable program-scale opportunities today. Accordingly, the group recommends that pilot programs be explored in the next several years to develop a better understanding of the opportunities, barriers, and mechanics of such programs. Specifically, the group recommends consideration of EV applications with long dwell times (i.e., long stints parked in one location) and relatively short commute distances. Examples include school buses – which could offer grid management opportunities based on set operating hours, given the predictable schedule of these buses – and residential customers with on-site solar generation – who can take advantage of the combination of EV batteries and on-site solar to optimize use of locally-generated carbon-free electricity.

5.3.9 Electricity Rate Design

Addressable Gap: Some electricity rate designs discourage further adoption of EVs or represent a missed opportunity to direct EV charging to low-cost and no- or low-carbon times.

Potential Actors: Utilities; third-party EVSPs.

5.3.9.1 Design Electricity Tariffs for EV Charging

Many of the working groups identified electricity rate design as an opportunity area for promoting TE. This is applicable both for LDVs – largely through EV-specific TOU rates that incent off-peak charging – as well as for MDVs, HDVs, and third-party EV service providers. For the non-LDV segments, managing demand charges is a critical component of enabling affordable EV charging given the high charging capacity required for larger EVs such as trucks and buses. EVSPs experience a similar concern with demand charges, especially those providing DC fast charging services. At low utilization rates (i.e., low capacity factors), public charging stations which are assessed demand charges present a challenging business model.

The *Vehicle Grid Integration* working group recommends that Arizona strive for the majority of EV loads to be managed in some form (TOU rates, demand response) by 2030 to limit the impacts on grid capacity needs and to maximize the benefits of charging during low-cost, low- or no-carbon hours. The group

specifically recommends a flexible approach to TOU rates be taken by the utilities, which can evolve over time. Peak periods and times of low-cost renewable generation will evolve with the changing electricity resource mix the utilities have committed to over the coming decade and beyond, and TOU rates (as well as DR programs) will need to accommodate this shift in order to maximize the benefits of low-cost and increasingly carbon-free electricity.

6. Establishing a Statewide Transportation Electrification Goal and Planned Utility Support Initiatives

Setting TE goals helps to align the many involved parties around a desired outcome to strive for. In this Phase II TE Plan process there has been discussion around what an appropriate goal should be, with a focus on establishing a 2030 target for the number of EVs on the road statewide.

6.1 Arizona 2030 Statewide EV Goal

APS and TEP support establishing a statewide goal aligned with the Medium adoption scenario modeled in the CBA. Most of the working groups have recommended an ambitious goal as a key outcome of this process[227] and the utilities believe that the following statewide targets for 2030 constitute such a goal:

- 1,076,000 electric LDVs
- 3,831 electric MD parcel delivery trucks
- 785 electric transit buses
- 1,422 electric school buses

Achieving these goals will require meaningful action and engagement from different TE stakeholders, including APS, TEP, and other electric utilities as well as state government agencies, municipalities, transit agencies, fleet operators, third-party EV charging providers, and others. As documented in Chapter 5, the working groups have provided a number of insightful and actionable recommendations for these different groups. This chapter focuses primarily on the initiatives that APS and TEP plan to undertake to support the statewide goal, but it is critical to understand the role that other groups must also play to achieve these targets.

Importantly, Salt River Project (SRP) has also committed to an ambitious EV target within its own service territory. In 2019, SRP's Board of Directors approved a goal to support the enablement of 500,000 EVs in its service territory and manage 90 percent of EV charging by 2035. This commitment from one of the other large electric utilities in the state – and the initiatives SRP is undertaking to support its 2035 target – is a great example of the engagement required from other entities in order to achieve the statewide goal proposed in the Phase II TE Plan.

6.2 APS and TEP Initiatives

In order to support the statewide goal APS and TEP plan to engage in a number of activities, many of which align directly with the recommendations from the working groups summarized in Chapter 5.

[227] The *EV Infrastructure* group recommends a 2030 goal of 1.5 million electric LDVs, or 22 percent of total LDVs, as well as the maximum charging station infrastructure to serve these vehicles. The *Equity* group also supports this LDV goal, as well as recommending that 30-40 percent of investments in charging infrastructure be spent in underserved communities. The *Goods Movement & Transit* group recommends a 2030 goal of electrifying at least 16 percent of MD and HD vehicles, and 35 percent of buses (including both school and transit buses). The *Programs & Partnerships* group recommends a goal be established but does not specify a particular target.

Table 17. Summary of Ongoing or Planned APS and TEP TE Initiatives

Barrier	APS Initiatives	TEP Initiatives
Lack of Collaboration	+ Continued engagement in industry events and collaborative working groups + Planned hosting of regular TE Collaborative meetings with stakeholders	+ Continued engagement in industry events and collaborative working groups + Planned hosting regular TE Collaborative meetings with stakeholders
Inequity in TE Planning	+ Planned hosting of regular TE Collaborative meetings with stakeholders	+ Planned hosting of regular TE Collaborative meetings with stakeholders
Education & Outreach	+ Participation in events throughout Arizona + Planning additional events for post-COVID timeframe + APS Marketplace; Improving APS EV website + Take Charge AZ (L2 & DCFC installation & ownership)	+ EV marketing plan + Customer Toolbox + Residential EV Calculator + Fleet Conversion Planning Tool + EV Infrastructure Cost Estimation Tool + Employee EV program and fleet electrification
Access for Underserved Communities	+ Take Charge AZ (L2 & DCFC installation & ownership)	+ TEP Owned Public DCFC + Smart EV Charging pilot
Insufficient Charging Infrastructure	+ Take Charge AZ (L2 & DCFC installation & ownership) + Proposed EV pre-wire incentive + TRU & electric forklift incentive	+ Smart Home EV pilot + Smart School EV & EE pilot + Smart EV Charging pilot + EV-readiness incentive
Grid Planning & Capacity Needs	+ EV adoption forecasting + Charging analysis + DCFC screening + Load forecasting using residential EV charging data	+ 5-yr Strategic EV Roadmap + EV penetration study + Charging siting forecasts + System cost benefit analysis + Load management platform
Electricity Rate Design	+ EV rate evaluation for APS- or EVSP-operated charging sites + Saver Choice Max rate for residential customers	+ TOU rates & EV rate discount + Stand Alone EV & Submeter EV rates

6.2.1 APS Initiatives

6.2.1.1 Take Charge AZ

Take Charge AZ is APS's flagship EV pilot program, through which the utility is installing and owning Level 2 EVSE (charging stations) at a variety of locations including businesses, government agencies, nonprofits, and multifamily residences. APS is also deploying DCFC in strategic locations near highway corridors. APS launched the Take Charge AZ program in May 2019 and anticipates deploying over 200 plugs through 2021.

This estimate is informed by recent research on EV growth and the required charging capacity required to meet this need in a cost-effective manner (described in further detail below).

L2 Program: As of December 31, 2020, APS received 130 valid applications from customers interested in L2 EVSE, of which 42 are energized, 33 are in one of three final stages of completion, and 55 are in preliminary stages. These stations are located across APS territory, including Goodyear, Florence, Sedona, Phoenix, Scottsdale, Chandler, Bisbee, Dewey-Humboldt, Cottonwood, Prescott, Prescott Valley, Peoria, Avondale, Surprise, Yuma, Holbrook, Show Low and Flagstaff. The majority of these applications are for EVSE at sites that will provide workplace charging. APS is currently partnering with three different providers of EVSE – ClipperCreek, ChargePoint, and EV Connect (selected through a competitive bidding process) – which allows customers to choose the equipment option which best suits their needs.

DCFC Program: APS and Electrify Commercial (a division of Electrify America) have partnered together on the DCFC portion of the Take Charge AZ program. Working together, APS and Electrify Commercial will install five new DCFC stations around APS territory. These sites include Globe, Prescott, Payson, Show Low, and Sedona. Ensuring that these installations are future proof is important to APS. Therefore, APS will design charging sites to accommodate the higher capacity batteries anticipated in future EV models and install multiple charging units to accommodate multiple EVs at one time.

In addition to directly supporting EV adoption through these EVSE installations, APS will gain valuable insights and expertise in the EV charging space by collecting data from the pilot installations. APS plans to collect data from the pilot charging locations for five years. The program is already providing valuable insights, for example:

- Some prospective workplace charging site hosts would like their charging units to be available to the public rather than only to employees.
- Some prospective site hosts have emphasized a desire for networked chargers that will allow them to accept payment from end-users (rather than providing charging as an amenity).
- Upgrade and construction costs vary widely across sites based on existing infrastructure.
- Site hosts appreciate the simplification of the turn-key charging installation process.

6.2.1.2 EV Rates

APS is currently evaluating rate tariff designs to support the unique electricity usage of DCFC stations. These rates would be intended for potentially APS-operated as well as third-party-operated charging sites. At the residential level, the existing Saver Choice Max rate is the ideal rate for EV drivers, with the lowest off-peak rate to encourage overnight charging.

6.2.1.3 Education and Outreach

APS participates in EV events throughout the state, providing customers with information on the Take Charge AZ Program as well as general information on EVs. Planning for additional events are being considered for the time when COVID-19 allows for in person gatherings. APS is also improving the EV website with the ability to understand if customers are on the best rate for EV ownership, guides to EV charging and new EV models that are available through the APS Marketplace.

6.2.1.4 Industry Collaboration Initiatives

APS is a member of the Electric Drive Transportation Association, Smart Electric Power Alliance's EV Working Group and is on the board of the Valley of the Sun Clean Cities Coalition. APS is also a member of the Electric School Bus Coalition, The American Council for an energy efficient economy (ACEEE) EV's in LMI Communities working group as well as the Alliance for Transportation Electrification (ATE). APS also participates in the Electric Power Research Institute (EPRI) electric transportation program and the National Electric Transportation Infrastructure Working council, which brings together experts from the utility and automotive industries to share knowledge, develop standards, and learn about the latest in EV technology.

6.2.1.5 Research Initiatives

In addition to the pilot program and planned EV rates detailed above, APS has been conducting several in-depth research initiatives to develop a comprehensive understanding of both the opportunities and the impacts to be expected from TE in its territory. This research has been undertaken in collaboration with Guidehouse Consulting, and has focused on three key questions:

- What level of EV adoption should APS anticipate in its service territory?
- What charging network will be needed to support this adoption?
- Where in this network should DCFC installations be located to address gaps and create a robust EV charging system?

EV Adoption Forecast: APS and Guidehouse conducted forecasting of EV adoption in APS service territory through 2038. As described in section 4.2.2, this adoption forecasting served as the basis for the Low adoption scenario modeled in the CBA and Air Quality analyses E3 conducted for the Phase II TE Plan. APS and Guidehouse estimate that the number of light-duty EVs in its service territory will increase from around 10,000 vehicles in 2018 to between 200,000 and 650,000 by 2038. This upper bound estimate equates to approximately 1.5 million EVs statewide in 2038 and assumes consumer awareness and preferences for EVs will increase significantly in the near-term. The base case scenario of approximately 250,000 LD EVs in APS's service territory by 2038 represents a 25-fold increase in EVs relative to 2018, indicating that even in the absence of more aggressive market transformation, significant growth in this market will occur over the next two decades.

Charging Analysis: APS and Guidehouse have also conducted a charging station siting analysis to identify optimal EVSE locations that meet the need forecast through EV adoption modeling. Different EV adoption scenarios and objective functions (e.g., minimizing the number of charging facilities or maximizing the covered range) provide a spectrum of potential charging network outcomes and configurations.

DCFC Screening: As part of the charging analysis, APS and Guidehouse evaluated the existing DCFC charging network and modeled growth in DCFC charging needs over the study period under different scenarios. The analysis showed that there are currently 157 DCFC ports at 29 locations in APS service territory. To serve the 2038 PEV vehicle forecast in the Base Scenario, 650 public DCFC ports would be needed. To support the 2038 PEV vehicle forecasts in the Market Transformation Scenario (which estimates 650,000 PEVs in APS territory by 2038), 1,700 total public DCFC ports would be needed. In addition to providing a perspective on anticipated charging needs, this evaluation identified the highest-priority DCFC sites required to address gaps in coverage to provide a complete DCFC corridor charging network within APS territory. APS will incorporate the identified high-priority sites into the DCFC portion of the Take Charge AZ program.

Residential Load Shape Data: APS is working with EnelX to evaluate residential load shape data from EnelX home charging stations. This information is being used to develop load forecasts, localized distribution area forecasts and potential benefits from load management efforts.

6.2.1.6 Demand Side Management Plans

In addition to the EV initiatives described above, APS included an EV charging demand response program in its 2020 Demand Side Management (DSM) Plan filed with the ACC. This plan has been approved and APS is moving forward to selecting a vendor and completing program design. The plan will work with individual EV owners to gather EV charging behavior data and to encourage off-peak charging to manage peak load. APS is also working with EnelX to gather data on how EV owners charge their vehicle. This data will help APS understand EV charging behavior and opportunities for different load management strategies.

EV Pre-Wire Program: In its 2020 plan, APS proposed a homebuilder incentive for residential new construction. The program offers $100 per home constructed with pre-wiring to enable L2 EV charging.

Standby Truck Refrigeration and Electric Forklifts: In the 2020 approved DSM plan, APS will be adding standby truck refrigeration and electric forklifts as new electrification measures to be included as part of the Non-residential Large Existing Facilities and New Construction program offerings. Refrigerating trucks using electric power rather than idling diesel engines when at truck stops or distribution facilities improves local air quality while also reducing fuel costs. APS proposes offering incentives of up to $750 per docking bay for eligible, newly installed electric conversion units. Replacing diesel- or propane-powered forklifts with electric units similarly improves local air quality and reduces operating costs, including an additional benefit of decreasing the need for ventilation by removing internal combustion (and the related emissions) from indoor spaces. APS proposes an incentive of up to $1,250 per new electric forklift or per conversion of existing internal combustion forklift to an electric version.

6.2.1.7 APS Marketplace

The APS Marketplace allows customers to view a variety of EVs and make comparisons with other types of vehicles. This marketplace also helps customers identify optimal charging stations and even purchase them from the website. Future capabilities will include test drives and advisory services for installing home charging stations in the interest of further promoting education and awareness of EVs.

6.2.2 TEP Initiatives

TEP estimates the number of EVs in its service territory will increase from under 4,000 in 2020 to between 27,000 and 52,000 by 2030.[228] In anticipation of this increase, TEP is significantly ramping up its TE initiatives in recognition of the value that EVs can bring to its customers and to Arizona as a whole. The company is working to implement a number of TE programs that were approved by the ACC in February 2019.[229] These initiatives include residential and non-residential EV programs, education and outreach activities, employee incentives, and investments in EV infrastructure. Most significantly, at the beginning of 2020, TEP developed a *5-Year Strategic EV Roadmap* which outlines the strategy for TEP to be a leader in Southern Arizona's

[228] Navigant Consulting, TEP Electric Vehicle 5-Year Strategic Roadmap, Feb. 21, 2020.

[229] Arizona Corporation Commission, "Decision No. 77085," February 20, 2019.

effort to electrify transportation by leading by example, empowering customers, balancing economic impacts and supporting the environmental and health benefits of TE.

The 45+ actions and initiatives outlined in the roadmap are driven by four opportunity areas:

- **Partnerships and collaboration**: Initiatives that foster collaboration across utilities, third parties, and partner organizations to align electrification efforts.
- **Supportive policies and incentives**: Initiatives that promote policies supporting EV adoption, e.g., high-occupancy vehicle lane access, building codes, rate design, incentives.
- **Consumer awareness and education**: Initiatives that empower customers in their EV purchasing decisions through targeted education, actionable tools, and increased awareness.
- **Charging infrastructure deployment**: Initiatives that encourage coordinated EV infrastructure planning and accelerate deployment.

6.2.2.1 Commercial EV Programs

Smart EV Charging Pilot Program: TEP's Smart EV Charging program aims to engage early adopters, provide customers with trusted information, and reduce barrier to adoption through technical and financial assistance. The program is available to commercial businesses, multi-family complexes and nonprofit customers that purchase and install EV charging ports at their location. The program, which officially launched in May of 2020, has a goal of activating 360 ports within TEP's service territory. The program provides a business or workplace with a rebate of $4,500/Level 2 port and $24,000/Level 3 (DCFC) port. Multi-family dwellings and non-profits have a slightly higher rebate at $6,000/L2 port. Additional financial support is provided for projects located in disadvantaged communities. As of Jan 30, 2021, nineteen projects have been approved, representing 114 ports, of which 104 are L2 and 10 are DCFC.

Smart School EV & EE Pilot Program: This program aims to provide electric vehicle chargers and energy efficiency measures and grants for schools within TEP service territory. Through solicitation letters, TEP qualified and ranked schools based their current EV plans and future infrastructure. There is currently one school with a project under construction.

6.2.2.2 Residential EV Programs

Smart Home EV Pilot Program[230]: TEP offers owners of existing homes rebates covering up to 75 percent of the cost of installing EVSE. Customers installing a qualified two-way, communicating Level 2 EVSE unit can receive up to $500, while installations of one-way, non-communicating Level 2 EVSE units are eligible for up to $250. Rebate recipients are required to enroll in and remain on a TEP TOU rate for at least two years. Over 40 homes took advantage of this program in 2020.

EV Readiness: TEP is also promoting EV adoption among new home buyers by working with builders to make new construction "EV Ready" through pre-wiring for EVSE. Currently incentives of $100 per home are offered to builders. Three homebuilders have signed contracts representing over 50 new homes that will be built to the program specifications.

[230] https://www.tep.com/ev-rebates/.

6.2.2.3 Rates

Residential: TEP offers several pricing plans for owners of battery and plug-in hybrid electric vehicles. Under these plans, customers can reduce their energy bills by charging their EV during super off-peak hours and shifting the majority of their energy usage to off-peak hours.

- **Residential TOU rates for EV customers**: These plans, Time-of-Use and Demand Time-of-Use, provide EV customers a 5% discount on a portion of their bills during off-peak periods[231], aiming to incentivize charging during times of lower system demand.
- **Residential Super Off-Peak Time-of-Use Electric Vehicle and Residential Demand Super Off-Peak Time-of-Use Electric Vehicle**: These rates, approved by the ACC in July of 2019, are structured to incentivize EV charging during off-peak hours. They incorporate a Super Off-Peak period (10 p.m. to 5 a.m. in both Summer and Winter) priced one cent lower than the non-EV Off-Peak period, and also include an Off-Peak "buffer" period between the On-Peak and Super Off-Peak periods; that buffer is intended to protect EV customers from inadvertently paying On-Peak prices when beginning to charge their EVs prior to the start of the Super Off-Peak period.

Commercial: TEP has also developed two commercial EV rates currently under consideration by the ACC.

- **Stand Alone Electric Vehicle Charging**: This rate, once approved, will be available to customers installing separately metered DCFC chargers and is designed to encourage charging at off-peak and super off-peak times. This rate limits demand charges by creating a tiered pricing structure.
- **Submeter Electric Vehicle Charging**: This rider, once approved, will be available to general service customers on a TOU rate who submeter their EV charging stations. Discounts are provided to customers that charge during super off-peak periods.

6.2.2.4 Education and Outreach

Marketing: TEP has developed a marketing plan around its EV initiatives ranging from quarterly residential and commercial newsletters, social media campaigns, strategic ad placement and community speaking engagements. While many in-person events have been delayed due to COVID, TEP has plans to work with dealerships, community and business organizations, schools and local jurisdictions to cross-market our EV initiatives.

Customer Toolbox: To assist both residential and commercial customers in the TE decision making process TEP developed a residential EV calculator and a fleet conversion total cost of ownership tool.

- **Residential EV Calculator[232]**: This online tool allows residential customers to consider costs and potential savings of switching from an internal combustion vehicle to an electric vehicle. It provides customers the ability to compare EV options and make informed decisions based on driving habits, home electricity use and available tax credits and incentives. Since March of 2020, the calculator has been used by over 640 unique customers.
- **Fleet Conversion Planning Tool**: This tool, developed in collaboration with West Monroe Partners, provides account managers with a total cost of ownership calculator to assist fleet customers with

[231] The 5% discount for EV customers during off-peak periods applies to the Base Power and Purchased Power and Fuel Adjustment Clause charges.

[232] https://tep.wattplan.com/ev/.

their electrification plans. The tool provides an easily digestible snapshot of upfront costs, long-term savings, environmental benefits and return on investment. This tool has been used with some of the largest fleets within our service territory as well as TEP's own internal fleet.

- **EV Infrastructure Cost Estimation Tool**: Navigant Consulting (now Guidehouse) and TEP developed this tool to provide customers with a rough order of magnitude estimate of infrastructure costs to execute their EV charging plans. The tool considers site specific conditions and inputs from the customer to estimate both customer and TEP infrastructure costs.

6.2.2.5 Industry Collaboration Initiatives

TEP is heavily involved with a number of organizations that are working on different aspects of TE. These include but are not limited to: Alliance for Transportation Electrification (ATE), Clean Cities Coalition, Smart Electric Power Alliance's EV Working Group, Forth, Peak Load Management Alliance, Open Charge Alliance, Association of Energy Services Professionals, EVCX CS Week, and Edison Energy Institute Fleet Electrification Working Group.

6.2.2.6 Research Initiatives

To have a more robust understanding of EV usage, adoption rate, EV charging grid impacts and opportunities TEP and Guidehouse embarked on two studies.

EV Penetration and Baseline Study: As described in section 4.2.2, this adoption forecasting served as the basis for the Low adoption scenario modeled in the CBA and Air Quality analyses E3 conducted for the Phase II TE Plan. The penetration and baseline study also provided TEP with a more detailed depiction of EV usage in its service territory, helping to inform and better target programmatic offerings. The study provided:

- A 20-year plug-in EV adoption forecast at the census tract level for LD, MD, and HD vehicles within the TEP service area.
- Charging siting forecasts by use case, technology (L1, L2, DC), and ownership at the aggregated census tract level.
- Estimates of annual energy and load impacts associated with LD, MD, and HD EV charging at the census tract level.

System Cost Benefit Analysis: The cost benefit analysis provides a tool in assessing the cost-effectiveness of EV charging infrastructure projects on a case-by-case basis. The insights provide TEP a better understanding of the value different types of EVSEs provide to the system and is helping to inform which TE initiatives present the best opportunities for its customers.

Load Management Platform: TEP will acquire a Load Management Platform, allowing for management of many distributed energy resources (DER), inclusive of EVSE. This will allow TEP to more effectively manage loads and resources to optimize the system, and to gain experience in this area in anticipation of the growing EV adoption in coming years. Additionally, this will help to unlock the benefits of other EV offerings being implemented by providing enhanced monitoring and management capabilities. An RFP for this effort will be released in Q2 of 2021, with ramp up of the platform anticipated in early 2022.

6.2.2.7 EV Project Highlights

Transit Electrification: Sun Tran, the public transit operator for the Tucson metropolitan areas, has made a commitment to add electric buses to its fleet. One leased electric bus has been in operation for one nearly

one year. In collaboration with TEP, Sun Tran was able to secure grant funding for an additional ten buses, five by April of 2021 and five more by April of 2022. TEP will continue to support the expansion of this fleet by assisting with installation of EVSE and related infrastructure. In 2020, TEP's efforts with Sun Tran focused on assisting with RFP development, site planning for future growth, identification of future funding opportunities, total cost of ownership calculations and optimization of infrastructure usage. After 2022, Sun Tran plans to electrify 8-10 buses annually.

Pima County Support: Pima County has made an ambitious commitment to fleet electrification. The County will purchase up to 40 EVs annually to reach its goal of electrifying all 150 sedans by 2023. By the end of fiscal year 2025, the County expects its fleet also will include 154 electric light-duty trucks. TEP will support the County with technical assistance and financial incentives as appropriate under its Smart EV Charging Pilot Program.[233]

TEP Employee EV Program and Fleet Electrification: As part of TEP's efforts to lead by example, TEP has initiated an experience-based employee EV program. The program also has vehicle purchase incentives to help reduce the upfront purchase costs. COVID has paused the roll out of this program but all policies have been developed and the program is scheduled for launch once the workforce returns to the office.

TEP Owned Public DC Chargers: TEP headquarters building is located in downtown Tucson near mixed-income neighborhoods. The downtown area lacks DC chargers and has a limited number of L2 chargers. TEP decided to install two DC chargers along the public right of way outside of its building to create a highly visible, complimentary fast charging station.

6.2.2.8 UNS Electric

In January 2018, TEP sister company UNS Electric filed an amendment to its DSM Implementation Plan proposing several TE initiatives. The plan, which has not yet been approved, is reflective of UNS Electric's proposed work to support EVs. While at the beginning planning phase, UNS is also working on an EV Strategic Plan for its service territory.

6.3 Metrics to Track Progress

In order to assess progress towards the statewide goal proposed in this chapter, APS and TEP plan to track various metrics and share this information with stakeholders through regular TE Collaborative meetings that the utilities plan to host. Example metrics could include:

- Public EV charging stations and plug counts, both statewide and within APS and TEP service territories
- Customers enrolled in EV or TOU rates.
- Customers enrolled in residential and commercial EV programs.
- Ratio of DCFC stations to battery electric vehicle adoption.
- EV models available to Arizona residents compared to total EVs available in the United States.
- Individuals and organizations attending and engaging in ongoing TE Collaborative meetings.
- Number of municipalities that have incorporated TE into their fleet(s).

[233] https://www.tep.com/smart-ev-charging-program/.

Gathering and reporting on these types of metrics will be part of the ongoing collaboration between Arizona's TE stakeholders. The structure for collecting, reporting and distributing updates will need to be developed, and APS and TEP anticipate that this will be one of the topics of discussion at the initial TE Collaborative meetings.

Tracking progress across these or similar key indicators will allow APS and TEP – and by extension, the engaged TE stakeholder community – to ensure that progress towards the 2030 goal is occurring at the required pace. Should this progress not materialize, additional efforts and initiatives can be put in place to ensure that the 2030 goal is not jeopardized. Revisiting progress towards this goal on a regular basis – both through ongoing collaborative meetings and more formally as part of the future iterations of the statewide TE plan – will constitute an important part of enabling robust TE in Arizona.

7. Conclusion

This Phase II TE Plan has demonstrated that transportation electrification is progressing due to market and technology changes, representing a monumental shift for both the transportation and electric power sectors. Momentum for TE will build as EV costs decline and increasing numbers of consumers begin to adopt these vehicles. Encouragingly, EVs can provide significant benefits not only to those purchasing the vehicles themselves, but also to other electric utility customers and, more broadly, to all Arizonans. These societal benefits will increase as the electric grid becomes increasingly powered by renewable sources, making EVs an increasingly cleaner option relative to conventional internal combustion engine alternatives.

To realize these benefits Arizona needs to both address the existing barriers to further EV adoption and to plan for the anticipated increase in TE, including the impacts this will have on the electric grid. The electric utilities have an important role to play in both of these areas, and APS and TEP plan to expand their TE initiatives in the coming years. However, the electric utilities alone cannot enable robust TE in Arizona; this will require action on the part of many different entities, including regulatory agencies, policymakers, advocates for underserved communities, automakers, third-party charging service providers, and others. Most of these entities have actively engaged in the Phase II TE Plan process. These stakeholders have provided insights, knowledge, and perspectives that collectively describe the key considerations in developing a cost-effective TE sector in Arizona that can provide benefits to all Arizonans, including historically underserved communities.

To point the state towards such a robust and expanded TE sector, APS and TEP support establishing a statewide goal for the number of EVs on the road by 2030. Specifically, APS and TEP propose a goal aligned with the Medium scenario modeled in the CBA, composed of the following statewide targets:

- 1,076,000 electric LDVs
- 3,831 electric MD parcel delivery trucks
- 785 electric transit buses
- 1,422 electric school buses

While achieving this goal will require the engagement of a diverse set of stakeholders, APS and TEP believe they have a key role to play in helping to support the development of a robust TE sector in Arizona. The utilities are committed to supporting TE through their ongoing programs as well as planned initiatives informed in part by the recommendations of the TE stakeholder group through the Phase II process.

The utilities are already offering a variety of TE programs, including education and outreach, EV pricing plans, pilot EV charging station deployments, and others. APS and TEP aim to expand upon these programs in the coming years, including through continued collaboration with the many stakeholders who have engaged in the Phase II TE process.

As requested by many of the stakeholder working groups involved in this process, APS and TEP plan to host regular TE Collaborative meetings to continue the sharing of insights, priorities, and perspectives around how TE should develop. Through such collaboration Arizona can effectively plan for the coming growth in EVs, enabling the achievement of the significant benefits offered by TE for all.

Appendix A: Additional Analytical Results and Methodological Detail

Adoption Trajectories by Vehicle Segment and Utility Service Territory vs. Statewide

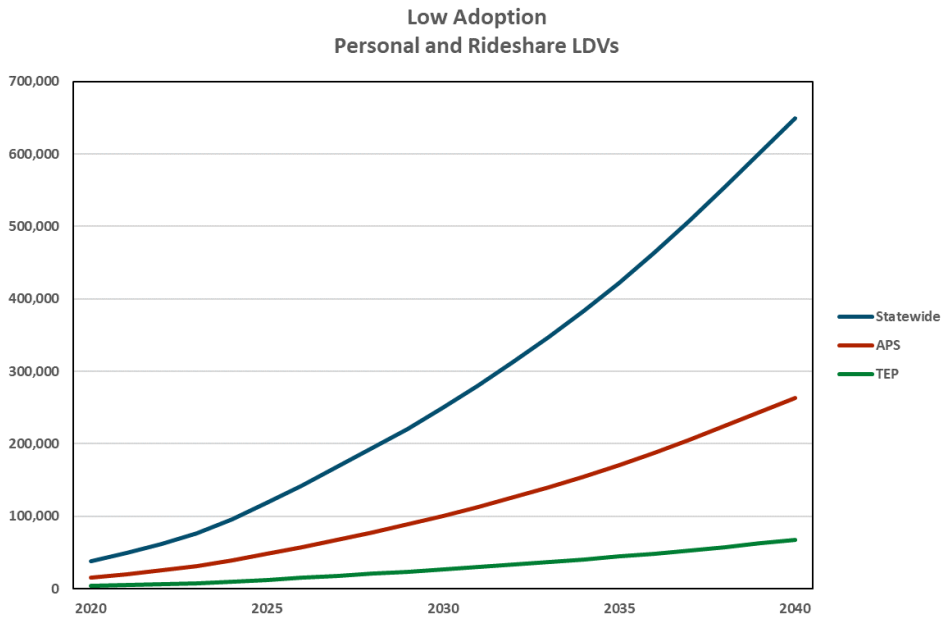

Figure 31. Low Adoption, Personal and Rideshare (TNC) LDVs

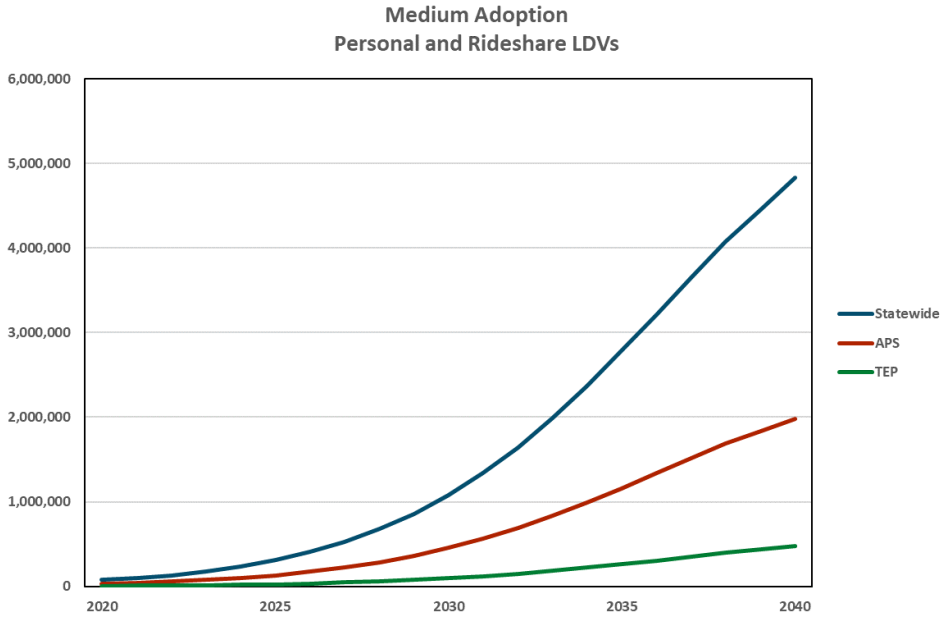

Figure 32. Medium Adoption, Personal and Rideshare (TNC) LDVs

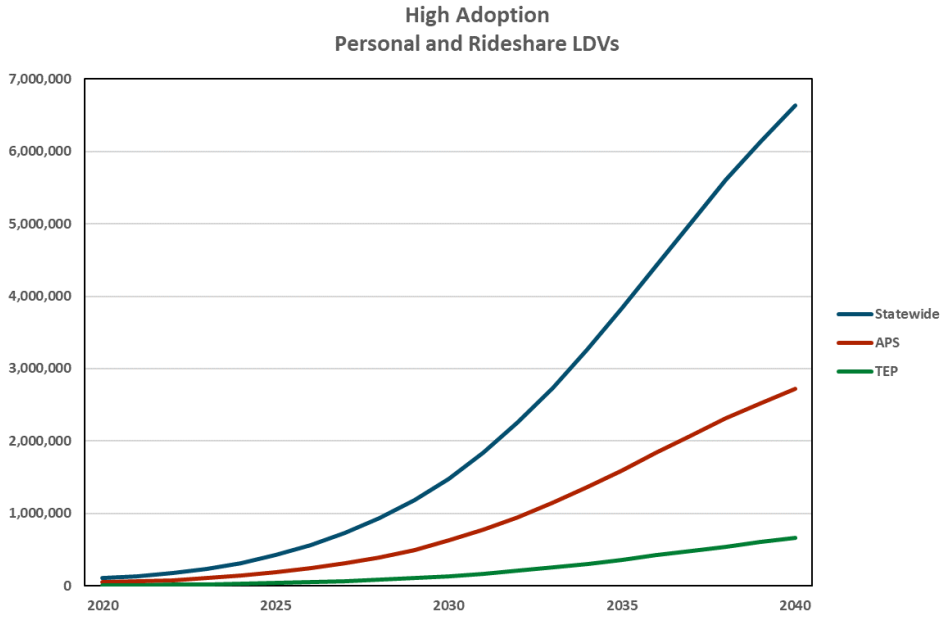

Figure 33. High Adoption, Personal and Rideshare (TNC) LDVs

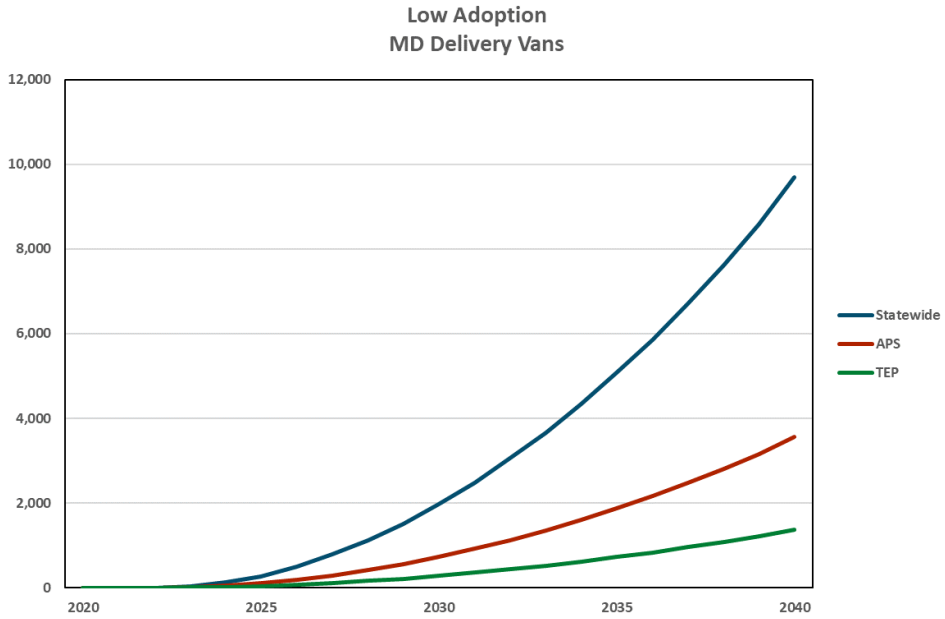

Figure 34. Low Adoption, MD Delivery Vans

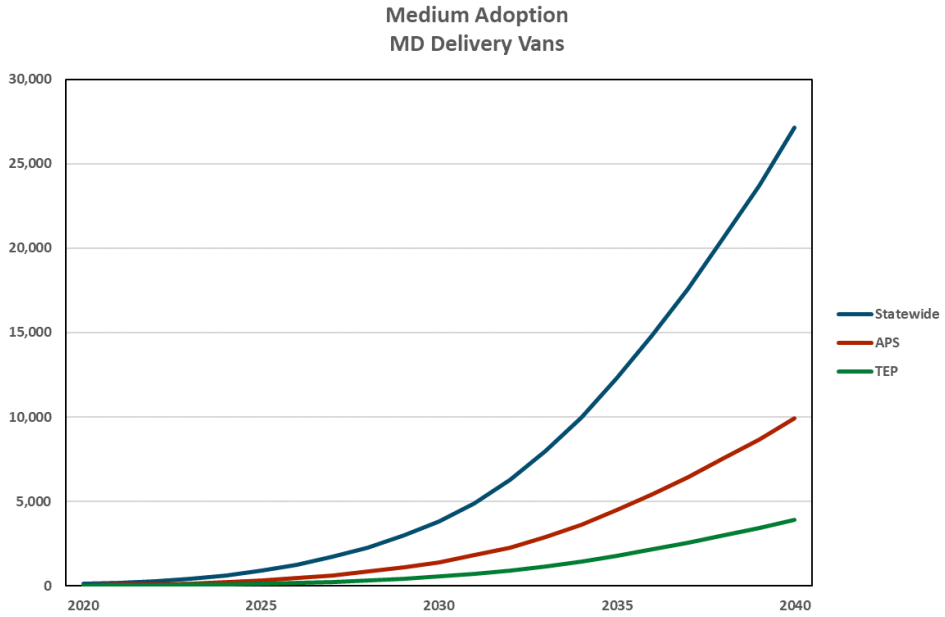

Figure 35. Medium Adoption, MD Delivery Vans

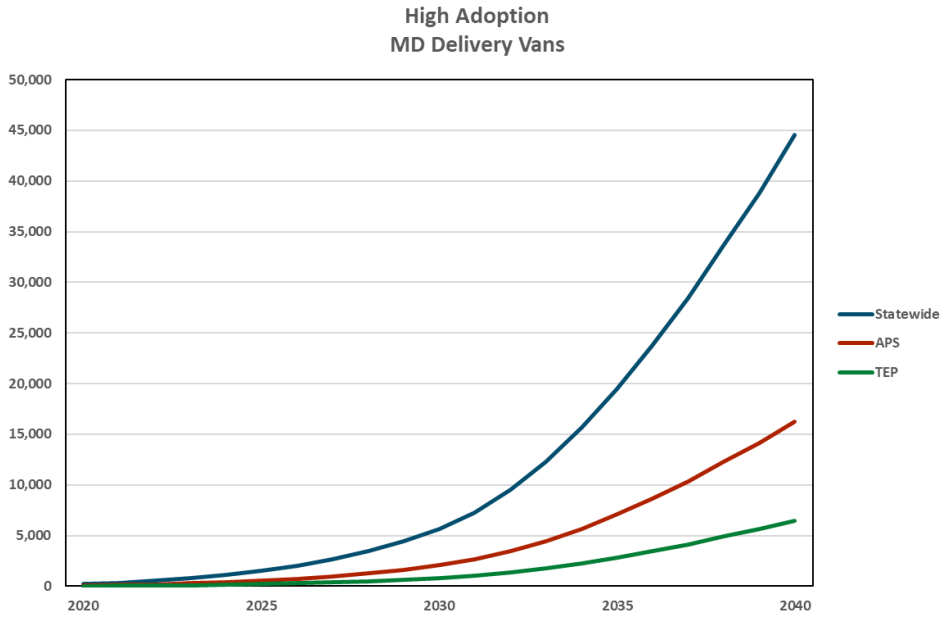

Figure 36. High Adoption, MD Delivery Vans

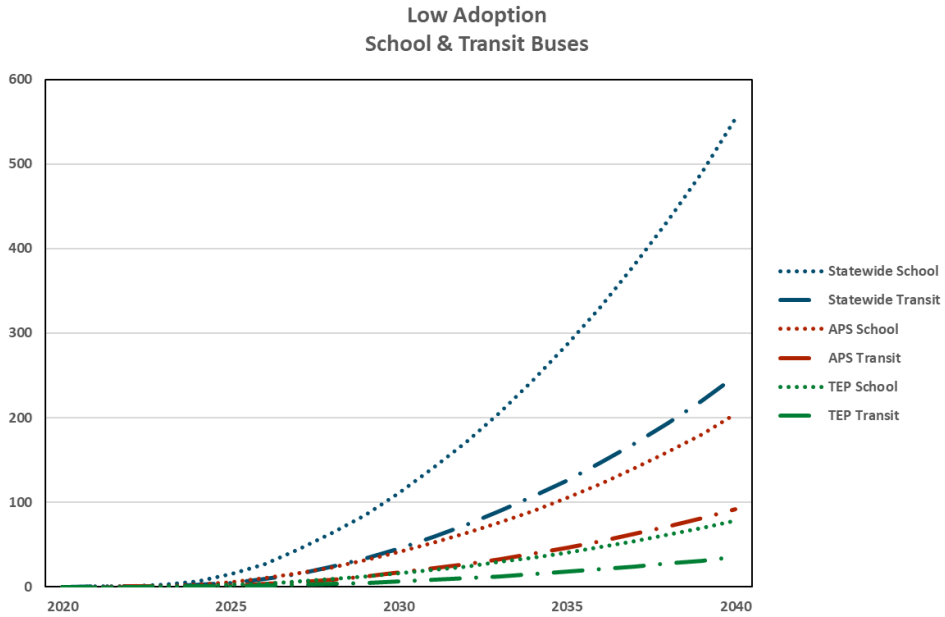

Figure 37. Low Adoption, School & Transit Buses

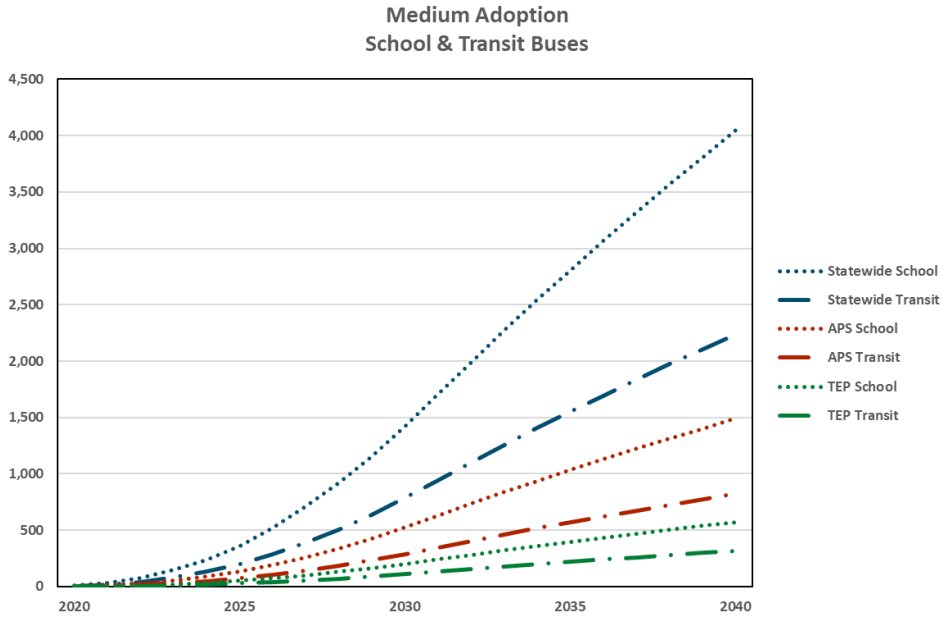

Figure 38. Medium Adoption, School & Transit Buses

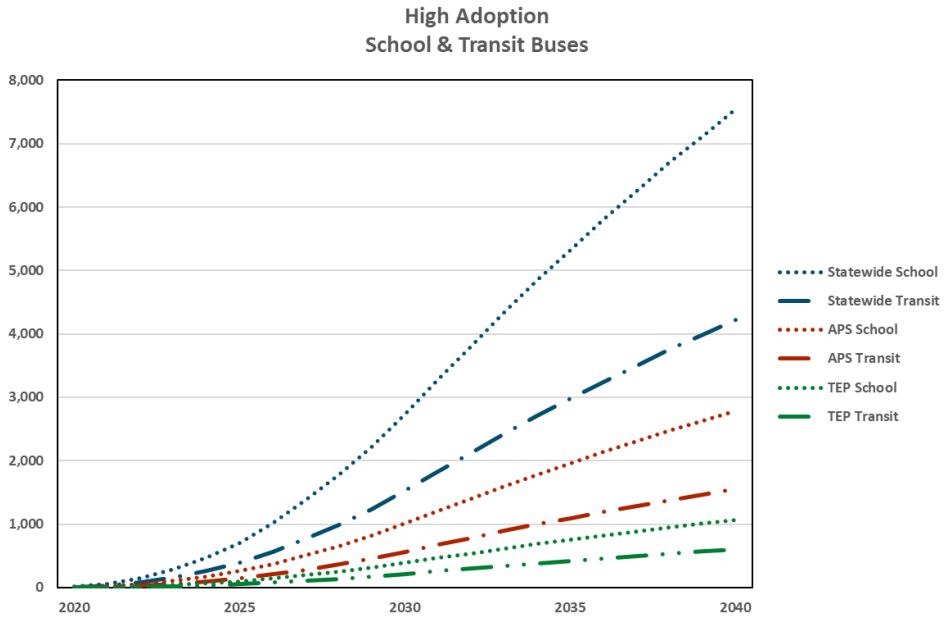

Figure 39. High Adoption, School & Transit Buses

Cost Benefit Analysis Results by Vehicle Segment, Utility, and Charging Assumption

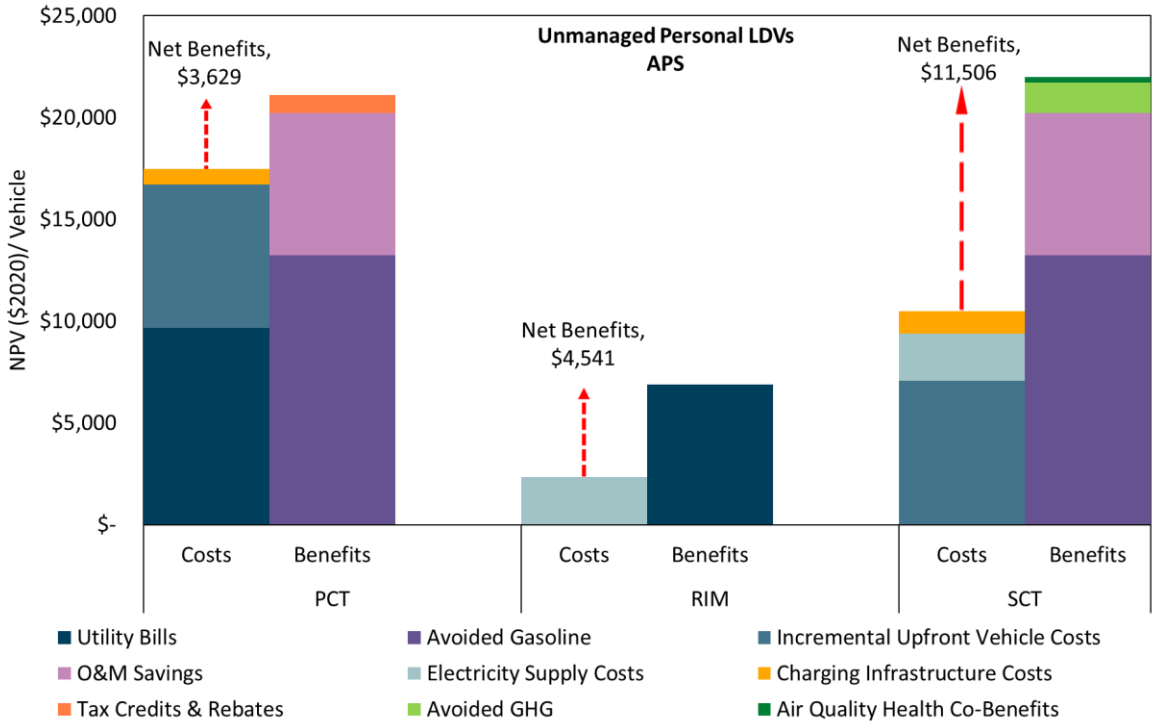

Figure 40. APS Personal LDV Unmanaged

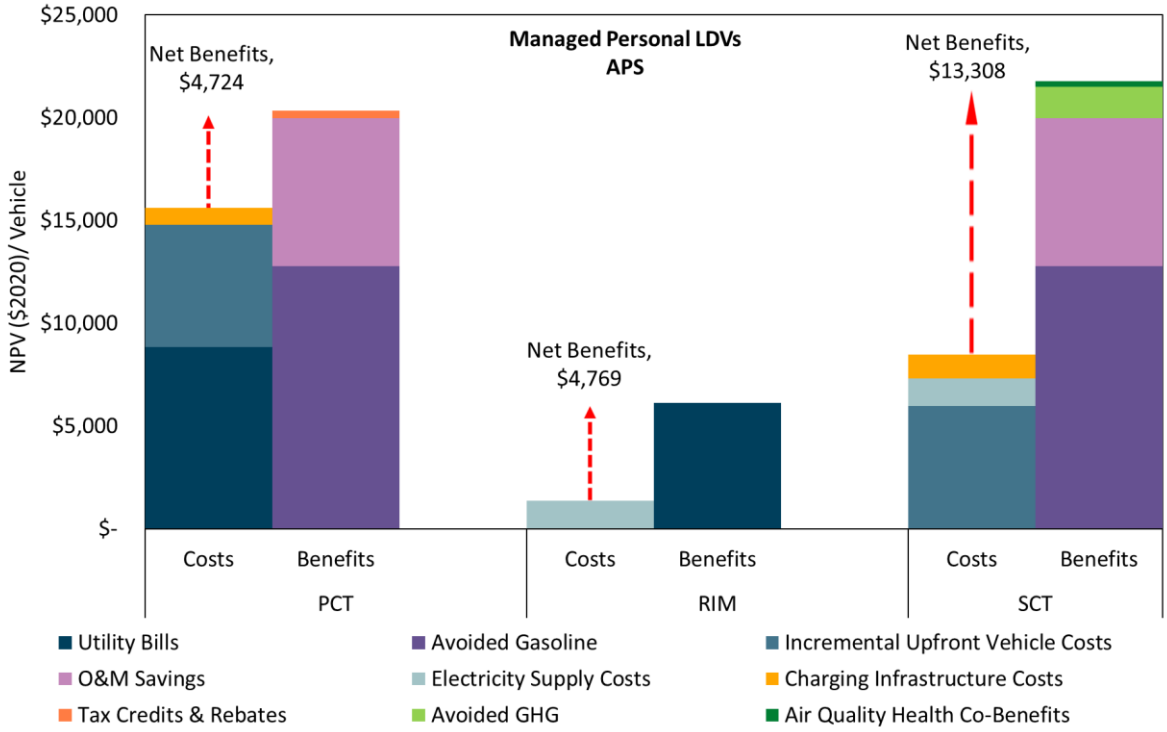

Figure 41. APS Personal LDV Managed

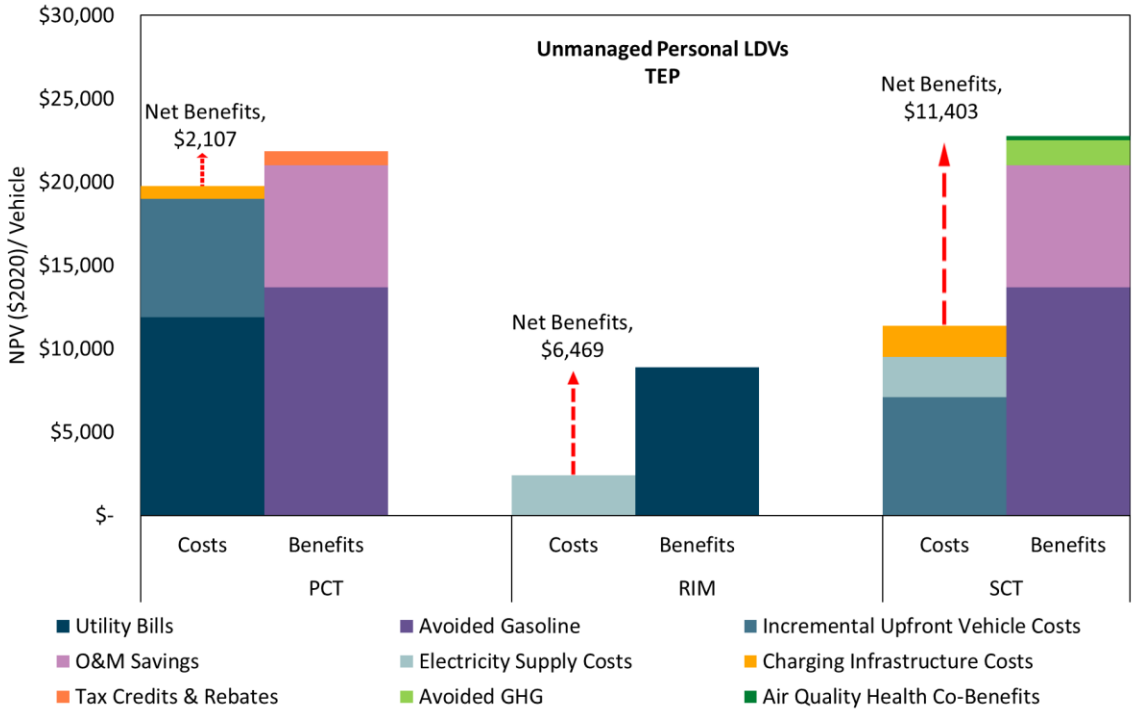

Figure 42. TEP Personal LDV Unmanaged

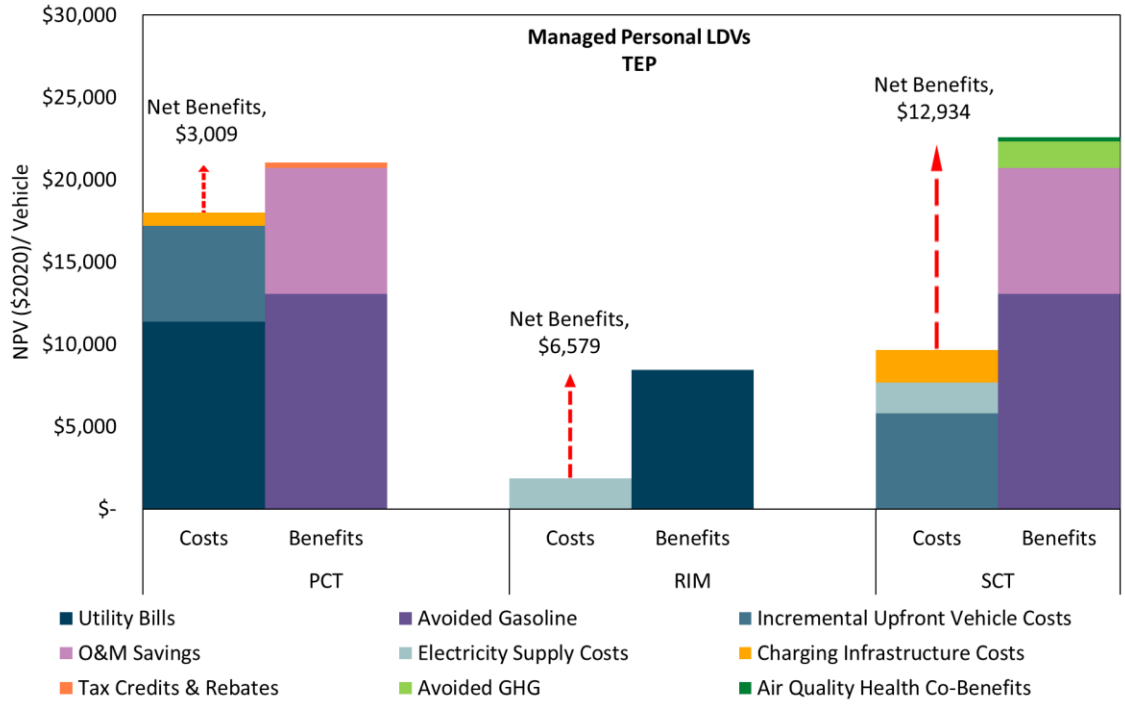

Figure 43. TEP Personal LDVs Managed

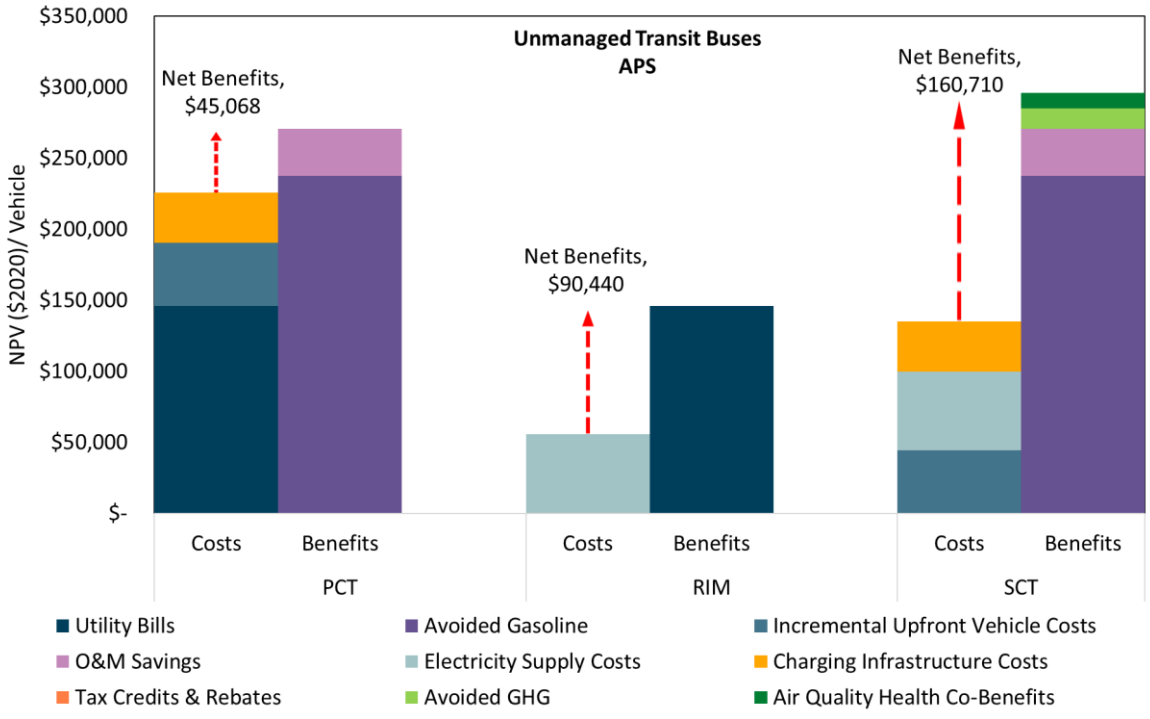

Figure 44. APS Transit Buses Unmanaged

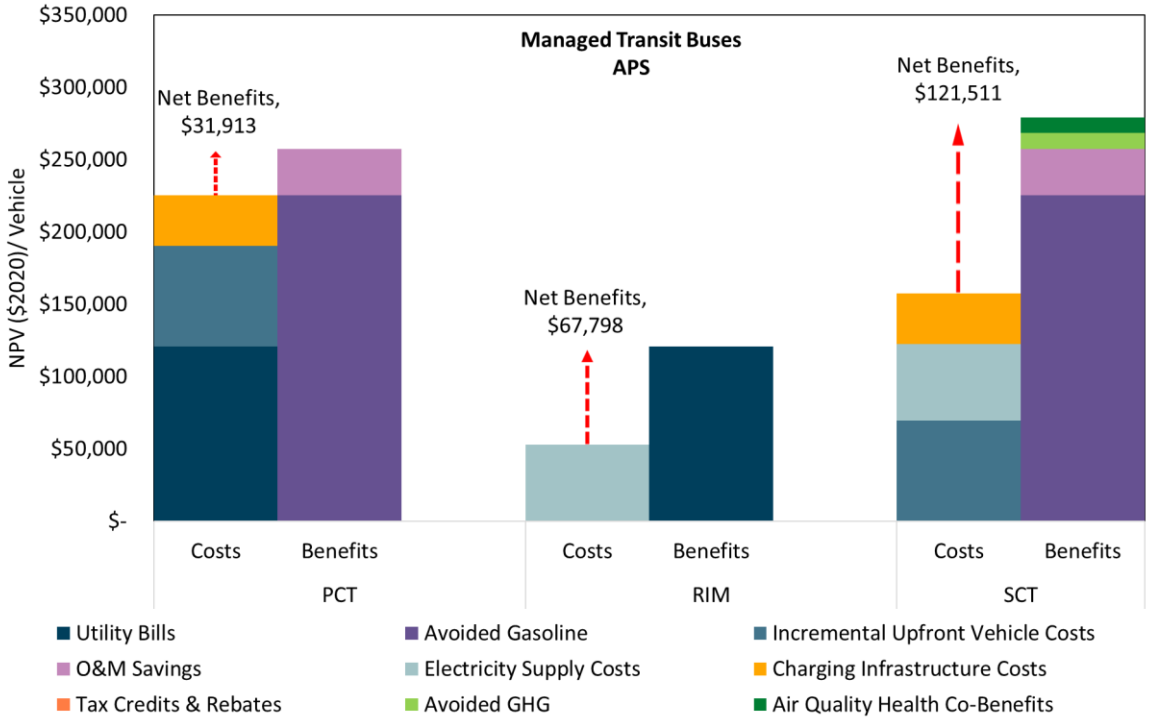

Figure 45. APS Transit Buses Managed

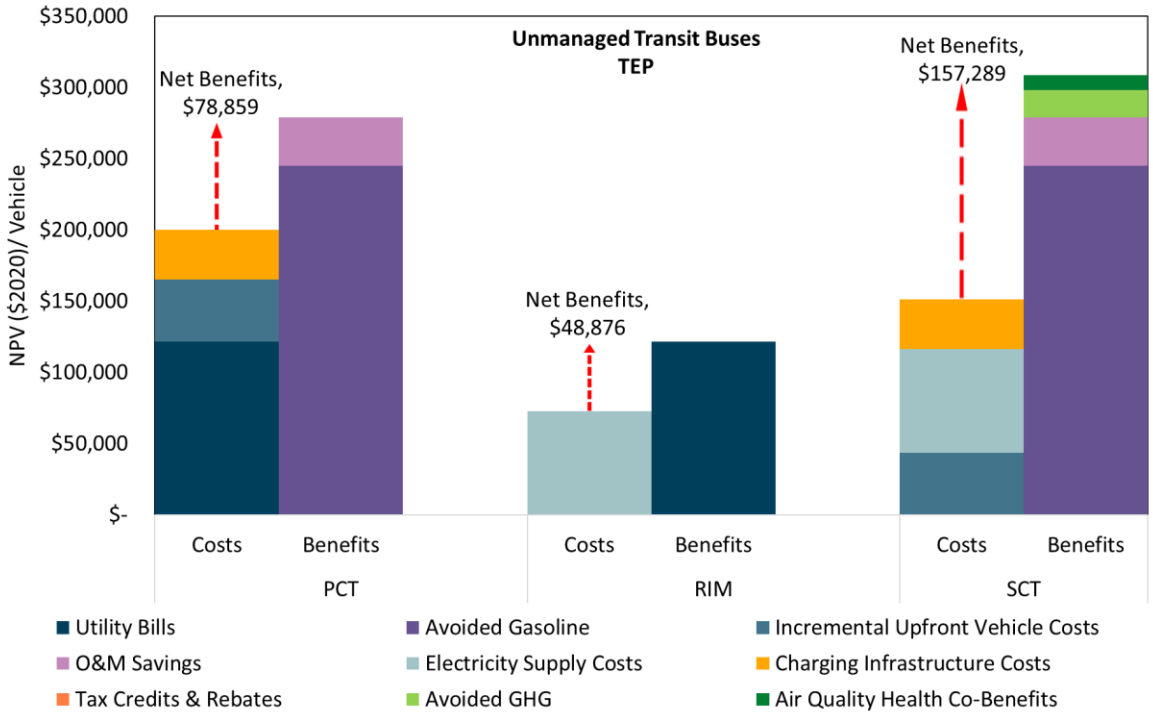

Figure 46. TEP Transit Bus Unmanaged

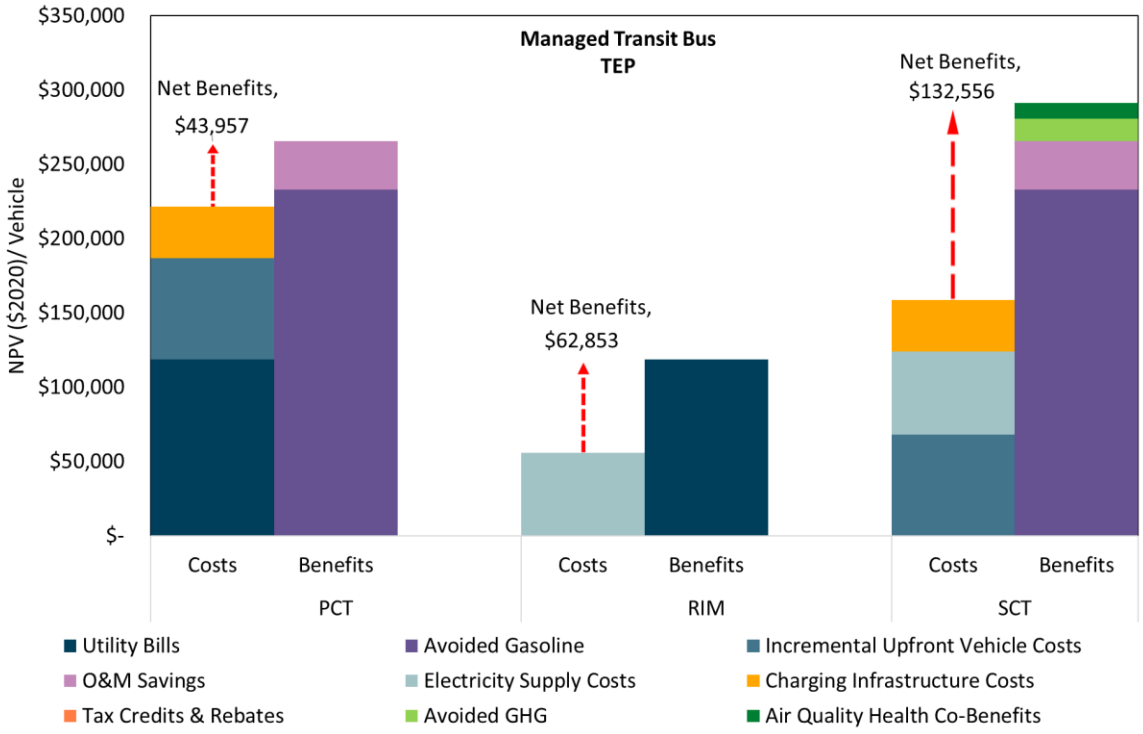

Figure 47. TEP Transit Bus Managed

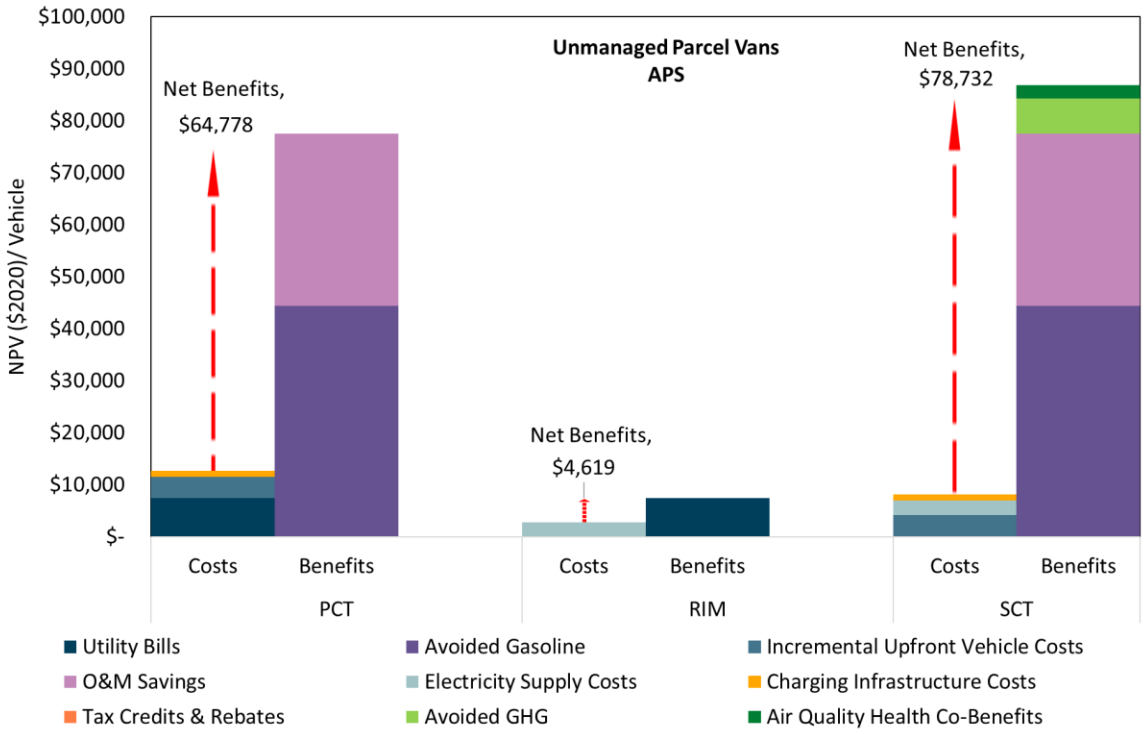

Figure 48. APS Parcel Vans Unmanaged

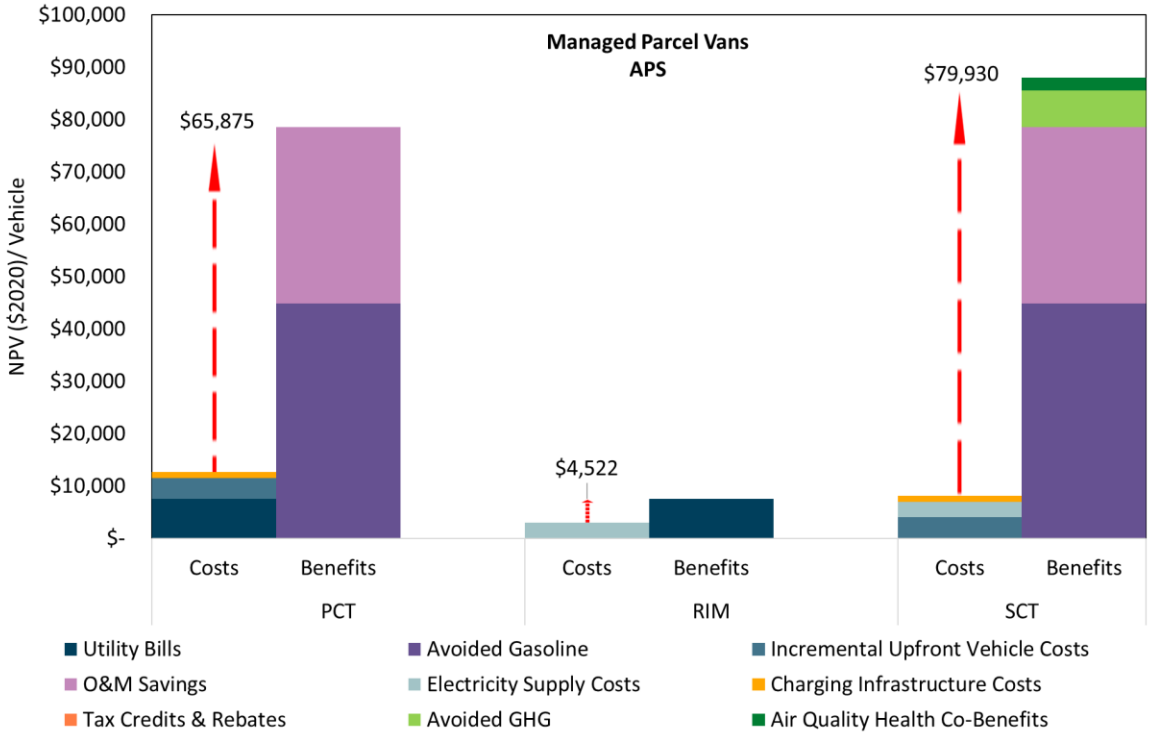

Figure 49. APS Parcel Vans Managed

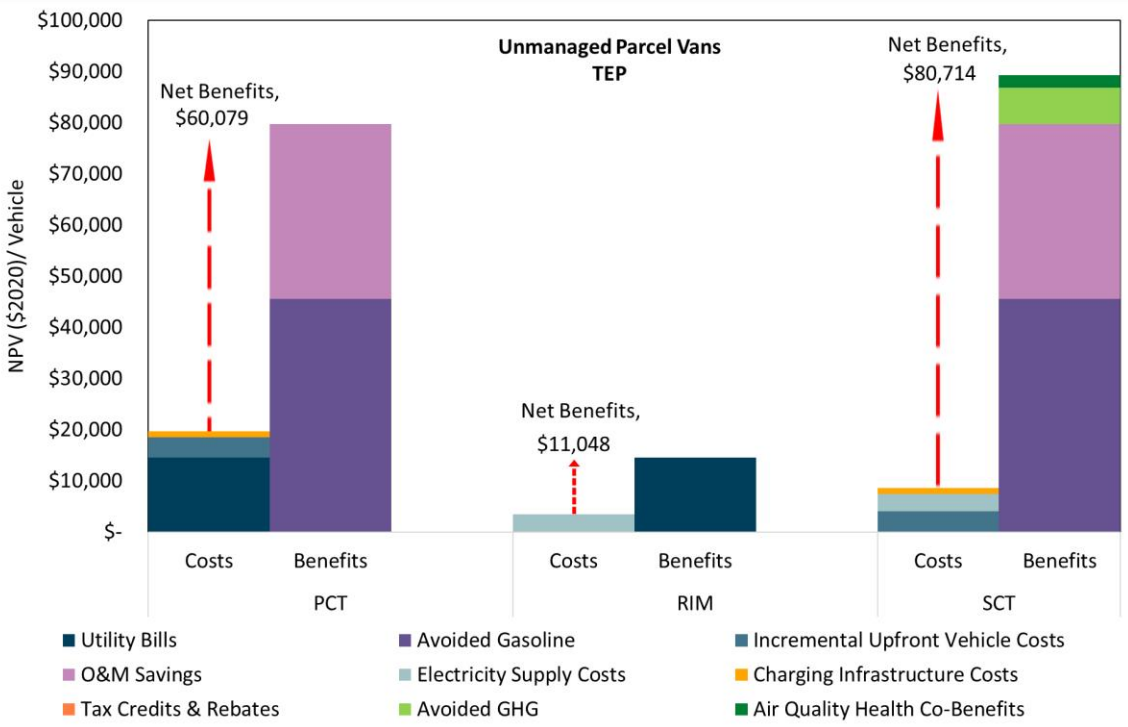

Figure 50. TEP Parcel Vans Unmanaged

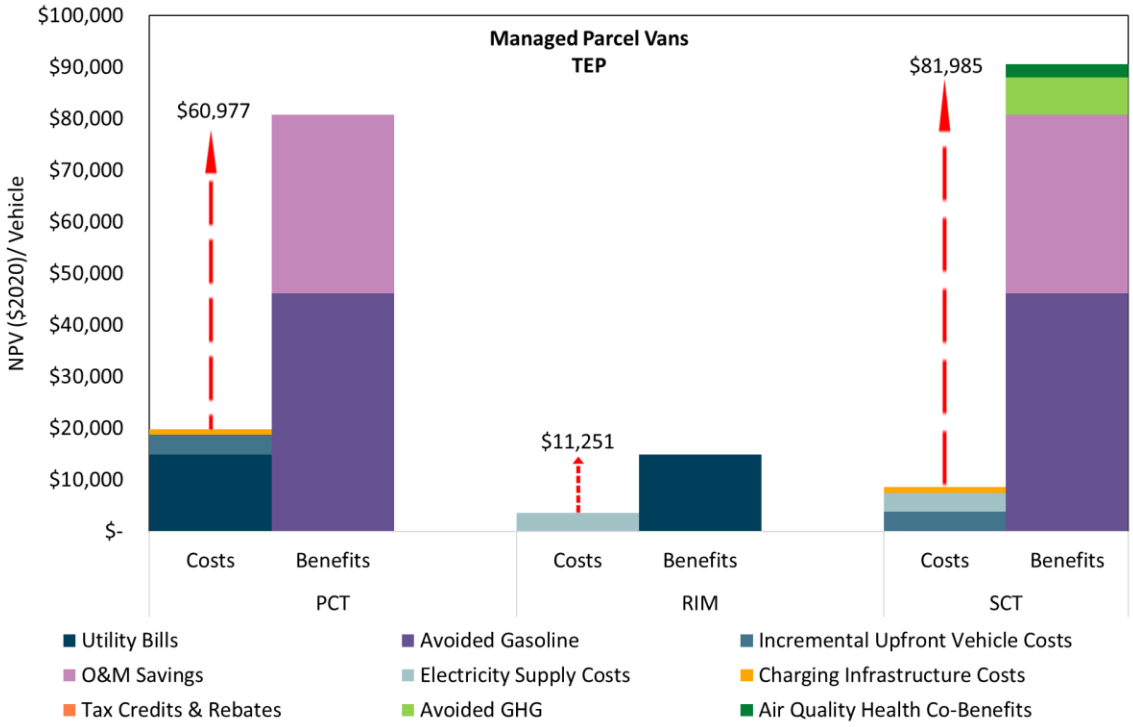

Figure 51. TEP Parcel Vans Managed

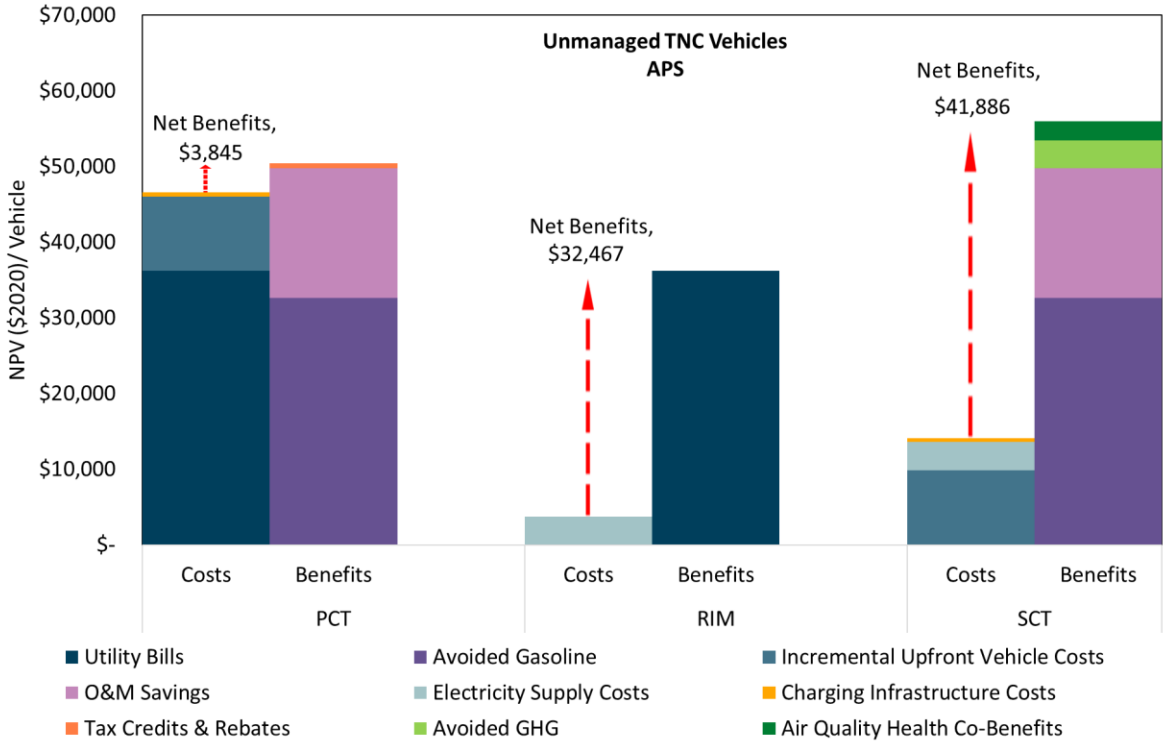

Figure 52. APS TNC Vehicles Unmanaged

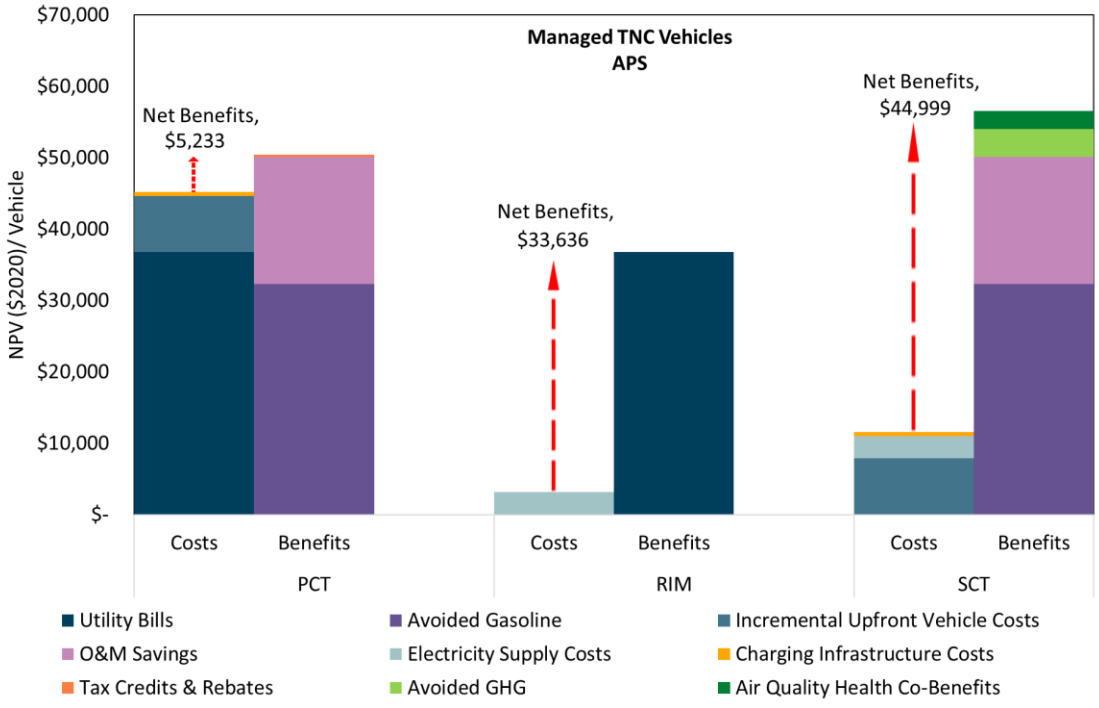

Figure 53. APS TNC Vehicles Managed

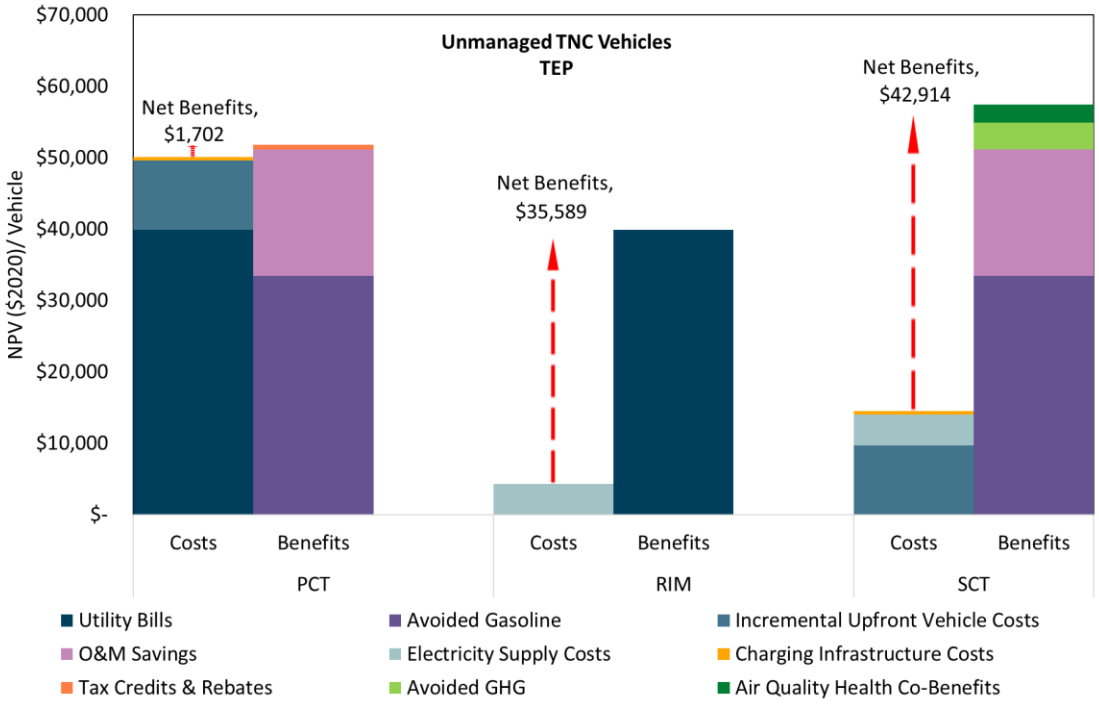

Figure 54. TEP TNC Vehicles Unmanaged

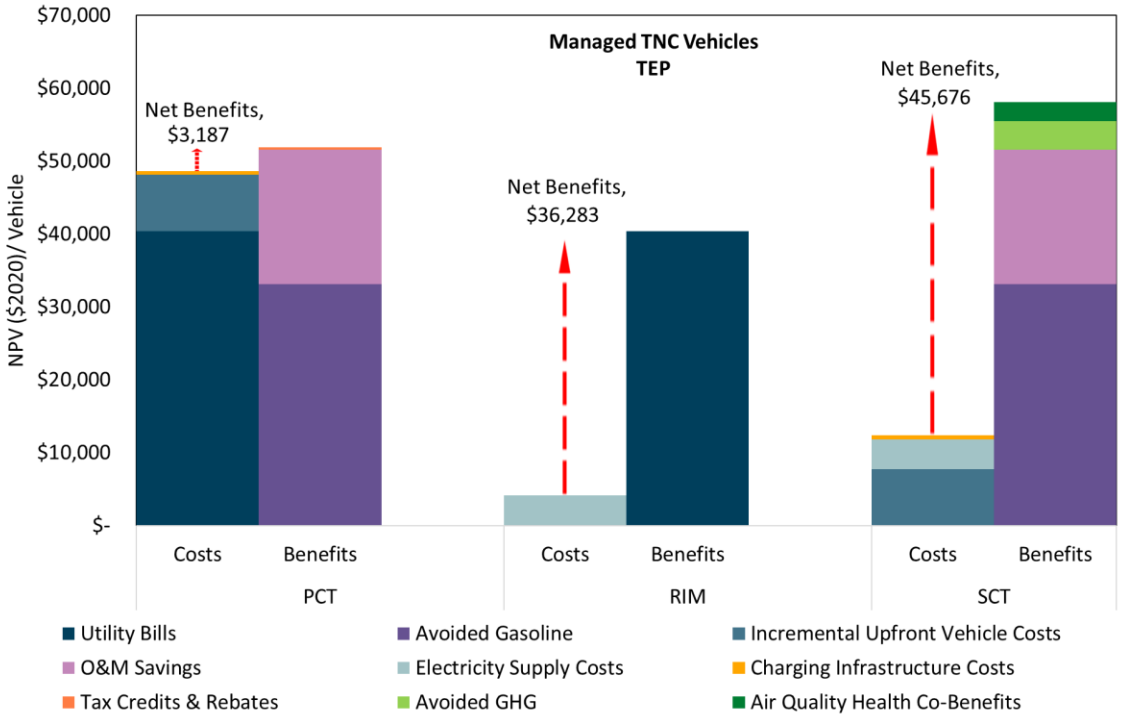

Figure 55. TEP TNC Vehicles Managed

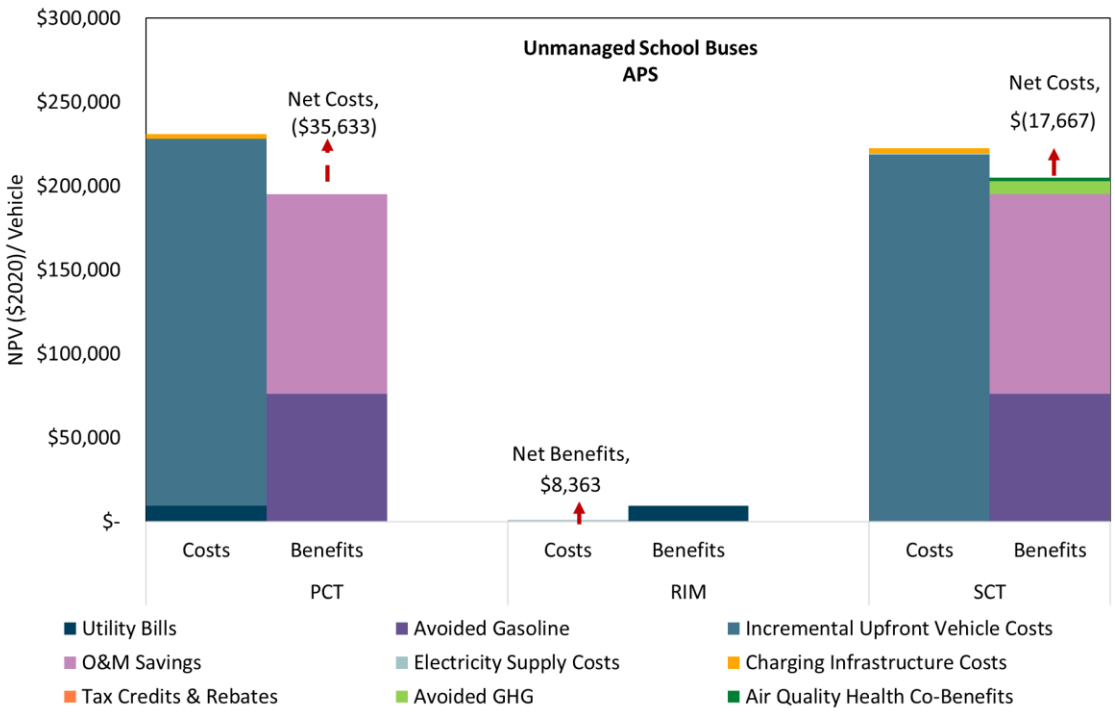

Figure 56. APS School Buses Unmanaged

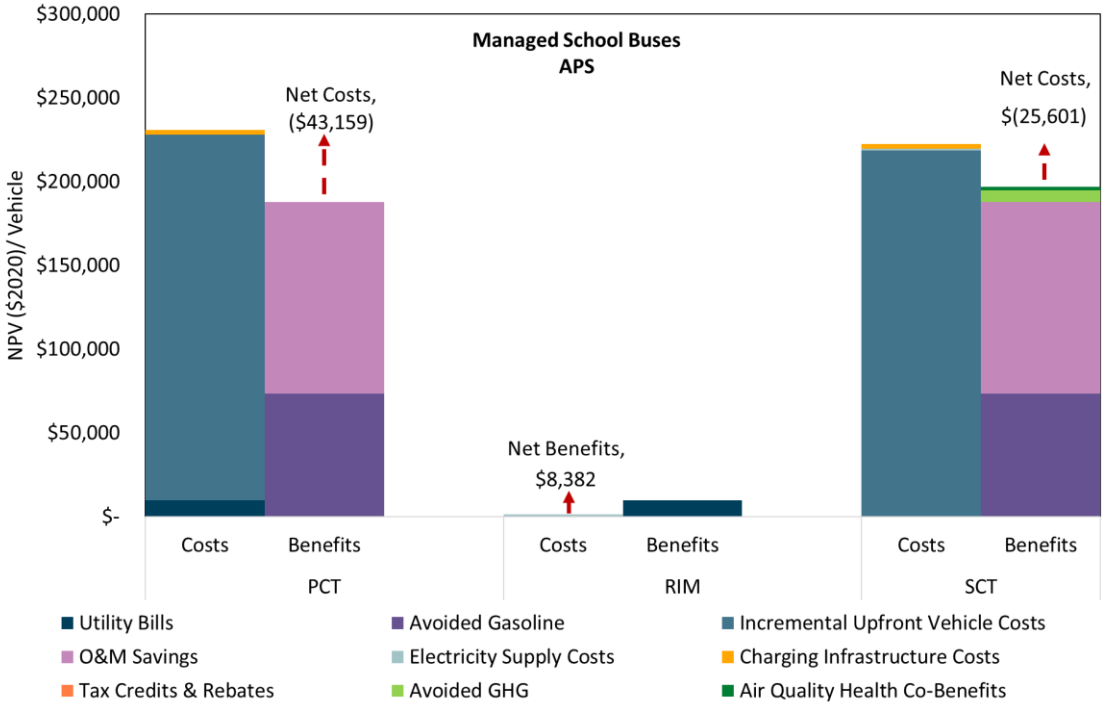

Figure 57. APS School Buses Managed

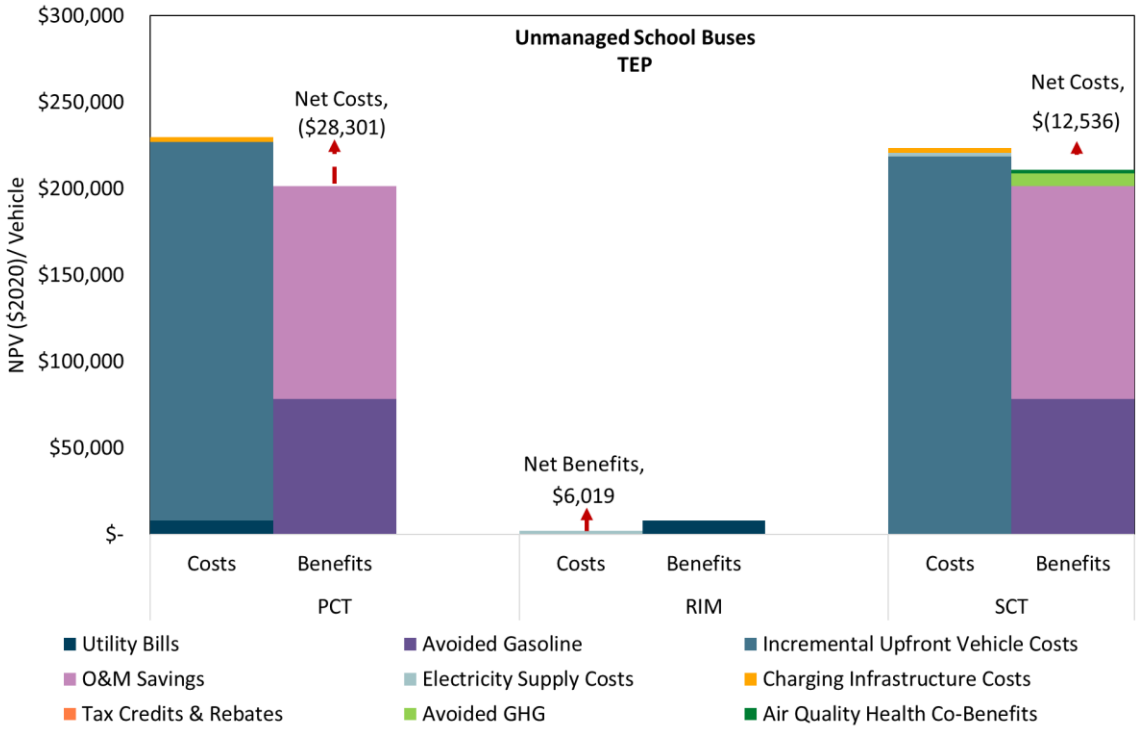

Figure 58. TEP School Buses Unmanaged

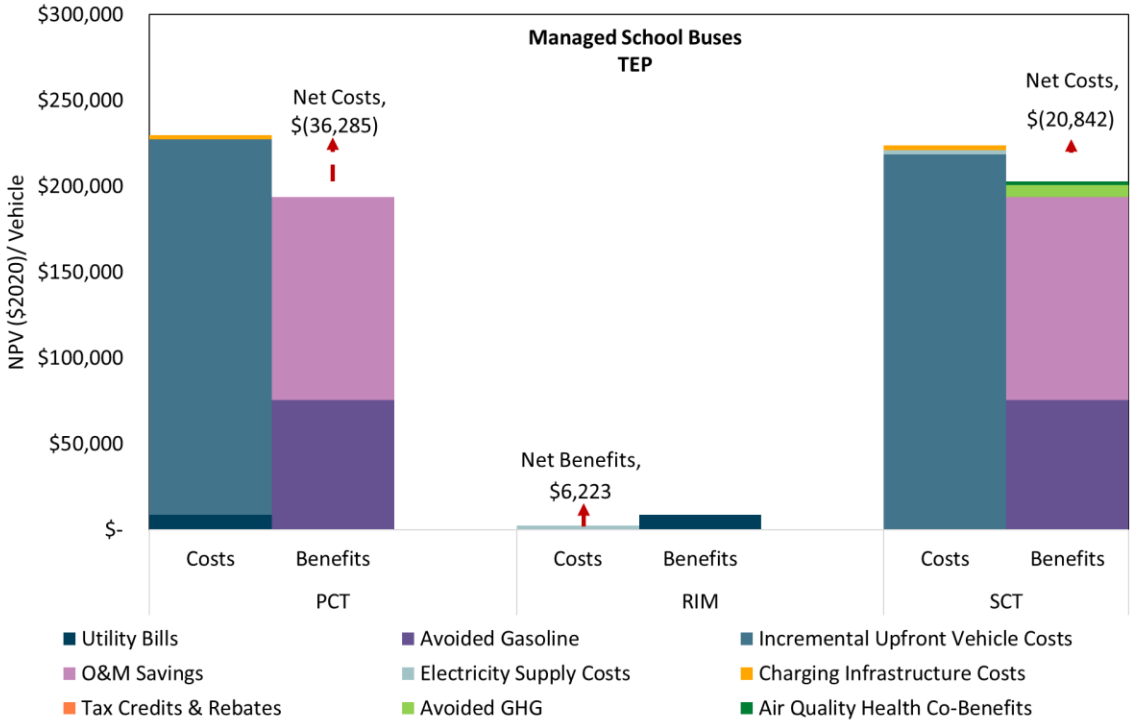

Figure 59. TEP School Buses Managed

Lifetime Net Present Value of EVs Adopted 2020-2040, by Vehicle Segment

Table 18. Net Present Benefits, Personal LDVs ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	453	70	1026	567	216	1535	1402	372	3476
Medium	3722	581	8435	3758	1271	9856	10264	2444	24909
High	5119	799	11601	5168	1748	13555	14117	3361	34258

Table 19. Net Present Benefits, Rideshare LDVs ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	16	2	36	189	83	534	223	92	618
Medium	90	19	213	735	321	2069	903	372	2499
High	124	25	293	1010	441	2845	1242	511	3437

Table 20. Net Present Benefits, Parcel Vans ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	88	34	237	6	6	24	103	44	287
Medium	234	92	639	16	17	65	275	120	774
High	381	150	1041	26	28	106	448	196	1261

Table 21. Net Present Benefits, Transit Buses ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	2	1	5	3	1	7	5	2	14
Medium	12	7	38	26	10	70	43	19	122
High	23	13	71	49	19	133	81	36	229

Table 22. Net Present Benefits, School Buses ($ Million)

Scenario	Participant Cost Test			Ratepayer Impact Measure			Societal Cost Test		
	APS	TEP	State	APS	TEP	State	APS	TEP	State
Low	$(3)	$(1)	$(7)	$1	$0	$2	$(2)	$(0)	$(4)
Medium	(29)	(10)	(78)	6	2	15	(19)	(6)	(49)
High	$(56)	$(19)	$(148)	$11	$3	$28	$(36)	$(12)	$(95)

Additional Methodological Detail and Sources

The following section describes additional data and assumptions used in the Cost Benefit Analysis, with a primary focus on LDVs given the outsized impact these vehicles typically have on overall CBA results (due to their prevalence).

Table 23. Vehicle Miles Traveled (VMT) Assumption

Vehicle Type	VMT	Source
Personal LDV	16,385	Previous E3 analysis in Arizona
TNC LDV	40,545	UC Davis survey in partnership with Uber
Parcel truck	14,000	NREL fleet DNA
Transit bus	50,000	Valley Metro actual bus schedule adjusted for electric bus range assumption
School bus	11,253	State Transportation Statistics

Table 24. Average range of BEV and PHEV (miles)

	2020	2025	2030	2035	2040
BEV	217	243	295	350	375
PHEV	29	34	42	46	50

LDV range sources:

- Average of NREL Adopt[234] and EV Adoption[235] used for BEV 2020 and 2025.
- NREL Adopt used for PHEV for 2020 and 2025.
- E3 internal analysis and assumptions for 2030-2045.

Table 25. Short/long range split for BEV and PHEV

	2020	2025	2030	2035	2040
BEV Short	48%	45%	32%	17%	9%
BEV Long	18%	26%	45%	66%	78%
PHEV Short	30%	22%	12%	7%	4%
PHEV Long	4%	7%	11%	10%	9%

Vehicle split was calculated based on BNEF EV Outlook BEV/PHEV split forecasts and NREL Adopt/EV Adoption/E3 range projections.

Rideshare / TNC Driver Treatment

TNC vehicles that are modeled in E3's EV Load Shape tool consist of full time TNC drivers with annual mileage on the order of 40,000 miles. In order to properly account for the number of TNC drivers who drive only part time a weighting factor was used to convert projected TNC drivers in terms of "full time

[234] https://www.nrel.gov/docs/fy18osti/70455.pdf

[235] https://evadoption.com/us-bev-fleet-to-average-300-miles-of-range-by-year-end-2023/

equivalents," in accordance with data from a UC Davis paper, *Characteristics and Experiences of Ride-Hailing Drivers with Plug-in Electric Vehicles.*[236]

Charging Access

Table 26 provides the segmentation of drivers by charging access type and urban vs. rural area.

Table 26. Charging Access by Housing Type

Work Charging?	Home Charging	Urban	Suburban	Rural	Total
Workplace	None	2%	6%	1%	**8%**
Workplace	L1	3%	14%	2%	**18%**
Workplace	L2	3%	17%	3%	**22%**
No Workplace	None	1%	6%	1%	**8%**
No Workplace	L1	3%	15%	2%	**19%**
No Workplace	L2	3%	18%	3%	**24%**
	Total	**15%**	**75%**	**11%**	**100%**

EV Supply Equipment Costs

Electric vehicle supply equipment costs are taken from the International Council on Clean Transportation[237] and Idaho National Lab.[238]

EVSE Costs Through 2025			
	Hardware	**Installation**	**Total**
Home L2	$ 737	$ 1,184	**$ 1,921**
Public L2	$ 3,127	$ 3,020	**$ 6,147**
Workplace L2	$ 3,127	$ 3,020	**$ 6,147**
DCFC (150 kW)	$ 75,000	$ 38,047	**$ 113,047**
Transformer upgrade costs for six 150 kW DCFC complex			**$ 30,750**

Fuel Economy

BEV fuel economy is based on forecasts from NREL[239] for a midsize car, while vehicle efficiencies are sourced both from NREL and from recent EV range testing by AAA.[240]

[236] https://escholarship.org/uc/item/1203t5fj.

[237] https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

[238] https://www.osti.gov/servlets/purl/1459664

[239] https://www.nrel.gov/docs/fy18osti/70455.pdf

[240] http://www.aaa.com/AAA/common/AAR/files/AAA-Electric-Vehicle-Range-Testing-Report.pdf

Table 27. LDV Efficiency Over Time

Year	BEV Fuel Economy	kWh/Mile		Miles/kWh	
	MPGe	Summer	Winter	Summer	Winter
2020	129	0.38	0.34	3.35	3.05
2021	131	0.37	0.34	3.40	3.10
2022	134	0.36	0.33	3.53	3.22
2023	137	0.35	0.32	3.75	3.42
2024	139	0.35	0.32	4.05	3.68
2025	141	0.34	0.31	4.42	4.02
2026	143	0.34	0.31	4.90	4.46
2027	144	0.34	0.31	5.47	4.98
2028	145	0.33	0.30	6.15	5.60
2029	146	0.33	0.30	6.96	6.33
2030	147	0.33	0.30	7.93	7.22
2031	147	0.33	0.30	7.93	7.22
2032	147	0.33	0.30	7.93	7.22
2033	147	0.33	0.30	7.93	7.22
2034	147	0.33	0.30	7.93	7.22
2035	147	0.33	0.30	7.93	7.22
2036	147	0.33	0.30	7.93	7.22
2037	147	0.33	0.30	7.93	7.22
2038	147	0.33	0.30	7.93	7.22
2039	147	0.33	0.30	7.93	7.22
2040	147	0.33	0.30	7.93	7.22

Internal combustion engine fuel economy was sourced from NREL, and the Arizona average for LDVs was calculated based on the weighted average of the registered LDVs in the state.

Table 28. Internal Combustion Engine Vehicle Fuel Economy (MPG)

Year	Arizona Average	Car, Compact	Car, Large	Car, Midsize
2015	26.6	27.8	22.0	26.8
2016	28.3	28.8	25.6	29.0
2017	29.2	29.5	26.6	30.4
2018	30.8	31.5	27.6	31.2
2019	31.7	32.4	28.5	32.2
2020	32.8	33.6	29.4	33.3
2021	33.8	34.6	30.1	34.2
2022	34.4	35.3	30.7	34.8
2023	35.3	36.3	31.2	35.4
2024	35.9	37.1	31.7	35.9
2025	36.5	37.9	32.0	36.1
2026	36.8	38.2	32.3	36.2
2027	37.2	38.7	32.5	36.4
2028	37.2	38.8	32.6	36.4
2029	37.3	38.9	32.7	36.4
2030	37.4	39.1	32.8	36.4
2031	38.5	40.2	33.9	37.3
2032	39.5	41.2	35.0	38.2
2033	40.6	42.4	36.1	39.1
2034	41.7	43.5	37.3	40.0
2035	42.8	44.7	38.5	41.0
2036	44.0	45.9	39.8	41.9
2037	45.2	47.1	41.1	42.9
2038	46.4	48.4	42.4	44.0
2039	47.7	49.7	43.8	45.0
2040	49.0	51.1	45.3	46.1

Appendix B: Working Group Reports

Arizona Statewide Transportation Electrification Plan
Electric Vehicle Infrastructure Working Group Deliverable

Table of Contents

Goal of EV Infrastructure Working Group

Co-Chairs of Working Group
Francesca Wahl (Tesla), Erik Williams (Clear Results), and Robert Bulechek (Energy Management)

Group Advisors

Devon Rood (APS), Judson Tillinghast (APS), Art Fregoso (TEP), Ben Shapiro (E3), Anne Dougherty (ILLUME)

We would especially like to recognize the efforts of:

Caryn Potter (Southwest Energy Efficiency Project), Phill Jones (Alliance for Transportation Electrification), Karen Apple (City of Phoenix), Douglas Fant (Southwestern Power), Chris McAbee (Maricopa County), Catherine O'Brien (Salt River Project), Robert Perez (City of Glendale), Jason Sekhon (Toyota Motor North America), Justin Wilson (ChargePoint), Erick Karlen (Greenlots), Rachelle Celebrezze (Cruise), William Drier (Electrification Coalition), Aaron Kressig (Western Resource Advocates), Braden Kay (City of Tempe), Grace Delmonte Kelly (City of Tempe), David Rubin (Cruise)

Working Group Participants
The table below contains a list of all stakeholders who signed up to be members of the Electric Vehicle Infrastructure working group.

FIRST	LAST	ORGANIZATION	EV Infrastructure
Erik	Williams	CLEAResult	Chair
Robert	Bulechek	Energy Consultant	Chair
Francesca	Wahl	Tesla	Chair
Dan	Bowerson	Alliance for Automotive Innovation	Member
Michael	Denby	APS	Member
Kathy	Knoop	APS	Member
Devon	Rood	APS	Member
Judson	Tillinghast	APS	Member
Todd	Wynn	APS	Member
Amanda	Reeve	Arizona Chamber of Commerce	Member
Marisa	Walker	Arizona Commerce Authority	Member
Cameron	Nance	Arizona Corporation Commission	Member
Diane	Brown	Arizona Public Interest Research Group	Member
Mick	Dalrymple	Arizona State University (ASU)	Member
Paul	Hirt	Arizona State University (ASU)	Member
Tony	Bradley	Arizona Trucking Association	Member
Laurie A.	Woodall	Arizona's Residential Utility Consumer Office	Member
C.J.	Berg	Black and Veatch Management Consulting, LLC	Member
Justin	Wilson	ChargePoint	Member
Robert	Perez	City of Glendale	Member
Karen	Apple	City of Phoenix	Member
Lori	Glover	City of Scottsdale	Member
Mike	Gent	City of Surprise	Member
Braden	Kay	City of Tempe	Member
Grace	Kelly	City of Tempe	Member
Eslir	Musta	Coconino County	Member

Rachelle	Celebrezze	Cruise	Member
David	Rubin	Cruise	Member
Ben	Shapiro	E3	Member
William	Drier	Electrification Coalition	Member
Jeffrey	Wishart	Exponent	Member
Joe	Galli	Flagstaff Chamber of Commerce	Member
Thomas	Ashley	Greenlots	Member
Erick	Karlen	Greenlots	Member
Rob	Mowat	HDR	Member
Anne	Dougherty	ILLUME Advising	Member
Chris	McAbee	Maricopa County	Member
Erin	Janicki	National Park Service - Grand Canyon	Member
Alana	Langdon	Nikola Motor / Nikola Defense	Member
Jeanette	DeRenne	Pima Association of Governments	Member
Dustin	Fitzpatrick	Pima Association of Governments	Member
Patrick	O'Leary	Pima County Facilities Management	Member
Katherine	Stainken	Plug In America	Member
Todd	Baughman	Policy Development Group on Behalf of Toyota	Member
Catherine	O'Brien	Salt River Project	Member
Travis	Madsen	Southwest Energy Efficiency Project	Member
Caryn	Potter	Southwest Energy Efficiency Project	Member
Douglas	Fant	SouthWestern Power Group	Member
Ken	Pratt	Sun Engineering	Member
Nicole	Hill	The Nature Conservancy	Member
Jason	Sekhon	Toyota Motor North America	Member
Julie	Donovant	Tucson Electric Power (TEP)	Member
Art	Fregoso	Tucson Electric Power (TEP)	Member
Camila	Martins-Bekat	Tucson Electric Power (TEP)	Member
David	Gebert	Unknown	Member
Darrel	Templeton	Valley Metro	Member
Don	Covert	Valley of the Sun Clean Cities	Member
Rem	Dekker	Waymo	Member
Juan Pablo	Soulier	Waymo	Member
Autumn	Johnson	Western Resource Advocates	Member
Aaron	Kressig	Western Resources Advocates	Member

Purpose

The EV Infrastructure Working Group (EVI WG) will:

- Identify key barriers and opportunities to develop sufficient charging capabilities to support anticipated levels of EV adoption.
- Identify and prioritize, by lead stakeholder, the near-, medium- and long-term actions necessary to enable greater TE in Arizona sufficient to meet the outlined adoption goal.

Structure

To answer the questions above, the EV Infrastructure WG determined that three subgroups would be necessary focused on: 1) Barrier and Opportunities, 2) Intervention Strategies and 3) Case Studies. Below are the work products for each of these subgroups which include recommendations on next steps.

Work Product 1: "Barriers & Opportunities"

Subgroup Leads
Phill Jones (Alliance for Transportation Electrification) and Caryn Potter (Southwest Energy Efficiency Project)

Subgroup Participants
Karen Apple (City of Phoenix), Douglas Fant (Southwestern Power), Chris McAbee (Maricopa County), Catherine O'Brien (Salt River Project), Robert Perez (City of Glendale), Jason Sekhon (Toyota Motor North America), Judson Tillinghast (Arizona Public Service)

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1. **Identify the key barriers to develop sufficient charging capabilities for anticipated levels of EV adoption.**

The following table is what the Barriers and Opportunities subgroup has identified as critical barriers that prevent greater EV adoption. The ranking does not indicate a specific barrier's lesser value; it is intended only for discussion purposes.

Barriers to Developing Sufficient Charging Capabilities for Anticipated Levels of EV Adoption	Barriers that Prevent Greater EV Adoption 4=Highest Barrier 1=Lowest Barrier
Education and Outreach (E&O)	4
Statewide, Local, and Utility Programs, Application, Investments, as well as public support for regional, state, and local decision-making	3
Costs of developing EV Charging Infrastructure	2
Access for BIPOC and Underserved Communities (Rural and Urban)[1]	1

Education and Outreach (E&O):
Generally, E&O is defined as any program or activity that promotes awareness, knowledge of electric vehicles (types of cars) and charging Infrastructure includes a variety of use cases: residential, workplace, multi-family, and public infrastructure. The following partners have differing definition of education and outreach, based on the role that they serve. They are clarified below:

- **For utilities:** E&O activities include programs such as enhanced web portals that explain the different types of EVs for purchase, ride and drive actions, the cost savings of EVs compared to traditional fuels, attractive rate design options for EV owners, and the environmental and other benefits. As fully regulated utilities, they must develop programs and have them approved by Commissions.

- **For Original Equipment Manufacturers/EVSPs:** E&O activities include traditional marketing activities that auto OEMs employ when marketing and selling new vehicles and can consist of traditional media, on-line marketing, direct marketing, and other approaches. These activities are not regulated by the Arizona Corporation Commission.

[1] Underserved Communities are defined as the following:

- **For Auto Dealerships:** Similar to OEMs' activities above and includes a variety of marketing activities, including traditional media, online social media, and word-of-mouth education and outreach. Furthermore, this provides for the training of the dealers' sales staff (either on-line or in-person) in how electric vehicles work, the different types of charging, and such. These activities are not regulated by the Arizona Corporation Commission.

- **For Non-Utilities:** E&O activities can also occur at the state and local levels through improved constituent outreach.

These definitions support the following barriers and opportunities for E&O that this subgroup has identified. *The following list is not in ranking order.*

1. Lack of awareness of EV models, plugs, and charging and fueling Infrastructure.
    a. Customers can be confused based on the lack of uniformity of various EV charging types.

2. Lack of clarity regarding the proportional role of Original Equipment Manufacturers (OEMs), Transportation Network Companies (TNCs), and Electric Vehicle Service Providers (EVSPs) related to publicly funded transportation electrification projects.

3. Role of dealerships: Lack of clarity with no-touch auto sales and delivery systems, as well as the future of dealership sales models with electric vehicles.

4. Utility role: What should be the appropriate budgetary level for marketing, education, and outreach dollars?
    a. Role in driving customers towards electric vehicles models through utility websites, sponsored ride and drives, bill credits, etc.

    b. Role in working with dealerships on financial incentives to make EVs more attractive and make the total cost of ownership comparable to conventional vehicles.

5. Lack of education and awareness campaigns geared towards legislators and regulators.

6. Many customers are unaware of the advantages and benefits of owning and electric vehicles.
    a. Lack of "visible infrastructure" limiting educational opportunities
        i. For example, actual charging stations and the education that is included with them, visible signage, utility websites, etc.
        ii. Visible education from utility

7. Lack of differing educational awareness for the various use types:
        i. Light Duty Vehicles
        ii. Medium-Duty/Heavy-Duty Vehicles
        iii. Public Transportation Buses
        iv. Electric School Busses
        v. Utility fleets and non-utility fleets

<u>Utility Programs, Application, and Investments</u>

The following list is not in ranking order.

1. Interconnection/service connection concerns: Lack of a single point of contact (SPOC) for EVSPs and providers, which makes it costly and difficult to get applications in a queue, process in a timely manner.

2. Lack of knowledge of where (locational) it may be good to site charging Infrastructure.

3. Lack of sharing that information via hosting capacity maps or something else externally with charging providers and others.

4. Rate design issues, such as volumetric, demand and non-demand billing and structures.

5. Planning issues – how much visibility do utilities have over the demand for services, and where the EVSPs and others may wish to locate stations and for DC Faster Chargers and public Level 2 Charging.

6. Unclear future decision making on how utilities will work with OEMS, EVSP's and TNC's will work together to ensure a seamless customer experience. It will include a certain level of data access from both entities.

7. Lack of decision-making to utilize VW Settlement funds towards EV infrastructure and investments.

Costs of developing EV charging Infrastructure

The following list is not in ranking order.

1. Procurement Costs
    a. Make Ready & Charger Hardware
    b. Managed Charging capability and software needs
    c. Request for Proposal/Information
    d. Software enhancements
    e. Labor and installation

2. Requirement and Operational Costs
    a. Payment Systems: Security and Financial Systems
    b. Measurement Standards Compliance
    c. Permitting, jurisdictional authorities (cities, fire, police, etc.), and utilities
        i. ADA Compliance and Parking Requirements
        ii. Consideration of loading and off-leading time valuation
    d. Multiple Plug Types for DCFC's (CCS, CHAdeMO, Tesla)
    e. Service Level Agreements
    f. Warranties
    g. Managed Charging capability, network operations, and software costs

3. Soft Costs
    c. Local government permits and restrictions on ROW
    d. Restrictions on on-street parking, and innovative solutions
    e. Arizona Department of Transportation project costs

Access for BIPOC and Underserved Communities (Rural and Urban)

The following list is not in ranking order.

As it relates to electric vehicle infrastructure, BIPOC and Underserved Communities are defined as ability to access charging Infrastructure and services that would make it easier to go electric.

- Limited charging access for those living in multi-dwelling units (MUDs), created charging station "deserts."
- No incentives for landlords (HOAs) to install electric vehicle charging stations and parking lots to build not, especially with COVID.

- Access to capital for underserved communities for electric vehicle purchases. Access to Infrastructure for ridesharing programs or public transportation

- "Luxury Good" perception – lack of low-income families utilizing electric vehicles.

- Lack of access to used EV markets

- Lack of enthusiasm by multi-dwelling unit trade associations/organizations toward new suggestions/requirements made by external parties

2. Identifies the key opportunities to develop sufficient charging capabilities for anticipated levels of EV adoption

The following list is not in ranking order.

1. Accelerated EV adoption and transportation electrification activities, if managed correctly, could lead to the following opportunities:

    a. Avoid indirect and direct GHG emissions as well as other key air pollutants– can be calculated for various scenarios. Avoided air pollutants, such as NOX and pm 2.5, especially with the Covid-19 crisis – Maricopa County is a clear case study for improvement here.

    b. Public Health Benefits- With ozone non-attainment, county, city, and state economic development opportunities are inhibited. However, transportation electrification jobs can allow Arizona the chance to play an important role (besides TX and CA and others) in the supply chain and development of EVs.

    c. Downward pressure on rates over time by increasing EV load while also heavily promoting managed charging.
    d. Removing future economic development barriers.

    e. Utility investments in larger volumes to achieve volume discounts.

    f. EV Infrastructure Underserved Localities - Opportunity to reach out to BIPOC and Low-Medium Income (LMI) and underserved communities and develop new and innovative programs to serve these consumers and communities.

    g. Grid Technology Advancements - Accelerate the transformation of the utility in its distribution grid and structure to accommodate not just EVs and EVSE, but a variety of DERs that can be integrated in grid (DERMS and ADMS and other solutions) – provide both system benefits and to EV owners.

    h. Consumer awareness of savings and incorporating benefits in overall education and outreach.

    i. Reduction in noise pollution and improvement to non-EV drivers' and EV drivers' lifestyles.

2. Develop a collaborative approach to developing these infrastructure programs with all of the potential "Partners," as defined from the "Programs and Partnerships" Working Group.

3. Identifies additional relevant research questions for further investigation.

The Electric Vehicle Infrastructure Vehicle working group recommends that there is further analysis of the benefits of electric vehicles, including light-duty vehicles, medium-heavy duty vehicles, as well as electric public and school buses, specifically in Arizona. The benefits that should be explored include but not limited to:

1. Greenhouse gas emission reductions through greater transportation electrification for light-duty vehicles, medium-duty/heavy-duty vehicles, and electric buses.

2. Air pollutant reductions through greater transportation electrification.

3. Statewide economic development as measured in gross domestic products and other key performance indicators.

4. Job development in localized economics in rural and urban portions of the state, including sovereign tribal entities.

Taking the above factors into account, consider a revised cost-benefit analysis to include the direct and indirect benefits and cost assessments.

Work Product #2: "Intervention Strategies"

Subgroup Leads
Justin Wilson (ChargePoint) and Erick Karlen (Greenlots)

Subgroup Participants
Rachelle Celebrezze (Cruise), William Drier (Electrification Coalition), Aaron Kressig (Western Resource Advocates)

Summary:

This work product builds off the work of the "Barriers and Opportunities" subgroup related primarily to EV Infrastructure. Below this report will identify the barriers identified either through this subgroup or others and intervention strategies that can be used to overcome these barriers. In instances where there are examples of intervention strategies deployed in other states, we provide references. Participants of this sub-group note that there has been much discussion around some of these topics already in Arizona, including in Arizona Corporation Commission (ACC) Docket No. 18-0284 when led to the development of both a Policy Statement (Decision No. 77044) and a Policy Implementation Plan (Decision No. 77289) on electric vehicles and more specifically electric vehicle infrastructure.

Barriers:

Broadly speaking the Barriers and Opportunities subgroup identified four categories of barriers related to infrastructure: Procurement Cost, Operational Cost, Soft Cost, and Utility Engagement and Information. This subgroup will continue to use these categories to guide our discussion of intervention strategies, noting that some intervention strategies could address multiple barriers. We have taken the work of the Barriers and Opportunities group and incorporated it below, in many cases synthesizing some barriers into broader categories, as well as, re-organizing some of the identified barriers based on the deployment experience of this group.

Procurement Cost:

Barrier	Intervention Strategies

Hardware Cost	• Government Incentive Programs • Utility Electrification Programs • Income Qualified and Equity Focused Programs. • EV Ready Building Codes • Creative financing and public-private partnership programs • Perhaps something about workforce development to help address installation costs?
Installation Cost	

Operational Cost:

Barrier	Intervention Strategies
Software and Networking fees	• Income Qualified and Equity Focused Programs • Government Incentive Programs • Utility Electrification Programs
Ongoing Maintenance (Service agreements and warranties)	
Utility Rates	• Utility Electrification Programs

Soft Cost:

Barrier	Intervention Strategies
Permitting	• State and Local Government Guidance • EV Ready Building Codes
Right-of-way and parking restrictions	
Compliance cost (ex. Data management cost associated with programmatic requirements, fees related to equipment inspections, hardware, and software requirements)	• Government Incentive Programs • Utility Electrification Programs • Income Qualified and Equity Focused Programs. • Regulatory relief.

Utility Engagement and Information:

Barrier	Intervention Strategies
Siting and Interconnection	• Electrification Teams and Dedicated Account Representatives • Transparent timelines for construction, energization etc.
Lack of Coordination and Clarity regarding roles and responsibilities related to publicly funded EV infrastructure projects.	• State Transportation Electrification Plan • Regulatory Workshops and Policies • Goal-setting/Policies opportunities through Public Utility Commissions and State Legislatures.

Description of Intervention Strategies

- Government Incentive Programs: Government incentive programs have been used across the country to assist in encouraging the development of EV infrastructure. There are many ways that governments have structured these incentive programs including: rebates, grants, tax incentives and competitive solicitations. The program structure utilized by governments may vary based on the type of EV infrastructure deployed, funding sources, and administrative considerations. Examples of these type of incentive programs include:
    - Use of VW Settlement and other Transportation funds to expand charging infrastructure and adoption of electric vehicles.
    - Grant or rebate programs to reduce cost of purchasing and installing charging equipment. Programs have utilized capital budgets, fees and taxes, and federal funds to deploy charging infrastructure. Examples include: CALeVIP, Charge Ahead Colorado.
    - Tax incentives: Tax incentives can help certain operators offset the cost of installing charging stations. Oklahoma has a tax credit for up to 45% of the cost of installing commercial alternative fueling infrastructure (including charging stations).[2]

- Utility Electrification Programs: Utilities across the US have proposed and received regulatory approval for electrification programs. In 2018, the Arizona Corporation Commission began investigating electric vehicles and the role of electrification programs in Arizona in Docket RU-0000-A-18-0284. The Commission has issued two decisions on this topic, generally referred to as the Policy Statement and Policy Implementation Plan. Each of these decisions provides guidance to Public Service Corporations regulated by the Commission on how best to approach electrification programs.
    - Make-Ready Programs: Make-ready infrastructure generally refers to all the electrical work and infrastructure necessary on either or both sides of the utility's electric meter to make a site ready to connect EV charging equipment. Many utilities have developed programs to provide make-ready infrastructure to site host either through rebate or utility owned models.
    - Rebates for Charging Hardware: To help offset the capital cost of charging equipment, utilities have separately or in combination with make-ready programs provide rebates to site hosts who seek to install charging equipment. Rebates for charging hardware are particularly helpful when sites may not need significant make ready upgrades or to encourage certain behavior such as using ENERGY STAR certified equipment.
    - Direct Ownership of Charging Hardware: In certain situations, utility direct investment and ownership of charging hardware can be appropriate, depending on the objectives and market barriers presented.
    - On bill financing[3] and tariff-based recovery[4]: separately or in combination with other strategies, creative financing programs facilitated by utilities can help overcome a variety of cost-related barriers.
    - Rates and Load Management: Electricity rates and load management programs, that encourage efficient use of the grid, maximize fuel costs savings, and minimize operational costs including the impacts of demand charges, are important for the proliferation, operations, and grid integration of EV charging stations. Utilities and regulators should ensure there are rates and/or

[2] https://afdc.energy.gov/laws/all?state=OK

[3] On-Bill Financing is a financing mechanism that has the utility provide financing to a customer for energy specific improvements. The loan is recovered through a charge on the customer's monthly bill.

[4] Tariff-Based Recovery sees the utility add a charge to a specific customer's monthly bill to recover the costs for an energy improvement. The charge is applied to the monthly bill up until the investment is fully paid.

load management options available for the unique operational characteristics of various EV charging use cases.
    - Electrification Teams: When questions arise, it is important for various actors in the EV charging ecosystem to know who to contact. Stakeholders believe it is best practice for utilities to dedicate specific staff members to provide assistance to EV charging developers, entities looking to electrify their vehicles, and site hosts, in particular during the siting and interconnection phase of development, but also more broadly in supporting the electrification decisions of its customers.
- Vehicle Incentives: Tax Credits and Rebates for EV incentive drivers to purchase electric vehicles. When more electric vehicles are on the road, it increases utilization of public charging infrastructure. When utilization of public charging stations increases it lowers the operational cost for charging station operators and also spurs the development of more charging infrastructure.
- State and Local Guidance/Mandates: State and local governments can assist in a variety of ways with the development of charging infrastructure.
    - State Transportation Electrification Plan
    - State guidance to local permitting authorities via permitting guidebook
    - EV Ready Building Codes
    - Regulatory Workshops and Policies
    - Goal setting
- Sector Specific Programs
    - Income Qualified and Equity Focused Programs.

Work Product #3: "Case Studies and Arizona Gaps Analysis"

Subgroup Leads
Braden Kay (Tempe) and Grace Delmonte Kelly (Tempe)

Subgroup Participants

David Rubin (Cruise), (Caryn Potter Southwest Energy Efficiency Project), Erick Karlen (Greenlots)

Identifies which of these actions are ripe for adoption, implementation, and expansion in Arizona.

The following table identifies what the Case Studies and Arizona Gaps Analysis subgroup has identified as key barriers that prevent the greater EV adoption. The following is not in ranking order.

Charging infrastructure: There are a variety of use cases for EV charging infrastructure based on charging demands, usage patterns, vehicle ownership models, and grid constraints. Each use case has its own pros and cons, and also has various metrics for success and accessibility. As Arizona considers case studies to inform and shape its own transportation electrification (TE) efforts, there are three specific use models that should inform future policy initiatives. These include public, multi-unit dwellings and the workplace, and fleet (be it private or public-owned).

Regional, State, and Local Policy Decisions: need cooperation and partnerships to make this work in a way that allows AZ drivers security about available charging to move forward with EV purchases. Require bottom up (cities/regional) plus top down (state/regional) planning to ensure all needs are met to move this path forward. The adoption of measures to move EV infrastructure forward is significantly dependent upon needs

and situation of specific localities and geography/population of Arizona along with transportation relationship to surrounding States. Ideas of specific policies are given below but the best policies should be selected given the requirements of each local area and its relationship with the surrounding area.

Intervention Strategy	Case Studies/Examples	AZ Recommendation
• **Public Access:** Chargers are strictly available to the public. Often have low utilization, with more limited near-term return on investment due to lower EV adoption. However, public access chargers will be critical in driving up broader adoption amongst the public, particularly in providing short-term charging solutions to backfill against home and workplace charging (explored below). Key policy questions and options for public access chargers are often included: ○ What level chargers should be installed (Level II, DCFC)? ○ Who should own public chargers - EVSPs, IOUs, site hosts? A combination? ○ Where should these chargers be sited? Curbside parking, garages and lots, gas stations, business locations? ○ Should state-backed incentives be allocated, and if so, what are metrics for success? Utilization? Location? ○ How do regulatory authorities treat back-end make ready infrastructure, especially for chargers with higher installation costs like DCFCs? Are these eligible for funding?	• **CALeVIP - Public Charger Program:**[5] One effective EV infrastructure deployment program is the California Electric Vehicle Infrastructure Project (CALeVIP). With appropriate programmatic revisions, Arizona may consider deploying a similar structure that provides rebates for EVSE infrastructure deployment, scaling with the power level/cost of installation. Incentives are available for Level II and Level III/DCFC infrastructure, with rebates available up to $6,000 for Level II and up to $80,000 for DCFC. The program has prioritized expanding public access to electric miles and has focused on both urban as well as suburban and rural counties that can ensure greater public access to this infrastructure. CALeVIP is administered by California's Energy Commission as part of the Clean Transportation Program, and funded indirectly through vehicle registration, tag and plating fees, as well as smog abatement fees. $71M is currently available, with a maximum of $200M. CALeVIP funds are allocated via Project Areas, selected at the county level through docketed regulations, allowing stakeholder feedback to prioritize certain geographies. When implemented, the Project Areas have some flexibility in terms of allocation and eligibility, including partial eligibility for MUDs and workplace chargers.	• **Public Chargers:** When considering public charger deployment, Arizona should prioritize areas with dense EV adoption while also balancing equity and access concerns. Specifically, for public charging infrastructure, weighing current and future demand is critical to ensure that deployed funding benefits all users. Furthermore, ensuring adequate coverage with DCFCs for major networks like the I-10 and I-17 corridors will help encourage adoption and reduce public concerns about charger availability. A successful sector will provide ample funding for public charger installation, offer flexibility in permitting and siting, and be responsive to different geographic needs. • **Utility Collaboration:** Critical to robust deployment of EV infrastructure will be the collaboration between utilities and EV charging companies. Data sharing, cost-effectiveness tests, and collaborative agreements can ensure all parties can benefit from mass charging infrastructure deployment. "A utility can reject a charger provider's proposal because it does not fit existing capacity, but it could also tell the provide what would work better. That would be tremendous." Jonathan Levy, EVgo
• **Workplace and Multi-Unit Dwelling:** Chargers available to specific populations - determined either by place of residence or work. While these chargers are not strictly off limits for public use, they are predominantly constructed to serve, incent, and accommodate EV adoption for certain groups. These chargers	• **Charge Ready NY - Workplace/MUD:**[6] New York's NYSERDA administers Charge Ready NY, a program that offers funding for Level II chargers for workplace and MUD sites, as well as limited public charging use cases. Up to $4,000 is available per charging port installed and can be used for both equipment and installation costs. The current program was initially funded	• **Workplace/MUD Chargers:** A successful workplace/MUD charger sector will provide incentives for property managers to install infrastructure, minimize barriers for these installations, and clearly delineate potential benefits from such investments to said property managers.

[5] State Led: CA CALeVIP and PA Level 2 EV Charging Rebate Program
[6] State Led: NY NYSERDA Charge Ready NY

Intervention Strategy	Case Studies/Examples	AZ Recommendation
are very useful for providing midday and evening charging solutions, and - in the case of MUD chargers - are critical in delivering greater equity for families and individuals who are unable to install their own chargers at home. Key policy questions for workplace and MUD chargers include: ○ What level chargers should be installed? ○ Are there certain public access requirements to receive funding? ○ With costs often born by property owners and managers, should state incentives be used simply for chargers, or to offset the cost of installation as well? ○ Should incentives allocated be the same as public chargers, given there is less overall access to this infrastructure? ○ How do regulators ensure access and equitable distribution of MUD and workplace chargers? ○ Should there be building code/zoning updates to mandate upgrades for EV charging?	with $17M, with roughly $7.5M remaining. The Level II specification helps MUD and workplace property managers fill a unique niche for mid-tier charging needs for longer duration stays (such as overnight and midday).	
• Fleet (Public or Private): Charging infrastructure for fleets is a very important component to more robust transportation electrification. This use case is much more unique than public access and workplace/ MUD, given that fleet operators often need much more predictability for charger availability to ensure seamless operations. Often, this infrastructure is privately operated (and, at times, owned) to ensure that vehicles can charge when needed. Despite the lack of public access, however, fleet applications are highly valuable in decarbonizing transportation given the often high-mileage vehicles and associated gains from electrifying fleets. Furthermore, there are a variety of applications for fleet chargers as well, including public transit, municipal fleets (law	• **CALeVIP - Public Charger Program:** One effective EV infrastructure deployment program is the California Electric Vehicle Infrastructure Project (CALeVIP). With appropriate programmatic revisions, Arizona may consider deploying a similar structure that provides rebates for EVSE infrastructure deployment, scaling with the power level/cost of installation. Incentives are available for Level II and Level III/DCFC infrastructure, with rebates available up to $6,000 for Level II and up to $80,000 for DCFC. The program has prioritized expanding public access to electric miles and has focused on both urban as well as suburban and rural counties that can ensure greater public access to this infrastructure. CALeVIP is administered by California's Energy Commission as part of the Clean Transportation Program, and funded indirectly through vehicle registration, tag and plating	• **Fleet Chargers:** A successful fleet charger sector in Arizona will ensure eligibility for all vehicle and charger ownership models (privately or publicly owned), remain vehicle class agnostic (LDV, MDV, or HDV), and prioritize high-mileage/high-emissions use cases to ensure the maximal impact for reducing transportation pollution.

Intervention Strategy	Case Studies/Examples	AZ Recommendation
enforcement and emergency response), rental vehicles, business and delivery fleets, and ride hailing. Key policy questions for this model include: ○ How will regulators address the various ownership models for vehicles and chargers? ○ How will regulators integrate and accommodate emerging mobility solutions such as shared EV fleets into new state incentive programs? ○ How will incentives for fleet chargers be allocated? Quantifiable benefit to the public? Needs-based application? Calculated fleet emissions reduction? ○ What role can IOUs play in deploying large banks of chargers for fleets, or in installing back-end make ready upgrades for sites? ○ Will LDV, MDV, and HDV fleet vehicles be treated similarly with incentive programs? ○ Do the unique owner/operator charging needs change the state's approach to incentives?	fees, as well as smog abatement fees. $71M is currently available, with a maximum of $200M. • **PG&E Fleet Ready Program - Fleet:** PG&E's Fleet Ready Program is an interesting case study on supporting fleet-specific EV infrastructure installation. The program is fairly broad and includes both vehicle-specific and charger-specific rebates. The funding for chargers scale with power level, from $15,000 (up to 50 kW), to $25,000 (50-150 kW), to $42,000 (<150 kW). The program is specifically available for a number of medium and heavy-duty fleet applications. Program eligibility is determined by being a PG&E customer, owning/leasing property, and deploying at least 2 EVs in a fleet. The program is ratepayer funded. • **Other relevant case studies include:** ○ Plug-In Austin Electric Vehicles (TX, IOU-led) ○ MassEVIP Fleets Incentives (MA, State-led) ○ PG&E EV Fleet Program (CA, IOU-led)	
• **Regional Collaborations:** Commitment to joining other Western states to expand/create a highway charging system; EV vendor coordination resulting in full but not duplicative coverage	• **REV West MOU** – create an Intermountain West Electric Vehicle Corridor that will allow for seamless driving for EV drivers between the signatory states. AZ is part of the REV West MOU, but we believe strengthening its goals and	• Join other Western states and creating an EV charging corridor so that travel between states is easy for EV drivers. Expand the REV West MOU. Include the Tribes. • Work together with other transportation agencies across the West to deploy DC fast chargers every 25-50 miles along major routes in Arizona. These routes should include routes that travel through Arizona to other states as well as popular destinations and Reservations across the state. It is important to have regular intervals for charging stations so that drivers feel ease traveling across and through Arizona. Additionally, it is important to have other amenities around the charging locations as charging typically takes 30 minutes.

Intervention Strategy	Case Studies/Examples	AZ Recommendation
	commitments to the MOU would be a benefit to the State.[7] • **West Coast Clean Transit Initiative** – a dozen utilities in CA, OR, WA extending the above with additional truck charging stations and cross-state routes.[8] • **West Coast Green Highway** – DC fast chargers and Level 2 chargers from British Columbia to the California/Mexico border. Chargers are installed every 25-50 miles and allow for EV drivers to drive the entire West Coast. Oregon is working on updating the infrastructure along this highway for faster charging. [9]	
• **State Collaborations:** Create an ongoing working group dedicated to EV solutions in the State; federal, state, and utility funding programs; EV goals; state and utility websites; EV vendor coordination; state tax credit for installing charging stations; grants; accommodation for low-speed EVs; exemption from emissions inspection; consistent and identifiable signage	• **Charge Ahead Colorado** - has provided $6M in grants which has produced more than 1,000 EV chargers across the state.[10] • **Oregon EV Collaborative** - large group of stakeholders, including state agencies, NGOs, and private companies to further EV goals in the state of Oregon.[11] • **Oregon EV Collaborative** initiated by Governor Executive Order resulting in Go Electric Oregon. Consists of a large group of stakeholders, including state agencies, NGOs, and private companies to further EV goals in the state of Oregon – goal is 50,000 vehicles by 2020 and 100% by 2050. Supports all aspects of EVs including promoting infrastructure. [12] Significant actions include: ○ State employee EV charging ○ Leverage 15% of VW Settlement with focus on rural, low-income, and multi-family.	• State - Create an ongoing EV Collaborative to continue to expand EV goals, including infrastructure, in Arizona. This collaborative can come from the TE plan stakeholder groups along with state agencies; add EV Steering Group to ASU Sustainable Cities and encourage participation from other state universities; establish framework for intrastate regional cooperation; various groups, including state agencies, utility companies, and private sector, must work together to increase EV charging infrastructure across the state.

[7] https://afdc.energy.gov/laws/11875
[8] https://westcoastcleantransit.com/#resources-section
[9] http://westcoastgreenhighway.com/electrichighway.htm
[10] https://energyoffice.colorado.gov/zero-emission-vehicles/colorado-ev-plan-2020
[11] https://www.oregon.gov/ODOT/Programs/Pages/Electric-Vehicles.aspx
[12] https://goelectric.oregon.gov/our-strategy

Intervention Strategy	Case Studies/Examples	AZ Recommendation
	○ Utility rebates and partnerships ○ EV charging priority for parking lot waitlists ○ Code to require EV ready for all new residential and commercial buildings by 2022. ○ Work with Electrify America to install DC fast charging on busy corridors using some VW Settlement funds	
• **Local Collaborations:** Providing grants for EV chargers and related infrastructure for low-income communities; EV ready requirements in code; light poles for charging; free parking; prominent websites with maps; EV no-cost borrowing program; charging hubs; etc. Set goal or at least have realistic projections of growth.	• Ft. Collins, CO ○ Wanted to make transport more convenient, accessible, and cleaner. As part of this, created EV Readiness Roadmap 2018 with implementation beginning 2019 with formation of Steering Committee – excellent and comprehensive; could be reference for cities as a place to start.[13] ○ Only took the City nine months to prepare detailed roadmap. ○ Gives 1- to 2-year goals, 3- to 5-year goals, and within 10-year goals. ○ Sets Goal Citywide for 50% of EV sales by 2030 as part of leading by example and knowing what to plan for. ○ Partnered from very beginning with County, other Cities, non-profits, utility, and the University • **Sonoma and Mendocino Counties (CA)** and other entities partnering with CA Energy Commission to increase EV charging from current 460 public stations. Pays $8,000 for Level 2 and $80,000 for DC Fast Chargers. At least $7M is available from a variety of agencies.[14] • **Portland, OR EV Strategy:** Carbon reduction plan – 40% by 2030 and 80% by 2050 – transportation 40% of emissions so of high importance. Lists 49 actions to increase EV adoption, with 23 specifically related to infrastructure.[15]	• Local – cooperate in upcoming MAG program in the Valley • Universities can assist in development of regional goals in absence of local drivers outside of MAG or Pima County; utilities can provide support and information regarding technical information; non-profits could be central to above • Goal setting helps define needs but even in absence of goals, growth assessment for each Region/City provided to Cities and Counties would be an excellent way to encourage governmental entities to begin to think about and potentially support EV charging in a way that allows ownership growth. City of San Francisco partnered with the International Council on Clean Transportation October to support charging station study for goal of 100% new vehicle sales by 2030. Excellent example of support communities need.[16]

[13] https://www.fcgov.com/fcmoves/files/cofc-ev-readiness-roadmap.pdf?1540496524
[14] https://sonomacleanpower.org/news/sonoma-and-mendocino-counties-selected-for-6-75m-incentive-program-for-electric-vehicle-charging-infrastructure
[15] https://www.portland.gov/sites/default/files/2019-07/final_electric-vehicle_report2016_web.pdf
[16] https://www.usdn.org/members/updates/39978#/

Case Study Spotlight

Policy or Program:	**CALeVIP** 
Place: **(e.g., SMUD)**	• California (deployed in certain counties based on solicitation and staff evaluation as "Projects").
Key Features	• Rebates for Level II and DCFC EV chargers. • Chargers must be open to the public.
Cost and Financial Impact	• Total funding up to $200M, currently authorized for ~$70M • Relatively self-sustainable funding (from vehicle registrations and smog abatement)
Equity Considerations	• Specific Projects have created floors for a minimum amount of funding to be allocated to low-income and disadvantaged communities. For example, the Peninsula-Silicon Valley Project stipulates that 25% of funding go to DACs and LICs. • Discussed further below as a potential barrier, a prerequisite to benefit from CALeVIP is actually owning an EV. The program stipulates that chargers must be public access, which has led to certain use but for those members of the public that cannot afford an EV
Potential Barriers:	• One of the major challenges of the CALeVIP program is that funding is limited to Project Areas. While this allows more deliberate, targeted, and focused allocation of funds, it has caused some bureaucratic delays where greater flexibility would have allowed for more installations. • Another issue is the overlap of equity and CALeVIP's eligibility requirement for public access. Specifically looking at future use cases, many emerging EV mobility solutions (such as managed EV rental, carsharing and ride hailing fleets) that directly provide green miles to the public and may benefit from more predictable access to chargers through CALeVIP, are ineligible for the program due to relying on privately managed chargers. While CALeVIP is intended to provide the public with greater charger access, EV ridesharing serves as a way for low-income communities to still access green miles even if they may not have the means to afford an EV. Disqualifying emerging mobility models with private chargers raises equity concerns about the program. In anticipation of these emerging technologies and growing trends towards mobility as a service, Arizona should consider adopting broader eligibility requirements - especially for business models that specifically exist to provide the public with access to all-electric transportation.

Overarching Goal-Setting Recommendations

The stakeholders of the EV Infrastructure Working Group recommend a statewide high adoption goal for light-duty vehicles by 2030, that by the year 2030, Arizona should have at least 22% or 1.5 million light-duty electric vehicles on the road statewide, and the maximum charging station infrastructure to serve this number of light-duty vehicles.[17] This high adoption goal is important to identify the level of make-ready infrastructure and other infrastructure projects that will be needed as well as the level of investments that will be needed to electrify Arizona's transportation sector. This goal should be adjusted and reevaluated at least every ten years, with an interim 5-year check-in.

References/external resources

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CERES, "Accelerating Investment in Electric Vehicle Charging Infrastructure", March 2018.
MJB&A, "Accelerating the Electric Vehicle Market- Potential Roles of Electric Utilities in the Northeast and Mid-Atlantic States", March 2017.
SEPA, "Utility Best Practices for EV Infrastructure Deployment", June 2020.

[17] These projections are based on the NREL EV Pro Lite Tool, available at https://afdc.energy.gov/evi-pro-lite.The NREL EV Pro Lite tool does not allow adoption scenarios where EVs exceed 10% of the light duty fleet, so the results had to be extrapolated to higher levels of EV penetration.

Arizona Statewide Transportation Electrification Plan

Equity Working Group Report

December 2020

Setting the Stage

Who We Are

The Equity Working Group consists of Arizonans working across public, private, academic and non-profit sectors. Our collective contribution to Arizona's Statewide Transportation Electrification Plan comes from the voices of our cities, towns, counties and Tribal Nations across the state. It comes from the voices of educational institutions including Maricopa Community Colleges, Arizona State University, Northern Arizona University, and Flagstaff Unified School District. It comes from voices of the business community and private sector industries including Arizona Hispanic Chamber of Commerce, Arizona Trucking Association, Intel, CLEAResult, and the Grand Canyon Shuttle Bus System. And importantly, our contributions come from voices of advocacy, public-interest and nonprofit organizations including Southwest Energy Efficiency Project, Western Resources Advocates, Wildfire, Arizona Sustainability Alliance and Chispa Arizona. For many, this work is very familiar and for others it feels brand new. Our strength is in our shared commitment to advancing equity, our belief that transportation electrification has potential to enable a higher quality of life for Arizona's communities, and the varied perspectives and expertise we bring to the table.

We also acknowledge who we are not. Like other working groups involved in this process, all of the Equity Working Group meetings were held online during normal business hours, conducted exclusively in English, and members were not compensated for their time or contributions. As a result, participation required, at minimum, access to the internet, a computer or smartphone, an emailed link to the meeting, the time to volunteer, and English proficiency and literacy. This process also assumed stakeholders had basic knowledge of, and interest in, transportation electrification. These requirements and assumptions prevented broader and deeper participation, especially across underserved communities in our state – the very people we seek to lift up through this work. **Development of future transportation electrification plans, policies and programs must break down these barriers and ensure that actions are aligned with the needs of underserved communities and result in meaningful improvements.**

When equity is not explicitly brought into the planning and decision-making process, social and racial inequities are likely to be reinforced and, in some cases, exacerbated. At its onset, the Equity Working Group consisted of 14 members. Compared to the state's demographic profile, whites were overrepresented in the group while communities of color were underrepresented. Recognizing this disparity, the first priority of the Equity Working Group was to increase the diversity of the group itself. Through our outreach efforts, the group grew to 64 members and was better equipped to discuss and recommend actions to advance equity in transportation electrification. This report is an important beginning, but there is much more work ahead.

For a full list of members, see Appendix A.

Equity and Transportation Electrification

The existing transportation system in Arizona has placed disproportionate burdens on communities of color and low income communities in the form of air pollution, climate change impacts, costs, and access to employment and other essential services. Equity can be thought of as a corrective mechanism of redistributing benefits and burdens. Transportation electrification (TE), if planned and implemented appropriately, has the potential to reduce or eliminate burdens and enable a higher quality of life for all communities in Arizona.

Emissions from gas and diesel vehicles are a predominant source of air pollutants including ozone, particulate matter, and carbon monoxide (ADEQ, 2018). Negative health impacts of air pollution from vehicle emissions disproportionately affect communities of color and low income communities (Greenlining Institute, 2020). These communities are often located in closer proximity to higher traffic roads and highways. As a result of ongoing exposure to dangerous levels of tailpipe emissions, they experience higher rates of respiratory illnesses like asthma, cardiovascular disease, and premature death (American Lung Association, 2020). Historical policies and practices that discriminated against BIPOC (Black, Indigenous, and People of Color) communities continue to impact society today. For instance, past generations of BIPOC families were prevented from accumulating and passing on wealth that could have enabled current generations the financial wellbeing to live in less polluted neighborhoods or enable them to afford healthcare to manage negative health impacts of prolonged exposure to pollution.

The transportation sector is also a major contributor of greenhouse gas emissions causing climate change, accounting for 41% of carbon dioxide emissions in Maricopa County (MCAQD, 2020). Low income communities and communities of color often live in areas that are more susceptible to the impacts of climate change, including excessive heat (ASU & ADHS, 2015). They may suffer greater heat stress due to (1) hotter urban environments from land use, building materials and lack of vegetative cover, (2) high physical exposure to heat from outdoor occupations (e.g., landscaping, construction), and (3) fewer resources available to mitigate heat (e.g., home and vehicle air conditioning, swimming pools). Transportation electrification can significantly reduce greenhouse gas emissions and alleviate negative impacts from climate change, which is especially crucial for underserved communities.

Low income communities and communities of color also stand to benefit the most from the cost-savings provided by transportation electrification. Low income households spend a higher portion of their income on transportation compared to wealthier households (ITDP, 2019). According to a recent publication by Consumer Reports, owning an EV will save Arizonans an average of $6,000 to $10,000 over the life of the vehicle compared to a similar gas-powered vehicle (2020). Arizonans can save an estimated 60% annually on fuel costs by switching to electric charging, and spend half as much on maintenance and repair. Additionally, EVs have been shown to hold their value better, making for a stronger investment. However, surveys of EV owners reveal that most EVs are purchased by white, college educated men with higher than average incomes (Center for Sustainable Energy, 2017; CarMax, 2017). If these trends hold true in Arizona, it could exacerbate existing social inequities in our state.

Modern-day Arizona has been designed for easy, convenient, and efficient transportation by personal vehicle. Our neighborhoods, businesses, and schools are connected by, and reliant

upon, on a vast network of roads and freeways. For many of us, it is hard to imagine getting to and from work, school, the grocery store, doctor's office, or other essential destinations without a car. Yet, this is an everyday reality for many Arizonans. While public transit such as buses, light rail, and dial-a-ride services are available in many parts of the state, it is rarely as accessible or optimal as travelling by personal vehicle. Within the Phoenix Metro, 53% of bus-riders do not have a personal vehicle (Valley Metro, 2019). An equity approach to TE calls for electrifying existing public transit services and expanding clean transportation options to increase access to economic opportunities, healthcare, education and other essential functions for individuals and families, especially in underserved communities.

In order to achieve statewide transportation electrification, we must prioritize equity for underserved communities throughout the state of Arizona. The Urban Sustainability Directors Network describes different forms of equity that can be advanced through design and decision-making, including: (1) **procedural equity** to ensure that processes are fair and inclusive in the development and implementation of any work; (2) **distributional equity** to ensure that resources, benefits, and burdens of a policy or program are distributed fairly, beginning with those most in need; (3) **structural equity** to ensure the correction of past harms, institutional racism, and the prevention of future negative consequences by changing decision-making and accountability structures; and (4) **intergenerational equity** to ensure that decisions do not result in unfair burdens on future generations (USDN, 2014).This report integrates aspects of each of these forms of equity to inform Arizona's Statewide Transportation Electrification Plan so that all communities may have access to and participate in a clean transportation future.

Our Objectives

The Equity Working Group focused on the following objectives:

1. Determine how EV policies and programs can grow access to Transportation Electrification (TE) in underserved communities.

2. Identify and prioritize the near-, medium- and long-term actions necessary to ensure equity in the development of programs and deployment of TE infrastructure in Arizona.

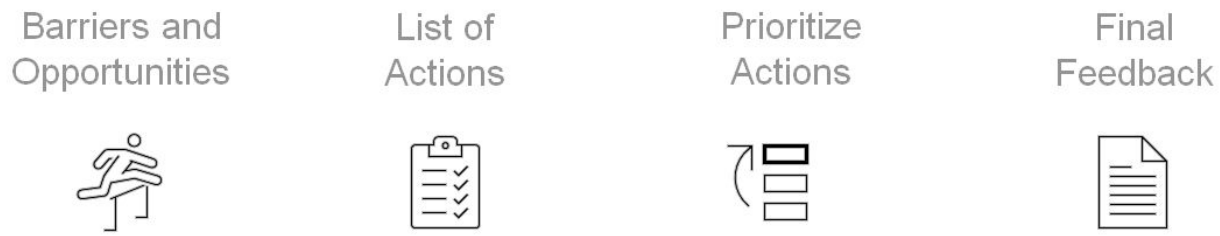
As used here, **access** to TE includes, but is not limited to 1) possessing the necessary means to own and maintain an electric vehicle, 2) availability and affordability of EV charging stations, 3) electrified public transit options and ridesharing services that are convenient, reliable and affordable, 4) job training and employment opportunities in industries associated with TE and related infrastructure and 6) awareness of TE choices, benefits, and incentives.

As used here, **underserved communities** refers to populations with inadequate access to TE due to economic, social, cultural, or geographic circumstances. Underserved communities may include, but are not limited to 1) low-income households, 2) communities of color, 3) non-English speaking households, 4) Indigenous Peoples, and 5) rural communities.

With regards to prioritizing time frames for actions, near-term was considered to mean within the next year, medium-term within one to four years, and long-term within five or more years.

Our Process

The Equity Working Group held five virtual meetings over Zoom between August and December of 2020. A Chair and Co-Chair were selected at the first meeting and were responsible for organizing subsequent meetings and communicating with working group members as well as staff from ILLUME, APS, and TEP. The Equity Working Group researched and discussed equity in transportation electrification in reference to accessibility, education and outreach, employment opportunities and funding mechanisms. We drew on our own expertise and experiences as well as the work of organizations such as Greenlining Institute, Forth Mobility, EVNoire, the Alliance for Transportation Electrification, and others leading in the equity and transportation electrification space. The graphic below depicts an overview of the process.



Working in subgroups, the members identified barriers preventing underserved communities from accessing transportation electrification and identified corresponding policies, programs and strategies to overcome these barriers. The responses were gathered and synthesized into 19 barriers and 56 opportunities (Appendix A). From this exercise, a list of 17 actions were generated and discussed with the working group. Next, the Equity Working Group reconvened and prioritized the 17 actions using an interactive polling platform. Members submitted their responses individually and the results were discussed as a group. This report serves as the culmination of our work and is provided as the Equity Working Group's final feedback to inform the larger stakeholder process for the Statewide Transportation Electrification Plan.

Overcoming Barriers

Our efforts to identify opportunities to overcome barriers that prevent distribution of an equitable TE process focused on providing solutions in a wide variety of focus areas. This summary highlights those areas of primary concern. A detailed list of barriers and corresponding opportunities can be found in Appendix B.

1. **Ensuring an Equitable TE Process**
    a. Including and empowering voices of the underserved community at the table during key stakeholder ratification
    b. Ensuring structures that enable and prioritize equity are visible and realized throughout the TE process
    c. Requiring early support and high engagement from key stakeholders throughout this process

2. **Access to TE through EV Ownership**
    a. Addressing high cost of purchase and leases of EV's for underserved communities
    b. Developing an EV charging strategy for lower income homeowners and renters in multifamily units
    c. Reducing the cost of EV Battery replacement
    d. Increasing the availability of the number of EV's in the marketplace
    e. Introduce campaigns to increase awareness, fact sharing, program availability to underserved communities and dealerships that serve those communities
    f. Establish equity or parity in the cost of EV's for lower income residents that does not further burden their debt to income ratio
3. **Access to TE through Public Transit, Ride Sharing, and Micro Mobility**
    a. Equity in TE across the spectrum of residents who do not own a vehicle nor have a desire to own a vehicle, by establishing public EV transit options
    b. Address the increasing need of Arizona residents to own a vehicle for basic transportation needs
4. **Access to TE through Infrastructure Investments**
    a. Develop and deploy solutions for EV charging in Tribal and Rural communities
    b. Incentivize owners and developers of multifamily housing units to install EV chargers
    c. Require sufficient public charging access on highways and interstates to address range anxiety
5. **Access to TE Employment Opportunities**
    a. Develop programs that provide the current ICE vehicle and service repair labor pool with the training to transition their skills to support maintenance of the EV market.
    b. Invest in establishing a pipeline of future EV technicians through skill trade and Career and Technical Education (CTE) programs at the highschool and secondary education level
    c. Additionally, establishing a pipeline of future EV technicians through skill trade and CTE programs within the Prison system. Promoting and providing access to Green Jobs
    d. Cultivate a state jobs initiative to increase opportunities for residents in TE fields such as manufacturing, transportation, and engineering

Prioritizing Actions

The Equity Working Group ranked 17 priority actions based on when they should be implemented, with the options of within the next year, in one to four years, or five or more years. Individual responses were collected through a survey tool and the aggregated results were discussed as a group. There was clear consensus around implementation timeframes for many actions, while others sparked more varied responses. In instances where there was no clear majority, discussions revealed that members struggled between responding with what they

wanted to see (e.g., near-term) and what they felt was realistic (e.g., medium- or long-term). The following table presents recommended implementation timeframes for 17 priority actions. Complete survey results are provided in Appendix C.

Implementation	Priority Action
Within the next year	Center voices and experiences of underserved communities in development of TE plans, programs, and policies
	Create structures to prioritize equity and track progress throughout development and implementation of TE Plan
	Build support for TE equity among key stakeholders
	Raise awareness using appropriate messages and trusted messengers
	Support e-bikes, e-scooters, and other electric micromobility options
1 – 4 years	Develop equitable funding mechanisms
	Reduce upfront cost to purchase/lease an EV and reduce cost of battery replacement
	Increase availability, quantity, and options of affordable EVs
	Equitably distribute charging stations with fair pricing models
	Electrify and expand public transit
	Electrify school buses
	Electrify ridesharing/carsharing programs
	Provide training programs to support transition to TE jobs to avoid job losses in ICE repair services, etc.
	Develop Career and Technical Education (CTE) programs in high schools and community colleges
	Allocate more funding for trade-focused R&D areas for high school and community colleges
	Create pipelines and training programs in prisons to provide access to green jobs
5+ years	Electrify autonomous shuttle services

Next Steps

Recognizing the critical need to expand and continue this work, the Equity Working Group recommends the following next steps.

1. Establish leadership group for TE equity efforts in Arizona

It is imperative to center the voices and experiences of underserved communities in the development of TE plans, policies and programs. Too often, those that are most impacted by transportation decisions are not at the table when those decisions are being made. The thoughts and voices of people in the most oppressed situations are our guides. The Equity Working Group recommends identifying a non-profit, academic, public or industry group to lead efforts to advance TE equity in Arizona. The group would work directly with underserved communities and stakeholders, develop a TE equity mapping tool using key metrics, recommend TE programs and policies, measure impacts of implemented actions, and report on progress.

Utilities can support this work by providing funding and resources to enable the group's success. Members of this Equity Working Group can assist in identifying a suitable organization and may continue to be involved. Greenlining Institute, Forth Mobility, and other regional and national organizations working in this space can provide training and insights to the Arizona group.

Additionally, the Equity Working Group recommends that utilities hold quarterly TE Collaborative meetings to ensure that all stakeholders are informed on utility TE actions and provide additional suggestions on ensuring equitable programming. It is critical that stakeholders have an opportunity to voice their opinions on programs before they are filed to be approved at the Arizona Corporation Commission.

2. Commit to equity in broader statewide goals

The Equity Working Group supports an ambitious statewide goal of **1.5 million light-duty EVs on the road in Arizona by 2030**. One way to approach this goal from an equity perspective would be to commit to **enable equal EV ownership regardless of income or race, and commit a certain percentage of total TE investments to be spent in underserved communities**.[1] This could be tracked and measured to indicate progress and identify potential inequities. For instance, if the demographics of EV owners reflects Arizona's demographic makeup this would indicate success towards this commitment, while significant deviations would help identify opportunities for improvement.

There have been discussions about a complementary goal for the number of charging stations required to support a statewide EV adoption goal. The Equity Working Group

[1] Please note that an appropriate percentage of investments for underserved communities would need to be decided through a public process that allows for meaningful community involvement.

recommends that **30-40% of overall investments in charging infrastructure be spent in underserved communities**. Further, we recommend that underserved communities be able to be served by ratepayer-funded charging infrastructure. We encourage developing goals that promote workplace charging and provide convenient, reliable and affordable access to charging for residents of apartments and other multi-family unit dwellings.

Beyond EV ownership, the state should work towards the goal of **100% TE accessibility as the primary mode of transportation for all underserved communities by 2030**. In addition to access through personal EVs, this goal would include access to electric buses, light rail, carsharing, electric school buses and other modes of electric transportation.

With any of these broader goals, it will be important to include interim targets and regularly track and report on progress.

3. Prioritize equity in state policies for TE

Government policy support is critical to success. To achieve statewide adoption of transportation electrification, the Equity Working Group supports Arizona becoming a Zero Emissions Vehicle state. Doing so will increase the EV market and choices available to Arizonans, promote growth of well-paying jobs in green tech industries, and improve public health and the environment.

Thanks and Acknowledgement

Members of the Equity Working Group commend the Arizona Corporation Commission for their leadership and forward-thinking vision in calling for development of Arizona's Statewide Transportation Electrification Plan (Decision No. 77289). We further commend APS and TEP's inclusion of equity as a priority issue in the plan's development and are grateful to have participated in the stakeholder process. We would like to provide special acknowledgement for two staff representatives from APS and TEP, Kathy Knoop and Nicole Hopkins, for their support, contributions, and attentive listening over the past several months. We also thank Victor Mercado, Goldie Christensen, and the rest of the ILLUME team for coordinating and facilitating the stakeholder process.

Last but not least, we would especially like to recognize the efforts of Danae Presler (City of Avondale), Tony Jones (Intel), Marsha Miller (HDR), McKenzie Jones (City of Sedona) and Caryn Potter (SWEEP) for their contributions in the development of this report.

Now is the time to turn planning into action and operationalize equity in Arizona's transportation electrification efforts.

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Appendix A
List of Equity Working Group Members

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Tony Jones, Intel
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Wendy Toney, Intel
William Drier, Electrification Coalition
Yemaya Bordain, Intel

Appendix B
List of Barriers and Corresponding Opportunities

Ensuring an Equitable TE Process

Barriers	Opportunities
Voices of underserved and underrepresented communities may be missing from the stakeholder process	● Continue to identify stakeholders and craft inclusive approaches to empower communities to have a voice in developing TE plans, programs and policies. ● Analyze demographic data across the state to help inform where gaps are (the company HDR has useful GIS data). ● Listen to the needs of BIPOC communities first. Focus groups and surveys may be useful tools, but conversations need to happen with community-based organizations, faith-based organizations, and local trusted community leaders and representatives. ● Partner with community-based organizations to build trust and ensure TE materials and messages are culturally sensitive, relevant and available in key languages. ● Including community voices in policy development can help avoid unintended consequences such as gentrification. ● Center experience of low-income households. ● Understand how the current transportation model affects issues of equity across the state (e.g. car-centric development, transportation burden, access to public transit)
Lack of structures in place to ensure equity is prioritized, and progress is tracked as TE Plan is implemented could result in further disparities	● Set up reporting structures to research and assess TE equity issues, identify and track key indicators. ● Set rules to ensure that high percentage of investment in EV upgrades (30-40%) directly benefit low-income communities and track progress. ● Establish Equity Advisory Council or similar body. ● Integrate equity into the TE Plan overarching goals and interim targets as they are developed (e.g. 1.5 million electric vehicles on the road by 2030)
Insufficient support from key stakeholders to consider and advance equity throughout TE planning and implementation process	● Center equity into all aspects of TE planning process.

could exacerbate existing inequities	
Funding mechanisms for TE need to be intentionally equitable or could exacerbate existing inequities	● Consider carbon tax with rebate to low-income households which would provide revenue that could be used to fund and facilitate low-income transition to TE.

Access to TE through EV Ownership

Barriers	Opportunities
High upfront cost to purchase/lease EVs puts them out of reach for many households	● Vouchers, rebates, tax credits and sales exemptions to offset costs and improve financing options. Tax credits are not as effective for low-income households since many will not be able to take advantage of these. ● Targeting vouchers exclusively to low-income drivers increases equity and cost-effectiveness of the voucher by directing funds to those who need it most. ● Trade-ins for ICE vehicles will also help transition to TE. ● Research Question: what percentage of low-income households own a vehicle? (ICE or otherwise). DOT or Census may have information. ● Research Question: what would be the target price range for an EV for the low-income household market? ● Research Question: How do costs of insurance plans and policies differ between EVs and ICE vehicles (used and new), and how does this relate to vehicle owner's age and income?
Unequal access to charging, especially for households renting apartments or multifamily units without dedicated garage, carport, or parking space with electrical outlet	● Provide free public charging in low-income communities. ● Utility companies could adopt a set of rules governing equitable investment in charging infrastructure. ● Cities and towns should adopt ordinances and standards requiring installation of EV charging stations, with a focus on providing free/low-cost charging for multifamily residences and workplace charging. ● Provide EBT-type cards for fast charging for low-income individuals.

High cost of battery replacement in used EVs	● Insurance and/or warranties provided my auto manufacturer. ● Utilities could subsidize batteries in exchange for managed charging. Program could be targeted to low-income households and reduce the cost of purchasing an EV.
Limited availability of EVs	● Incentivize manufacturers to develop smaller and more affordable EV options. ● Consider opportunities to encourage different types and sizes of EVs. ● Arizona could adopt a Zero Emissions Vehicle Standard. ● Promote multi-modal electric transportation options. ● Encourage auto dealers specialized in selling EVs to locate near low- and moderate-income communities and provide equitable financing options (monitor for predatory lending).
Insufficient information on EVs (AZ residents and auto dealers)	● Listen to the needs of disadvantaged/underinvested communities and create programs and informational campaigns on TE that resonates with the community and uses relevant mediums and messengers. ● Provide training and education for auto dealers on EV benefits and incentives, especially for low-income consumers.
Cost of vehicle ownership places higher burden on low-income households and individuals (registration, maintenance, operation)	● Program modeled after “Energy Efficiency Audits” to assist low-income households with reducing costs of vehicle ownership. ● Employers could create incentive program to help with commuting and benefits as part of the employment package ● Low-income communities could be provided an opt-in access for electric ride-sharing

Access to TE through Public Transit, Ride Sharing, and Micromobility

Barriers	Opportunities
Very limited access to TE for households without access/desire to own a personal vehicle and who rely on public transit, ride-sharing, or other means of transportation.	● Subsidize or provide public electric transportation targeted to raise transportation equity. ● Incentivize/require public buses to be electric. ● Incentivize/require school districts to transition to electric buses. ● Incentivize/require EV adoption for ride-sharing. ● Develop public ride-sharing programs targeting service to low-income communities. ● Cities and towns to adopt policies that support road access for electric micromobility (e-bicycles, e-scooters, etc.) ● Autonomous electric vehicle shuttles (e.g. Local Motors Olli development in Chandler).
Arizona's car-centric development patterns have resulted in reduced access to jobs and services for households and individuals without personal vehicles as compared to those with personal vehicles.	● Expand and electrify public transit systems to provide comparable access and level of service that personal vehicles provide – convenient, efficient, reliable, and safe transport at all times of the day. ● Provide more road lanes specifically for (electric) public buses and reduce lanes available to cars. ● Promote use of clean alternative modes of transportation.

Access to TE through Infrastructure Investments

Barriers	Opportunities
EV charging on Tribal Nations and rural communities impacted with lack of infrastructure may not have necessary capacity and resources to install EV charging stations.	● Explore opportunity for fleet electrification for Tribal governments. ● Rooftop solar, standing EV charging stations with solar and battery setup can be used as charging stations.

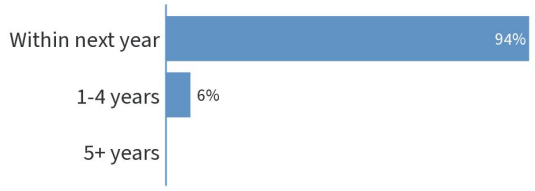
Cost of infrastructure may dissuade owners/developers of multifamily housing units from installing EV chargers.	● Utilities could offset some of the costs to developers. ● Cities and towns could require EV-Ready or EV-Capable parking spaces in new developments (it is significantly cheaper to build infrastructure at time of development than retrofitting existing construction). ● Promote availability of manufacturer agnostic charging stations. ● Financial mechanisms to ensure incentives align between landlords, building owner and tenants.
Lack of public charging stations along highways and interstates reduces ability of travelers with EVs to move around and through the state.	● Identify main travel routes and target EV charging infrastructure investments to fill gaps to support broad adoption of EVs

Access to TE Employment Opportunities

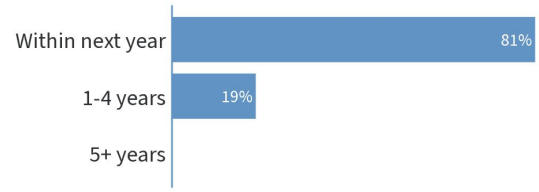
Barriers	Opportunities
Insufficient planning for existing workers could lead to job losses for individuals in ICE-related industries.	● Create training programs to support a just transition for employees in automotive repair services, gas stations, and other industries relying on internal combustion engines.
Limited training for high school career and technical education in TE could lead to lack of skilled labor market	● Develop Career and Technical Education (CTE) programs in high schools and community colleges, especially those serving primarily low-income and underserved communities. ● Allocate more funding in trade-focused and research and development areas for high school and community college programs.
Ex-felons are not always supported by pipelines into these careers	● Create pipelines and training programs in prisons and provide access to green jobs.
Limited availability of TE-related careers in the state	● Position Arizona to recruit economic opportunities in TE and related fields (e.g. manufacturing, supply chain support, used EV market, charging station development and installation, etc.)

Appendix C
Results from Survey Prioritizing Actions

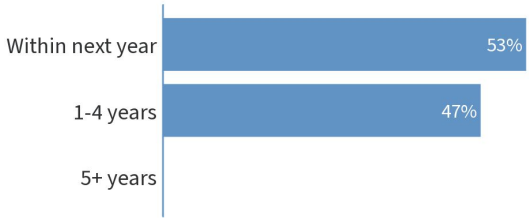
(When should the following take place?) Center voices and experiences of underserved communities in development of TE plans, programs, and policies



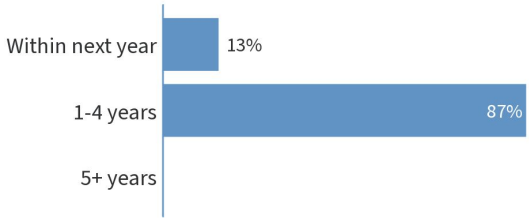
(When should the following take place?) Create structures to prioritize equity and track progress throughout development and implementation of TE Plan



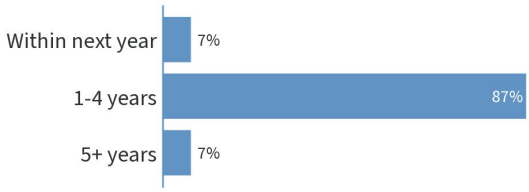
(When should the following take place?) Build support for TE equity among key stakeholders



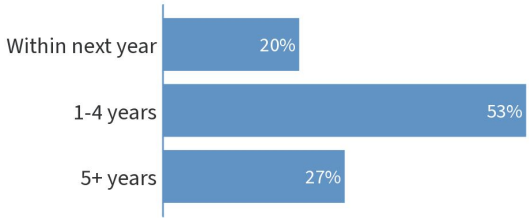
(When should the following take place?) Develop equitable funding mechanisms



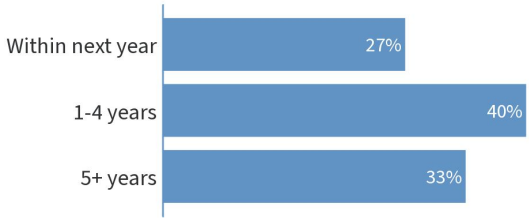
(When should the following take place?) Reduce upfront cost to purchase/lease an EV and reduce cost of battery replacement



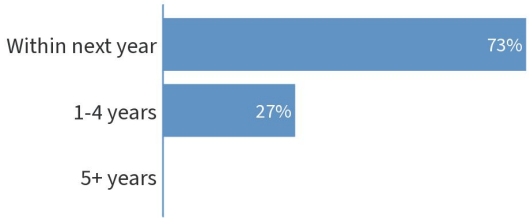
(When should the following take place?) Increase availability, quantity, and options of affordable EVs



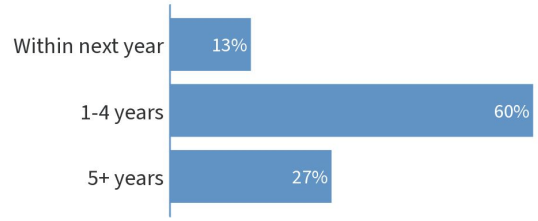
(When should the following take place?) Equitably distribute charging stations with fair pricing models



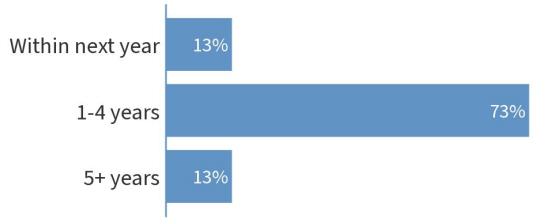
(When should the following take place?) Raise awareness using right messages and right messengers



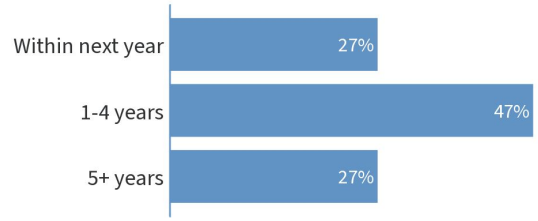
3. (When should the following take place?) Electrify and expand public transit



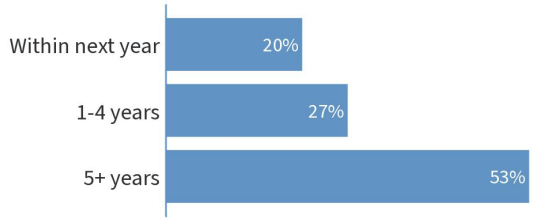
(When should the following take place?) Electrify school buses



(When should the following take place?) Electrify ridesharing/carsharing programs

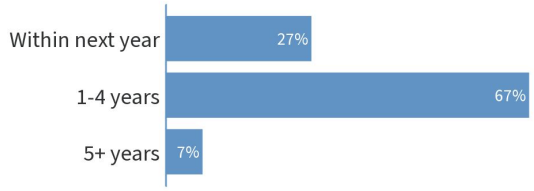


(When should the following take place?) Electrify autonomous shuttle services

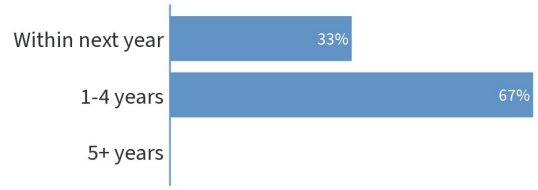


(When should the following take place?) Support e-bikes, e-scooters, and other electric micromobility options

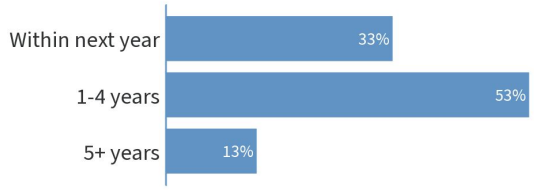
(When should the following take place?) Training programs to support transition to TE jobs to avoid job losses in ICE repair services, etc.



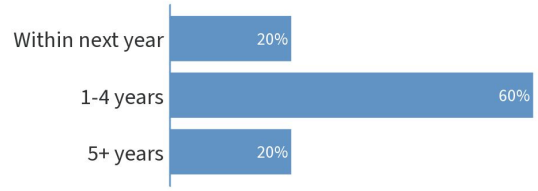
(When should the following take place?) Develop Career and Technical Education (CTE) programs in high schools and community colleges



(When should the following take place?) Allocate more funding for trade-focused R&D areas for high school and community colleges



(When should the following take place?) Create pipelines and training programs in prisons to provide access to green jobs



Arizona Statewide Transportation Electrification Plan
Programs & Partnerships Working Group Deliverable

Table of Contents

Background

The Programs & Partnership Working Group (PPWG) was comprised of individuals, non-profit and for-profit organizations, utilities, and local governments to identify and develop an overall strategy for EV programs that assist in the adoption of EVs. By collaborating with the diverse expertise and backgrounds, we can improve AZ air quality, improve health outcomes, and reduce our costs due to climate impacts.

PPWG Support Team

Co-chairs: Caryn Potter (SWEEP), Amanda Reeve (Arizona Chamber of Commerce)

Group Advisors: Brent Goodrich (APS), Kerri Carnes (APS), Camila Martins-Bekat (TEP), Kimberly Jaeger Johnson (ILLUME)

We would especially like to recognize the efforts of: Karen Apple (City of Phoenix), Anne Reichman (Arizona State University, Sustainable Cities Network), Ursula Nelson (Pima County), Jennifer Anderson (Arizona Center for Law in the Public Interest), Robert Bulechek (Tucson Commission on Climate, Energy & Sustainability), David Gebert (Tucson Electric Vehicle Association), Nicole Hill (The Nature Conservancy), Autumn Johnson (Western Resource Advocates), Tony Perez (Salt River Project), Hanna Breetz (Arizona State University), Lori Glover (City of Scottsdale),

PPWG Members

The table below contains a list of all stakeholders who originally signed up to be members of the Programs & Partnerships working group.

FIRST	LAST	ORGANIZATION	Programs & Partnerships
Amanda	Reeve	Arizona Chamber of Commerce	Chair
Caryn	Potter	Southwest Energy Efficiency Project	Chair
Chris	Baggot	APS	Member
Michael	Denby	APS	Member
Brent	Goodrich	APS	Member
Kathy	Knoop	APS	Member
Devon	Rood	APS	Member
Jennifer	Anderson	Arizona Center for Law in the Public Interest	Member
Dominic	Papa	Arizona Commerce Authority	Member
Heather	Colson	Arizona Department of Environmental Quality	Member
Jordy	Fuentes	Arizona Residential Utility Consumers Office	Member
Hanna	Breetz	Arizona State University (ASU)	Member
Mick	Dalrymple	Arizona State University (ASU)	Member
Paul	Hirt	Arizona State University (ASU)	Member
Anne	Reichman	Arizona State University (ASU)	Member
Tony	Bradley	Arizona Trucking Association	Member
Robert	Perez	City of Glendale	Member
Karen	Apple	City of Phoenix	Member
Lori	Glover	City of Scottsdale	Member
Mike	Gent	City of Surprise	Member
Eslir	Musta	Coconino County	Member
William	Drier	Electrification Coalition	Member

Robert	Bulechek	Energy Consultant	Member
Jeffrey	Wishart	Exponent	Member
Jerry	Mendoza	Friendly House	Member
Erick	Karlen	Greenlots	Member
Kimberly	Jaeger Johnson	ILLUME Advising	Member
Craig	McCurry	Intel	Member
David	Lane	Lake Havasu City	Member
Chris	McAbee	Maricopa County	Member
Elizabeth	Collins	Mountain Line / Northern Arizona Intergovernmental Public Transportation Authority	Member
Alana	Langdon	Nikola Motor / Nikola Defense	Member
Patricia	Hibbeler	Phoenix Indian Center	Member
Jeanette	DeRenne	Pima Association of Governments	Member
Ursula	Nelson	Pima County Department of Environmental Quality	Member
Patrick	O'Leary	Pima County Facilities Management	Member
Katherine	Stainken	Plug In America	Member
Catherine	O'Brien	Salt River Project	Member
Tony	Perez	Salt River Project	Member
Ken	Pratt	Sun Engineering	Member
Francesca	Wahl	Tesla	Member
Nicole	Hill	The Nature Conservancy	Member
Julie	Donovant	Tucson Electric Power (TEP)	Member
Camila	Martins-Bekat	Tucson Electric Power (TEP)	Member
David	Gebert	Unknown	Member
Juan Pablo	Soulier	Waymo	Member
Autumn	Johnson	Western Resource Advocates	Member

Defining Partners

The PPWG identified the barriers and opportunities for Transportation Electrification Programs & Partnerships can be grouped into three categories: *Awareness, Support, and Funding*. The PPWG Identified Residential Customers, Non-Residential Customers, Government Agencies, and Electricity providers to be partners in the transition to electrifying Arizona's transportation sector.

Residential Customers

- Residential Customers - New Adopters/EV Interested: Customers who purchase electricity for their personal home who have *minimal* understanding of electric vehicles (EVs) and/or customers who are thinking about adopting EVs.
- Residential Customers - Intermediate: Customers who purchase electricity for their personal home who have *a beginner to moderate* understanding of EVs.
- Residential Customers - Advanced: Customers who purchase electricity for their personal home who have an *advanced* understanding of EVs.

Non-Residential Customers

- Non-Residential Customers - Small-Medium Business/Organizations: Customers include small businesses/organizations, local businesses/organizations, and medium businesses/organizations.[1]
- Non-Residential Customers - Large Commercial-Industrial Enterprises: Customers include large commercial businesses/organizations and industrial enterprises/organizations.

Government Agencies

- Cities, Counties, Regional, and Sovereign Nations: Arizona government entities who develop and recommend policies and programs.
- Elected Officials and Policymakers: The decision makers that develop federal, state and local laws that effect Arizona.
- Regulators: Entities who oversee the regulation, zoning ordinances, building codes, metrics, and evaluation of transportation electrification and environmental and air quality compliance.

Electricity Providers

- Utilities: Electricity providers that have a designated service territory and are regulated by the Arizona Corporation Commission and/or regulated by an elected board of directors, such as Salt River Project.
- Homeowners: A significant number of EV owners use residential solar energy to power their vehicles, further reducing air pollution.

Third-Party Companies[1]

- Transportation Network Companies: Companies that offer ridesharing options via mobile apps or websites.
- Original Equipment Manufacturers: An original equipment manufacturer is a company that produces parts and equipment that may be marketed by another manufacturer.
- Electric Vehicles Service Providers: An EVSP provides the connectivity across a network of charging stations. Connecting to a central server, they manage the software, database, and communication interfaces that enable the operation of the charging stations.

Defining Programs

For each of the partner groups, the PPWG divided programs into three different categories: Awareness, Supporting, and Funding. An overall customer funnel program approach was used to evaluate the proposed programs.

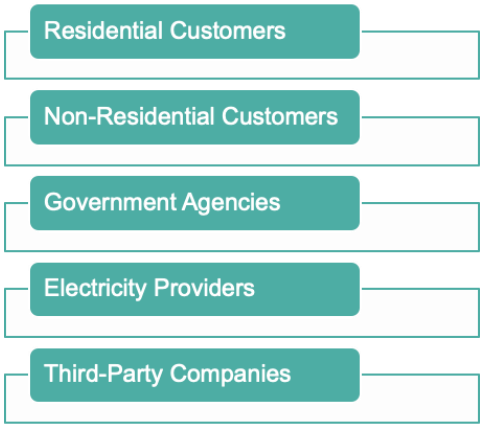
Awareness Programs: Located at the "Top of Funnel" customer acquisition model, these programs are mainly focused on education, outreach, customer service, and marketing.

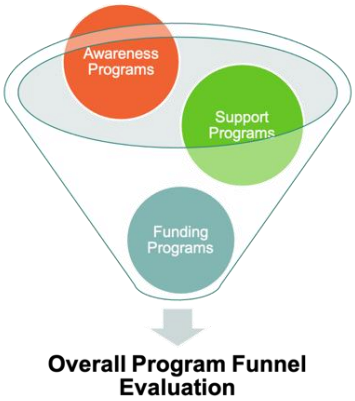
Supporting Programs: Located in the "Middle of Funnel" customer acquisition model, these programs are mainly focused on the deployment of electric vehicles, charging stations, supporting technologies, as well as other actions that enable further adoption.

Funding Programs: Located in the "End of Funnel" customer acquisition model, these programs are mainly focused on the distribution of equipment capital.

[1] Because Third-Party Companies enabled the growth of electric vehicles, we are considering the barriers and opportunities listed throughout this document to also apply to those entities as well.

Illustrative graphics representing a model for various customer segment acquisitions





Work Product 1: "Barriers & Opportunities"

Subgroup Participants:
Karen Apple (City of Phoenix), Anne Reichman (Arizona State University, Sustainable Cities Network), Amanda Reeve (Snell and Wilmer), Ursula Nelson (Pima County), Caryn Potter (Southwest Energy Efficiency Project)

High-Level Barriers and Opportunities

The following table identifies the Barriers and Opportunities identified by the Subgroup as key barriers that prevent increased EV adoption. The ranking does not indicate lesser value of a specific barrier; it is intended for discussion purposes only.

Barriers for EV Deployment For Key Defining Partners	Barriers that Prevent Increase EV Adoption 3=Highest 1= Lowest
Insufficient support for EV friendly policies from elected officials, policy makers at the jurisdiction and state level.	3
Insufficient financial incentives for all customer segments to be able to pay the higher upfront cost, enabling lower lifetime costs. Includes fixed, variable, one-time and ongoing costs.	2
Insufficient residential and non-residential customer education and outreach.	1

Detailed Barriers and Opportunities

Awareness Programs: Awareness Programs are at the Top of Funnel customer acquisition model. These programs are mainly focused on education, outreach, customer service, and marketing.

Residential Customers Barriers and Opportunities for Awareness Programs

	Residential Customers (New Adopters/EV Interested):	Residential Customers (Intermediate):	Residential Customers (Advanced):
Barriers	• Lack of education and expertise on maintenance/fuel savings and differences with conventional vehicles. • Access to Single family/Multi-Family/Work off-street and other types of public EV charging stations. • Access to financing. • Concern about ability to charge when needed.	• Access to Single family/Multi-family/Work off-street charging infrastructure. Access to public EV charging infrastructure. • Access to financing. • Awareness of charging process/requirements for converting to Level 2 charger or rate design.	• Limited battery life for certain model types. • Limited model options in non-ZEV states. • Awareness of inter-city charging infrastructure. • Older homes having lack of electric capacity or infrastructure near parking locations. • Access to charging in rural parts of the state.
Opportunities	• Right to Install/operate charging infrastructure.	• Right to Install charging infrastructure.	• Seasoned EV customers are at a different place on the funnel than non-seasoned EV customers. • Advanced EV customers often serve as advocates for building awareness and education among New Adopters/EV Interested.

Non-Residential Barriers and Opportunities for Awareness Programs

	Non-Residential Customers (Small-Medium Business):	Non-Residential Customers (Commercial-Industrial Enterprises):
Barriers	• Limited charging network impacts customer confidence. • Vehicle orders can frequently take long periods of time before delivery. • Limited availability of trained vehicle service technicians. • Reluctance from existing maintenance providers • Related EV and infrastructure space requirements. • Limited funding for EV acquisition. • Land use/development services issues. • Parking space retrofit challenges. • Inadequate equipment configuration for charging scenarios. • Dealership salespersons have a limited education on how to sell or discuss EVs with customers. • Some dealerships can be adverse to the idea of EVs due reduced service revenue. • Utility Demand Charges on public fast charging networks • Small businesses are unaware of how to best utilize electric vehicles or electric vehicle charging stations at their business locations.	• Lack of vehicle diversity and models for purchase. • Rate design and demand charge costs for bus operators and C&I customers. • Limited availability of trained vehicle service technicians. • Staff training (drivers and technicians). • Site reconfiguration and space challenges. • Understanding and awareness of Utility Demand Charges. • Understanding the pros/cons of leasing vs purchasing options for EVs. • Limited commercial/industrial EV options. • Rapidly changing EV technologies for commercial and Industrial vehicles. • Opportunity for integrating new industries to use EVs. • Limited access to EV maintenance technicians for EV fleets or having to retrain vehicle maintenance staff on EV technologies/repairs.

Non-Residential Barriers and Opportunities for Awareness Programs

	• Limited current educational opportunities for Chambers of Commerce and its members. • Limited understanding of how reduced vehicle operating costs can serve business purposes.	
Opportunities	• EV Fleet pricing/leasing opportunities. • Development of EV-Ready Building Codes.	• EV Fleet pricing/ leasing opportunities. • In-vehicle operational sheet. • Driver education classes. • Marketing/Promotion of EV fleet vehicles when deployed on mass scale (ex. Amazon delivery vans out in communities with promotion wraps touting benefits of it being an EV vehicle).

Government Agencies Barriers and Opportunities for Awareness Programs

	Cities, Counties, and Sovereign Nations	**Elected Officials and Policymakers**	**Regulators**
Barriers	• Limited access to garages with charging stations after hours. • Lack of resources at various government agency levels. • Understanding and awareness of Utility Demand Charges.	• Lack of education on policies needed to promote EV transition equitably.	• Lack of experience in transportation, electrification planning and regulation. • Lack of policies to determine proper demand charge optimization for DC Fast Chargers, which quickly erode revenues from business model.
Opportunities	• Multiple models will need to be tested in pilot programs. • Provide information to government agencies demonstrating the benefits, financial, air quality and others, of providing public charging infrastructure. • Determining the best locations for EV charging that will match neighborhood typology. • Regional approach to get help from governmental agencies to collaborate on funding and resource opportunities.	• Modernize Arizona's transportation fund in order to address revenue shortfalls associated with increased fuel efficiency, air quality, and climate externalities. • Education campaigns specifically geared towards legislators. • Using the lot for overnight, wall-socket, Level I charging may be possible at limited parking spaces.	

Electricity Provider Barriers and Opportunities for Awareness Programs

	Utilities
Barriers	• Lack of understanding of who is responsible for long-term electric charging infrastructure maintenance and the proportion that is utility-owned, or third-party-vendor owned. • Unclear roadmap for engaging with Transportation Networking Companies (TNCs).
Opportunities	• Promoting pilot program models to identify the right mix of ownership based on the needs of Arizonans. • Limited educational planning for EV purchase and managed charging. • A No-Demand-Charge EV Charging Rate Plan.

Supporting Programs: Supporting Programs are in the "Middle of Funnel" customer acquisition model. These programs are mainly focused on the deployment of electric vehicles, charging stations, supporting technologies as well as other actions that enable further adoption.

Residential Customers Barriers and Opportunities for Support Programs

	Residential Customers (New Adopters/EV Interested):	Residential Customers (Intermediate):	Residential Customers (Advanced):
Barriers	Need for charging outlets/EVSEs at parking spaces.	• Lack of consistent credit options for EV access. • Inconsistencies with EV model availability from state to state.	Need for charging outlets/EVSEs at parking spaces.
Opportunities	• Used EV market expansion. • Increase and/or make available state agency incentives for EVs and EVSEs. • Increase model availability. • Increase dealer education programs and OEM incentives. • Increase virtual and in person education events. • Utility/Dealership collaborations - sales education. • Right-To-Charge Legislation & EV-Ready Building Codes	• EV Charger incentives – funding levels commensurate with specific scenario - Need to be more robust – tiered approach. • Develop EV owner "welcome kits." • Right-To-Charge Legislation & EV-Ready Building Codes	• Develop loyalty customer focused programs. • Offer utility incentives to those users reaching a certain level of "savings" per use/monthly/annually/ quarterly. • Referral Programs. • Right-To-Charge Legislation & EV Ready Building Codes

Non-Residential Barriers and Opportunities for Support Programs

	Non-Residential Customers (Small-Medium Business):	Non-Residential Customers (Commercial-Industrial Enterprises):
Barriers	• Limited charging network impacts customer confidence. • Vehicle orders can frequently take long periods of time before delivery. • Limited availability of trained vehicle service technicians. • Reluctance from existing maintenance providers • Related EV and infrastructure space requirements. • Limited funding for EV acquisition. • Land use/development services issues. • Parking space retrofit challenges • Inadequate equipment configuration for charging scenarios.	• Lack of vehicle diversity and models to choose from. • Rate design and demand charge costs for bus operators and C&I customers. • Limited availability of trained vehicle service technicians. • Staff training (drivers and technicians). • Site reconfiguration and space challenges.
Opportunities	• EV Fleet pricing/leasing opportunities. • Development of EV-Ready Building Codes.	• EV Fleet pricing/ leasing opportunities. • In-vehicle operational sheet. • Driver education classes.

Government Agencies Barriers and Opportunities for Support Programs

	Cities, Counties, and Sovereign Nations	Elected Officials and Policymakers	Regulators
Barriers	• Multi-Unit Dwellings (MUDs) have limited access to EV charging. • Human resource limitations.	• Lack of pricing options to meet EV customer needs.	• Approving pilot programs and full-fledged programs in a timely manner.
Opportunities	• EV charging planning fact sheet (installation guide, vendors, qualified installers, pricing). • Voucher/Rebate programs for electrification (like water saving programs) • Partnering opportunities with eBike shops (marketing) • Cross-promotional marketing (dealerships, EVSE vendors) • Partner with Utilities on Drive and Ride events • EV-Ready Building Code development • Lead by example – Fleet conversion and charger deployment – EV Roadmap	• Regional EV planning/deployment coordination. • Influence state government officials for EV adoption. • Climate action and adaptation plan development to include EV transition targets. • Right-To-Charge legislation	• Ensuring regulatory lag doesn't hinder the growth of programs for all partner-types.

Electricity Provider Barriers and Opportunities for Support Programs

	Utilities
Barriers	Regulatory approval for EV support programs and infrastructure development and funding.
Opportunities	• EV Roadmap program development. • Proposals to ACC for EV program dedicated funding stream. • Cross-promotional marketing for charging station, supportive EV dedicated rate design, and EV models. • Identify areas of lower cost to install charging infrastructure – Load and needs assessment.

Funding Programs: Funding Programs are in the "End of Funnel" customer acquisition model. These programs are mainly focused on the distribution of funds.

Residential Customers Barriers and Opportunities for Funding Programs

	Residential Customers (New Adopters/EV Interested):	**Residential Customers (Intermediate):**	**Residential Customers (Advanced):**
Barriers	• Financial incentives/rebates for EVs and charging equipment to support higher adoption rates. • Federal rebates are no longer available for Tesla models or Chevy Bolts, which are two very popular automakers.	• Credit risk and access to low interest loans.	• State and utility grants and incentives for individual customer purchases. • EV Sales Tax Exemption
Opportunities	• EV Sales Tax Exemption.	• Making multi-family residential projects cost-effective by making variable rebates. • EV Sales Tax Exemption	• Support for multi-family and workplace charging

Non-Residential Barriers and Opportunities for Funding Programs

	Non-Residential Customers (Small-Medium Business):	**Non-Residential Customers (Commercial-Industrial Enterprises):**
Barriers	• Financial incentives/rebates for EVs and charging equipment to support higher adoption rates.	• Having Arizona state government or utilities incentivize the EV charging station and related equipment, electrical service upgrades required for the installation, design and engineering services, construction, and installation (materials and labor), Service, warranty, and O&M agreements as a way of getting closer to cost-parity.
Opportunities	• Utility & government support for workplace and fleet charging.	• Encouraging vehicle manufacturers to incentivize vehicles that are more expensive up front than other models. • Redefining project costs to include all costs for EV charging station installation and maintenance.

Government Agencies Barriers and Opportunities for Funding Programs

	Cities, Counties, and Sovereign Nations:	Elected Officials and Policymakers	Regulators
Barriers	• Limited clarity regarding which business model works best for "third places," meaning workplace charging and public city locations.[2] • Financial incentives/rebates for EVs and charging equipment to support higher adoption rates. • DC Faster Chargers have a high price point but have low utilization rate if they are placed in rural areas, making the incentive to install them lower. • No federal rebate programs are available from the state for cities and rural communities.	• Lack of supporting policies for EV growth. • Vehicle purchase incentives are expensive to implement and may be seen negatively if not implemented thoughtfully. • Inadequate transportation fund systems. • Lack of statewide car sharing programs.	• Lack of policies requiring transportation electrification activity for compliance with state and federation regulations. • Zoning laws that create hurdles for MUD, workplace, and public EV charging. • Reduced or limited state budgets. • Lack of decision-making to utilize VW Settlement funds towards EV infrastructure and investments.
Opportunities	• Metro Planning Organizations (MPOs) to conduct EV studies and transition fleets. • Purchasing collaboratives. • Clean Cities initiatives.	• Reduced lifetime fleet operating costs.	• Reduced health, air quality, and climate disaster costs.

Electricity Provider Barriers and Opportunities for Funding Programs

	Utilities
Barriers	• Lack of long-term planning to ensure customer connections to electric grids for EVs are as efficient as possible. • Lack of community organization-vetted plans for public charging infrastructure maps. • Limited Time-of-Use differential in rate plans to incentivize managed charging.
Opportunities	• Financial support for single families, multifamily, and fleet charging. • Cost comparison tools for electric vehicle options.

[2] http://www.seattle.gov/documents/Departments/OSE/FINAL%20REPORT_Removing%20Barriers%20to%20EV%20Adoption_TO%20POST.pdf

Work Product 2: "Intervention Strategies"

Subgroup Participants: Jennifer Anderson (Arizona Center for Law in the Public Interest), Robert Bulechek (Tucson Commission on Climate, Energy & Sustainability), David Gebert (Tucson Electric Vehicle Association), Nicole Hill (The Nature Conservancy), Autumn Johnson (Western Resource Advocates), Camila Martins-Bekat (Tucson Electric Power), Tony Perez (Salt River Project), Francesca Wahl (Tesla), Patrick O'Leary (Pima County)

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1. **Describes best practice EV programs and intervention strategies implemented across the country to accelerate EV deployment and overcome the barriers from Work Product #1.**

The following table identifies what the Intervention Strategies subgroup has identified as intervention strategies to consider when creating transportation electrification programs This is not an exhaustive list of policy actions or intervention strategies.

Barriers	Intervention Strategies to Address Barriers
• Insufficient support for EV friendly policies from elected officials, policy makers at the jurisdiction and state level.	• Right-To-Charge Legislation & EV-Ready Building Codes • Zero Emission Vehicle Legislation/Administrative Action • Group Buy Programs • EV Fleet Targets • Support for appropriate EV Registration Fees • Uniform EV Signage Legislation/administrative action • Open Access / Interoperability Legislation • Reinstatement of statewide office that participates in regional collaboration, funding, and program coordination on transportation electrification. • Utility administered programs that assist cities, counties, and sovereign nations in further developing transportation electrification programs and goals.
• Support for financial incentives for all customer segments to lower the upfront cost and experience lifetime cost savings.	• State and/or utility incentives programs for OEM's, fleets, personal vehicles purchase, used EV market expansion, and for electric installers of home electric charging stations. • Low-Income Rideshare programs. • Ensuring appropriate portion of customer financial incentives are dedicated to enhancing the use EV market. • Collaborate with regional and national entities working towards removing the financial disincentive for dealerships to promote and sell electric vehicle. • Inclusion of pilot projects to test the latest macro and micro eMobility solutions.
• Insufficient residential and non-residential customer education and outreach.	• Utility education and awareness programs for non-EV drivers, local dealerships and OEM, as well as businesses/companies with fleets and workplace charging capability. • Increase Original Equipment Manufacturer (OEM) incentives for individual customer purchases. • Utility hosted quarterly "Transportation Electrification Collaborative" meetings to update stakeholders and what they are seeing in the field, and to allow other entities that announced public goals to create an environment to strategize action items.

Awareness Programs

Awareness Programs are at the Top of Funnel of the customer acquisition model. These programs are mainly focused on education, outreach, customer service, and marketing.

Awareness Program Intervention Strategies				
Residential Customer	**Non-Residential Customer**	**Government Agencies**	**Electricity Provider**	**Third-Party Companies'**
• Utility education and awareness programs. • Education to dealers, automakers on how to market electric vehicle specifics to residential customers. • Education on the best rate plans for EV owners and how to be set up for success on that rate plan. • Increase virtual and in person education events.	• Workplace Charging Programs. • Workplace fleet targets. • Group Buy Programs. • Marketing/Promotion of EV fleet vehicles when deployed on a mass scale.[3]	• Low-Income Rideshare programs • Streetlight and Right-Of-Way Charging. • Regional approach for governmental agency collaboration. • Legislative education campaigns. • Use of a wall-socket, Level I charging at limited parking spaces.	• Spearheading pilot program models to identify the right mix of ownership for the needs of Arizonans. • Educational planning for EV purchases and managed charging.	• Utility/Third-Party education and awareness programs. • Education to dealers on how to market EV specifics to residential customers.

Supporting Programs

Supporting Programs are in the "Middle of Funnel" customer acquisition model. These programs are mainly focused on the deployment of electric vehicles, charging stations, supporting technologies as well as other actions that enable further adoption.

Support Program Intervention Strategies				
Residential Customer	**Non-Residential Customer**	**Government Agencies**	**Electricity Provider**	**Third-Party Companies'**
• Programs to support used EV market expansion. • Increase and/or make available state agency incentives for EVs and EVSEs. • Utility/Dealership collaborations - sales education. • EV Charger incentives – funding levels commensurate with specific scenario - Need to be more robust – tiered approach. • Develop EV owner "welcome kits."	• EV Fleet pricing/leasing opportunities or EV Fleet targets. • Enable workplace charging opportunities.	• EV Fleet pricing/ leasing opportunities. • Inclusion in state vehicle procurement and operations sheets. • Driver education classes. • Right-To-Charge Legislation & EV Ready Building Code • Zero Emission Vehicle legislation. • Electric Charging Stations at "Park & Ride" Locations • Airport Electric Charging Stations • Fleet Mandates • EV-Ready Building Codes • Right to Charge charging infrastructure. • Development of EV readiness codes.	• EV Roadmap program development. • Proposals to ACC for EV program dedicated funding stream. • Cross-promotional marketing for charging stations, supportive EV dedicated rate design, and electric vehicle models. • Identify areas of lower cost to install charging infrastructure – Load and needs assessment. • A No-Demand-Charge EV Charging Rate Plan.	• Increase dealer education programs and OEM incentives • Increase model availability.

[3] One example is of an Amazon delivery van out in communities with promotion wraps touting benefits of it being an EV vehicle.

Funding Programs

Funding Programs are in the “End of Funnel” customer acquisition model. These programs are mainly focused on the distribution of funds.

Funding Program Intervention Strategies				
Residential Customer	**Non-Residential Customer**	**Government Agencies**	**Electricity Provider**	**Third-Party Companies'**
• EV Sales tax exemption. • Making multi-family residential projects cost-effective by making variable rebates. • State and utility grants and incentives for individual customer purchases.	• Redefining project costs to include all costs for EV charging station installation and maintenance. • Charging Infrastructure Funding and Financing	• Metro Planning Organizations (MPOs) want to do EV study and transition fleets. • Purchasing collaboratives. • Clean Cities Initiatives. • Vehicle purchasing Incentives. • Fair EV Registration Fees. • Uniform EV Signage Legislation/Administrative Action. • Open Access / Interoperability Legislation. • Restaff a statewide Energy Office tasked with participating with regional collaboration, funding, and program coordination to deal with Arizona’s pressing, energy, climate mitigation, and transportation electrification issues. • Utility administered programs that assist cities, counties, and sovereign nations in further developing transportation electrification programs and goals.	• Financial support for home charging. • Cost comparison tools for electric vehicle options. • Time-Of-Use Rates (TOU) and EV Tariffs • Commercial Tariff/Demand Charge Optimization • Continued Partnership and Stakeholder Engagement (Advisory Councils)	Encouraging vehicle manufacturers to incentivize vehicles that are more expensive up front than other models.

Work Product 3: "Case Studies & Arizona Gaps"

Subgroup Participants:
Hanna Breetz (Arizona State University), Lori Glover (City of Scottsdale), Amanda Reeve (Snell and Wilmer), Caryn Potter (Southwest Energy Efficiency Project)

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1. **Identifies which of these best practices and strategies are ripe for adoption, implementation, and expansion in Arizona**.

The following table identifies what the Case Studies and Arizona Gaps Analysis subgroup has identified as intervention strategies to consider when creating transportation electrification programs This is not an exhaustive list of policy actions or intervention strategies.

Intervention Strategy	Case Study	AZ Gap Analysis	AZ Recommendation
• **State and/or utility incentives programs for OEM's, fleets, personal vehicles purchase, used EV market expansion, and for electric installers of home electric charging stations.**	• Oregon's Clean Vehicle Rebate Program offers a $2,500 rebate for new EVs and also used EVs rebates. • Washington has a sales tax exemption.	• Arizona does not currently have this program in place.	• AZ adopt incentive programs.
• **Right-To-Charge Legislation & EV Ready Building Codes**	• Atlanta,[4] Seattle,[5] and Palo Alto[6] have all adopted ambitious EV building codes MUDs. • Honolulu has approved buildings codes that require 25% of parking to be "EV-Ready," in MUD's[7]	• Only Flagstaff has currently been adopted EV-Ready Building codes.[8]	• Arizona's utilities should work with local governments to adopt EV-Ready Building Codes.
• **Zero Emission Vehicle Legislation/Administrative Action[9]** **Make it easier to sell directly in the market for OEMs?**	• Currently ~10 states have adopted and processing requirements that 5-10% of near vehicles must be a ZEV in 2025.[10]	• AZ does not currently have an ZEV standard.	• AZ should implement a ZEV requirement, or a similar policy to bring more EV models into the state.
• **Group Buy Programs**	• There are currently 48 group-buy programs in 20 states.[11]	• AZ currently does not have a statewide group buy program.	• AZ should implement a statewide Group Buy Program to make is easier for government agencies, residential and non-residential customers to purchase EVs.

[4] https://library.municode.com/ga/atlanta/ordinances/code_of_ordinances?nodeId=869232
[5] http://www.seattle.gov/DPD/Publications/CAM/cam132.pdf
[6] https://www.cityofpaloalto.org/civicax/filebank/documents/40333
[7] http://www4.honolulu.gov/docushare/dsweb/Get/Document-237153/BILL25(2019).pdf
[8] https://www.flagstaff.az.gov/DocumentCenter/View/61147/2019-AMENDMENTS-TO-FLAGSTAFF-CITY-CODE-TITLE-4-BUILDING-REGULATIONS-FINAL?bidId=
[9] ZEV refers to CARB states.
[10] https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about#:~:text=Currently%20there%20are%20nine%20states,Oregon%2C%20Rhode%20Island%20and%20Vermont.
[11] http://www.swenergy.org/data/sites/1/media/documents/publications/documents/Electrifying_Transportation_-_Boulder_County's_Clean_Future_FINAL%202.2.18.pdf

Intervention Strategy	Case Study	AZ Gap Analysis	AZ Recommendation
• **Fair/ Supportive EV Registration Fees**	• California has a Road Improvement Fee of $100 for EVs that is roughly equivalent to the gas tax paid by gas cars.[12] Washington has a $150 fee with $100 going towards the Motor Vehicle Account, and $50 going towards the Multimodal Transportation Account.[13]	• AZ current The vehicle license tax (VLT) for an AFV is changed to a rate of $4 per $100 of assessed valuation, which is determined by: • For the first year, the assessed value is 1-percent of the factory list price (FLP) of the AFV. • For subsequent years, the assessed value is depreciated 15-percent each year. • The minimum VLT for an AFV registration is $5.	• AZ should implement A fair EV registration fee is designed to not prohibitive to EV adoption and look for more sustainable, long-term options for transportation funding.[14]
• **Uniform EV Signage Legislation/Administrative Action.**	• The Departments of Transportation in Washington, Oregon and California adopted a standardized symbol to identify publicly accessible electric vehicle charging stations along major roadways.[15]	• AZ currently have a few different EV signage symbols used throughout the state.[16]	• AZ should implement uniform signage and/or symbology standard for EVs.
• **Open Access / Interoperability Legislation**	• California adopted regulations that require EV charging stations to support credit card readers among other provisions that allow for easy payment access[17] and a seamless EV charging experience.	• AZ currently has not set-in place a separate Open Access or Interoperability Standard.	• AZ should implement the standards already implement by others neighboring states.
• **Education and awareness programs for non-EV drivers, local dealerships and OEM, as well as businesses/companies with fleets and workplace charging capability.**	State E&O Programs: The only state with a major EV education and outreach campaign underway is California, run by the non-profit Veloz. Called "Electric for All", the campaign was launched in 2018 with a social and digital media campaign called "Opposites	• AZ currently does not have a holistic education, marketing, and outreaching plan for to address these various levels.	• AZ should develop education, awareness, marketing, and outreach programs at the state, city, regional and utility level.

[12] https://www.marketwatch.com/story/states-charge-more-for-electric-cars-as-new-laws-take-effect-2019-12-30
[13] Page 61, http://leg.wa.gov/JTC/trm/Documents/TRM%202019%20Update/StateTaxesFeesREV.pdf
[14] https://www.nrdc.org/experts/max-baumhefner/simple-way-fix-gas-tax-forever

[15] http://www.westcoastgreenhighway.com/evsigns.htm
[16] https://azmag.gov/Portals/0/Documents/pdf/cms.resource/BCC_2010-03-17_EV-Infrastructure-Deployment-Guidelines-for-Phoenix-and-Tucson-Areas_65119.pdf?ver=2017-04-06-131917-790
[17] https://ww3.arb.ca.gov/regact/2019/evse2019/isor.pdf

Intervention Strategy	Case Study	AZ Gap Analysis	AZ Recommendation
	Attract", and in 2019 launched a campaign with Arnold Schwarzenegger called "Kicking Gas."[18] <u>City Level E&O Programs:</u> city of Denver, which launched a campaign in Sept. 2018 called "Pass Gas."[19] In addition, in the Denver EV Action Plan released in April 2020, the plan includes an E&O campaign focused on the below key audiences, with equity considerations as well: • Company owners and decision-makers, including those that maintain fleets of vehicles • Employees of large companies, as well as small and medium-size businesses • CCD employees • Residents of Denver with a focus on underserved communities.[20] <u>Regional E&O Programs:</u> The Northeast States for Coordinated Air Use Management (NESCAUM) non-profit, together with auto manufacturers, launched an EV E&O campaign in 2018 in the northeast called "Drive Change. Drive Electric," that features the program "Destination Electric", which provides window stickers for businesses that have charging stations available to the public. Six northeast States participated in this campaign.[21] <u>Utility E&O Programs:</u> Furthermore, E&O programs are included in only 20 of the 55 approved programs; that investment from the 20		

[18] https://www.veloz.org/initiatives/electric-for-all/
[19] https://www.denvergov.org/Government/Departments/Climate-Action-Sustainability-Resiliency/Programs-Services/Pass-Gas
[20] https://pluginamerica.org/wp-content/uploads/2020/12/EO-White-Paper.pdf
[21] https://driveelectricus.com/

Intervention Strategy	Case Study	AZ Gap Analysis	AZ Recommendation
	utilities is spread over only 11 states.[22]		
• **Low-Income Rideshare/carshare programs**	• These programs make publicly-owned EV fleets available to qualifying low-income residents to rent on a per-mile basis. Parking is typically free for participants, and cars can be dropped off anywhere, making it easier to access transit hubs or make emergency trips. BlueLA[23] is a prominent example.	• AZ does not have this.	• AZ should have this.
• **Sales Tax exemptions for a percentage of total cost?**	• In the State of Washington, there is a sale and use tax exemption for new or used clean alternative fuel and certain plug-in hybrid vehicles are available.[24]	AZ currently does not offer sales tax exemptions for electric vehicles.	• AZ should have continued discussions on what would be an appropriate percentage for sales tax exemptions.

Overarching Goal-Setting Recommendations

The Programs and Partnerships Working Group recommends a statewide goal for transportation electrification so that each of the defining partners mentioned above can work together to realize this ambitious goal through their respective jurisdictions. The Programs and Partnerships Working Group also recommends that this is further quantitative investigation into the needs of Arizona Consumers and what would encourage them to go electric. This investigation could include information on customer demographics, preferences, and other key metrics that can help the defining partners further strengthen the Awareness, Support, and Funding programs.

One example of a prospective customer EV owner survey is from Salt River Project.
One example of a national EV owner demographic survey can be found here.

[22] https://www.atlasevhub.com/data_story/less-than-two-percent-of-utility-investment-going-towards-ev-awareness/
[23] https://www.bluela.com/
[24] https://dor.wa.gov/content/clean-alternative-fuel-and-plug-hybrid-vehicles-salesuse-tax-exemptions

Arizona Transportation Electrification Plan
Goods Movement and Transit Group
Deliverable

Background

The Goods Movement and Transit Working Group (GMTWG) was one of five working groups identified by the Phase II Arizona Statewide Transportation Electrification Plan Study Team. The GMTWG was represented by 35 members with diverse backgrounds who met on five occasions. The focus of the group was to discuss barriers and opportunities to Statewide EV adoption particularly related to medium and heavy-duty vehicles serving public and private fleets. The participants of the GMTWG were affiliated with a variety of interests and represented the following entities:

- Transit Agencies
- Metropolitan Planning Organizations
- Consultants and Advocates
- Public Fleet Operators
- Private Fleets
- Study Team and Sponsors

The conversations were documented and resulted in a dynamic worksheet that the summarized existing barriers to EV adoption, with identification of potential opportunities overcome these barriers. These barriers were then ranked with a proposed implementation term.

GMTWG Support Team

Chair: Mike Barton, HDR

Plan Context: David Peterson, APS and Francisco Castro, TEP

Study Insights: Ben Shapiro, E3

Group Facilitation: Amanda Maass, ILLUME Advising

Active Group Contributors[1]: Josh Lloyd and Lucas McIntosh (1898 and Co.), Diana Alarcon (City of Tucson), Diane E. Brown (Arizona PIRG Education Fund), Bizzy Collins (Mountain Line), Jim DeGrood (Pima Association of Governments), Caryn Potter (Southwest Energy Efficiency Project), David Gebert (Tucson Electric Vehicle Association), Mackenzie McGuffie (Valley Metro), Autumn Johnson (Western Resource Advocates), Robert Bulechek (Energy Consultant)

GMTWG Members

The table below contains a list of all stakeholders who signed up to be members of the Goods Movement & Transit working group.

FIRST	LAST	ORGANIZATION	MEMBER TYPE
Mike	Barton	HDR	Chair
Josh	Lloyd	1898 and Co	Member

[1] These members actively participated in at least one GMT working group meeting and/or were key contributors to the GMT deliverables.

FIRST	LAST	ORGANIZATION	MEMBER TYPE
Lucas	McIntosh	1898 and Co	Member
Michael	Denby	APS	Member
Kathy	Knoop	APS	Member
David	Peterson	APS	Member
Devon	Rood	APS	Member
Amanda	Reeve	Arizona Chamber of Commerce	Member
Diane	Brown	Arizona Public Interest Research Group	Member
Tony	Bradley	Arizona Trucking Association	Member
Robert	Kanter	Auto Safety House	Member
C.J.	Berg	Black and Veatch Management Consulting, LLC	Member
Scott	Chandler	City of Phoenix, Public Works Fleet Operations Manager	Member
Mike	Gent	City of Surprise	Member
Diana	Alarcon	City of Tucson	Member
Steve	Spade	City of Tucson	Member
Ben	Shapiro	E3	Member
Alissa	Burger	Electrification Coalition	Member
William	Drier	Electrification Coalition	Member
Robert	Bulechek	Energy Consultant	Member
Jeffrey	Wishart	Exponent	Member
Rob	Mowat	HDR	Member
Amanda	Maass	ILLUME Advising	Member
Lucy	Mckenzie	Independent Subcontractor to E3	Member
David	Lane	Lake Havasu City	Member
Chris	McAbee	Maricopa County	Member
Philip	McNeely	Maricopa County Air Quality Department	Member
Elizabeth	Collins	Mountain Line /Northern Arizona Intergovernmental Public Transportation Authority	Member
Alana	Langdon	Nikola Motor / Nikola Defense	Member
Jim	DeGrood	Pima Association of Governments	Member
Jacob	Kavkewitz	Pima County Department of Transportation	Member
Katherine	Stainken	Plug In America	Member
Catherine	O'Brien	Salt River Project	Member
Terry	Rother	Salt River Project	Member
Caryn	Potter	Southwest Energy Efficiency Project	Member
Francesca	Wahl	Tesla	Member
Adam	Kretschmer	Tucson Airport Authority	Member
Francisco	Castro	Tucson Electric Power (TEP)	Member
Julie	Donovant	Tucson Electric Power (TEP)	Member
Camila	Martins-Bekat	Tucson Electric Power (TEP)	Member
David	Gebert	Tucson Electric Vehicle Association	Member
Mackenzie	McGuffie	Valley Metro	Member
Juan Pablo	Soulier	Waymo	Member
Autumn	Johnson	Western Resource Advocates	Member
Aaron	Kressig	Western Resources Advocates	Member

Outcomes

The GMTWG have proposed the following as the recommended barriers, opportunities, and intervention strategies to highlight in the statewide Arizona Transportation Electrification planning process. For this working group, we have focused exclusively on public transportation options, public fleets for various levels of government and school districts, and medium-duty and heavy-duty (MD/HD) vehicles. All strategies and opportunities described that relate to education and knowledge sharing are near-term and ongoing actions.

Describe and document the primary barriers or challenges to electrifying different medium-duty and heavy-duty (MD/HD) vehicles, focusing on distinctions between these vehicles and light-duty vehicles.

<u>High Priority Barriers:</u>

- Adopting technologies that may not have years of practical experience and may be rapidly changing.
- Total up-front cost of ownership for purchasing vehicles, charging equipment, maintenance, and insurance.
- Utility rate structures tailored explicitly to MD/HD vehicles, public and private fleets, as well as public and school buses.
- Lack of technical expertise by entities, including cities, counties, sovereign nations, and local communities, to build the infrastructure needed for MD/HD vehicles and public transportation. Lack of knowledge of the various bus options in the market today and what fits the geographic conditions.

<u>Medium Priority Barriers:</u>

- Impact of weather extremes (heat/cold) on the range, longevity (or battery lifetime) based on the climate.
- Extra planning for transit routes, including aligning the battery life with route length, placement of chargers along the route(s), and maintaining route flexibility.
- Planning and development fees and permitting related to the installation of charging stations or modifying depot footprints.
- The capacity to train existing staff on the new vehicles, including vehicle maintenance and vehicle operation.

<u>Low Priority Barriers:</u>

- Lack of planning to remove current bus stock \to enforce fleet transformation and demonstrate a commitment to electrification.
- Lack of understanding of the requirements to upgrade infrastructure.
- Need to leverage federal dollars effectively across Arizona.
- Limited technical understanding on the service side. Who will support large fleets? Will there be networks in the future. What happens when the technology outpaces the availability to maintain it?
- Adapting to electricity loss due to MD/HD vehicles and public transportation options drawing more power than the average light-duty vehicle.
- Resistance to being the first-generation to adopt new MD/HD vehicle technology in the public sector, as well as a reluctance to limited public funding to new technology.
- Limited availability of vehicle types.
- Scaling investments past the initial pilot programs.

- Suitability/capability/availability of vehicles; range concerns for rural applications. Shuttles typically log several hundred miles a day (fare transit point-to-point, and shuttles with longer distances in rural areas). Need for opportunity charging at various locations.
- Understanding drawbacks of capacity constraints, and how that impacts fleet charging cycles.
- Lack of standards or protocols for MD/HD vehicles and public buses.

Identify and prioritize, by lead stakeholder, the near-, medium- and long-term actions necessary to enable MD/HD TE in Arizona.

Near Terms Actions:

- Consider adopting a statewide aspiration goal that helps to guide other actions. Arizona's decision makers work with local schools, public transit authorities, as well as trucking for commercial and industrial entities to enable the following:
    - at least 16% Medium-Duty (MD) and Heavy-Duty (HD) vehicles by 2030
    - at least 35% of buses on the road are electric, including both school bus and public transit.
- Utilities can create the incentive to adopt these vehicles by mitigating some of the financial risks. This can be done by providing grant funding, specialized EV rate structures, or owning/maintaining EV charging infrastructure.
- Encourage Bus Rapid Transit" and incorporate electric vehicles at the early stages to integrate fast-charging.
- Coordinate between entities (public or private) and utilities to plan infrastructure.
- Support a diverse group of bus manufacturers entering the market. Grow knowledge of options.
- Revolving loan fund from the state, easing school and transit agency accounting regulations,
- Facilitation of group purchases through ADOA for government fleets and ADOT for other opportunities.
- Coordination between utilities and major stakeholders to determine charging needs and schedules.
- Utilities can lengthen the payback period for charging infrastructure investments based on the type of vehicle charged. Currently, it is based on a single-occupancy vehicle, six years. Because public transit vehicles technology, utility sponsored programs would need to incorporate a 12-year minimum lifespan and payback into investments for public transit.

Medium-Term Actions:

- Education and detailed planning. Create learning opportunities to help entities plan their transition to EVs and deployments well in the future.
- Detailed planning and communication between regions with a similar climate. Municipalities can learn from one another and share best practices on mitigating heat or cold impacts on batteries.
- Competitive grant funding through utilities to support the purchasing and installation of charging equipment, coordinating vehicle charging times.
- Coordinated training from OEMs, Vehicle Innovation Center online courses, Center for Transportation and the Environment webinars.

Long-Term Actions:

- Pilot fleets as low-hanging fruit. Municipalities are willing to make large shifts and balance this with risk exposure (getting stuck with six v 60 buses).
- Joint procurement between partners, municipalities, districts, state. Coordination of efforts to ensure lower prices particularly. for medium- and heavy-duty vehicles.
- Creation of fleet management plans to cycle vehicles back-and-forth to avoid range anxiety to avoid expensive infrastructure costs with a long-term expansion plan.
- Knowledge of Financial mechanisms in place to mitigate expenses.
- Research information from states who have a stronger commitment to electric fleet/vehicle implementation and see what is feasible for Arizona.
- Encourage utilities and third-party companies should consider "Charging As A Service," programs, which would allow building owners to provide electric charging without owning or installing equipment.

Discuss EV load impacts and related management or mitigation strategies to integrate electric MD/HD vehicles into the electricity system.

Because many MD/HD vehicles and public transit buses are operating during off-peak times of the day, there is an opportunity to ensure that these types of vehicles that would require to draw a lot of power from the electric grid, can "soak up," access renewable energy not being utilized in the middle of the day. While managed charging of these vehicles may not be possible at all times of the day, it is essential that rate design, public policy, financial incentives, and third-party equipment, assist in managing MD/HD vehicles and public transit bus load as much as possible.

Arizona Transportation Electrification Plan

Vehicle Grid Integration Group

Deliverable

Background

The Vehicle Grid Integration Working Group (VGIWG) was one of five working groups identified by the Phase II Arizona Statewide Transportation Electrification Plan Study Team. The VGIWG was comprised of the following:

- Industry experts
- Environmental advocates
- Consumer advocates
- Technology Analysts

Objectives and Ties to Phase II TE Plan

1. Provide guidance on the priority VGI opportunities to be explored and developed in Arizona including managed charging, demand response, vehicle-to-home and vehicle-to-building.
2. Develop recommendations for VGI programs and partnerships to prioritize, and the specific actions which the utilities and other TE stakeholders should take to realize these opportunities. Focus on near-term actions, while documenting medium- and long-term needs to develop a comprehensive approach to VGI planning and use cases.

VGIWG Support Team

Co-Chairs: Varun Thakkar, Jim Stack

Group Advisors: Jay Delaney (APS), Derek Seaman (APS), Ray Martinez (TEP), Eric Cutter (E3), Anne Dougherty (ILLUME Advising)

We would especially like to recognize the efforts of: Caryn Potter (SWEEP) and CJ Berg (Black and Veach)

VGIWG Members

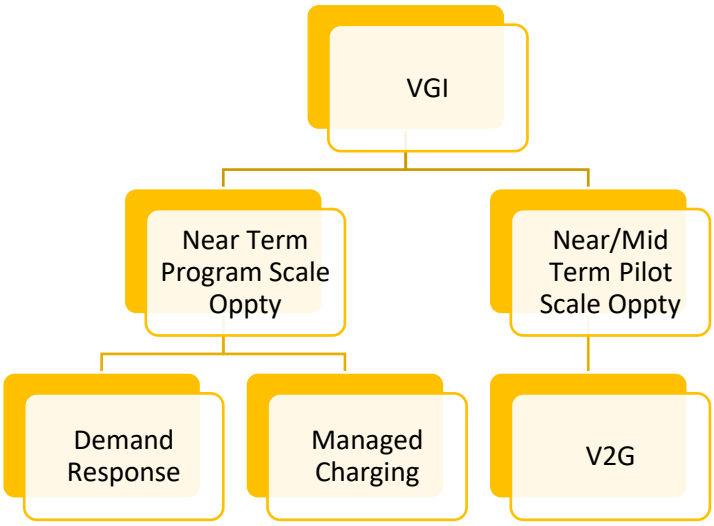
The table below contains a list of all stakeholders who signed up to be members of the Vehicle Grid Integration working group.

FIRST	LAST	ORGANIZATION	Vehicle Grid Integration
Varun	Thakkar	CLEAResult	Chair
Jim	Stack	Phoenix Electric Automotive Association	Chair

Dan	Bowerson	Alliance for Automotive Innovation	Member
Jason	Delaney	APS	Member
Michael	Denby	APS	Member
Laura	Herman	APS	Member
Kathy	Knoop	APS	Member
Derek	Seaman	APS	Member
Amanda	Reeve	Arizona Chamber of Commerce	Member
Bob	Gray	Arizona Corporation Commission	Member
Shahrzad	Badvipour	Arizona Department of Environmental Quality	Member
Tony	Bradley	Arizona Trucking Association	Member
C.J.	Berg	Black and Veatch Management Consulting, LLC	Member
Robert	Perez	City of Glendale	Member
Mike	Gent	City of Surprise	Member
Martin	Lucero	City of Surprise	Member
Eslir	Musta	Coconino County	Member
Eric	Cutter	E3	Member
William	Drier	Electrification Coalition	Member
Robert	Bulechek	Energy Consultant	Member
Jeffrey	Wishart	Exponent	Member
Erick	Karlen	Greenlots	Member
Anne	Dougherty	ILLUME Advising	Member
Chris	McAbee	Maricopa County	Member
Alana	Langdon	Nikola Motor / Nikola Defense	Member
Jeanette	DeRenne	Pima Association of Governments	Member
Jacob	Kavkewitz	Pima County Department of Transportation	Member
Katherine	Stainken	Plug In America	Member
Nicole	Lee	Salt River Project	Member
Catherine	O'Brien	Salt River Project	Member
Caryn	Potter	Southwest Energy Efficiency Project	Member
Sharon	Carpenter	State House of Representatives	Member
Thomas	Moll	Sun Engineering	Member
Francesca	Wahl	Tesla	Member
Julie	Donovant	Tucson Electric Power (TEP)	Member
Ray	Martinez	Tucson Electric Power (TEP)	Member
Camila	Martins-Bekat	Tucson Electric Power (TEP)	Member
Anthony	Lombardi	UniSource	Member
David	Gebert	Unknown	Member
Darrel	Templeton	Valley Metro	Member
Juan Pablo	Soulier	Waymo	Member
Autumn	Johnson	Western Resource Advocates	Member
Aaron	Kressig	Western Resources Advocates	Member

Opportunity Hierarchy

The Group identified the following opportunity, hierarchy, as a way of organizing its focus and priorities.



Managed Charging and Demand Response Opportunities and Guiding Principles

The group recognized early on that the tools of Managed Charging and Demand Response, while ready for Program scale opportunities today, will continue to evolve rapidly. And, within the context of this Group, we made recommendations on how to use them as simultaneous or integrated solutions. Rather than have an overly prescriptive approach for Programs that should be deployed, the Group created program design principles, and identified opportunities for deployment within different contexts.

Recommendation 1: The Group recommends a stacked or layered approach for infrastructure build out and program design that provides different avenues for incorporating Managed Charging and Demand Response principles in a manner that is tailored for different customer segments and use cases. The overarching goal of this approach would be to integrate electric vehicles at a mass adoption scale with the Arizona grid in a way that optimizes the use of existing infrastructure, puts downward pressure on customer rates, and facilitates a transition to a clean energy system. Starting at a localized level, and then moving upwards in layers to a macro grid scale.

Recommendation 2: Starting at the localized level, the group recommends creating shared or public charging infrastructure Programs, that prioritize load sharing design for maximizing a building's existing electrical equipment to be able to support the maximum amount of EV chargers possible. Moving a layer above, these Programs should look at local infrastructure nodes to prioritize how this shared charging approach can be designed to limit local grid upgrades. The effect of these kinds of Program designs would be increasing the number of charging ports available for customers while limiting the amount of costly customer and rate payer electrical systems upgrades required to support them. Load sharing EV chargers are an off the shelf technology today and designing these Managed Charging elements into Programs should save AZ residents significant capital costs. For customers able to install Level 2 EV

chargers at home, providing incentives to encourage, “smart”, chargers capable of responding to TOU prices signals and DR Program signals will be another pathway for encouraging Managed Charging and Demand Response viability at the localized infrastructure level.

Recommendation 3: Moving to the macro level layer of Program design, the Group recommends prioritizing a flexible approach to Rate and Program design that can evolve at a meaningful enough pace to keep up with the changing technological and economic landscapes around EV’s. The stakeholders recommend that vehicles should be charged through managed charging at least 90% of the time by 2030. With the commitment of AZ’s two largest investor-owned utilities to a largely renewable power generation fleet over the next decade, the Group identified the evolution of Time of Use rates to encourage customers to use electricity for amongst other things charging their EV’s at a beneficial and efficient time of day, as a critical step, and one that regulators may need to revisit a few times over the coming decades. With the proliferation of, “Smart”, EV chargers at residences, layering in Demand Response program designs to complement evolving Time of Use rates will likely be needed to avoid unintended consequences such as artificial peaks as rates switch to of peak. This again goes back to the Group’s recommendation that a stacked or layered approach be utilized for Program design.

Recommendation 4: The Group also recommends Program designs tailored towards special customer segments and end uses such as interstate goods movement, transit agencies and companies looking to provide fast charging for passenger vehicles near freeway corridors. For such instances incentivizing novel approaches such as dedicated onsite storage to avoid contributing to peak loads and providing grid flexibility should be explored as options. Taking this kind of stacked or layered approach, the Group recommends that efforts be made to reach the majority of EV customers by some form of Managed Charging or Demand Response program design by 2030. In order for these efforts to be successful the Group acknowledges that a large-scale consumer education campaign will be a critical step, with an emphasis made of Outreach to low-income communities.

Vehicle to Grid Opportunities and Guiding Principles

The Group identified Vehicle to Grid as a nascent area that could evolve into a key part of a clean energy future for Arizona. While Program scale opportunities may not be viable today, the Group does recommend exploring Pilot scale opportunities in the interim to understand the mechanics of how these kinds of Programs could be operated in the future and identify barriers and opportunities for Program evolution. Organizations such as the Vehicle Grid Integration Council are working with all the relevant stakeholders and are optimistic that with the emergence of, ‘mobile”, inverters integrated into future EV models and the drop in price of AC Vehicle to Grid Chargers, this technology could become mainstream by 2030. This could result in hundreds of megawatts of peak time generation available to the AZ grid in the future. For Pilot design consideration, the Group recommends looking at applications with long dwell times and relatively short commute distances. Below are some of the opportunity areas the Group identified as having potential for key learning opportunities.

- School Bus – Grid Management Around Set Operating Hours
- Residential Solar Customer – Onsite Consumption and Peak Shaving

Appendix C: Organizations Involved in the Phase II TE Plan Process

Organization	
1898 and Co	HopiÂ Tribe
AARP	ILLUME Advising
Albertson's/Safeway	Independent Subcontractor to E3
Alliance for Automotive Innovation	Ingenuity Academy
Alliance for Transportation Electrification	Intel Corporation
American Lung Association	International Research Center
Arizona Public Service (APS)	InterTribal Council of Arizona
Arcadis US, Inc.	Jobs for Arizona's Graduates
Arizona Asian Chamber of Commerce	John Martinson Consulting
Arizona Center for Law in the Public Interest	Kingman Chamber of Commerce
Arizona Chamber of Commerce	Knight-Swift Transportation
Arizona Commerce Authority	Kroger/Fry's
Arizona Corporation Commission	Lake Havasu City
Arizona Department of Administration	Lake Havasu School District
Arizona Department of Environmental Quality	LaPaz County
Arizona Department of Transportation	League of Arizona Cities and Towns
Arizona Electric Power Coop (AEPCO)	Local First Arizona/Fuerza Local
Arizona Forward	Love's
Arizona G&T Cooperatives	Lucid Motors
Arizona Governor's Office	Lyft
Arizona Hispanic Chamber of Commerce	Marana
Arizona League of Cities and Towns	Maricopa Association of Governments
Arizona Minority Contractors Association	Maricopa Community Colleges
Arizona Public Interest Research Group	Maricopa County
Arizona Small Business Association	Maricopa County Air Quality Department
Arizona State Government	Marine Corps Air Station Yuma
Arizona State House of Representatives	Mayo Clinic
Arizona State Senate	Mesa Community College
Arizona State University	MetroPlan (formerly Flagstaff Metropolitan Planning Organization)
Arizona State University LightWorks	Mohave Electric Cooperative
Arizona Transit Association	Mountain Line / Northern Arizona Intergovernmental Public Transportation Authority
Arizona Transportation Authority	Move Tucson
Arizona Trucking Association	NAACP Maricopa County Branch
Arizona's Residential Utility Consumer Office	National Park Service - Grand Canyon
Asian Corporate and Entrepreneur Leaders	Native American Connections
Atlas Public Policy	Navajo County

Organization	
Audi	Navajo Nation
Auto Safety House	Navajo Tribal Utility Authority
Big Data Southwest	Navopache Electric Cooperative
Black and Veatch Management Consulting, LLC	Nikola Motor / Nikola Defense
Black Chamber of Arizona	Nogales U.S. Custom Brokers Association
Center for Biological Diversity	Northern Arizona Council of Governments
Center for the Future of Arizona	Northern Arizona Intergovernmental Public Transportation Authority
Ceres	Northern Arizona University
Chandler-Gilbert Community College	Office of Congresswoman Ann Kirkpatrick
ChargePoint	PCSO
Chicanos Por La Causa	Phoenix Chamber of Commerce
Chinese Chamber of Arizona	Phoenix College
Chispa Arizona	Phoenix Electric Automotive Association
Chispa AZ	Phoenix IDA
Chrysler Proving Grounds	Phoenix Indian Center
City of Avondale	Phoenix Revitalization Corporation
City of Buckeye	Phoenix Union High School District
City of Chandler	Phoenix-Mesa Gateway Airport
City of Coolidge	Pima Association of Governments
City of El Mirage	Pima Community College
City of Flagstaff	Pima County
City of Gilbert	Pima County Department of Environmental Quality
City of Glendale	Pima County Department of Transportation
City of Holbrook	Pima County Facilities Management
City of Mesa	Pima County Fleet Services
City of Nogales	Pima County Office of Sustainability and Cultural Resources
City of Peoria	Pinal County
City of Phoenix	Pinyon Environmental
City of Scottsdale	Pivot Manufacturing
City of Sedona	Plug In America
City of Showlow	Policy Development Group on Behalf of Toyota
City of Somerton	Port of Tucson
City of Surprise	Proterra Inc.
City of Tempe	QCM Technologies
City of Tucson	Radio Campesina | Cesar Chavez Foundation
City of Tucson	Raytheon Missile Systems
City of Winslow	Rose Law Group
City of Yuma	RPA & Associates

Organization	
CLEAResult	Salt River Pima-Maricopa Indian Community
Club for Youth	Salt River Project
Cochise County	Santa Cruz County
Coconino County	Sierra Club
Columbus Electric Cooperative	Sierra Southwest Cooperative
Commission on Climate, Energy and Sustainability	Southwest Energy Efficiency Project
Conservative Alliance for Solar Energy	SouthWestern Power Group
Cruise	St. Vincent de Paul
Duncan Valley Electric Cooperative	Sulphur Springs Valley Electric Cooperative
Economics Collaborative of Northern Arizona	Sun Corridor
Electric Power Research Institute	Sun Engineering
Electrification Coalition	Sundt
Electrify America	Swift Transportation
Energy & Environmental Economics	Tesla
EV Transportation Alliance	The Art Hamilton Group, LLC
EVAZ	The Nature Conservancy
EVgo	Tohono O'odham Housing Authority
Exponent	Tohono O'odham Utility Authority
FCA Group	Town of Cave Creek
Flagstaff Airport	Town of Parker
Flagstaff Chamber of Commerce	Town of Quartzsite
Flagstaff Downtown Business Alliance	Town of Snowflake
Flagstaff Unified School District	Town of Tusayan
Forth Mobility	Toyota Motor North America
Fortis Networks	Trellis
Fresh Produce Association	Trico Electric Cooperative
Friendly House	Tripshot
Garkane Energy Cooperative	Tucson Airport Authority
General Motors	Tucson Auto Dealer's Association
Generation Seven Strategic Partners	Tucson Electric Power (TEP)
Gila River Indian Community	Tucson Electric Vehicle Association (TEVA)
Graham County Electric Cooperative	Tucson Metro Chamber
Grand Canyon Shuttle Bus System	U-Haul International
Grand Canyon State Electric Cooperation	UniSource
Greater Flagstaff Chamber of Commerce/Northern Arizona Chamber Organization	University of Arizona
Greater Phoenix Economic Council	Valle Del Sol
Greater Phoenix Urban League	Valley Metro

Organization	
Greenlots	Valley of the Sun Clean Cities
Habitat for Humanity	Veloz
Harmon Electric	Walmart
Havasu Chamber of Commerce	Waymo
HDR	Western Resource Advocates
Hensley Beverage Company	Wildfire
Home Builders Association of Central Arizona	World Resources Institute
Hopi Housing Authority	YWCA Southern Arizona

Appendix D: Stakeholder Comments on Draft Report