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Arizona Transportation Electrification Plan, Phase II

Stakeholder Workshop #2

November 10, 2020

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Agenda

- **E3 Presentation (*2:00 – 3:00pm*)**
  - Introduction
  - Market Assessment Highlights
  - Cost Benefit Analysis: Summary Results
  - Air Quality Potential: Summary Results
  - Q&A
- **Working Group Updates (*3:00 – 4:00pm*)**

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Introduction

Recall the workstreams which will culminate in the Phase II TE Plan

- Industry Update (complete)
- Stakeholder Workshops
- Market Assessment
- Air Quality Potential & Analysis
- Cost-Benefit Analysis
- Gaps Analysis & Proposed Actions
- TE Plan & Statewide Goal

Today we'll focus on the primary analytical tasks, as well as share-outs from Working Groups

- Industry Update (complete)
- Stakeholder Workshops
- Market Assessment
- Air Quality Potential & Analysis
- Cost-Benefit Analysis
- Gaps Analysis & Proposed Actions
- TE Plan & Statewide Goal

Focus of Today's Presentation from E3

+ Updates from Working Groups

At Workshop 3 (Jan. 2021) E3 will present a draft Gaps Analysis & TE Plan, informed by Working Group input

- Industry Update (complete)
- Stakeholder Workshops
- Market Assessment
- Air Quality Potential & Analysis
- Cost-Benefit Analysis
- Gaps Analysis & Proposed Actions
- TE Plan & Statewide Goal

Input from Working Groups

Workshop 3 (January)

EV adoption forecasts are distinct from more ambitious EV goals

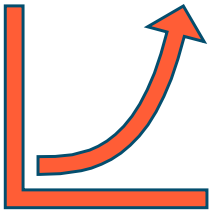
- **The Cost-Benefit and Air Quality Potential analyses consider both a base case EV forecast and a high adoption scenario**

Base Case

- **Forecast based on**
  - Vehicle, fuel, electricity costs
  - Technology progress (e.g., EV range)
  - Charging infrastructure availability
- **A *Business-as-Usual* scenario, based on prior EV adoption modeling by APS and TEP**

High Adoption Case

- **Aspirational goal *above and beyond* the forecast**
- **One desired outcome of this stakeholder process is to put forth a goal of this nature in the final Phase II TE Plan**
- **Reaching such a goal *requires concerted efforts from all TE stakeholders***



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Arizona TE Market Assessment

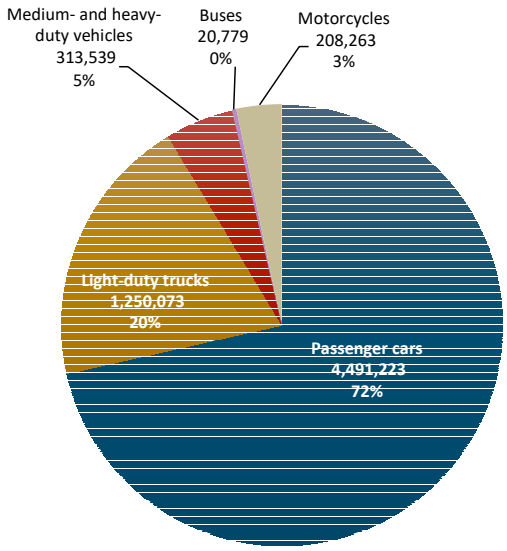
What is the goal of conducting this market assessment?

- **Aims:**
  1. **Describe and quantify vehicle segments in Arizona to help assess potential for electrification**
  2. **Identify existing electrification efforts across the state**
- **Assessment is based on publicly-available data, research, and interviews**
- **Significant detail included here (and in Appendix); presentation can be used as reference for participants.**
  - Sources in *Notes* section of slides
- **What are we missing?**
  - Stakeholder input (primarily through Working Groups) can help to ensure that the Phase II TE Plan provides a comprehensive view of the Arizona transportation landscape, including current electrification efforts
  - Is data available on vehicle inventories and electrification opportunities within native communities?

Arizona has 6.3 million registered on-road vehicles, mostly cars and light-duty trucks

On-road gasoline or diesel vehicles registered in AZ*

**As of January 2020*

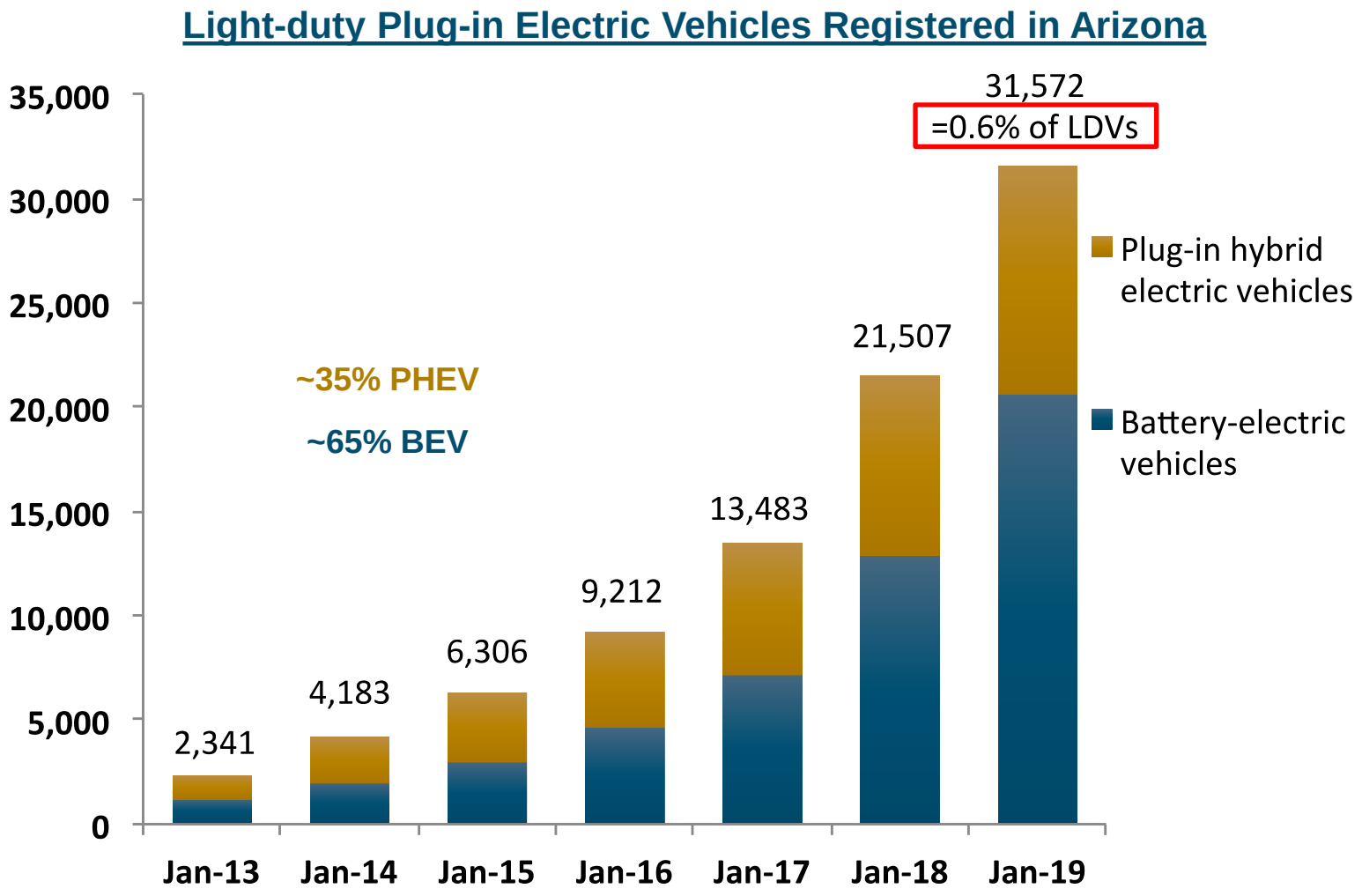


Over 90% of registered vehicles are **passenger cars** and **light-duty trucks**

Source: Arizona Department of Transportation (ADOT)

- **~4.5 million registered passenger cars, 1.3 million light-duty trucks**
  - ~70,000 of these are rentals
  - Prior to COVID-19, over 75% of Arizona commuters were driving alone to work
- **Cities and universities also have large light-duty fleets**
  - E.g., ~2,500 sedans in the City of Phoenix fleet
  - 330 LDVs / vans at Northern Arizona University; 680 at Arizona State University
- **Rideshare vehicle counts are not publicly available; not registered as such in Arizona**

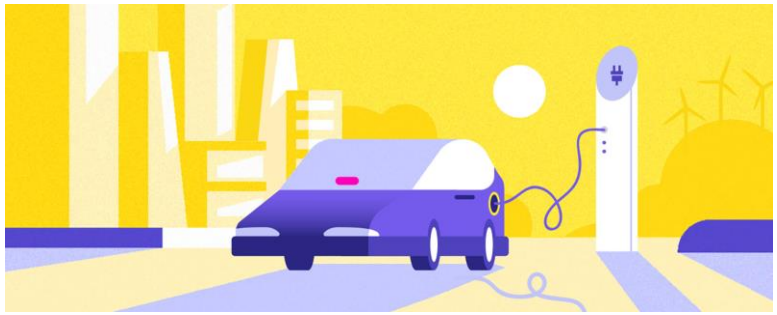
PEVs have been increasing, but are still only 0.6% of light-duty vehicles on Arizona roads



Source: Electric Power Research Institute

Trajectory of LDV electrification depends on interconnected stakeholder actions, markets

- **Lyft and Uber have both recently announced commitments to electrify 100% of US rides by 2030**
  - Modeling by E3 and Lyft shows PEVs can be cost-effective for full-time drivers, though barriers remain



Source: Lyft

- **Numerous local-level initiatives support TE across Arizona, for example:**
  - Many cities have put forth emissions targets, requiring GHG reductions from transportation as well as other sectors (e.g., Phoenix, Tucson, Flagstaff)
  - City of Flagstaff EV pre-wiring requirements in new construction
  - Pima County aims to replace 120 sedans w/ EVs by FY 2023
  - Arizona universities are making early inroads into electrifying their light-duty fleets and assessing results

- **E3 has modeled several adoption trajectories as part of the cost-benefit analysis, reflecting different potential levels of vehicle electrification**

Arizona has ~21K total buses on its roads, many of which are school buses

- **20,779 buses registered with the Arizona Department of Transportation**
  - 62% diesel, 38% gasoline

- **~7,200 (35%) are yellow school buses**
  - Prior to COVID-19, almost 300,000 students rode school buses every day, making it the most used mode of public transport in the state

- **Arizona's first <u>electric</u> school bus hit the road in January 2020 (Phoenix Union High School District)**

Source: League of Conservation Voters

Phoenix, Tucson, Flagstaff & Yuma operate ~1,200 transit buses

City	Agencies	Count of ≥35ft buses in fleet
Phoenix*	Valley Metro & City of Phoenix	939
Tucson	Sun Tran	253
Flagstaff	Mountain Line	29
Yuma	Yuma County Area Transit	24
Total		**1,245**

*Including Glendale & Scottsdale shuttles & Regional Connectors)

- **Agencies also operate significant fleets of paratransit and other vehicles**
- **Valley Metro is trialing a route with battery electric buses from 3 manufacturers to assess performance**
- **Sun Tran launched first battery electric bus route in May 2020; received federal Low-No grant funding to take receipt of five in 2021 and an additional five in 2022**
  - TEP provided charging infrastructure for initial bus & committed to in-kind funding for chargers and associated infrastructure as part of the Low-No grant
- **Mountain Line has adopted an ambitious electrification plan to purchase battery electric buses on replacement of existing vehicles: full fleet by 2032**

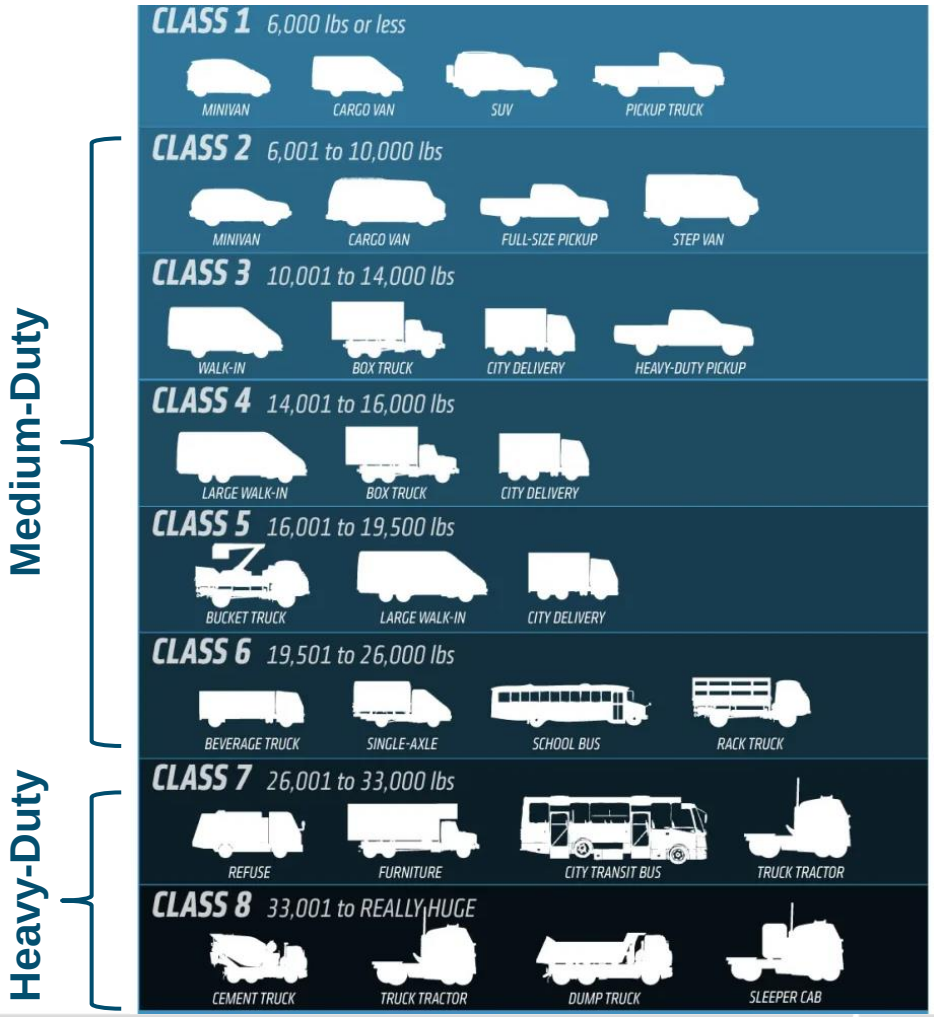
Universities & the National Park Service operate smaller bus fleets

- **Universities operate or host smaller fleets, and are currently investigating the potential for electrifying**
  - 26 buses at Northern Arizona University
  - 10 buses at Arizona State University
  - *E3 is confirming the count for University of Arizona*
- **National Park Service operates 40 shuttle buses at the Grand Canyon and is working with utility to assess feasibility of electrification**
- **Significant remaining bus count suggests several thousand privately-owned tour, shuttle & event buses in AZ; electrification challenges for these will vary**

Arizona has ~314K registered on road medium- and heavy-duty trucks

- **After passenger vehicles, this vehicle segment represents the largest TE opportunity (by # of vehicles)**
- **Many of these trucks are gasoline-powered (73%), with the remainder running on diesel**
- **Beyond in-state registrations, Arizona also sees a lot of 'through trips' which start & end outside the state**
  - 61% of AZ's truck tonnage & 62% of truck cargo value as of 2013
  - Governor Ducey also aims to grow flows across the Arizona-Mexico border
    - 2018 announcement of $134M to build out highway from Mariposa Port of Entry to Interstate 19

Vehicle Classes



Source: Jalopnik

Additional results are included in the Appendix and will be detailed in final report

- Arizona trucking freight volume projections and TE opportunity
- Global investments in truck electrification and implications for AZ
- Arizona Truck Stop Electrification opportunity and statistics
- Airport ground supply equipment electrification in Phoenix and Tucson

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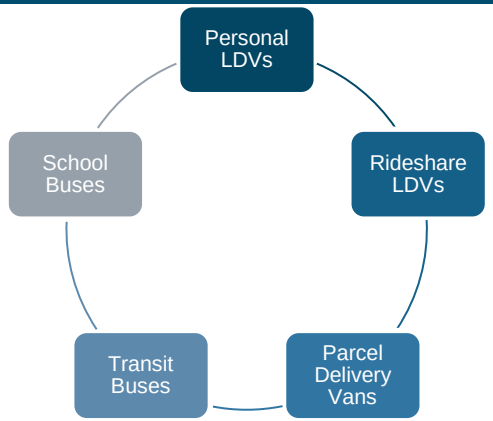
TE Cost Benefit Analysis

E3 conducted a cost-benefit analysis (CBA) for five different types of EVs

- **Five vehicle segments assessed through the CBA**
- **Costs and benefits analyzed under three different adoption scenarios**
  - Base case informed by recent APS and TEP adoption forecasts
  - High adoption scenario pegged to Rocky Mountain Institute national goal (50 million EVs by 2030)

Vehicle Segments (5)



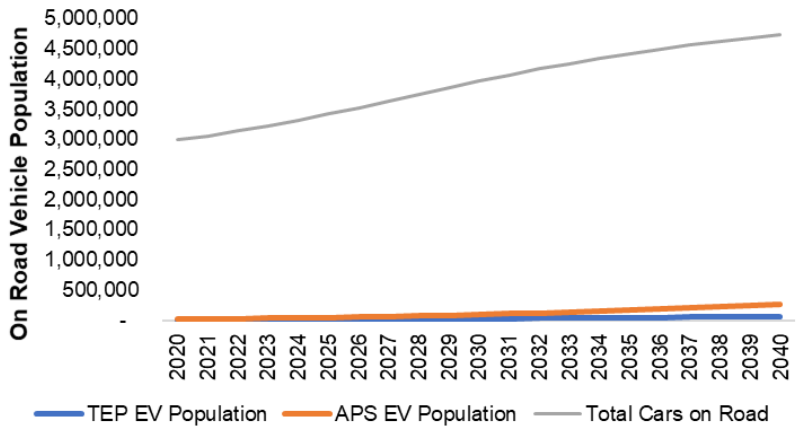
Adoption Scenarios (3)

- Base Case
- Base + Managed Charging
- High Adoption*

* High adoption scenario includes managed charging assumption

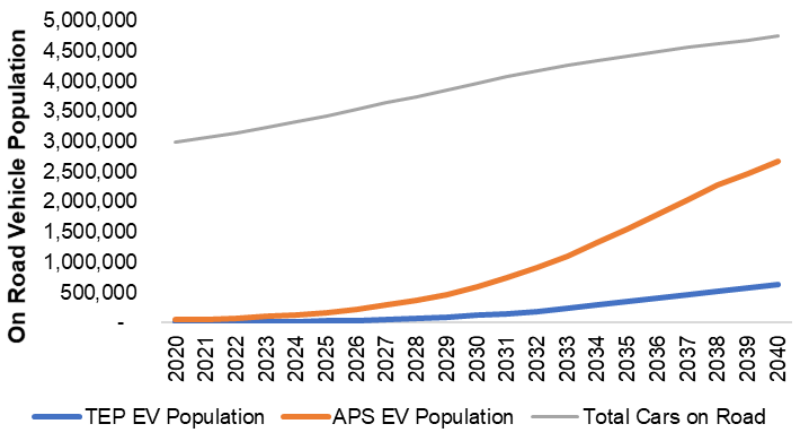
Adoption forecasts based on existing APS & TEP modeling and a separate "High Adoption" scenario

Base Case Adoption, Personal LDVs



- **Base case provided by APS and TEP, developed through separate modeling effort**
  - Can be considered a *Business-as-Usual* scenario
  - Reaches 7% on road personal LDVs electrified by 2030

High Adoption, Personal LDVs

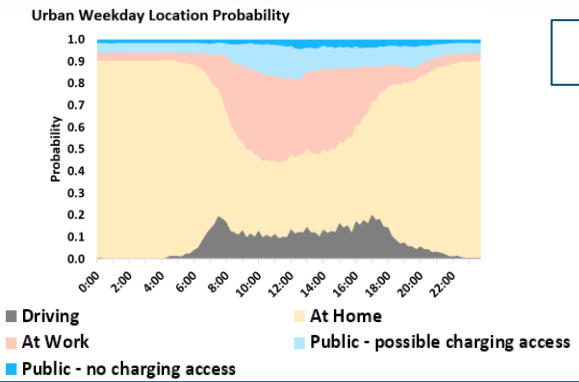


- **High Adoption Case pegged to Rocky Mountain Institute goal**
  - Pegged to 1.5° C global target
  - Reaches 20% on road personal LDVs electrified by 2030
  - Source: Rocky Mountain Institute

General CBA Methodology

Step 1

Driving Profiles

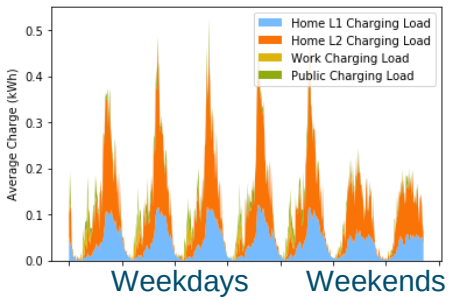


Markov Chain Monte Carlo Method

Key Inputs
- National Household Travel Survey Driving Data
- OEM Driver Data
- EVSE Charging Data

Step 2

Charging Profiles

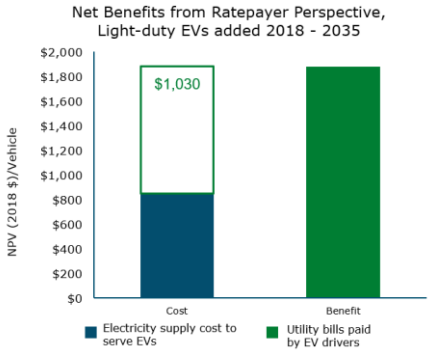


EV Load Shape Tool

Scenarios & Features
- Unmanaged charging
- Managed charging based on rates
- Charging by location

Step 3

Cost Benefit Analysis



Illustrative CBA Results

EV Cost Benefit Analysis Tool (EV Grid)

Core Outputs
- Cost Tests
  - Participant Cost Test (PCT)
  - Ratepayer Impact Measure (RIM)
  - Societal Cost Test (SCT)
- Net Emissions Impacts
- Peak Load Impacts

EV costs and benefits were assessed from three perspectives

- **Participant:** *How does cost of ownership compare to a conventional vehicle?*
- **Ratepayer:** *What happens to electricity rates?*
  - *(Does marginal bill revenue cover electricity supply costs?)*
- **Societal:** *What are the direct and indirect costs and benefits to Arizona?*

Cost & Benefit Components by Perspective

Cost/Benefit Component	Participant Cost Test (PCT)	Ratepayer Impact Measure (RIM)	Societal Cost Test (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	
Environmental benefits			Benefit

Transportation electrification provides net benefits in both APS and TEP

- **Bookends**
  - *Low*: Base Case Adoption + Unmanaged Charging
  - *High*: High Adoption + Managed Charging
- **Significant net benefits in both utilities**
  - Aggregated results, all vehicle types
  - Results are primarily driven by personal LDVs
- **Results present the lifetime net present value (a benefit) of vehicles adopted between 2020 and 2040**
  - Analysis window extends through 2053 to account for full lifetime of all vehicles
- **Ratepayer benefits equate to reductions in electricity rates for all customers**

Base Adoption, Unmanaged Charging (Net Present Benefit, $ million)

Utility	PCT	RIM	SCT
APS	$565	$1,112	$1,732
TEP	$109	$407	$509

High Adoption, Managed Charging (Net Present Benefit, $ million)

Utility	PCT	RIM	SCT
APS	$5,660	$9,209	$15,851
TEP	$997	$3,023	$4,092

Key CBA findings by vehicle segment

Personal LDVs

- Significant **benefits to participants, ratepayers and society**
- Constitute more than **80% of the net benefits across all vehicle types studied**

Transportation Network Companies (e.g., Lyft & Uber)

- Small benefits to drivers (high charging cost from public charging)
- **Large benefits to society** (high annual miles driven)

Transit Buses

- **Large emission savings** from replacing diesel and compressed natural gas (CNG) usage

School Buses

- **High incremental vehicle costs** and **low VMT** lead to **net costs** for drivers

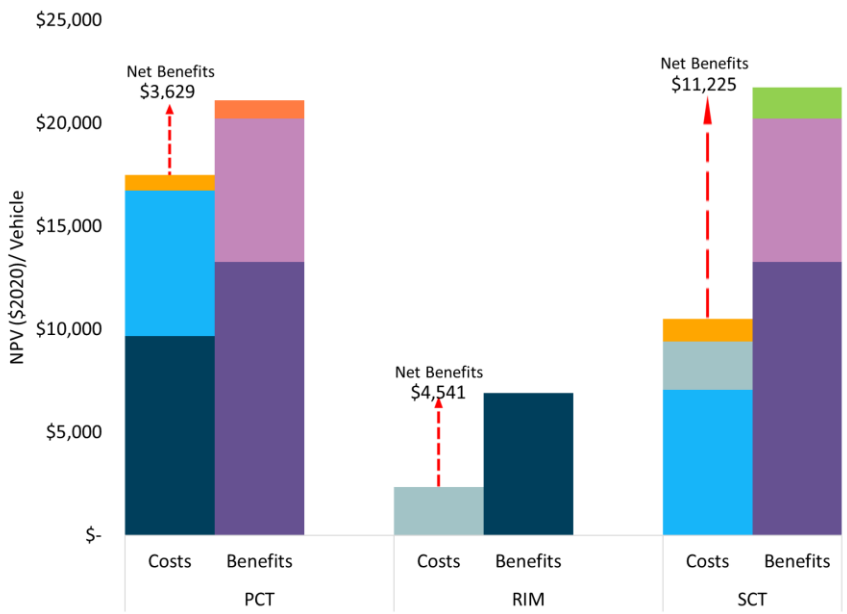
Parcel Vans

- **Benefits to participants, ratepayers and society**

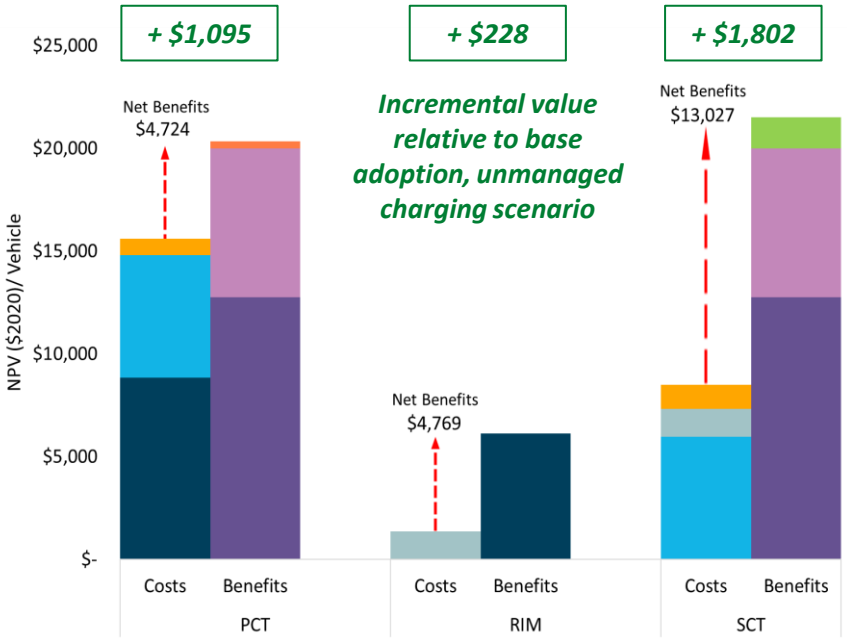
Across all three cost tests, personal LDVs provide significant net benefits per vehicle

APS Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
- Incremental Upfront Vehicle Costs
- Electricity Supply Costs
- Charging Infrastructure Costs

Benefits

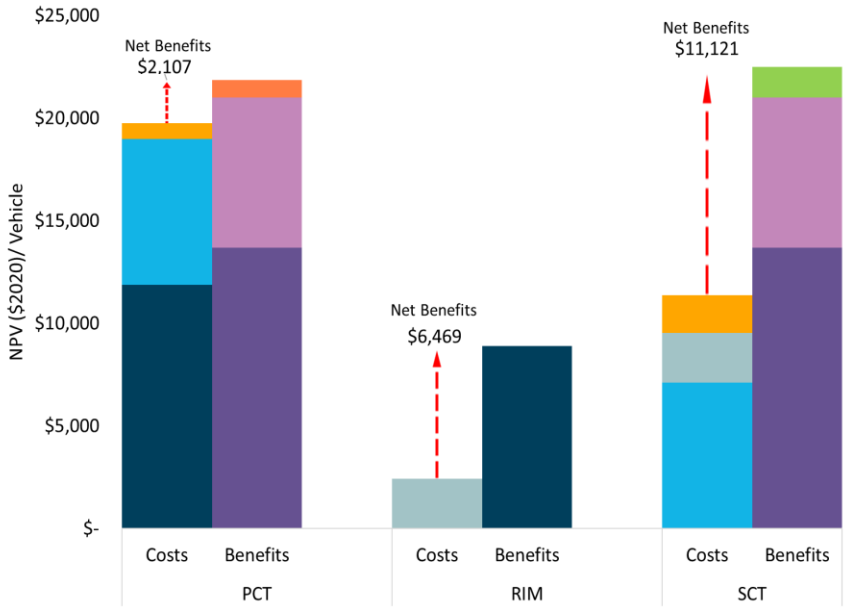
- Avoided Gasoline
- O&M Savings
- Tax Credits & Rebates
- Emissions

***Note*: differences in results between scenarios predominantly due to managed vs. unmanaged charging; however smaller differences due to adoption assumptions exist (vehicles adopted later in study horizon have lower incremental costs, but do not receive tax credits).**

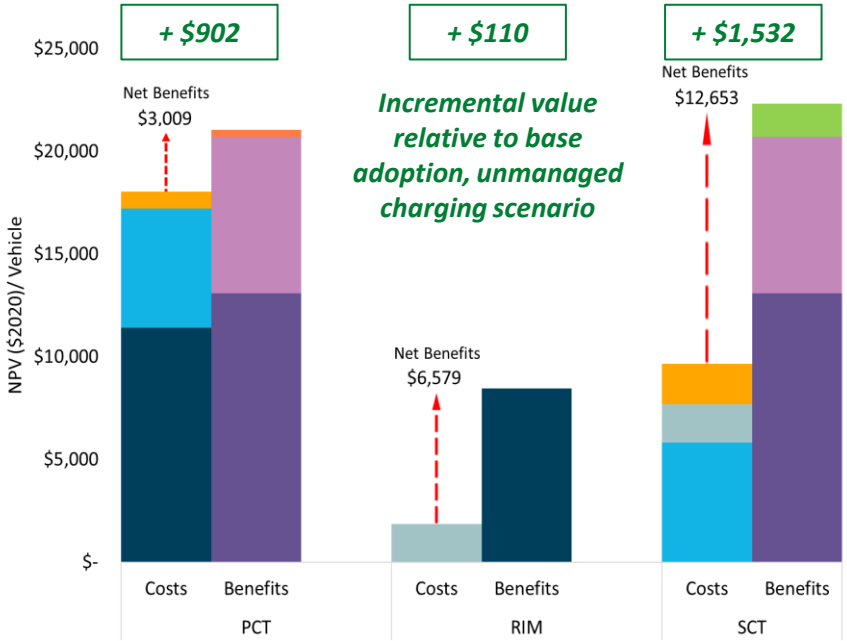
Across all three cost tests, personal LDVs provide significant net benefits per vehicle

TEP Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

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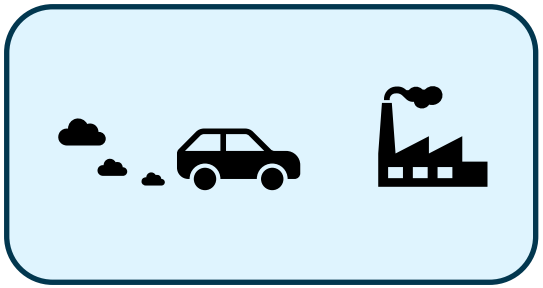
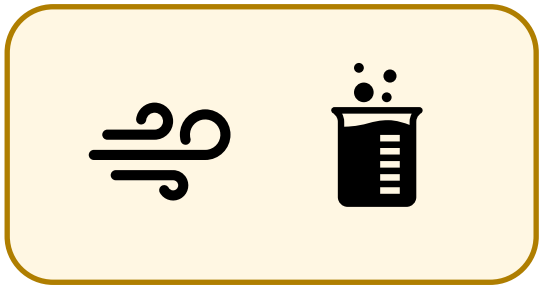
Air Quality Co-Benefits Analysis

To model health co-benefits of TE impacts on air quality, E3 used emissions outputs from the cost-benefit analysis and the EPA COBRA tool

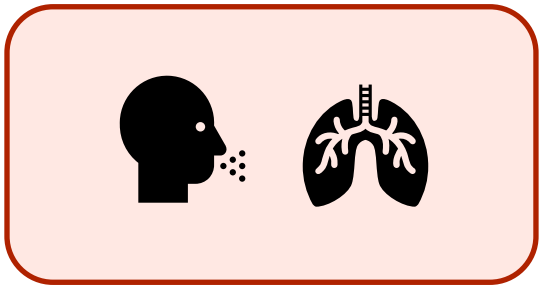
Cost Benefit Analysis | **COBRA**



Direct criteria pollutant emissions estimated for scenarios in main cost-benefit analysis



Changes in ambient air quality resulting from scenarios estimated in COBRA, using estimates of atmospheric transport and chemistry



Impact of air quality changes on human health estimated in COBRA, and monetized

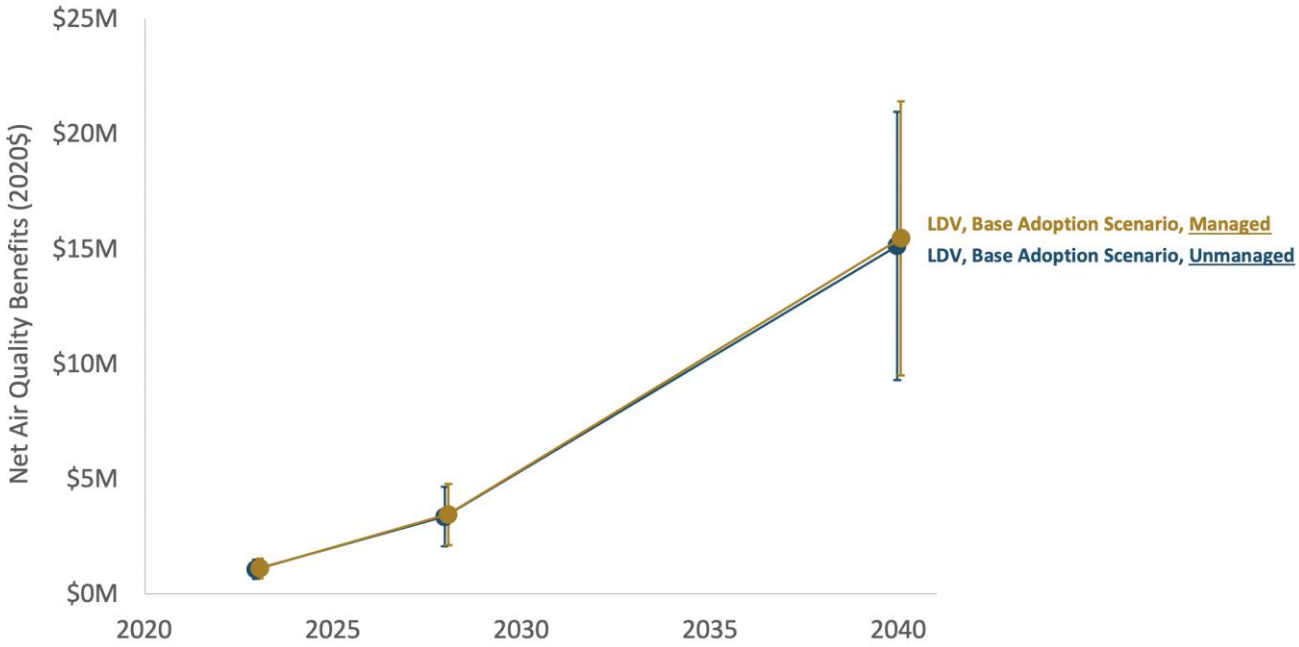
Result of this analysis is the **monetized air quality co-benefits** for each adoption scenario and vehicle type

Air quality impacts and the effects of managed charging, personal LDVs

- Results show a **positive net air quality benefit from LDV electrification**, accounting for both increased electric generation emissions, and decreased direct emissions from vehicles
- Managed charging shows relatively small air quality impact

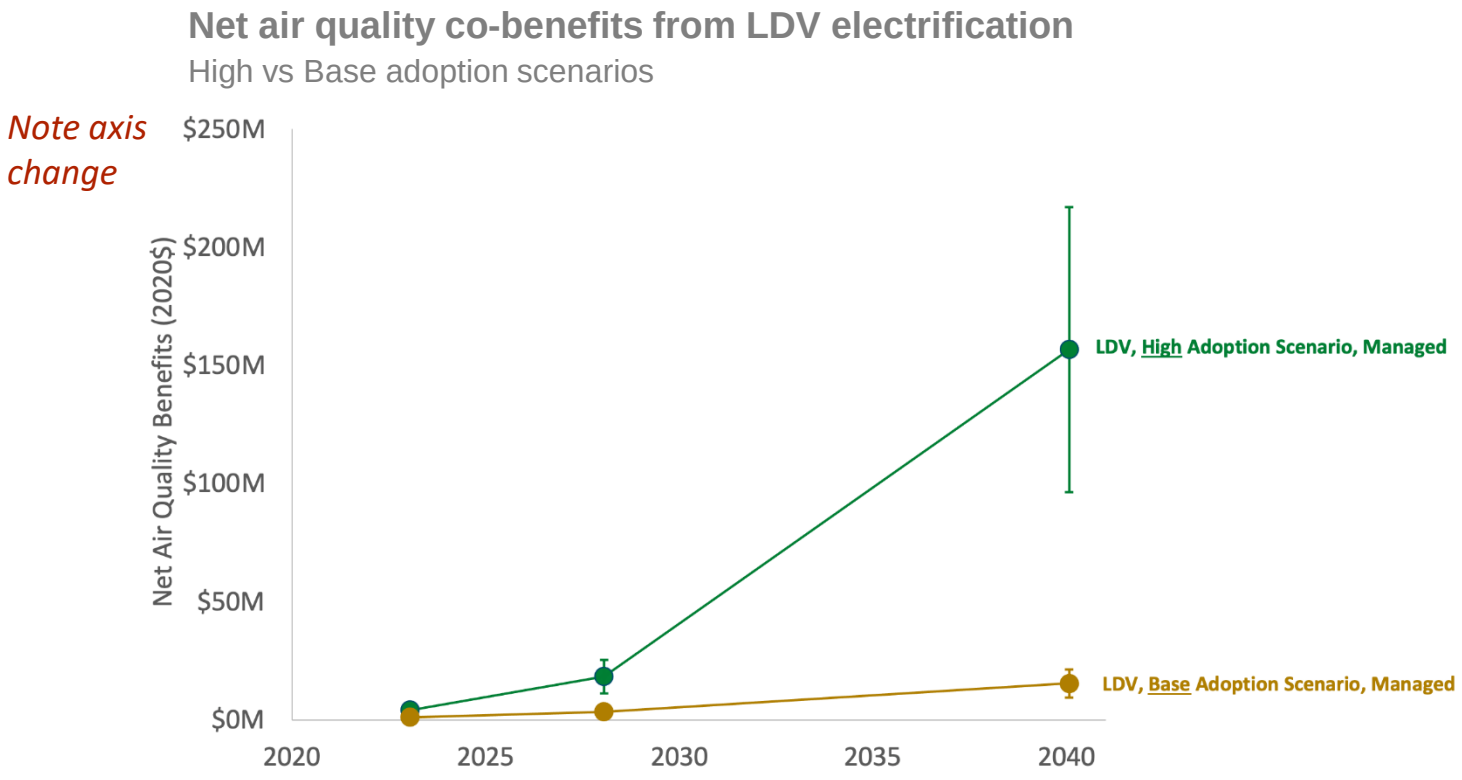
Net air quality co-benefits from LDV electrification

Managed vs unmanaged charging scenarios



The larger number of vehicles electrified in the high adoption scenario drives greater benefits

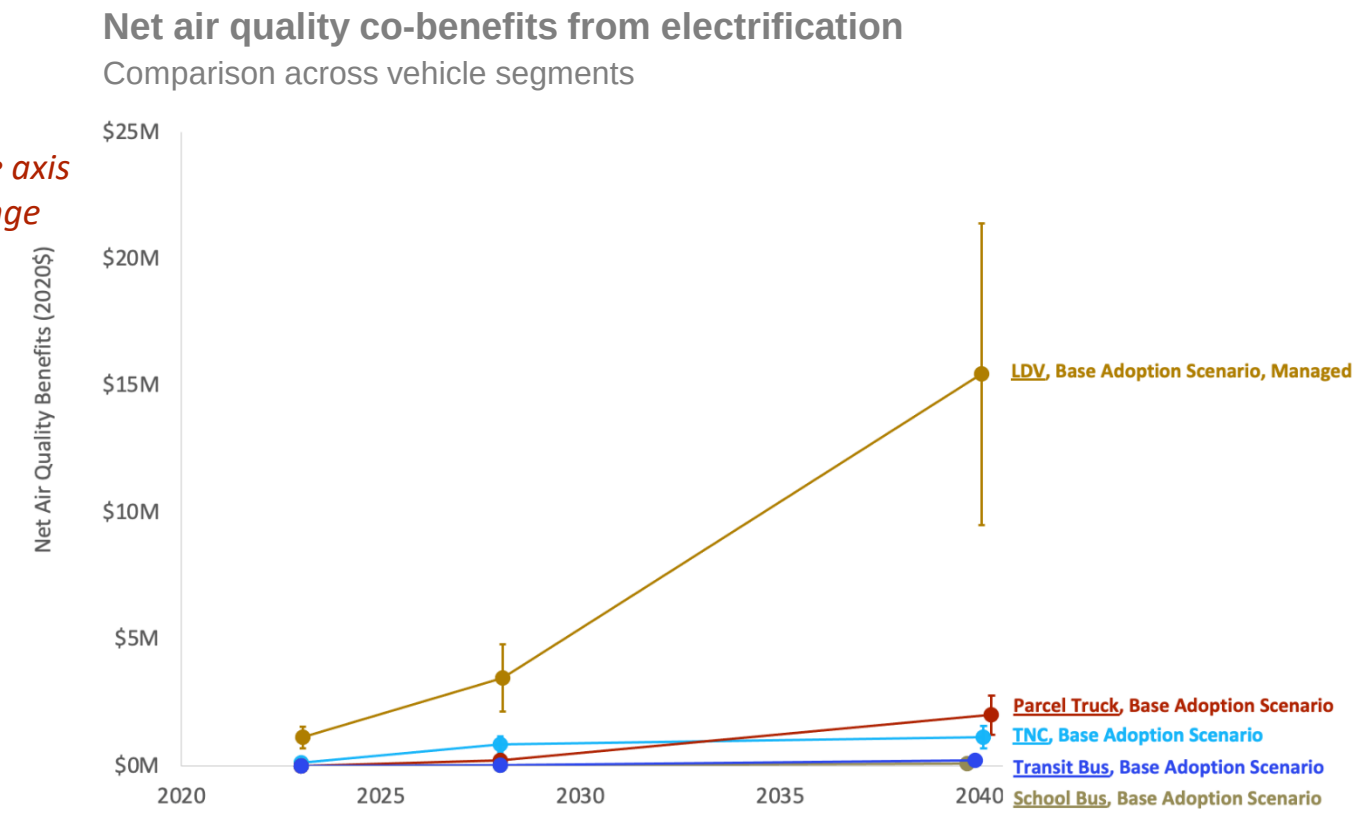
+ **High adoption scenario shows significantly higher air quality co-benefits, even in near term when electric grid is not as clean**



All vehicle segments show positive net air quality benefits, but LDV impact dominates

+ **Electrification has positive net air quality benefits across all vehicle segments modeled, but impact is highest by far in LDVs due to higher amount of displaced vehicle emissions**

Note axis change



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Q&A

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Thank You

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Lakshmi Alagappan, lakshmi@ethree.com

Eric Cutter, eric@ethree.com

Consider attending the upcoming, 2nd annual *Arizona Transportation Electrification Forum*

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Appendix

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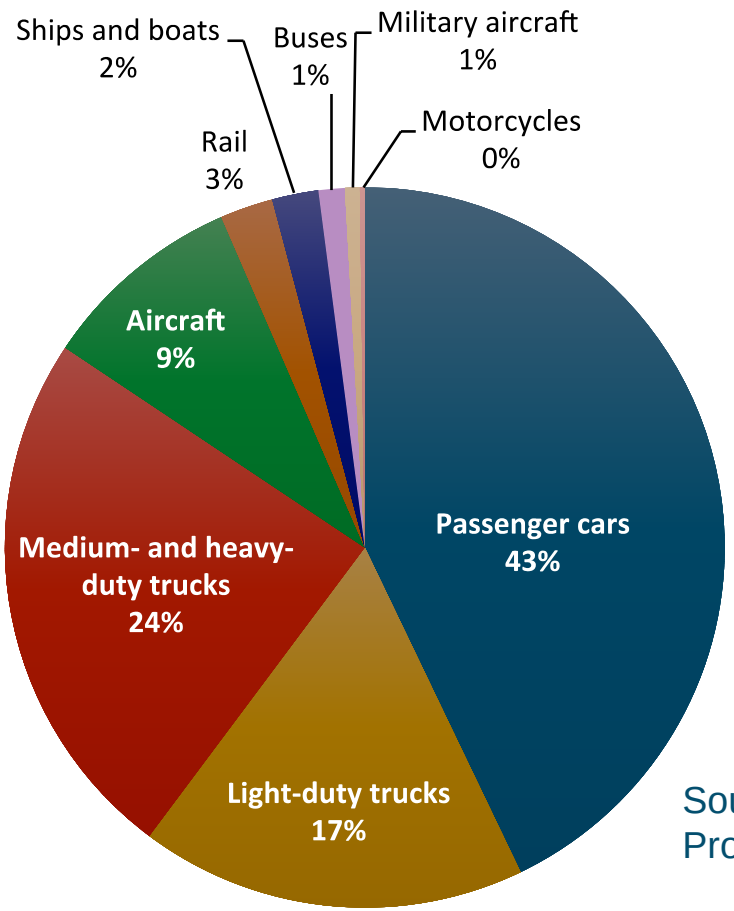
Additional Market Assessment Slides

US-wide transportation related carbon emissions driven primarily by passenger vehicles



Source: U.S. Environmental Protection Agency (2018 emissions)

+ **Similar analysis could not be found for AZ**

Truck volume on Arizona's roads is increasing, presenting TE opportunities

- **Phoenix area is an emerging hub for distribution and warehouse space**
  - Annual sq. footage of warehouse and distribution space delivered around Phoenix has been increasing
  - For example, Amazon has 5 fulfillment centers across Maricopa County, and 1 in Tucson
- **Truck tonnage in AZ is expected to <u>nearly double</u> between 2013 & 2040**

Forecast increase in freight moved by trucks, 2013 to 2040

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 IHS data in CPCS 2019 Arizona Truck Parking Study

- **These trends suggest <u>increasing opportunities for electrification of medium- and heavy-duty trucking</u> in the state**

10 of the top 500 largest private truck fleets in the U.S. are headquartered in AZ

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

Source: FleetOwner Top 500 Private Fleets

+ **Republic Services recently ordered 2,500 battery-electric collection trucks from Arizona-based Nikola**

Global companies are investing in electric trucks; not clear when these will come to AZ

- **Delivery companies are making significant purchases of electric delivery vans to support sustainability goals**
  - **UPS** ordered 10,000 from Arrival to be deployed in US and Europe
  - **DHL** bought electric van company StreetScooter in 2014; has thousands of electric delivery vans & planned to add 2,500 in 2019
  - **Amazon** ordered 100,000 from Rivian
  - **FedEx** ordered 1,000 Chanje V8100 for delivery in late 2020; slated to go to CA
  - **Ikea** has committed to using EVs for all in-home furniture deliveries by 2025

- **PepsiCo has placed significant e-truck orders, so far deployed largely in CA; unclear if/when these will come to Frito-Lay facility in Casa Grande, AZ**
  - Large fleet of electric delivery trucks
  - Ordered 100 Tesla Semis in 2017
  - Took delivery of 6 Peterbilt MD battery electric trucks in 2019

Source: Frito-Lay

Electrified Parking Spaces and Transport Refrigeration Units are another area of opportunity

+ **Electrified parking spaces (a.k.a., truck stop / truck terminal electrification) provide electric heating, cooling, Wi-Fi, TV, and other onboard appliances so that trucks don't have to idle**
  - Benefits include emissions reductions and improved air quality near truck stops, plus savings of 40-70% on operating costs during waiting periods

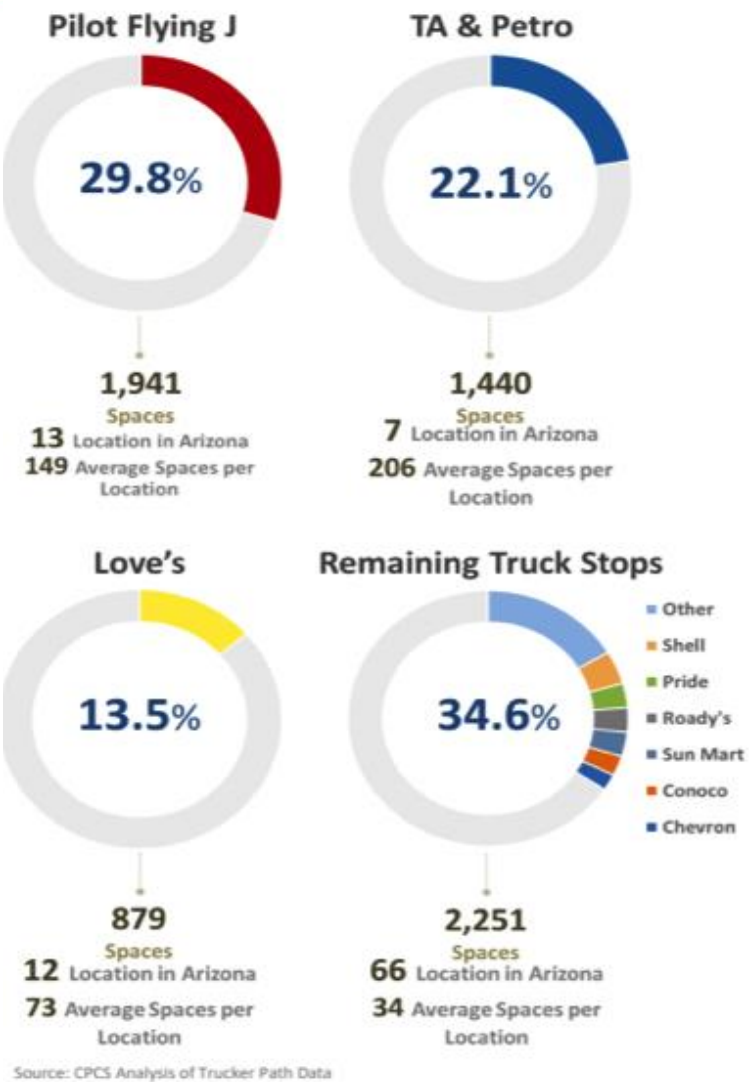
+ **Electrified transport refrigeration units use electric power to refrigerate freight using "shore power"**

Electrified parking spaces & refrigeration are near-term opportunities in Arizona

- **NREL electrified 50 truck stops across the country, incl. one in western AZ on the I-40**
- **IdleAir and Shorepower provide electrified parking spaces within Arizona on I-10 and I-40**
- **Maricopa County Air Quality Department covers up to 30% of the cost of electrified parking spaces**
  - Via U.S. EPA's Diesel Emissions Reduction State Clean Diesel Program
- **SRP offers a $1,000 rebate to install truck stop electrification**
  - Has been used to support project with IdleAir at the Schneider Trucking Terminal

Arizona has 129 truck parking locations open to the public

- **These provide > 7,000 truck parking spaces statewide.**
  - ~ 93% are provided by the private sector; 7% provided by ADOT
  - Of the private sector spaces, the top 3 companies -- Pilot/Flying J, TA-Petro, and Love's – provide > 65%
- **ADOT has identified shortages of publicly-accessible truck parking in the state; implementing $10M in National Highway Freight Program to improve truck parking**
- **Public data on the number of parking spaces as truck *terminals* (private parking facilities that are not open to the public) is not available**



Publicly-accessible truck parking spaces provided by the private sector, by company. Source: CPCS 2019 Arizona Truck Parking Study, for ADOT

Airports

- **Airlines typically supply their own Ground Support Equipment (GSE)**
- **Phoenix Airport's own fleet includes:**
  - Have also installed 13 Level 1 and 20 Level 2 charging stations at airport parking
- **Tucson Airport has 45 GSE vehicles & is assessing electrifying them, as well as preconditioned air units and tug vehicles**

Source: Jetex

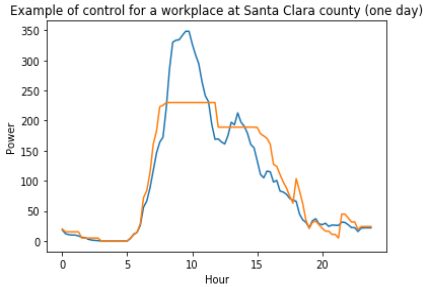
Energy+Environmental Economics

Additional Cost Benefit Analysis Slides

EV Cost Benefit Analysis (CBA) Tool Overview

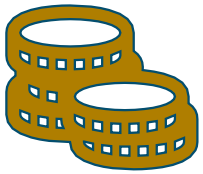
Key Inputs

EV Load Shapes

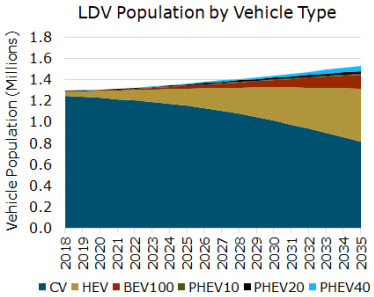


Utility Marginal Costs

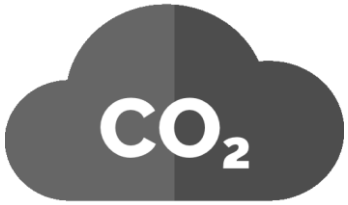
Utility Rates



EV Adoption Forecasts

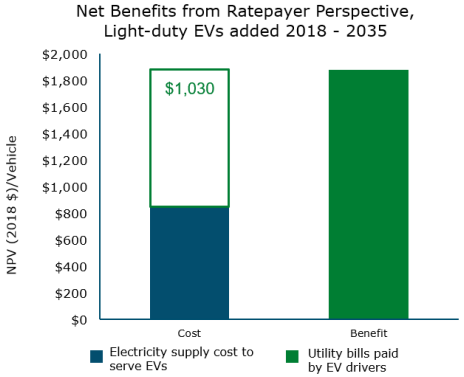


Emissions



Gas Prices

CBA Results



Illustrative CBA Results

- Costs and benefits from different stakeholder perspectives*
- Comparison of smart charging versus unmanaged charging scenarios

*E.g., Participant Cost Test (PCT), Ratepayer Impact Measure (RIM), Societal Cost Test (SCT)

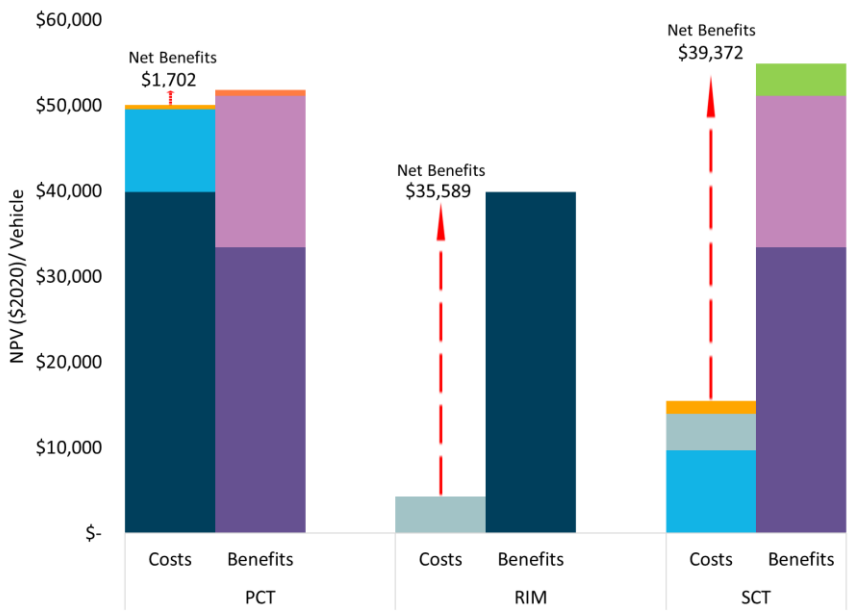
CBA Input Assumptions

Key input assumptions and data sources

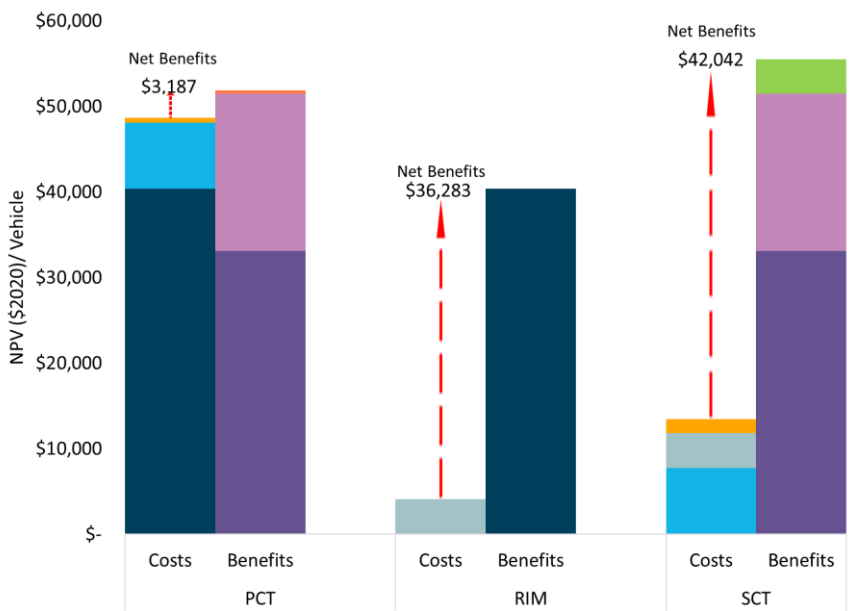
Input	Source
EV Load Shapes	National Household Travel Survey, E3 EV Load Shape Tool. Managed charging load shapes were optimized against utility rates.
Marginal Electricity Costs	Marginal energy and capacity costs (generation, transmission and distribution capacity) and loss factors were provided by TEP and APS.
Electricity Rates	Residential, Public and Workplace EV specific rates were provided by APS and TEP.
Adoption Forecasts	Base Case adoption forecasts were provided by APS and TEP and were developed through previous modeling efforts. High Adoption Case forecasts were pegged to the Rocky Mountain Institute (RMI) national goal of 50 million on road EVs by 2030, which is aligned with achieving global carbon emissions reduction targets in line with limiting global warming to 1.5°C.
Emissions	Electricity: utility resource planning models Gasoline: Argonne National Laboratory assumptions
Gasoline Prices	EIA mid forecast

TEP TNC per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

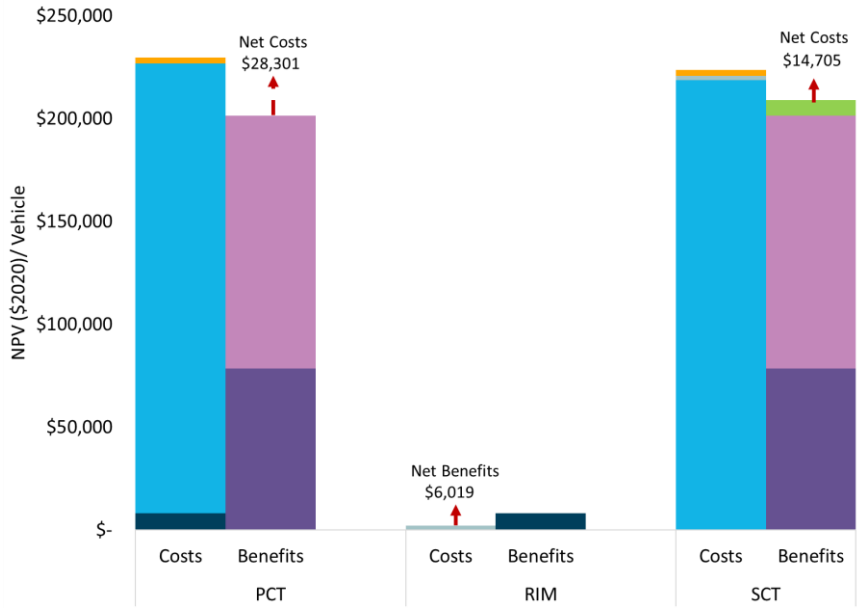
- Utility Bills
- Incremental Upfront Vehicle Costs
- Electricity Supply Costs
- Charging Infrastructure Costs

Benefits

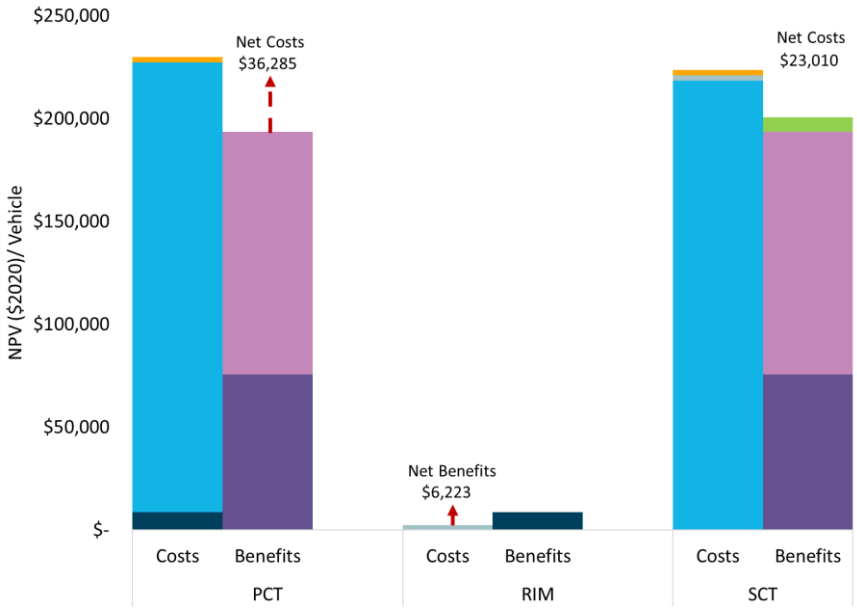
- Avoided Gasoline
- O&M Savings
- Tax Credits & Rebates
- Emissions

TEP School Bus per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
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Benefits

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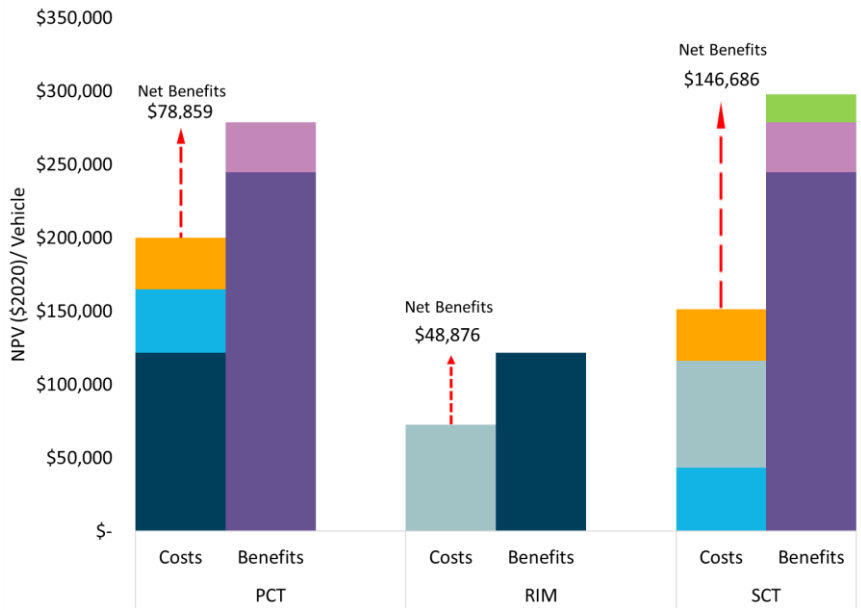
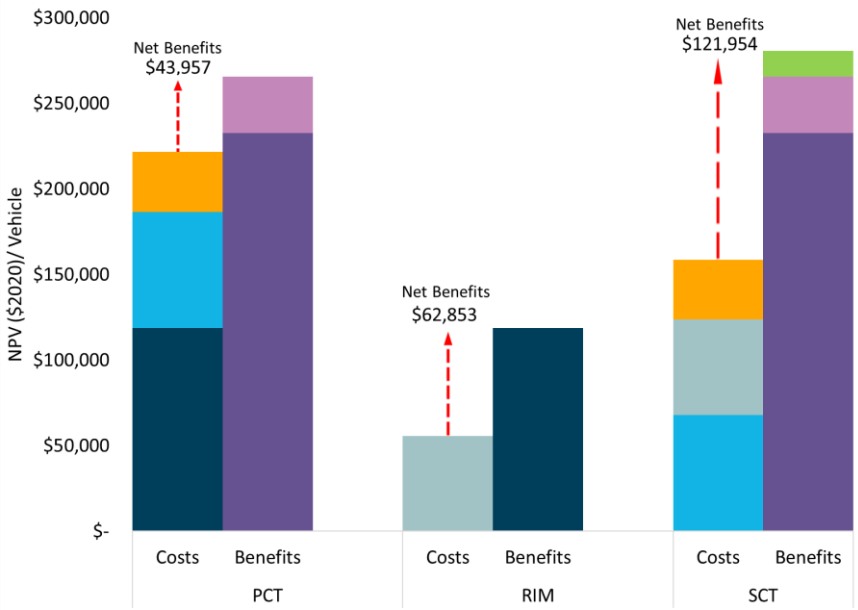
- Emissions

TEP Transit Bus per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
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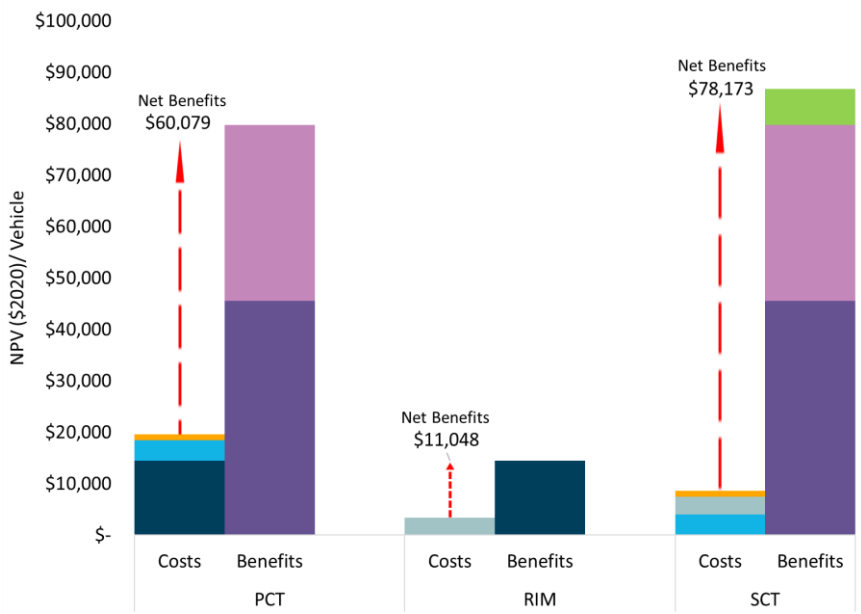
- Electricity Supply Costs
- Charging Infrastructure Costs

Benefits

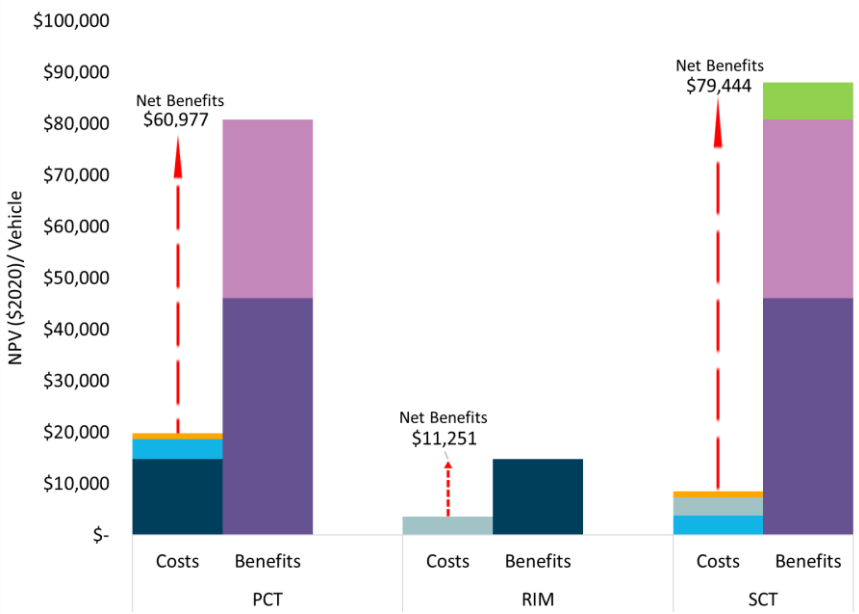
- Avoided Gasoline
- O&M Savings
- Tax Credits & Rebates
- Emissions

TEP Parcel Van per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
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- Electricity Supply Costs
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Benefits

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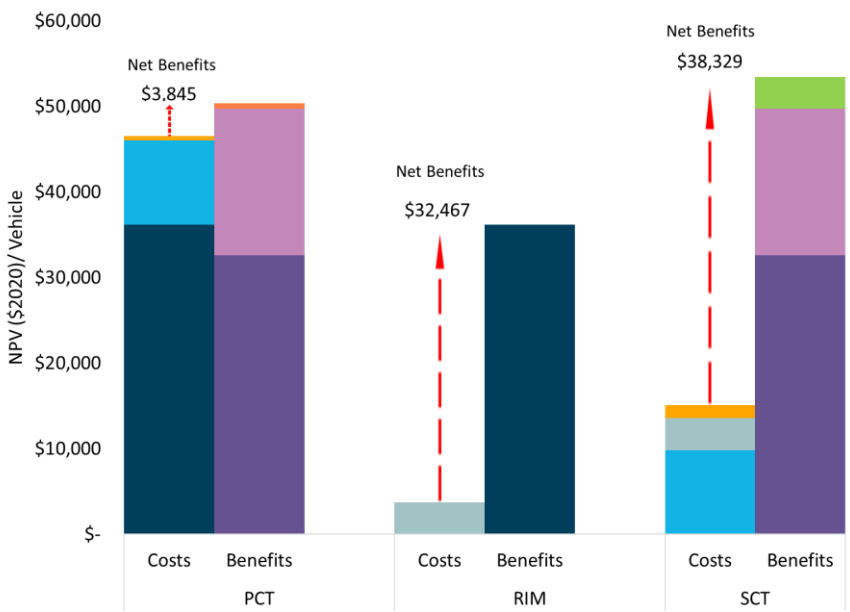
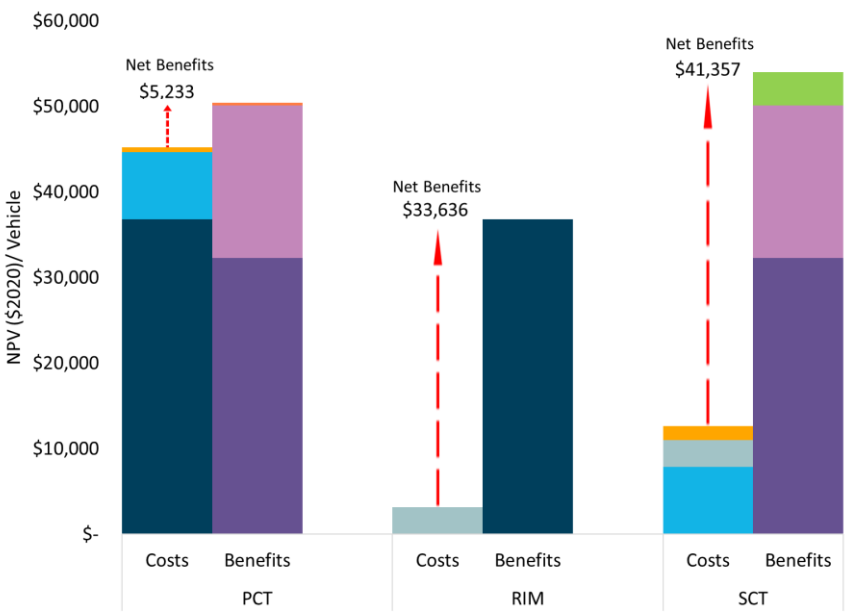
- O&M Savings
- Tax Credits & Rebates
- Emissions

APS TNC per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

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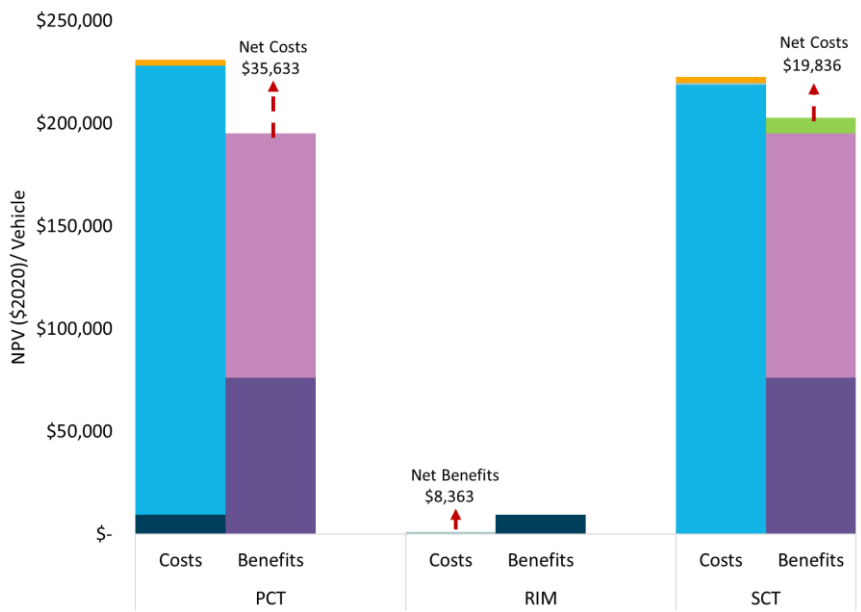
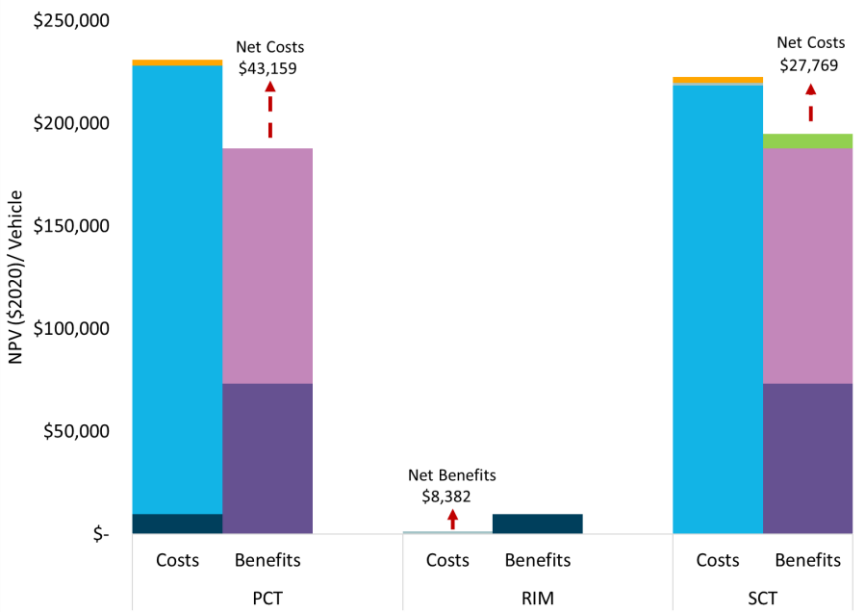
- Tax Credits & Rebates
- Emissions

APS School Bus per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
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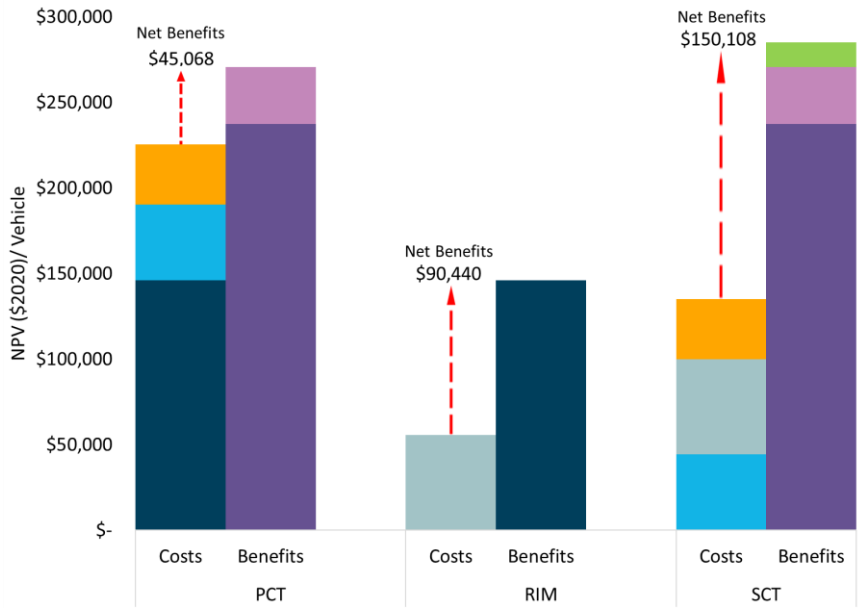
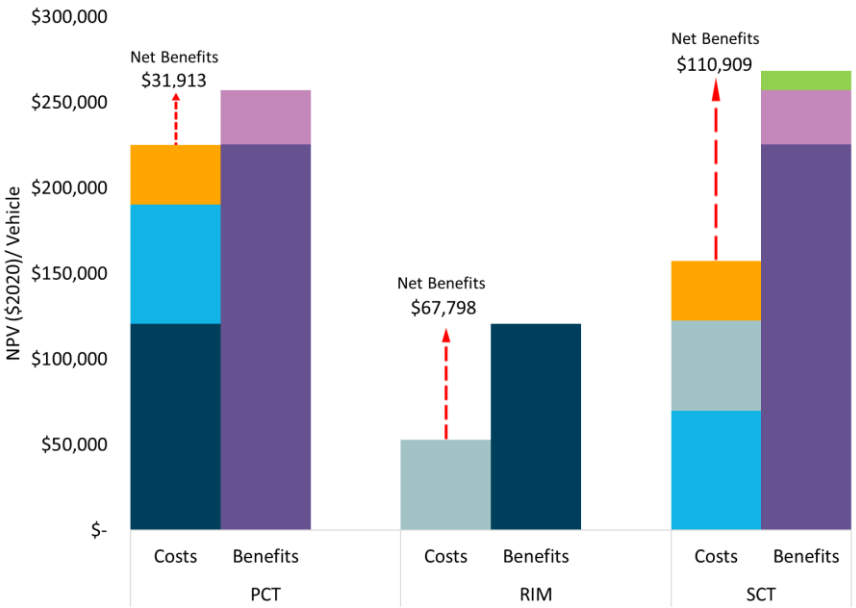
- Emissions

APS Transit Bus per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

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Benefits

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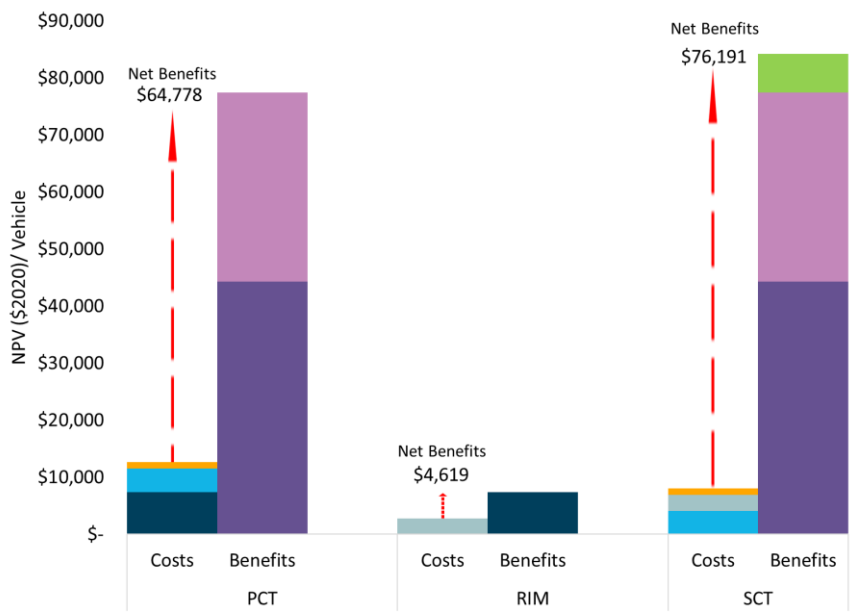
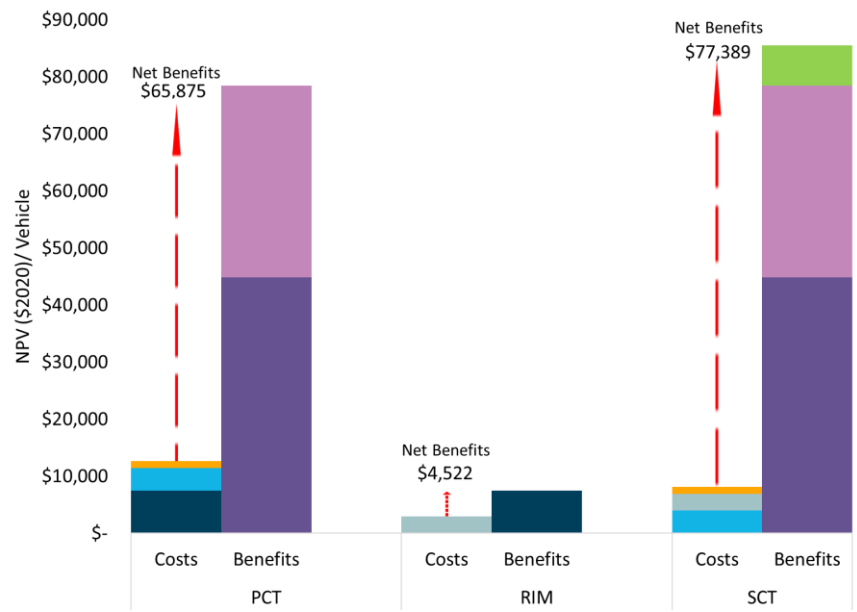
- Emissions

APS Parcel Van per-vehicle Cost Test Results

Base Adoption, Unmanaged Charging



High Adoption, Managed Charging



Costs

- Utility Bills
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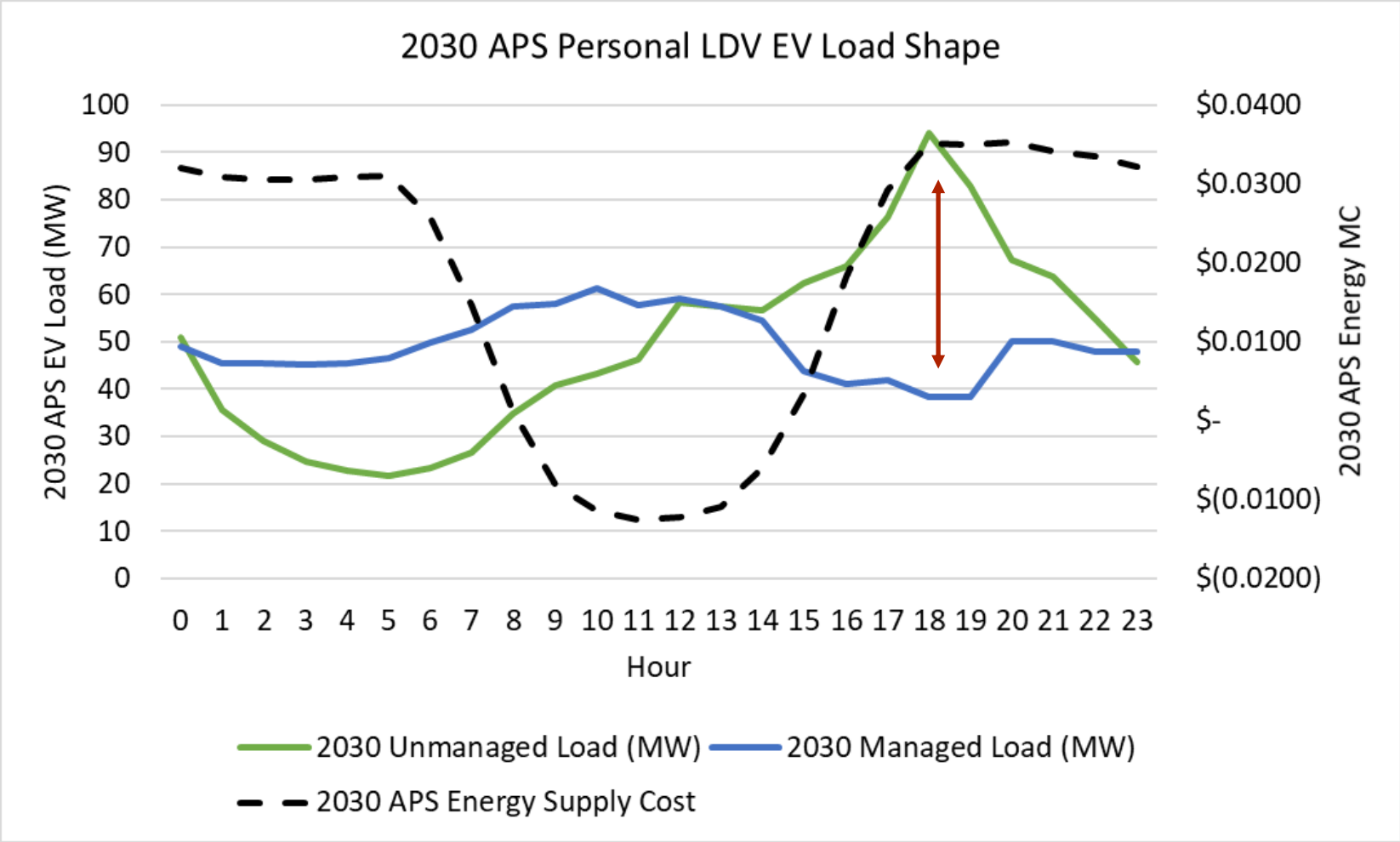
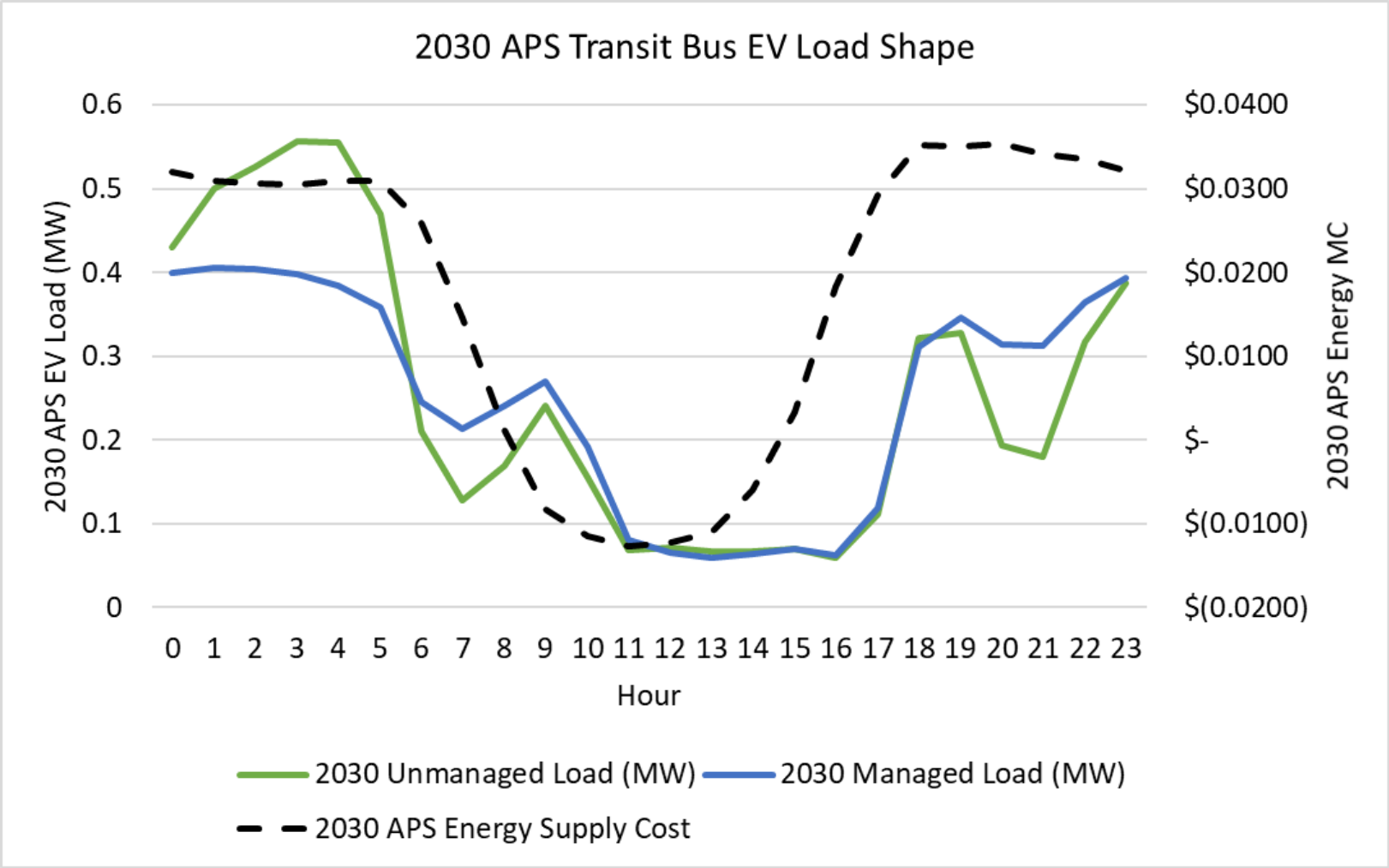
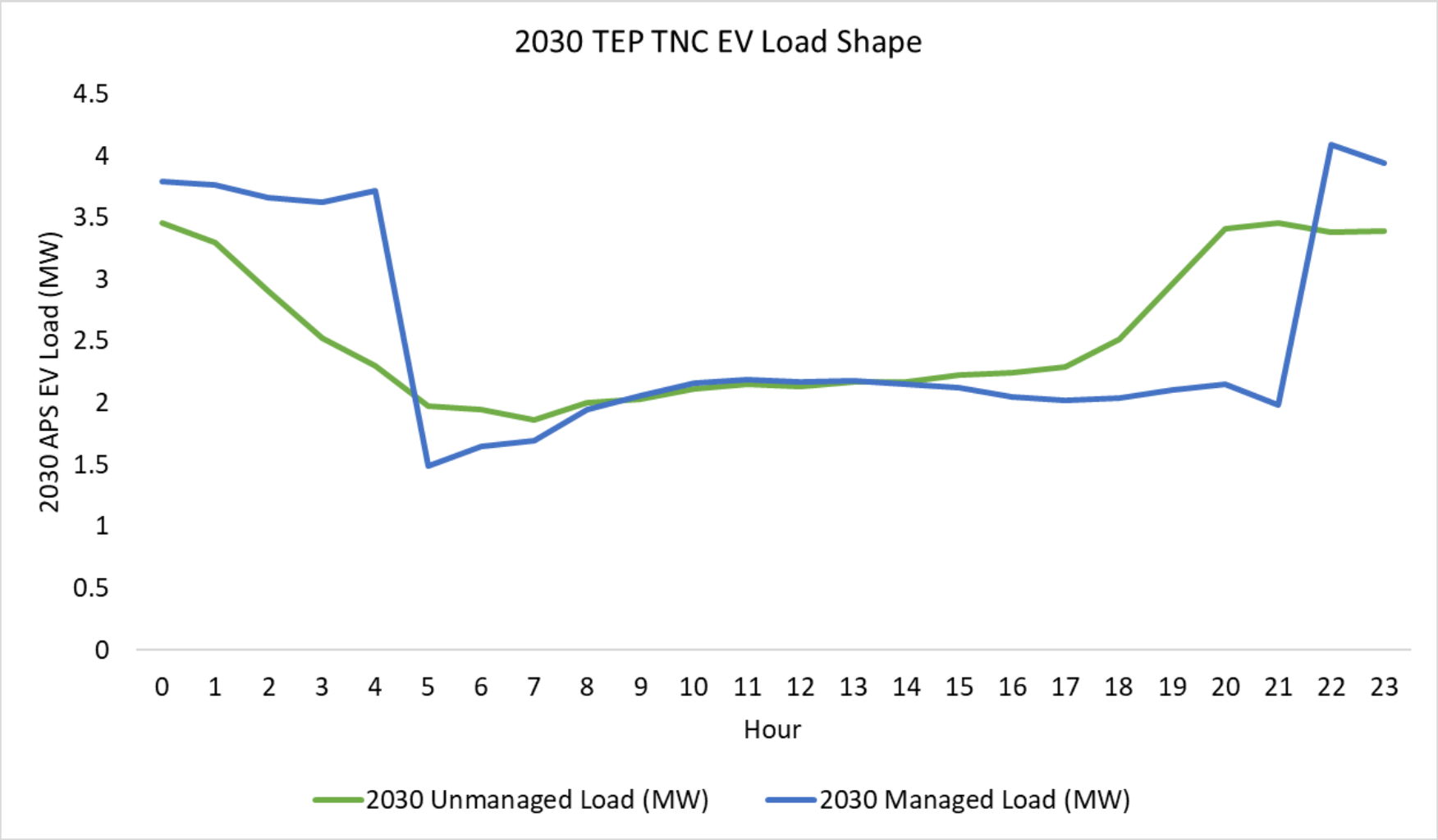
2030 APS Personal LDV EV Load Shape Comparison



2030 APS Transit bus Load Shape Comparison

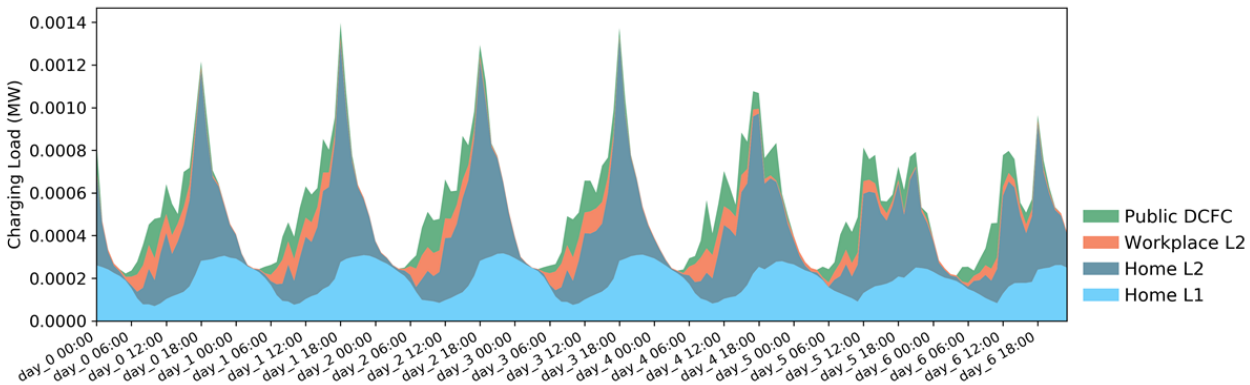


2030 TEP TNC EV Load Shape Comparison



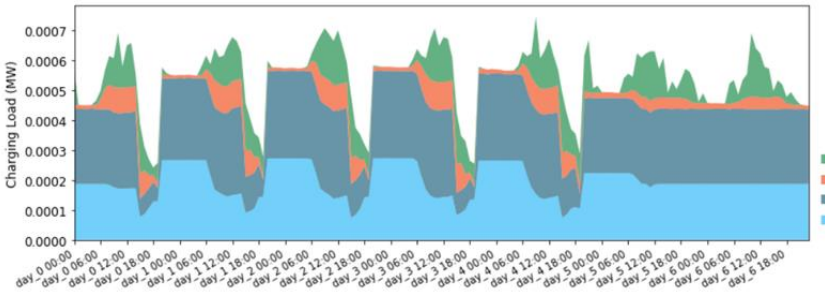
Personal LDV Charging Load per Vehicle

- Personal LDV charging without management leads to high peaks during evening peak hours
- Unmanaged



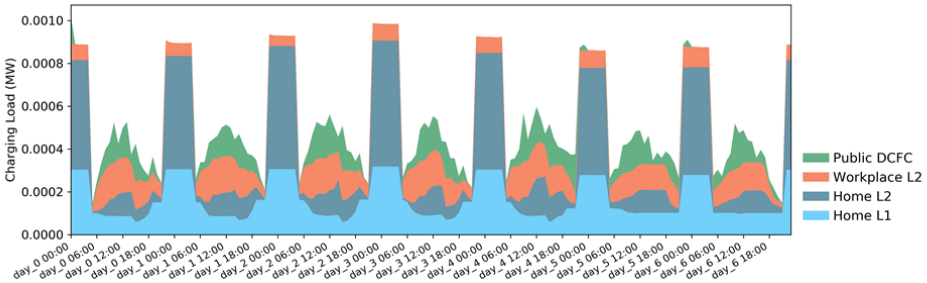
- APS Managed

Note axis change



- TEP Managed

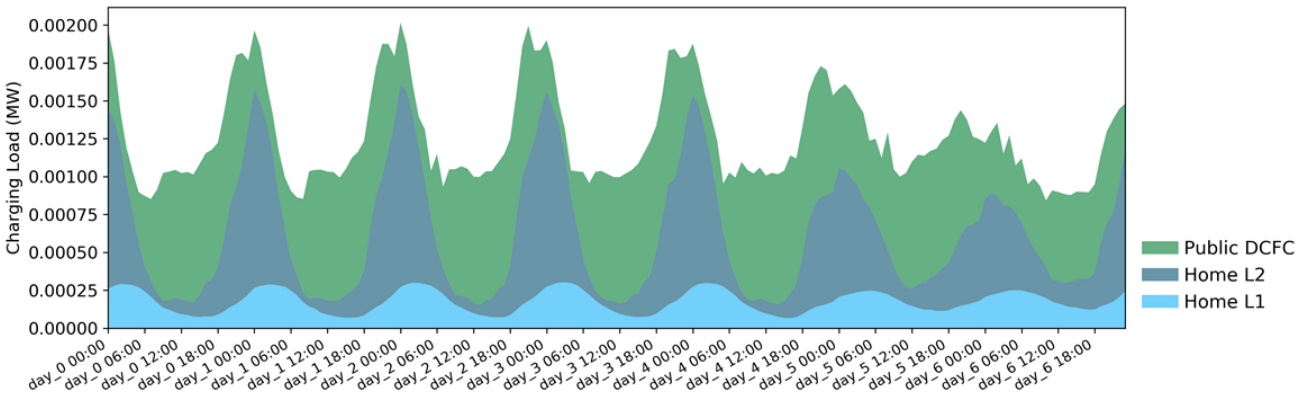
Note axis change



TNC Charging Load per Vehicle

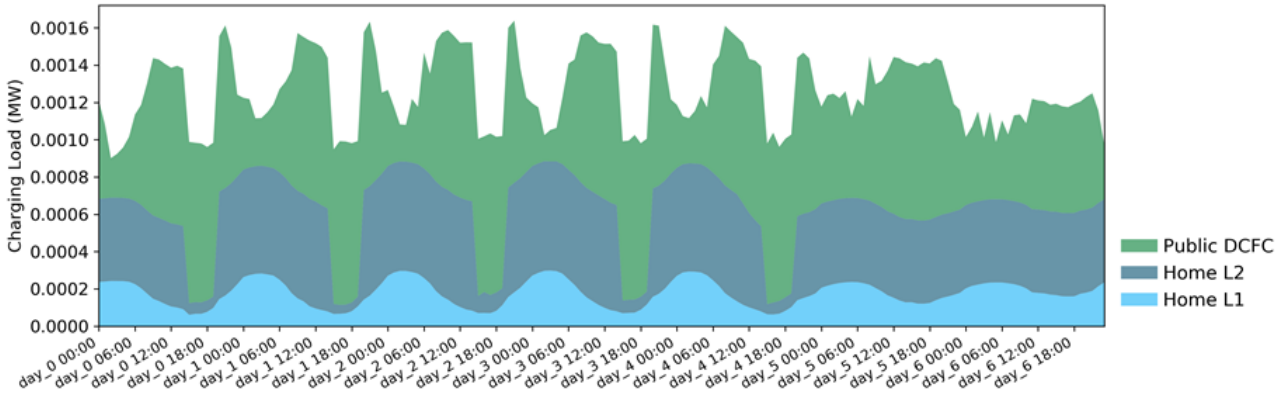
- TNC drivers rely heavily on public DCFC charging due to limited access to home charging and high opportunity cost of charging during shifts

- Unmanaged



- Managed (APS)

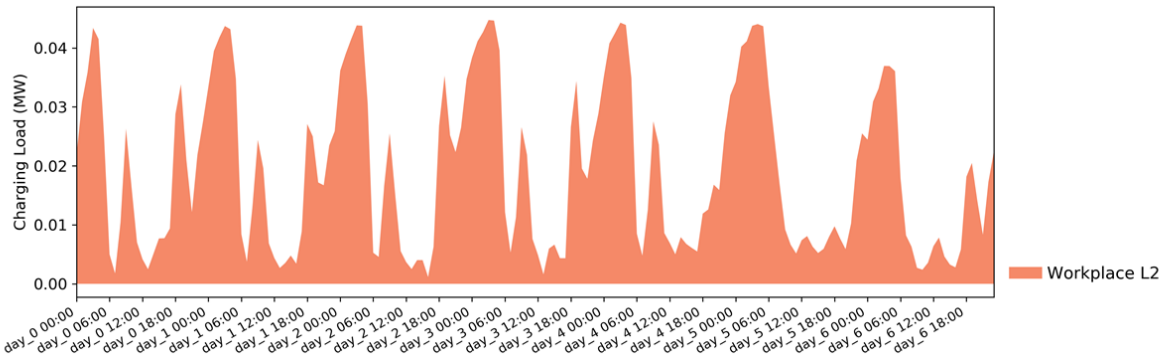
Note axis change



Transit Bus Charging Load per Vehicle

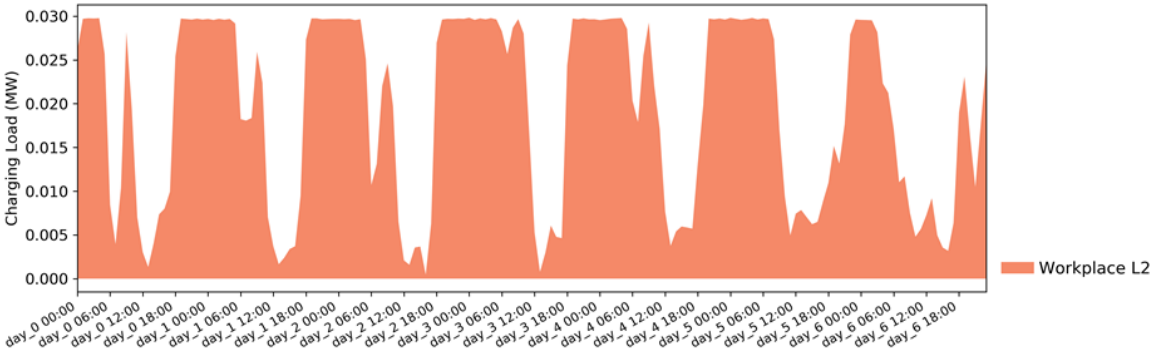
+ **Managed charging at bus depots helps reduce charging during peak**

+ **Unmanaged**



+ **APS Managed**

Note axis change

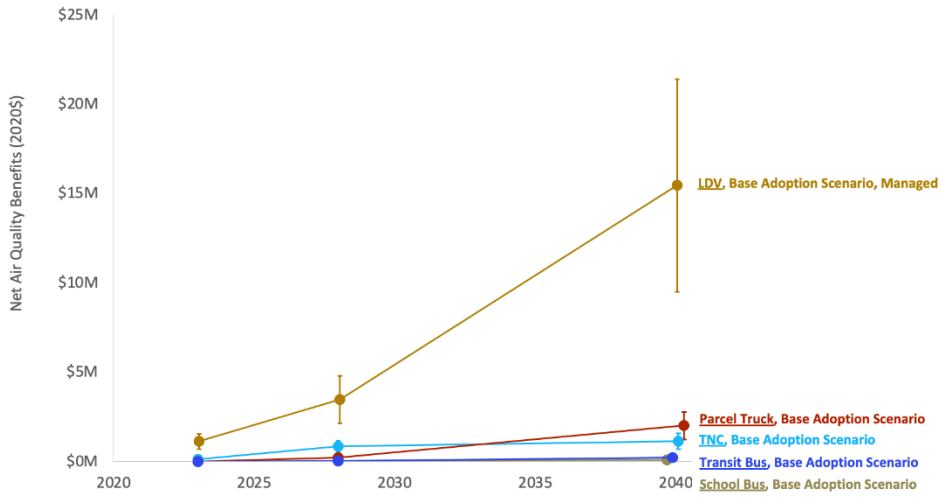


Energy+Environmental Economics

Additional Air Quality Analysis Slides

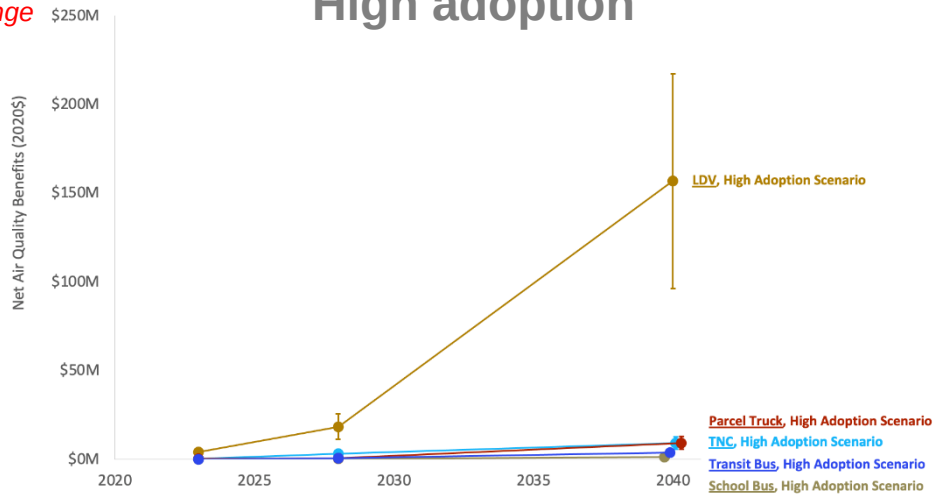
AQ Impacts: Base vs High Adoption

Base adoption



Note axis change

High adoption



Air quality impacts of TE assessed using the U.S. EPA's COBRA tool

- **COBRA assesses the health impacts of changes in air pollutants from a baseline level**
  - Examples of health impacts include adult mortality, infant mortality, respiratory hospital admissions, non-fatal heart attacks, and lost workdays, among others
- **Model estimates health impacts due to changes in particulate matter, and the associated monetary value**
- **E3 analysis includes changing electricity mix over time, in line with utility resource plans and anticipated emissions reductions**
  - Increasing air quality benefits over time as electricity sources emit less pollution

COBRA
Co-Benefits Risk Assessment
Health Impacts Screening and Mapping Tool

Notes, by slide number

Slide 10

Medium- and heavy-duty vehicles are defined as those weighing at least 8,500 lbs.

Slide 12

Uber, September 2020, “Driving a Green Recovery,” https://www.uber.com/us/en/about/sustainability/

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

Slide 13

Headline source: ADOT

School buses: League of Conservation Voters, January 2020, “The Future is Electric – Phoenix Celebrates First Electric School Bus,” https://www.lcv.org/article/future-electric-phoenix-celebrates-first-electric-school-bus/

Slide 14

“Sun Tran’s first all-battery electric bus hits Tucson streets,” May 2020, https://kvoa.com/news/2020/05/18/sun-trans-first-all-battery-electric-bus-hits-tucson-streets/#:~:text=On%20Monday%2C%20Tucson%20Mayor%20Regina,city's%20vehicle%20and%20transit%20fleet.%22

Interview with Sun Tran, August 21, 2020

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”

Slide 16

Source for headline: ADOT

Example of larger pickup truck = Ford F-250

Source for through trips: CPCS for ADOT, July 2019, “Arizona Truck Parking Study”

Source for AZ-MX border stats: Arizona State Freight Plan A to Z, 2017

Source for Ducey announcement: "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

Slide 37

Source: 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

Slide 38

https://azbigmedia.com/real-estate/big-deals/industrial/phoenix-becomes-a-magnet-for-distribution-and-warehouse-facilities/

Colliers International 2019 Q4 Greater Phoenix Industrial Market Report, available at https://www2.colliers.com/en/research/phoenix/2019-q4-greater-phoenix-industrial-market-report#:~:text=Q4%202019%20Industrial%20Market,to%20%240.59%20per%20square%20foot

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.

Slide 39

FleetOwner Top 500 Private Fleets, https://www.fleetowner.com/truck-stats/fleet-owner-500/article/21703705/fleet-owner-500-top-private-fleets-of-2019

Slide 40

On Frito Lay: https://www.truckinginfo.com/342682/peterbilt-delivers-first-electric-model-220ev-to-frito-lay

https://www.foxbusiness.com/money/ups-electric-delivery-vans-announces-waymo-partnership

https://www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1580304360144-453&WT.mc_id=TWT_BB4_EV_PRESSRELEASE_012920

https://www.reuters.com/article/us-deutsche-post-dhl-streetscooter/dhl-to-debut-zero-emission-electric-delivery-vans-in-u-s-cities-idUSKBN1XZ2E7?utm_source=Triggermail&utm_medium=email&utm_campaign=Post%20Blast%20bii-transportation-and-logistics:%20DHL%20brings%20EV%20pilot%20to%20the%20US%20%7C%20Automation%20to%20help

%20UPS%20handle%2032M%20packages%20per%20day%20during%20holidays%20%7C%20Indian%20mobility%20startups%20see%20cash%20infusions&utm_term=BII%20List%20T%26L%20ALL "

Slide 41

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 generally install 6 – 12 TSE units/electrified parking spaces. Using grid-connected electric power for these services improves air quality through reduced emissions and can save trucking companies an estimated 40% to 70% on operating costs during these waiting periods. These air quality improvements can be especially significant to communities that are near truck stops, which are often financially and environmentally disadvantaged.

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

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

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

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

Slide 43

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