EXAMINING COSTS AND BENEFITS OF ELECTRIC VEHICLES WITH AFLEET

ANDY BURNHAM
Principal Environmental Scientist
aburnham@anl.gov

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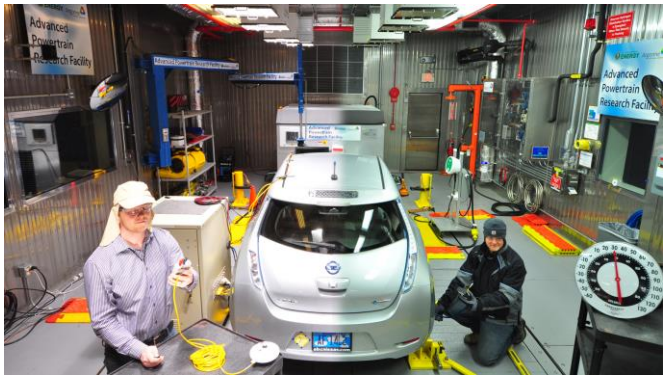
OUTLINE OF PRESENTATION

- **AFLEET Introduction**
- **AFLEET 2019 Updates**
  - Off-Road Footprint Calculator
  - EV Charging Calculator
- **AFLEET EV Case Study**

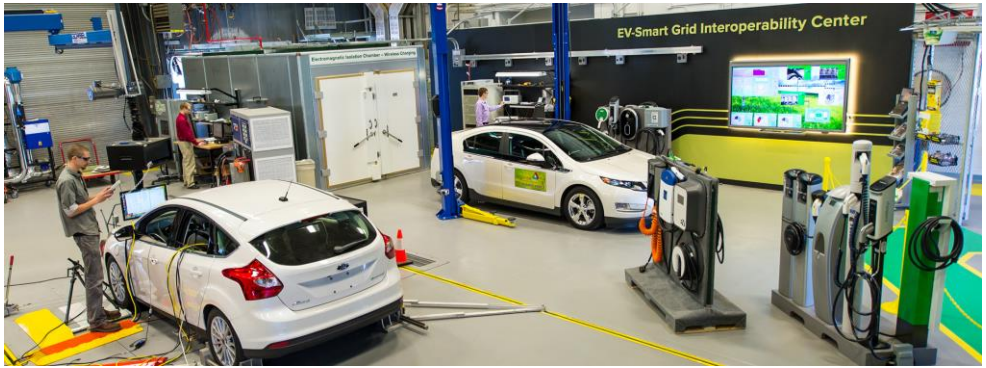
AFLEET TOOL INTRODUCTION

ARGONNE'S BATTERY AND ELECTRIC VEHICLE RESEARCH



ARGONNE'S EV-SMART GRID INTEROPERABILITY CENTER

- **Develop EV charging standards & research grid impacts**
  - 50 AC EVSEs, PV fed charging - 80kW, Wireless - 50kW
  - 10 DC Fast ports: 25, 50, 200 & 400kW; 1MW - commercial trucks



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“AFLEET TOOL” TO ANALYZE AFV COSTS & BENEFITS

- **Examines light-duty & heavy-duty vehicle:**
  - Petroleum use
  - GHGs
  - Air pollutants
  - Cost of ownership

- **Contains 18 fuel/vehicle technologies**
  - Conventional
  - Hybrids
  - Plug-in electrics
  - Alternative fuels: CNG, LNG, LPG, H2, ethanol, biodiesel, renewable diesel
- **New features in AFLEET 2019 Spreadsheet**
  - Off-Road Footprint calculator
  - Public EV Charging calculator
  - Low-NOx LPG engines
- **AFLEET Online and Spreadsheet; HDVEC: afleet-web.es.anl.gov**
  - Updates will be released this fall

AFLEET TOOL'S CALCULATION METHODS

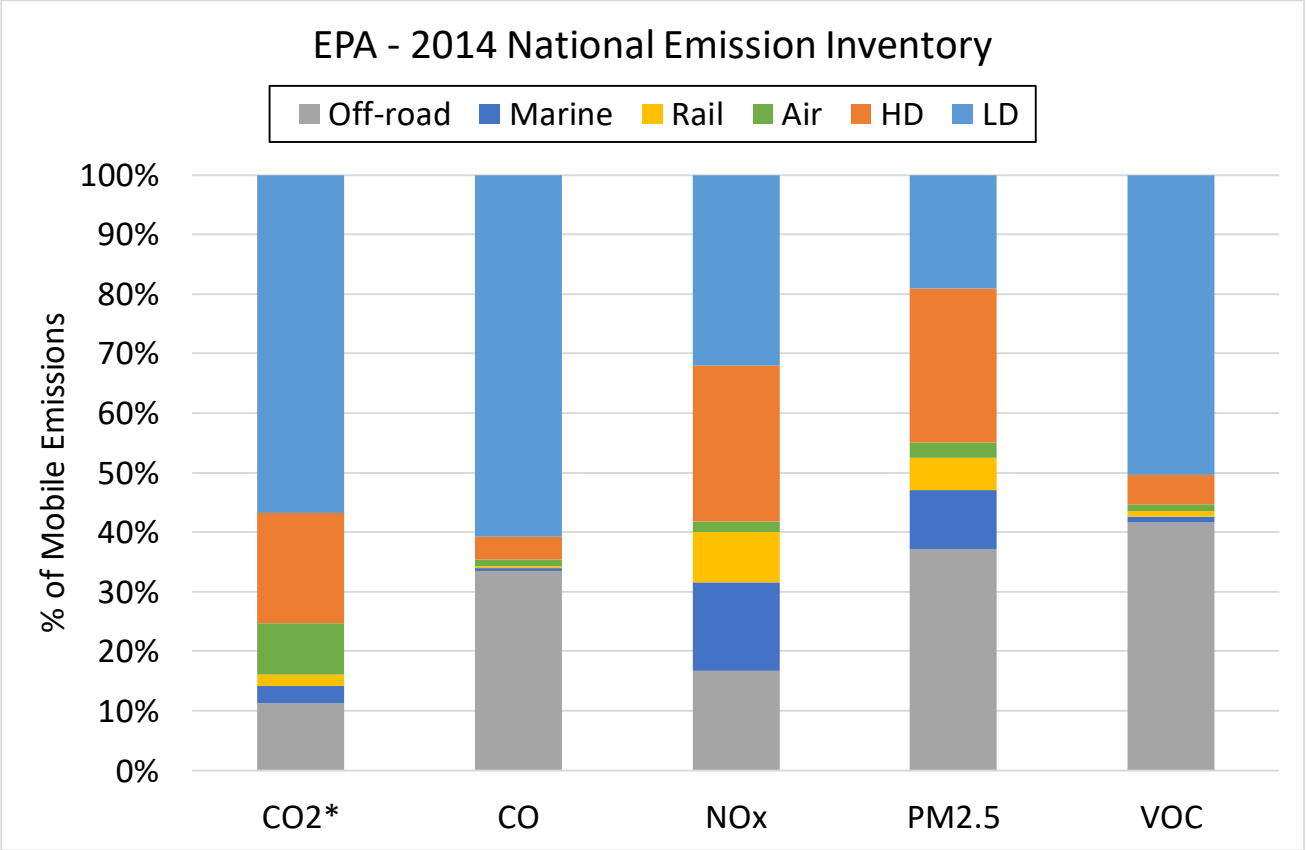
1. **Simple Payback Calculator**
   - Annual emissions & simple payback: new AFV vs. conventional
2. **Total Cost of Ownership Calculator**
   - Lifetime emissions & NPV of costs: new AFV vs. conventional
3. **Idle Reduction Calculator**
   - Annual emissions & simple payback: IR equipment vs. idling
4. **On-Road Fleet Footprint Calculator**
   - Annual & remaining lifetime emissions of existing & new vehicles
5. **Off-Road Fleet Footprint Calculator**
   - Annual & remaining lifetime emissions of existing & new off-road equipment
6. **EV Charging Calculator**
   - Annual emissions benefit of utilizing public charging infrastructure

*red text = new feature

AFLEET 2019 UPDATES

OFF-ROAD FOOTPRINT CALCULATOR

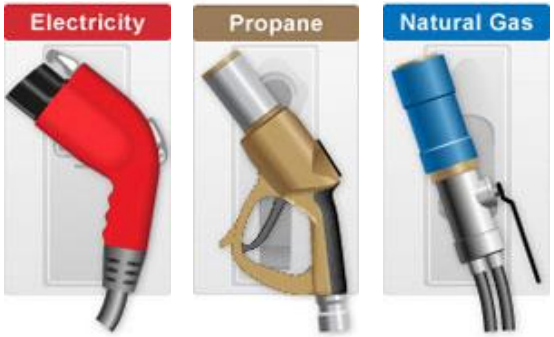
OFF-ROAD = LARGE SOURCE OF MOBILE AIR POLLUTION



*CO2 from Marine, Rail, Air based on EPA 2019 GHG Inventory

OFF-ROAD FOOTPRINT CALCULATOR INTRODUCTION

- **Examines off-road equipment:**
  - Petroleum use
  - GHGs
  - Air pollutants



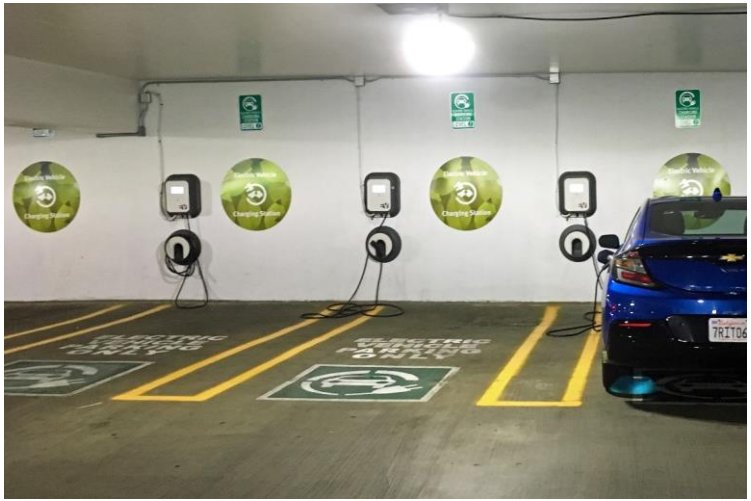
- **Contains 12 fuel/equipment technologies**
  - Conventional
  - Electric
  - Alternative fuels: CNG, LNG, LPG, H_2, ethanol, biodiesel, renewable diesel

- **Includes 22 equipment types (in 6 EPA NONROAD categories)**
  - Data based on EPA MOVES2014b
    - Emission factors: conventional and alt. fuel
    - Annual usage
    - Rated horsepower
    - Equipment lifetime

AFLEET OFF-ROAD EQUIPMENT CATEGORIES & TYPES

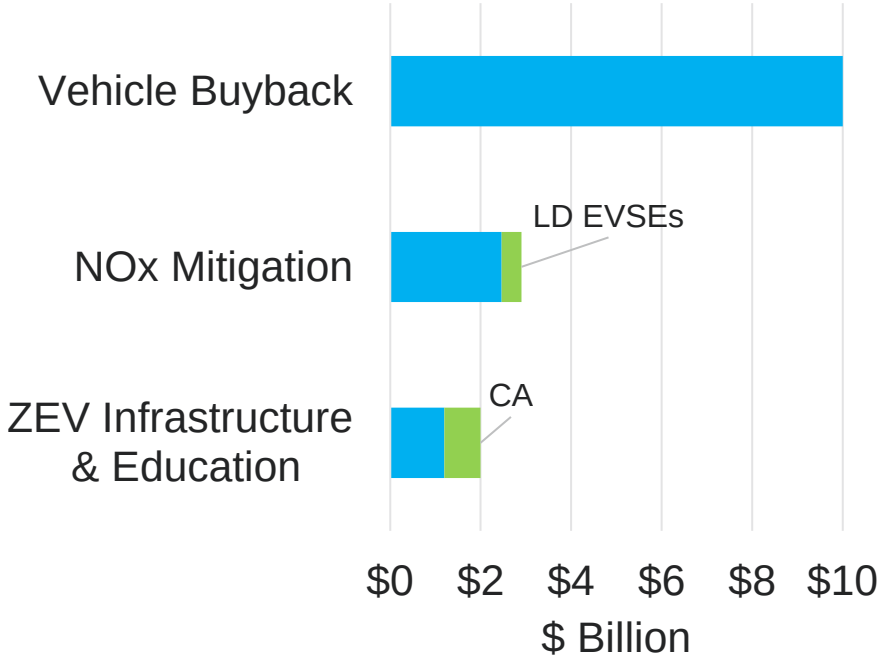
1. **Agricultural**
   - Agricultural tractors
2. **Airport support**
   - Airport support equipment
3. **Construction**
   - Cranes
   - Crawler tractor/dozers
   - Excavators
   - Rollers
   - Rubber tire loaders
   - Skid steer loaders
   - Tractors/loaders/backhoes
4. **Industrial**
   - Aerial lifts
   - Forklifts
   - Sweepers/scrubbers
   - Terminal tractors
5. **Lawn & garden**
   - Chain saws
   - Commercial turf equipment
   - Lawn & garden tractors
   - Lawn mowers
   - Leafblowers/vacuums
   - Snowblowers
   - Trimmers/edgers/brush cutter
6. **Recreational**
   - All terrain vehicles
   - Golf carts

EV CHARGING CALCULATOR



SIGNIFICANT FUNDING FOR CHARGING PROJECTS

VW Settlement Breakdown



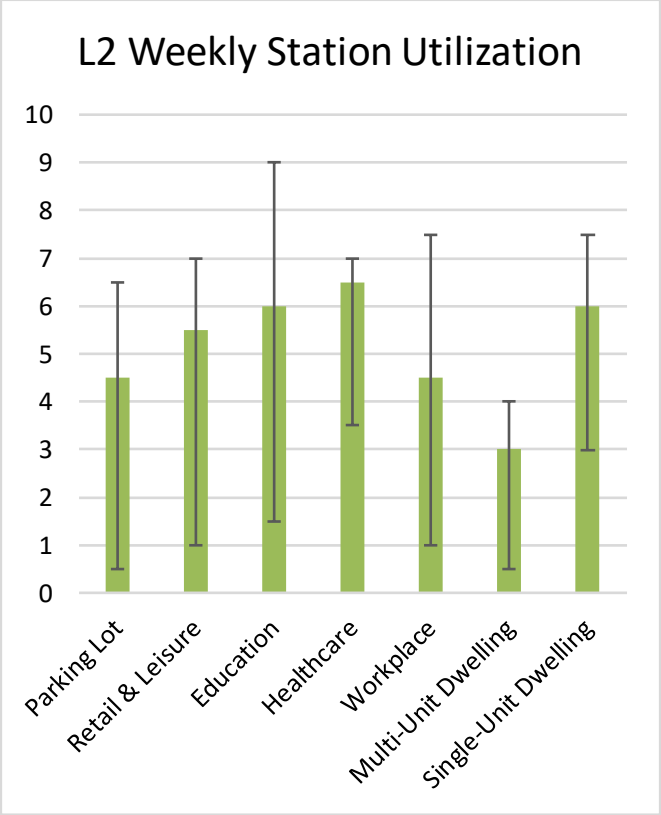
Public Utility Filings 2012 – June 2019

Approved	Pending/Filed
21 States	21 States
61 Filings	31 Filings
39 Utilities	25 Utilities
$1,152,227,741 Investment	$1,579,700,976 Investment
1,996 DC Fast Charging Stations	1,048 DC Fast Charging Stations
45,112 Level 2 Charging Stations	125,740 Level 2 Charging Stations

Nigro 2019, Atlas Public Policy

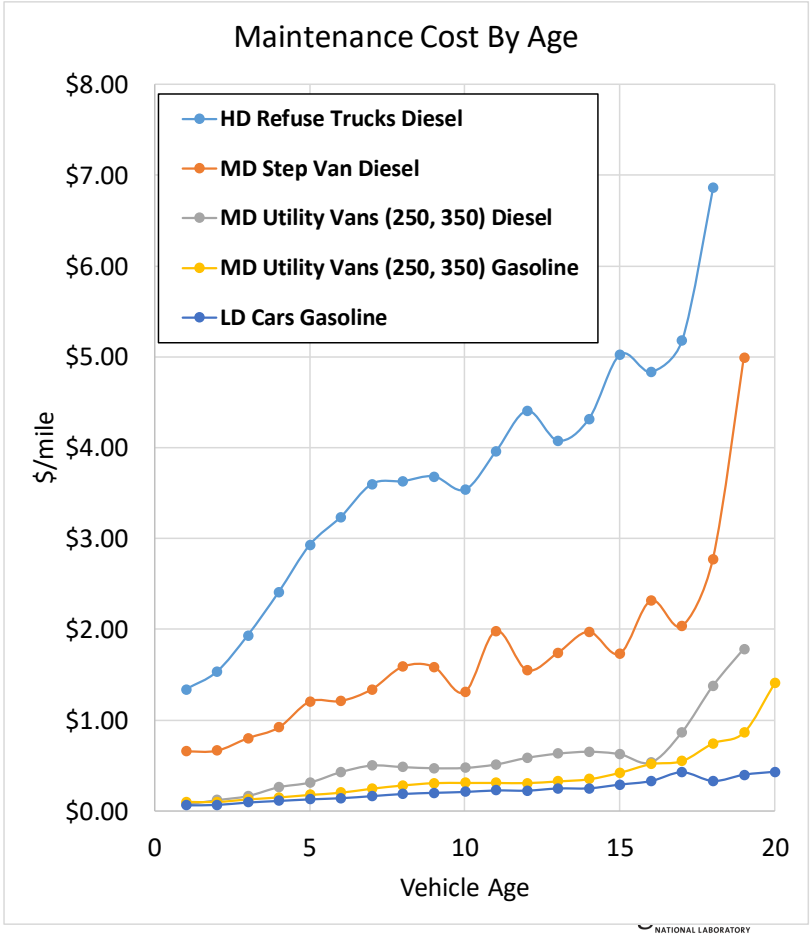
EV CHARGING CALCULATOR INTRODUCTION

- **What are emissions/energy benefits of EV public charging infrastructure?**
- **Methodology:**
  1. Utilization, kW & charge time
     - L2 vs DC Fast
     - Parking lot, retail/leisure, education, healthcare, workplace, multi-unit dwelling
       - Single-unit dwelling included for comparison
  2. Electricity dispensed by charger
  3. EV miles based on electricity dispensed & weighted EV efficiency
  4. Emissions from EV miles
  5. Emissions from gasoline miles being displaced
  6. Benefit = gasoline emissions - EV emissions
- **Relationship between public charging & EV adoption**
  - Literature is inconclusive
  - Availability acts as incentive, but not enough to spur adoption



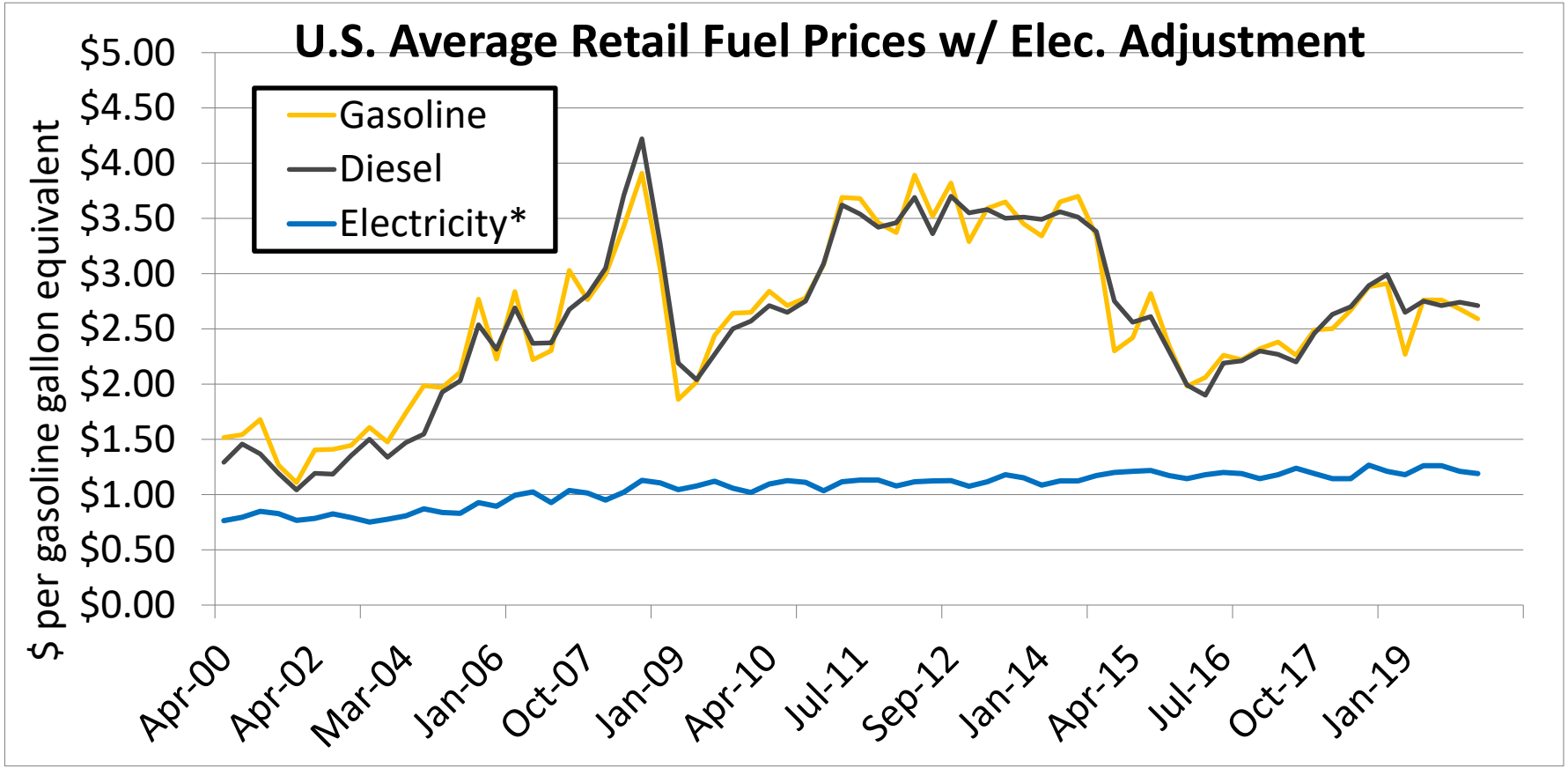
AFLEET TOOL 2019 UPDATES – VEHICLE & FUEL DATA

- **Updated petroleum use, GHGs, air pollutants factors from Argonne's GREET 1 2019**
  - Updated fuel economy data
- **Updated vehicle air pollutant emission factors from EPA's MOVES 2014b**
- **Updated fuel prices using Clean Cities Alternative Fuel Price Reports**
- **Updated vehicle maintenance costs**

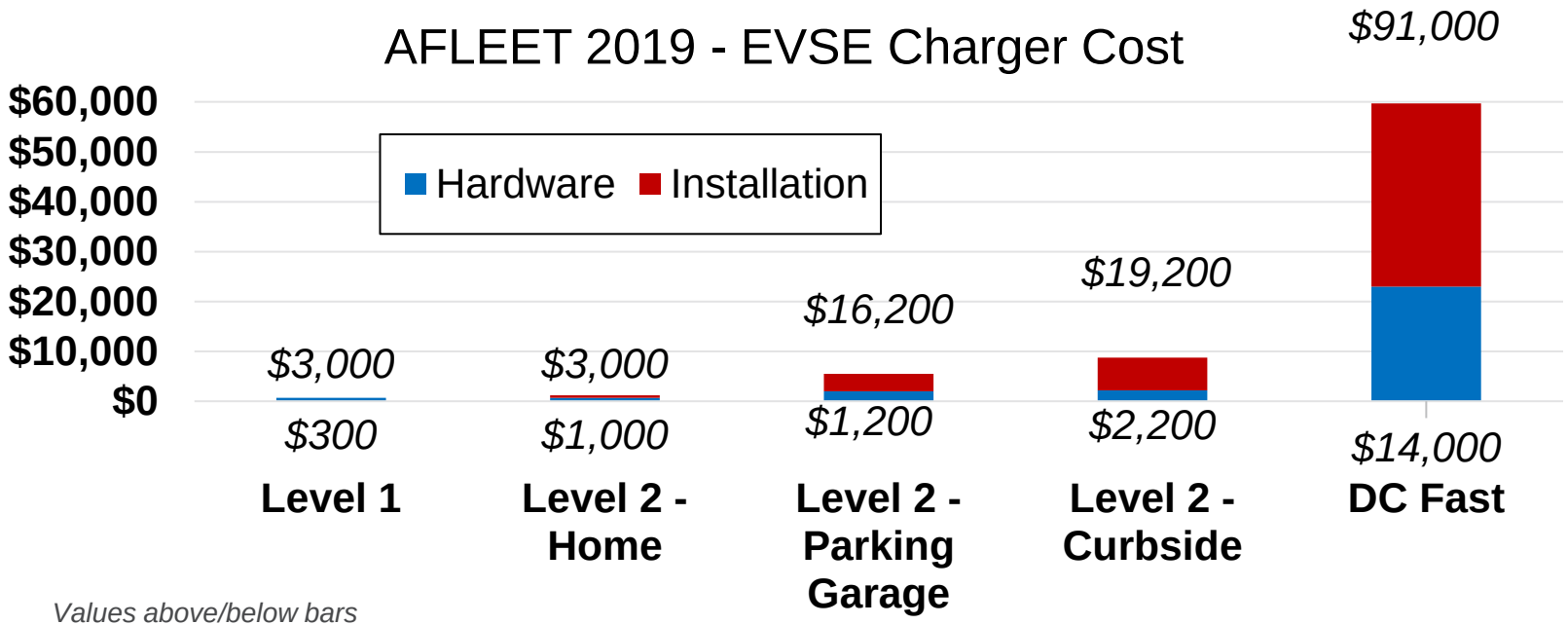


EV CASE STUDY

FUEL PRICES HAVE DRIVEN INTEREST IN ALT. FUELS



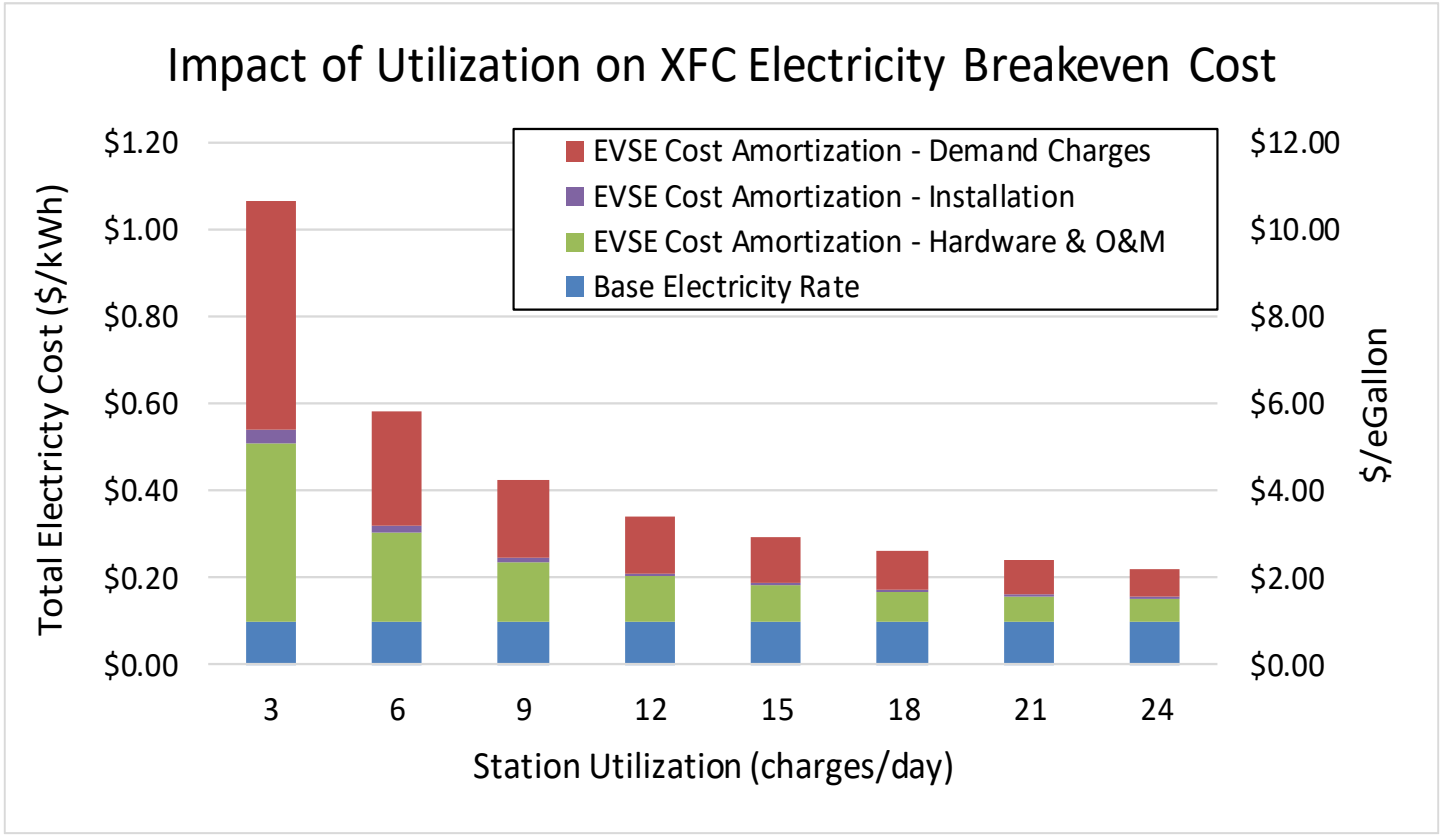
EVSE COST VARIES BY TYPE AND INSTALLATION



Values above/below bars = high/low estimates

Annual Costs	Lv 2 - Public	DC Fast
Demand Charges	$0	$12,000
Data/Connectivity	$500	$500
Maintenance	$200	$2,300

FAST CHARGING DEMAND CHARGES LARGE W/ LOW UTILIZATION



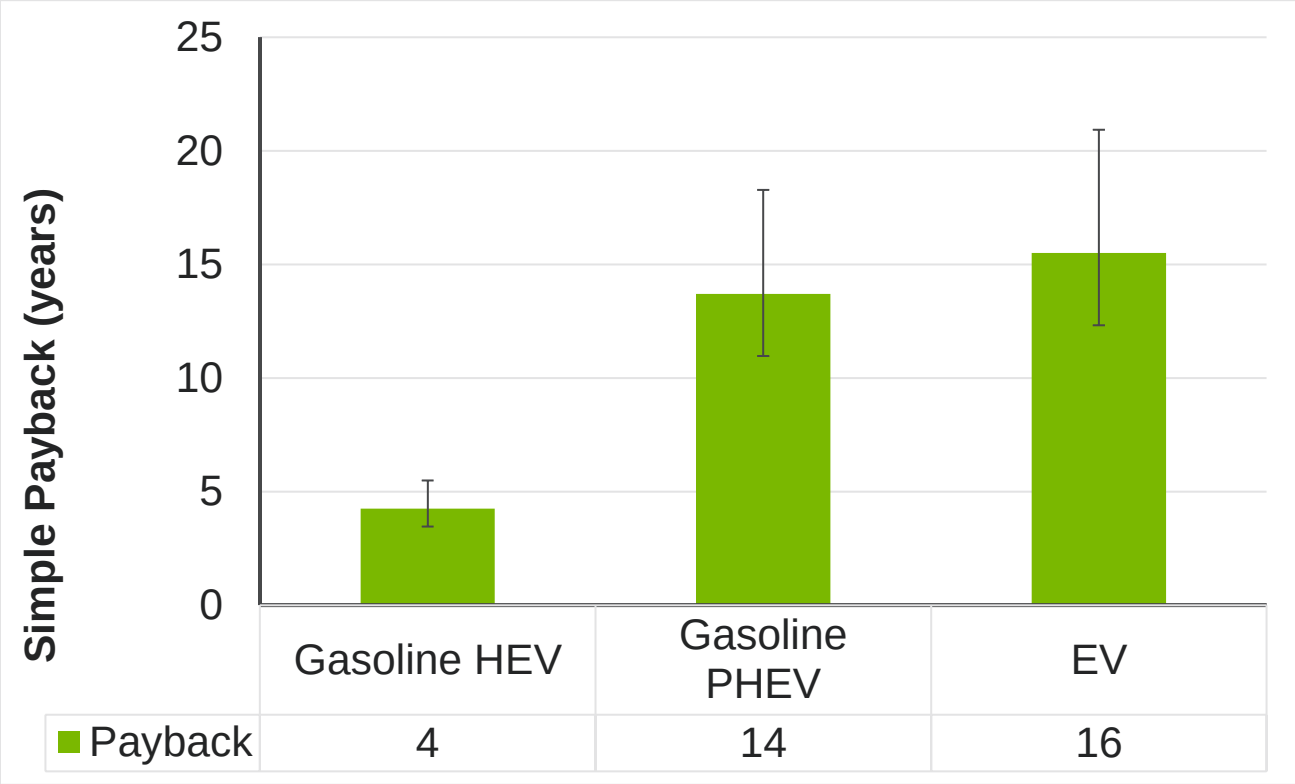
PASSENGER CAR CASE STUDY

- **Incremental cost of Electric-Drive Powertrain vs. Gasoline Car**
  - HEV ~ $2,000
  - PHEV ~ $8,000
    - 2nd case ~$3,500
  - EV ~ $17,000
    - 2nd case ~$10,000

- **Fuel price**
  - Gasoline ~ $2.50/gal
    - Sensitivity ~ $1.50 and $3.50
  - Electricity ~ $0.10/kWh (default)
    - 2nd case ~$0.05

- **Other**
  - Fleet size = 10 vehicles
  - Annual miles ~ 15,000
  - Annual baseline fuel use ~ 570 gge
  - EVSE ~ $1,200
  - Grid mix ~ national average

CAR CASE STUDY – PAYBACK ($0.10/kWh)



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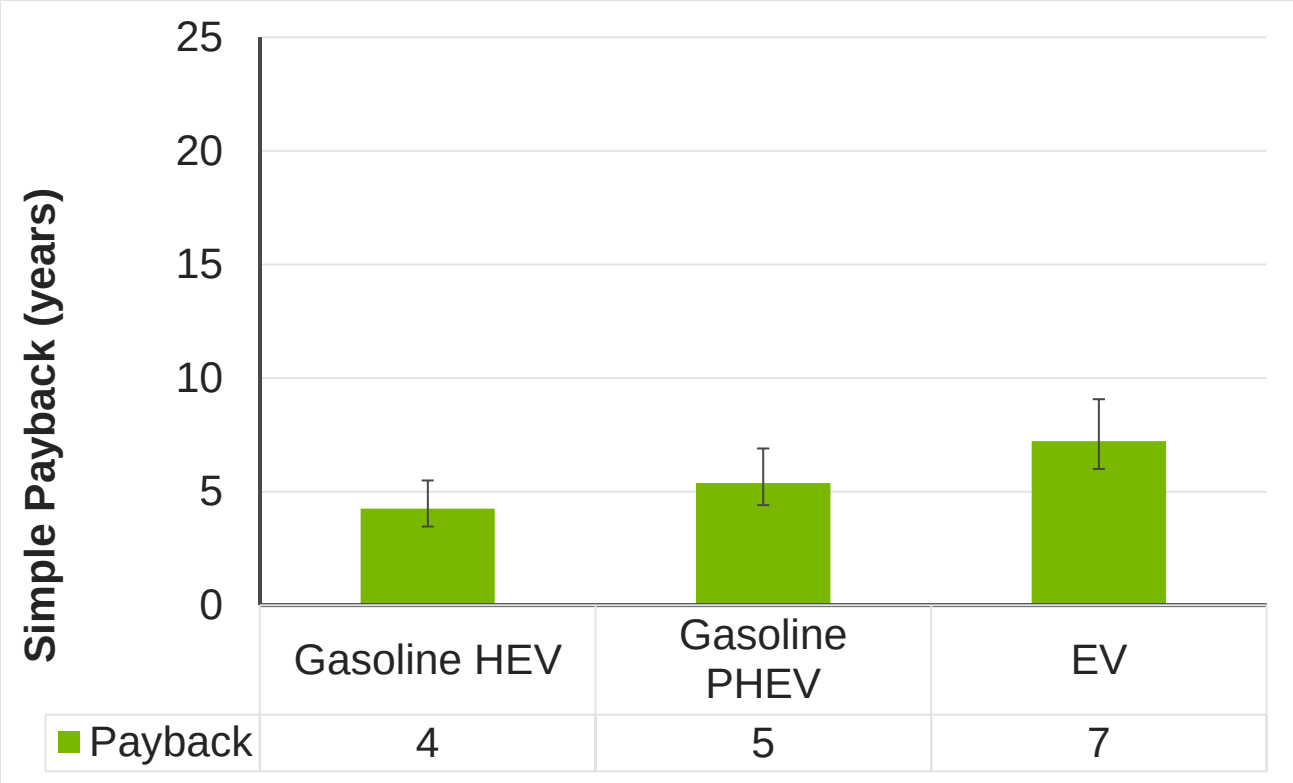
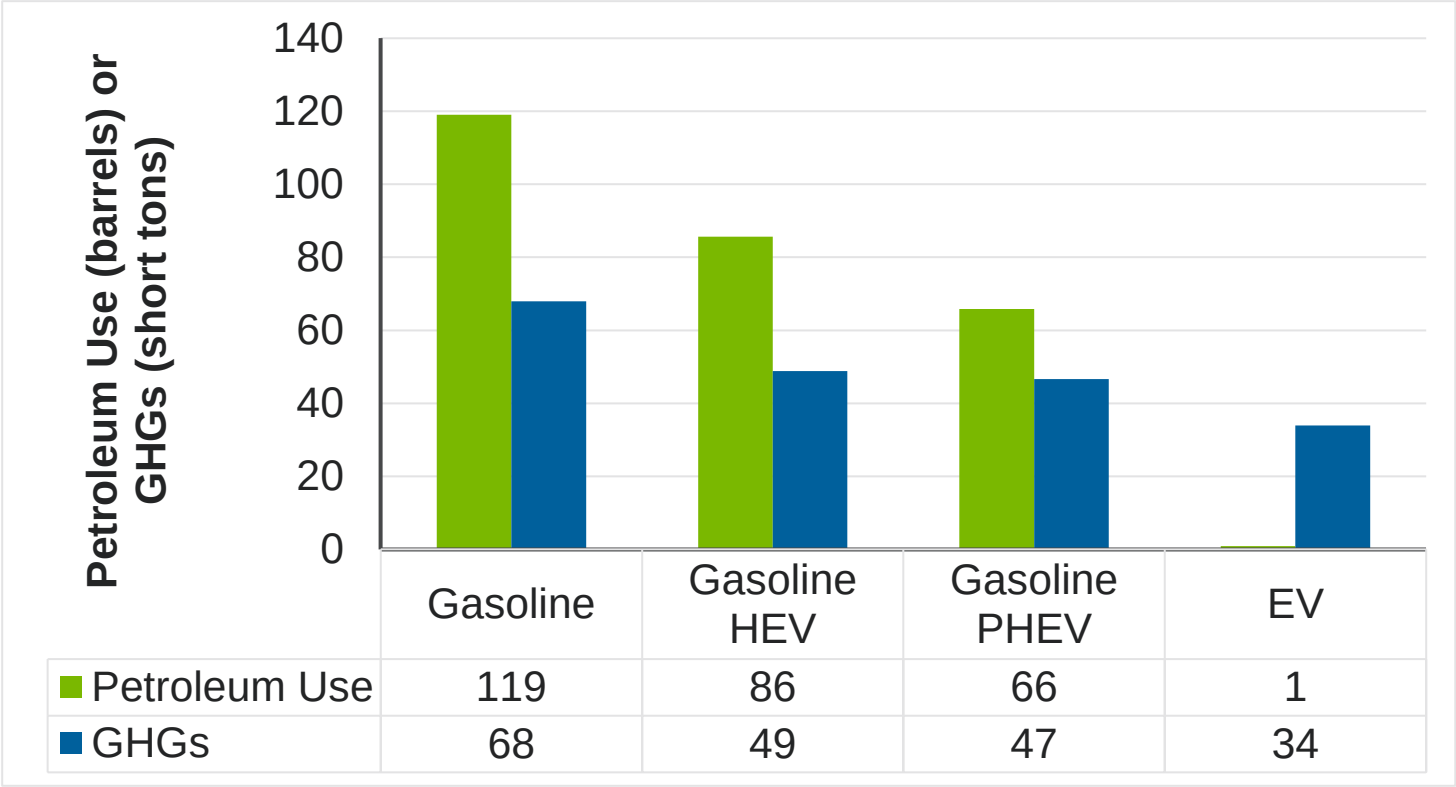
CAR CASE STUDY – PAYBACK ($0.05/kWh & Low COST PEVs)



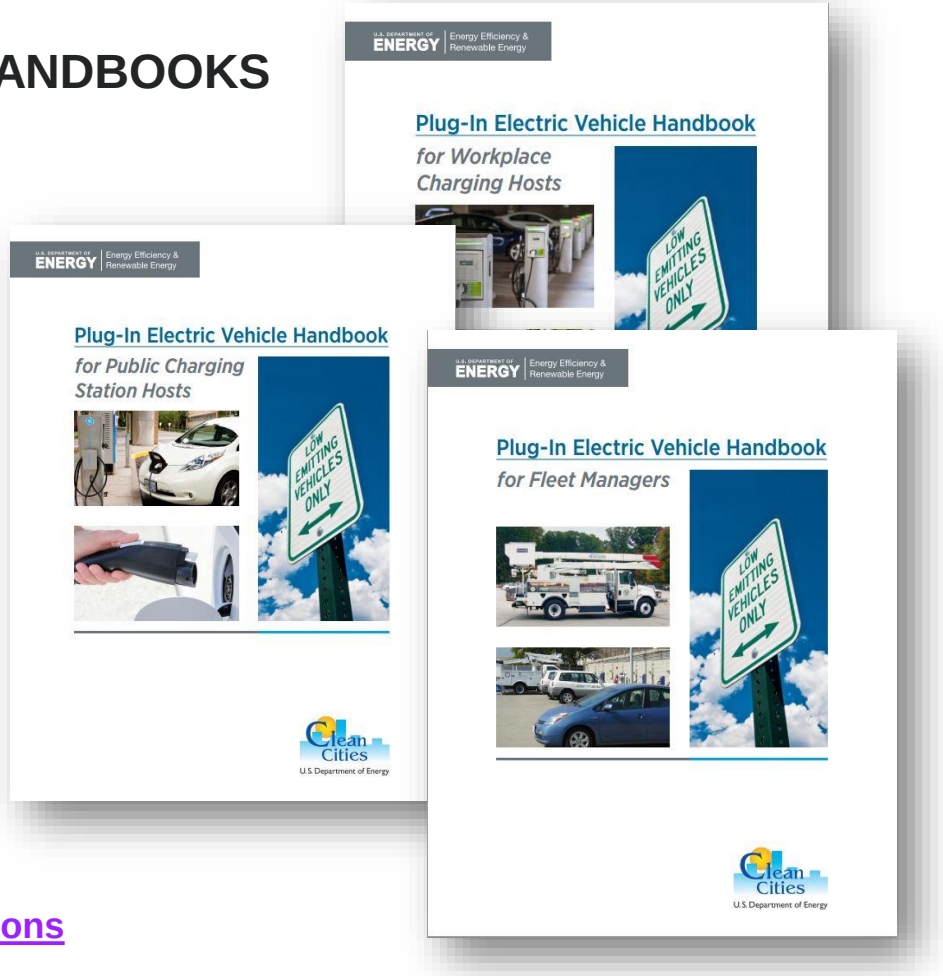
CAR CASE STUDY – PETROLEUM USE & GHG



	Gasoline	Gasoline HEV	Gasoline PHEV	EV
Petroleum Use	119	86	66	1
GHGs	68	49	47	34

GETTING STARTED: PEV HANDBOOKS

Clean Cities PEV Handbooks **are great resources for fleet managers, station owners, and individuals who are ready to start using PEVs and infrastructure.**



afdc.energy.gov/publications

cleancities.energy.gov/technical-assistance/workplace-charging/

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OTHER HELPFUL RESOURCES

- **Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool Updates.** A. Burnham, Argonne (2020); cleancities.energy.gov/webinars#26761
- **Multi-port, 1+MW Charging System for Medium- and Heavy-Duty EVs: What We Know and What Is on the Horizon?** T. Bohn, Argonne (2020); cleancities.energy.gov/webinars#26542
- **Electric Vehicles: Used Vehicle, Battery Second Life and Life Cycle Analysis.** J.Kelly, Argonne (2020); cleancities.energy.gov/webinars#26476
- **"Preparing to Plug In Your Bus Fleet," EEI (2019)** eei.org/issuesandpolicy/electrictransportation
- **"Chicago Commercial Electric Vehicle Readiness Guide,"** Calstart (2020); chicago.gov/city/en/progs/env/drive_electric_chicago.html
- **"Electric Fleet eBook,"** Black and Veatch (2019); bv.com/resources/electric-fleets-ebook
- **"Ready for Work - Now Is the Time for Heavy-Duty Electric Vehicles"** UCS (2019); ucsusa.org/resources/ready-work
- **"Lessons Learned on Early EV Fast-Charging Deployments,"** M. Nicholas, ICCT (2018); theicct.org/publications/fast-charging-lessons-learned
- **"Contributing factors in plug-in electric vehicle adoption in the United States: A Metro/County level approach,"** Y. Zhou, (2016); trid.trb.org/view/1439160

THANK YOU!!!

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Marcy Rood: Argonne

Joann Zhou: Argonne

Shannon O'Donnell, Maddy Seveska, Sandra Marquez