EVTC
Electric Vehicle Transportation Center

Electric Vehicle Fleet Implications and Analysis

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Electric Vehicle Transportation Center

- Consortium of University of Central Florida, Tuskegee University and University of Hawaii
- Focus is on EV technology, transportation planning, infrastructure, social and environmental impact
- Co-located with the Florida Solar Energy Center in Cocoa, Florida

ucf.edu/

- October 17th-20th Cocoa, Florida
- Presentations, Workshops and Displays
- EV R&D, Grid Integration, Policy, Planning
- Planners, Researchers, Electric Utilities, Sustainability Managers, Employers, Fleet Managers, Auto

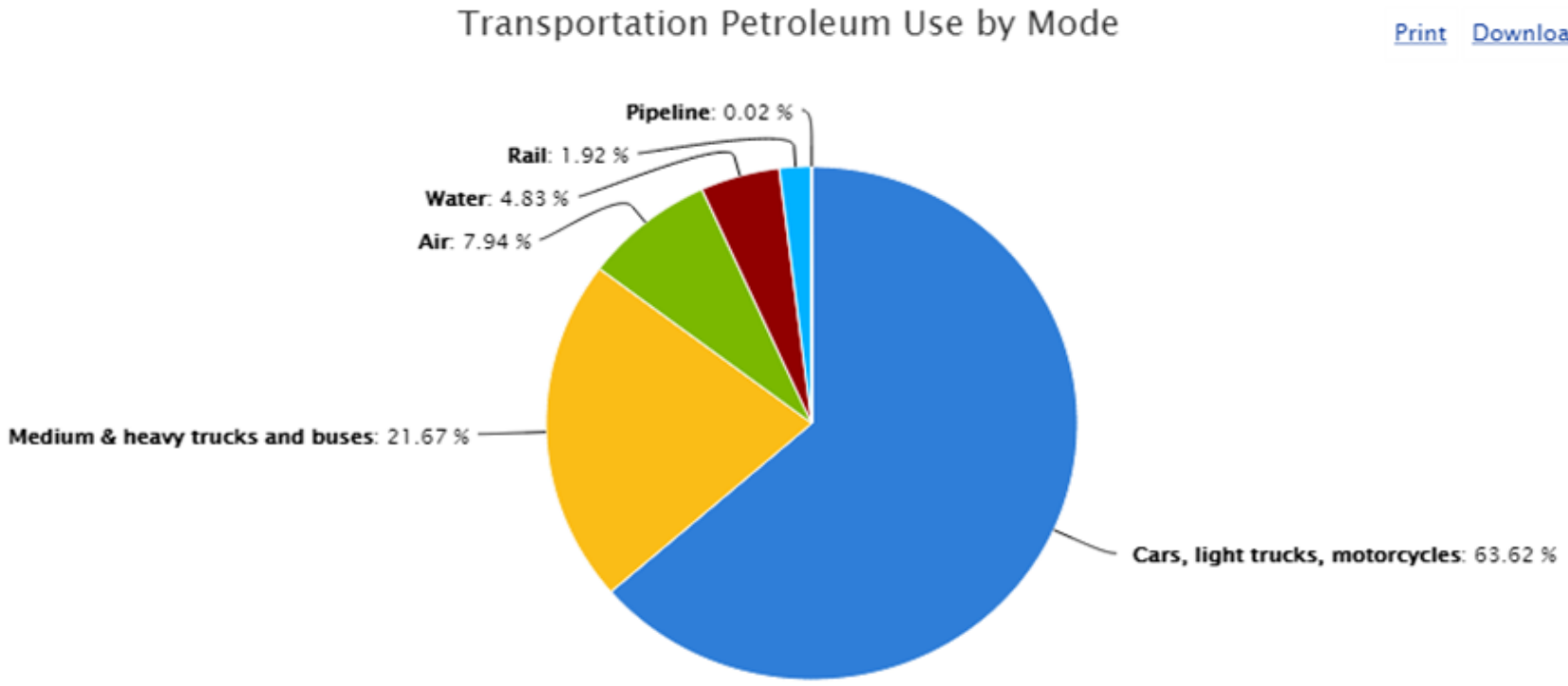
The Potential of Electric Vehicle Fleets

- Fleet profile, fuel use, environment impact
- Advantages and benefits of EV fleets
- Fleet regulatory requirements
- EV fleet operational considerations
- EV transit bus case study
- EV taxi case study
- EV fleet requirements summary

U.S. Transportation Fleet Profiles

- More than 11 million fleet cars and trucks
- Generally feature standardized operations
- Operations are often required to maintain detailed operational data
- Drive and duty cycles frequently compliment EV technology and business requirements

Transportation Petroleum Use

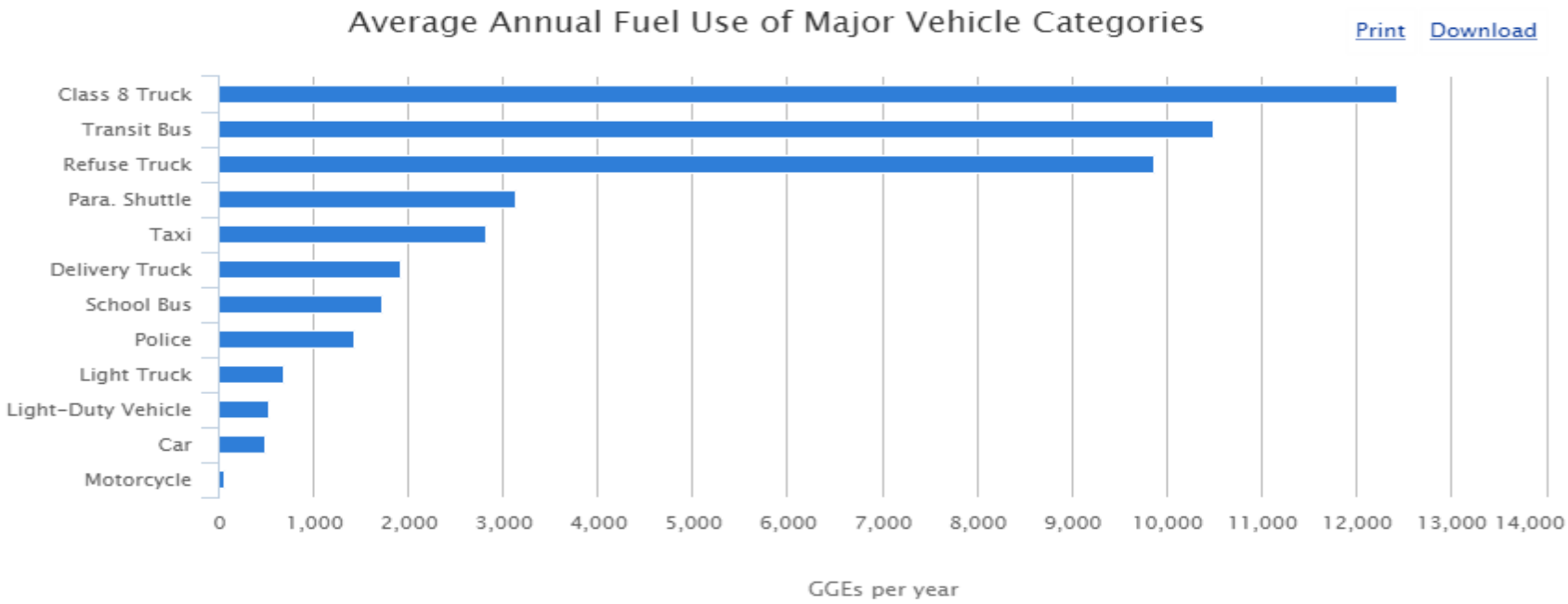


Source: Table 1.17 and 1.14, Oak Ridge National Laboratory's Transportation Energy Data Book, Edition 31 (2012), circa 05/08/2013.

Notes: Data does not include for fuel used off-road by activities such as farming.

This chart shows the petroleum used by transportation, which is 70% of total petroleum use in the United States. Of this, the largest amount is used in the form of gasoline by light-duty vehicles. The second largest portion is used in the form of diesel fuel in medium- and heavy-duty vehicles. Air travel consumes 8% of the transportation petroleum in the form of aviation fuel. Finally, water and rail (our two most efficient forms of freight transport) consume the remaining 7% in the form of diesel.

Fuel Use by Vehicle Category

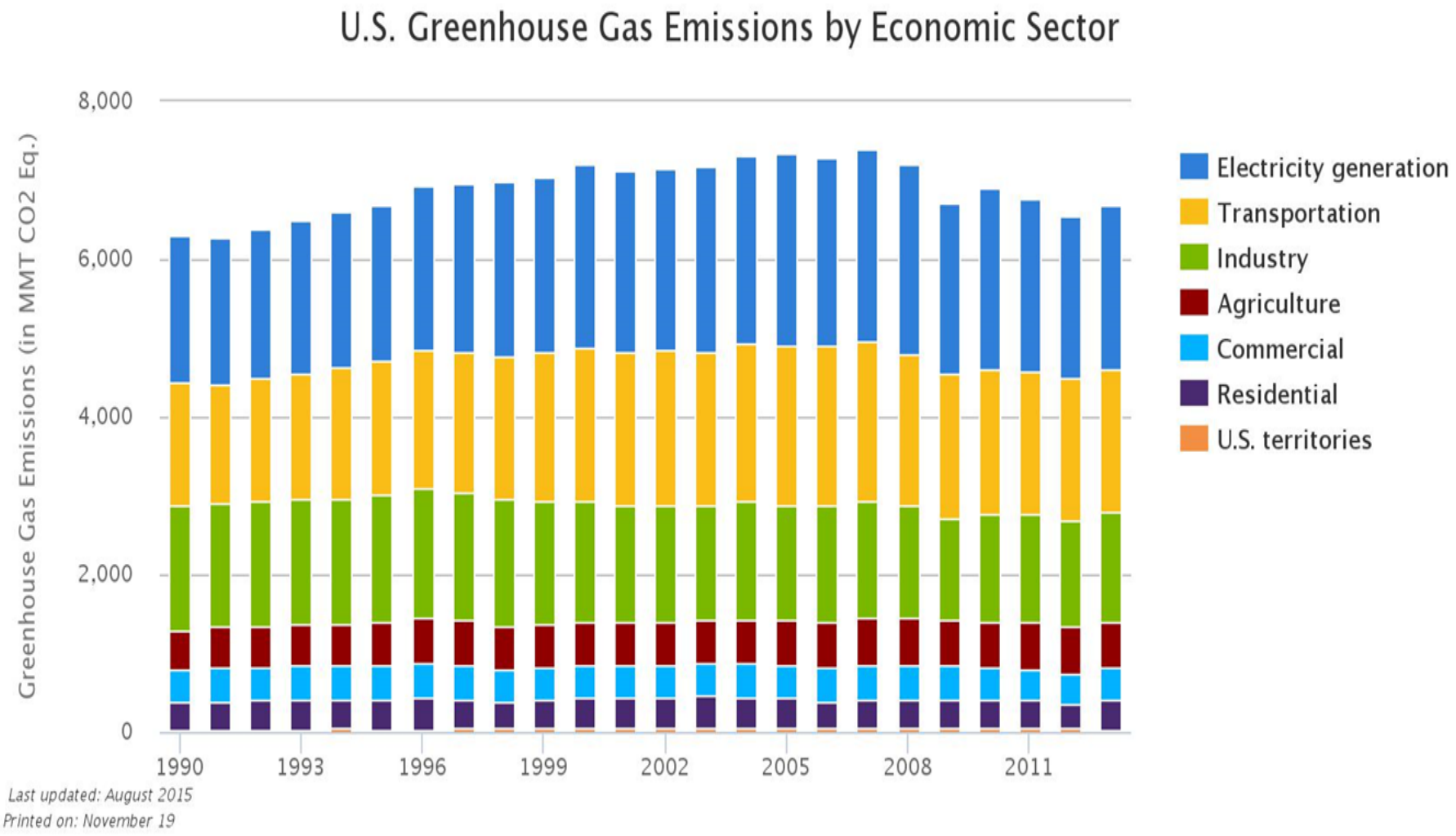


Source: Federal Highway Administration Table VM-1 and American Public Transit Association's Public Transportation Fact Book Tables 8, 16, and 21.

Notes: Fuel use is measured in gasoline-gallon equivalents (GGEs), representing a quantity of fuel with the same energy content as a gallon of gasoline.

This chart shows average annual fuel use of major vehicle categories in the United States. The two factors affecting the average annual fuel use of a vehicle are the average miles per year (correlative) and the fuel economy of the vehicle (inversely correlative). Class 8 trucks, which typically travel long distances carrying heavy loads, consume more fuel on average than any other vehicle type. Transit buses and refuse trucks also use large quantities of fuel since they both log high numbers of miles on average and have relatively low fuel economy. The last four vehicle types are owned by individual consumers, and they each use a fraction of the fuel used by fleet-based vehicles, on a per-vehicle basis. See also Average Annual Vehicle Miles Traveled by Major Vehicle Categories and Average Fuel Economy of Major Vehicle Categories.

Transportation GHG Contribution



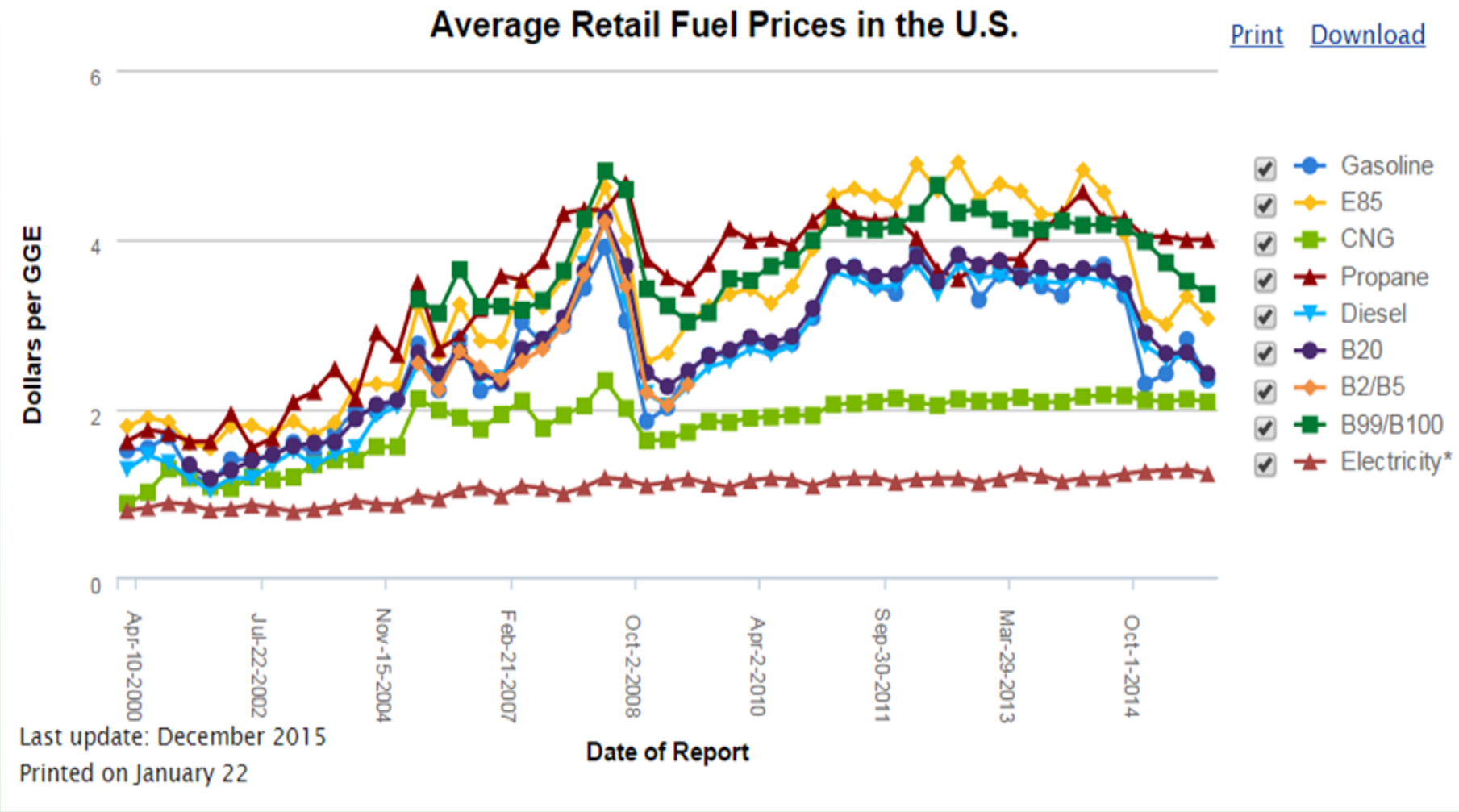
Advantages of EV Fleets

- Fuel reduction--Vehicles consume more than six billion gallons of fuel at idle, EVs do not idle
- Best opportunity for large-scale reduction of adverse impacts to the economy, environment and public health
- Particularly effective in reducing adverse environmental and health impacts in urban areas
- Reduced fuel and vehicle maintenance cost
- Attractive alternatives to conventionally fueled buses, taxis, ride-sharing and government fleets

EV Fleet Operational Benefits

- Effectively addresses CAFE, CAA and EPAct requirements
- Standardized operations document effective management and measurement of benefits
- Crash safety, insurance, etc. closely comparable
- EVs require much less maintenance
- Fuel cost are substantially lower
- Cost of electricity is stable and predictable

Cost Electricity Versus Other Fuels



Regulatory Requirements

- Corporate Average Fuel Economy Standards (CAFE) *NHTSA standards to reduce petroleum use and GHGs*
- Clean Air Act(CAA)

  EPA standards for CO, Ozone, Particulate, NOx, etc.
- Energy Policy Act(EPAct)

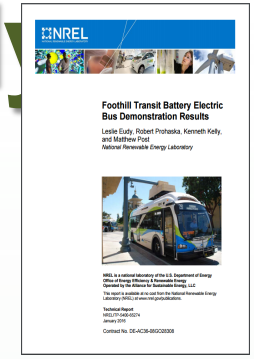
  Fleet Operators acquire AFVs or reduce petroleum use
- Executive Order 13693 (March 2015)

  Fed agencies set GHG goals, acquire PEVs, plan for infrastructure

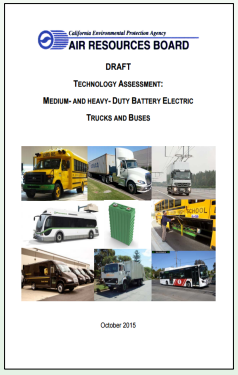
EV Fleet Operational Considerations

- EV application must accommodate the specific duty and drive cycle
  - ü Drive Cycle: How the vehicle is used (speeds, stops, idle time, etc.)
  - ü Duty Cycle: How much the vehicle is used (hours/day, total miles, etc.)
- High EV utilization rate is key
- Vehicle capital cost is higher but is offset by much lower fuel and maintenance cost
- Support infrastructure capital and operating cost can be significant
- Driver training and behavior is key in achieving benefits

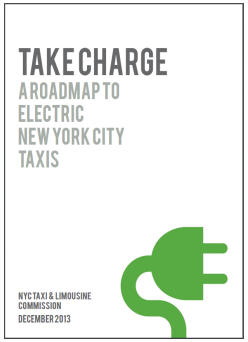
EV Transit Bus Case Study



- Efficient transportation and significant health and environmental advantages
- Drive cycle is short, fixed, low-speed with frequent stops
- Drive cycle conserves battery charge, maximizes regenerative braking
- Battery chemistries can be optimized to duty and drive cycles
- Mileage: BEB 17.5 miles/DGE CNG 4.5 mile/DGE
- Annual fuel: BEB $7500 CNG $30,000
- Maintenance cost savings over 12 years, $70-90K



EV Taxi Case Study



- Efficient transportation with significant health and environmental advantages
- Drive and duty cycle conserves battery charge, maximizes regenerative braking
- EV taxi emissions reduction impact equal to eight personal vehicles.
- Urban heat and noise dramatically reduced
- MPGe cost is ~$1.00/gal @ $.012/kWh for electricity
- Overall maintenance is lower, battery replacement cost is a factor
- Charging infrastructure and charging downtime are a challenge

EV Fleet Requirements Summary

- EV application must accommodate the specific duty and drive cycle
- High vehicle utilization necessary
- Driver training and behavior is key in achieving benefits
- Support infrastructure capital and operation cost can be significant
- Higher vehicle capital cost offset by much lower operating cost

For Future Reference

- U.S. Department of Transportation, Bureau of Transportation Statistics
  http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_14.html
- U.S. Department of Energy, Alternative Fuels Data Center
  http://www.afdc.energy.gov/data/
- National Highway Traffic Safety Administration, Corporate Average Fuel Economy (CAFE) http://www.nhtsa.gov/fuel-economy
- U.S. Environmental Protection Agency, Clean Air Act (CAA)
  http://www.epa.gov/clean-air-act-overview
- U.S. Department of Energy, Energy Policy Act (EPAct)
  http://www1.eere.energy.gov/vehiclesandfuels/epact/pdfs/standard_compliance.pdf
- Federal Facilities Compliance Assistance Center (FedCenter.gov), Executive Order 13693 https://www.fedcenter.gov/programs/eo13693/

For Future Reference

- Idle Reduction Research, Argonne National Laboratory
  http://www.anl.gov/sites/anl.gov/files/idling_worksheet.pdf
- Technology Assessment, California EPA Air Resources Board
  http://www.arb.ca.gov/msprog/tech/techreport/bev_tech_report.pdf
- Foothill Transit Battery Electric Bus Demonstration Results, National Renewable Energy Lab http://www.nrel.gov/docs/fy16osti/65274.pdf
- Take Charge, A Roadmap to Electric New York City Taxis, NYC Taxi & Limousine Commission
  http://www.nyc.gov/html/tlc/downloads/pdf/electric_taxi_task_force_report_20131231.pdf
- Electric Vehicle Transportation Center
  http://evtc.fsec.ucf.edu/publications/index.html

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