



K-12 Cohort Call: Transportation Fleet Conversion

**October 26, 2017
2-3pm ET**

Agenda

- How Does Transportation Fit into the Conversation about Energy Efficient K-12 School Facilities?
 - Crystal McDonald, Moderator, Policy Advisor, Office of Energy Efficiency and Renewable Energy, DOE
- Fuel Cell Buses in the U.S.
 - Greg Kleen, Fuel Cell Outreach Team Lead, Fuel Cell Technologies Office, DOE
- Clean Cities Program: Alternative Fuel School Bus Case Studies
 - Ellen Bourbon, Senior Energy Policy Analyst, Vehicle Technologies Office, Clean Cities Program, AST
- VW Settlement Funds
 - Jonah Steinbuck, Advisor, Office of Energy Efficiency and Renewable Energy, DOE
- Questions & Answers

How Does Transportation Fit into the Conversation about Energy Efficient K-12 School Facilities?

Crystal McDonald, Policy Advisor
Office of Energy Efficiency & Renewable Energy
U.S. Department of Energy

Elements of School District Energy & Environmental Sustainability Plans

- Building energy efficiency
- New construction & design
- Beyond buildings, infrastructure projects
- Healthy learning environments
- Reducing emissions
- Cost savings strategies



Alternative Fuels for School Buses



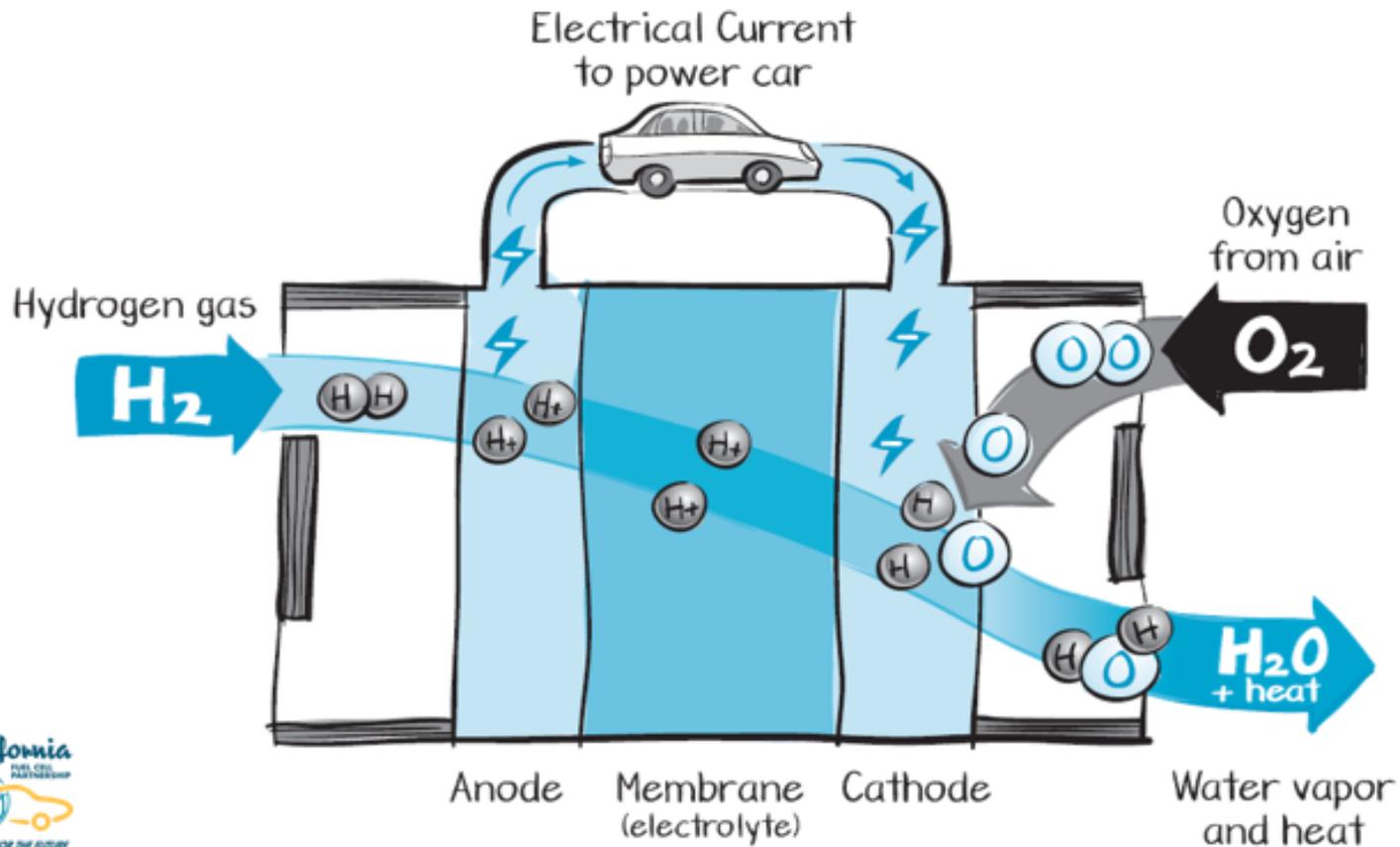
- [Case Studies for School Bus Fleet Conversion](#)
- [Clean Cities YouTube Channel](#)
- [EPA 2017 School Bus Replacement and Retrofit Rebates](#)
- [National Renewable Energy Laboratory – Transportation Research](#)

Fuels Cell Buses in the U.S.

Greg Kleen, Fuel Cell Outreach Team Lead
Fuel Cell Technologies Office
U.S. Department of Energy

Fuel Cell Basics

Takes hydrogen in and puts electricity and water vapor out



Why Hydrogen and Fuel Cells?



Efficient

Internal combustion engine in a car

20% - 30%

Fuel cell in a car

60%

Efficiency



Uses domestic fuels



- Natural gas
- Renewable sources (wind, solar, biomass, etc.)
- Nuclear
- Coal



Convenient



Refuels in minutes



Quiet



No noise in operation



Clean



Zero tailpipe emissions



Versatile and easily scalable



Transportation



Stationary



DOE Hydrogen and Fuel Cells Program

Early R&D Focus

Applied research, development and innovation in emerging hydrogen and fuel cell technologies leading to:

- Energy security
- Energy resiliency
- Strong domestic economy

Early R&D Areas



Fuel Cells

- PGM- free catalysts
- Durable MEAs
- Electrode performance

PGM = Platinum group metals
MEA = Membrane Electrode Assembly

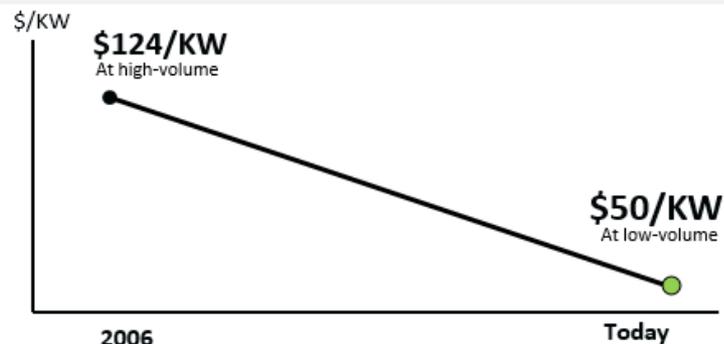


Hydrogen

- Production pathways
- Delivery components
- Advanced materials for storage

Early R&D Impact

60% Lower Fuel Cell Cost



Greater Fuel Cell Durability

4X more hours of fuel cell lifetime since 2006

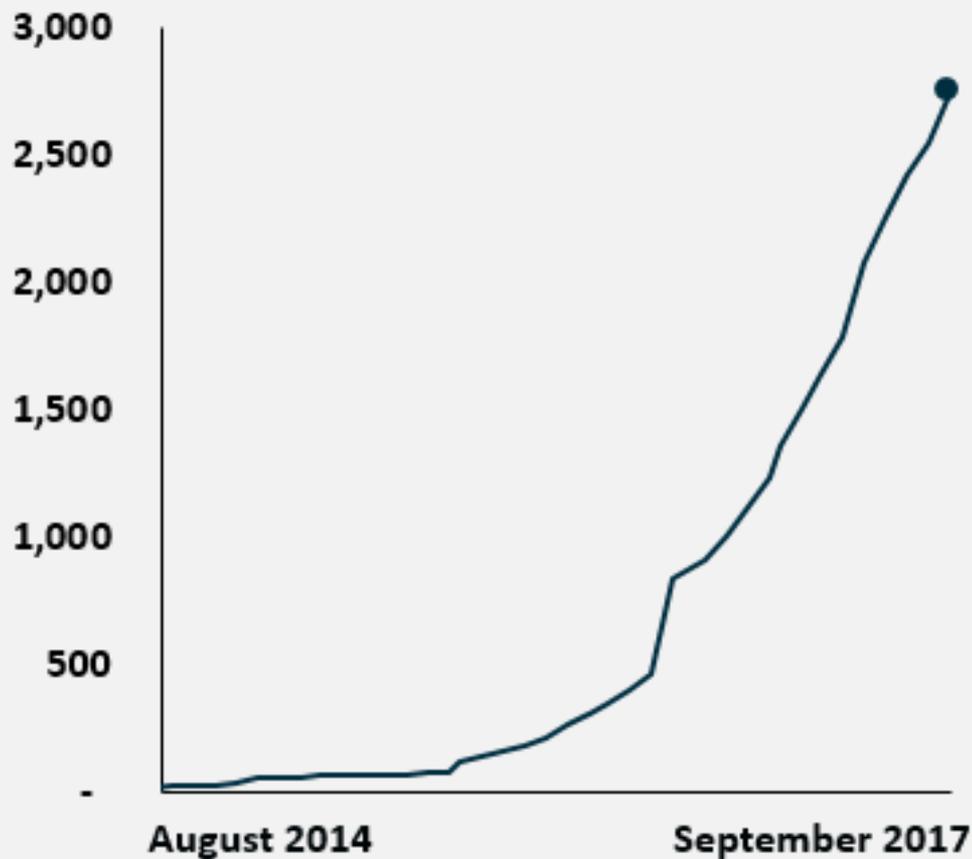


80% Lower Electrolyzer Cost

for H₂ production since 2002

Fuel Cell Cars are Here!

Fuel Cell Car Sales Growing



2,800
fuel cell cars

sold or leased in the U.S.

78%
of executives



Absolutely or partly
agree that

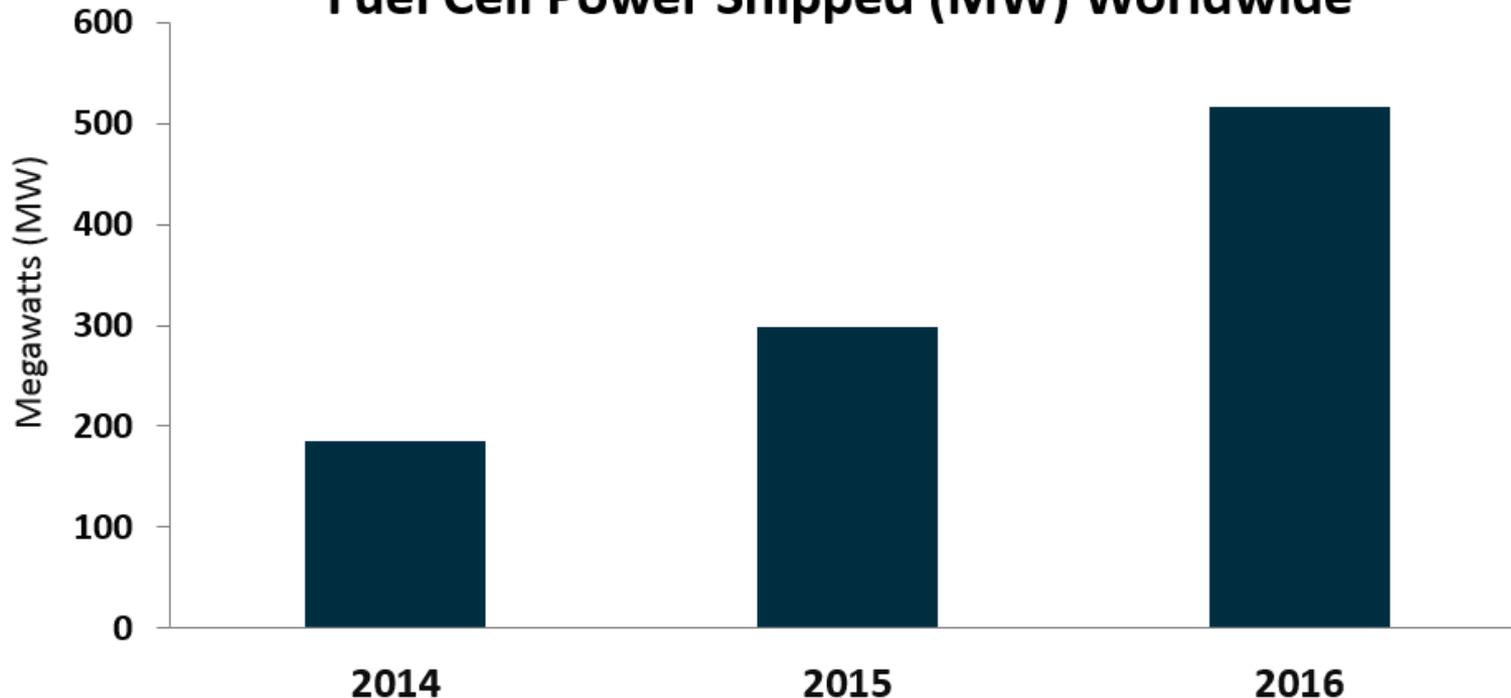
**Fuel cell cars will be
the real breakthrough
for electric mobility**

KPMG, Global Automotive Executive Survey 2017 (Jan. 2017)

10 Note: Cumulative number of vehicles sold/leased. Source: hybridcars.com

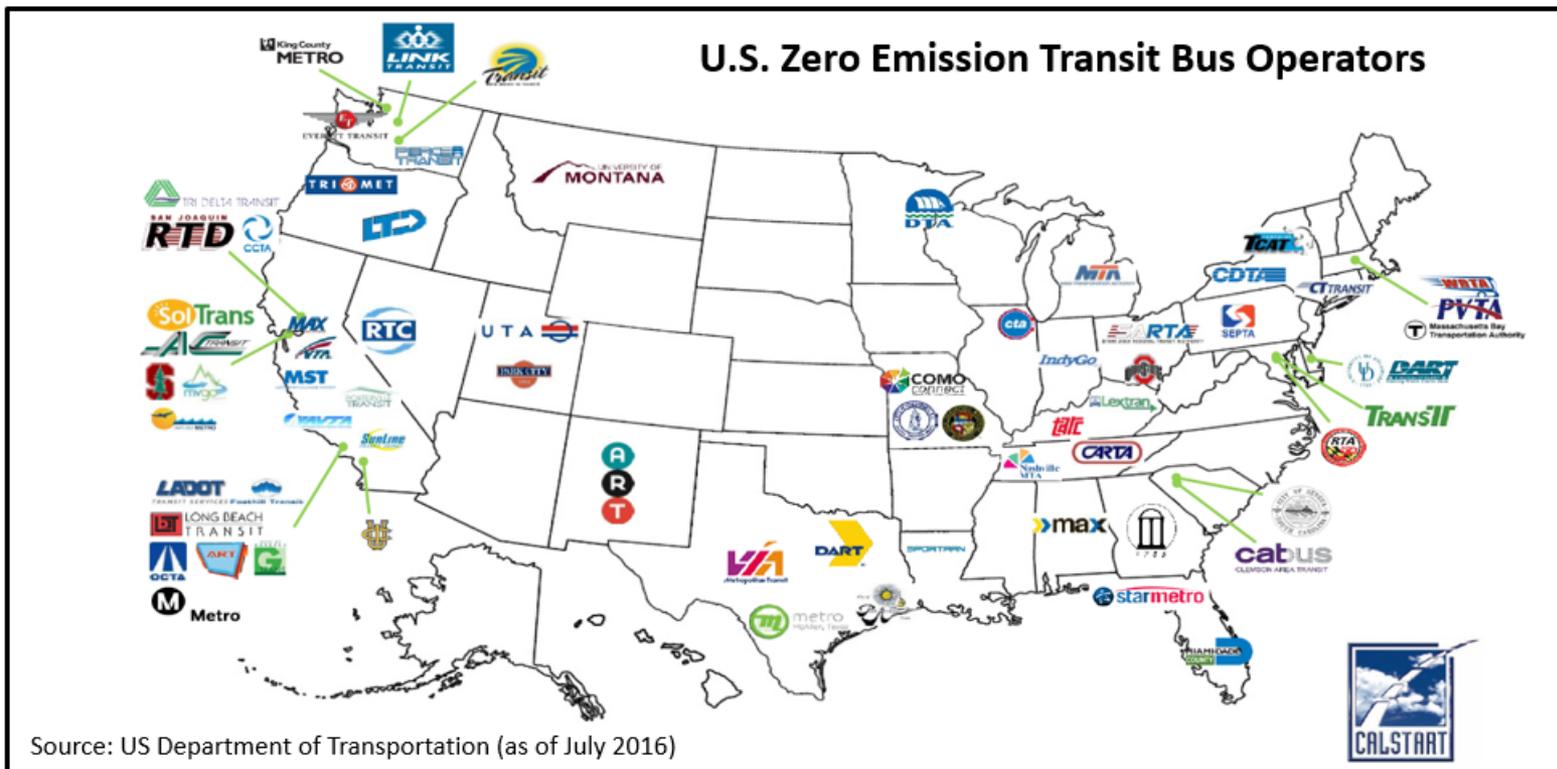
Market Growth in Fuel Cell Sales

Fuel Cell Power Shipped (MW) Worldwide



 <p>500 MW fuel cell power shipped worldwide</p>	 <p>62,000 fuel cell units shipped worldwide</p>	<p>Approximately</p>  <p>\$1.6 Billion fuel cell revenue</p>
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U.S. Electric Bus Coverage and Progress

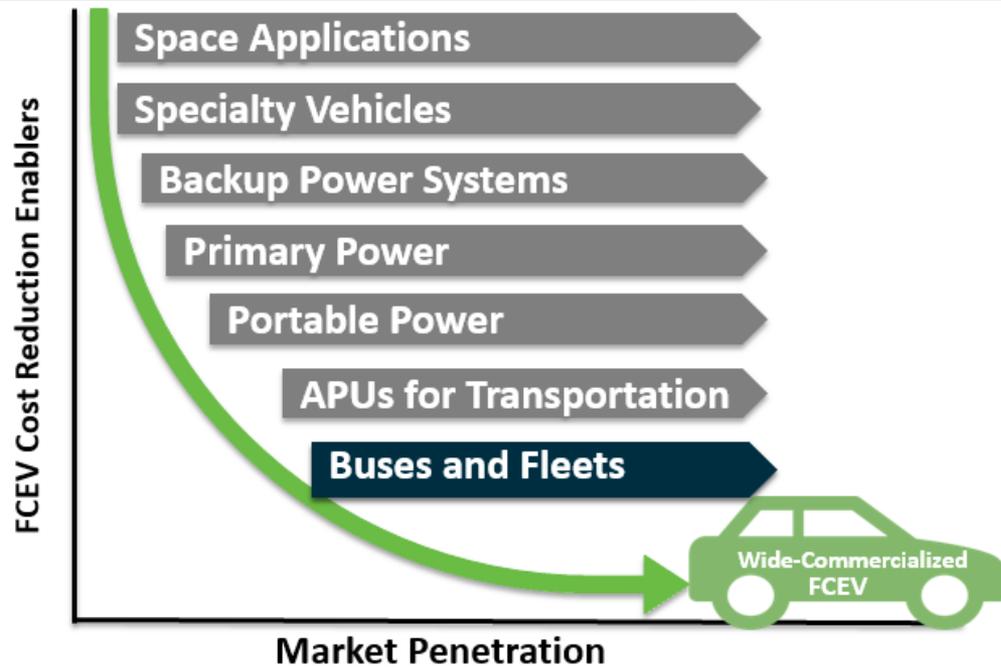


Electric /Hybrids : % in Bus Fleet	No. of Electric Buses	Electric Bus Price
From 1% in 2007 to 18% in 2014	5X increase from 2007 to 2014	20% reduction from 2010 to 2015

Fuel Cell Buses Enabling Markets

Early Markets enable:

- Fuel cell **cost reduction**
- Robust **supply base**
- Emerging **infrastructure**
- Customer **acceptance**



Early Markets Applications Recently Deployed in the U.S.



Fuel Cell Tow Trucks



Fuel Cell Bus Fleets

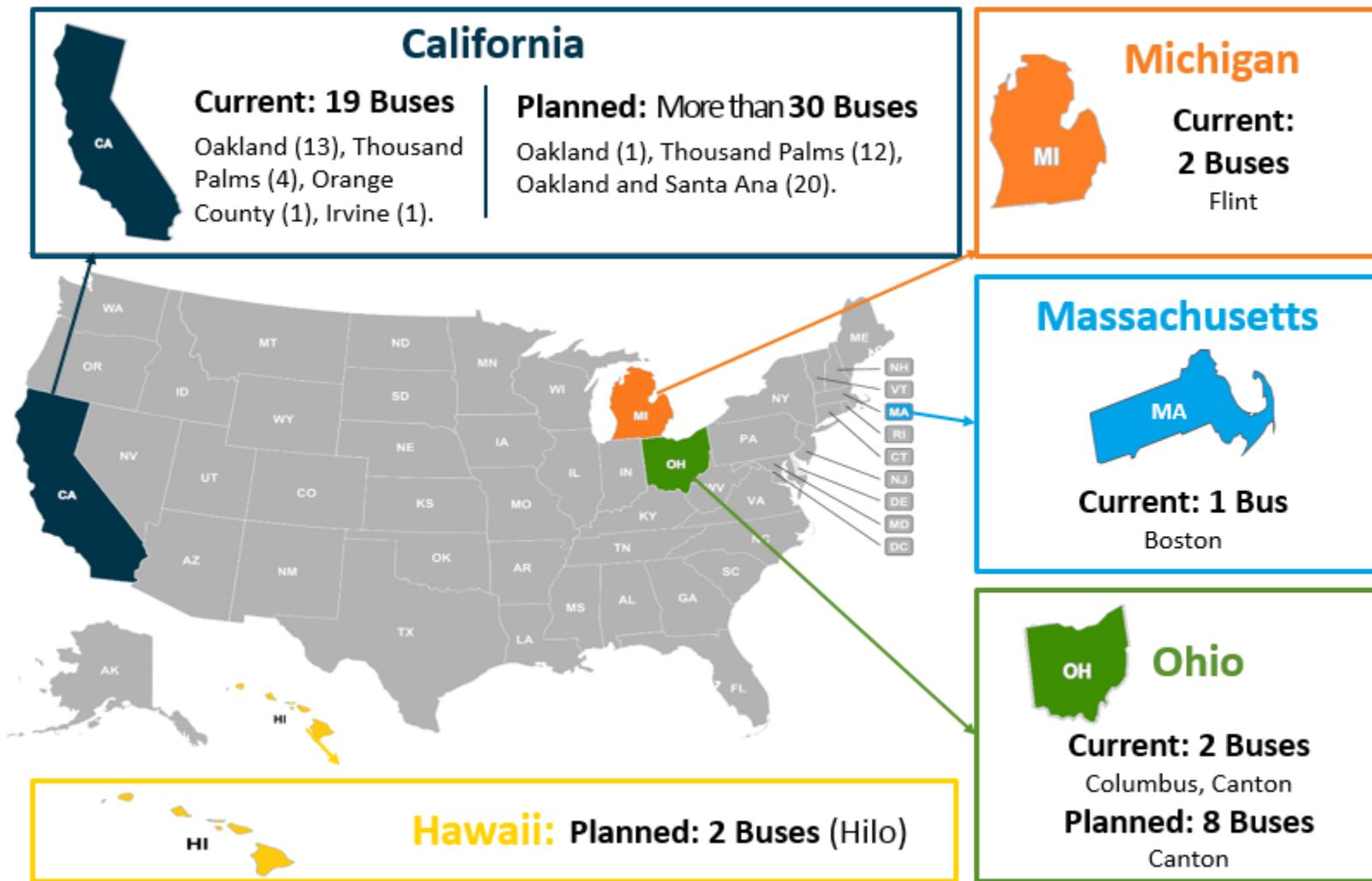


Forklifts



Backup Power

Fuel Cell Buses are Here!



Fuel Cell Bus Highlights – Examples

AC TRANSIT FLEET



Largest 
in North America



AC Transit Fuel Cell Electric Bus

FTA Funding and Collaboration with DOE- NREL Data collection

RECORDS



Record **Durability:**
Approximately
25,000 hours



Driven for
approximately
1.8M miles

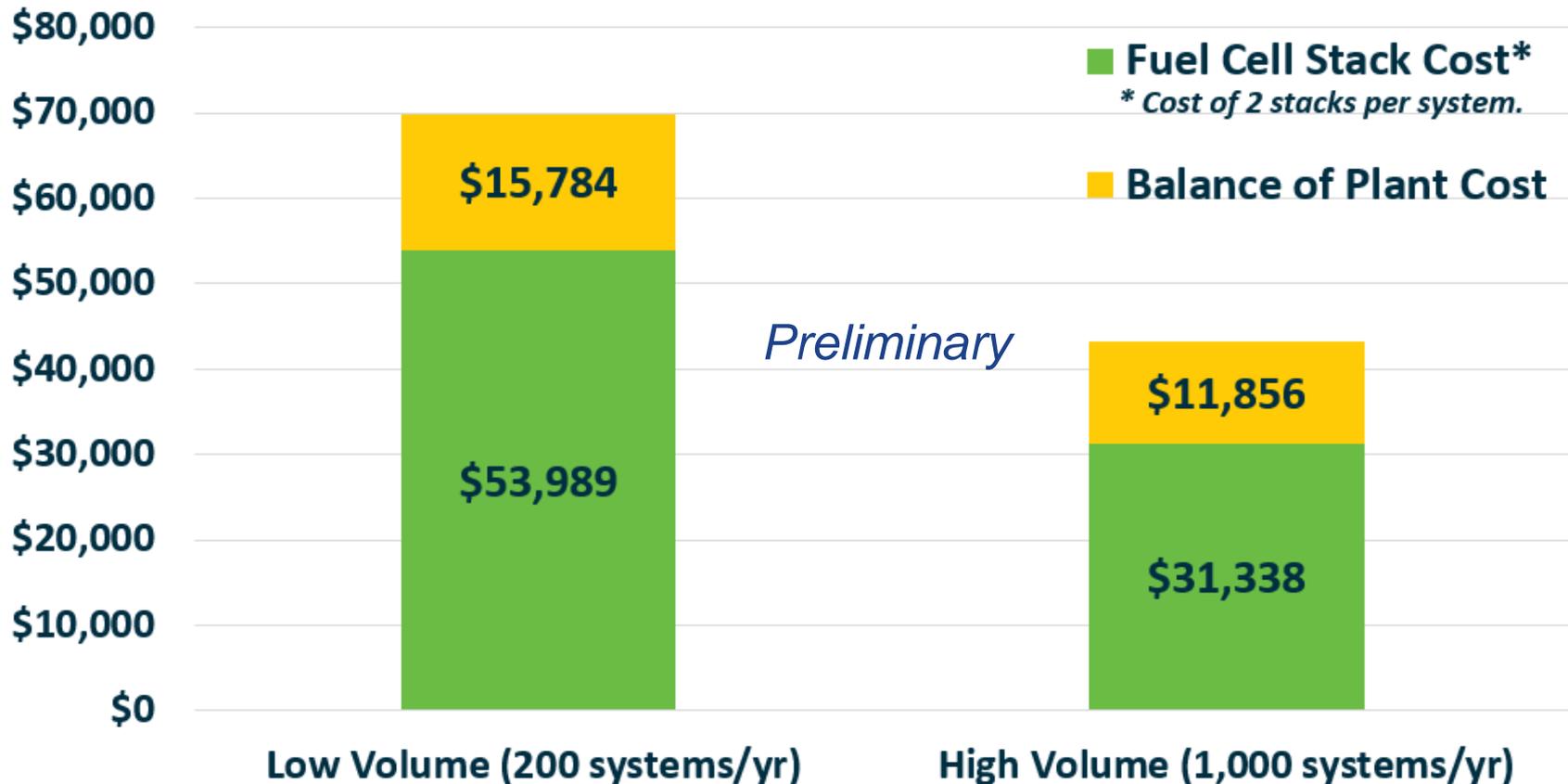


More than
17 million
passengers

As of June 2017

Cost Projections for Bus Fuel Cell Systems

Low- and High-Volume Fuel Cell System Costs for Buses



Source: DOE and SA, updates underway

Fuel Cell Bus Status vs. Targets

	Units	Current Status ^a (Range)	2016 Target ¹	Ultimate Target ¹
Bus lifetime	years/miles	0.8–6/ 22,700–155,000 ^b	12/500,000	12/500,000
Power plant lifetime ^c	hours	2,300–23,000 ^{b,d,e}	18,000	25,000
Bus availability	%	32–93	85	90
Fuel fills ^f	per day	1	1 (<10 min)	1 (<10 min)
Bus cost ^g	\$	1.8M–2.5M ^h	1,000,000	600,000
Roadcall frequency (bus/fuel cell system)	miles between roadcalls	2,500–7,400/ 7,900–143,800	3,500/ 15,000	4,000/ 20,000
Operation time	hours per day/days per week	7–21/ 5–7	20/7	20/7
Scheduled and unscheduled maintenance cost ⁱ	\$/mile	0.46–2.06	0.75	0.40
Range ^j	miles	165–298	300	300
Fuel economy	miles per diesel gallon equivalent	4.91–7.09	8	8

Source: 2016 NREL Bus Report, updates underway

Data, Models, and Resources Available

Data Validation of Real World Applications through the NREL's NFCTEC

- Data products provide insights on technology improvements, issues and gaps



NFCTEC: The National Fuel Cell Technology Evaluation Center

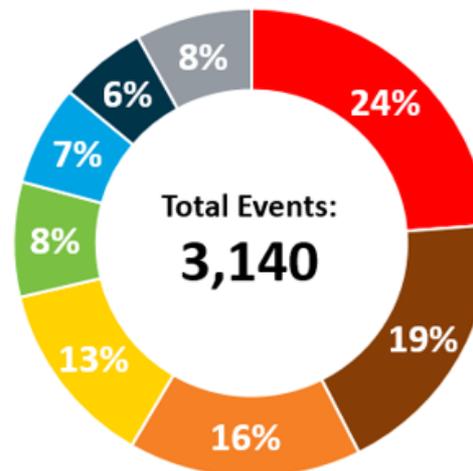
To Participate

techval@nrel.gov

Models "Toolbox" Online

- Financial, technical and economic models covering H₂ infrastructure, jobs, and more.
- Visit: energy.gov/eere/fuelcells/hydrogen-analysis-toolbox

Example: Sources of H₂ Infrastructure Maintenance



Compressor
Dispenser
Entire
Safety
Storage
Reformer
Thermal Management
Other Chiller, Feedwater

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Most maintenance related to **compressors** and **dispensers**

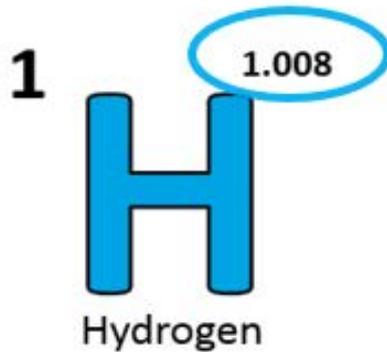
Ways to Spread the Word

**Celebrate Hydrogen &
Fuel Cell Day**

October 8 or 10/8

(Held on its very own atomic- weight-day)

**Give an “*Increase
your H2IQ*”
presentation in
your community!**



INCREASE YOUR
H₂IQ

Learn more:
energy.gov/eere/fuelcells

Download for free at:
[energy.gov/eere/fuelcells/downloads
/increase-your-h2iq-training-resource](https://energy.gov/eere/fuelcells/downloads/increase-your-h2iq-training-resource)

Thank You

Greg Kleen

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Clean Cities Program Alternative Fuel School Bus Case Studies

Ellen Bourbon, Senior Energy Policy Analyst
Vehicle Technologies Office
Clean Cities Program, AST

Clean Cities Program

Alternative Fuel School Bus Case Studies

Ellen Bourbon, Senior Energy Policy Analyst, AST

October 26, 2017



About the Clean Cities Program

Clean Cities Mission

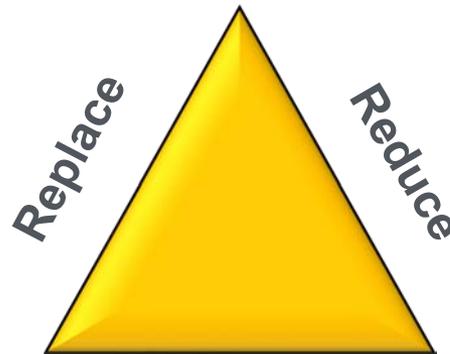
To advance the energy, economic, and environmental security of the United States by supporting local decisions to adopt practices that reduce the use of petroleum in the transportation sector.

Alternative & Renewable Fuels

Biodiesel
Electric Vehicles
Ethanol
Hydrogen
Natural Gas
Propane

Idle Reduction

Heavy-Duty Trucks
School & Transit Buses
Light-Duty Vehicles



Eliminate

New Area of Emphasis

Energy Efficient Mobility Systems

Fuel Economy

More fuel efficient vehicles,
adopting smarter driving and
vehicle purchasing habits

Hybrids

Light- and heavy-duty
Electric hybrids
Plug-In hybrids
Hydraulic hybrids

Clean Cities Coalitions



* Connecticut Clean Cities Include:
 - Norwich
 - New Haven
 - Connecticut Southwestern Area
 - Capitol Clean Cities (Hartford area)

Map Date: 5/5/17

Nearly 100 coalitions with thousands of stakeholders
Representing ~80% of US population

Alternative Fuels Data Center Case Studies

(<https://www.afdc.energy.gov/case>)

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Case Studies

Find case studies and success stories about alternative transportation technologies and alternative fuels.



Natural Gas Stations Abound on Oklahoma's Interstate Highway System

Drivers of compressed natural gas (CNG) vehicles along Oklahoma's interstate highways don't need to worry about finding a place to fill up—the state now has public CNG stations located every 100 miles.

[Learn More](#)

Category | **Keyword**

Choose one or more items from the following categories.

Fuel/Technology <input type="checkbox"/> All Fuels <input type="checkbox"/> Biodiesel <input type="checkbox"/> Ethanol <input type="checkbox"/> Hydrogen <input type="checkbox"/> Propane <input type="checkbox"/> Natural Gas <input type="checkbox"/> All-Electric <input type="checkbox"/> Hybrid Electric <input type="checkbox"/> Plug-In Hybrid Electric <input type="checkbox"/> Fuel Economy Improvements <input type="checkbox"/> Idle Reduction	Applications <input type="checkbox"/> All Applications <input type="checkbox"/> Long-Haul Trucking <input type="checkbox"/> Refuse Collection <input type="checkbox"/> Taxi Services <input type="checkbox"/> Airport <input type="checkbox"/> Delivery Services <input type="checkbox"/> Law Enforcement <input type="checkbox"/> Park Services <input type="checkbox"/> Public Transit <input checked="" type="checkbox"/> School Transportation <input type="checkbox"/> Shuttle Services <input type="checkbox"/> Off-Road
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SEARCH CLEAR

Search Results | 35 case studies

Date	Title	Type
May 26, 2017	New Hampshire Cleans up with Biodiesel Buses	Video
Feb. 18, 2017	Natural Gas Fuels School Buses and Refuse Trucks in Tulsa, Oklahoma	Video
Dec. 23, 2016	Baton Rouge School District Adds Propane Buses to Its Fleet	Video
Oct. 28, 2016	Propane Powers School Buses in Tuscaloosa, Alabama	Video
Aug. 20, 2016	Boston Public Schools Moves to Propane	Video
April 20, 2016	Deploying Clean Buses in Texas through Supplemental Environmental Projects (SEPs)	Web Story
Jan. 26, 2016	Mesa Unified School District Reaps Economic and Environmental Benefits with Propane Buses	Web Story
Jan. 26, 2016	Minnesota School District Finds Cost Savings, Cold-Weather Reliability with Propane Buses	Web Story
Jan. 12, 2016	School Districts Move to the Head of the Class with Propane	Document
Sept. 22, 2015	Kern County Schools Expands CNG Station for Bus Fleet and Public Use	Video

Showing 1 to 10 of 35

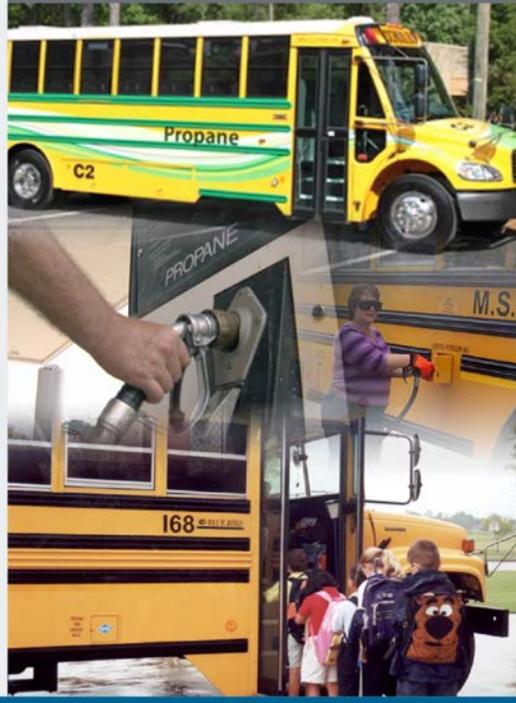
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Alternative Fuels Data Center Case Studies: Propane School Buses

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Case Study – Propane School Bus Fleets

August 2014



U. S. Department of Energy

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Photo by Dennis Schroeder, NREL 31480

School Districts Move to the Head of the Class with Propane

School districts across the country are under pressure to reduce their cost of operations and ensure their budgets are spent wisely. School bus fleets operate more than 675,000¹ buses in the United States, and many school districts have found the answer to their budget woes in the form of propane, or liquefied petroleum gas (LPG). Propane is a reliable, domestic fuel, and it's used in approximately 2% of school buses nationwide.



Unlike diesel engines, propane engines do not require advanced emissions controls and their related maintenance. Photo from MotorWeek/Maryland Public TV, NREL 17180

Propane's School Bus History

While propane has been used in buses for decades, recent technological advancements have made it more reliable than ever. Prior to 2007, all propane vehicles used vapor injection technology. In 2007, Blue Bird rolled out a propane school bus using direct liquid injection for the first time, and this was followed by Thomas Built Buses and Navistar. Liquid injection technology makes propane buses a more reliable option.

Since 2007, vehicle emissions standards have tightened for all vehicles. Propane vehicles meet these emissions standards without aftertreatment systems required for diesel vehicles. Because of this, and other reasons, many districts have found propane meets their criteria as an affordable, clean alternative.

Economic and Environmental Impacts

Propane is a domestic fuel created as a byproduct from crude oil refining and natural gas processing. Propane engines have simpler emissions controls, which allow them to meet U.S. Environmental Protection Agency standards. In addition, some school districts are reporting cost savings from reduced preventive maintenance such as oil changes (an effect also attributed to the fuel's clean-burning nature). Most significantly, propane also typically costs less than diesel fuel, particularly for fleets that work with their local propane marketers and equipment providers to install private

¹ Federal Highway Administration - Highway Statistics 2012, Table MV-10, fhwa.dot.gov/policyinformation/statistics/2012/pdf/mv10.pdf



U.S. Department of Energy

VEHICLE TECHNOLOGIES OFFICE

cleancities.energy.gov

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May 26, 2017

New Hampshire Cleans up with Biodiesel Buses



Find out how the Manchester Transit Authority improves air quality with biodiesel buses.

For information about this project, contact [Granite State Clean Cities Coalition](#).

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MotorWeek
Television's Original Automotive Magazine

Provided by Maryland Public Television

See more videos provided by [Clean Cities TV](#) and [FuelEconomy.gov](#).

Related Videos



[North Carolina Commits to Clean Energy with EV Charging](#)
Oct. 7, 2017



[National Park Saves Natural Resources with Alternative Fuels](#)
Sept. 16, 2017



[Phoenix Utility Fleet Drives Smarter with Biodiesel](#)
Aug. 26, 2017



[Cooking Oil Powers Biodiesel Vehicles in Rhode Island](#)
Feb. 14, 2017

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Alternative Fuels Data Center Case Studies: Natural Gas School Buses

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Feb. 18, 2017

Natural Gas Fuels School Buses and Refuse Trucks in Tulsa, Oklahoma



Natural Gas Fuels School Buses and Ref...

Watch how Tulsa, Oklahoma, powers its school buses and refuse trucks with compressed natural gas.

For information about this project, contact [Tulsa Clean Cities](#).

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MotorWeek Provided by Maryland Public Television
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- [National Park Saves Natural Resources with Alternative Fuels](#)
Sept. 16, 2017
- [Phoenix Utility Fleet Drives Smarter with Biodiesel](#)
Aug. 26, 2017
- [Idaho Transports Mail and Reduces Emissions with Natural Gas Trucks](#)
June 23, 2017
- [America's Largest Home Runs on Biodiesel in North Carolina](#)

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Clean Cities Recovery Act Project: Kentucky Hybrid-Electric School Buses

Hybrid-Electric School Buses

Vehicle Deployment, Outreach & Education



A INGESTOR COMPANY



HYBRID HORSEPOWER
FOR KENTUCKY SCHOOLS

- Data Collection
- Curriculum Writing
- First-Responder,
Driver & Maintenance
Training



19

Contact: Melissa Howell, KY Clean Cities Coordinator
mhowell@kentuckycleanfuels.org, 502-593-3846

Massachusetts Dept. of Energy Resources (DOER) Vehicle-to-Grid Electric School Bus Pilot Project



Contact:

Steve Russell

MA Clean Cities Coordinator

Stephen.Russell@state.ma.us

617-626-7325

- One of the first demonstrations of electric school bus technology on the East Coast of the U.S.
- 3 grants awarded for purchase of electric school buses and chargers by Amherst, Cambridge and Concord Public Schools
- Pilot will test ability of electric school buses to provide supplemental energy to buildings during times of peak energy use.

Thank You!

For more information:

Clean Cities website

<https://cleancities.energy.gov/>

Alternative Fuels Data Center

<https://www.afdc.energy.gov/>

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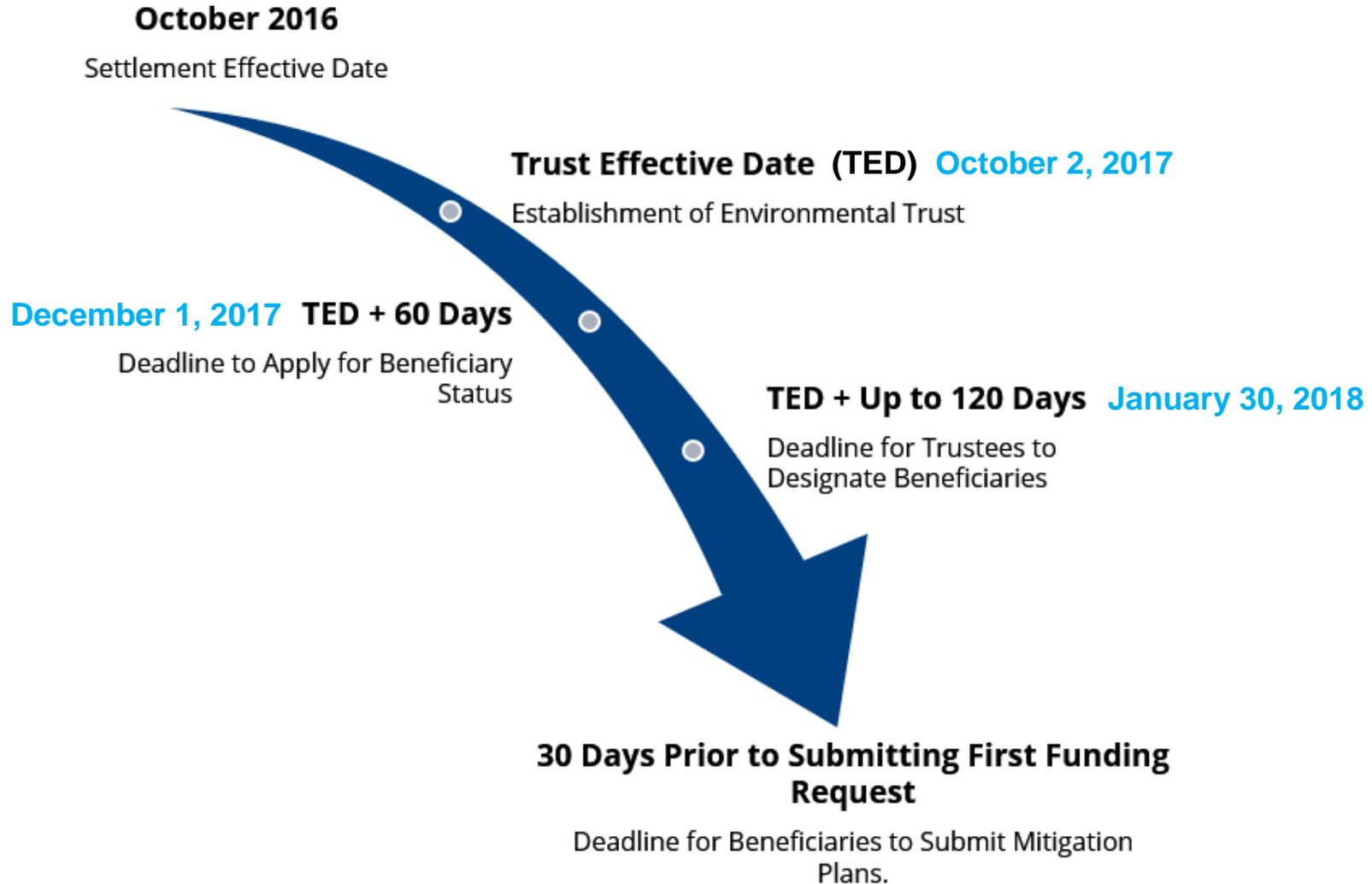
VW Settlement Funds

Jonah Steinbuck, Advisor
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

VW Settlement – Outline

- Funds
- Timeline
- Eligible Actions
- Application to School Buses
- KY and CA Case Studies
- Resources

VW Settlement – Timeline



Environmental Mitigation Trust – Eligible Actions

- Eligible mitigation actions must result in decreased NOx emissions.
- Eligible Action Areas:
 - (1) Class 8 Local Freight Trucks and Port Drayage Trucks (Eligible Large Trucks)
 - (2) Class 4-8 School Bus, Shuttle Bus, or Transit Bus
 - (3) Freight Switchers
 - (4) Ferries and Tugs
 - (5) Ocean Going Vessels (OGV) Shorepower
 - (6) Class 4-7 Local Freight Trucks (Medium Trucks)
 - (7) Airport Ground Support Equipment
 - (8) Forklifts and Port Cargo Handling Equipment
 - (9) Light Duty Zero Emission Vehicle Supply Equipment
 - (10) Diesel Emission Reduction Act (DERA) Option

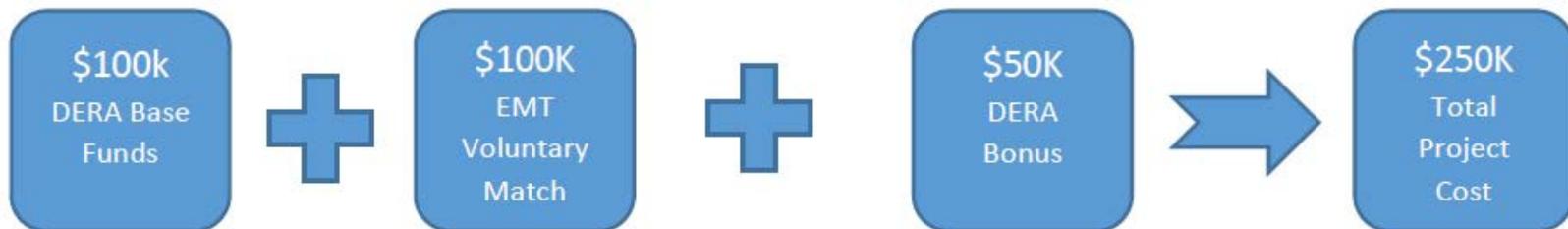
Environmental Mitigation Trust – Buses

Option (2) Class 4-8 School Bus, Shuttle Bus, or Transit Bus

Percentage of Project that can be Funded through Trust – School Buses and Transit Buses

	Government Owned	Non-Government Owned
Repower with new diesel or alternate fueled engine	Up to 100%	Up to 40%
Replace with new diesel or alternate fueled vehicle	Up to 100%	Up to 25%
Repower with all-electric engine (includes infrastructure)	Up to 100%	Up to 75%
Purchase new all-electric vehicle (includes infrastructure)	Up to 100%	Up to 75%

Option (10) Diesel Emission Reduction Act (DERA) Option



Case Studies: Bus Fleet Projects in KY and CA

Hybrid Horsepower for Kentucky Schools



- 2009 American Recovery and Reinvestment Act award of \$13M to KY Dept. of Ed. to cover the incremental costs of hybrid buses over traditional diesel buses.
- Utilizing a master purchase agreement streamlined paperwork and allowed many districts to order hybrid school buses.
- 157 hybrid school buses throughout the state.
- ~35% improvement in fuel efficiency.



Sources:

<https://www.afdc.energy.gov/case/1045>

https://www.afdc.energy.gov/uploads/publication/arra_cc_project_awards.pdf

<http://kentuckycleanfuels.org/projects/hybrid-horsepower/>

CA Rural School Bus Pilot Project



- \$10 million California Air Resources Board and North Coast United Air Quality Management District pilot to encourage turnover of California's school bus fleet to zero emission and cleaner-burning school buses.
- Eligible school bus technologies: fuel cell; battery electric; plug-in hybrid; vehicle charging equipment; renewable diesel, natural gas, and propane.
- Project could fund as many as 60 new school buses statewide.

Sources:

<https://www.arb.ca.gov/newsrel/newsrelease.php?id=895>

<http://www.ncuaqmd.org/index.php?page=rural.school.bus>

Resources

- Your state's lead agency (listed on VW Clearinghouse and NACAA sites below)
- NASEO-NACAA VW Clearinghouse: <http://vwclearinghouse.org/>
- NACAA: [http://4cleanair.org/Volkswagen Settlement Information](http://4cleanair.org/Volkswagen_Settlement_Information)
- NASEO: <http://www.naseo.org/volkswagen-settlement>;
<http://www.naseo.org/publications>
- DOE Clean Cities: <https://cleancities.energy.gov>
- DOE Alternative Fuels Data Center: <http://www.afdc.energy.gov>
- EPA: <https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement>
(settlement background)

Thank You

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202-586-0844

Program Announcements



Zero Energy Schools Accelerator

www.zeroenergy.org



Accelerator Goals

- **Identify** strategies to overcome barriers to building ZE K-12 schools and realizing the associated health, savings, and resiliency benefits
- **Share** solutions, resources, and technologies that help schools achieve ZE goals
- **Develop** replicable road maps to build ZE schools and achieve associated benefits
- **Increase** visibility and replication of best practice approaches and successful models

Implementing partners

State of Minnesota



State of California



State of Maryland



National partners





K-12 School Districts are Eligible

Known – Still large potential for industrial/commercial energy savings, historic improvement focus has been on ad hoc projects, low hanging fruit

We believe - Best way to achieve the fullest EE potential is to adopt programs & policies that improve energy performance on a continuing basis

Value of 50001 Ready Program – Positions your organization to achieve and sustain energy and cost savings through informed systematic decision making

What is 50001 Ready?

- ✓ *DOE program assisting and recognizing organizations for adopting a culture of continuous energy performance improvement*
- ✓ *Self-attesting, no certifications, no external audits, do-it-yourself with DOE free online resources*
- ✓ *Online energy management tools and guidance, can be rebranded/repurposed if desired*

Participants are eligible for technical assistance. Contact Crystal McDonald at crystal.mcdonald@ee.doe.gov for more information.

Questions & Answers

Contacts

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