Fuel Cells for Public Transportation in CT

- Economic and other Benefits
- State of the Technology
- Business Outlook

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Economic & Other Benefits

Fuel Cell Efficiency:
~2X better than Diesel,
~2.7X better than CNG

Emissions & Health:

Fuel Cell Bus: Water vapor exhaust
Diesel Bus: The EPA classifies diesel exhaust as "likely to be carcinogenic to humans."

Energy Security

Flexible Sources:
Natural gas, coal & oil based electrical

Energy storage for solar, wind, geothermal
Fuel Cell Technology - Design & MFG

**PureMotion**

**MODEL 150**

**Next Gen Fuel Cell Bus**
- US Manufactured & Serviced
- Lightweight body
- Electric Drive & Accessories
- ~300 mile range

**Cost:** 25-50% lower in moderate volumes

**Size:** 1/3 the size of previous model

**Manufacturing:** Pre-production design
Current durability forecast: Fuel cell powerplants will meet or exceed diesel bus engines within 2-3 years
Business Outlook

Key enablers for fuel cell buses:

- Larger bus deployments
  - Fuel cell buses are costly due to very low volumes of key components
  - US bus OEM’s production methods are for larger orders
- Federal or local incentives for the initial higher capital cost of FC buses
- Low cost and available H2 Infrastructure

Active sponsors of fuel cells for transportation:
USA: Connecticut, California, Michigan, Ohio, Hawaii
Worldwide: EU, Japan, Korea
Thank You!
EnviroExpress

LNG/CNG Fueling Facility

LNG Storage Tank
(-260 Degrees F)
Kenworth T800

15 Liter LNG Tractor
Clean Cities Mission

To advance the energy, economic, and environmental security of the U.S. by supporting local decisions to reduce petroleum use in transportation.

- Provides a framework for businesses and government agencies to work together
- Goal: Reduce U.S. petroleum use by 2.5 billion gallons per year
Clean Cities Coalitions

- Nearly 87 coalitions in 45 states
- 775,000 AFVs using alternative fuels
- 6,600 fueling stations
Coalitions are made up of local and national stakeholders.

- 8,400 stakeholders nationwide
- 49% private-sector stakeholders
- 51% public-sector stakeholders
Clean Cities Strategies

- **Replace** petroleum with alternative and renewable fuels
- **Reduce** petroleum use through fuel efficiency measures, smarter driving practices, and idle reduction
- **Eliminate** petroleum use by promoting mass transit, trip elimination, and congestion mitigation

Clean Cities has saved nearly 3 billion gallons of petroleum since 1993.
Clean Cities Portfolio of Technologies

Alternative and Renewable Fuels
- Biodiesel
- Electricity
- Ethanol (E85)
- Hydrogen
- Natural gas
- Propane

Fuel Economy
- Fuel efficient vehicles
- Driving habits
- Vehicle maintenance

Idle Reduction
- Technologies
- Behavioral changes

Trip Elimination
- Telecommuting
- Ridesharing
Clean Cities Strengthens Markets

- Connecting fleets with fuel providers and industry partners
- Training and information
- Technical assistance
- Funding
- Education and outreach to decision makers, fleets, and the public
Online Information Resources

Clean Cities
  [www.cleancities.energy.gov](http://www.cleancities.energy.gov)

Alternative Fuels & Advanced Vehicles Data Center
  [www.afdc.energy.gov](http://www.afdc.energy.gov)

FuelEconomy.gov
  [www.fueleconomy.gov](http://www.fueleconomy.gov)

Clean Cities Coordinators and Coalitions
The Greater New Haven Clean Cities Coalition, Inc.

- Designated October 1995
- Non-Profit Under Transportation Energy Partnership (TEP)
- More than 40 Stakeholders
- Initially only included the City of New Haven, expanded in late 1990 to include all of New Haven County
- Started Coalition and took over as coordinator in 1997
- Registered as a Authorized Recipient of USDOE and other Federal Funds
- Fuel Neutral
New Haven Public Works Compressed Natural Gas Filling Station

- CNG Station at New Haven Public Works Opened 2000
- Used CNG Station from Gas Utility
- Funding from Unused Grant Funds
- Date: Initiated in 1990 with $50,000 Federal Funding
Electric Ranger Project

Ford Electric Ranger Pickup

- 4 Ford (Lead Acid) Electric Ranger Pickups for City of New Haven Use
- Connecticut DOT Alternative Fuel Program
- Funding Source FHWA CMAQ Funds $14,000 Federal Funding for Leasing
- In Service Feb 2002 — 3-year Program with Data Reporting Requirement
- Vehicles were leased from Ford and Used by New Haven Departments
- Short Range and Vehicle Poor Mean Time Between Failure Rate
New Haven Electric Trolley

Project Cost: $1,510,081
Federal Funding: $1,208,065
Cost Per Trolley: $252,175 X 4

Started Service August 12, 2002

Two Trolleys
Route Length: 1.9 Miles
15 Minute Headways
Average-6 days a week
12 Hours a Day
The project started in 2004 on a napkin. $3,430,019 in funding from three years of Federally Directed Funds was released February, 2004. The whole project was supported by Congresswoman Rosa DeLauro, Former Sen. Dodd and Sen. Lieberman. The next $8,000,000 was put together by Carla York, Innovation Drive, who manages our coalitions grant activities. Proterra is now located in South Carolina, primarily building Fast Charge Electric Buses.
The BioWatz grant consisted of $738,000 in Federal Funds and $1,507,057.73 total costs with the partner match from BioPur, Innovation Drive, and Sabre Engineering. The project had full support from Congressman Chris Murphy.

www.biowatz.com
Technology Introduction to Coalition Member

- Technology is moving very fast
- Electric Vehicle Systems Equipment (EVSE) Technology
- Smart Grid Interface
- Charging Data Collection
- Experts in High quality technology low production
Clean Cities Recovery Act: Vehicle & Infrastructure Deployment

Connecticut Clean Cities Future Fuels Project

Lee Grannis
Principal Investigator
Greater New Haven Clean Cities, Inc.
Capitol Clean Cities — Hartford
Southwestern CT Clean Cities — Fairfield
Norwich Clean Cities
Innovation Drive—Carla R. York — Project Manager
FUELS and VEHICLES
General Approach

• Fuel neutral approach –
  – 5 fuels;
  – 9 locations;
  – 6 public access stations;
  – Major corridor ease of access for all public sites;
  – Ensures capability for statewide and regional mobility using Alternative Fuels

• Fueling capability for the largest public transportation fleet of Hydrogen buses on the East Coast traveling over 200,000 miles per year in and around the Greater Hartford and Greater New Haven areas of the state

• Fleets and Fueling for three large commercial operations, representing 238 of the in-project vehicle deployments – representing 15 Million Miles Traveled Annually on busy Connecticut Highways and Interstates

• ARRA Federal Grant $13.2 Million with Partner Match $29 + Million Project Total

220 CNG Taxi’s hitting the roads of CT – Metro Taxi in West Haven & The Yellow Cab Company in Bloomfield purchased 110 CNG vehicles each to fill up at the CNG stations commissioned at their facilities. (both stations offer public access.)
Strategic diversity with regard to fuel, application, vehicle class and geographic placement in the state ensures statewide mobility for >90% of the in-project deployments and increases future fuel load additions in this ARRA project funded through the DOE Vehicle Technologies Program.

- 11 fleets (10 fully deployed, 1 fleet partial deployed)
- 5 Fuels – CNG, LNG, Hydrogen, B20 and Electric
- 5 Applications: Public Transportation, Municipal Fleets and 5 different Commercial Operations
- 3 Classes: Light, Medium and Heavy-Duty Vehicles
- 11 Zip Codes: Geographic diversity of locations, primary focus on heavily congested, high visibility areas – all positioned on or near Major Corridors

272 Vehicle Deployments
Project Infrastructure

- Bridgeport
- Meriden
- Fairfield
- West Haven
- Bloomfield
- Windsor Locks
- Glastonbury
- Norwich - CNG
- Norwich - EVSE
- Norwich - B20
- Hartford - H2 (Manufacturing now)
Follow on Non Grant Vehicles

LNG and CNG Heavy Duty Trucks have been added to fleets and fueling…. driving petroleum displacements UP!

12 LNG Tractor Fleet
Privately Funded
Cumberland Farms-Gulf

120 Vehicle AT&T Fleet fueling
at West Haven and EnviroExpress Sites

Privately Funded Additional
Vehicles
EnviroExpress
Fueling Approach/Locations

Fueling Installations located on or near major corridors with Public Access stations positioned along heaviest traveled roadways

COMMISSIONED/OPERATIONAL
- Bridgeport- 1 LNG/CNG Station
- Norwich — NPU; 8 EVSE, B20, efficiency upgrade to existing CNG Station
- West Haven- 1 CNG Station
- Bloomfield- 1 CNG Station
- Meriden- 1 CNG Station
- Glastonbury- 1 CNG Station
- Fairfield- 1 CNG Station
- Windsor Locks- 1 CNG Station
- Hartford- 1 Hydrogen Station 1Qfy13

Connecticut’s Constellation of Stars – 11 Clean Alternative Fuels Available in 9 different locations across the state
Site Openings

Stations

- 7 New Stations Completed and Operational in Meriden, Bridgeport, Fairfield, West Haven, Glastonbury, Bloomfield, and Windsor Locks
- 2 Fuel Station Upgrades Completed and Operational in Norwich at NPU + 8 new EVSE’s
- 1 Station under construction with commissioning planned prior to end of 1QFY13
- 2 Ribbon Cuttings still outstanding

Fairfield CNG
10 June 2011

Norwich CNG, B20, EVSE
1 May 2012

Bridgeport LNG/CNG
10 December 2010

Glastonbury CNG
26 October 2011

West Haven CNG
26 September 2011

Bloomfield CNG
9 December 2011

Meriden CNG
19 October 2010
Training & Media

Outreach/Education/Marketing Results
- 16 Press Releases Issued
- One major marketing collateral distributed throughout the state, to policy makers, fleet operators, regulatory officials and others across the state of CT (6,000)
- 15 Local/Regional TV Spots
- 5 Local/Regional Radio Interviews
- 87 Internet Publications
- 93 Local/National Print Publications (Newspapers)
- 11 Trade Publication Stories

Outreach/Education/Marketing Results
- 22 Events
- 1356 Event Attendees
- Media/Marketing Exposures 142,821,683 (Calculated at 30% of Potential Viewers/Circulation)

Training Results
- 43 Training Classes
- 1092 Attendees

Marketing/Media Activities
- 16 Press Releases Issued
- One major marketing collateral distributed throughout the state, to policy makers, fleet operators, regulatory officials and others across the state of CT (6,000)
- 15 Local/Regional TV Spots
- 5 Local/Regional Radio Interviews
- 87 Internet Publications
- 93 Local/National Print Publications (Newspapers)
- 11 Trade Publication Stories
### Collaborations/Partnerships

#### Project Team

- **Innovation Drive – 1st Tier Sub**
- Sabre Engineering
- Signature Transportation
- Enviro Express
- Avalence
- Metro Taxi
- The Yellow Cab Company
- Clean Energy (CE)
- Air & Gas Technologies (AGT)
- Nana Corporation
- Baker Equipment
- Bonner Electric, Inc.
- Manchester Honda
- Matthews Bus
- Interstate Ford
- VPG
- Ford Motor Company

#### Non-Profit Partners
- Greater New Haven Clean Cities - **PRIME**
- Capital Clean Cities
- Norwich Clean Cities
- Southwestern CT Clean Cities

#### Local Government Partner
- City of Bridgeport
- Town of Glastonbury
- City of Meriden
- Town of Fairfield

#### Utilities Partners
- Norwich Public Utilities (NPU)
- Southern Connecticut Gas Company
- Connecticut Natural Gas Corporation

#### State Agencies & Organizations Partners
- CONNDOT
- CTTRANSIT

#### Supporting Organizations
- Connecticut DECD
- Connecticut DEEP
- Yankee Gas

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**Private Industry Partners**

- Innovation Drive – 1st Tier Sub
- Sabre Engineering
- Signature Transportation
- Enviro Express
- Avalence
- Metro Taxi
- The Yellow Cab Company
- Clean Energy (CE)
- Air & Gas Technologies (AGT)
- Nana Corporation
- Baker Equipment
- Bonner Electric, Inc.
- Manchester Honda
- Matthews Bus
- Interstate Ford
- VPG
- Ford Motor Company

*No designation indicates 2nd and 3rd Tier Sub or Supporting as indicated*
Over the project’s 4-year life the environmental benefits will include displacing (or eliminating):

- More than 6 Million Gallons of petroleum
- More than 11 Million pounds of Greenhouse Gases (GHG)
- Over 500 Thousand pounds of Carbon Monoxide (CO)
- Over 300 Thousand pounds of Nitrogen Oxides (NOx)
- Over 50 Thousand pounds of Volatile Organic Compounds (VOC), and,
- Over 3 Thousand pounds of Fine Particulate Matter (PM2.5)
Lee Grannis
Greater New Haven Clean Cities Coalition, Inc.

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## Upcoming Meetings

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<tr>
<th>Month</th>
<th>Topic</th>
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<tr>
<td>Dec 12, 2012</td>
<td>Meet the Regulators (PURC Members)</td>
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<tr>
<td>Jan 16, 2013</td>
<td>Legislative Preview (Jointly with CBA Public Utility Law Section)</td>
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<tr>
<td>Feb 13, 2013</td>
<td>Emerging Technologies</td>
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<tr>
<td>Mar 13, 2013</td>
<td>CT Energy, Environment and Economic Development Conference</td>
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<td>Apr 10, 2013</td>
<td>UTC Fuel Cell Manufacturing Tour</td>
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<tr>
<td>May 19-21, 2013</td>
<td>New England Energy Conference and Expo, Mystic, CT</td>
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<tr>
<td>Jun 12, 2013</td>
<td>CPES Awards and Case Studies</td>
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