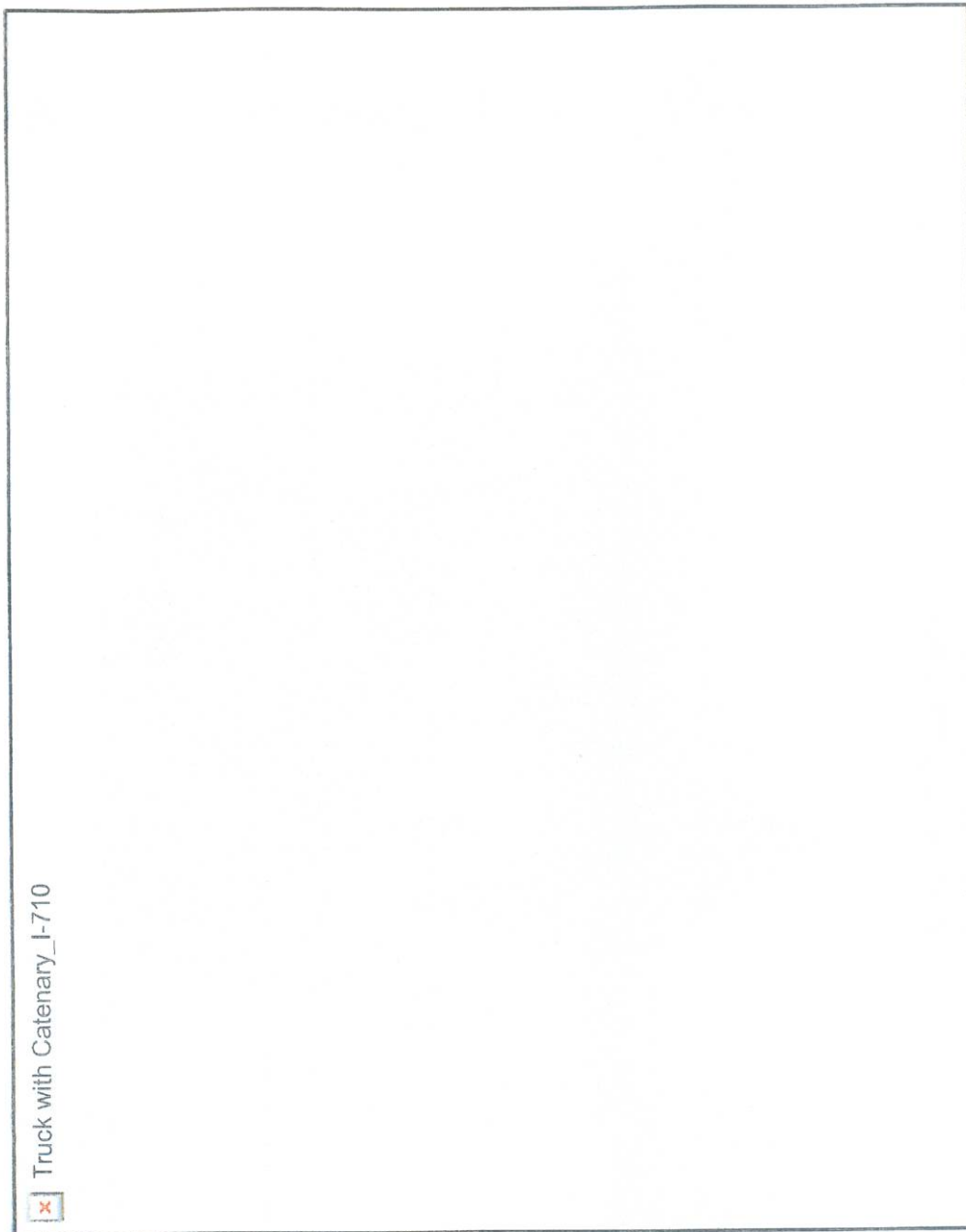


Zero Emissions Technology

Zero Emission Trucks

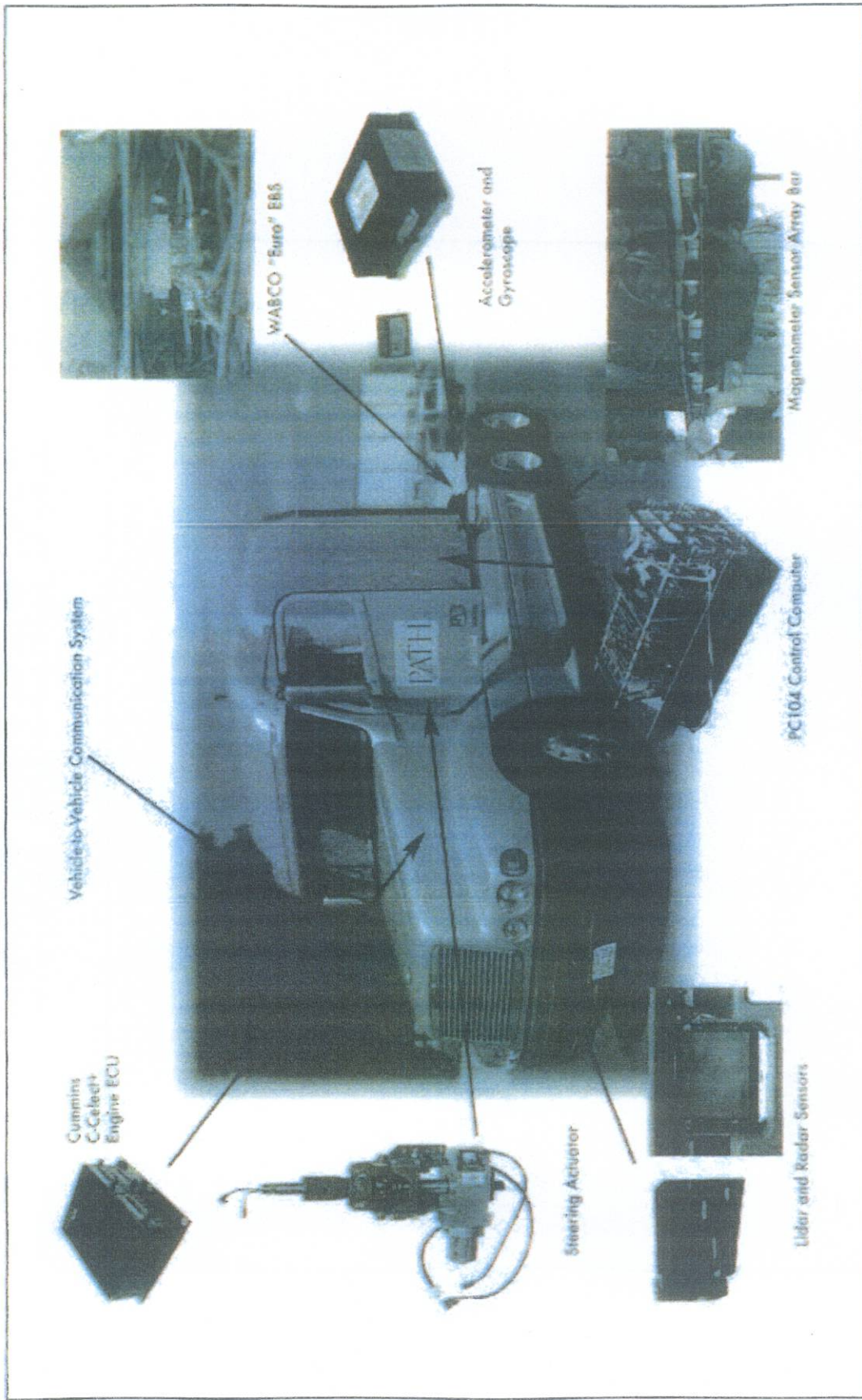


 Truck with Catenary_I-710



Metro

Automated Guidance



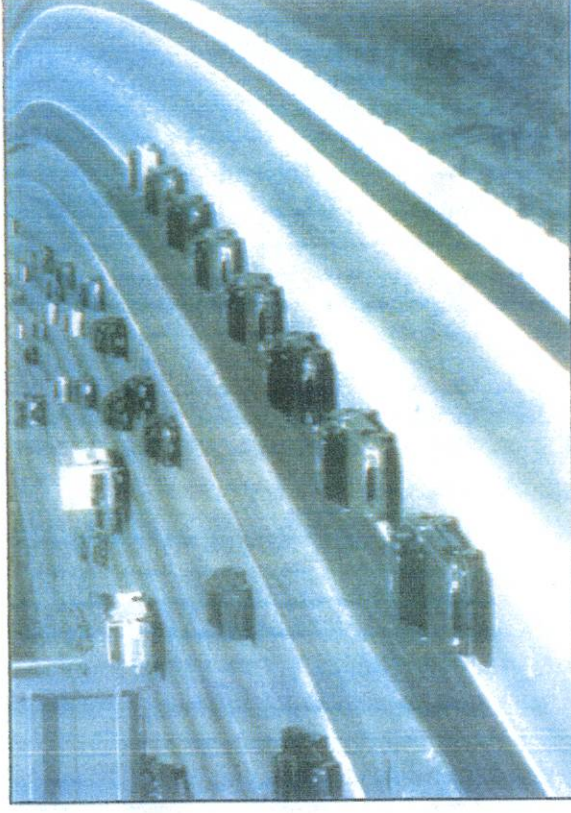
California Path Program, Institute of Transportation Studies
University of California, Berkeley



Automated Guidance

- **Currently in Demonstration Phase of Development**
- **Allows for Platooning of Commercial Vehicles**
- **Reduces Spacing Between Trucks**
- **Results in 50% Increase in Freight Corridor Lane Capacity**

Example (with Autos)
Automated Guidance - Platooning



Regulatory Considerations

Incentives / Disincentives to Spur Private Sector Use of New “Zero Emissions” / Automated Guidance Technologies

- **New Enabling Legislation**
- **Port Restrictions**
- **Enforcement Component**



Metro

I-710 Corridor Alternatives

Alt. 1

No Build
Improvements

Alt. 6A

Freight Corridor
(FC) - 4 Lanes

Widen I-710
to 10 Lanes

Arterial System
Improvements

No Build
Improvements

Added
Transit

Alt. 5

Widen I-710
to 10 Lanes

Arterial System
Improvements

No Build
Improvements

Added
Transit

Zero Emissions Vehicles

Automated Guidance

Alt. 6B

Freight Corridor
(FC) - 4 Lanes

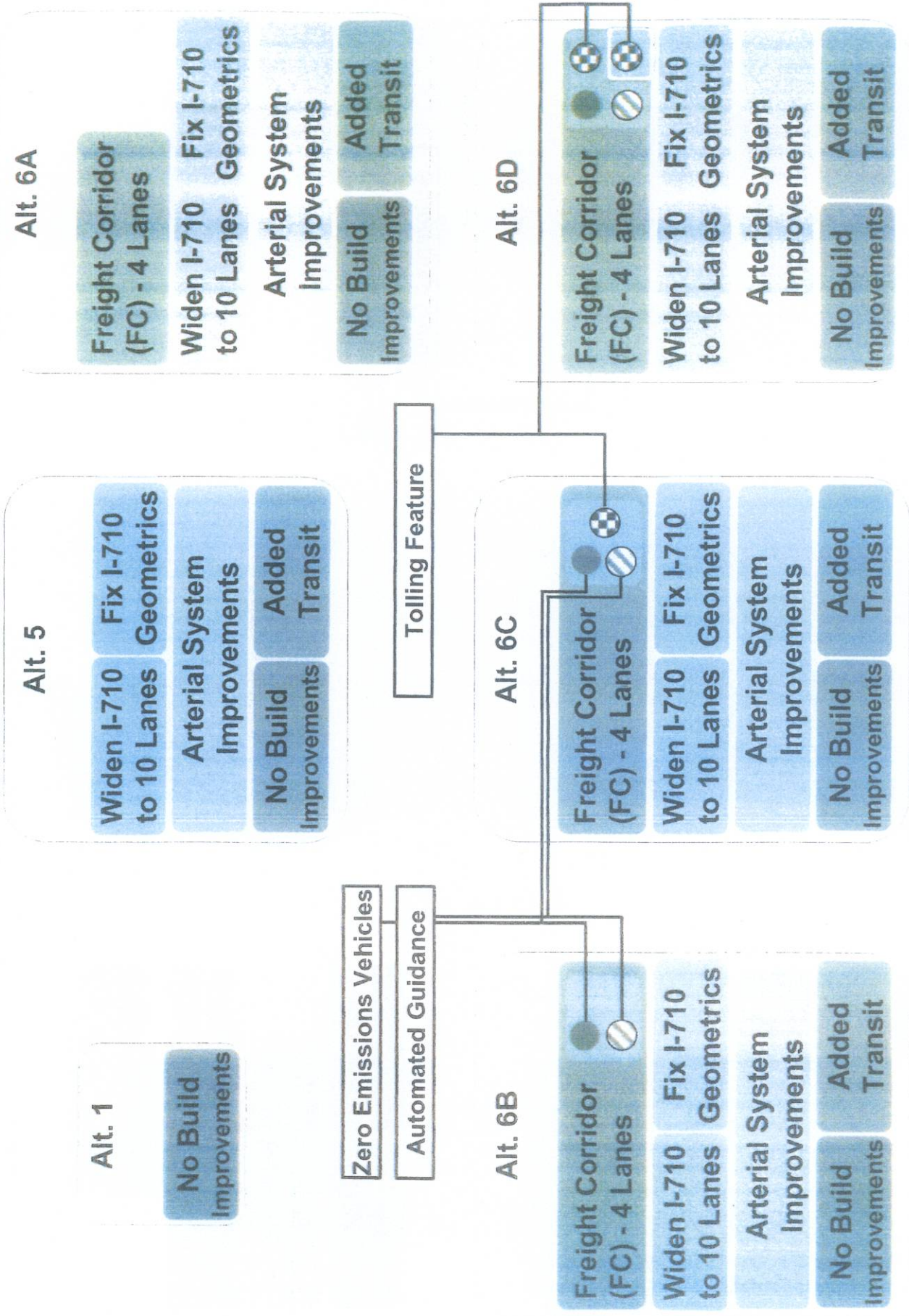
Widen I-710
to 10 Lanes

Arterial System
Improvements

No Build
Improvements

Added
Transit

New Options – Alternatives 6C and 6D



New Options – Alternatives 6C and 6D

Element: Adds Tolling Feature

- Tolls Freight Corridor Lanes Only (Alt 6C)
- Tolls both Freight Corridor and Trucks on I-710 General Purpose Lanes (Alt 6D)
- Creates Revenue Source
- Opportunity for Public / Private Partnership

I-710 Freight Corridor & Zero-Emission Trucks: Technologies, Opportunities, & Barriers



*Clean Transportation
Technologies and
Solutions* SM

Bill Van Amburg
Senior Vice President

Michael Ippoliti
Director, Clean Transportation Solutions

June 2011

- Can Zero Emission Trucks be commercially available if a Zero Emission Freight Corridor is built?

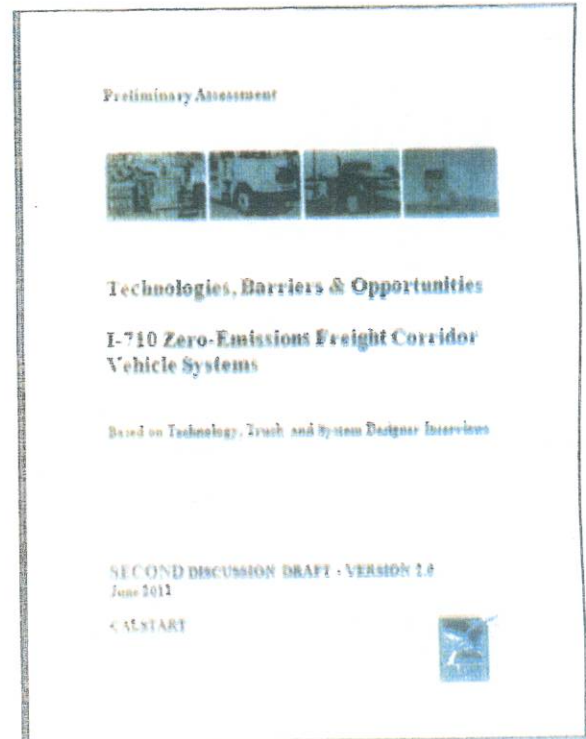
Question





Approach

- Research
- Confidential Delphi Interviews
- CALSTART Expertise
- Examination of Technology Options
- Identification of Barriers
- Define Opportunities



Trucks CAN Deliver Zero Emissions Goods Movement
in the I-710 Corridor, within the time frame of the
project

- Several Options for Zero Emissions
 - Hybrid with Dual-Mode Operation (ZEV Mode)
 - Range Extender EV (Fuel Cell or Turbine w/ZEV mode)
 - Full EV (with fast charging or infrastructure power)
 - Road-Connected Power
- Additional Options for Near-Zero Emissions
 - Alt Fuel Hybrids
 - Zero NOx dedicated fuel engines (CNG, RNG, H2 ICE)
 - Range Extender EV (turbine)

Findings





Examples: Dual-Mode Hybrids (w/ Zero Emissions Mode)

Meritor – Navistar

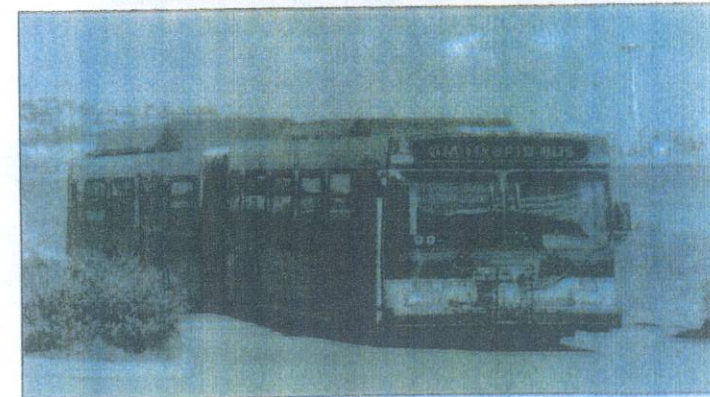
- Electric drive at lower speeds (up to 48 mph), blended mode at higher speeds
- Can greatly reduce fuel use, cut idle emissions, provide partial zero emissions

Eaton

- Electric drive for short range, low speeds (prototype)

Transit (buses)

- Long Beach Transit
- King County Metro



Examples: Series Electric/Hybrid – Range Extender

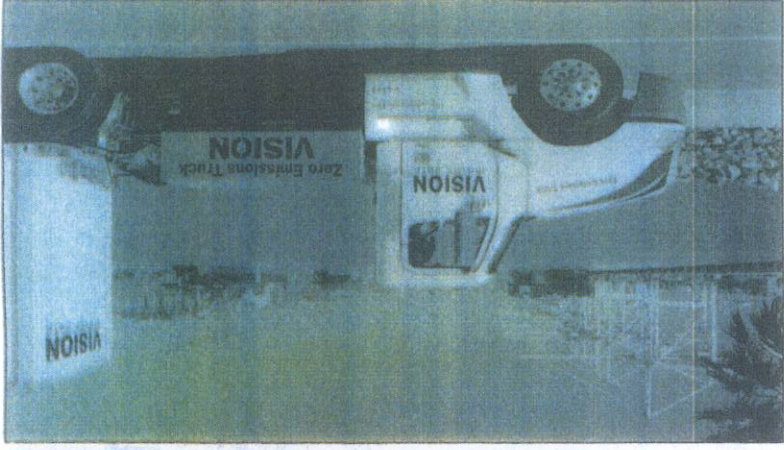
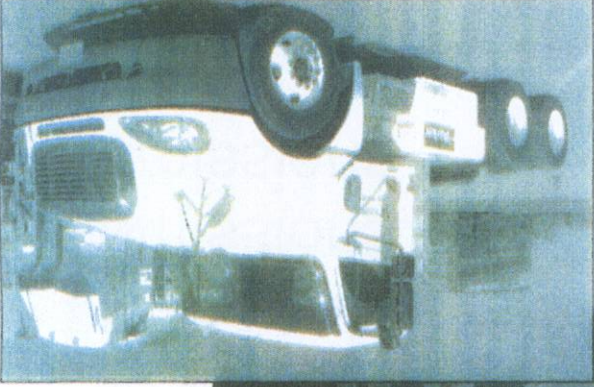
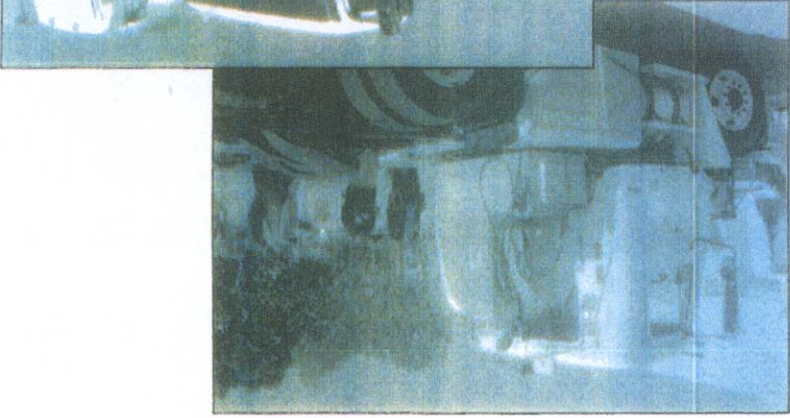


Artisan-Parker

- Electric drive system with turbine range extender (with ZEV mode)
- Much development in turbines, focus on NG

Vision Industries

- Electric with fuel cell range extender (zero-emissions)





Examples: Full Battery Electric

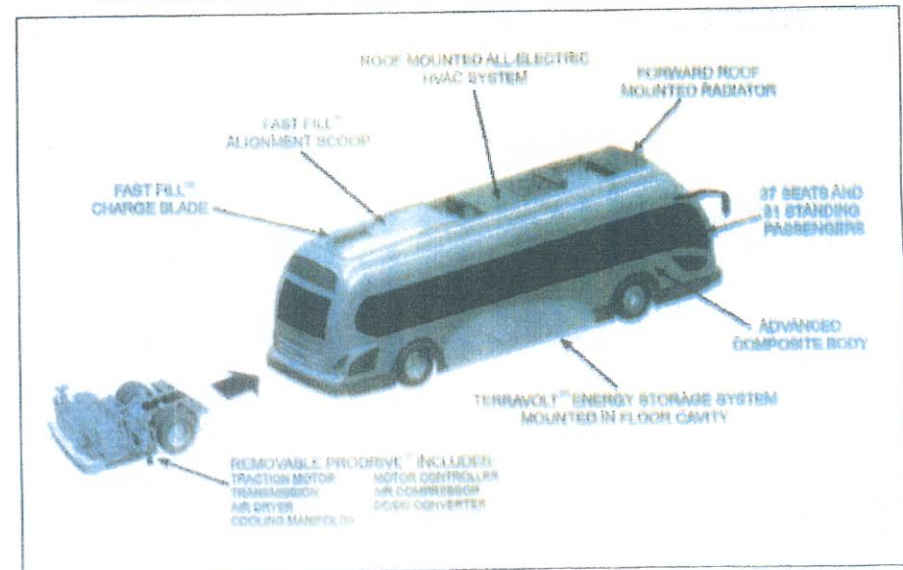
Balqon

- Drayage trucks



Proterra

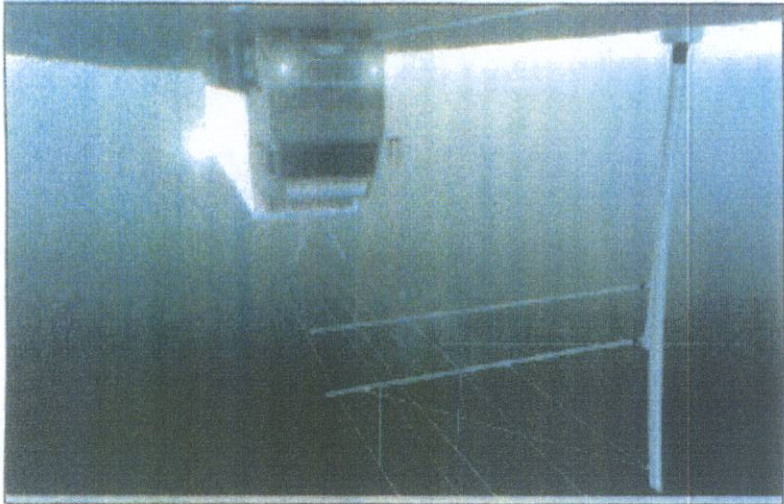
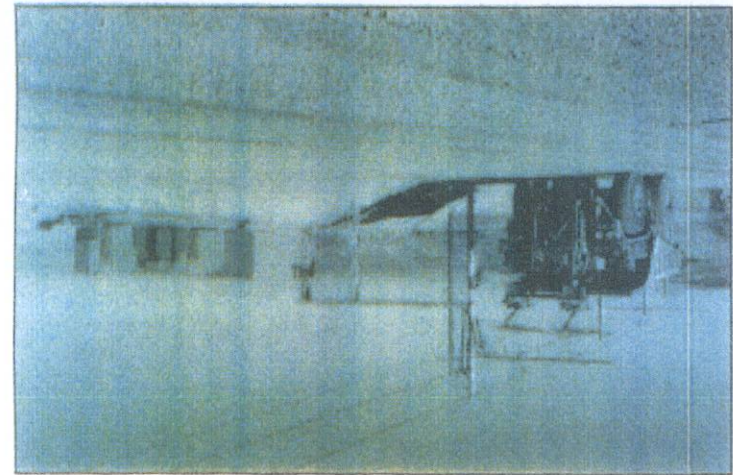
- All-electric bus operating with Foothill transit
- Reduced battery pack size augmented with fast charge



Examples: Road-Connected Power



- Well known in transit industry (electric trolley-bus)
- Used widely in mining with extremely heavy equipment
- Now beginning testing in Europe (Siemens) for heavy-haul trucks
- Other tests looking at in-road power alternative



Siemens eHighways Concept



Opportunities

- Multiple technologies available
- Variations in feasibility
 - Dual Mode Hybrid Vehicles have “multiple” uses (not just corridor)
 - Fuel Cells and Full-EV require Infrastructure
- Pathway Trucks (near zero emissions)
 - Can test and validate a production “pathway” to reach zero in succeeding model generations

- Design Factors
 - Durability
 - Weight/Volume
 - User Needs
 - Development
 - Resources
- Infrastructure
 - Fuels
 - Corridor Design
 - Costs

- Costs
 - Development Cost
 - Materials/Component Cost
 - Vehicle Cost
- Business Case
 - Corridor Economics
 - Market Demand & Volume Potential
 - Regulations & Legislation
 - Fuel (Oil) Prices

Barriers





Conclusions

- Zero Emission Trucks are Technically feasible within the timeframe of the project
- Barriers need to be addressed (Esp. Business Case)
- Pathway Trucks (Near-Zero emission) can help validate zero emission technology

Clean Transportation Solutions SM

Advanced Transportation Technologies SM

www.calstart.org

For info contact:

Bill Van Amburg
Michael Ippoliti
(626) 744-5600

bvanamburg@calstart.org
mippoliti@calstart.org

