

| reduce emissions |

| improve fuel economy |

| lower operating costs |

Hybrid Electric School Bus Project

Everyone in your seats and enjoy the ride



www.hybridschoolbus.org

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

10 Year Effort (2003-2013)

- 4 Phases

I. **Feasibility Study (2003-2005)**

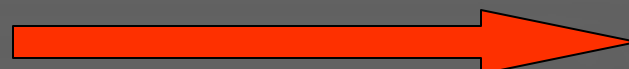
II. Pre-Production Operation (2006-2009)

III. Fleet Testing (2008-2012)

IV. Full Market Deployment (2013)

Technical Feasibility
Business Feasibility
Overall Feasibility

**Completed and
available on the web**



reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

10 Year Effort (2003-2013)

- 4 Phases
 - I. Feasibility Study (2003-2005)
 - II. Pre-Production Operation (2006-2009)
 - III. Fleet Testing (2008-2012)
 - IV. Full Market Deployment (2013)

20 Bus Purchase
Data Gathering
Emissions
Fuel Economy
Maintenance

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

What is a Plug-in Hybrid?

- Plug-in can* receive a portion of battery energy from grid
- Categorized either by
 - all electric range PHEV-20 (20 Mile All Electric Range)
 - Depletable energy storage PHEV-20kWh (Each recharge draws 20 kWh and the vehicle will deplete this over a typical commute)
- Allows for “emission free zones”
- Electricity is MUCH cheaper than diesel, about 70¢ per equivalent gallon.
- Electricity is MUCH cleaner, and gets cleaner over time with no investment on the users part.

* Plugging in is optional depending on conditions at the time

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project


EARLY PRODUCTION PURCHASE

Recent studies on children and diesel fumes

CHILDREN'S EXPOSURE TO DIESEL EXHAUST ON SCHOOL BUSES

Children's Exposure to Diesel Exhaust on School Buses

Research and publication of this report was made possible by the Belden Foundation, the Torrey Foundation, the Diner Foundation, and the Alida B. Messinger Charitable Lead Trust, No. 2.



Environment & Human Health, Inc.
1183 Ridge Road • North Haven, CT
Phone: (203) 218-6382 • Fax: (203) 218-6383
www.ehhi.org

WHAT YOU SHOULD KNOW ABOUT DIESEL EXHAUST AND SCHOOL BUS IDLING

Children breathe 10 percent more air per pound of body weight than adults.

Recent studies have found that children have a higher percentage of body weight that is exposed to diesel exhaust and spend more time in school buses.

School buses are the U.S. with the highest number of diesel engines.

EPA Region 6
AR-LA-MI-DC-DE

For more info, call the EPA Air Quality Hotline at 1-800-621-1237

HOW ARE CHILDREN AFFECTED?
Air pollution from idling school buses can accumulate in children. When buses idle in the school yard, particularly during and just after the school start, the school yard can become a health risk to children. Moreover, idling school buses can cause lung damage. However, there are some simple steps that schools can take to reduce idling time and air pollution.

RECOMMENDED ACTIONS TO REDUCE DIESEL POLLUTION
Although every school district is unique, there are a number of steps that schools can take to reduce the health risks associated with exposure to diesel exhaust. Here are some action school districts should consider:

ESTABLISH IDLING GUIDELINES
When school bus drivers arrive at loading or unloading sites to drop off or pick up passengers, they should turn off their buses as soon as possible to decrease idling time and reduce harmful emissions. The school bus should not be restarted until it is ready to depart.

STEPS YOU CAN TAKE TO REDUCE DIESEL POLLUTION

1. Distribute this information to all school buses as they arrive at the school yard.
2. Limit idling time to only what is necessary for loading and unloading.
3. Provide a space with the school yard to reduce idling time.

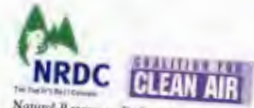
NO BREATHING IN THE AISLES

Diesel Exhaust Inside School Buses

Principal Authors and Researchers
Gina M. Solomon, M.D., M.P.H.
Todd R. Campbell, M.E.S., M.P.P.
Gail Ruderman Fester
Julie Masters
Artineli Sumkian
Karin Ann Paul

Contributor
Jesse Santos Guzman, M.D., M.S.

School Bus Monitoring Study Development and Oversight
The school bus monitoring protocol and study were developed and implemented jointly with Dr. S. Katharine Hammond, Ph.D., at the University of California, Berkeley School of Public Health, with the capable assistance of Amy Kimmer and Charles Ferriss. We are grateful for their invaluable participation in the development and execution of this monitoring program and study.



January 2001

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE



Why Plug-in Hybrid Electric School Buses?

- Significant emission reductions
 - Reduces NO_x by ~60%
 - Reduces PM by ~95%
 - Reduces CO₂ by ~30%

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Advisory Group

NC Department of Public Instruction
SC Department of Education
Florida Department of Education
Napa Valley Unified School District (CA)
US Army (Fort Bragg)

S Bus
Du
C
on
Lator
M/Alliso

Duke Power
Progress Energy
NC State Energy Office
California Energy Commission
South Carolina Energy Office
Florida Energy Office
NC DOT
NC DENR
NCSU
ITRE
US EPA
SC DHEC
NYSERDA
NYPA

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Buyers Consortium

- Demonstrate demand to interest the manufacturers
- Consortium has:
 - Developed RFP and Specifications
 - Located additional funding
 - Issued RFP
 - Selected a manufacturer
- Early Production Purchase of approximately 20 buses – more possible pending funding

reduce emissions |
improve fuel economy |
lower operating costs |

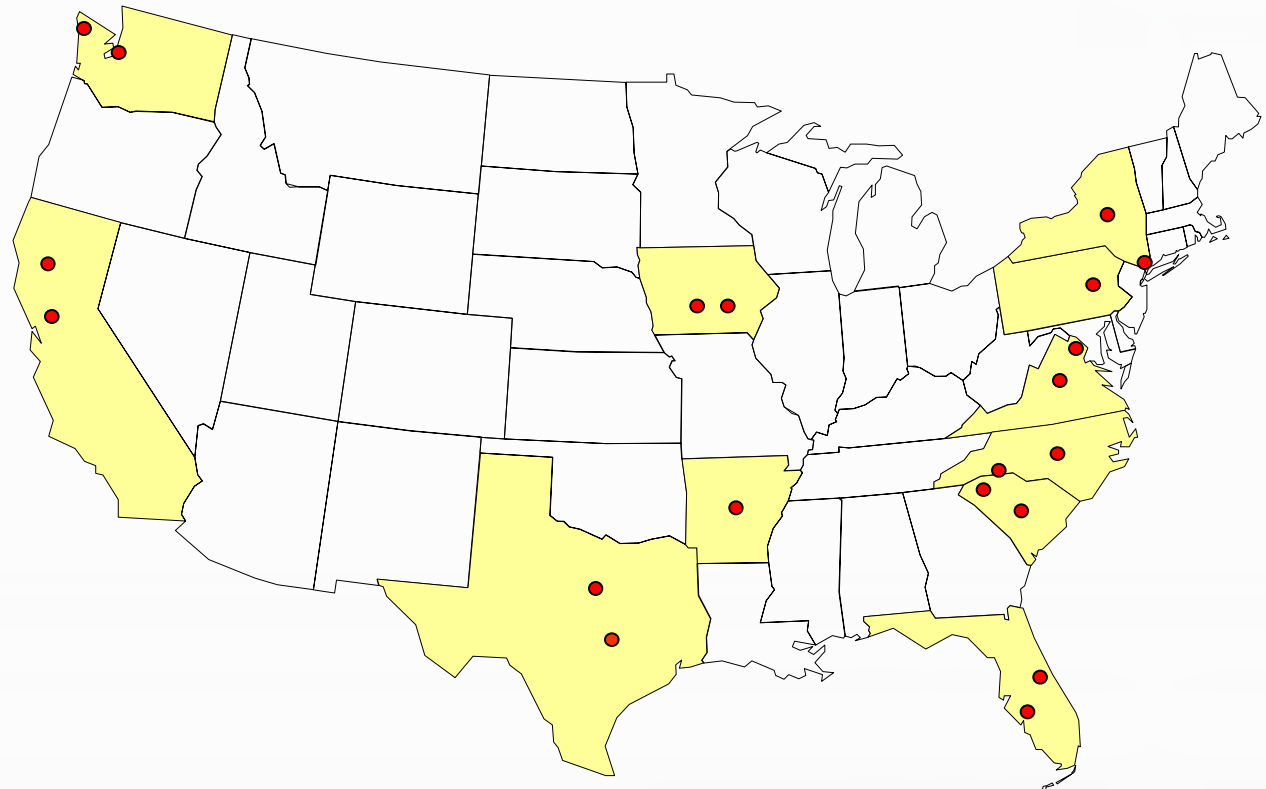
Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE



Nationally Distributed

- North Carolina (2)
- South Carolina (2)
- Florida (2)
- Virginia (1)
- Washington DC (1)
- Pennsylvania (1)
- New York (2)
- Arkansas (1)
- Iowa (2)
- Washington (2)
- California (1)
- Texas (2)



| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

19 Buses will be delivered to 11 states

- RFP for buses was released in June
- Buyers consortium selected IC Corporation (International) from bidders based on specific criteria.
 - The bus is PHEV-22.5kWh with Lithium Ion batteries
 - The average cost is \$220k or a \$139k premium over an existing bus.
- Press Conference in Reno, NV on July 25th 2006.



SEATS 66C 44A

CE 200

DIESEL ELECTRIC
HYBRID

DIESEL

Hybrid
Power by
Enova

R STEP







| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Publicity

- Publicity joint with Duke Power, IC Corp and Enova
- Picked up by over 62 Television stations in major markets across the nation
 - Estimated over 2.5 Million viewers
- Print media in numerous trade journals in both school and energy marketplaces.

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Next Steps

- First buses will be delivered in January of 2007
- Monitor for 2 Years
 - Emissions
 - Fuel economy
 - Maintenance & operation
 - Driving performance
- Funding still an issue

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

The Road Ahead

Dealing with the first cost issue

- Volume price - \$90,000-\$100,000
 - 20 - 50% premium
- Grant Support
 - EPA clean school bus program
 - State air quality funds
- Legislative support
 - Schumer (NY) tax credits for manufacturers
- Outreach and information
 - Lifecycle costs

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Next Stop Utilities

- Off-peak energy sales
- Assemble consortium
 - Develop charging infrastructure
 - Fund outreach activities

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Lessons

- Address the market
 - Supply/Demand
 - Run with the big dogs
- The power of multi-state collaboration
 - Stakeholder group - open doors/provide credibility
 - Buyers group - get the attention of manufacturers
- The need for “Glue”
 - Passion/Persistence
 - But how does it get paid for?

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Lessons

- Let all parties play the role appropriate for them **(and keep them out of places they don't belong)**
 - Advisory Group – “bless” the project, open doors
 - School Systems - spec. the bus, raise the money
 - Manufacturers – design the bus
 - Advanced Energy – initial feasibility, recruit the players, prompt the discussion, manage the project

| reduce emissions |

| improve fuel economy |

| lower operating costs |

Hybrid Electric School Bus Project



www.hybridschoolbus.org

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE



| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Who is Advanced Energy?

- Independent non-profit located in Raleigh, N.C.
- Bring energy-saving technologies to market
- Focus on solutions that are economically viable, environmentally responsible and reduce energy consumption
- Work in residential, commercial, industrial and transportation markets

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

What is a Hybrid?

- Hybrid electric combines electric motor with combustion engine
- Regenerative braking allows energy recovery

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Diesel Exhaust Impacts

- Increasing mobile source emissions
- Links between air quality and children's health
 - "Pollution Report Card," UCS
 - "Children's Exposure to Bus Exhaust," EHHI
 - "No Breathing in the Aisles," NRDC
- US EPA Clean School Bus Program

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE



Why Plug-in Hybrid Electric School Buses?

- Increased energy efficiency
- Reduced engine maintenance
- Lifecycle costs are approximately equal to conventional diesel bus
- Less risk because of significant reduction in fuel consumption
- Less risk due to dual fuel nature

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

What are the program costs?

- Initial Cost: > standard diesel
- Operating Cost: < standard diesel
- Lifecycle Cost = standard diesel
- Infrastructure
 - Same diesel pumps
 - Same maintenance garage
 - Electric plug-in chargers

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Other Emission Reduction Options?

- Compressed Natural Gas (CNG)
 - Not available as Type C
 - Good emission reductions
 - Maintenance facility upgrades
- Propane
 - Lower infrastructure costs than CNG
 - Not available yet

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Other Emission Reduction Options?

- Ultra Low Sulfur Diesel (ULSD)
 - Available nationwide in June 2006
 - Few cents more per gallon
- Biodiesel
 - Slight reduction in PM, slight increase in NOx
 - B20 may be 15 to 30 cents more per gallon

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Different stakeholders, Different goals

- Each will take the path of least resistance
 - DOE wants to reduce dependence on foreign oil
 - likes to fund technology development, especially fuel cells, but...
 - EPA wants emission reductions
 - likes to fund proven technologies with least cost per gram reduction
 - School Districts
 - Have little time, funding, or confidence to get their voices heard
 - Want the technology with the fewest headaches
 - Too busy “fighting fires”
 - Manufacturers
 - Want to do the right thing, especially if they can make money from it
 - Need to see
 - Demand
 - Funding

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Other Emission Reduction Options?

- Particulate Traps
 - Only with ULSD, Only with post-1995
 - Cost \$5k – \$10k
 - ~85% reduction in PM
- Oxidation Catalyst
 - Best with ULSD
 - Cost \$660 – \$2000
 - ~20% reduction in PM

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Other Emission Reduction Options?

- Selective Catalytic Reduction (SCR)
 - Excellent NOx control
 - Preferred in EU, not available in US yet
- Exhaust Gas Recirculation (EGR)
 - Available on 2007 engines
- Every technology mentioned can be incorporated as a plug-in hybrid for increased benefits.

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Why now?

- The community is very sensitive to the impacts of increased fuel prices on their kids – reduced field trips, longer walks to stops, elimination of routes.
- Now is the time to act to stop this happening again
- Some funding available through grants
- Participation ensures influence

reduce emissions |
improve fuel economy |
lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Thanks to the many pioneers in the school bus market for making this happen!

- Bill Schroyer (Fla.)
- Don Ross (Fla.)
- Marshall Casey (SC)
- Don Tudor (SC)
- Ben Matthews (NC)
- Derek Graham (NC)
- Craig Warren (NC)
- Charley Ball (NC)
- Dave Duvall (VA)
- Brian Waymire (VA)
- Meghan Ochs (PA)
- Randy Solomon (NY)
- Patrick Bolton (NY)
- Peter Manella (NY)
- Bill Fahey (NY)
- Dennis Kroeger (IA)
- Max Christianson (IA)
- Dave Harris (IA)
- Danny Thede (IA)
- Mike Martello (AR)
- Kris Hafezi (TX)
- Joe Perez (TX)
- Marty Smonko (TX)
- Ralph Knight (CA)
- Brian Higginbotham (WA)
- Scott Logan (WA)
- Dave VanHolde (WA)

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE

Why should districts participate?

- Need to reduce emissions.
- Emission and idle reduction technologies are coming whether you like it or not.
- Plug-in hybrid expected to be cost neutral or slightly positive in the long term.
- Other technologies have significant disadvantages to the purchasers such as higher operating costs and increased maintenance.

| reduce emissions |
| improve fuel economy |
| lower operating costs |

Hybrid Electric School Bus Project

EARLY PRODUCTION PURCHASE



So, what have we learned?

- Hybrid school buses can be both technically and financially feasible
- The benefits of hybrids are favored towards the districts
- Substantial emission reductions are possible. These are as good or better than other alternatives