PARTNERS

The organizations that contributed to the development of the UPS hydraulic hybrid demonstration vehicles are: U.S. EPA, UPS, Eaton Corporation, International Truck and Engine Corporation, and the U.S. Army – National Automotive Center. Major technical support was provided by FEV Engine Technology, Inc., Southwest Research Institute and Morgan-Olson.

CLEAN AUTOMOTIVE TECHNOLOGY

EPA's Clean Automotive Technology Program conducts this innovative research primarily to:

- Achieve ultra-low pollution emissions
- eenhouse gases
- efficiency

cost-effective technologies, Clean Automotive Technology also encourages manu- produce cleaner and more fuel-efficient vehicles. Fleets and consumers benefit by being able to recoup the initial hybrid system costs through lower operating costs within a few years.

Environmental Protection Agency

U.S. EPA National Vehicle and Fuel Emissions Laboratory (NVFEL)

2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: (734) 214-4200
http://www.epa.gov/otaq/technology

United States Environmental Protection Agency
Office of Air and Radiation

EPA420-F-06-043
June 2006

CLEAN AUTOMOTIVE TECHNOLOGY

COST EFFECTIVE HYBRIDS

HYDRAULIC HYBRIDS

The Most Efficient Lowest Cost Hybrids

World's First Full Series Hydraulic Hybrid Delivery Vehicle Prototyped in a UPS "Package Car"

http://epa.gov/otaq/technology/#hydraulic

HHV-HYDRAULIC HYBRID VEHICLES

HIGHEST EFFICIENCY - LOWEST COST

Through the use of innovative hydraulic hybrid technology EPA and its industry partners have been able to create the most efficient and cost-effective powertrain technology in the world. EPA has been able to improve city fuel economy of a UPS package car by 70% and reduce CO_2 greenhouse gas emissions by 40%. The unique energy recovery technology used while braking reduces brake wear by 75% increasing the net savings substantially.

A fleet owner operating one of these high efficiency vehicles would save up to 1,000 gallons of fuel each year.

What is even more astounding is that the additional cost for this technology manufactured in high volume has the potential to be less than 15% of the price of the base vehicle. At current fuel prices, this technology will pay for itself in two to three years.

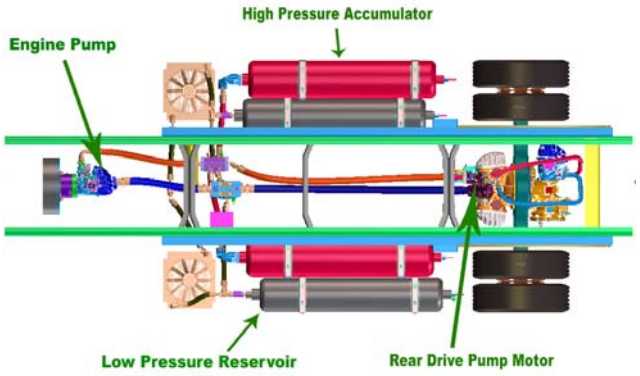
The net lifetime savings over this vehicle's typical 20 year lifespan would be over $50,000.

Hydraulic Hybrid Vehicles (HHVs) rely on proven innovative technology which can be applied to light duty work trucks, SUVs and heavy duty urban vehicles such as city transit buses and garbage trucks.

HOW IT WORKS

This innovative technology is simple. The main components in HHVs are:

- The high pressure accumulator stores energy as a battery would in a hybrid electric vehicle using hydraulic fluid to compress nitrogen gas .
- The low pressure reservoir stores the low pressure fluid after it has been used by the pump/motor.



- The rear drive pump/motor converts the pressure from the hydraulic fluid into rotating power for the wheels, and recovers braking energy which is stored in the high pressure accumulator
- The engine pump/motor pressurizes and transfers hydraulic fluid to the rear drive pump-motor and/or high pressure accumulator
- The hybrid controller monitors the driver's acceleration and braking, and commands the hybrid system components.

There are three key design features enabling an HHV to provide maximum fuel efficiency:

1. Regenerative Braking When stopping the vehicle, the hybrid controller uses the energy from the wheels by pumping fluid from the low pressure reservoir into the high pressure accumulator. When the vehicle starts accelerating, this stored energy is used to accelerate the vehicle. This process recovers and reuses over 70% of the energy normally wasted during braking.
2. Optimum Engine Control The engine pump pressurizes and transfers fluid from the low pressure reservoir to the rear drive pump-motor, and under certain operating conditions, to the high pressure accumulator. In the full series hybrid design, there is no conventional transmission and driveshaft connecting the engine to the wheels freeing the engine to be operated at its maximum efficiency "sweet" spot to achieve optimum vehicle fuel economy.
3. Shutting Engine Off When Not Needed The unique hybrid design not only allows the engine to be operated at its maximum efficiency, but also enables the engine to be completely shut off during certain stages of operation because it is activated by the controller only when it is needed. As a result, in stop and go urban city driving engine use is cut almost in half.