

Are Developing Countries Ready for Hybrid Buses?

- Why consider hybrid buses?

As proposals to reduce emissions from buses in developing countries are being discussed, several options have been proposed, including use of natural gas buses and hybrid buses. Natural gas use in buses decreases emissions through advances in engine and emission control system technology, while hybrid buses can potentially reduce emissions by using less fuel and operating the engine at a narrow range of speeds and loads.

- What is a hybrid and how does it work?

The most common form of hybrid technology combines an electric drivetrain with a diesel engine which powers an alternator or generator to produce electrical power.^{1,2} Decoupling the engine from the drivetrain, allows it to be operated independently of vehicle speed. At a steady-state operating speed, a hybrid bus might be less fuel efficient than the same bus using a conventional drivetrain. However, the real world driving environment of the typical transit bus involves constant starts and stops. With a conventional drivetrain, the engine must be sized to provide sufficient power to accelerate the bus while operating all the needed accessories. A hybrid reduces the maximum power demand on the engine by recapturing braking energy and using it to help accelerate the bus from rest. This reduces the peak power requirement of the engine, allowing it to be smaller. By decoupling the engine from the drivetrain, further gains are possible by operating the engine only at its most efficient speeds and loads. Emissions are reduced, but primarily as a function of reduced fuel consumption — the diesel engines used in hybrids have no inherent emissions advantages.

- Hybrid Buses are in the prototype phase of development

Hybrid bus technology is just being developed, with a few early prototype systems in use in the U.S. Several transit properties in the U.S. are experimenting with hybrid buses, but they are far from being a reliable commercial product. A current major concern is premature battery failure due to uneven charging.³ A current partial remedy is an added maintenance step requiring charging of the batteries overnight or for an entire day to equalize their initial state of charge and operating voltage. It is recommended to do this to hybrid buses in the field at least once a month, or more frequently. Unless premature battery failure can be avoided, the cost of operating hybrid buses will be very high.

- Hybrid buses require highly skilled maintenance personnel

Hybrid bus technology has been made possible primarily by the availability of compact and efficient power electronics. The heart of a hybrid bus is its control system. Very

¹ “New York City Transit Makes First Large-Scale Order of Hybrid Buses,” Lockheed Martin press release.

² “Allison Electric Drives™ Bring Fuel Economy, Environmental Benefits to New York City,” General Motors Press Release.

³ Presentations at the World Bus and Clean Fuels Conference, June 2000.

sophisticated controls and the ability to quickly switch from using power to storing energy is essential to making hybrids work. These controls will take the capabilities of an electronics technician to diagnose problems and effect repairs.

- The cost of hybrid buses is currently very high

Hybrid buses are currently much more expensive than conventional buses, about 50% higher at present. Contributions to this increased expense include:

- an electronic control system
- a battery pack for energy storage
- an electric drive motor
- recouping of R&D investments

This increase in cost is despite the use of a smaller engine and a simpler transmission or no transmission. Also, because diesel engine emission standards are in terms of specific power output, any cost to comply with new engine emissions standards will apply equally to the engines used in hybrid buses as those in conventional buses.

It is possible hybrid buses will have lower operating costs than other bus technologies (excluding capital costs). The reasons include lower fuel consumption and longer brake pad life.⁴ However, these cost savings are offset by more expensive component costs (the power electronics), battery replacements needed over the life of the bus, and the need for more skilled maintenance personnel.

- When might all the “bugs” be worked out of hybrid buses?

Hybrid technology has much potential for use in transit buses. However, it is very difficult to predict when they will be reliable and economically competitive with existing clean bus technologies. For example, development of natural gas bus technology has been proceeding for more than 10 years and is now just being acknowledged to be equally reliable and cost competitive, despite being a much simpler technology than hybrids.

- Are hybrid buses a good choice for use in developing countries?

In the abstract, yes they are. However, their high initial cost, the need for specialized skills to maintain them, and less than complete development represent severe hurdles for implementation. If experience with natural gas buses is applicable, it will be around 2010 before hybrid buses have similar reliability and are economically competitive with other clean bus technologies. In the interim, there are less complex and more cost effective means to reduce emissions from buses in developing countries.

⁴ “Hybrid-Electric Drive Heavy-Duty Vehicle Testing Project” by M. J. Bradley & Associates, Inc., 8030 South Willow St., Building 2, Suite 7, Manchester, NH 03103, February 15, 2000.