Innovative electric hybrid drive systems for commercial vehicles: the modular Elfa system from Siemens

The growing need for mobility is leading to a significant increase in city traffic, making the use of private cars more and more uneconomical. This has resulted in a growing demand in our major cities for innovative alternatives in the field of public transportation. Electric drive systems can make buses and other commercial vehicles in our cities both environmentally-friendly and low in energy consumption. With its Elfa modular hybrid drive system, Siemens has a solution capable of meeting every possible requirement.

The global trend toward urbanization coupled with environmental protection measures will lead to more and more people using buses as a means of transport. The demands placed on urban buses will therefore become more exacting: they will be expected to be easy on the environment with reduced CO₂ emissions and will also have to consume less fuel and run as quietly as possible. The modular Elfa system from Siemens offers all of these benefits. It is based on hybrid technology in which different methods of energy generation – such as diesel generators or fuel cells for example – are combined with energy storage systems such as batteries or ultracapacitors. Siemens is the only manufacturer that can meet all the requirements of bus operators with just one modular system: from vehicle weight and energy management through to the energy sources and storage systems used. Siemens offers a whole family of motors, generators, power electronics and ultracapacitor storage systems to meet these demands.

Elfa Technology

Siemens' Elfa system is not only able to be deployed in buses but also exhaust gas and noise emissions can be significantly reduced in other urban commercial vehicles such as trucks used for garbage collection or short-range distribution services. The system is based on hybrid technology
in which an electric motor is fitted in addition to an internal combustion engine. Eugen Holl, Head of Hybrid Drives at Siemens, explains the basic approach taken with this technology: "When vehicles are equipped with our traction systems, braking energy is stored and can be reused when the vehicle sets off again. With the typical stop-and-go situation in city traffic, savings of over 30 percent can be made." Operators are able to save a great deal of fuel depending on the vehicle in question and the conditions under which it is deployed. Furthermore, less climate-changing gas is emitted.

With Elfa technology, the electric traction motors in diesel hybrid buses are powered by both an internal combustion engine and an energy storage unit. The generator is used during normal running. It supplies the electric drive with energy via converters. However, when the vehicle sets off, the energy storage unit can supply the electric motors. It charges when the bus brakes as the electric traction motors then act as generators, converting the mechanical braking energy into electrical energy. High performance capacitors, known as "ultracaps", are used for storage. These are able to absorb and release energy very quickly. The advantages of ultracaps compared to batteries are their high power density, high levels of efficiency and long lifetime, which corresponds to that of the vehicle. The dimensions of the traction motors and generators are based on the geometry of the automatic gearbox. Vehicle manufacturers therefore do not need to make significant changes to their chassis when switching over to hybrid technology.

**Benefits of the Elfa system**

The major advantages of Siemens' hybrid system are its flexibility and efficiency: the drive system can be adapted to any type of bus, regardless of any individual characteristics such as regional, climatic or topographical conditions. Over 1,500 systems have already been delivered worldwide. Besides Europe and the USA, China is one of the main markets providing the impulse for this new drive technology. There are signs that the market is increasingly seeking electric-only solutions.

Besides bus operators, passengers and city dwellers also benefit from this drive system. Thanks to the outstanding performance of electric drives, there is no need for an automatic gearbox. Eugen Holl explains the benefits of the technology: "Passengers benefit from enhanced riding comfort as the bus starts smoothly rather than with a jerk. City dwellers also profit from a reduction in emissions as well as from a noticeable reduction in noise levels." The software-based energy management system can be attuned to meet a wide range of requirements placed on vehicle performance and of course to optimize energy consumption.
The serial hybrid solution

Serial hybrid drives are the ideal drive technology for city buses both now and in the future. With a serial hybrid solution, the vehicle's drive axle is always powered by the electric motor. In contrast to parallel hybrid systems, the motor is large enough to store the maximum amount of otherwise unused energy in the energy storage unit during braking, when the motor acts as a generator. In a series design, the traction components are only connected electrically. This mechanical decoupling opens up new opportunities in component layout. This system also leaves room for future developments in drive technology. For example, small diesel generator sets acting as so-called "range extenders" could replace larger aggregates. This makes it very easy to take the next step toward a 100% electric vehicle by simply omitting this unit. The system is extremely flexible and can be adapted to a wide range of user needs. It opens up the opportunity for future developments all the way to an emission-free vehicle.

Innovations for the future

Siemens is also launching another innovation – a new generation of motors featuring a permanently excited synchronous system in serial design. This new family of motors also has a modular structure. It boasts a compact design and significantly enhanced performance. Even when the motor is running at low speed, as is usual in city traffic, the available torque is always high and the efficiency even better than before. There is also no need for a reduction gearbox between the electric traction motor and the drive axle's differential gearbox as the speed of both components is synchronized. These two effects – increased motor efficiency and no losses through a gear stage – result in further significant energy savings. With no gearbox required, the operator also saves maintenance costs.

The Elfa system is based on the requirements of the future - the aim is to have totally emission-free buses. This can be achieved in two ways: either with battery-driven buses where the energy storage unit is recharged at the depot and while the vehicle is running, or with an additional hybrid model driven by a combination of fuel cells and battery. Eugen Holl: "In future, city buses will be electrically driven. The energy will come directly from charging stations or from hydrogen in combination with fuel cells. Thanks to our innovations, we are well on the way to realizing this aim."
Hybrid city bus in London with the Elfa traction system: energy-efficient, quiet and comfortable.

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