

Here's a dump truck that puts others to shame. Next to it, a man looks like a mouse. Its tires measure four meters in diameter. All in all, it's as tall as a three-story building and as wide as a two-lane highway. Such super-sized trucks are hard at work around the world in the copper mines of the Andes, in the diamond mines of Zambia, and in the bituminous sand pits of Canada. In their load compartments, each the size of a swimming pool, they haul raw materials to collecting points, sorting plants, and washing plants.

These trucks may be massive, but they're not mass-produced. After all, they cost up to €2 million each. "It is crucial that these machines be used as efficiently as possible and experience an absolute minimum of down time," says Walter Köllner from Siemens Energy & Automation in Atlanta, Georgia. The trucks' three-phase current drive systems, which Köllner also shares responsibility for marketing, are helping to ensure that this is the case. The motors, which are positioned on the rear wheels, can accelerate the dump trucks to 60 kilometers

Excavators can lift up to 120 tons per scoop. Trucks move up to 400 tons per trip. Catenaries (right) make transport quicker and more economical, while reducing emissions.



For over 30 years now, Siemens has been using three-phase current drives for mining vehicles. "The rotating electric field can be transformed directly into mechanical rotation," says Köllner. Some manufacturers, on the other hand, still prefer DC drive systems. In such motors, however, the current has to be constantly interrupted and re-engaged to generate a rotational movement. This limits the revolutions per minute that a motor of this type can attain. And it requires more parts that need to be maintained regularly. "Our alternating current

leased when a truck rolls downhill is fed back into the network via a second pair of conductors. Thanks to all these benefits, the technology quickly pays for itself, says Köllner. "After no more than three years, a mine operator can recover the costs of buying the trolley trucks and the costs associated with the installation of the overhead lines."

Speed is king not just in terms of transportation but also loading performance. That's why monster excavators are also used in mines, alongside the giant trucks. These excavators

These converters, which are located in outsized steel cabinets, convert current from the diesel generator or cable into three-phase current that can be modulated. The converters feature particularly long-lasting circuit components that have proven their capability in rail technology. "Like mining vehicles, trains experience extreme conditions," says Köllner. They have to be able to run at minus 40 degrees Celsius and in blistering heat. In addition, the converters' air coolers must be extraordinarily dependable, even where air pressure is low.

# Monster Drives

At open pit mines all over the world, mechanical monsters are hard at work. They dig for bituminous sand, for example, or transport tons of copper ore. By equipping the giant excavators and trucks with state-of-the-art, ultra-efficient electrical drive systems, Siemens helps its customers to save energy, time, and money.



per hour as well as brake them. This is no mean feat, since the trucks weigh around 200 tons each — about the same as 130 mid-range cars. Once the trucks are fully loaded, the drives need to move up to 600 tons through sand, mud, and deep holes, as well as over steep hills.

**Electricity, not Diesel.** A 3,000 hp diesel engine generates the current. So why doesn't it just propel the truck too? "The reason is simple. It's just not worth putting the engine and gears of a car onto the slopes of a mine. A gearbox powerful enough to handle the workload required of these trucks would be enormous, and would also need a lot of maintenance," says Köllner, explaining the drawbacks of purely mechanical propulsion.

Not only do the trucks dispense with gearboxes. Thanks to their electric drive systems, they also do without clutches and brake disks in normal operation. Electrical resistors are used to brake the vehicles, and speed can be steplessly adjusted via three-phase current frequency. "Such trucks are essentially driven like a car with an automatic gearbox," says Köllner, who is an engineer and has actually driven one of the behemoths.

motors can deliver up to seven percent more performance from the same amount of energy, and downtimes for maintenance and repair work are rare," says Köllner. "Generally, just one technology check a year is all that's needed."

**Giant Trucks, Zero Emissions.** AC drives also form the basis for a development from Siemens that can significantly speed up the transport of mining products: trolley trucks. Such vehicles function like streetcars — sporting antler-like pantographs that can be raised and lowered at the press of a button. This means that the driver can link the truck to overhead conductors (catenaries), which are generally installed on steep slopes. "This is where conventional trucks, despite their 3,000 plus hp, can only advance at a snail's pace," says Köllner. The catenaries can provide the drive systems with almost 6,000 hp. This means that the truck's speed can almost double, and the mine operators can reduce the number of expensive mechanical giants they need to have on site.

The environment benefits from trolley technology too. There are no local emissions, since the diesel engine switches itself off automatically when contact is made with the overhead line. What's more, the braking energy that is re-

are massive steel systems that resemble the bow of a ship and sit atop caterpillar tracks. Their grab arms look like electricity pylons and their shovels are as big as mobile homes. With just one scoop, they can move around 120 tons. It takes just four shovelfuls to fill the load compartment of a giant truck. "The process barely takes two minutes," says Köllner.

Such excavators are also powered by Siemens three-phase drives. At present, there

**Digital assistants.** Sophisticated control systems are also vital when it comes to keeping maintenance and repair times short. For example, thanks to these systems, the machines' functionality can be monitored from a control center (see *Pictures of the Future*, Spring 2005, p. 51). "Our regional set-up and local partners can also offer rapid assistance if need be," says Christian Dirscherl, who develops full-service solutions for mine operators at Siemens' Indus-

**Thanks to catenaries and three-phase current drives, giant trucks can achieve outputs of up to 6,000 hp.**

are more than 150 such excavators in operation worldwide. "We use four motors with different outputs," says Köllner. "The most powerful, at 2,600 hp, lifts and lowers the excavator arm, while another moves the shovel. A third ensures that the excavator can turn and a fourth drives the caterpillar tracks." Unlike the trucks, the excavators remain in the same place for long periods and don't require a diesel generator.

Be it trucks or excavators, converters are at the heart of all three-phase current drives.

try Sector in Erlangen, Germany. In fact, service is due to be expanded even further. "In the future, we want to equip excavators and trucks with sensors that will enable obstacles to be detected reliably, even in very dusty conditions," says Dirscherl. As is the case with road traffic, new assistance systems will increase safety and make the driver's job easier. One day, the giant trucks may even be able to set off on their hunt for raw materials without drivers. "But that really is still a pipe dream," says Dirscherl. ■ *Andrea Hoferichter*