

# Revolutionary new drive design for Rubber Tired Gantry's

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Reductions in emissions, noise and operating costs are becoming more and more important in the ports and shipping industry. The nature of the business calls for high power demands, so potential savings are high as well. Rising oil prices and environmental concerns have triggered a huge demand for more economically sound and environmentally friendly container handling equipment. Siemens Cranes and APM Terminals have jointly developed a revolutionary Rubber Tired Gantry's (RTG's) drive system. This ECO-RTG® system is very energy-efficient and promises terminal operators large reductions in fuel consumption and hence emissions and operational costs.

Ten years ago, Siemens developed a rugged-design drive for use in hybrid vehicles. This technology has proven itself in the hybrid vehicles market, where Siemens is a leading supplier of such drives. These small inverter units can be installed directly in the vehicles' engine compartment, saving a lot of space. When installed on an RTG, the need for a large electrical room can be dispensed with.

Field tests of these drives during real operations on the ECO-RTG® prototype at APM Terminals Algeciras, Spain, show savings in fuel consumption of more than 50%. In addition to savings in fuel consumption and reductions in noise levels and emissions, the ECO-RTG® also leads to less maintenance and fewer fuel stops.

## Oil Prices and Hybrid Vehicle Technology

This year, the price of crude oil has been rising and rising.

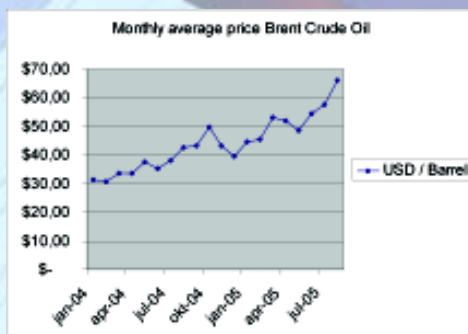


Figure 1: Brent Crude Price 2004-2005.

Experts in the oil industry expect a further surge in oil prices this year, with possible upper limits of over USD 100 per barrel. In the oil futures market, all US oil futures dated up to December 2011 are priced above USD 60 per barrel. This means the market does not expect prices to fall back to levels seen in 2004.

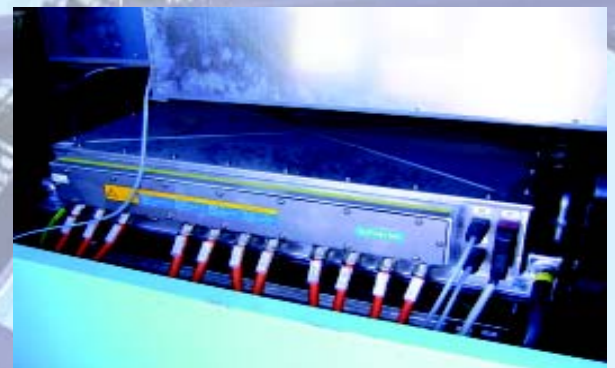


Figure 2: Siemens DUO inverter for hybrid applications. However, the extra equipment makes a hybrid bus up to 50% more expensive than a standard bus. This is the main reason why Return On Investment for a hybrid bus still takes over 10 years. The current hybrid vehicle market is thus mainly driven by environmental concerns, not by economic incentives.

## RTG's and Hybrid Vehicle Technology

In 2003, APM Terminals asked Siemens Cranes to look into this promising technology. The goal of the pilot project was to refurbish an existing RTG (built in 1994)

with a complete new power pack and drive section. As a clearly defined goal, a saving on fuel consumption of 30% was agreed at the start of the project.



Figure 3: ECO-RTG prototype test site Maersk España terminal in Algeciras, Spain.

APM Terminals in Algeciras, Spain, offered to refurbish one of their 40-ton RTGs. Within a year, the first results were available, and a container handling benchmark was organized. In a predefined sequence of 30 moves, a total of 1 hour and 45 minutes of container handling operation time was simulated. The crane moved as in normal operation, handling different sizes of containers. The conventional RTG used 28.1 liters during this period (equivalent to 16.0 liters per hour).

#### 48% fuel savings

The result was astonishing. The ECO-RTG® used only 14.2 liters (equivalent to 8.1 liters per hour) corresponding to an impressive 48% saving in fuel.

The price to the consumer of car fuel has also surged in recent months, increasing the demand for smaller and possibly hybrid vehicles. Over the last few months there has been a spurt in sales of hybrid cars in the U.S. The retail price of a hybrid car model is typically 10 to 15% higher than the original version of a car, due to the installation of additional equipment such as an electric motor, drive and control components. It takes a relatively long time, around 10 years or more, to earn the additional investment back, based on current fuel pricing. However, higher fuel prices will shorten Return On Investment in due course.

In 1996, Siemens reorganized its department responsible for mobile transportation drives. With a new world of hybrid drives and more environmentally friendly modes of transportation in mind, a modular drive concept was developed. Innovations in hybrid drive trains and fuel cell technology were the initial trigger for this new development.

Since 1997, several hundred buses and trucks have been built with these types of drives. The new technology has already clocked up over 8 million operating hours of experience; which is more than the efforts of all other competitors combined.

Figure 4 shows what a typical hybrid bus looks like. The hybrid system is modular and can be connected to all kinds of equipment. For instance, batteries can be included to reuse braking energy. Depending on operating mode, fuel savings of 25-30% are possible.

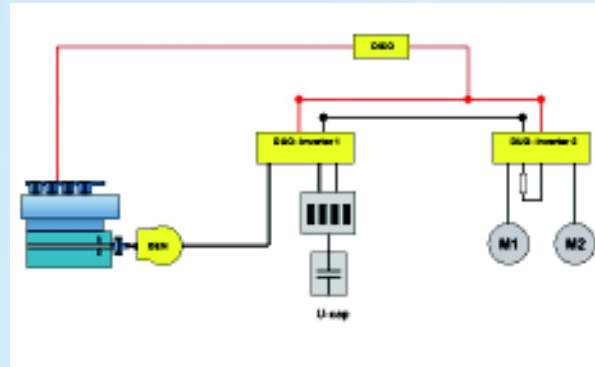


Figure 4: The drive configuration of a hybrid bus. The key to this new technology is the custom-made DICO controller and the DUO inverters. In the controller, many sophisticated energy management strategies are programmed. The controller is the heart and soul of the hybrid system, enabling for instance a full electric drive mode or semi-hybrid drive mode. Depending on, for instance, the location of a city bus, a GPS controller could switch the drive train into full electric mode when the bus is in the vicinity of a hospital. In this case, an energy storage unit such as an Ultra Capacitor bank could provide the power needed by the DUO inverter No. 2 to provide power to the motors. A high-speed, synchronous generator provides power which is rectified by DUO inverter No. 1. This inverter will charge the energy storage as well.

Installing an energy storage device such as the Ultra Capacitor bank holds out the prospect of even higher fuel savings and very short Return On Investments. Intelligent energy management and efficient drive train design are key to the savings.

#### ECO-RTG® configuration

In figure 5 is shown what the ECO-RTG® configuration looks like. The hybrid system is modular in design and can be configured for 40 ton SWL or 50 ton SWL, in which case an additional inverter will be added.

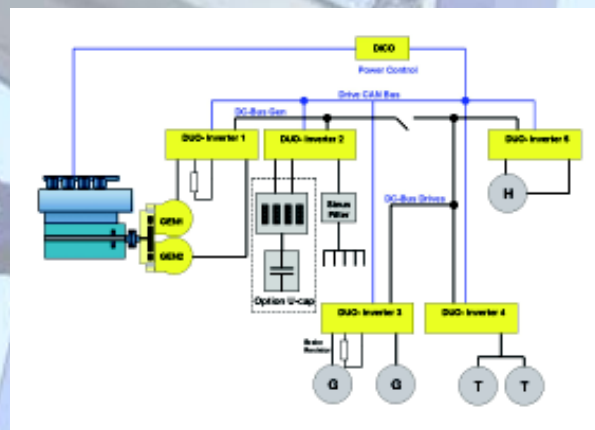


Figure 5: The drive configuration of the ECO-RTG 40 ton version.

The system is designed so that some kind of energy storage can be connected.

There is one DUO unit for powering the DC busbar. The DICO unit is connected through a CAN bus system, which is commonly used in the automotive industry. The hoist inverter is specially designed for the ECO-RTG®. This special design is needed because the power demands in the container crane market are higher than in the hybrid vehicle market.

The converters can be used as rectifier or inverter. One DUO-unit consists of 2 different inverters (output 2x 120 kVA). Also included are 1 or 2 phases for connection of a braking unit (if no energy storage is available). The DICO is pre-programmed especially for the application. The units are extremely rugged in design, and can be mounted

next to the diesel engine in the motor compartment. The units are designed to operate in a warm, dusty marine environment.

Part of the design is that the inverters and generators use coolant. An integral, normal truck cooling circuit provides cooling for the generators and converters. The difference in frame size for the generators is astonishing.

Included are 2 pictures of the generator, one taken before and one taken after refurbishment. The red line indicates a length of 50 cm.

The ECO-RTG® system has multiple benefits for end-users. Besides the huge fuel saving potential, reductions in emissions and noise will revolutionize the RTG container handling business.



Figure 6: Generator before refurbishment.

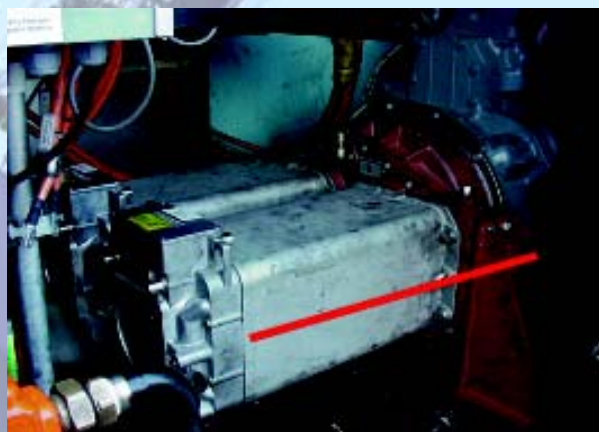


Figure 7: Generators after refurbishment.