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**ELECTRIC PROPULSION  
SYSTEMS FOR LNG CARRIERS**

Converteam is your partner  
to power your business

## Success Story in Electric Propulsion for LNG Carriers

Converteam's expertise and major references in the domain of electric propulsion have been decisive for the deployment of electric propulsion systems on LNG carriers. More and more shipowners now consider that electric propulsion is *the* solution for LNG carriers.



### A world leader in electrical solutions

Converteam is an engineering company providing customized solutions and systems converting electrical energy into productive performance. These solutions are built around 3 core components: rotating machines, variable speed drives, automation and process controls. Our scope covers consulting, design, manufacturing, system integration, installation, commissioning and a broad range of services. Our worldwide workforce remains fully committed to one overriding goal: to bring you the best in technology, backing this up with truly effective service on all markets. Our expertise covers marine, oil & gas and offshore, industry, energy and more.

Over many years, Converteam has supplied a comprehensive range of electric power and propulsion systems based on electric motors and frequency converters, either in inboard or in pod configurations.

A variety of ships, from cruise ships, offshore supply vessels, cable layers, FPSO's, chemical tankers to military vessels are equipped with electric propulsion systems. Recently, shipowners have chosen electric propulsion for LNG carriers.

### Electric Propulsion Boosts LNG Carrier Performance

Traditionally, propulsion of LNG tankers has been based on boil-off boilers and steam turbines. Electric propulsion is considered as the ideal solution to all drawbacks in the current set-up such as poor global efficiency of such systems and the non-availability of skilled personnel in steam turbines.

Converteam provides customized and optimized solutions to meet all special requirements of LNG carriers. These solutions range from electric systems for reliquefaction plants to Dual-Fuel Diesel Electric propulsion systems using boil-off.

### Service-oriented Global Offer

Converteam has forged partnerships with major suppliers and has positioned itself as a single source vendor to the marine industry. Its extensive offer comprises support in every phase namely preliminary design, design, manufacturing, commissioning and a wide range of services: technical assistance, maintenance and lifetime support through a coordinated worldwide service network, training, upgrades and modernization.

### Significant References

In 2004, Converteam supplied the first LNG carrier with electric propulsion: the «Gaz de France energyY» fitted with two 9.55MW - 1200rpm synchronous motors. Recently, Converteam has been awarded by the Korean shipyards a series of significant orders to equip larger LNG carriers with Dual-Fuel Diesel Electric propulsion. Most of these new ships will be propelled by induction motors fed by PWM converters.

- Close partnership with customers from the preliminary design stage
- Customized solutions with sustained focus on performance and cost-effectiveness.
- Dual-Fuel Diesel Electric Propulsion enhance ship performance

# Induction Propulsion Motors and PWM MV7000 Converters

# For Enhanced Performance: High Efficiency and Availability

Converteam's new medium voltage PWM MV7000 converters feature press-pack IGBTs. The new propulsion solution that combines the use of these converters and high torque induction motors significantly enhances ship propulsion performances. Both medium-speed and slow-speed induction motor solutions are available, whatever the configuration is (single skeg or twin skeg design).

## PWM MV7000 Converter and Induction Motor solution: a Major Step

In combination with induction motors, these converters significantly enhance electric propulsion in terms of efficiency, ease of maintenance, low noise & vibration levels and optimization of the total power and propulsion plant design. Both medium and slow-speed induction motor solutions are available.

## High Torque Density Induction Motors

High torque density induction motors feature a simple design with a squirrel cage rotor and a robust technology since several sensitive parts are no longer necessary: no brushes, no rotor windings, no rotor insulation, no field exciter. These motors are fully suited to marine applications, with a large air gap, high efficiency and a low noise and vibration level.

## Press-pack IGBT PWM MV7000 Converters

The press-pack IGBT technology makes the drive easy to control and leads to a very compact design. Thus, the new range of press-pack IGBT PWM MV7000 converters offers a series of advantages, mainly: compactness, robustness, high efficiency and fuseless design. These converters are fully suited

to induction motors without any oversizing due to motor power factor. Furthermore, there is no need for harmonic filters.

## Integrated Vessel Automation

The Converteam integrated automation system is a high-performance digital control system, designed and manufactured according to international standards. It meets the automation requirements of a whole range of vessels and ensures the control of the following installations and functions:

- Power management
- Alarms & monitoring
- Propulsion supervision
- Bilge/ballast system
- Cargo management and handling
- Ship auxiliaries (HVAC, etc.)
- Process Control

## Dynamic Positioning Systems

Converteam's dynamic positioning systems provide manual lever control, combined joystick control, fixed and tracking control and form a major part of the integrated bridge solution.

PWM: Pulse Width Modulation  
IGBT: Insulated Gate Bipolar Transistor

Dual-Fuel Diesel Electric propulsion offers a large range of advantages for naval architects and shipowners as well as for ship operators. With Converteam's new electric propulsion solution with induction motors supplied through MV7000 converters, the gains in terms of availability, efficiency, flexibility and easy maintenance are significantly increased.

## High Global Efficiency

Fixed pitch propellers operate at their maximum limit with variable-speed main propulsion systems. The maximum torque is always available irrespective of the rotational speed. Electric propulsion enhances efficiency, especially at low speeds and when maneuvering. It also allows high acceleration at low speeds.

The new solution based on press-pack IGBT PWM converter offers excellent efficiency, adjustable pattern and frequency system and limited components (without filters, etc.). This significantly enhances LNG carrier propulsion efficiency.

## Enhanced Availability and Simple Maintenance

The rotor simplicity of an induction motor is a key feature in increasing reliability and reducing maintenance time and costs. Adding to its performances, the MV7000 drive has been designed for easy maintenance especially of the most important components such as press-pack IGBTs. Reduction of maintenance is achieved by easily replaceable modules designed using the Plug & Play technology.

## Extra Cargo due to Compact Equipment

The compactness and layout flexibility of Converteam's electric propulsion equipment increase the LNG carrier capacity up to at least 3% (by comparison with steam LNG carriers).

## Optimized Commissioning and Installation Costs

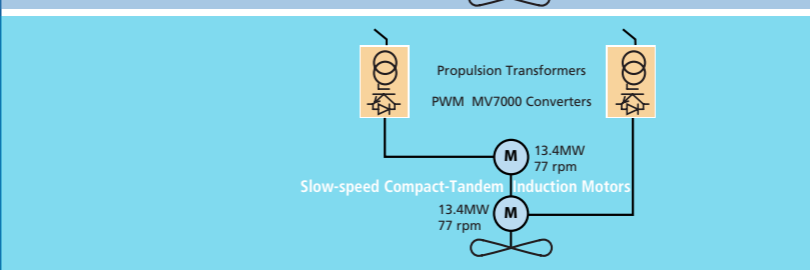
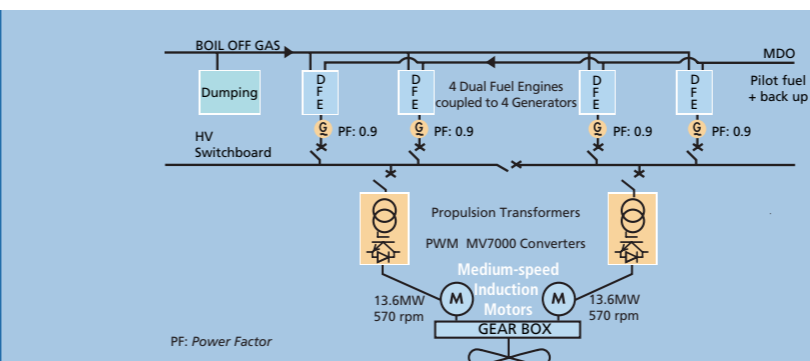
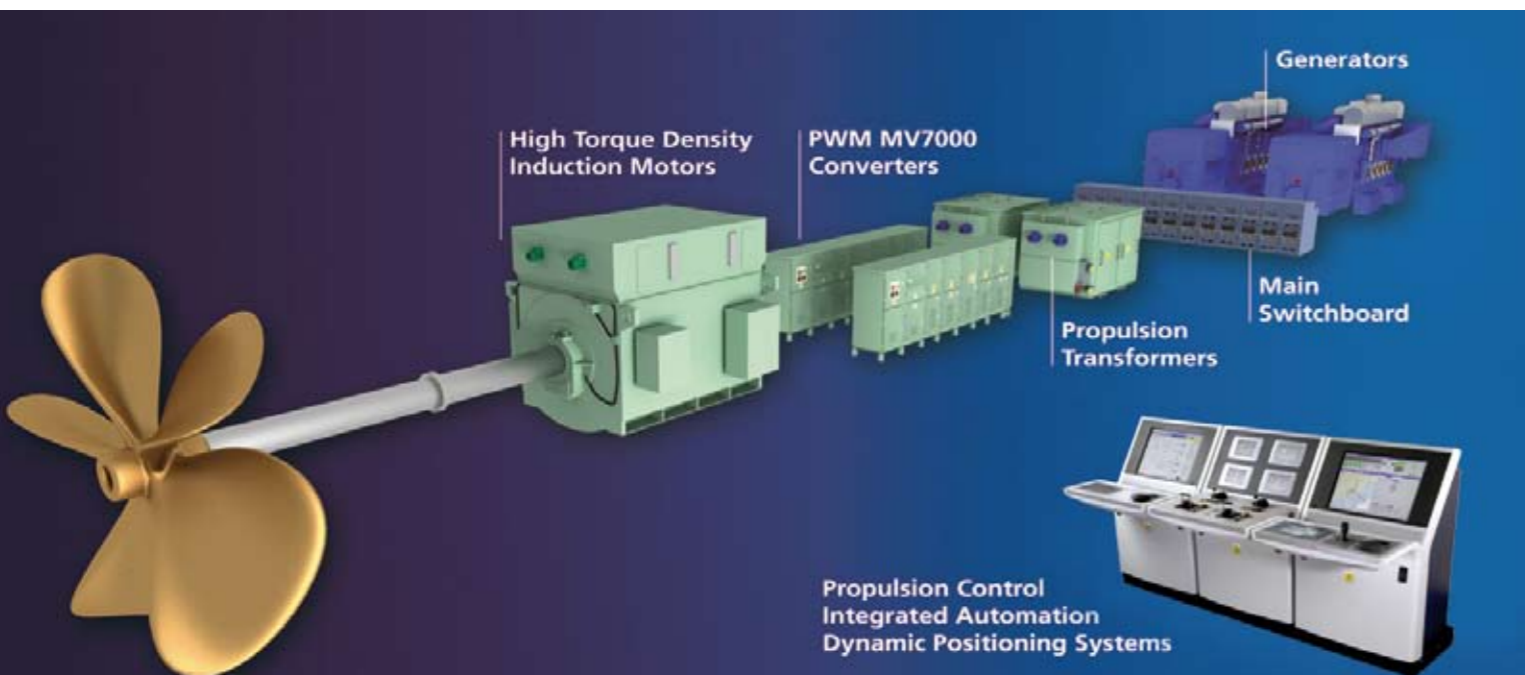
Converteam's integrated Motor Control Centers (MCC) reduce maintenance time and costs. The I/O racks that control the auxiliary motors are inserted in the MCC. Therefore, external wiring and on-site commissioning are not required since I/O racks can be fully tested at the factory.

## Filterless Solution

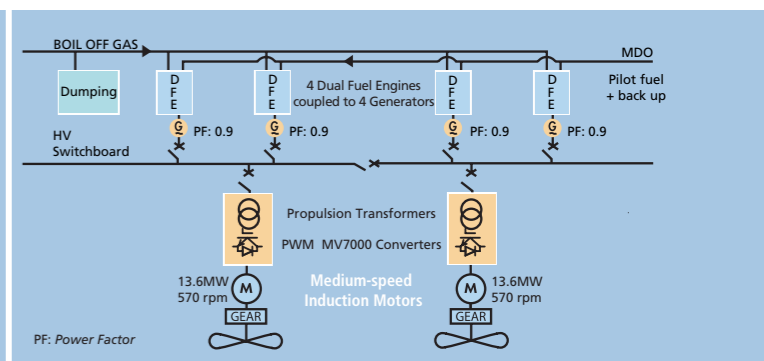
Converteam's PWM MV7000 converter has been specifically designed to eliminate the most powerful harmonic currents. Thanks to this solution, harmonic filters are no longer required, thus improving compactness and increasing efficiency of the propulsion chain.

- Other main benefits**
- Layout flexibility
  - Low operating costs
  - Environmentally friendliness (low emissions)

- High performance propulsion controllers**
- Encoderless vector control
  - Adjustable PWM control strategy



Dual-Fuel Diesel Electric propulsion diagram - Single skeg design



Dual-Fuel Diesel Electric propulsion diagram - Twin skeg design

## Variable-speed Drive Solution to enhance Compressor Performance

When using a dual-stroke diesel engine propulsion system, the boil-off has to be reliquified and sent back to the LNG tank.

The reliquefaction plants use increasingly powerful compressors which are considered as heavy consumers, and may disturb the power plant during starting, loading and unloading operations. To avoid such problems, Converteam offers a variable-speed drive solution to supply the compressors' motors.

The variable-speed drive solution comprises a transformer and the PWM MV7000 converter, feeding a medium-speed induction motor. This helps the compressor to operate in a smooth mode (soft starting, soft loading and unloading), and ensures the safe functioning of the power plant. These converters prevent any disturbances (undervoltage, blackout and underfrequency) from occurring when the compressors are direct on line.

## Electric Drives for Reliquefaction Plants

For four LNG carriers for Qatar Gas II, seven LNG carriers for Ras Gas III and three for Qatar Gas III, propelled by dual stroke diesel engines, Converteam has supplied electric drives for N<sub>2</sub> compressors that are used in the reliquefaction plants, with 2 PWM MV7000 converters per ship.



## Inovelis™, a New Generation of Podded Propulsion

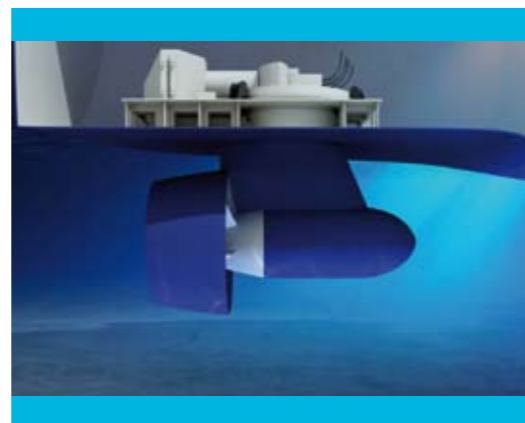
Converteam has implemented the podded electric propulsion solution - an outboard propulsion system placed under ship hull - on a large number of passenger, naval and offshore vessels. The podded system combines propulsion and steering functions. Its main advantages are high efficiency, comfort and space savings since a number of mechanical parts are no longer necessary.

Inovelis™, the new generation of pod solution, represents a real technological breakthrough. It combines a very compact pump jet hydrodynamic concept with high performance technologies such as induction motors and PWM MV7000 converters. Inovelis™ will bring significant advantages for LNG carriers:

- Increased cargo capacity thanks to the compactness of the pump jet system which allows reduction of ballast
- Reduced operation costs thanks to the high propulsive efficiency
- Higher availability thanks to the sea proven technologies used inside the podded propulsor

Inovelis™ will represent a way forward to increase ship functions and profitability of your new generation LNG carriers.

Inovelis™ is jointly developed with DCNS.



Converteam aims at providing its customers with optimum support and then makes available a complete set of service packages, ranging from basic services – spare parts, training, repairs – to maintenance and expert evaluation service agreements. Our service team can intervene anywhere in the world in a very short time.

## Technical Assistance

Converteam's technical support is available through a 24hours/7days call center, to assist ship operators in trouble-shooting.

Converteam also supplies telediagnosics facilities that allow an efficient data transfer from the vessel to Converteam's main office for remote trouble-shooting by our skilled engineers.

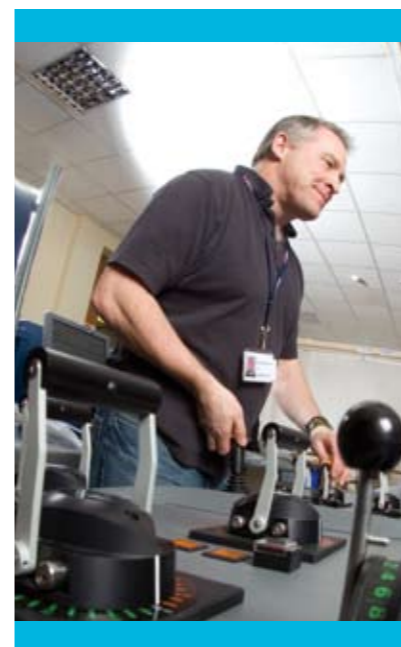


## High Quality Training to Enhance Crew Skills

At Converteam, training is given prime importance. The teaching staff comprises experts in electric propulsion systems, power electronics and control systems to give ship operators relevant and sound knowledge. Training sessions are either conducted on-board or in our Marine training center.

## Maintenance

Maintenance services feature access to Converteam's call center for on-call inspection and technical assistance, regular inspection and routine maintenance, maintenance of equipment during dry and wet dockings, spare parts management and training sessions on-board or in Converteam training center.



## Expert Evaluation

Converteam also offers expert evaluation services including technical assistance, system and product technical assessment, Equipment and System Health Monitoring (EHSM), trouble-shooting and technical recommendations.

- Expertise center for maintenance and trouble-shooting
- Telediagnosics facilities
- Worldwide support 24/24h - 7/7days

## Upgrades and Modernization

To help shipowners cope with the quick and continuous evolution in terms of performance, safety regulations and more stringent environmental requirements, Converteam offers a wide range of possible upgrades of its electric propulsion systems. Each solution will be designed with the latest technologies in power and control electronics and suited to meet customers' specific requirements.

