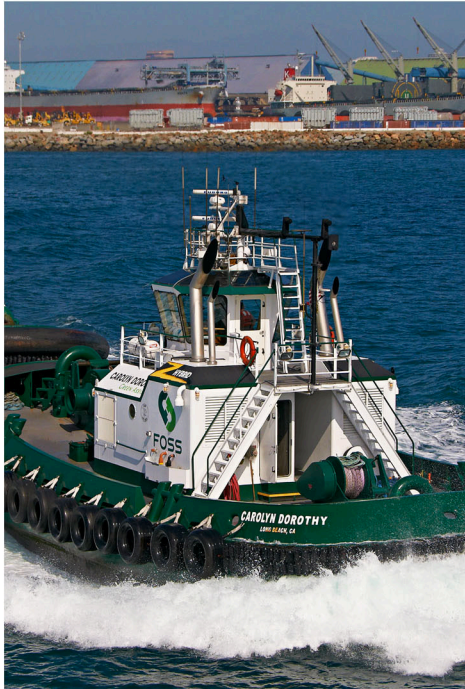


# MARINE HYBRID PROJECTS



## Milestones



### World's First Hybrid Tugboat

#### **CAROLYN DOROTHY:**

**Contract with Foss Maritime**

**Delivered in first quarter 2009**

Foss Maritime's Carolyn Dorothy is the world's First Hybrid tugboat. The project introduced a new hybrid concept - a combination of diesel engines, electric motors, generators, electrical storage, and modern power conversion techniques. It is controlled by Aspin Kemp & Associates' (AKA) energy management technology to optimize the tug's power plant efficiency. The California Air Resources Board (CARB) reports the hybrid system demonstrated a reduction by 73%, nitrous oxide by 51% and carbon dioxide (proxy for fuel) by 27%.



### Europe's First Hybrid Tugboat

#### **RT ADRIAAN:**

**Contract with Kotug**

**Delivered in first quarter 2012**

In early 2012, Europe's first hybrid tugboat was introduced in the Netherlands. Kotug's Rotor Tug Adriaan underwent a hybrid retrofit and now operates in the Port of Rotterdam. The Rotortug concept is a unique tug design with two thrusters forward and one aft. This allows for enhanced operational capabilities and is a revolutionary concept in the workboat market. The hybrid system onboard the RT Adriaan has a mode for single engine operation which provides even greater fuel and emissions savings.



### World's First Intrinsically Safe Egress Mode

#### **BM DRYDEN:**

**Contract with Bhagwan Marine**

**Delivered in 2014**

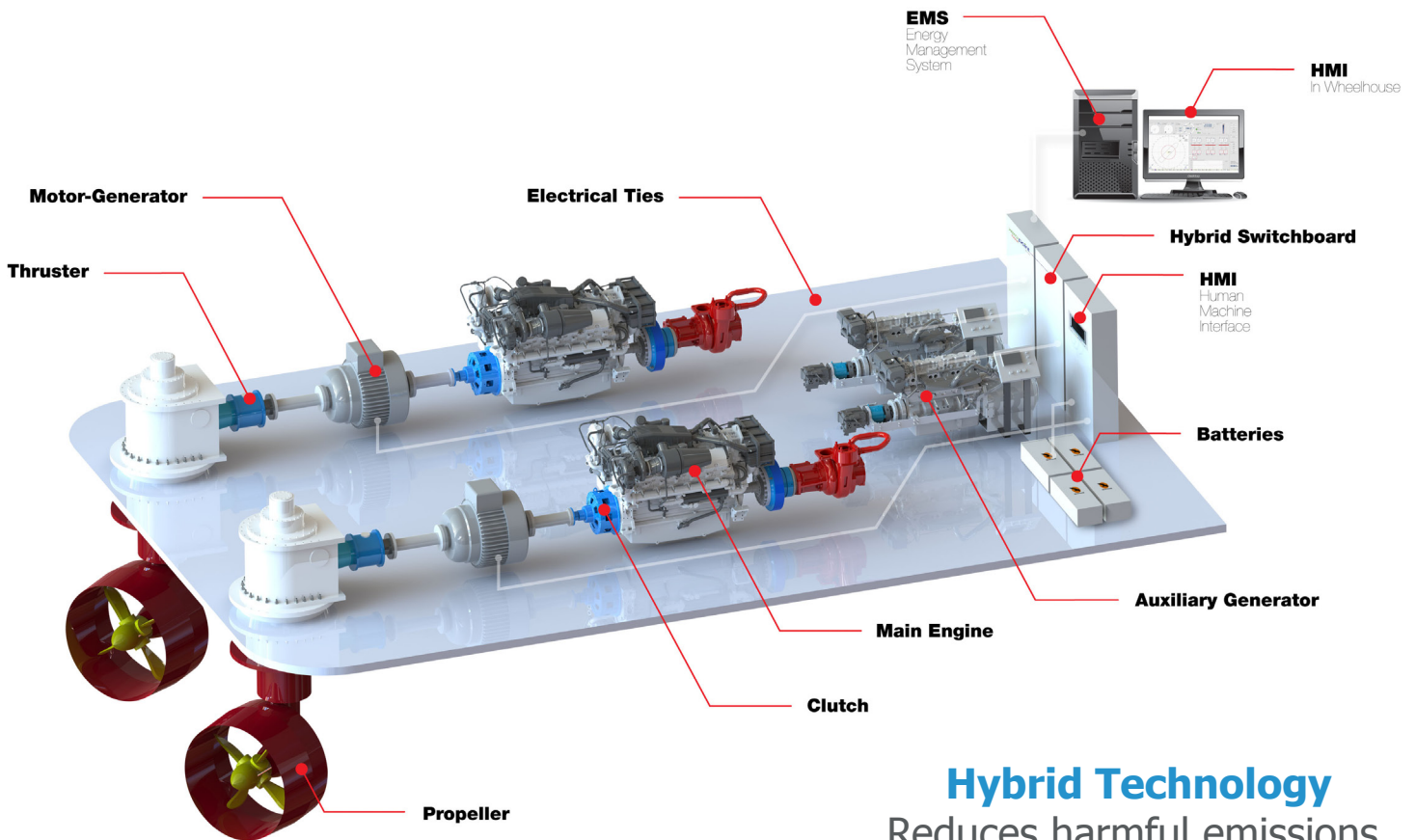
The Bhagwan Marine Dryden is a Dive Support Vessel which operates off the coast of Australia. It is unique in its ability to operate safely in hazardous environments including where gases are present, due to its ability to operate in all-electric mode for safe egress. It is the world's first hybrid diesel/electric vessel to hold both NOPSEMA and DMP accepted Safety Cases and is reporting approximately 65% fuel saving over traditional DSVs.



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[www.aka-group.com](http://www.aka-group.com) • [sales@aka-group.com](mailto:sales@aka-group.com)

# Marine Hybrid Propulsion



Sample Hybrid Configuration

**Hybrid Technology**  
Reduces harmful emissions,  
lowers maintenance costs,  
and improves fuel economy.

## Hybrid Modes of Operation:

The AKA Hybrid System allows the vessel to operate in four different modes:

### 1 STRICTLY-ELECTRIC

In Strictly-Electric, batteries permit the vessel to be operated without the use of diesel engines or generators. Strictly-Electric allows operators to operate their vessel with zero emissions and complete noise reduction. Batteries are available in lead acid or lithium polymer chemistry.

### 2 DIESEL-ELECTRIC

In Diesel-Electric, power and propulsion is provided from the auxiliary generator via the motor generator without the need for diesel engines.

### 3 ELECTRICAL-MECHANICAL

In Electrical-Mechanical, both the main engine and the motor generator provide propulsive power to the shaft line.

### 4 CONVENTIONAL

In Conventional, the vessel operates as a traditional vessel with the diesel engines providing propulsive power and the shaft generator supporting hotel loads using modern conversion technology to provide constant voltage regardless of shaft speed.



**HEADQUARTERS**  
PO Box 577  
23 Brook Street  
Montague, PE  
Canada C0A 1R0

**LOCATIONS**  
North America - Canada  
EU - Germany, Norway  
Asia - Singapore, China

**SALES INFO**  
+1.902.620.4882  
sales@aka-group.com  
[www.aka-group.com](http://www.aka-group.com)

