

# BlueDrive PlusC

Makes vessels safer, more profitable and environmentally friendly



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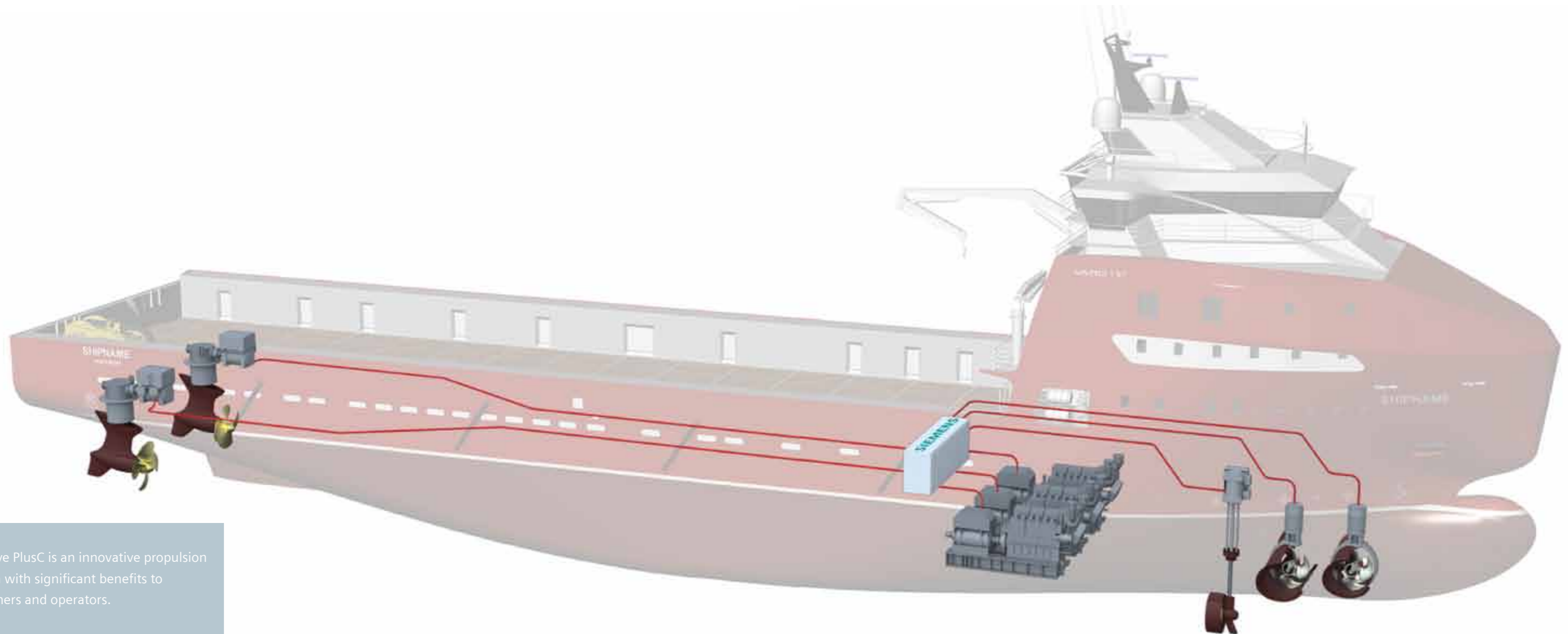
# A system of benefits

BlueDrive PlusC is Siemens' innovative solution for ship propulsion. This holistic approach to diesel-electric vessels increases safety, cuts operational costs, improves lifecycle economics and decreases the environmental footprint. No other vessel propulsion system can match BlueDrive PlusC.

## To summarize, BlueDrive PlusC delivers the following benefits:

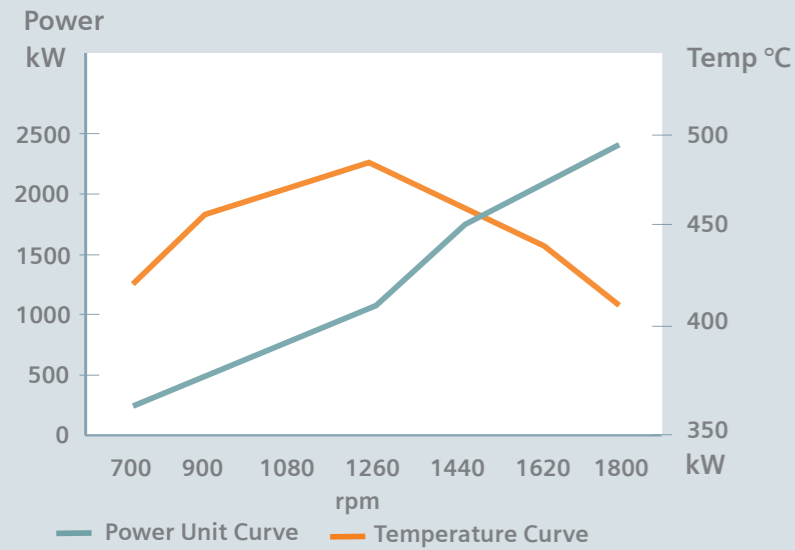
- Lowers operational costs – includes gaining record levels of energy from each fuel unit
- Provides significant lifetime maintenance and repair cost savings by cutting engine time at rated speed and reducing the number of electrical components required
- Reduces greenhouse gas emissions by optimizing combustion. Provides better control and improves safety through its energy management and thruster control systems
- Delivers flexibility as each generator, diesel engine, propeller and thruster is independently controlled
- Cuts space required for main switchboard and frequency converters
- Reduces installation costs due to streamlined system configuration
- Improves working environment by minimizing noise and vibration
- Is suitable for both high-speed and medium-speed engines
- Option to use battery power to reduce engine running time and provide further savings in fuel and greenhouse gas emissions
- Increases vessel resale value

Over the next pages, we'll take a detailed look at how this next-generation propulsion system achieves these significant benefits for your fleet.

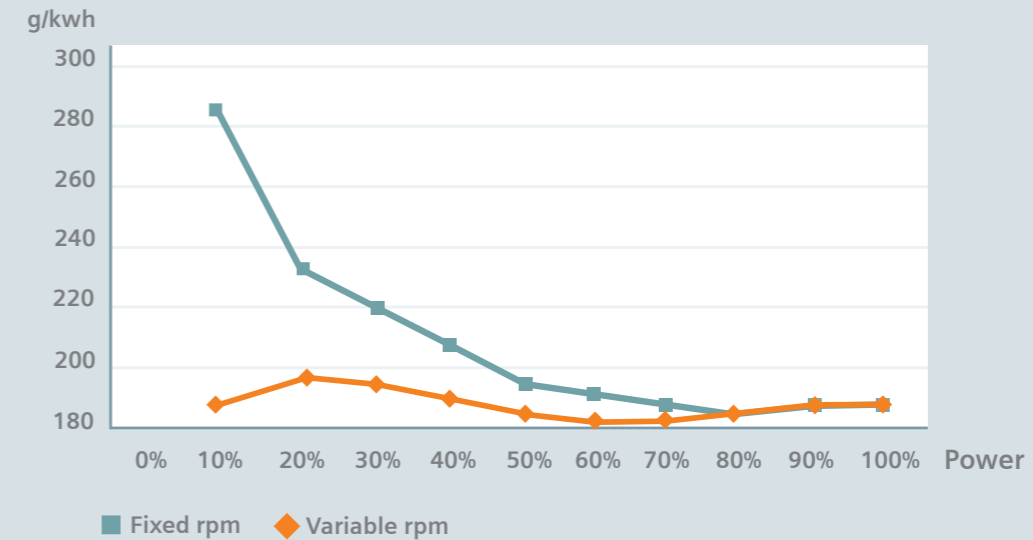


BlueDrive PlusC is an innovative propulsion solution with significant benefits to shipowners and operators.

Exhaust temperature for a variable high-speed diesel engine as a function of speed and load.



An essential part of the BlueDrive PlusC propulsion system is its variable-speed generator sets (gensets). The generators are purpose-built, brushless and synchronous, and deliver a wide range of frequencies and voltage for diesel, dual-fuel or gas-operated vessels. At all times, BlueDrive PlusC controls the engines to achieve optimal speed set points based on torque capability and most-efficient fuel consumption. To avoid overload, engine capability is constantly monitored. The result is a very flexible system that runs optimally through all operations.



Fuel consumption is dramatically reduced at low loads for variable-speed gensets compared to fixed-speed gensets.

# Playing the variables

## Reduced fuel consumption

Variable-speed gensets dramatically reduce fuel consumption at low loads compared to fixed-speed alternatives.

## Reduced wear and tear

Optimized operation places less strain on engines, which pays dividends in reduced maintenance and longer engine life.

## Simply time saving

As generators do not need synchronizing with BlueDrive PlusC, the start-up process is simplified and standby-start time is reduced. Opportunities for individual fuel and operational optimization are endless as parallel gensets can be operated independently of each other. The system's spinning reserve generating capacity can also be used through a network connection, even when engines are idling.

## Fast response gives improved vessel operation

Intensive testing shows that both medium- and high-speed engines provide impressive dynamic response times with BlueDrive PlusC. Even under variable speed control, highly demanding dynamic positioning is supported. Together with gas engines for instance, BlueDrive PlusC provides even greater advantages since the system is not synchronized and operates

seamlessly, even if individual engines differ in response times.

## Less noise and vibration

By reducing speed at any load below rated power, noise and vibration are cut significantly. This includes engine-room and structural-borne noise that carry into accommodation and other vessel areas. Vessels operating at low load experience the greatest improvements in working environment.

## Environmentally friendly

When engine speed reduces with decreasing load, exhaust temperatures remain high. This means that selective catalyst reduction (SCR) is kept operational, even at low loads, and substantial reductions in NOx emissions are achieved compared to constant-speed gensets.

Furthermore, as BlueDrive PlusC provides more energy from each fuel unit than any other propulsion system, other greenhouse gas emissions are reduced accordingly.

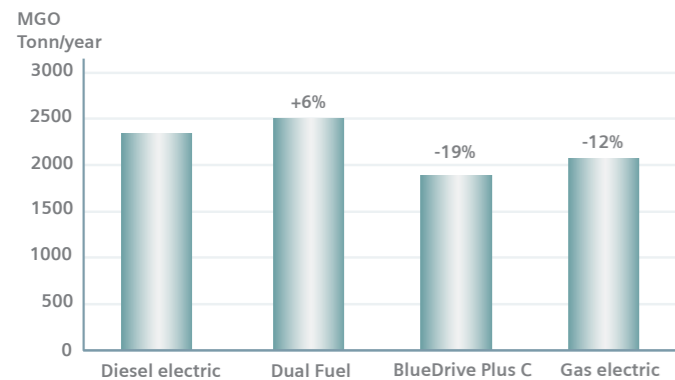
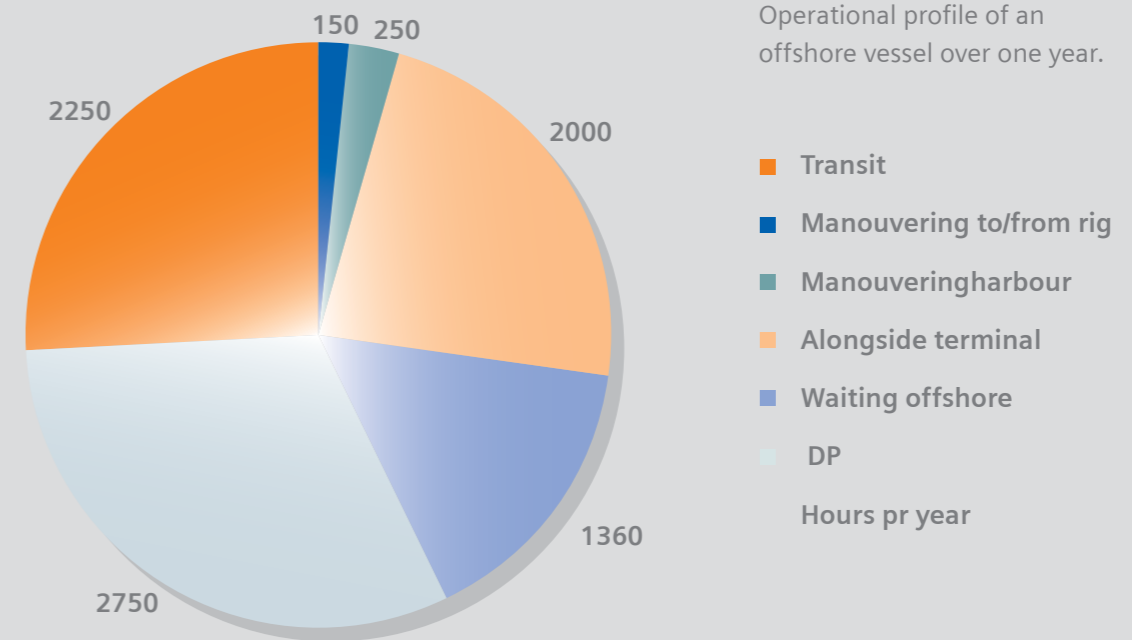
Add the smaller environmental footprint from longer equipment life and reduced maintenance and the total environmental benefits are substantial compared to alternatives.



Variable-speed operated genset

# Green credentials

BlueDrive PlusC reduces fuel consumption and greenhouse gas emissions, but by how much and how do these savings vary by engine type? Here are the findings from detailed analysis into vessel operation. The results are based on a typical offshore vessel run with fixed-speed diesel, dual-fuel and gas engines, and BlueDrive Plus C variable-speed diesel engines. Differences in fuel savings and greenhouse gas emissions are significant.



### Fuel consumption

A consumption comparison of Marine Gas Oil (MGO) equivalents for three electric-propulsion systems with fixed-speed engines and one with variable-speed diesel engines show that a propulsion system with BlueDrive PlusC delivers the most savings.

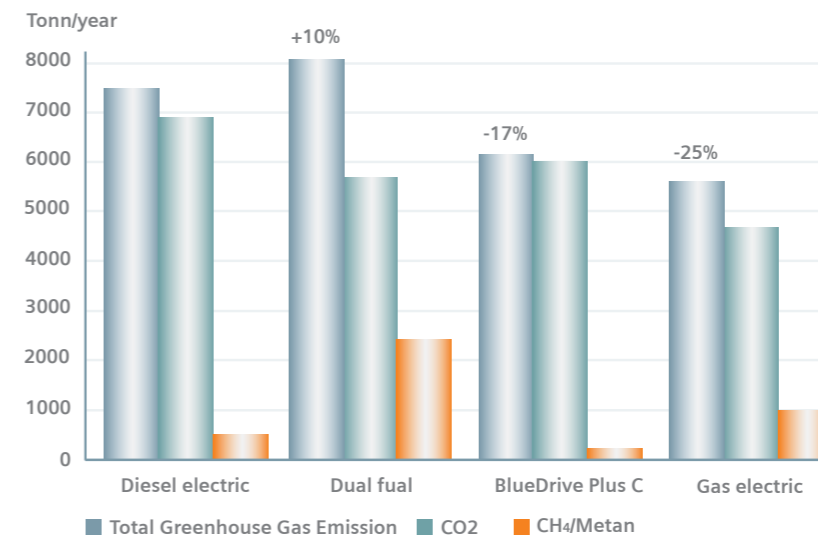
### NOx emissions

A NOx emission comparison of the same four propulsion systems as noted above shows that diesel-electric engines run with BlueDrive PlusC reduces NOx emissions by 83% in comparison to fixed-speed diesel engines and by 53% compared to gas-electric solutions. This can save the atmosphere from up to 24 tonnes of NOx a year.

### Other greenhouse gas emissions

The bar chart shows greenhouse gas emissions for the same electric-propulsion systems detailed previously – fixed-speed diesel, dual-fuel, gas and BlueDrive Plus C variable-speed diesel. When considering emissions, it's important to remember that dual-fuel and gas engines produce methane slip, i.e. incomplete combustion of methane (CH4) in the cylinders, which releases methane through the exhaust system. This increases greenhouse gas emissions significantly as methane's greenhouse effect is over 20 times more powerful than carbon dioxide's. Consequently, even a small release of methane easily counters other gains.

Perhaps the most significant comparison is between dual-fuel offshore vessels with the same operating profile, which are given CO2-fee exemption due to their environmental profile. Calculations show 25% lower greenhouse-gas emissions for variable-speed diesel engines alternative.



Comparison of greenhouse gas emissions by engine type.

Bar chart 1: Comparison of fuel consumption by engine type.  
Bar chart 2: Comparison of NOx emissions by engine type.

# Full Control

The energy management system ensures that gensets are working at speeds and loads that safely deliver lowest fuel consumption and emissions of greenhouse gases. It operates engines, propellers and thrusters at different speeds to reach optimal vessel operation. No other propulsion system provides lower fuel consumption in all operational modes.

## How it works

The energy management system (EMS) is preprogrammed with curves giving engine fuel consumption under different load conditions. The EMS interfaces with sub-controllers for gensets, thrusters and remote controls to monitor and set optimal engine speed. Together with Siemens' renowned genset-protection systems – Power Plant Protection (P3) and Generator Power Adaption (GPA) – an integrated propulsion control system is created for the entire process.

## Reliable and redundant

Individual sub-controllers for each genset, thruster and half-switchboard give flexible operation. Only market-leading Siemens' SIMATIC controllers are used to ensure full reliability.

## Clear for battery power

Batteries can be used as short-term spinning reserve during start up or as a continuous power source to replace supply from gensets.

## Seamless operation

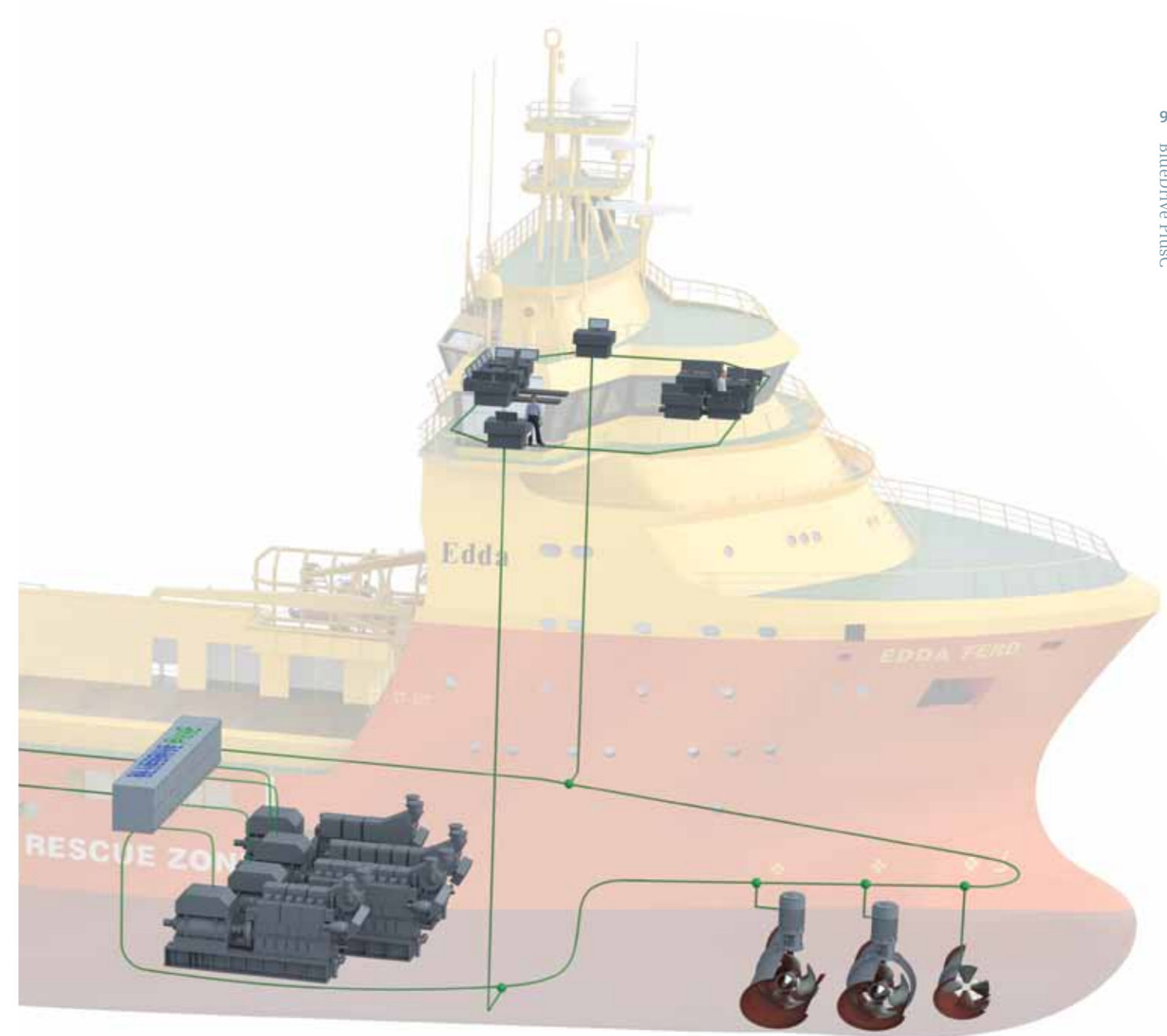
Genset, switchboard, propulsion and thruster control systems are fully integrated to ensure seamless ship operation.

## A controlling interest

BlueDrive PlusC also manages the following operations:

- Gensets monitor and control engine speed and generator voltage

- Propulsion control handles, for example, DP/maneuvering based on speed management and transfer operations through power control of propulsion units. It prevents windmilling and reduces out-of-water propeller spinning
- An intelligent load controller linked to the bus-tie breaker monitors power demand and determines the number of gensets in operation at any given time
- The thruster control system contains separate levers for thruster speed and rotation settings. It also contains alarm and monitoring capability, mode selectors and interfaces to various sub-systems in the vessel



Version 3

Integrated engine and thruster control

Redundant Profinet/Profibus

# Battery powered

BlueDrive PlusC is designed for easy connection to alternative energy sources and storage modules. These can be fuel cells, super capacitors, batteries or other means of energy production and storage. Energy storage modules, such as batteries, will significantly reduce vessels' energy use and emissions in the years to come.



## Battery utilization

Modern lithium batteries can safely handle substantial charge and discharge power. In addition, weight, volume and price have all been greatly reduced in recent years, which suits ship operation. Stored energy can be produced onboard or transferred from land. This stored energy can be used in a variety of ways to improve vessel performance and reduce fuel consumption.

## Hybrids = fuel savings

In combination with a combustion engine, energy storage modules can either store excess energy or provide it when needed. This improves fuel consumption still further and increases redundancy. Batteries support and improve operation of any primary energy source, such as gas, dual-fuel or diesel engines. Battery energy is immediately available and improves dynamic operation of engines with low response capability in critical situations, as well as reducing rapid speed changes during normal operation. Reduced engine running time is also a benefit of hybrid systems.

## Only batteries included

It is fully possible to operate vessels using battery power only. In fact, the world's first fully battery-operated ferry becomes a reality in 2015. The Norwegian ferry will use BlueDrive PlusC with onboard batteries charged from onshore land-based charging stations at either side of its crossing. Importantly, as the shore-based power is from the local hydroelectric-powered electricity grid, it will be the world's first emission-free electric-powered ferry.

## Hybrid operation enhances DP capability

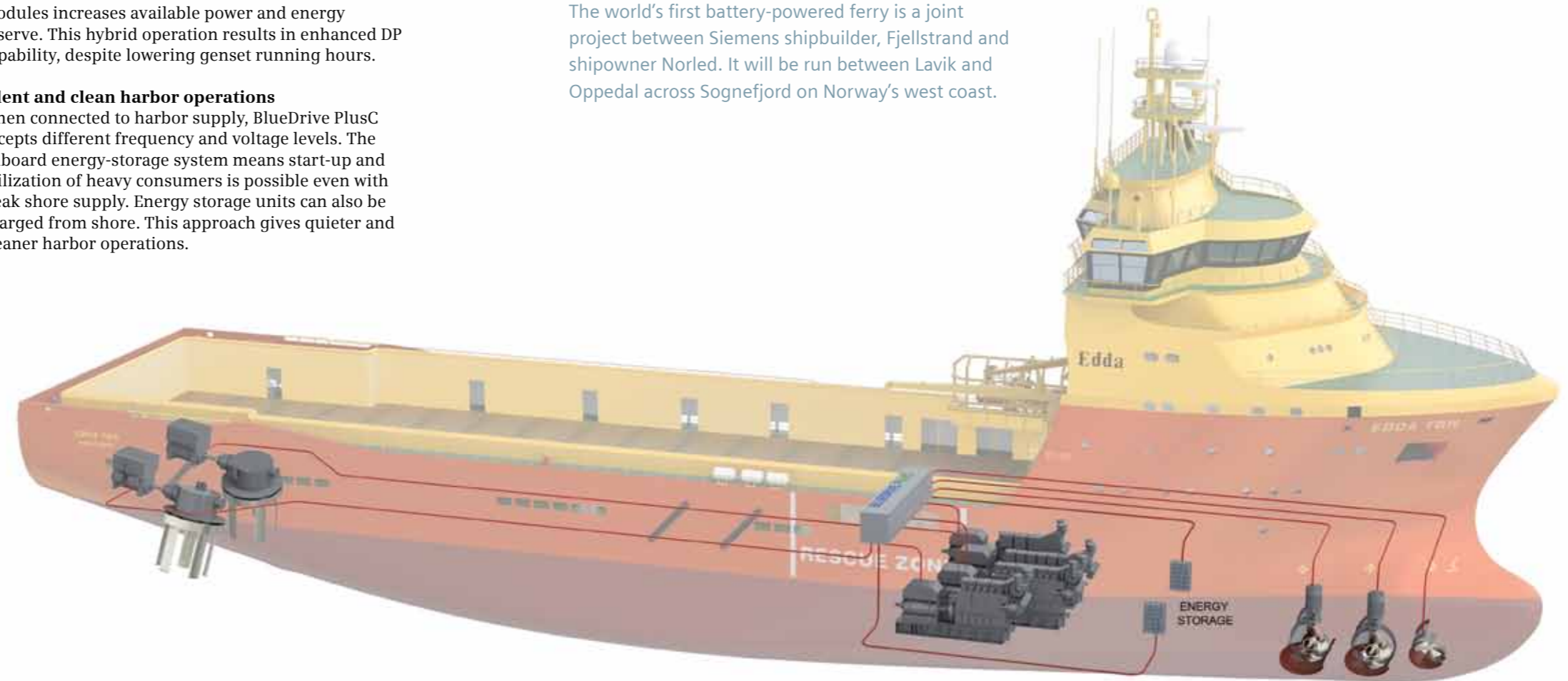
For offshore vessels, DP capability and high ERNs conflict with fuel economy and reduced genset-running hours. Introduction of energy storage

modules increases available power and energy reserve. This hybrid operation results in enhanced DP capability, despite lowering genset running hours.

## Silent and clean harbor operations

When connected to harbor supply, BlueDrive PlusC accepts different frequency and voltage levels. The onboard energy-storage system means start-up and utilization of heavy consumers is possible even with weak shore supply. Energy storage units can also be charged from shore. This approach gives quieter and cleaner harbor operations.

The world's first battery-powered ferry is a joint project between Siemens shipbuilder, Fjellstrand and shipowner Norled. It will be run between Lavik and Oppedal across Sognefjord on Norway's west coast.



New possibilities with integrated energy storage system

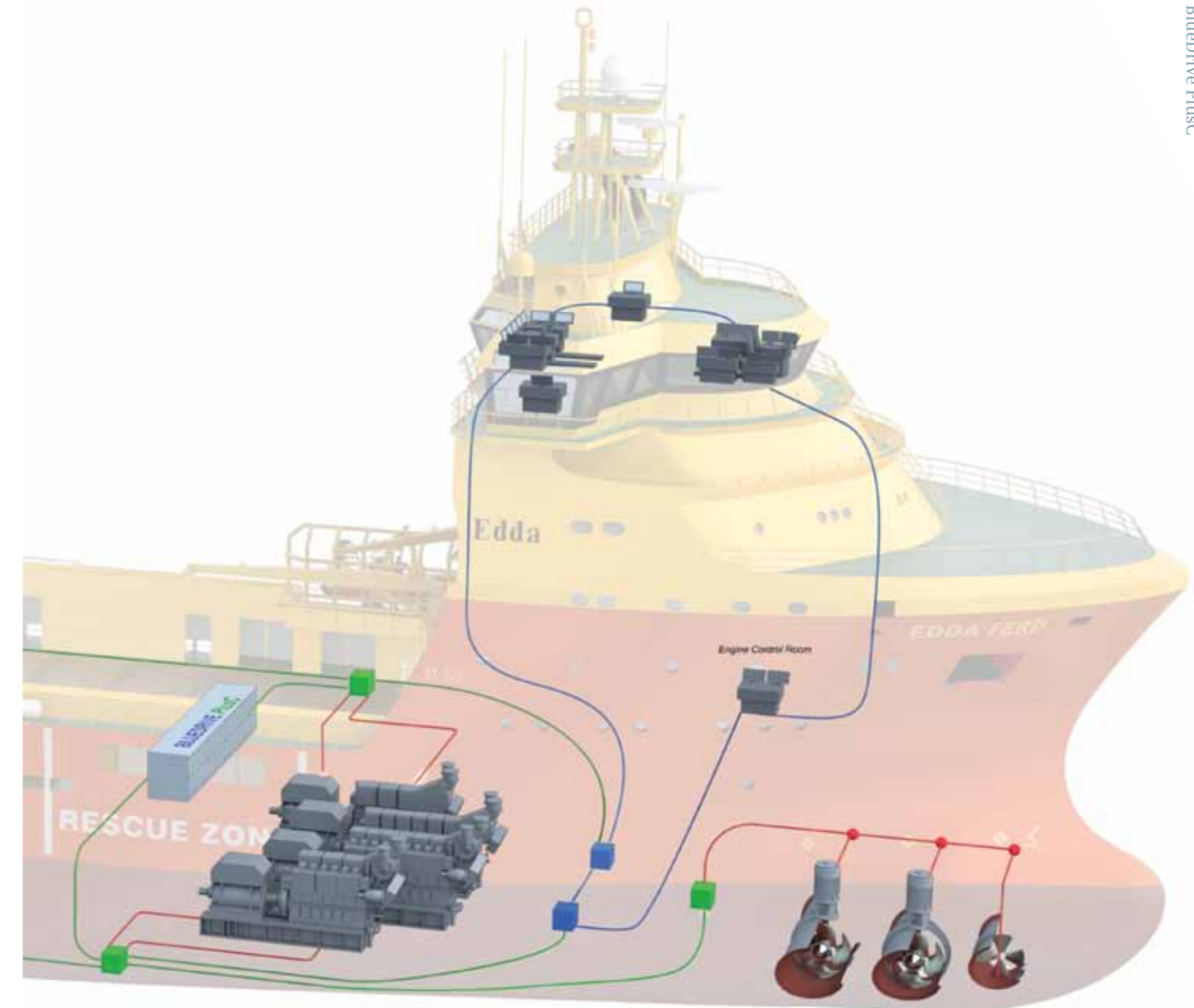
# Integrated automation and control

Siemens is the world's single-source leader of automation technology products. Its best-in-class SIMATIC automation system defines totally integrated automation (TIA). It includes a range of industrial automation products designed for a wide variety of tasks. Flexible and cost-effective, SIMATIC is ideally suited for managing the ever-growing demands of today's fast-changing world. Naturally, extensive training, service and support are an important part of Siemens' total solution. Siemens' commitment to superior engineering and technology makes SIMATIC automation systems synonymous with excellence. For more than 50 years, Siemens has consistently advanced technological progress in automation. Its systems cover all industry requirements and sets standards in their respective fields.

## Keep fully informed

BlueDrive PlusC, together with integrated automation and control based on SIMATIC, enable crews to operate and monitor all onboard systems, such as main engines, propulsion, auxiliary equipment, process actuators and sensors. This combination makes it possible to carefully control and fine-tune all ship processes, so that the vessel operates safely and reliably using less fuel and emitting lower levels of greenhouse gases. Here's an overview of additional applications run by the integrated automation and control system:

- Integrated safety systems
- Redundancy concepts
- Intelligent alarm management
- Cargo control
- Remote diagnostic system
- Dead man alarms
- Fire and gas detectionAutomatic event log with synchronizing capability
- Built-in exclusive control
- HVAC remote control
- Decentralized architecture with redundant communication using Profinet and Profibus to process input, output, power station, energy storage, propulsion, steering, thruster control, pumps, fans, actuators, sensors and motor control



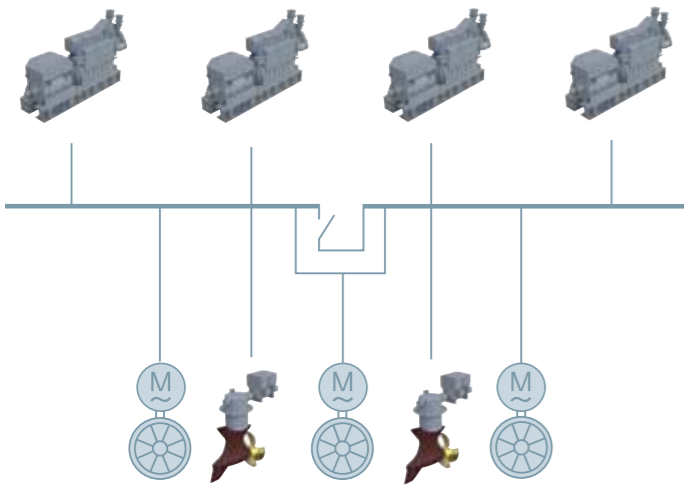
Version 2

Seamless integration of all systems onboard

- Fiberoptic Ethernet Ring
- Redundant Profinet/Profibus

# Power play

BlueDrive PlusC is based on fully integrated power distribution, with the main switchboard and all drives collected into one compact unit. The main switchboard has in/out AC voltage and supplies clean power to other switchboards. Engine speed is controlled to optimize fuel consumption and reduce load-deviation issues. BlueDrive PlusC also has the advantage of integrated speed-control drives.



**Save space**

The single compact unit provides space savings of around 30% compared to equivalent 12-pulse systems.

**20,000 times faster**

Closed bus-ties give better operational availability and reduced running hours for the main engines. With BlueDrive PlusC, an intelligent load controller splits the switchboard 20,000 times faster than a regular bus-tie breaker if a short circuit occurs. Here, the breaker's performance makes it possible to operate with closed bus-ties.

**Flexible shore connection**

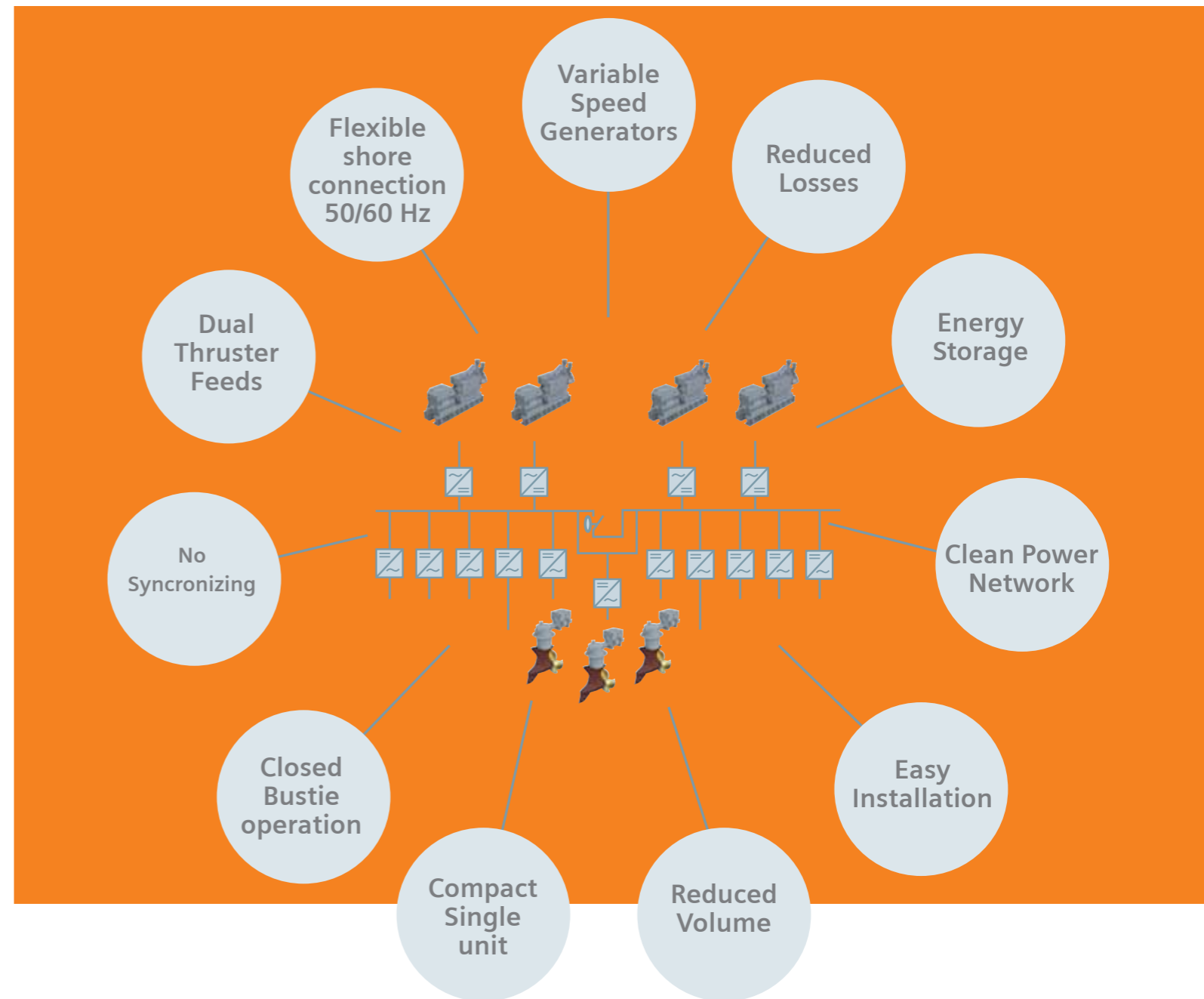
BlueDrive PlusC connects the ship to shore with a flexible frequency of 50/60 Hz. It automatically adapts frequency in relation to supply and tackles differing voltage of 400 to 440 V. Batteries can also be charged from land if these are installed.

**Redundant feed thruster**

Redundancy is improved through thruster feeds from two switchboards that have their own supply to all relevant auxiliary systems. This is particularly important for dynamic positioning (DP) vessels to improve environmental regularity number (ERN) capability. Reduced installation costs as the drives and main switchboard are in one compact unit, Siemens can run comprehensive integration tests before delivery to the yard. The combination of less equipment installed and early testing reduces build time and costs.

True redundant thruster feeds.

A new world of advantages





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# Install Siemens' quality throughout your vessel

**Siemens' broad portfolio of quality products for assimilation into the integrated automation and control system reduces installation and operational costs.**

- CCTV systems
- Fire and security systems
- LED and emergency lighting
- HVAC system
- Process instrumentation
- Sensors
- Actuators
- Valves
- Motor management and control devices
- Gearboxes
- Gas- and steam turbines
- Ballast water treatment
- Digital product management
- Engineering process management
- Manufacturing process management
- Drives and control for aux. equipment