

GE Power



Products & Solutions for the Marine Industry

GE's Power Conversion Business

gepowerconversion.com



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Challenge & GE Value

GE's Marine Ecosystem is a new approach to the challenges the industry is facing as it heads into a new era. We bring together electrification and digital technology with our systems know-how to be a life cycle partner for optimized, high-performing vessels.



Productivity and Operational Efficiency

Challenge



Complexity

Projects, operating conditions and rate of technology change.



Volatility

Economic, political and security turbulence.



Environment

Regulation and safety.

› *Complexity drives up cost and risk on projects; harsh operating conditions demand high-performing equipment*

› *Volatility can lead to increased risk and lower revenues and investment*

› *Marine industry focus on regulation compliance and social responsibility*

GE Value

› *Our digital solutions can improve asset availability, vessel productivity and reduce maintenance costs*

› *We contribute our marine know-how and electrification expertise early in project phases to manage risk*

› *Our energy-efficient systems can reduce emissions by up to 20%*

Marine Solutions

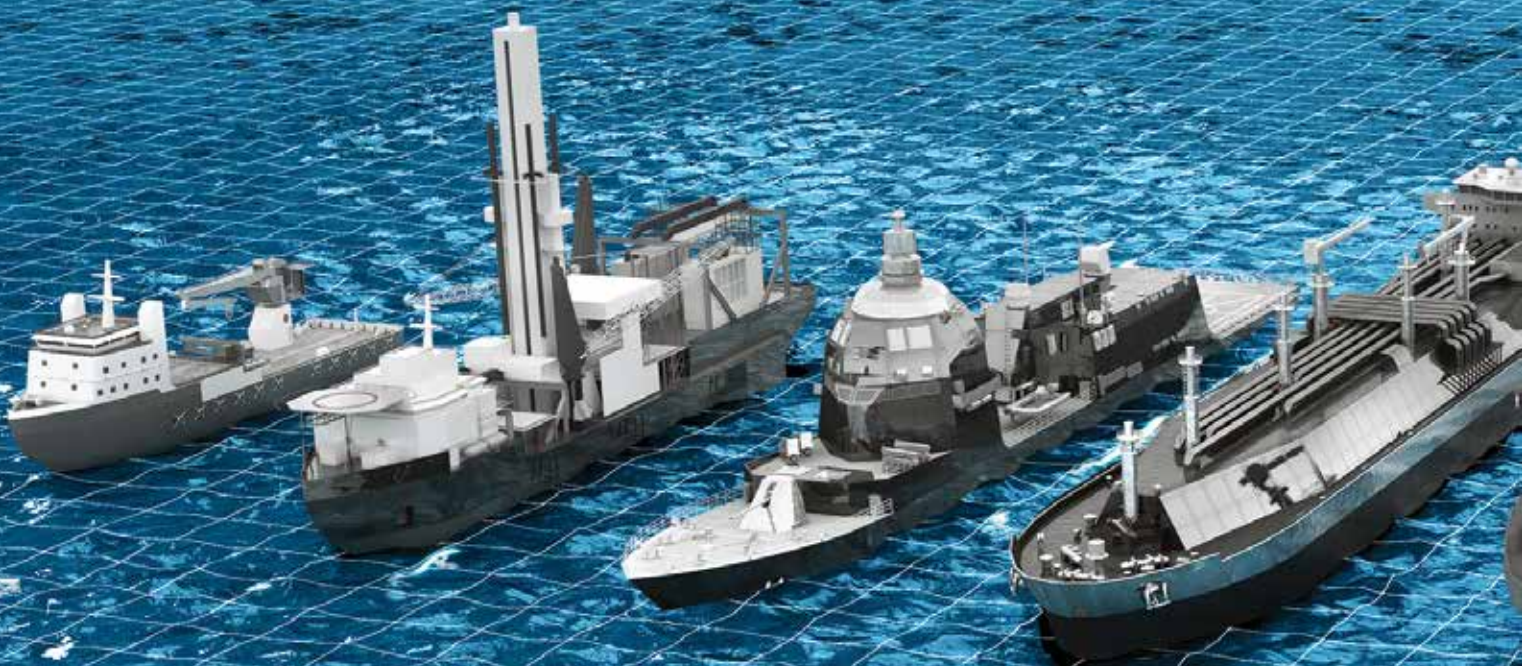
Trusted to Bring Electrification to More Than 1,000 Ships

Offshore Energy

- Drilling vessels
- FPSO and FLNG production
- Specialist and support vessels
- Survey and research
- Floating power plants

Navies and Coastguards

- Aircraft carriers and landing platforms
- Destroyers and frigates
- Logistic support
- Specialist patrol



Transportation

- Container ships and tankers
- Cruise ships and ferries
- Icebreakers and workboats



Marine Solutions

Marine Ecosystem Electrification

- Electric and hybrid power, propulsion and automation
- Energy-efficient systems reduce environmental emissions to help our customers stay competitive and comply with regulations

We specialize in vessel applications with high power, energy and thrust, as well as other complex needs.

From the heart of the ship's power network...

Propulsion Solutions

SeaJet™, SeaPulse™

- Advanced induction motors
- MV and LV propulsion drives
- Podded propulsion
- Hybrid power take-in

Power Generation

SeaGreen™

- Generators
- Hybrid power take-off
- Energy storage
- Process drives

Marine Ecosystem Digitalization

- Improved return on fleet assets
- GE brings together smart engineering, operational know-how and analytics to provide customers with data-driven efficiency across a ship's life cycle

Our strength lies in providing an integrated system to improve performance and reduce project risk.

...to the brains of the system

Integrated Platform Management

SeaStream™, SeaLyte™

- Vessel control and automation
- Dynamic positioning
- Intelligent power management

Digital Life Cycle Support

SeaStream™, SeaLab™

- Asset Performance Management (APM)
- Remote monitoring and diagnostics
- Vessel Performance Analyzer (VesPA)

Marine Naval Solutions

Surface Combatant, Logistic Support and Special Vessels

GE supports naval missions by delivering flexible and reliable solutions for integrated, full electric and hybrid propulsion. Vessels range from high-capability warships to the latest fast fleet support and coastguard ice-patrol.



Photo courtesy of U.S. Navy



Photo courtesy of ACA



Photo courtesy of U.S. Navy



Photo courtesy of Fincantieri

QE Class Aircraft Carrier, Royal Navy

The UK Navy's largest ever vessels – the first now commissioned featuring fully integrated electric propulsion producing 110 MW on-board power

DDG 1000, US Navy

The US Navy's first full electric propulsion ships producing over 78 MW installed electric power

PPA Frigate, Italian Navy

Hybrid electric with Power Take-Off/Take-In (PTO/PTI) and 2 MW shore supply

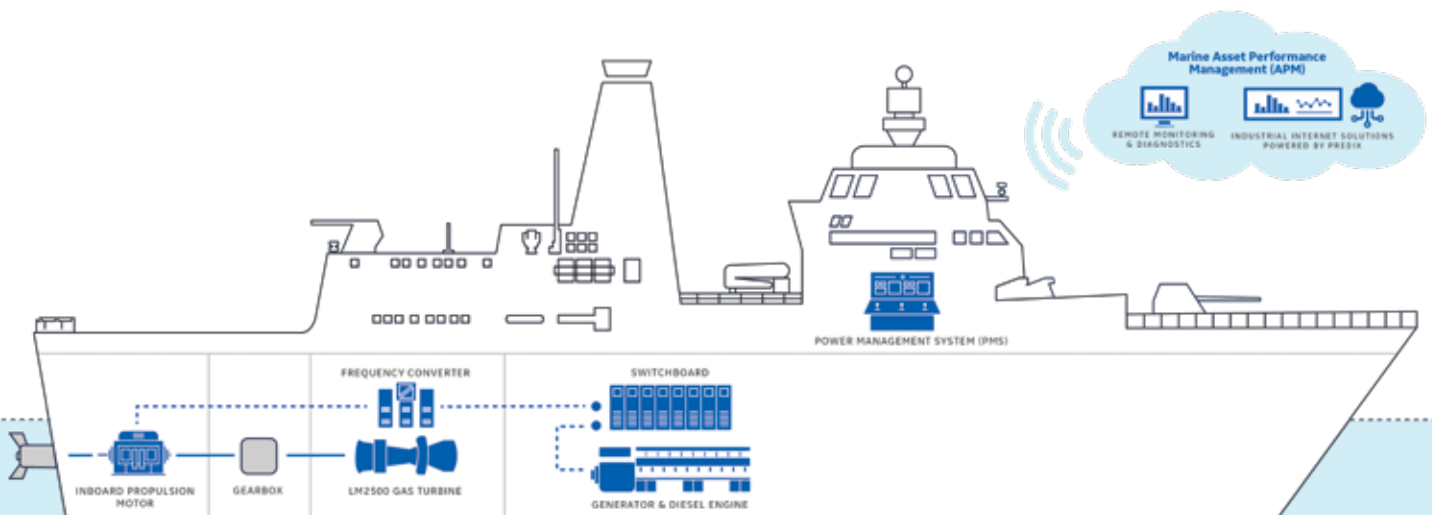
We Have References For Nearly 100 Electric And Hybrid-Electric Naval Ships

GE's **powerful electrical networks** are capable of **supporting** a ship's major requirements, including **propulsion, high-power sensors, service loads and pulse power for defense systems**.

Options include **full-electric** or **hybrid-systems**, in **geared** or **direct-drive** configurations. The versatile design provides **greater flexibility** in vessel layout, survivability and maintainability.

Operating **electric and hybrid drive vessels** enables navies to attain cruise speed whilst realizing **fuel savings**, and reducing **operating and life cycle costs**. Reduced acoustic signatures also bring **low radiated noise** for anti-submarine warfare (ASW).

GE's **dependable** technologies are **proven** on **fully shock rated** naval applications and commercial fleets.



Marine Transport Solutions

LNG and Cargo Vessels, Cruise and Passenger Ships
Peace of mind, power and propulsion for precious cargos.



MSC Seaside
Powering the latest generation of passenger experience



Maersk Line's Largest Container Ships
Fitted with e-efficient PTO/PTI



Höegh FSRU
Providing critical power to floating storage and re-gasification processes

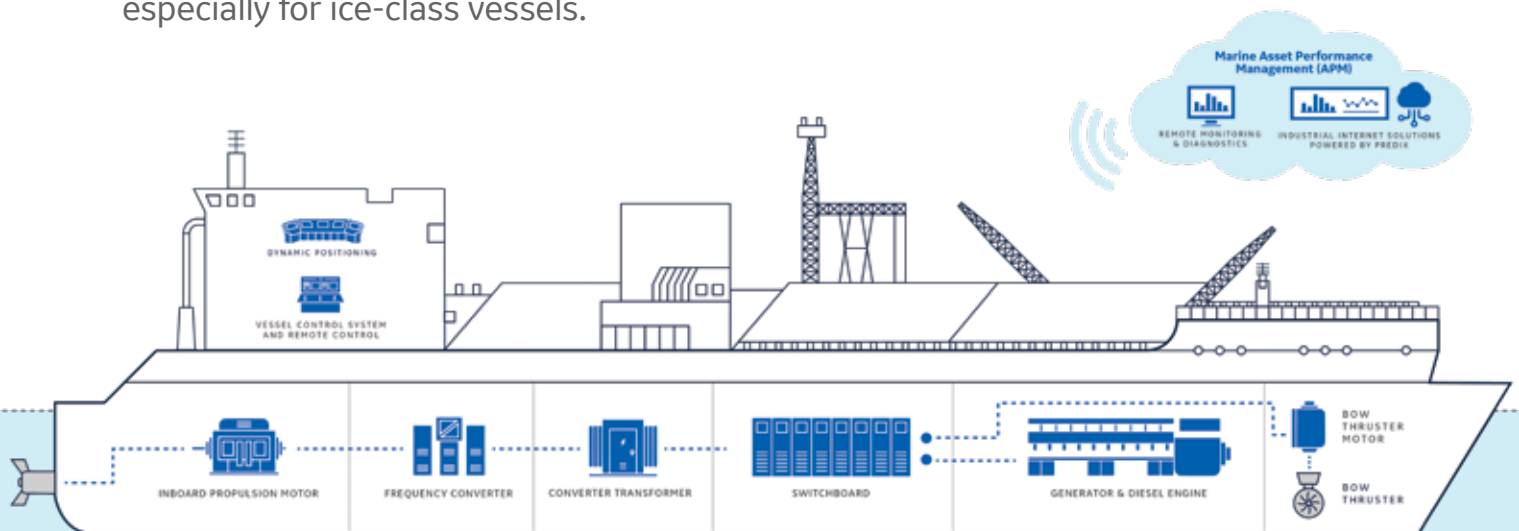
We Have References for 200+ Transport Vessels

In today’s competitive market, fleet operators need to maximize vessel capacity and voyage performance for their customers.

However, ship owners also need to manage operating costs while complying with increasing environmental and emission regulations. That’s why energy-efficient solutions are critical. Vessels using GE’s electric propulsion can benefit from up to 10% fuel efficiency improvements for specific & complex operation profiles.

Power systems generate power for on-board operational needs, from gas processing to passenger comfort. A range of hybrid options from energy storage to Power Take-Off/Take-In (PTO/PTI) provides flexible options and solutions to reduce emissions.

Focusing on vessel performance, GE’s **high-efficiency electric propulsion** induction motors and power electronics enable excellent maneuverability and thrust. **Podded propulsion units** provide exceptional performance in demanding conditions, especially for ice-class vessels.



Marine Offshore Solutions

Specialist Vessels and Workboats

Meeting vessel power demands for on-contract performance, GE is always tough enough to get the job done. We work across offshore industries, from energy to fishing, marine science to communications.



Heerema

Integrated power system for the world's largest offshore construction vessel

Shanghai Salvage

The world's most advanced deep-water dive support vessels

SeaJacks Wind Turbine Installation Vessel

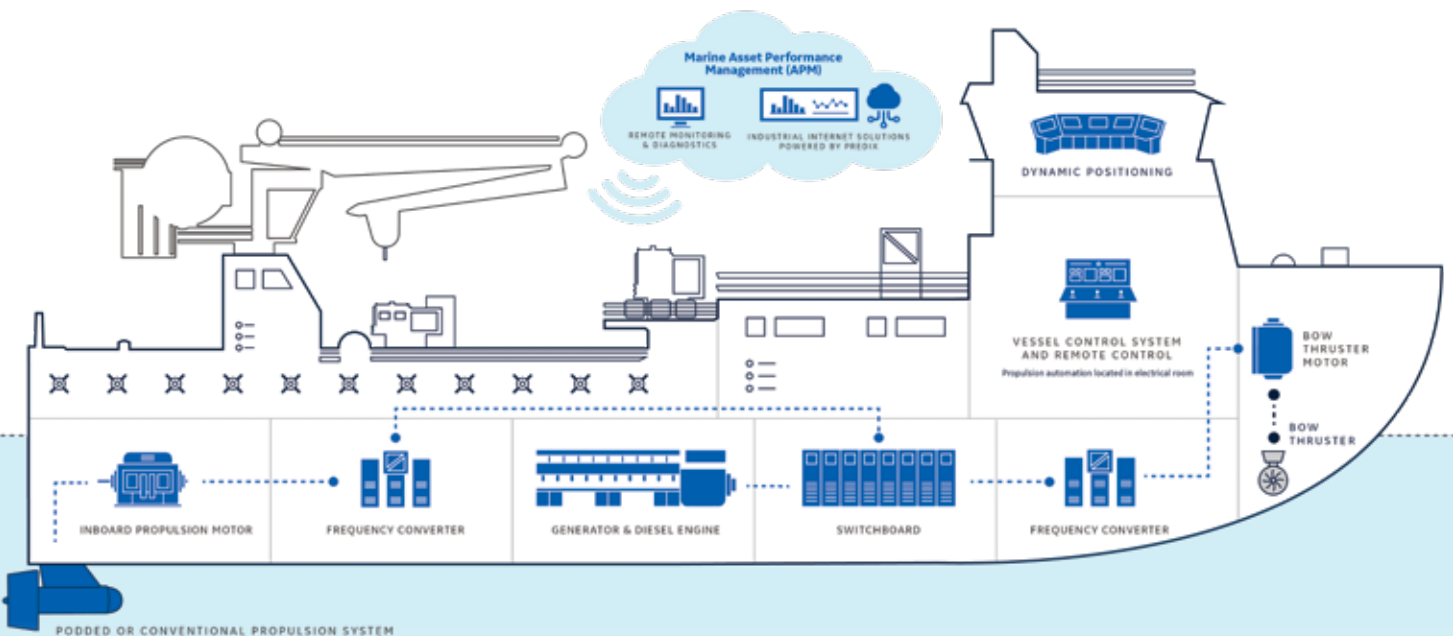
Supporting a growing offshore wind industry

We Have References for 800+ Vessels

GE provides highly customizable modular solutions for electric and hybrid propulsion and power.

We specialize in vessels that require the power to carry out on-board operations or high levels of thrust to support large drilling and production assets.

Experts from our Marine Offshore Center of Excellence configure the best solutions, considering operating conditions and operating cost trade-offs.



Marine Offshore Solutions

Exploration and Production Vessels

GE technology meets the harsh requirements of offshore energy companies, providing integrated energy, control and automation, and digital solutions to power next-generation vessel operations.



Transocean Deepwater Drillship
Integrated vessel and drilling power, e-propulsion and DP



Noble's Globetrotter I
The world's first 'Digital Rig™' fitted with GE's digital asset performance management



FPSO for Libra Field
e-House electrical distribution module being installed on FPSO topside

We Have References for 150+ Vessels And Platforms

At GE we're specialists in ultra-deep water, high-specification rigs and production vessels – delivering electrification that enables the latest offshore exploration and production technologies.

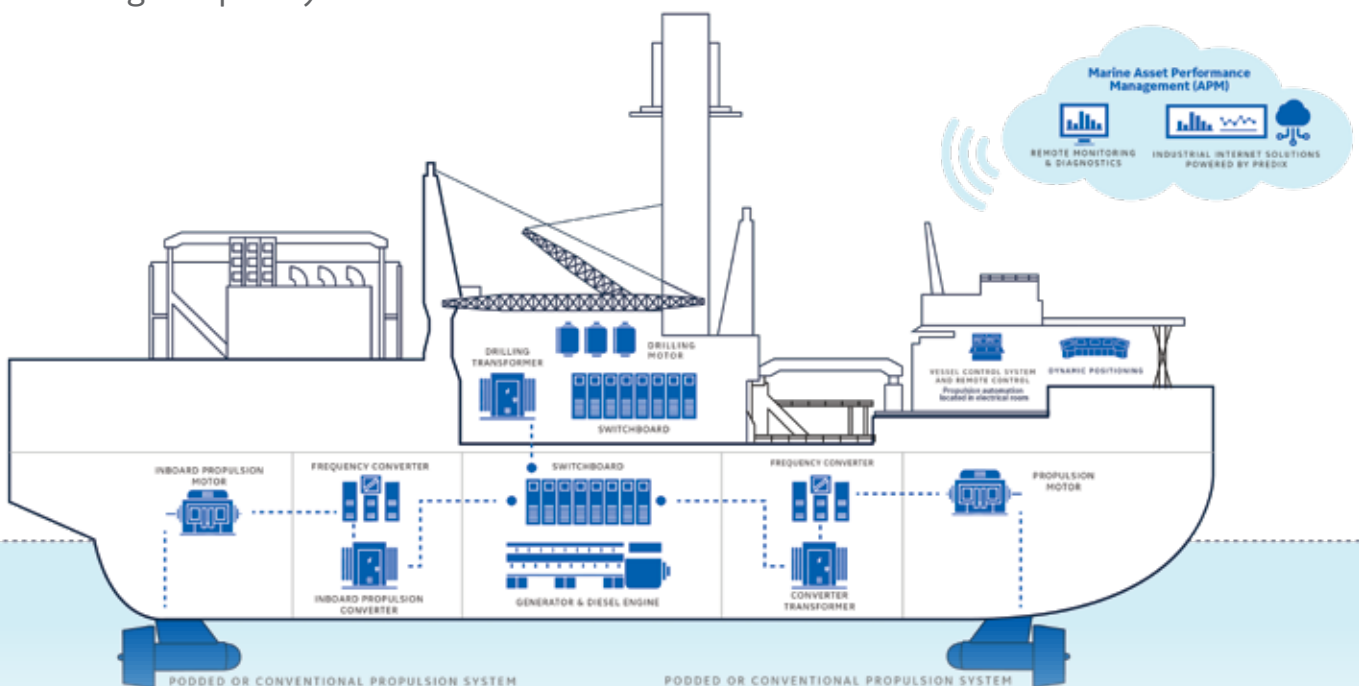
Our experienced engineering and project management specialists take the pressure off your project team. We add value and reduce project risks, using our expertise to provide a turnkey solution, from Pre-FEED phase concepts and advice to EPC capabilities for simpler interfaces and faster integration.

Innovating the Digital Rig™

In a partnership formed by GE and Noble Drilling, the two companies have launched the world's first digital drilling vessel, targeting a 20% operating expenses reduction and improved drilling efficiency.

Powered by Predix™, the solution connects target systems, including drilling control and power networks, using data to apply predictive analytics. This provides an early warning to operators, mitigating problems before they strike.

Simple dashboards provide improved situational awareness and decision support, reducing complexity.



Queen Elizabeth Class (QEC) Aircraft Carriers

HMS Queen Elizabeth and HMS Prince of Wales: World's Largest, Electric-Propelled Warships

The new QE Class is the UK Royal Navy's new aircraft carrier class. At more than three times the displacement of the Invincible Class it replaces, the QEC represents a step change in both size and capability, using proven architecture and technology from other naval and commercial platforms to help minimize both cost and risk.



Background

The first ship, HMS Queen Elizabeth, was commissioned in 2017 – the new carriers the biggest, most powerful surface ships ever built for the Royal Navy.

The QEC vessels are the first Royal Navy ships to have been designed from the outset with Integrated Full Electric Propulsion (IFEP), enabling the ship's mission and reducing life cycle costs.

Design Process

GE has been involved in the program since 2001 and has been a key member of the Aircraft Carrier Alliance (ACA) and Power and Propulsion (P&P) sub-alliance, selected for the critical HV, propulsion and system integration.

At 11 kV and >130 MVA, This is Power and Propulsion on a Grand Scale

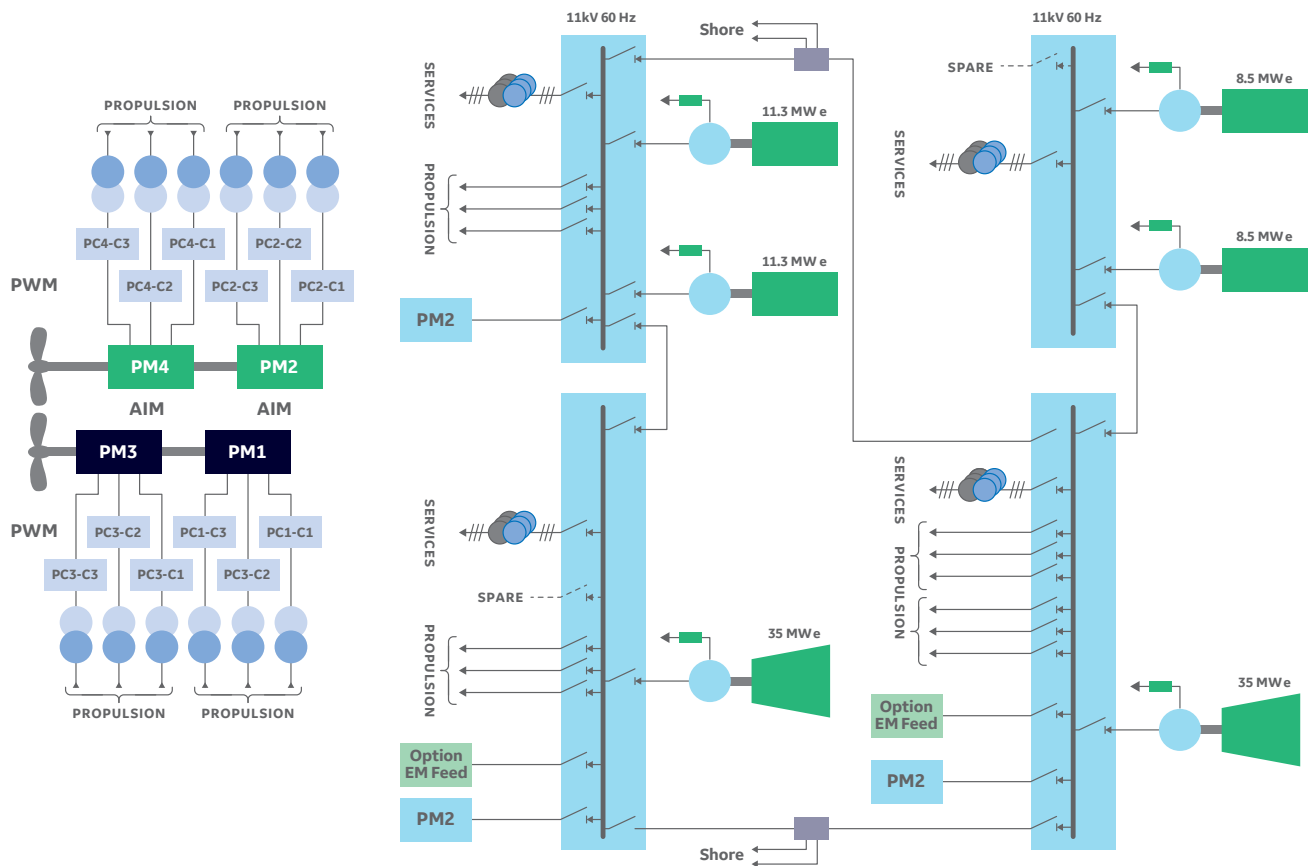
- An efficient electric propulsion system yielding increased range and autonomy via fuel economy
- 80 MW power from advanced induction motors
- Graceful degradation, rather than redundancy, maximizing availability
- Shore supply connection

Key Facts:

- Operator: Royal Navy
- Length: 280 meters (920 ft)
- Displacement: 65,000 tons
- Speed: Over 25 knots
- Crew: Accommodates 1,600

Case Study

Four Propulsion Motors in Twin Arrangement, One Behind the Other on Each Shaftline



QEC HV P&P Configuration

- 4 x 20 MW Advanced Induction Motors (2 per shaft)
- VDM25000 drives
- 6 x generators (2 x 35 MW, 2 x 11.3 MW and 2 x 8.5 MW)
- 3 x HV harmonic filters
- 2 x MV switchboards (11 kV)
- Propulsion and service transformers
- Power Management System (EPCAMS)

Marine Product Portfolio

Power Electronics

Offering high power density, reliability, availability and power scalability, our Voltage Source Inverters (VSI) use IGBT-based technology and are a core component of electrical propulsion.

Models

- MV7 Series
- IV3 Series
- MV3 Series

Technical Capabilities

- Output power: 0.25–120 MW
- Output voltage: up to 13.8 kV
- Output frequency: up to 300 Hz
- Input frequency: 50 or 60 Hz \pm 5%



Electric Motors

Our electrified propulsion systems for marine and offshore deliver high quality and performance in the most challenging environments. These include the:

- Main propulsion motor
- Thruster motor
- Shaft generator motor
- PTI/PTO
- AC/DC drilling motor

Models

- Compact Induction Motors (low and high speed)
- Vertical Induction Motors
- Advanced Induction Motors

Technical Capabilities

- Power: 3000 kW–40 MW
- Voltage: up to 13.8 kV
- Marine and offshore certifications



Podded Propulsion Units

These external integrated electric propulsion systems feature an energy-efficient induction motor, electrical steering and propeller unit, with ice-capable rating.

Models

- Seajet™ Pod
- Seajet™ Pod Polar Class*

Technical Capabilities

- Output power: 3–22 MW
- High thrust capability at high transit speed vessels
- High bollard capability for DP application
- Designed for maximum availability
- Noise and vibration optimization for comfort
- Digital twin solution

*The ice-class range of SEAJET™ is a joint technology development with AETC Sapphire.



Vessel Control System

Delivering centralized supervision, control and automation of all vessel systems.

Models

- C-Series Vessel Control System
- SeaLyte Vessel Control System

Functionalities

- Central alarm system
- Centralized power plant monitoring and control
- Propulsion, thruster and steering systems
- CCTV
- Auxiliary systems
- Fluid and cargo systems
- Power Management System (PMS)



Dynamic Positioning

Dynamic positioning for all vessel types using enhanced UX that puts the mariner back in control.

Models

- SeaStream™ DP
- SeaLyte DP
- Energy Efficient Mode
- Up to DP 3

Functionalities

Computer-controlled system used to maintain a vessel's position and heading. This works by automatically activating propellers and thrusters to counteract the displacing effects of the external environment.



Asset Performance Management

Covering the entire vessel, system and fleet operations.

Models

- SeaStream™ Insight

Functionalities

- Machine and equipment health lets you gain an advanced view of an asset's status and condition
- Reliability management allows you to predict and diagnose asset issues
- Maintenance optimization provides balance reliability, performance and costs to create better maintenance strategies



SeaStream™ Insight

Digital Asset Performance Management

Optimizing Maintenance and Processes

SeaStream™ Insight is GE's digital marine Asset Performance Management (APM) solution, powered by Predix.

SeaStream™ assists energy contractors and fleet owners to optimize their operations by shifting from gut-feel to data-driven decisions. It's part of a drive to reduce maintenance costs and improve operations efficiency by:

- Harmonizing industrial data from vessel equipment
- Generating analytics for early performance and predictive insights
- Providing repeatability and predictability in operational processes

Get Connected

Machine And Equipment Health

Better situational awareness through an advanced view of an asset's status and health.

Get Insights

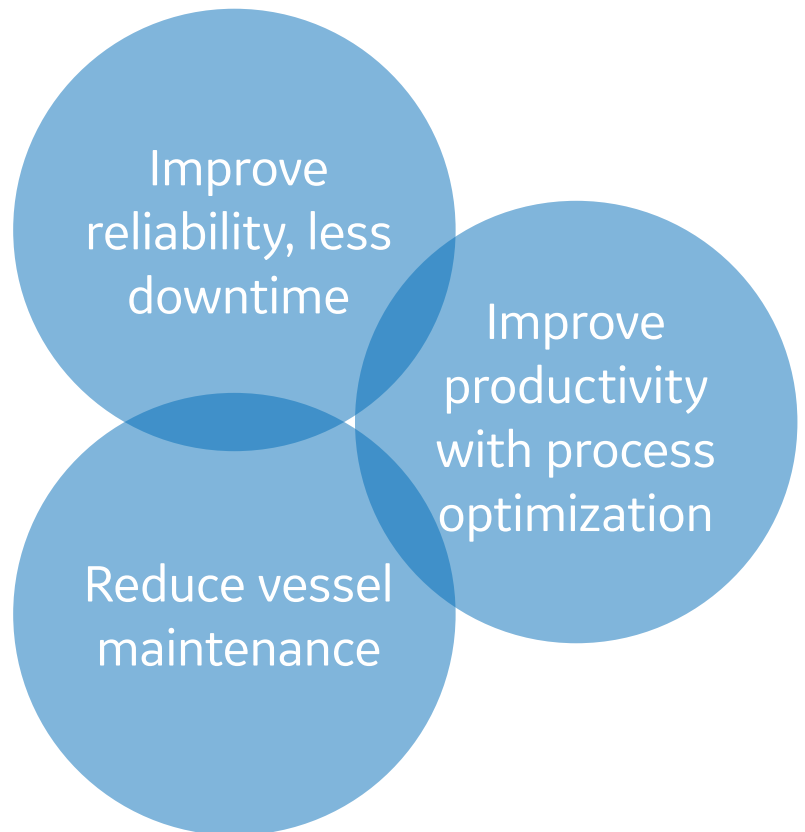
Reliability Management

Predict and diagnose asset issues.

Get Optimized

Rethink Maintenance

Balance reliability, performance and costs to create better maintenance strategies.



Step 1

Performance Indicators

Stakeholder dashboards offer rapid drill-down via an intuitive interface to access:

- Centralized data for single source of information
- Key performance indicators for operations processes
- Efficiency reports to automatically derive a current performance baseline.

Step 2

Performance Analytics

Data-driven insights and decisions enable operational anomaly detection

- Digital twin performance analytics highlight potential deviations in equipment use and process, providing guidance on how these can be prevented
- Detailed insights establish a baseline and assist optimization.

Step 3

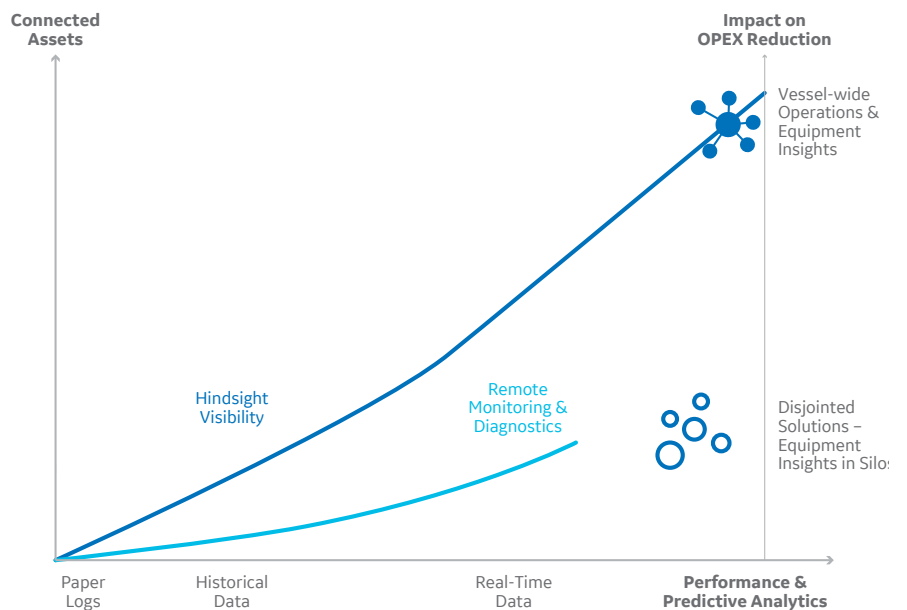
Predictive Analytics

Shift from **calendar-based to predictive maintenance** with early warning and alerts

- Access information on potential future degradations in equipment reliability and performance
- Drive continuous improvement using stakeholder-relevant dashboards to make informed decisions
- Systemize data-driven operational methods and enable digital transformation

The GE Difference:

- IT and OT expertise
- Real expertise and outcomes through connecting the world's first Digital Rig™
- Organizational transformation experience
- Operator-friendly approach



Life Cycle Support



Energy Efficiency Design Optimization and Modeling

VesPA, GE's real-time configurator, helps design the entire electrical system to optimize thrust and power. It allows shipbuilders and owners, together with GE's SeaLab design team, to rapidly simulate and compare multiple configurations at the design stage. We can then select the best system based on the specific vessel's performance requirements and predicted operating cost.



Marine Power Test Facility

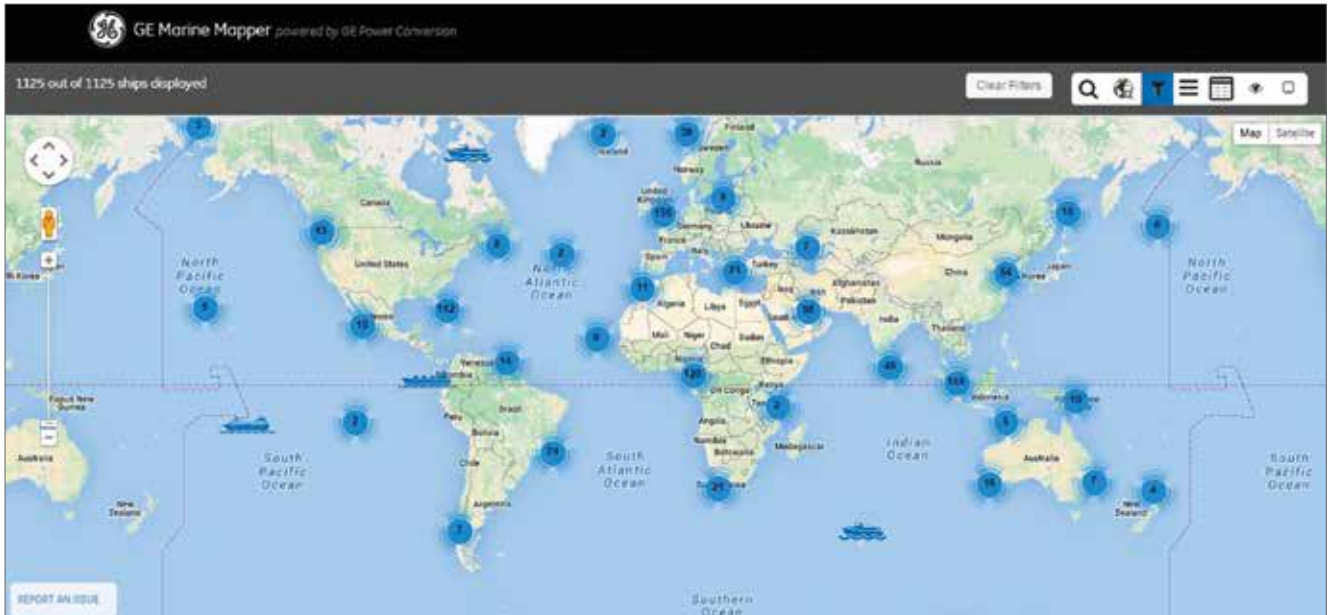
We have the world's only commercially owned facility that offers full-scale electric and hybrid power system testing. This helps to reduce risk prior to installation and sea trials for cost-effective program management.



Marine Training Centers

We offer hands-on training and simulation in our regional customer support facilities, including dynamic positioning operator training.

Services 360°



ServiceMax is our Operations Center system that provides thorough case management and history, automatic support scheduling and dispatch. GE's Marine Mapper helps our teams track vessel location and status from our Service Operations Centers. Responsiveness is our priority.

A simple installation of our ship **Visor** system connects you to our onshore global tech experts to remotely diagnose problems and advise on immediate next steps.

With Services 360°, you can take advantage of mobile tools and apps to connect quickly with our skilled and experienced services team. Our Online Manager puts you in control, generates your case and keeps you updated with your services expert.

GE's Marine Digital Roadmap

Asset Performance Management (APM)

- Reducing unplanned downtime by predicting equipment issues before they occur
- Increasing health and usage situational awareness

Voyage and Energy Optimization

- Delivering fuel and energy efficiency
- Optimizing route, speed and vessel systems to suit environmental conditions

Smart Automation

- Reducing manning through optimized and remote controls
- Enabling corrective action

SeaStart – Vessel Reactivation

Informed and Ready to Go

In the current market, vessel owners face critical decisions relating to their fleets, whether small or large.

Stacked vessels can't be put straight back into service. Yet you need to be ready when market opportunities do appear.

Bringing in an experienced OEM partner to support your core team and evaluate the impact of returning a vessel to work will provide the information you need to make the right decisions.

Showing clear and simple cost options, recommendations may include repair, upgrades or replacement – based on the state of the vessel.

Life Cycle Service Support

As a Full-Scale OEM, We Also Offer:

- Dedicated fleet managers
- Digital asset performance management solutions to improve availability and return on assets
- GE's Visor remote diagnostics with tech support and fast troubleshooting
- Long-term service agreements with life cycle support, based on your needs
- Modifications for charter needs.

Through the practical SeaStart Program, GE offers its expertise to help customers restart the operation of stacked, laid-up vessels in the best way possible.

We can help ensure a smooth, timely and safe transition back to high-performing vessels. This enables you to be competitive and get back on contract as soon as the time is right.

Your SeaStart Package Includes:

- **A structured survey** tailored to your needs that helps you make informed decisions regarding your restart and assists with your financial planning
- **Recommendations** for restart of equipment or identification of reusable equipment from vessels to be scrapped
- Support for meeting **class society approvals**
- **Experienced marine field service engineers** to restart equipment and supplement your team, as and when you need us
- **Third-party equipment recommendations** on a case-by-case basis

Four Levels of Support

GE's SeaStart program offers four levels of support giving you options for each vessel before committing to work:

- 1) Survey and recommendation
- 2) Reinstatement package – back to work with **critical spare parts package**
- 3) Reinstatement 'plus' – **upgrade** packages with efficiency and latest technology enhancements
- 4) **Training refreshers** for your team **including NI and OSVDPA classification**

SeaStream™ Dynamic Positioning Upgrade

Enhanced Features and Managed Obsolescence

With years of experience in the design and development of Dynamic Positioning (DP) systems, we have applied our expertise to create the latest, mariner-focused SeaStream™ DP System with enhanced features. With excellent operator feedback for usability and energy efficiency, choosing to upgrade can improve operations and manage obsolescence with the latest RXi-based hardware and software.

Power of SeaStream™ DP

- Enhanced HMI, intuitive and user-friendly
- Energy-efficient DP control mode
- Enhanced serial link processing
- Advanced Position Measuring Equipment (PME) filtering techniques
- Enhanced PME checking and processing
- Wider range of PME interfaces supported
- Compass rose added to the motion screen
- Inhibit selection of DP mode at high speed
- Enhancements to thruster software to increase stability of the vessel's control



SeaStream Human Machine Interface (HMI)

- Award-winning design
- Configurable displays and intuitive graphic interface
- Structured areas making navigation easier
- Adjustable screen tilt angle
- Easy alarm management

Energy Efficient DP

- Reduces fuel consumption, emissions and mechanical wear and tear
- Predicts position over a two-minute window
- Configurable soft and hard zones for thruster engagement
- Optimizes thrust to stay within soft and hard limits
- Optimal energy use for different vessel operating modes

Upgrade Packages Customized for Your Fleet

- Seamless system upgrade, installation and commissioning
- Peace-of-mind, up-to-date
- Single vessel to fleet-wide
- Expert, practical advice from services team
- GE training centers for refreshers
- GE DPS 900, A-series and C-series upgrades and third-party upgrades



For more information on GE Power Conversion's Marine Solutions, please contact your local sales representative.

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