

Customer Service

Hyundai Global Service Co., Ltd
6F Centum Science Park, 79,
Centum Jungang-ro, Haeundae-gu,
Busan 48058, Korea
Tel +82 52 202 7301-10

Warranty Service

Tel +82 52 204 7760 (2-Stroke Marine)
Tel +82 52 204 7887 (4-Stroke Marine)
Fax +82 52 204 7760 (2-Stroke Marine)
E-mail service@hyundai-gs.com

HYUNDAI
HiMSEN

www.hhi.co.kr

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 **HYUNDAI** | ENGINE & MACHINERY
HEAVY INDUSTRIES

HIMSEN HYBRID PROPULSION SYSTEM

HIMSEN HYBRID PROPULSION SYSTEM

Toward a Sustainable
Future, Together

A smart, green marine solution for
maximum efficiency and minimal
emissions levels

 **HYUNDAI** | ENGINE & MACHINERY
HEAVY INDUSTRIES

HIMSEN

SPEEDING TOWARD A GREENER FUTURE

CO₂
-40%

IMO 2030
Reduction in CO₂
emissions

CO₂
-70%

IMO 2050
Reduction in CO₂
emissions

SO_x
0.1%

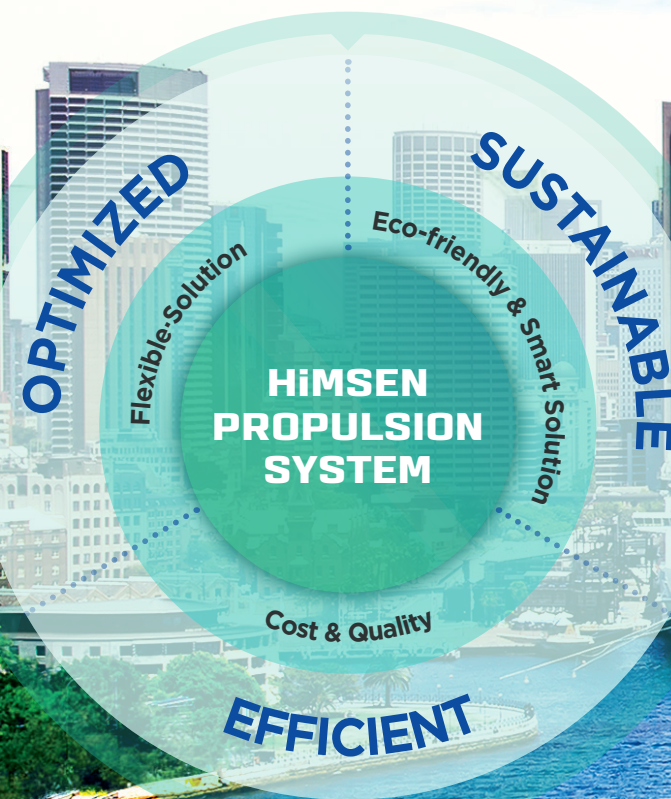
Sulphur limit inside
ECAs from 2015

NO_x
Tier III

Inside ECAs from 2016

Reducing Greenhouse gas Emissions from Ship

ECAs: Emission Control Areas



The International Maritime Organization (IMO) adopted a strategy for reducing greenhouse gas emissions (GHGs) from international shipping operations. The strategy called for a reduction in the carbon intensity of international shipping that would lower the average level of CO₂ emissions caused by their operations by 40% as of 2030 and 70% in 2050 in comparison with 2008 levels. It also mandated that the industry's total annual GHG emissions should be reduced by at least 50% by 2050 compared to levels recorded in 2008. Dramatically increased levels of R&D will be both crucial and integral to meeting these goals, given that the targets agreed on in this strategy will not and cannot be met using conventional propulsion systems relying on fossil fuels. This means that a paradigm shift is currently underway within the marine industry. It recognizes that green, efficient, and smart propulsion systems will be required to ensure safe, secure, clean, and sustainable shipping operations.

SPEARHEADING AN ERA OF ECO-FRIENDLINESS AND ULTRA-EFFICIENCY

The heart of a ship is its engine and propulsion system. Achieving the goals of the IMO's Initial GHG Strategy will require a mixture of innovative technical and operational solutions that are applicable for use in ships in both practical and pragmatic terms. Among all the solutions that are currently undergoing R&D in this regard, an electric and hybrid propulsion system is being heralded as one of the leaders. Taking the fullest possible advantage of all the data accumulated during its decades-long experience and expertise in state-of-the-art diesel and gas engine technologies, as well as its enviable record of close cooperation with recognized industry experts in electric power components, Hyundai Heavy Industries has launched a program called the HiMSEN Hybrid Propulsion System. Its goals include minimizing fuel oil consumption and GHG emissions by means of variable speed operations, the strategic sizing of operating components, and optimized operational modes.



Up to Zero Emissions

- Lower emission levels can be gained using variable engine speeds and optimized engine loads
- The Zero-emission mode can be reached using the energy storage system
- The Auto-optimization mode is available using our Energy Management System



High Performance, Enhanced Efficiency

- Cold starting, instant backup spinning reserve and load-taking
- Advanced-level Energy Efficiency Design Index for newer ships
- Ultra-low Harmonic Drive produces exceptionally low harmonic content
- Fewer vibrations, less noise



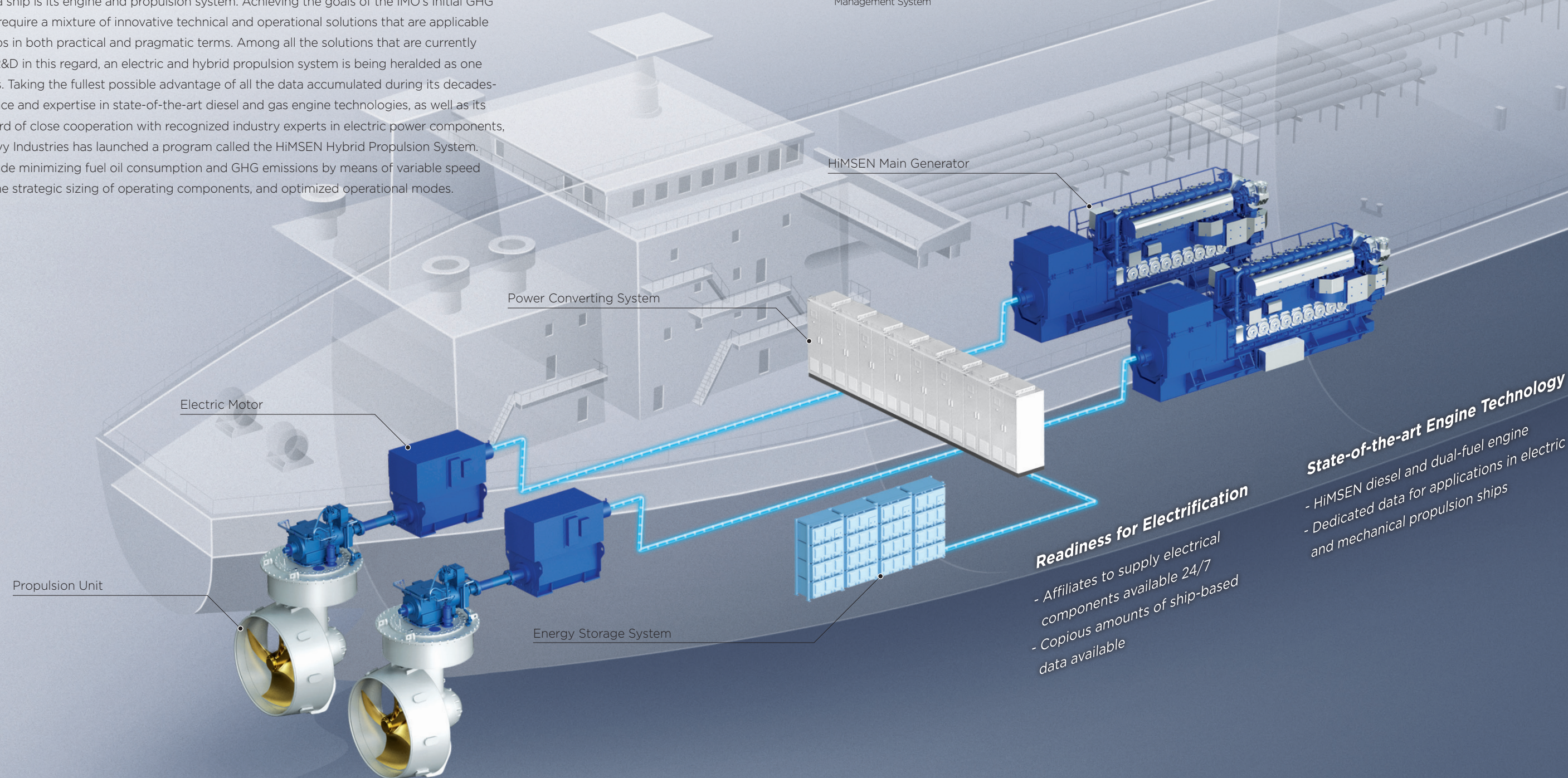
Reduced Ownership Costs

- Remote performance analyses performed by company experts
- Short payback times
- Fewer installed engine cylinders and running hours
- Reduced fuel consumption and maintenance costs



Flexible Integration of Equipment

- All essential features come built-in
- Wide selection of energy-efficient equipment for improved reliability, energy savings, and productivity
- High operating mode for added flexibility
- Tailor-made control system



State-of-the-art Engine Technology

- HiMSEN diesel and dual-fuel engine
- Dedicated data for applications in electric and mechanical propulsion ships

Readiness for Electrification


- Affiliates to supply electrical components available 24/7
- Copious amounts of ship-based data available


HIGHER PERFORMANCE, COST EFFICIENCY


Electric Propulsion System


Our fully electric-powered system comes equipped with HiMSEN Diesel and Dual Fuel main generator, power converting systems, propulsion motors, propulsion units, energy storage systems (i.e., batteries), and control systems. The HiMSEN engine is designed for use with variable engine speeds leading to reduced fuel consumption. A fully battery-operated propulsion system for use without the HiMSEN engine is also available. A wide range of power options for use with propulsion and other electric consumers is provided. The system's detailed power capacity will be determined during the design phase, through a thorough investigation of the intended ship's operational profile.


Available Equipment

- 

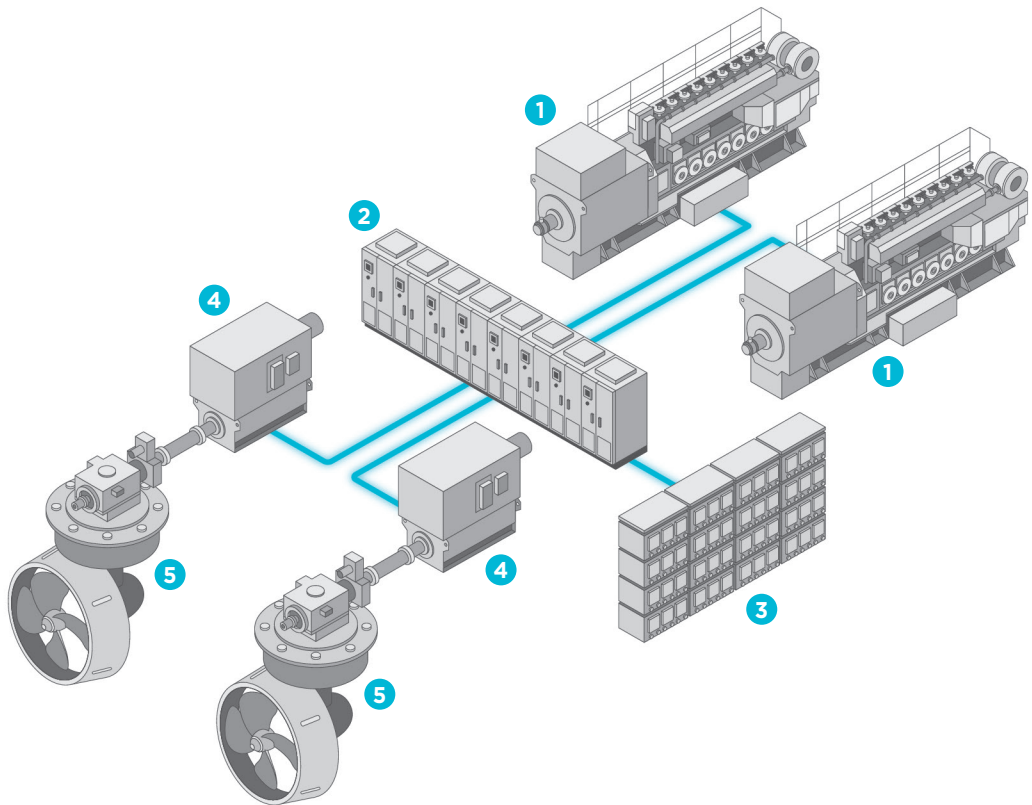
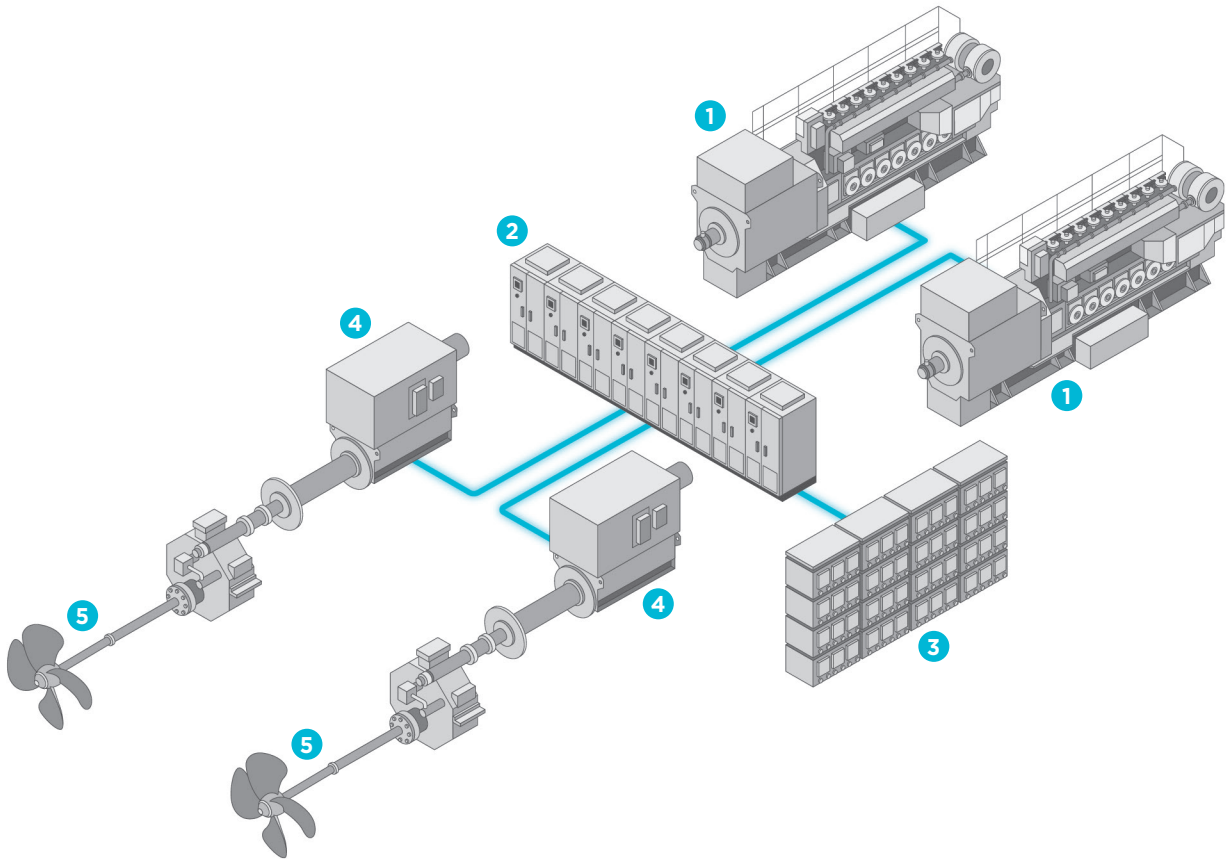
High-efficiency dual-fuel/
diesel engine generator
- 

Motor drive/grid protection/
power conversion
- 

Spinning reserve/
peak shaving
- 

Optimized control with
motor drive system
- 

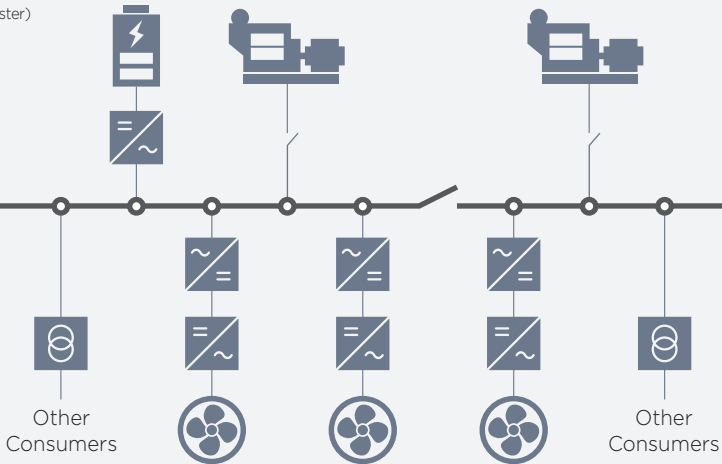
Direct propulsion/
azimuth thruster



~ = Power Converting System ⊕ = Transformer ⊕ = Propulsion Motor (or Thruster)

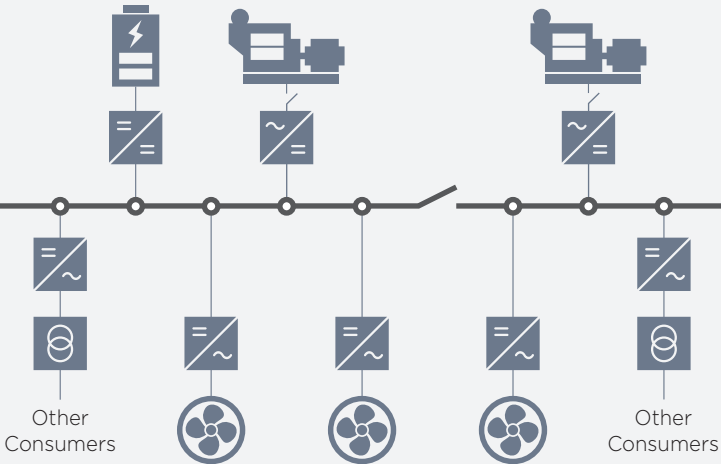
Configuration - AC Grid

Electrical power is fed directly from the synchronous generators into an AC grid. The motor speed and torque are controlled by a frequency converter that provides an optimal operating point for the propellers.



Configuration - DC Grid

Engines no longer have to run at a constant speed, since fuel efficiency can be increased for variable engine speeds. Combining other energy sources such as fuel cells, solar power, and energy storage gives operations added flexibility.

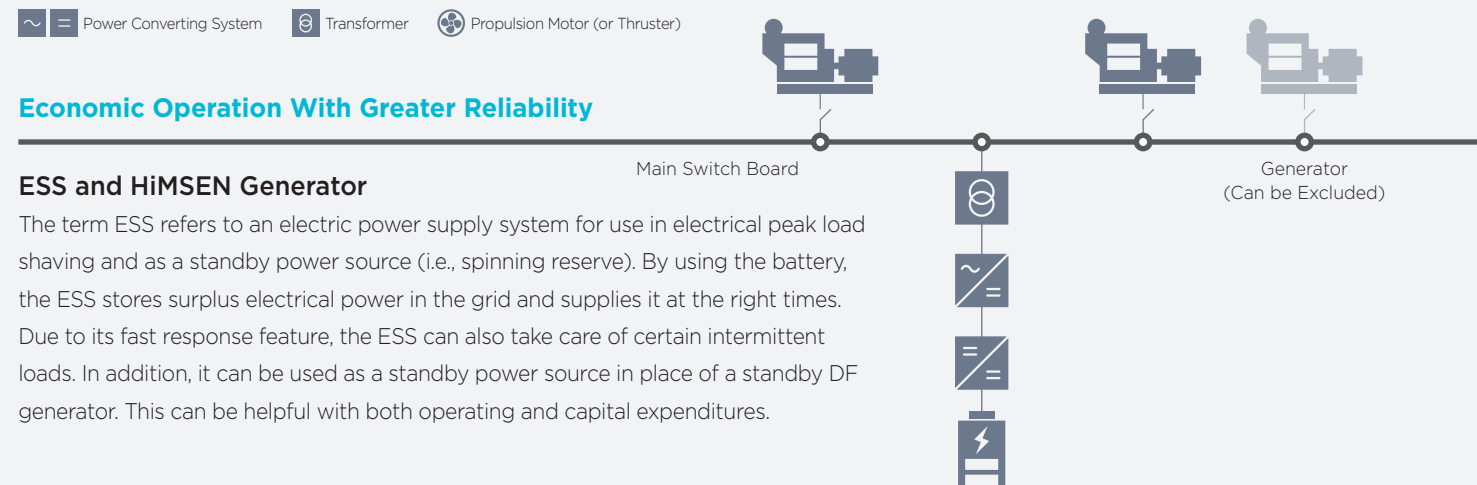
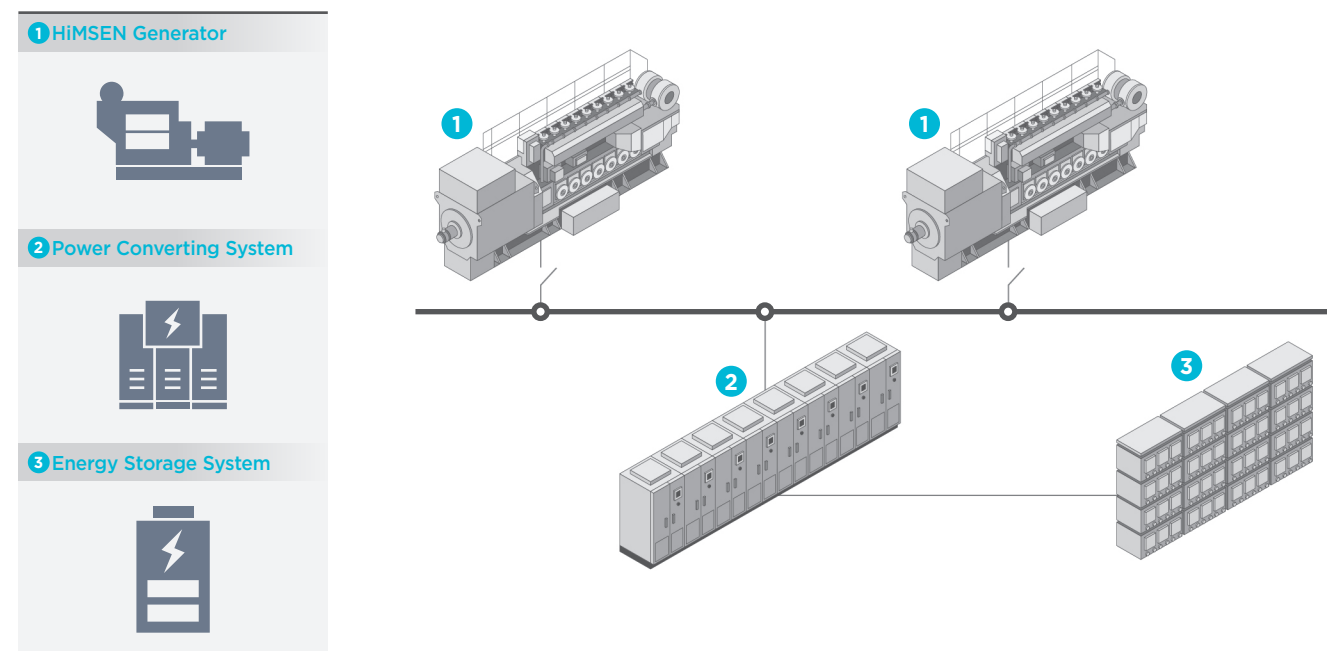


BEST COMBINATION FOR ENERGY FLEXIBILITY

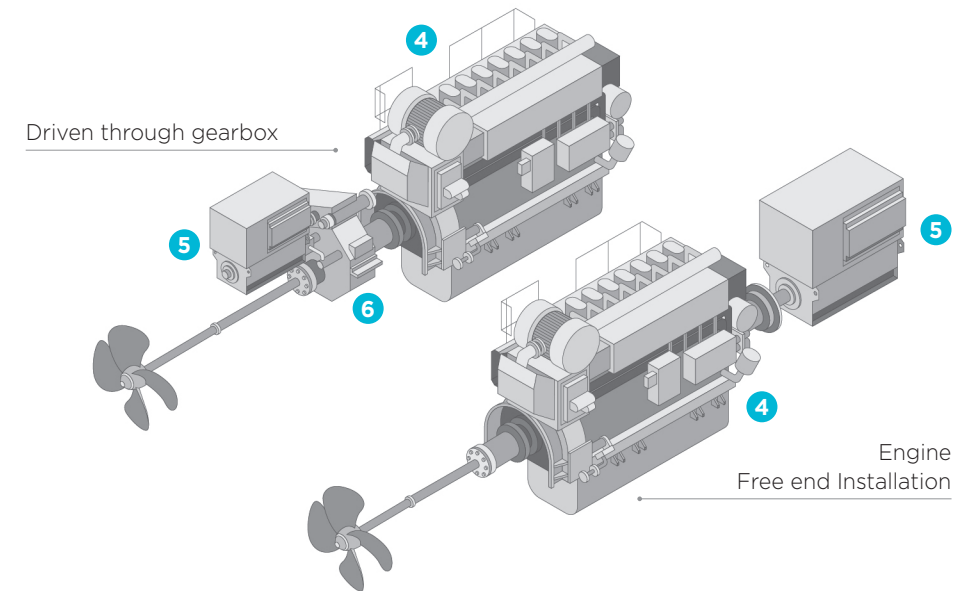
Hybrid Propulsion System

A hybrid propulsion system with shaft generators Power Take Out, Power Take In, and Power Take Home can be used with a shaft generator. Our hybrid propulsion system comes equipped with HiMSEN Diesel and Dual Fuel generators, reduction gears, power converting systems, shaft generators/motors, and control systems. An Engine-mounted generator (EMG), HHI's own shaft generator, is also applicable for use with 2-stroke main engines, resulting in minimal cargo loss.

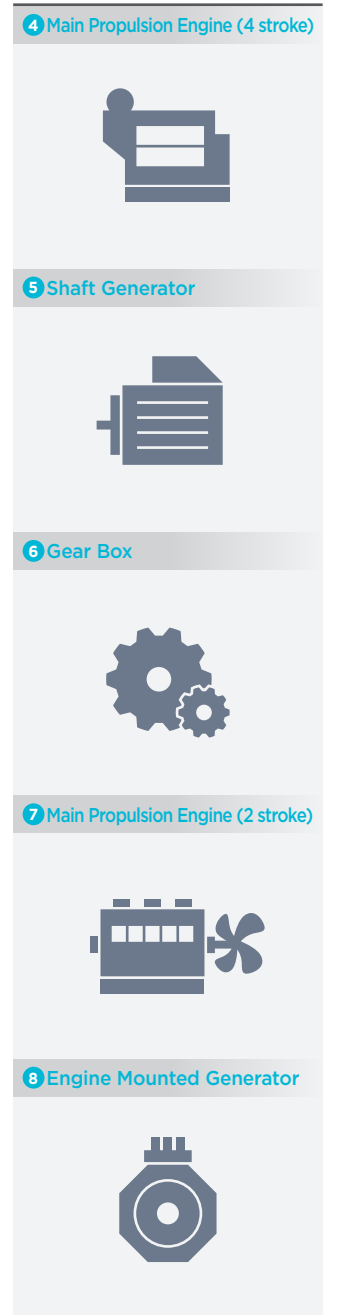
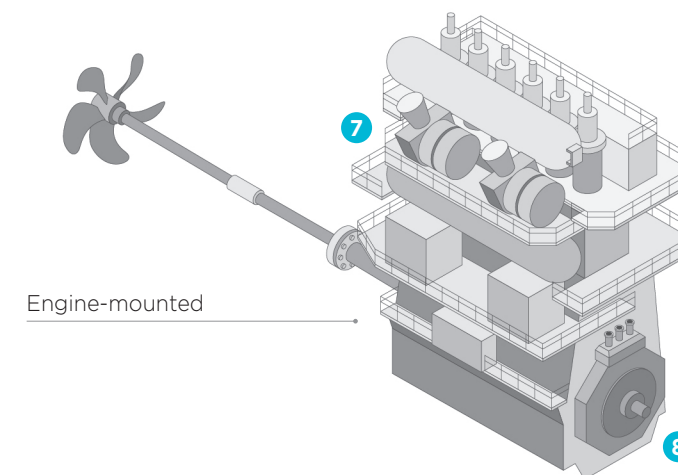
Hybrid Electric Power System



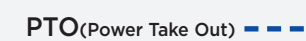
Shaft Generator with HiMSEN Propulsion Engine



Engine-mounted Generator with 2-stroke Main Engine



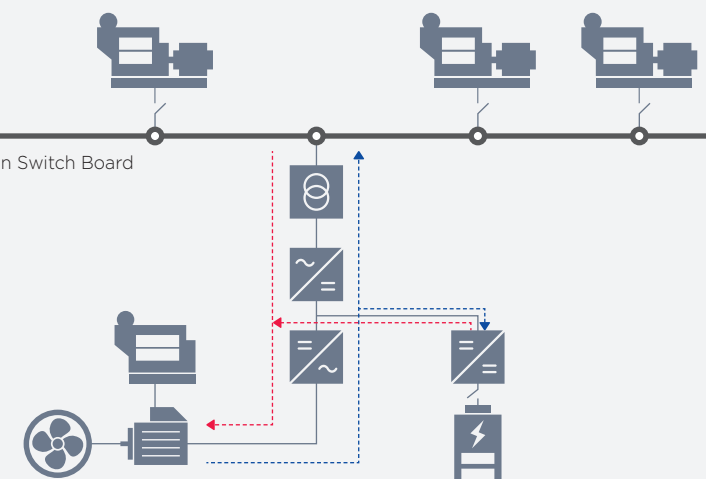
Hybrid Propulsion System



The shaft generator is utilized as a PTO generator

PTI/PTH(Power Take in/Power Take Home) - - -

The shaft generator can also be used as an electric motor to drive the ship's propeller, either in tandem with the main engine or without it when it is not available.



FULLY PACKAGED SOLUTION FOR COMPLETE SYSTEM INTEGRATION

Hyundai Heavy Industries can provide users with fully packaged electric and hybrid propulsion systems.

Single Contact Point

Our easy project handling system allows customers to contact a single provider for assistance with class approvals, equipment deliveries and installation, integration, commissioning, and any other forms of support.

Low Cost and Flexibility

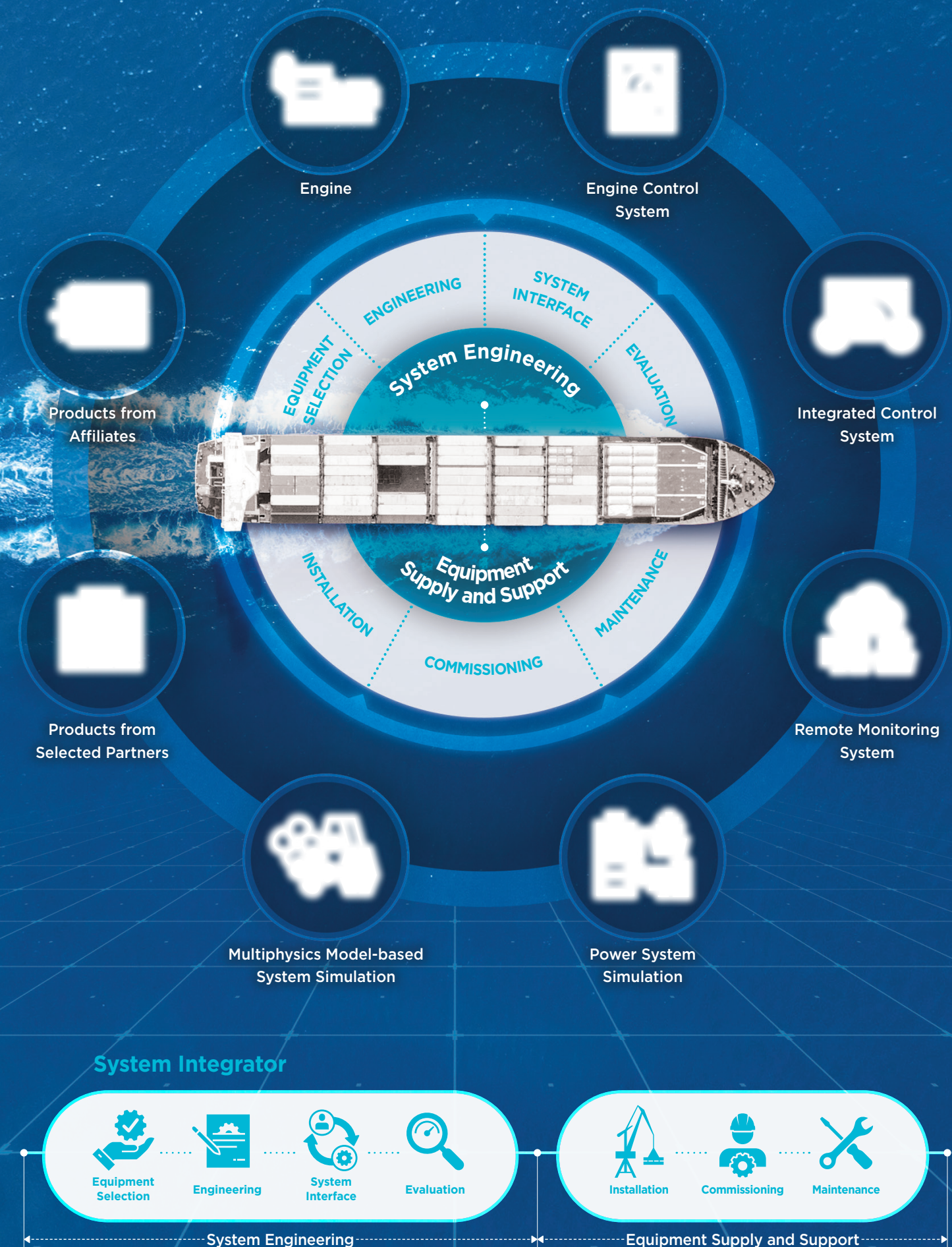
Minimizing and simplifying the overall system and the interfaces between equipment. The entire system can be custom-designed, ranging from the main power source to the propulsion unit.

High Efficiency

Efficient performances are guaranteed thanks to our industry-leading engineering and evaluation systems.

Low Risk with Product Care

We deliver only the most robust and proven technologies, as well as products from carefully selected business partners. Our global network ensures total readiness and supports in terms of both commissioning and maintenance.

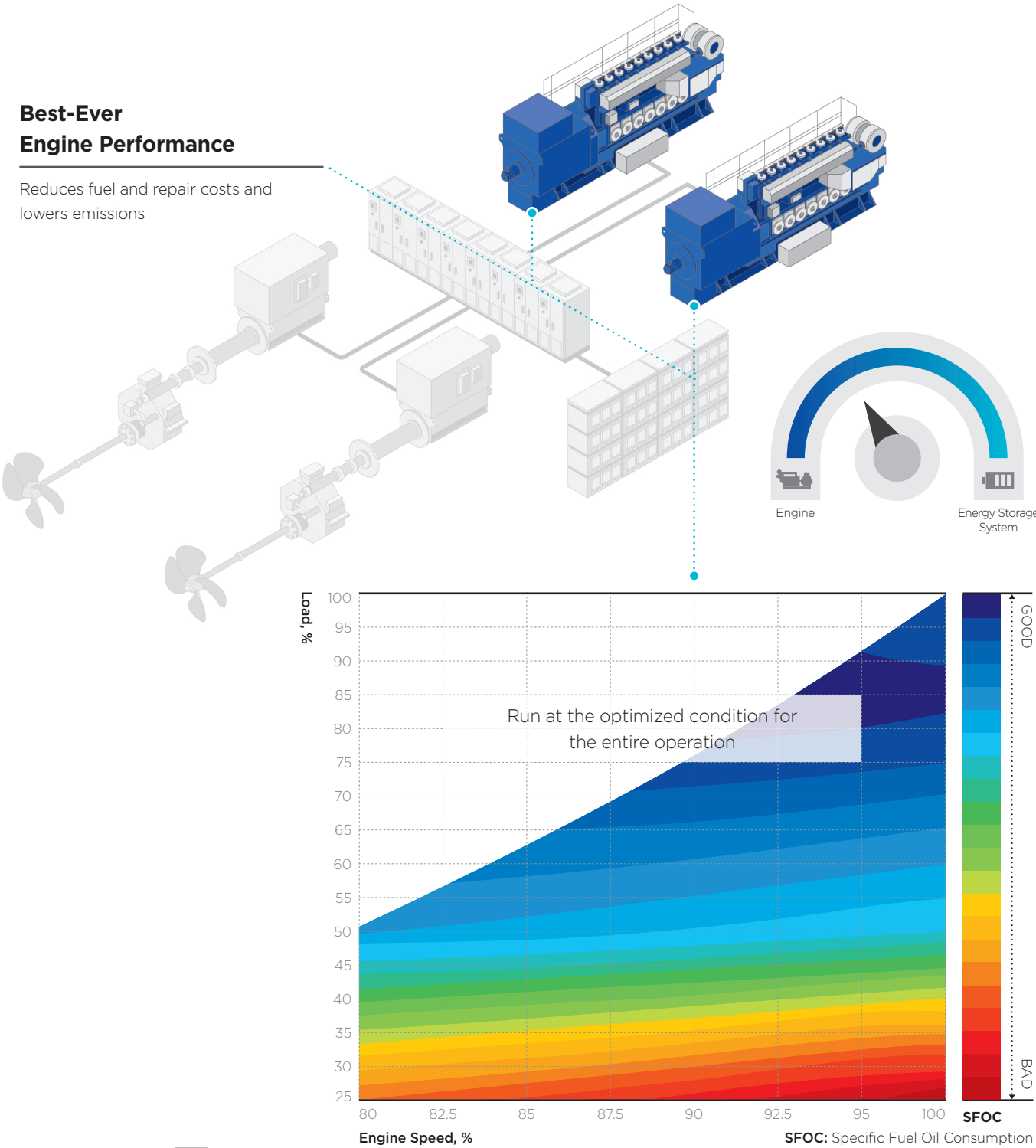


Making a Real Difference with Powerful and Variable Speed Engine Generator

Engine runs at higher efficiency in DC grid. Compared to a conventional AC system, the DC power system allows the DC-connected generators to operate at their optimal speeds at the required load level, bringing the customer significant financial and environmental values. For example, the level of engine fuel oil consumption can be adjusted by changing the speed of the engine at certain load points, allowing the HiMSEN engine to provide a wide range of variable and efficient speeds. This wide range of variable speeds is achieved by optimizing the engine-driven and standby pumps. As seen in the figure below, changing the speed of the engine at certain load points in combination with the power management system can achieve significant fuel oil consumption and emissions savings.

Best-Ever Engine Performance

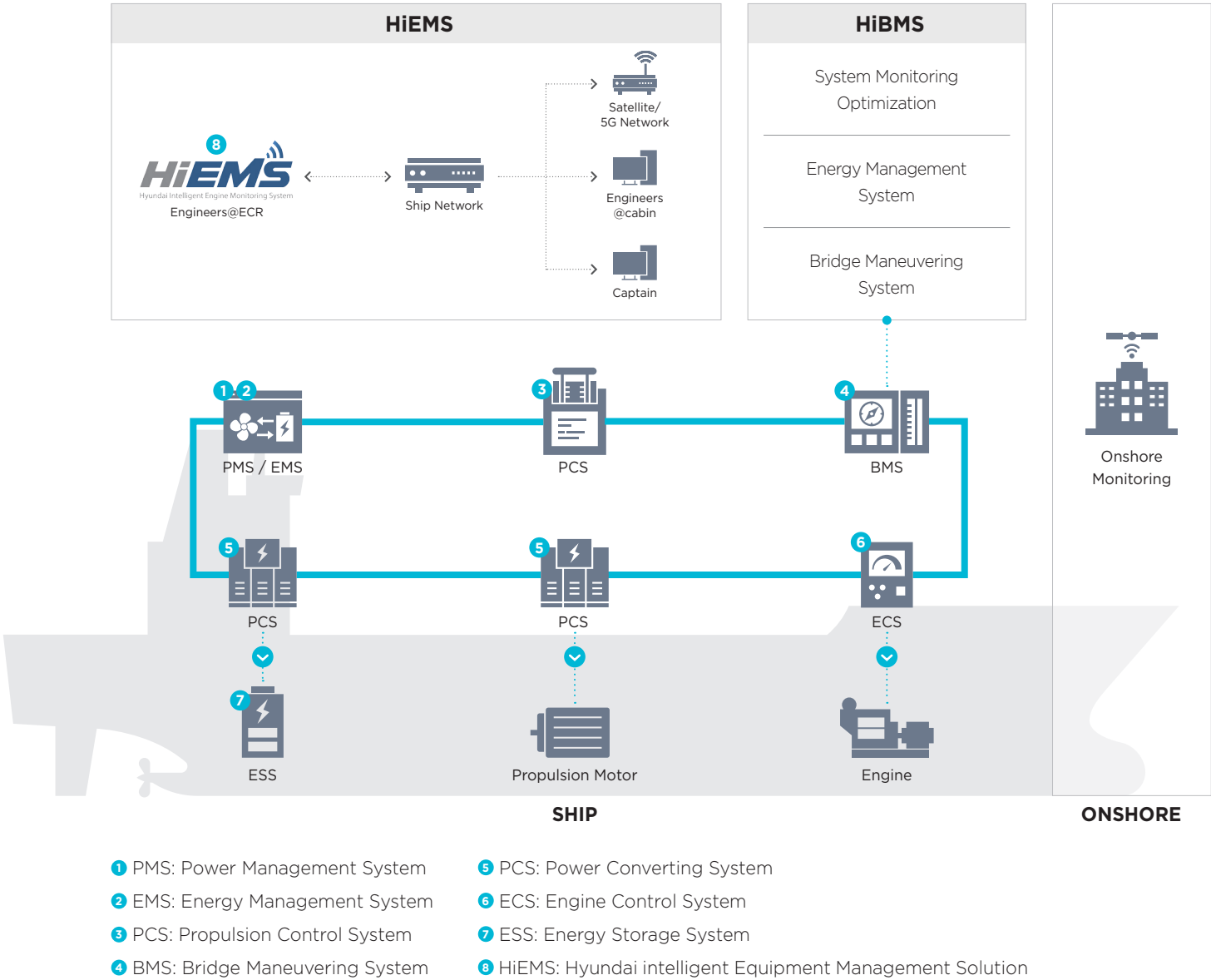
Reduces fuel and repair costs and lowers emissions



Maximizing Performance with Integrated Controls


From the engine control system to the energy management system, our extensive expertise and product knowledge guarantees that users will achieve excellent performances and functionality of their package equipment. Our multiphysics-based simulations allow us to virtually assess and optimize the performance of all of our electric power and mechanical propulsion systems. This in turn allows our systems to boost overall productivity all the way from the initial development stages until the stage of final performance validations and controls calibrations.


Integrated Control System for Maximizing the Performance of Packaged Equipment



FLEXIBILITY AND MANEUVERABILITY FOR A WIDE RANGE OF VESSELS


The HiMSEN Hybrid Propulsion System is designed for use with both full electric and hybrid propulsion with a wide range of power. Applicable types of ships are included in the list below, but are not limited to it.



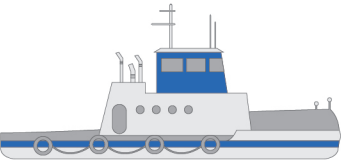




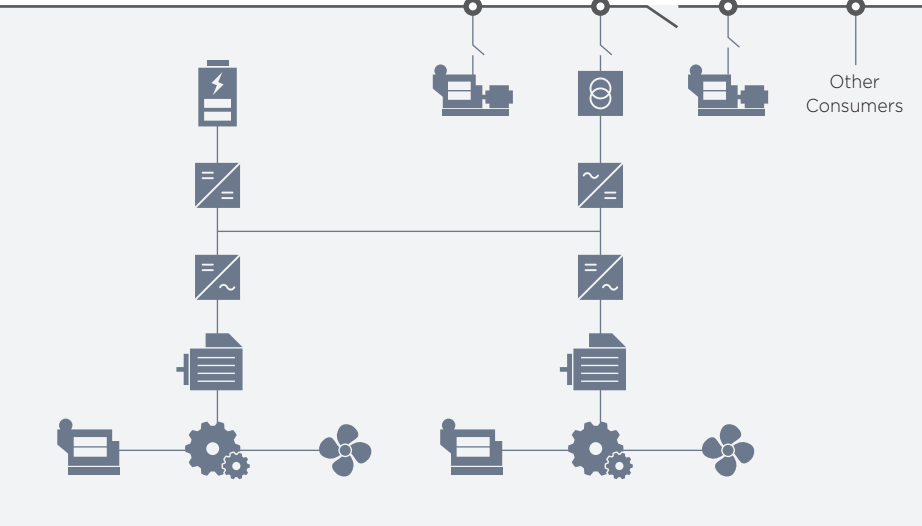




Tugs/Dredgers



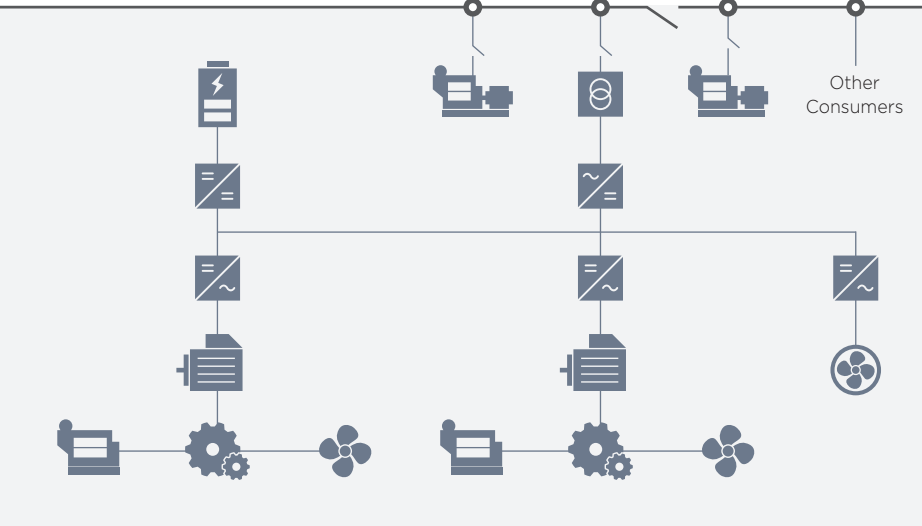
The ESS provides additional power for more bollard pull and power demand. Its features include cold starting, zero emissions, increased load acceptance, and enhanced reliability.



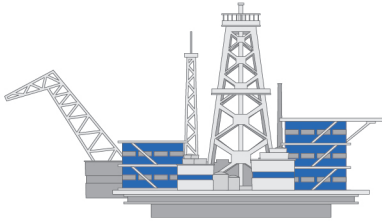
Ferries/Passenger Ship



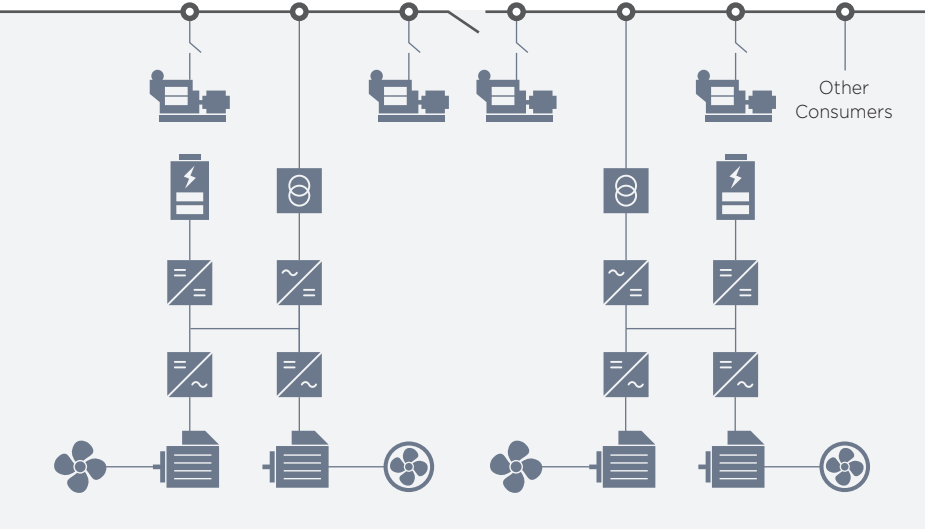
Boasts zero emissions due to full-electric power being driven by the ESS. Engine noises, vibrations, and smoke levels are all drastically reduced or eliminated when a vessel is in port and/or during short sailing routes. Additional features include excellent maneuverability, high fuel efficiency, and low operating costs.



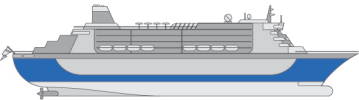
Offshore



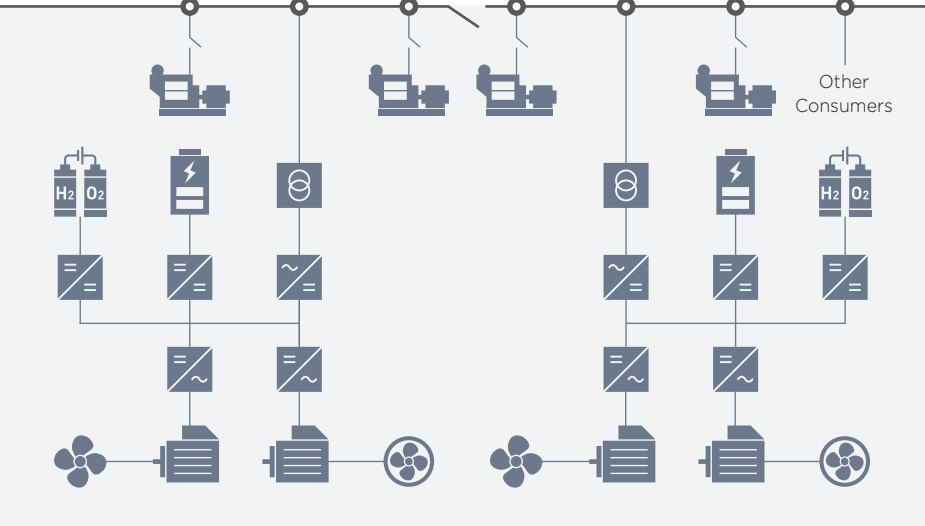
The ESS can handle load fluctuations easily, leading to stable operations of the machinery. It also features reduced fuel consumption, especially during dynamic positioning operations. The long time needed between overhauls enables a higher rate of vessel utilization.



Cruise Ships



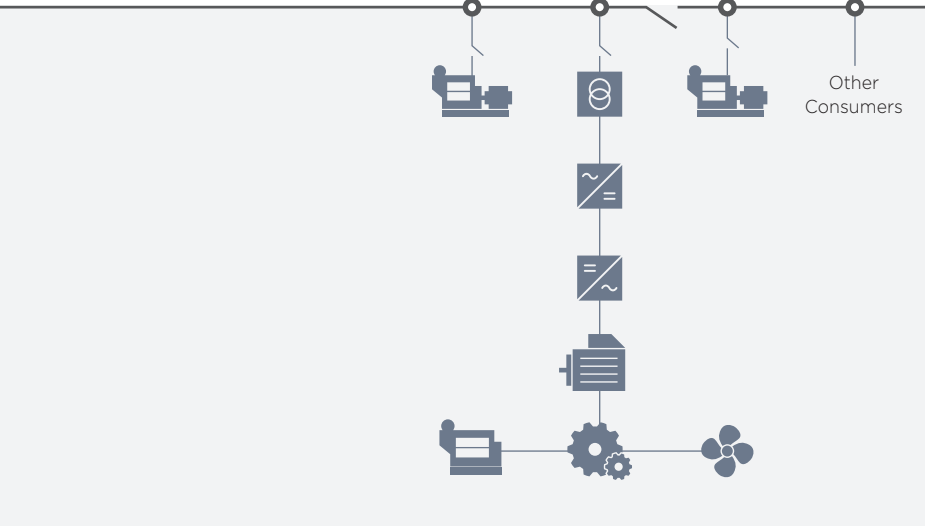
The ESS enables a zero emissions future and an ultra-efficient way of powering cruise ships. Its ability to use fuels with different energy transformers make it a key element in creating eco-friendly cruise vessel boasting enhanced safety, flexibility, and versatility. The fuel cell also provides operators with the necessary power to deal with blackouts and restart the engines electronically.



Carriers



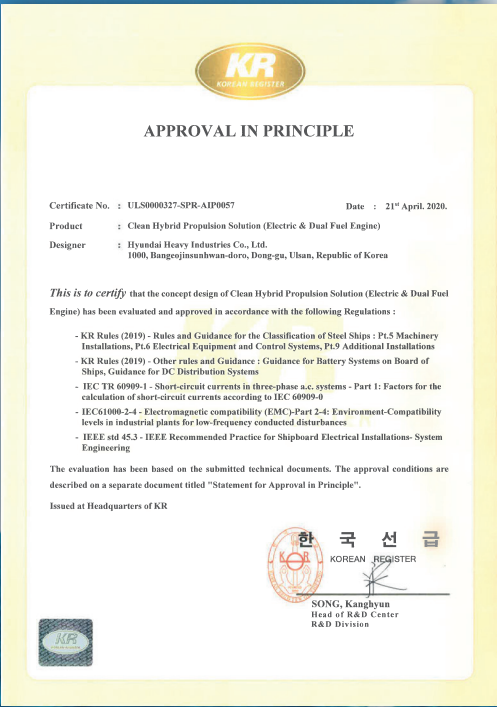
Installing a shaft generator in tandem with the main engine eliminates the need for an auxiliary engine. In addition, the main engine's operating level can be boosted by using the shaft generator in power-take-in mode. If main engine fails, the shaft generator ensures the vessel can return to the nearest port.



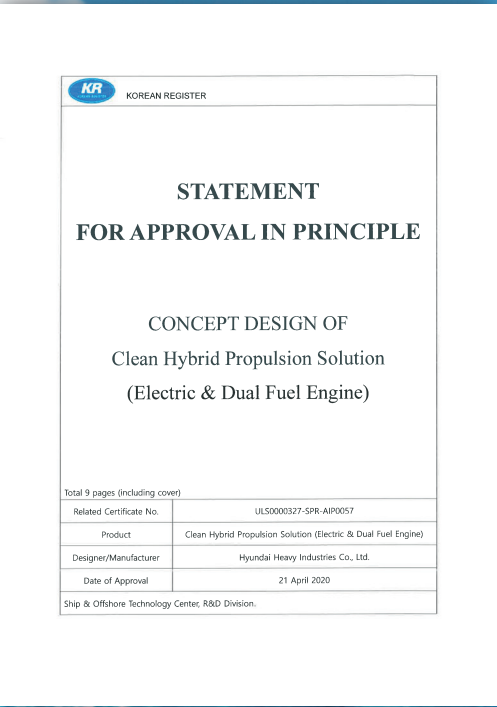
LEADING IN RELIABLE AND SEAMLESS SOLUTIONS

Reviewed and verified by Korean Register: "The target system of this AIP is the HiMSEN Hybrid Propulsion System (Electric and Dual Fuel Engine) for use in electric propulsion packages for small and medium vessels. The system's distinctive features are its Seamless Electric Propulsion system, Wide-range Speed Variable Engine, Onshore ESS charging, and Speed-based Propulsion-mode Control."

APPROVAL IN PRINCIPLE



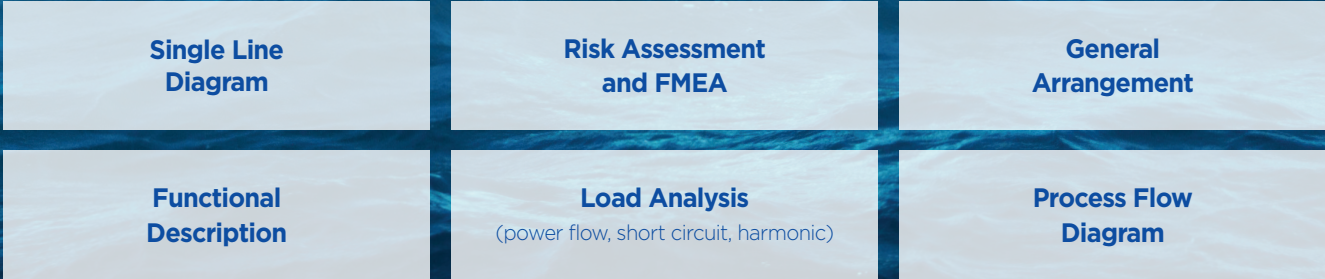
STATEMENT
FOR APPROVAL IN PRINCIPLE



PLUG IN HYBRID PROPULSION SYSTEM FOR TODAY AND TOMORROW

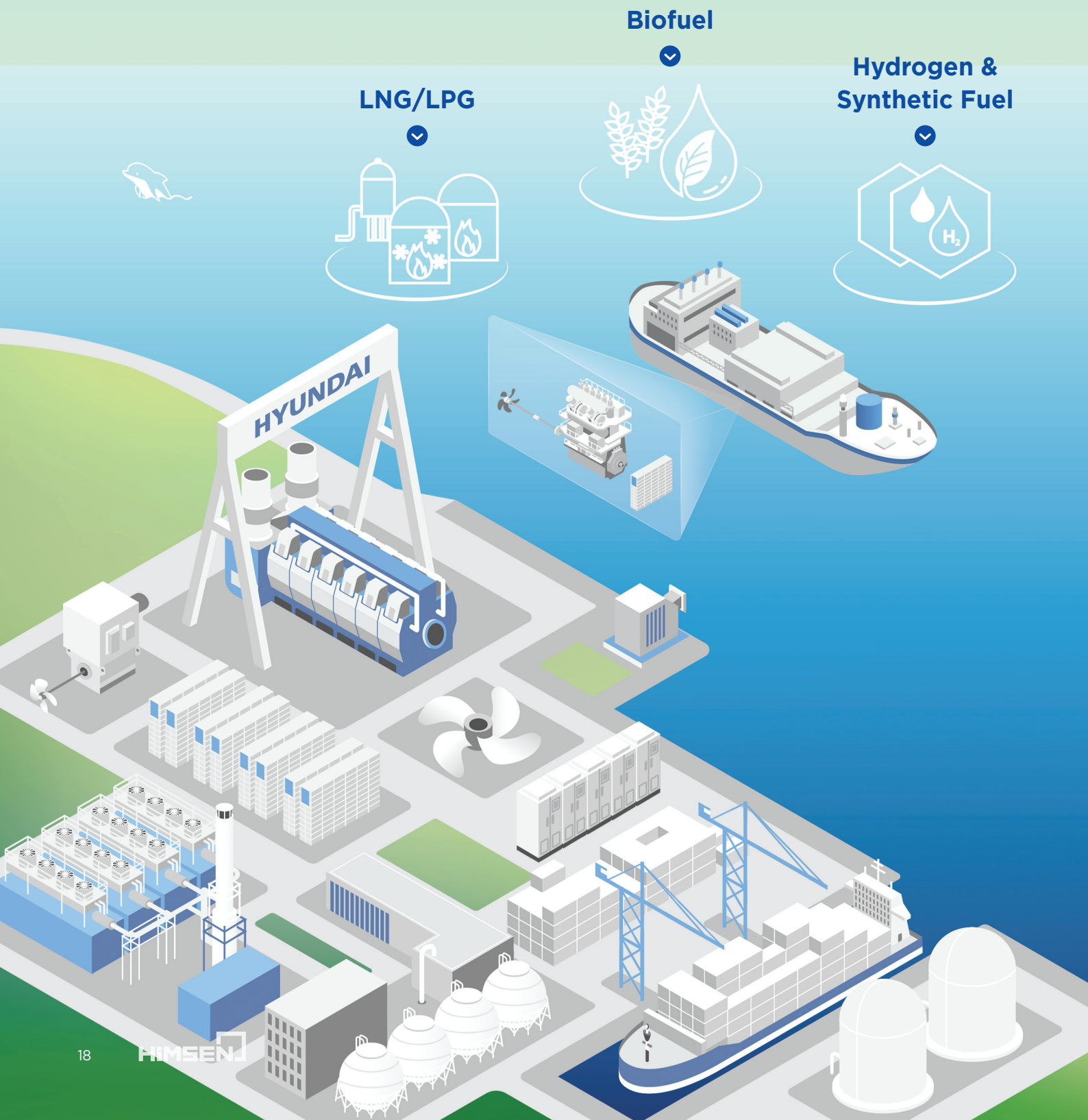


Hyundai Heavy Industries (HHI) has been a leader in the world's shipbuilding industry since 1972. Our Engine and Machinery Division, or HHI-EMD, was launched in 1978 to manufacture marine and stationary engines, and has enjoyed a dominant position as the world's leading engine manufacturer to date. Its superb products and service record have enabled it to capture 35% of the global 2-stroke engine market, making it the recognized leader in the world's engine power generation sector as well. The Hyundai Heavy Industries Group is currently leading the future in such operating areas as offshore and industrial plants, oil refineries and petrochemicals, electric systems, construction equipment, green energy, and engines and machinery.



FOR A SAFE, SECURE, CLEAN, AND SUSTAINABLE FUTURE

HHI is involved in R&D activities covering a wide variety of design, operational, and economic solutions for global users. We are an eager contributor to the global fight against climate change and its many negative impacts. All options regarding possible sources of power, such as electrification, hybridization, and alternative fuels (including hydrogen, biofuels, and others) are being considered in our search for worthwhile candidates. The process also includes developing engines that are capable of running on both carbon-based and zero-carbon fuels in existing fleets. We are especially investigating ways of replacing traditional forms of fuel seamlessly and with maximum energy efficiency for use by all types of ships, no matter what work they are doing.



LNG/LPG



Biofuel



Hydrogen & Synthetic Fuel



Electrification



Energy Management



Fleet Management
Logistics & Incentives



Voyage Optimization

