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WHITEPAPER

ULSTEIN® POWER VSG
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AC vs. DC power architectures in offshore vessels and the operational advantages of the ULSTEIN VSG system

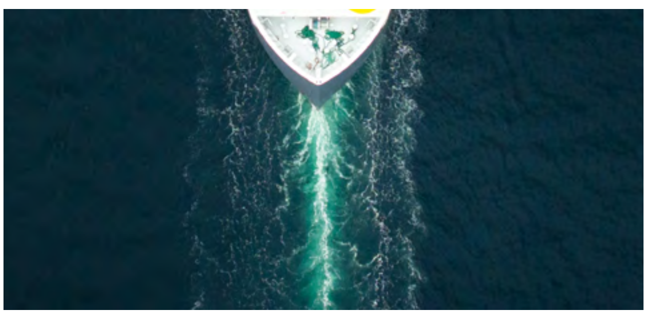
ABSTRACT

Offshore vessels operate under some of the most demanding electrical load profiles in the maritime industry. Their power systems must support propulsion, dynamic positioning, heavy auxiliary loads, ROV equipment, cranes, and hotel functions—often simultaneously. In recent years, DC-based marine power systems have been proposed as a pathway to improve fuel efficiency and enable modern hybrid solutions. However, the practical complexity of DC protection, the heavy reliance on power electronics, and the increasing demand for specialised technical competence pose significant challenges for operators. This whitepaper provides an integrated discussion of AC and DC power system architectures in offshore vessels, examines operational and staffing implications of full DC adoption, and presents the ULSTEIN® POWER Variable Speed Generator (VSG) system as a hybrid AC/DC approach that achieves DC-like efficiency while maintaining the robustness of traditional AC distribution. Verified operational data from the Olympic Notos and Olympic Boreas demonstrates the potential of this approach.

INTRODUCTION

Offshore construction and subsea vessels are characterised by dynamic load patterns. During transit, propulsion demand dominates; during crane operations or ROV support, high auxiliary loads are present; and during dynamic positioning, power demand fluctuates constantly and often sits well below installed capacity. Traditional diesel-electric propulsion systems, based on fixed-speed AC generation, have been favoured for their stability and maturity. However, they force the diesel engines to run at a fixed speed regardless of the vessel's power requirement.

As fuel prices rise and emissions tightening accelerates, alternative power architectures have gained attention. DC distribution systems have been promoted to operate diesel engines at variable speeds, thereby reducing fuel consumption at low loads. Yet the transition to DC is not without significant operational and economic consequences.



AC POWER SYSTEMS IN OFFSHORE VESSELS

For decades, the standard electrical architecture on offshore vessels has been based on fixed-frequency AC distribution. Diesel engines must maintain a constant speed to ensure the generator produces the required frequency. This architecture is supported by extensive class rules, electrical standards, and proven component designs, making it predictable for crews to operate and maintain.

However, the inherent limitation of AC systems is the inability to decouple engine speed from electrical frequency. This forces engines to remain at a constant RPM even during low-power scenarios, pushing them outside their optimal fuel-consumption region and leading to increased emissions and wear.

KEY BENEFITS

- Reduced emissions
- Improved fuel efficency
- Improved onboard comfort
- Reduced maintenance cost
- Robust and future-proof technology

DC DISTRIBUTION IN MARINE POWER SYSTEMS

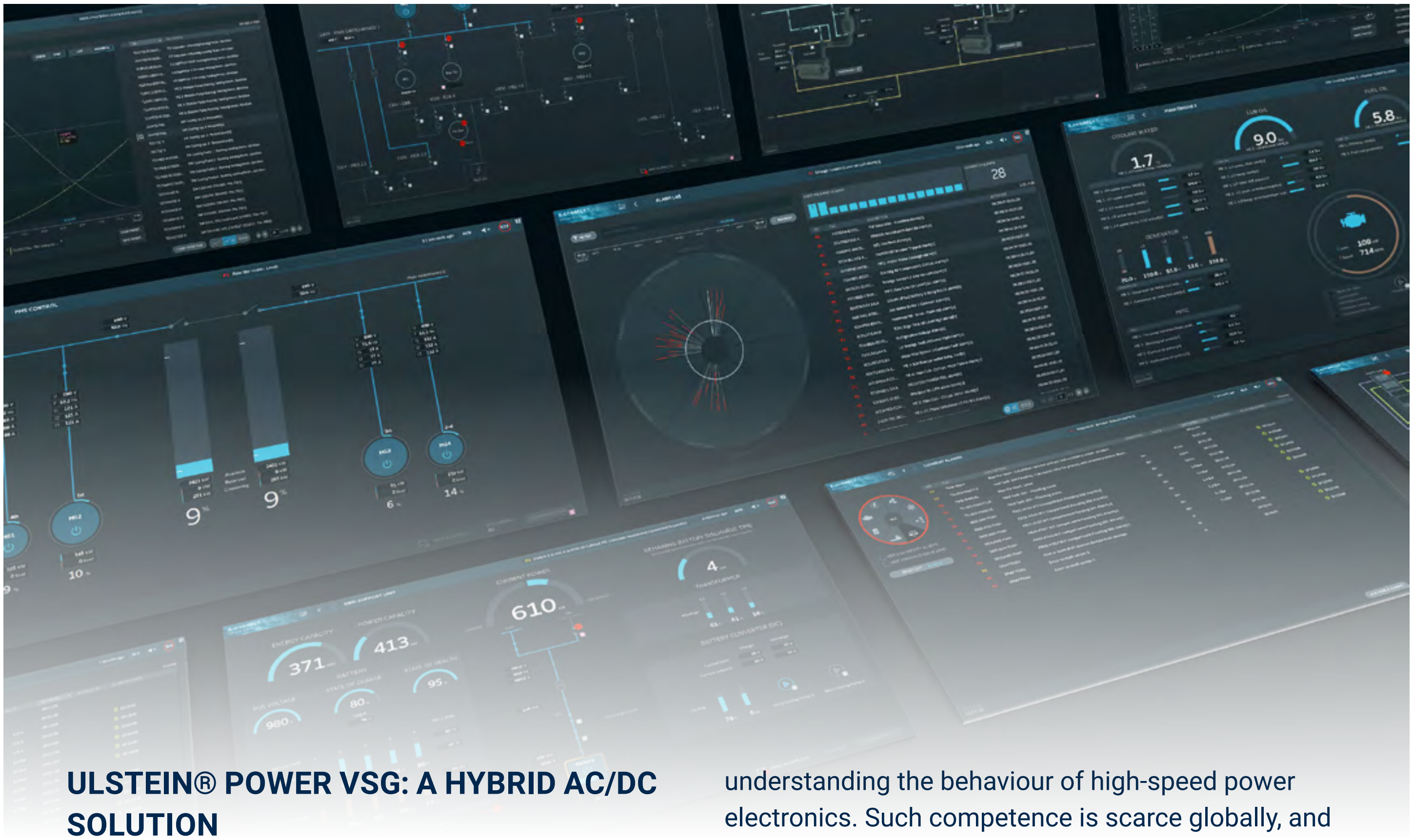
DC distribution removes the strict link between generator RPM and output frequency, allowing diesel engines to operate at optimal fuel consumption points. This flexibility makes DC attractive for hybrid propulsion, battery integration, and low-load operations.

However, DC introduces challenging fault behaviour. Without the natural zero-crossing of AC current, DC arcs do not extinguish themselves. Fault currents rise extremely quickly because DC networks, dominated by converters, have low impedance and large capacitor banks. DC protection, therefore, requires advanced hybrid or solid-state breakers and complex coordination algorithms. A DC vessel becomes heavily reliant on power electronics, which introduces heat, new failure modes, and higher maintenance demands.

TOTAL COST OF OWNERSHIP AND PRACTICAL CONSIDERATIONS

Although DC systems can improve fuel efficiency, their total cost of ownership is often significantly higher. Investments in power electronics, converters, advanced DC breakers, cooling systems, and specialised protection devices add substantial upfront and lifecycle costs. Integration complexity increases, maintenance becomes more demanding, and reliance on OEM support grows.

For vessel operators in harsh offshore environments, where downtime is expensive, these risks are significant.



ULSTEIN® POWER VSG: A HYBRID AC/DC SOLUTION

Ulstein’s Variable Speed Generator (VSG) system combines the efficiency benefits of DC distribution with the operational robustness of AC grids. It introduces a converter between the diesel generator and the AC switchboard, decoupling the generator’s RPM from the output frequency while preserving AC distribution.

The vessel maintains all the advantages of a mature AC architecture—conventional protection, known switchboards, and familiar troubleshooting—while achieving the efficiency gains of variable-speed operation.

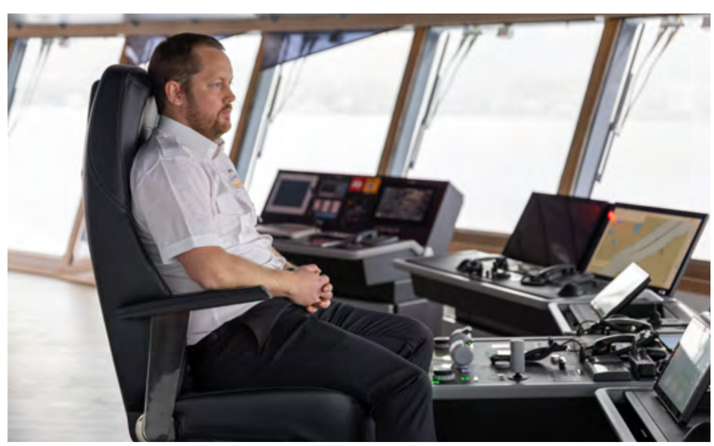
CREW AND OPERATIONAL ADVANTAGES

One of the most overlooked aspects of the AC vs. DC debate is the impact on crew competence and vessel operability. Transitioning to DC fundamentally changes how faults must be diagnosed. DC protection logic, converter-dominated fault signatures, and non-linear behaviours require training far beyond traditional AC marine electrician experience.

Troubleshooting DC systems often requires interpreting converter logs, analysing protection events, and understanding the behaviour of high-speed power electronics. Such competence is scarce globally, and marine operators must usually rely on OEM technicians.

This dependency introduces a tangible operational risk. If a DC-related fault occurs offshore that the crew cannot resolve, the vessel may be forced off-hire until specialists arrive. Given offshore day rates, even short delays can result in substantial financial losses.

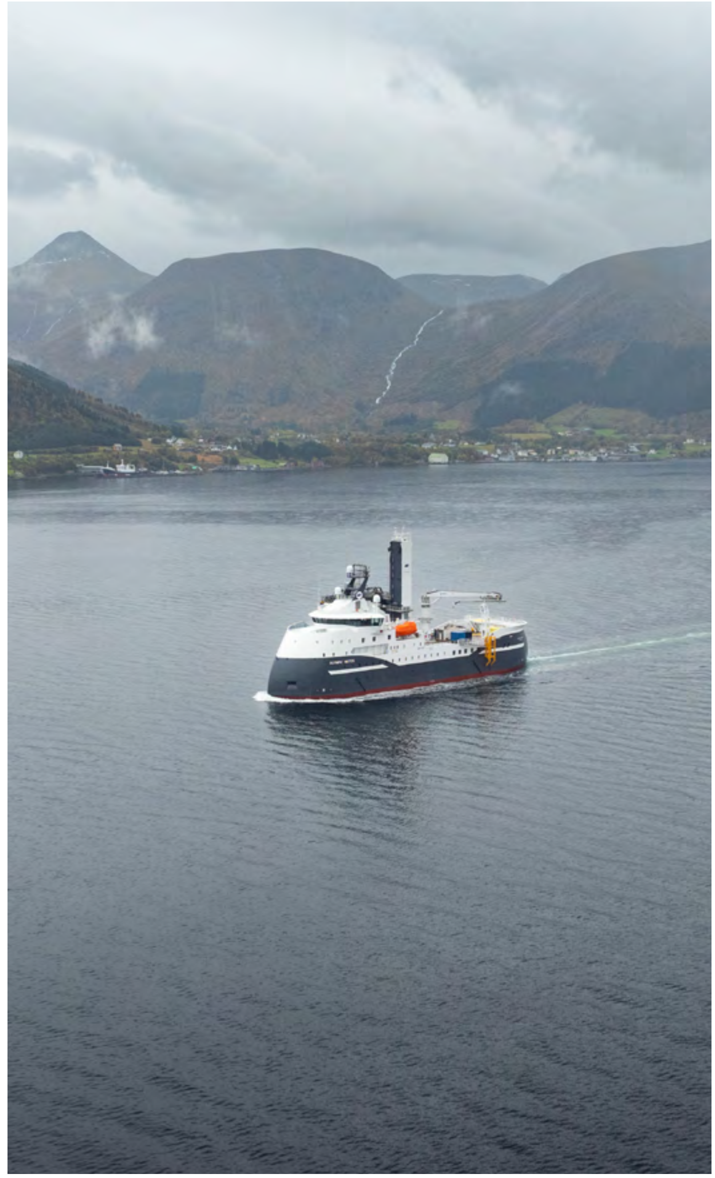
Ulstein’s VSG avoids this issue by retaining AC switchboards and protection characteristics. A traditional electrical crew can manage most electrical issues without waiting for external specialists, significantly reducing downtime risk.



CASE STUDY: OLYMPIC NOTOS & OLYMPIC BOREAS

Both the Olympic Notos and Olympic Boreas are equipped with VSG technology, hybrid energy storage, and the ULSTEIN X-BOW® hull. Their operational profiles demonstrate exceptional fuel efficiency across all modes. In dynamic positioning, where vessels often operate far below rated power, VSG keeps engines near optimal efficiency. During transit and standby, the same principle applies.

Operators have reported double-digit percentage reductions in fuel consumption, along with reduced noise, vibration, and emissions.



CONCLUSION

DC systems offer theoretical efficiency benefits but introduce substantial engineering and operational challenges. Ulstein's VSG provides a hybrid solution that achieves variable-speed efficiency within a familiar AC framework. Real-world results from Olympic Notos and Olympic Boreas confirm significant fuel savings, reduced emissions, and improved operational uptime.

Fun fact: The original AC/DC feud

Long before AC and DC marine applications were debated, the world witnessed the famous War of the Currents between Thomas Edison and Nikola Tesla, with George Westinghouse. Edison championed direct current, hindered by its inability to efficiently transmit power over long distances, while Tesla's alternating current system enabled voltage transformation and long-distance transmission. Edison attempted to undermine AC with public demonstrations, but the commissioning of the Niagara Falls hydroelectric station secured AC as the global standard.

Today's AC/DC debate on offshore vessels mirrors the same themes: AC is simple and robust; DC offers efficiency at the cost of complexity and risk.

Ulstein's VSG represents a modern hybrid solution that captures the best of both systems.

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Let's talk. We're here to help.

Rolf Ottar Rovde
Sales Manager
Ulstein Power & Control AS
Tel: +47 901 05 673
rolf.ottar.rovde@ulstein.com

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ulstein.com

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