INSIGHTS INTO
FUTURE OSV DESIGNS AND OPERATIONS

TABLE OF CONTENTS

MARKET OUTLOOK: OPERATIONAL FLEXIBILITY

The trends for offshore support vessels (OSV) point to a carbon neutral future with operations fully integrated with offshore fields, port infrastructure and supply chains.

They will need to be fully digitalized, connected and highly automated to tie into their supporting ecosystems. The future OSV will be configured and connected to provide clear operational visibility and the ability to track vessels, cargo, equipment and people around the clock. At this level of connectivity, OSVs also will have the capacity to better manage the wellbeing of their crews.

The OSV of the future will be powered by 'green' alternative fuels – and alternate low-carbon transitions to energy-storage systems (ESS) and hybrid-propulsion solutions - future OSVs also will need to be equipped with systems designed to track emissions and improve operational performance. These ships will feature enhanced levels of autonomy.

The future OSV will be multi-functional – equipped to serve multiple offshore sectors - with larger accommodation spaces, heavy-lift cranes, helidecks and streamlined hull forms, all designed to perform complex support operations. Their specialized services include: platform supply, anchor handling, subsea construction, installation, maintenance, repair, pipe-laying, platform decommissioning, as well as support for diving systems and remotely operated vehicles (ROV).

The operational capabilities of OSVs may evolve to support many disparate sectors such as offshore wind, space missions (launches and recoveries), carbon capture (transport) and subsea mining.

One design concept currently on the industry's drawing boards is for an OSV 'mothership' that would be crewed, but also house a fleet of autonomous surface vessels, ROVs and autonomous underwater vehicles used for operations such as repair and maintenance, cargo distribution and subsea inspections.

The hulls of future OSVs will be designed to operate in higher sea states, to allow for greater multi-mission operational flexibility. Offshore wind farms, which are getting larger and migrating into deeper waters, will demand higher operability requirements of OSV operators and their ships.

Transitioning the global OSV fleet to 'zero-emissions' operations will need to be accomplished while not only maintaining but improving the levels of safety, operational performance and bunkering efficiency as current practices, without increasing risk.

The technologies are available to reduce CO_2 emissions from current OSV fleets, through electrification and 'green' alternative fuels. Some of those technologies are mature, while others remain in discovery phases. These technologies are expected to prove suitable for both oil-and-gas and windfarm vessels.

Though the current carbon-reducing measures are encouraging (such as retrofitting batteries), there are limits to what can be accomplished with the existing fleet. Ultimately, any further changes will be driven by regulation and whatever the industry and its suppliers can support.

To gain operational efficiency, new OSV designs are examining the potential of 'tri-fuel' technologies, such as dual-fuel or alternative 'green' fuel-ready concepts in combination with ESS. The adoption of battery and battery-hybrid propulsion systems is expected to continue in tandem with a gradual electrification of the fleet.

Future sources of propulsion power could also become modular, a transition that would support the installation or retrofitting of power plants and systems upgrades.

As shipping escalates efforts to reduce its CO_2 output, 'green' fuel pilot projects are underway, exploring the use of biofuels – biogas or bioLNG – ammonia, hydrogen and methanol. Among these alternatives, hydrogen and fuel cells have gained considerable traction. As some renewable fuels can lack the energy density required for longer voyages, studies on the future demand for additional refueling infrastructure are happening concurrently.

In many respects, establishing how quickly fueling infrastructure can be expanded will set the pace for the adoption of alternative fuels; it is not just about the fuels' compatibility and efficiency.

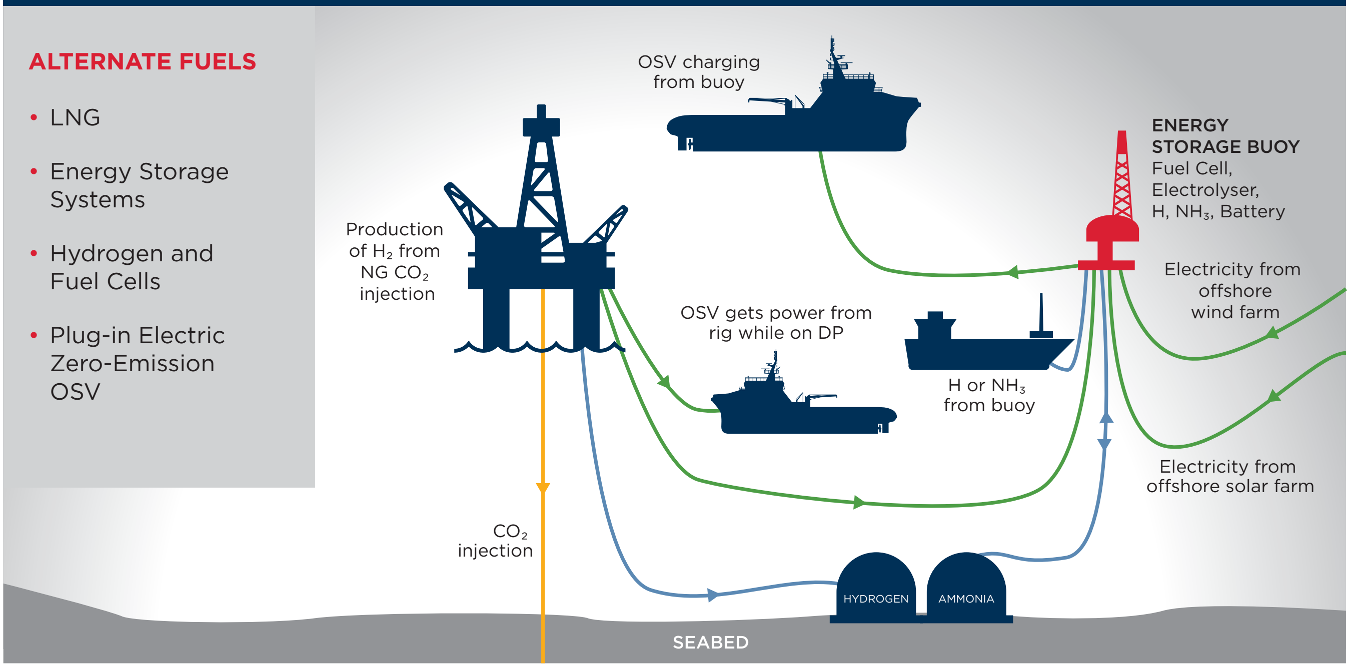
It is possible that other market-tested infrastructure could be used to provide renewable alternative fuels to the OSV sector. One such strategy would provide the vessels with access to electrical power at ports connected to the grid.

Shore power and offshore charging buoys are evolving technologies, but they hold the potential to charge vessels with the renewable energy produced by offshore windfarms, for example.

Sustainable fuels aside, connectivity is a critical functionality that all future OSVs will need. The digital twin – a virtual representation that serves as the real-time counterpart of a physical asset or process – can help operators to analyze disruptive events before they happen, increasing safety and operational efficiency.

Virtual performance simulations allow operational issues to be examined before they can go wrong, building dependability and operator confidence. The emergence of 'digital twin' concepts supports real-time decision-making and planning.

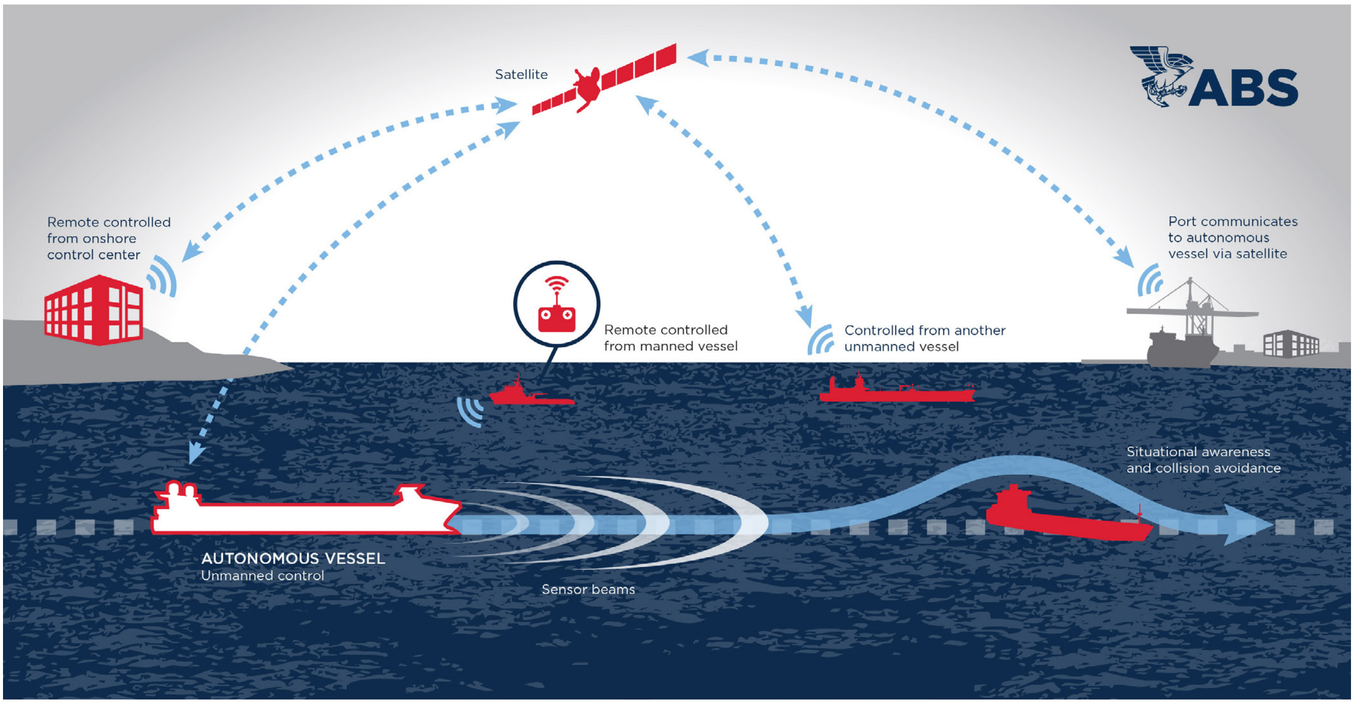
THE FUTURE OSV - GREENER POWERING



ALTERNATE FUELS

- LNG
- Energy Storage Systems
- Hydrogen and Fuel Cells
- Plug-in Electric Zero-Emission OSV

Digital support also is increasingly available from other members in the OSV value chain. Original Equipment Manufacturers (OEM) are now monitoring their components and equipment from the shore, via onboard sensors.



The popularity of these services is growing as quickly as they become available; charterers are already looking for more operational transparency, just as operators are seeking the kind of insights into an OSV's 'health' that can be provided by artificial intelligence (AI).

Digital products can offer visibility of everything from the performance of individual vessels or the fleet, to the operating state of each propulsion system and its components and the wellbeing of the crew.

The future OSV also will incorporate more autonomous functionality, a transition that will begin apace when shipping builds more confidence in the decision-making ability of AI.

Class societies are collaborating with the OSV community on building the capabilities of the digital fleet, the reduction of crewing, increased autonomous functionality and enabling the kind of remote or condition-based programs that increase operational dependability.

Industry stakeholders such as charters, owners, shipyards, designers, systems integrators, flag administrations and class societies are working together to produce the next generation of OSVs. This collaboration will bring environmentally sustainable and connected vessels, which can help to deliver business goals into the 2050s.

MARKET OUTLOOK: RENEWABLE ENERGY

The offshore wind (OSW) market has witnessed tremendous growth in the past year, despite a constant negative impact from COVID-19 pandemic on the global economy.

Last year (2021), China led all nations by connecting just under 17 gigawatts (GW) of new OSW power to its grid[1]; by comparison, at last official count the U.K. had a total installed capacity of just 10.4GW. However, in January (2022), the UK reaffirmed its plans for the sector by awarding developers 15GW of the 25GW in new capacity the country is committed to developing across 17 OSW sites.

The American Bureau of Shipping (ABS) last year provided classification services to two of the world's largest floating OSW projects: Wind Float Atlantic, which saw the largest ever turbine installed on a platform 20km off the coast of Portugal, brought three turbines and 25MW online in July 2021; and Kincardine, built in 60-80 meters of water some 15km off Scotland's Aberdeenshire coast, brought five turbines (or 50MW) online in October of 2021.

The latter forms part of a larger first-round commitment to OSW project leasing by ScotWind, a Scottish crown corporation, which aims to add 15GWs to a committed project pipeline and build the kind of local supply chain that would support even larger projects.

These new, deeper water OSW markets and the growing size of turbine components will require most existing designs for offshore support vessels (OSV) to be modified if they are to continue to support this growing industry.

On the other side of the Atlantic, U.S. developers this year will begin construction of two offshore projects that are destined to add just under 1 GW to the sector's national power capacity; the U.S. is committed to adding 30GW by 2030 and to developing the associated supply-chain infrastructure and capabilities – such as manufacturing, ports and shipbuilding – to support that goal.

The infrastructure requirements alone are significant. A recent report by the U.S. Department of Energy (DoE) estimated that reaching the 2030 capacity goal would require: 2,110 new turbines, about '7,100 thousand tons' (7.1m tons) of steel, 45 substations and more than 9,240 miles of cabling. At least nine ports have committed to upgrading their facilities to support the OSW sector's heavier lifting requirements, as well as dredging programs to provide deeper water at their berths.

---

[1] https://www.windpowermonthly.com/article/1738591/china-reports-169gw-new-offshore-wind-2021

The DoE report also estimated that the sector's existing fleet of OSVs would need to be expanded by more than 110 units to move all the components and personnel to and from the project sites. As with the Europe projects (sited above), part of demand for new ships will be driven by the projects' need to transport larger turbines and their associated components.

Outside of China, there are known global commitments for 152GW of installed capacity by 2030 at an estimated capital expenditure of US$532 billion. By comparison, there is 34GW of operating capacity presently installed (mostly fixed-bottom installations), while the U.S. has a mere 42MW.

While most of the early OSW platforms are of the 'fixed' variety, the future is now floating. And, for some countries and states, that future is a lot closer than others. South Korea, Scotland, Portugal, Italy, the U.S. west coast and the states of Maine and New York, all have nearshore deeper water resources to tap in the near term.

For example, in January this year New York announced plans to kickstart its "Master Plan 2.0 Deep Water", which initially involved finalizing lease commitments in a February auction of deeper nearshore sites in federal waters.

In general, the offshore wind market is developing rapidly, spurred on by the success of early project deployments across a variety of operating environments, a more secure project pipeline and a better understanding of the associated risks.

New design, construction and installation standards are being developed for OSVs, as well as for the original equipment manufacturer (OEM)-supplied components used in the platform bases for floating or substation structures.

In the past 10 years, the increased height and blade lengths for wind turbines have seen their unit ability to capture and produce energy grow from 3MW for the early units to 12-15MW for the next generation of projects. Some forecasts expect the unit capacities for turbines to continue to grow at about 15% annually.

As early OSW power plants begin to retire, the inherent technological advancements - including improvements in manufacturing and installation — are guiding the sector down the same development path as solar energy, one where the price of its energy becomes more competitive and attractive to power markets.

With the OSW market established and its supply chain adapting to the new requirements, many nations have begun to look to sea for new energy sources. The globalization of the market has increased competition and is it spurring on new creative vessel designs that lessen the risks associated with crew and product transfers.

In line with the global goals of the transition away from carbon-based forms of energy, member partners in OSW project supply chains are increasingly mindful of the full lifecycle carbon footprints for their products.

OSW developers, engineering, procurement and construction contractors, OEM turbine suppliers, vessel owners, shipyards, ports and designers are joining forces to support hybrid approaches to fuel consumption and blending, or to balance current energy sources with cleaner alternatives.

As project supply-chain partners consider their options for cleaner technologies, potential opportunities are arising for energy to be collectively sourced by developers, local ports and associated vessel owners.

Some companies are examining the potential for offshore wind projects to generate 'green' hydrogen (via fuel cells) before delivering it to ports for onshore use, or at sea for remote refueling.

Opportunities also are being explored for 'port-to-project' battery-charging initiatives, including the potential for smaller vessels to recharge at OSW substations. Both hydrogen from fuel cells and electric battery charging would require new forms of OSV integration suitable to refueling or recharging in the disparate operating conditions found at sea and onshore.

For OSW project developers, the future will include ever-larger turbines being installed on fixed and floating platforms that increasingly incorporate 'greener' energy into the supporting vessels and manufacturing supply chains. Far from future fantasy, that 'green' transition is happening now.

And as the speed of the transition escalates, the OSV community will be increasingly under pressure to respond with new vessel designs.

MARKET OUTLOOK: CCS AND TRANSPORT

Projected greenhouse gas (GHG) emissions present a growing concern as science continues to show the causal link between carbon emissions and global warming.

The Paris Agreement, adopted in 2016 by signatories to the United Nations Framework Convention on Climate Change, aimed to limit global warming to well below 2°C, and preferably to a safer 1.5°C above pre-industrial levels.

The Intergovernmental Panel on Climate Change presented four scenarios to limit the rise in global temperature to 1.5°C in a special report issued in 2019. All scenarios included carbon capture; in fact, three of them envision substantial use of the associated technologies with carbon capture.

With the increased focus on more sustainable operations, carbon capture and storage (CCS) projects have recently gained new momentum.

The International Energy Agency in its Sustainable Development Scenario envisioned a decline in global CO_2 emissions to 'net zero' levels, inspired by the United Nations' (UN) energy-related sustainable-development goals for emissions, energy access and air quality. The report explicitly states that reaching 'net zero' will be virtually impossible without CCS.

A coalition of 19 countries at the UN's recent COP26 climate summit in Glasgow agreed to create zero-emissions maritime trade routes to speed up the decarbonization of shipping, which accounts for nearly 3% of the world's CO_2 emissions.

The International Maritime Organization has set an initial target to reduce the overall GHG emissions from ships by 50% (from 2008 levels) by 2050, but the agency is under increasing pressure to set more ambitious targets. There are also compelling commercial demands for reducing CO_2 emissions for shipping companies to consider.

For example, the Poseidon Principles, a global framework covering the climate alignment of the shipping portfolios of financial institutions, is quickly gaining traction with the signatory lenders, leasers, financial guarantors, and export credit agencies to which they apply. Those signatories represent nearly 50% of the current global ship finance portfolio, valued at about US$185 billion.

In December 2021, the maritime insurance sector joined the Poseidon initiative; in general, current financial trends indicate that capital is moving towards asset classes that offer lower emissions.

Initially spurred by onshore carbon capture projects and the demand for sustainable transportation around ports, hubs and carbon sequestration sites, carbon capture technology is now being considered in more and more maritime applications.

Research and development projects are building a better understanding of the economic and environmental feasibility of different methods of forming partial and complete carbon capture, utilization and storage (CCUS) supply chains for shipping and offshore oil and gas projects.

Technical and operational gaps remain, but these are rapidly being filled as the technology behind CCUS matures and usage becomes more widespread.

Shipboard carbon capture uses similar technologies to those for onshore facilities, albeit in a smaller footprint and with more consideration for the process's power consumption. Human and equipment demands for reliability, training and operability are important variables when considering onboard carbon capture.

Carbon capture can be part of an overall strategy for GHG reduction that incorporates technologies such as alternative fuels (e.g., ammonia, hydrogen), hybrid-electrical systems and energy storage; it also holds promise for organizational practices designed to save energy.

For shipping's offshore support vessels (OSV), a major challenge to onboard carbon capture is the size and weight of the equipment currently used. These were designed for onshore projects where size and weight are not major considerations.

Furthermore, the traditional operating profiles of OSVs differ from that of general shipping; they usually make shorter voyages and spend significant amounts of time on-station, using dynamic positioning.

With these different challenges, the current development of onboard carbon capture is not suited to a 'one size fits all' fleet strategy; a techno-economic analysis for each ship type and service profile is needed to develop a set of conditions that will provide the desired result. This would include decisions on capital and operating expenditure relative to the solutions mentioned above, and as part of an overall GHG-reduction strategy.

For example, the intended CO_2 reduction from a specific capture is part of the equation: systems can gather anywhere from 30-95% of the carbon from exhaust gases; the higher the target, the greater the impact on cost and energy resources.

Aside from onboard capture, the OSV has a potential role in transporting captured carbon from mobile offshore units or offshore production facilities. Again, these vessels will have a range of energy savings and GHG-reducing features but, if carbon is captured as part of the strategy, it will need to be offloaded and sent for processing, further use, or permanent storage.

This exercise would continue the OSV's well-established role of transporting supplies and waste products to and from offshore assets. The amount of CO_2 to be transported, and the time between loads, will depend on the daily output from the rig or energy production installation.

In the short-term, carbon-reduction technologies such as alternative fuels, energy storage, etc., may remain more attractive to shipowners. However, marine carbon capture is expected to receive long-term investments and infrastructure development as demand grows.

Governments have an important role in carbon capture, as restrictions and policies such as carbon taxes or cap-and-trade systems could influence the speed and nature of the segment's growth.

The OSV, along with other vessels engaged in all aspects of the marine and offshore industries, will play their part in proving the value of emerging technologies and infrastructure as shipping transitions to cleaner practices.

For more information on this topic, refer to the ABS publication *Carbon Capture, Utilization and Storage* published in July 2021.

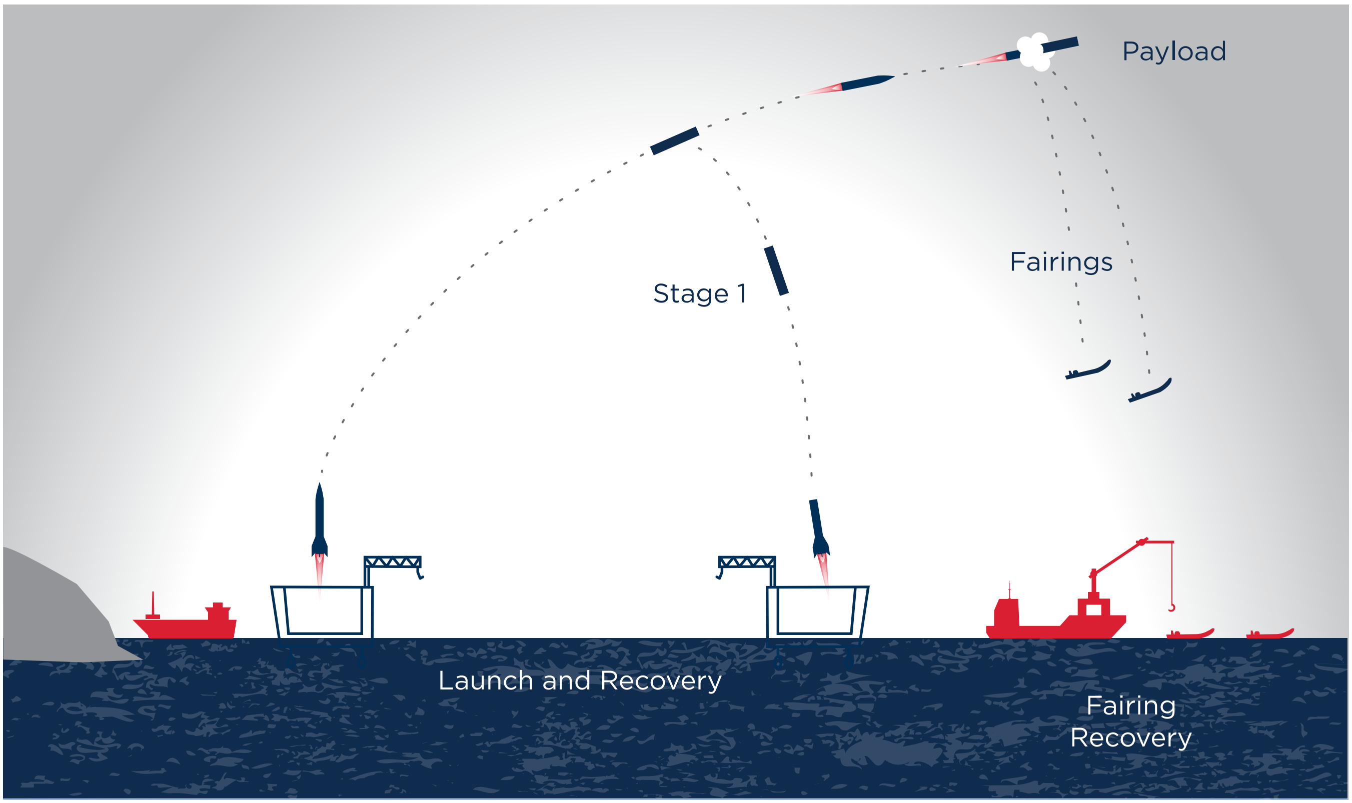
MARKET OUTLOOK: LAUNCH AND RECOVERY PLATFORMS AND SPACE SUPPORT VESSELS

This decade has been a turning point for private space flight. The feasibility of stage 1 rocket re-use was proven by companies such as SpaceX; Falcon 9 was the first private orbital class rocket capable of re-flight. Its stage 1 boosters are now routinely recovered and reused to launch manned capsules and cargo payloads to space .

Blue Origin also is developing reusable launch vehicles such as the New Glenn. As a result, specialized offshore support vessels (OSVs) and platforms will be needed for this unique theatre of operations.

Below is a conceptual launch cycle, as well as the associated vessels that may be needed for support. They fall into two broad categories:

1. Launch and Recovery Platforms (a.k.a., Spaceports) – uses include:
    a. Recovering stage 1 booster rockets at sea
    b. Launching rockets at sea
2. Space Support Vessels – uses include:
    a. Personnel transfer
    b. Towing
    c. Recovery of the reusable fairings separated in the launch cycle
    d. Recovery of manned capsules re-entering from space



Marine assets used for the first category, launch and recovery platforms, can take forms as simple as a barge, or a complex as a dynamically positioned semi-sub. There are two primary purposes for them: to launch and recover rockets.

For rocket recovery, platforms must be located offshore to be physically under the anticipated re-entry trajectory of the booster rocket. This minimizes the re-entry distance and optimizes the required rocket fuel. It is currently being performed by barges with support from OSVs for towing and personnel transfer.

For rocket launching, offshore is becoming more attractive than onshore sites because it minimizes the impact on local communities; launch operations are disruptive, creating some of the loudest sounds ever recorded.

The company Sea Launch began launching commercial rockets offshore in the 2000s, using the Ocean Odyssey, a converted drilling platform. SpaceX is planning to take this further with their Starship program, which is a "fully reusable transportation system … (and) the world's most powerful launch vehicle ever developed…"

In 2020, SpaceX purchased two drilling rigs about which Elon Musk, the company's founder, tweeted: "SpaceX is building floating, super-heavy-class spaceports for Mars, the moon [and] hypersonic travel around earth."

These units were re-named Deimos and Phobos after the moons of mars and are Liberia flagged and ABS classed.

Space Support Vessels are OSVs that assist in launch and/or recovery operations by transferring personnel, as well as towing and recovering reusable fairings and manned capsules. Their risk profiles are different than the traditional OSV designed to support oil-and-gas activities.

The recovery operations, which occur only when rockets are launched, take place miles offshore and may last just a few hours, so the OSVs can spend much of their time in standby, idling until the next launch.

The offshore industry has seen OSVs continually evolve as technology develops; 'use cases' come and go. In this decade, we will likely see a new type of OSV emerge, a space support vessel. The exact work scopes for and fleet sizes of offshore spaceports and their support vessels remains undetermined at present.

Visionary companies such as Blue Origin see a future where "millions of people are living and working in space…" and SpaceX envisions humans "becoming a multi-planetary species." For these grand visions to become reality, the industry will need OSVs and offshore platforms to support them.

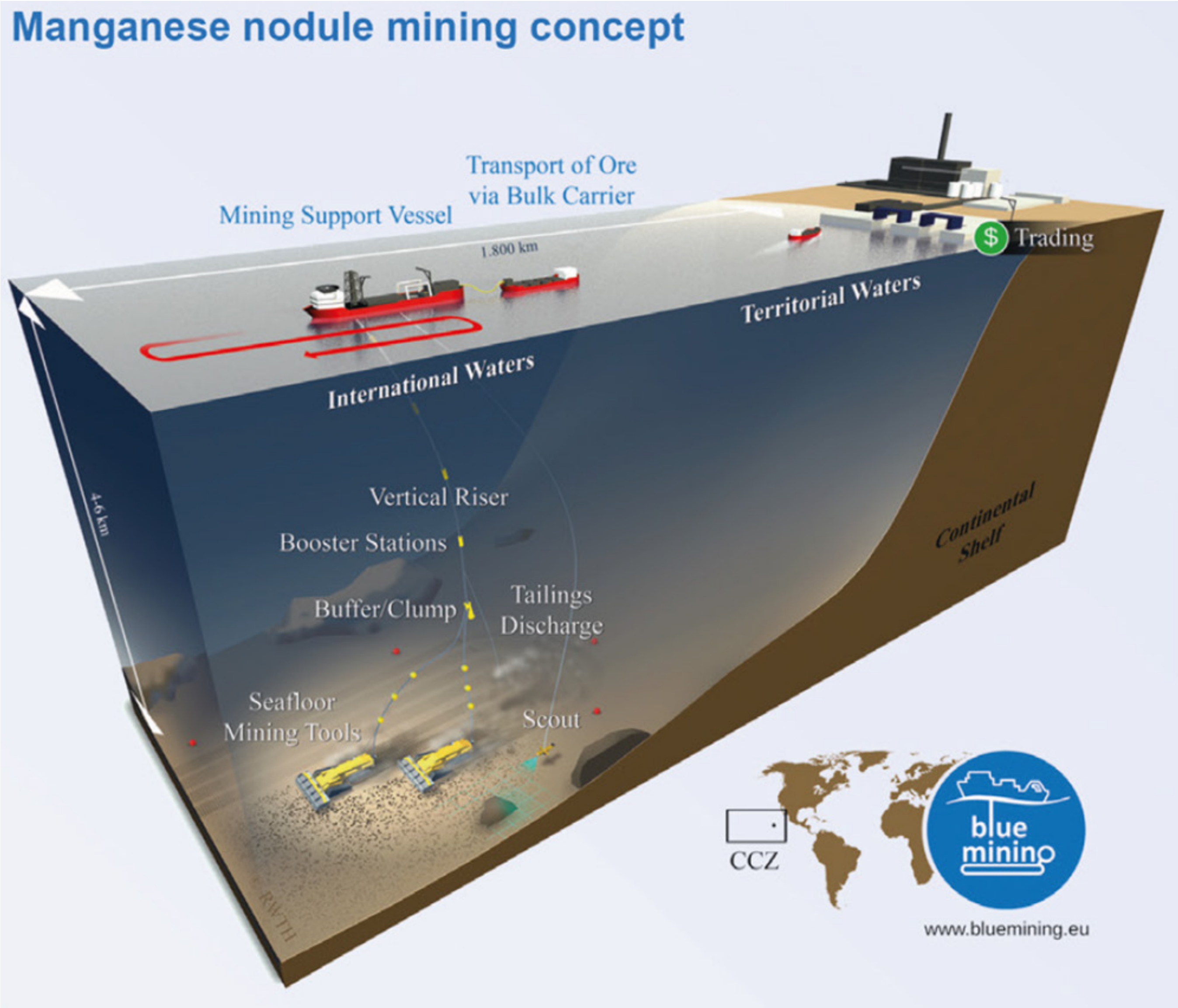
MARKET OUTLOOK: DEEP SEA MINERALS

The production of the metals needed to support the transition to lower carbon forms of energy will need to increase six-fold by 2040 to meet the world's ambitious climate targets, according to the International Energy Agency.

Many of these metals are becoming increasingly difficult to extract sustainably from terrestrial sources, but they are found in abundance at sea in the form of polymetallic nodules (a.k.a. manganese nodules).

The offshore industry is exploring innovative ways to meet the functional, performance, safety and environmental requirements to responsibly extract these vital subsea minerals. The present configurations for offshore support vessels (OSV) will need to be adapted to fit a new concept of operations that will support the recovery of polymetallic nodules from deep waters.

The image below shows an overview of a deep-sea mining operation, courtesy of Blue Mining. A large subsea nodule collector is deployed from a surface vessel to gather polymetallic nodules on the seabed using methods that resemble those of a land-based crop harvester.



The ore is then pumped to a vertical riser via a jumper hose and lifted onto the surface vessel. It is processed and stored onboard the vessel and eventually transferred to a bulk carrier for shipment to shore.

This operation presents many challenges to the typical OSV, such as:

- The offshore handling of heavy collector vehicles (current designs weigh hundreds of tons)
- The remoteness of work locations (many areas are thousands of miles from shore)
- The handling and stowage of cargo, which takes the forms of slurry or dry bulk
- The transfer of cargo to a transport vessel
- Deployment/retrieval of the equipment used for environmental monitoring

The industry is currently evaluating a series of innovative concepts that are being designed to maximize safety and minimize cost. OSVs will be needed to support these offshore operations, potentially performing functions from towing support to assisting in the deployment and retrieval of mining tools and environmental equipment.

ABS can assist with concept selection through its new ‘technology-qualification’ process outlined in the ABS Guidance Notes for Qualifying New Technologies. These guidance notes take a systems-engineering approach to qualification and support the systematic and consistent evaluation of new technologies and novel concepts.

ABS can also perform a preliminary approval of a novel concept using the Guidance Notes on Review and Approval of Novel Concepts. As part of the Novel Concept Class Approval process, ABS grants an approval in principle at an early phase of conceptual design to help the client demonstrate the feasibility of a project to partners and regulatory bodies.

In 2020, ABS published the *Guide for Subsea Mining*, which provided the first classification requirements for the design, construction, installation and survey of mobile offshore mining units. Successful applicants are awarded the ‘Subsea Mining’ class notation.

Much needs to be understood about the role of the OSV in subsea mining. But, as the world continues its transition to low- and zero-carbon fuels, it is a promising new frontier for shipowners and operators.

MARKET OUTLOOK: DECOMMISSIONING AND SHIP RECYCLING

Investments in the offshore oil and gas and renewable energy industries are driving the expansion of the market for offshore support vessels (OSVs), with owners and operators expected to benefit from more deep-water activity and the decommissioning of outdated infrastructure.

Many oil-and-gas fields, particularly in the Gulf of Mexico and North Sea, are approaching their design lives. Globally, more than 7,500 oil and gas platforms in 53 countries are expected to become obsolete in the next few decades; their removal is a looming issue for the industry.

A growing government focus on well plug and abandonment activities, colloquially known as the ‘P and A wave’, is driving the market for related decommissioning services.

Multi-purpose supply vessels (MPSVs) are equipped to perform many complex deep-water support operations, such as subsea construction, installation, maintenance, repair, pipe-laying, platform decommissioning and support for remotely operated vehicles (ROV). When offshore assets are decommissioned, an MPSV or subsea vessel often performs services such as flowline flushing with ROV-based skids, cutting and recovering wellheads and their protection structures, in addition to recycling and waste-management activities.

On the renewables side, as the offshore generation of wind power increases globally, the decommissioning of wind turbines also is expected to add to demand for OSVs. In that light, it is just as crucial for wind-farm developers to design safe and cost-effective decommissioning plans for their assets as it has been for the owners of offshore oil and gas assets.

Logistics and waste management are important contributors to the decommissioning business for OSVs, which can support heavy-lift vessels by helping to prepare the turbines and their support foundations for disconnection and transit. The structures are then transported on crane or feeder vessels and barges or towed to port.

As most support vessels are built for operational flexibility, demand for their services across several offshore sectors – traditional and non-traditional – is expected to remain robust.

ACHIEVING CARBON NEUTRALITY: PREPARING OSVS FOR THE FUTURE

The work scopes for offshore support vessels (OSV) are going to shift in the coming decades as more industrial sectors begin to require the services of maritime industry's most multi-talented workhorses. But one thing that will remain constant is that they will have to ply their trades, both old and new, while transitioning to a carbon-neutral work environment.

It is often said that you cannot manage what you don't measure; these practices are now common among modern OSV and other shipowners as the collection of operational data is increasingly mandated by the world's regulatory authorities.

The ability to track and report emissions and other pollutants is foundational to lowering shipping's collective carbon footprint and gaining compliance with the associated regulations. As data collection and analysis helps to improve fuel efficiency, it is also seen as good business.

There are an increasing number of digital tools to help owners monitor and track fleet or vessel-specific data across environmental categories such as emissions, garbage, waste and consumables. They help operators to view emissions output and fuel consumption from categories as diverse transit and dual-propulsion-fueled modes and emissions per transport to emissions per consumer, compiling the kind of key performance indicators that guide coherent business decisions.

Regulations, too, are changing to support more effective measurement. The proportional emission-reduction targets set by the IMO for 2030 and 2050 remain firm, but there is impetus to change the way shipping counts its emissions from combustion cycles (tank-to-wake) to lifecycles (well-to-wake), which can offer a more accurate assessment of the industry's carbon footprint.

Current lifecycle analyses clearly identify the need to produce green ammonia, hydrogen and methanol to encourage meaningful reductions in greenhouse-gas emissions with zero-carbon fuels.

Two other promising pathways for the proactive OSV owner to achieve carbon neutrality from their marine propulsion systems are electrification and the use of hybrid power. These can increase system flexibility, while also helping to optimize the fuel efficiency of conventional engines.

Energy storage systems (batteries) are expected to play a major role in the OSVs of the future, and the adoption of hybrid-electric propulsion systems is currently being led by OSVs and harbor tugs, for which propulsion systems need to provide additional energy on demand.

Another pathway to carbon neutrality is biofuels. Not all of them will reduce OSV emissions from the combustion cycle (tank-to-wake). But, depending on the type of feedstock and the associated production pathway, they can offer benefits from the well-to-tank component of the fuel cycle.

While the environmental benefit of some alternative biofuels is being proven in the world's laboratories, much more work needs to be done on assuring their feedstock supplies and associated marine infrastructure before they can be produced and supplied at commercial scale.

In the interim, there are more traditional measures that OSV owners adopt to continue moving towards achieving carbon neutrality.

Optimizing hull forms for newbuilds and installing/applying energy-saving devices (ESD) both offer incremental steps towards more efficient operations.

As the mission of an OSV is now more likely to change during its lifetime, new technologies can help to design hull forms better suited to those diversified market requirements and improve the chances of keeping the ship working throughout its lifecycle.

In recent years, computational fluid dynamics and advanced algorithms have made it easier to optimize the design of specific hull forms, making newbuilt OSVs better suited for the disparate tasks the are asked to do, and the changing environments in which they are asked to perform.

For existing vessels with long lives ahead of them, ESDs, including wake-equalizing ducts, flow-separation alleviators and pre/post-swirls, can help to correct the energy efficiency of a sub-optimal hull form or augment efficient designs by improving the effectiveness of propulsion units.

There are a lot of options available for OSV owners as they carve out their own customized paths to carbon-neutral operations.

ACHIEVING CARBON NEUTRALITY: EMISSIONS TRACKING AND REPORTING

The offshore support vessel (OSV) of the future is expected to be carbon neutral. For owners, that transition has already begun with efforts to lower their ships' carbon footprints, before ultimately moving to a zero-carbon or carbon-neutral future. During this process, the ability to track and report emissions and other pollutants will be essential.

Environmental monitoring tools play significant roles in achieving carbon neutrality by simplifying tracking and reporting emissions through a variety of digital interfaces.

Those tools' key features may include the ability to:

- Monitor and track fleet or vessel-specific data on environmental categories such as emissions, garbage, waste and consumables
- View all elements of a vessel's emissions profile, including the output of emissions across categories such as laden and ballast voyages, emissions per transport, emissions per distance and emissions per consumer
- Perform calculations in accordance with the Environmental Ship Index and/or the Poseidon Principles
- Track key performance indicators for garbage, waste and consumables metrics, such as disposal methods and categories, water-production efficiency, consumption efficiency by voyage, etc.
- View the performance of scrubbers based on reporting requirements for Exhaust Gas Cleaning Systems
- View historical data for fleet or vessel voyages

The ABS Environmental Monitor™ is the maritime industry's most comprehensive digital sustainability solution and includes all the key features and benefits noted above. It can help shipowners to achieve their sustainability goals by monitoring multiple data sources, including vessel routing, waste streams, operations, and emissions, and provide transparent reporting.

ACHIEVING CARBON NEUTRALITY: ELECTRIFICATION AND HYBRID POWER

Two promising pathways for achieving carbon neutrality in marine propulsion systems are electrification and the use of hybrid power. Both potentially offer clear routes to decarbonization and for powering zero-emission vessels.

By integrating diesel-electric propulsion and energy-storage systems (such as lithium-ion batteries, flywheels and supercapacitors) into vessel designs, or installing them as upgrades, electrification and hybrid power can increase the flexibility of a vessel's propulsion system. They also allow internal-combustion engines to run at optimal levels of fuel efficiency and the vessel to operate with zero emissions when solely using battery power.

Electrified vessels have three typical main power and propulsion topologies: electrical propulsion, electrical propulsion with a hybrid power supply and electrical propulsion with a DC hybrid power supply.

A typical architecture of an electric-propulsion system is depicted in Fig. 1 (below). Multiple diesel generator sets feed a fixed-frequency (either medium or low voltage) electrical bus. The bus then feeds the electrical propulsion motor drive and the hotel load, in most cases through a transformer. The motor drive includes a power electronic converter, which is used to control the speed of the shaft line, and therefore the speed of the ship.

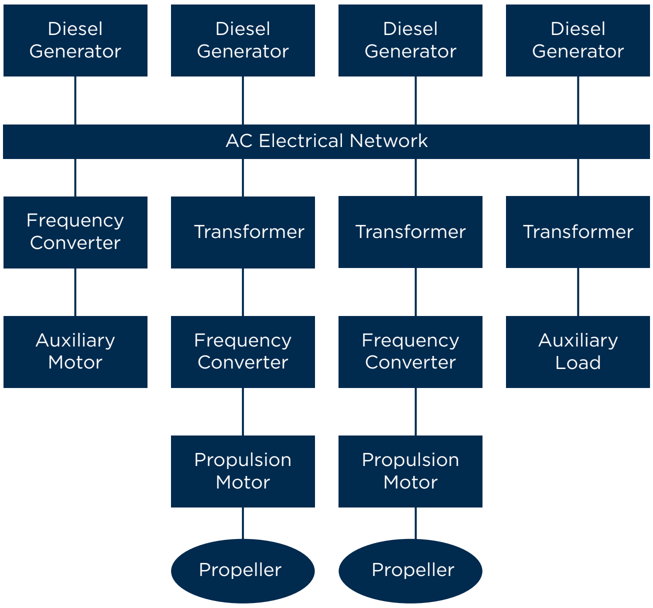


Figure 1: Typical electrical propulsion system layout.

The benefits of the electrical propulsion system are multiple. For one, it is a fuel-efficient propulsion solution when the hotel load comprises a significant proportion of the requirement for related power, and when the operating profile is diverse.

Electric propulsion also is likely to produce fewer NOx emissions than mechanical propulsion systems, as well as less radiated noise than traditional systems due to the absence of a mechanical-transmission path from the engine to the propeller.

Electrical propulsion systems are not without challenges, however. Due to the additional conversion stages in power converters and electric motors, power losses are increased with electrical propulsion. This leads to increases in specific fuel consumption (SFC), particularly when ships are close to reaching their top speeds.

Cavitation (such as the formation of bubbles in liquid) can increase during operation, particularly for electric-propulsion units with fixed-pitch propellers and speed controls.

Also, because all loads use the electrical network's voltage and frequency, the associated swings under fault conditions can switch off electrical systems, reducing their reliability. Particularly in power systems with high amounts of variable speed drives, the consistency of power loads can be compromised.

Electrical propulsion with a hybrid power supply typically features a combination of two or more types of power. The supply can come from more traditional combustion units, such as diesel engines, gas turbines or steam turbines, or from electrochemical power sources such as fuel or solar photovoltaic cells, and energy-storage systems such as batteries, flywheels and supercapacitors.

A typical architecture for an electric-propulsion system with hybrid power supply is depicted in Fig. 2 (below).

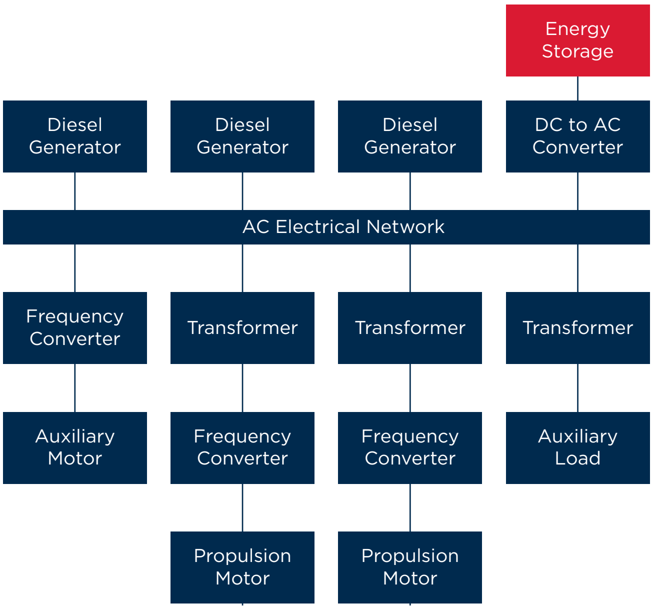


Figure 2: Typical electrical propulsion system with hybrid power supply

The benefits of using hybrid power supply for ships' power and propulsion systems include:

- Energy storage can provide electrical power and allow one or more engines to be switched off when they otherwise would be running inefficiently at partial load.
- Energy storage can be recharged when the engine is running at an operating point with lower SFC and CO_2 and NOx emissions. This can save fuel, reduce emissions and noise, increase crew comfort and support sailing without emissions, noise and vibrations from the engines.
- The battery can enable load leveling and peak shaving
- Fuel consumption and local emissions can be reduced when the battery is recharged from the power grid.
- The battery can be used to store regenerated energy when braking on electric motors.
- The battery also can provide back-up power during a failure of combustion power supplies (such as offered by diesel generators, for example).

The challenges of an electrical propulsion system with hybrid power supply include:

- The control strategy needs to maximize the reduction in fuel consumption and emissions by charging and discharging the battery at the right times.
- Load fluctuation on diesel engines increases fuel costs, emissions and maintenance loads. The control strategy should ideally share dynamic loads between the battery and the diesel engine in ways that minimize fuel costs, emissions and maintenance loads for all power suppliers.
- The increase in purchase cost due to the installation of batteries will need to be minimized or offset by reducing the installed power from diesel engines.

One of the major drawbacks of electrical propulsion is that the engine's fuel consumption in partial load is higher when running at fixed rather than variable speed. However, DC distribution systems can enable variable engine speeds.

A typical architecture of an electrical propulsion system with DC hybrid power supply is shown in Figure 3 (below).

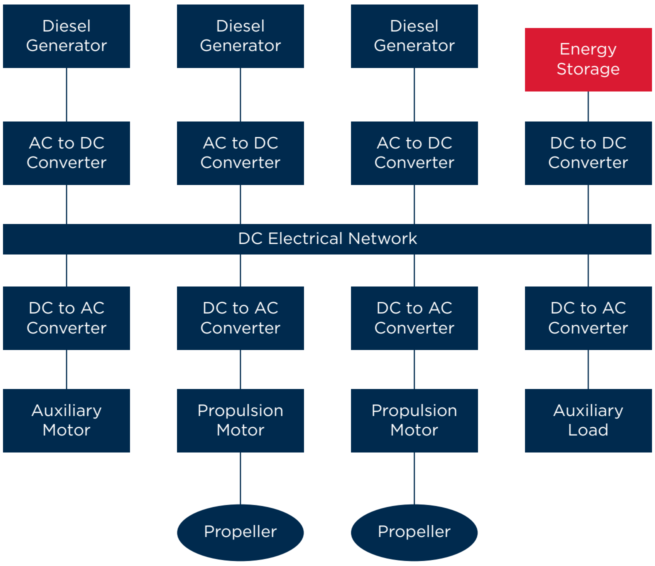


Figure 3: Typical electrical propulsion system with DC hybrid power supply

The DC architecture allows operators to run a diesel engine at variable speed, potentially reducing fuel consumption, emissions, operating noise and its mechanical and thermal loading.

DC architectures are more resilient to faults, because power electronics allow instantaneous control of electrical variables, preventing the faults from spreading across the network and disturbing voltage and frequency. The amount and size of the switchgear also can reduce when the power electronics in the system perform fault protection.

As with pure electrical and electric-hybrid power supplies, electrical systems with DC power supply also have challenges.

For example, all power sources and loads need to be connected to the DC network by converters. If large amounts of fixed-frequency AC loads need to be fed, this can lead to significant cost increases; but if a significant amount of the load is already fed through variable-speed drives, DC architectures can also reduce costs.
Fault protection will need to be resolved to enable DC architectures, and a coordinated control strategy is required to resolve stability issues and achieve optimal performance.
Generally speaking, none of the challenges presented by the three main power and propulsion topologies mentioned above is insurmountable; in fact, considerable industry knowledge has been accumulated for each.

However, each application is likely to require a solution that is customized to the desired power and operating profile of the vessel.

ALTERNATIVE FUELS: EMERGING REGULATIONS

The regulations that will govern shipping's transition to alternative fuels are emerging cautiously as policymakers consider the implications of imposing a new regulatory framework aimed at widening the focus from the emissions created during extraction and combustion of the fuels to those created in their full lifecycles.

At the IMO Intersessional Meeting of the Working Group on Reduction of GHG Emissions from Ships (ISWG-GHG) two proposals were submitted to "further consideration of concrete proposals to encourage the uptake of alternative low-carbon and zero-carbon fuels, including the development of lifecycle GHG/carbon intensity guidelines for all relevant types of fuels and incentive schemes".

The first, ISWG-GHG 9/2, suggested "introducing lifecycle guidelines to estimate well-to-wake green-house gas emissions of sustainable alternative fuels to incentivize their uptake at a global level". Based on the number of signatories, it had considerable support from European members.

The second proposal, ISWG-GHG 9/2/3, looked to examine an update for the "draft lifecycle GHG and carbon intensity guidelines for maritime fuels"; it was submitted by Australia, Japan, Norway and the International Chamber of Shipping.

The report of the ninth meeting of the ISWG-GHG is available on the IMO Marine Environment Protection Committee's site (MEPC 77/WP.6). However, the related rules at the IMO remained in draft form as of January 2021, so they are subject to change.

The European Commission's proposed Fuel EU Maritime initiative, part of a basket of European measures aimed at decreasing the emissions from shipping, includes a common EU regulatory framework to increase demand for renewable and low-carbon fuels in the maritime industry.

It is consistent with previous EU regulations, including 'Fit for 55', the European Emissions Trading System, the Energy Taxation Directive, the Alternative Fuels Infrastructure Directive and the Renewable Energy Directive.

The current regulatory framework focuses on vessel emissions (tank-to-wake) rather than the life-cycle emissions of a fuel (well-to-wake), even though the latter likely provides a more accurate assessment of the carbon footprint of a fuel throughout its life cycle.

Once the IMO's lifecycle regulations enter into force, it will drastically alter the fuel choices made by owners, operators, designers, shipbuilders and charterers.

- Today, fuel life-cycle analyses clearly identify the need to produce green ammonia and hydrogen to meaningfully reduce the GHG-emissions of zero-carbon fuels.
- LNG provides about a 25% reduction in carbon emissions on a tank-to-wake basis; however, on a well-to wake basis – which includes methane slip and fugitive emissions – the reduction drops to 6-16%, depending on the engine technology. On a life-cycle basis, the maritime industry no longer considers LNG to be as environmentally friendly as it once did.
- Methanol can be made carbon neutral on a well-to-wake basis.
- Ammonia offers very low well-to-wake emissions, but the use of pilot oil would contribute to the carbon emissions from a vessel.
- Biofuels do not reduce emissions on a tank-to-wake basis, but they can offer benefits on the well-to-tank component of the fuel cycle. The feedstock and production pathways greatly affect the well-to-tank emissions of biofuels. Also, several variables in biofuel production can shift the estimated well-to-tank emissions.
- The escalation (by an order of magnitude) of the technology used to produce green fuels is required before they can be widely adopted by the global fleet.

ALTERNATIVE FUELS: FUEL OPTIONS AND TECHNOLOGIES

With the IMO having set ambitious mid-term (2030) targets to reduce the CO_2 and GHG output from ships, owners now face the difficult task of decarbonizing their fleets. There are so many technology options (including fuels) to consider that selecting a sustainable, fleetwide decarbonization strategy that aligns with a company's business goals is increasingly complex.

The carbon footprints of each fleet will be different, and each ship will require a unique strategy to find the most effective path to compliance within the new regulations and emissions targets. Furthermore, the industry is now recognizing how a low-carbon transition is required throughout the value chain, with progress at every link having the potential to positively affect shipping's overall carbon intensity. The value-chain perspective is becoming more and more prominent.

The OSV of the future is expected to run on low- and zero-carbon fuels, and the maritime industry has many promising alternate-fuel options that could help to reach compliance. Some are relatively mature, including LNG, methanol, offshore wind and biofuels; others, including ammonia and hydrogen, are still in the developmental phase.

Some technologies have inherent challenges, but they may become more competitive with time; these include nuclear and floating solar. Using nuclear technology to power OSVs would need heavy investments, including significant government investments, to give impetus to this languishing sector.

The alternate fuels all have different characteristics (see charts below) and are expected to have different use cases.

LNG

FUEL CHARACTERISTICS

Chemical Composition	CH_4
Boiling Point, °C 1 bar	-166
LHV, MJ/kg	48
Auto Ignition Temp, °C	650
Flammable Range, % vol in air	5-15%
Energy Density, MJ/lt	21.6
Volume Comparison HFO (Energy Density)	1.85
Carbon Content	0.75
Carbon Content Reduction (Compared to HFO)	12%
CO_2, kg CO_2/kWh	0.206
CO_2, kg CO_2/kWh Reduction (Compared to HFO)	26%
Low Flashpoint Fuel	Yes

LPG

FUEL CHARACTERISTICS

Chemical Composition	COMBINATION*
Boiling Point, °C 1 bar	-26.2
LHV, MJ/kg	46.06
Auto Ignition Temp, °C	428
Flammable Range, % vol in air	18.8-8.9%
Energy Density, MJ/lt	24.88
Volume Comparison HFO (Energy Density)	1.6208333
Carbon Content	0.82148
Carbon Content Reduction (Compared to HFO)	3.3%
CO_2, kg CO_2/kWh	0.2353
CO_2, kg CO_2/kWh Reduction (Compared to HFO)	15.6%
Low Flashpoint Fuel	Yes

*60% Propane, 40% Butane

METHANOL

FUEL CHARACTERISTICS

Chemical Composition	CH_3OH
Boiling Point, °C 1 bar	65
LHV, MJ/kg	19.9
Auto Ignition Temp, °C	450
Flammable Range, % vol in air	5.5-26%
Energy Density, MJ/lt	15.7
Volume Comparison HFO (Energy Density)	2.54
Carbon Content	0.375
Carbon Content Reduction (Compared to HFO)	56%
CO_2, kg CO_2/kWh	0.2486
CO_2, kg CO_2/kWh Reduction (Compared to HFO)	11%
Low Flashpoint Fuel	Yes

AMMONIA

FUEL CHARACTERISTICS

Chemical Composition	NH_3
Boiling Point, °C 1 bar	-33
LHV, MJ/kg	22.5
Auto Ignition Temp, °C	630
Flammable Range, % vol in air	15-28%
Energy Density, MJ/lt	15.7
Volume Comparison HFO (Energy Density)	2.55
Carbon Content	0
Carbon Content Reduction (Compared to HFO)	100%
CO_2, kg CO_2/kWh	0
CO_2, kg CO_2/kWh Reduction (Compared to HFO)	100%
Low Flashpoint Fuel	No

HYDROGEN

FUEL CHARACTERISTICS

Chemical Composition	H_2
Boiling Point, °C 1 bar	-253
LHV, MJ/kg	120.2
Auto Ignition Temp, °C	535
Flammable Range, % vol in air	4-74%
Energy Density, MJ/lt	9.2
Volume Comparison HFO (Energy Density)	4.33
Carbon Content	0
Carbon Content Reduction (Compared to HFO)	100%
CO_2, kg CO_2/kWh	0
CO_2, kg CO_2/kWh Reduction (Compared to HFO)	100%
Low Flashpoint Fuel	No

Retrofitting ships to use LNG and biofuels seems viable in the short term, while ammonia, methanol, hydrogen and fuel cells would all require complete redesigns, and are more suited for newly built vessels in the longer term. Some of the fuel technologies are seen as transitional (LNG, etc.); they could help the industry to meet the IMO's 2030 goals, but not those for 2050. Hence, investments in long-term solutions (NH_3, H_2, etc.) are likely to happen in the next few decades.

Improving energy efficiency through data-driven operations also will play a significant role in reducing short-term fuel consumption.

At present, the majority of OSVs are platform-service vessels. However, new models such as service-operation vessels, wind turbine installation vessels, commissioning service operation vessels, crew transfer vessels, multi-purpose supply vessels and subsea mining vessels are all expected to diversify the nature of the OSV sector in future. These vessels are expected to run on alternate fuels or combinations of alternate fuels.

Energy storage systems (batteries) are expected to play a major role in the alternate-fueled OSVs of the future. Innovative solutions such as offshore wind power, high-voltage long-distance shore power, subsea cables for nearshore operations and power cables from nearby hydroelectric power plants all could reduce overall carbon footprints. Alternate-fuel bunkering vessels also may see a rise in demand, depending on the operation.

Hybrid-electric propulsion systems are currently used in the maritime industry and are increasing in popularity. Their adoption is being led by OSVs and harbor tugs, where existing systems readily provide additional energy on demand.

The advent of modern dual-fuel engine technology is making the transition to low- and zero-carbon fuels easier than in the recent past. It can be made even more attractive if the transition is planned at the ship's design stage. In particular, the design of the fuel tank should be specified for all the fuels to be used during the life of the vessel.

That said, the investments for low-carbon and carbon-neutral technologies are substantial, and many of those promising technologies are significant way from market maturity.

ALTERNATIVE FUELS: RENEWABLE ENERGY SOURCES

The market for offshore support vessels (OSV) has been impacted by significant external factors recently, including the commercial performances of its core oil and gas industries and the COVID-19 pandemic.

Nevertheless, the offshore sector is undergoing another cycle of infrastructure renewal that will impact all members of its value chain. With more renewable energy sources emerging as viable options, OSV operators are looking for propulsion alternatives that can support fleet operations and lessen their collective environmental impact.

They want to capture the business opportunities inherent in renewable energy booms such as offshore wind by deploying 'greener' onboard technologies such as Lithium-ion battery and hybrid fuel systems, which combine conventional with renewable power technologies.

To do so, OSV operators and owners will need to explore construction and/or retrofitting options that offer new topologies for electrical power systems and their facilities, and they will need to overcome the current challenges faced by their organizations, by:

- Increasing operational knowledge of and experience with hybrid technologies by creating competence-training programs for crew and operational personnel
- Investing in the research and development of cooling technologies for Lithium-based battery technologies, as well as the thermal-management practices of associated installations in the ships' electrical rooms

Once these electrical power systems are fully ready for marine use, the intention is to integrate them with conventional onboard power generators and energy-storage systems (ESS) — including supercapacitors, lithium-ion battery systems and flywheels – and/or energy sources such as fuel cells, solar-photovoltaic panels and electrical-generation systems from wind.

Shipowners are currently involved in demonstration projects featuring fuel-cell power systems with several major shipyards and their vendors. Examples include ABS' recent approval in principle1 for solid oxide fuel cell technology developed by South Korea's Daewoo Shipbuilding & Marine Engineering (potentially destined for VLCCs) and a new technology qualification2 for hydrogen fuel cell concepts (destined for LNG carriers) developed by Bloom Energy Services.

As technologies such as these become ready for integration and onboard trials, shipowners are expected to combine them with conventional technologies to improve the operating flexibility of their ships and reduce their carbon footprints.

Separately, significant industry resources are being applied to designing and creating external marine infrastructure that can deliver cleaner energy supplies.

For example, one energy company in the offshore wind sector recently partnered with a major European shipowner to investigate whether 'charging buoys' can be deployed to house and distribute 'green' electricity to a range of OSVs and other vessels; the current project3 targets OSVs that support wind farms, but its application has potential for a wider range of ships, including conventional ships awaiting berths at port.

Aside from the environmental benefits, installing electric buoys closer to the offshore assets that the vessels are serving would burn less fuel while the ships are idle and offer the benefit of charging times that are less disruptive to operations.

Whatever decarbonization path(s) they choose, owners and operators would be well advised to work with classification societies to identify the guidelines and rules that support safe construction and conversion on shore, and/or safe installation in the field. Class experience with marine applications of hybrid and emerging technologies can help to improve a project's energy efficiency, while reducing carbon emissions and operating expenses.

For lithium-ion battery installations, ABS recently awarded SEACOR Marine's SEACOR Maya with an 'ESS-LiBATTERY' notation; the ESS is integrated with ship's hybrid-propulsion systems, and has been deployed for operations in the Gulf of Mexico.

ABS also recently classed the Harvey Energy, which features a dual-fuel (LNG/diesel) engine equipped with a battery-converter system. A 1,450kW battery was installed as part of a hybrid energy solution that was designed to reduce the ship's exhaust emissions, fuel consumption and noise levels.

It was the first U.S.-flagged OSV equipped with a battery/converter system; savings in overall fuel costs are expected to be 10-20%, according to Harvey Gulf International.
Alternative Fuel: Fuel Cells

As shipping transitions away from the combustion of hydrocarbons, fuel-cell technologies are also drawing careful attention from shipowners.

Consensus is building that the types of fuels currently being used in fuel-cell technology can be easily adapted to support maritime operations. These include:

- Methanol or methanol/water solutions (regardless of concentration) used to produce electricity
- Formic acid
- Hydrogen
- Methanol clathrate compound
- Borohydride compounds
- Butane

Among these fuel sources, hydrogen, despite its lower energy content compared to conventional marine fuels, holds promise for the maritime sector's energy transition. At this early stage, hydrogen-fueled energy harnessed by fuel-cell technology looks set to play a role as a decarbonization solution.

With the aid of the ABS Hybrid Electric Power Guide, fuel-cell technologies can be integrated with current and future electrical power-generating technologies as depicted in Figure 4 (below). The technology is as easily scalable as conventional power technologies.

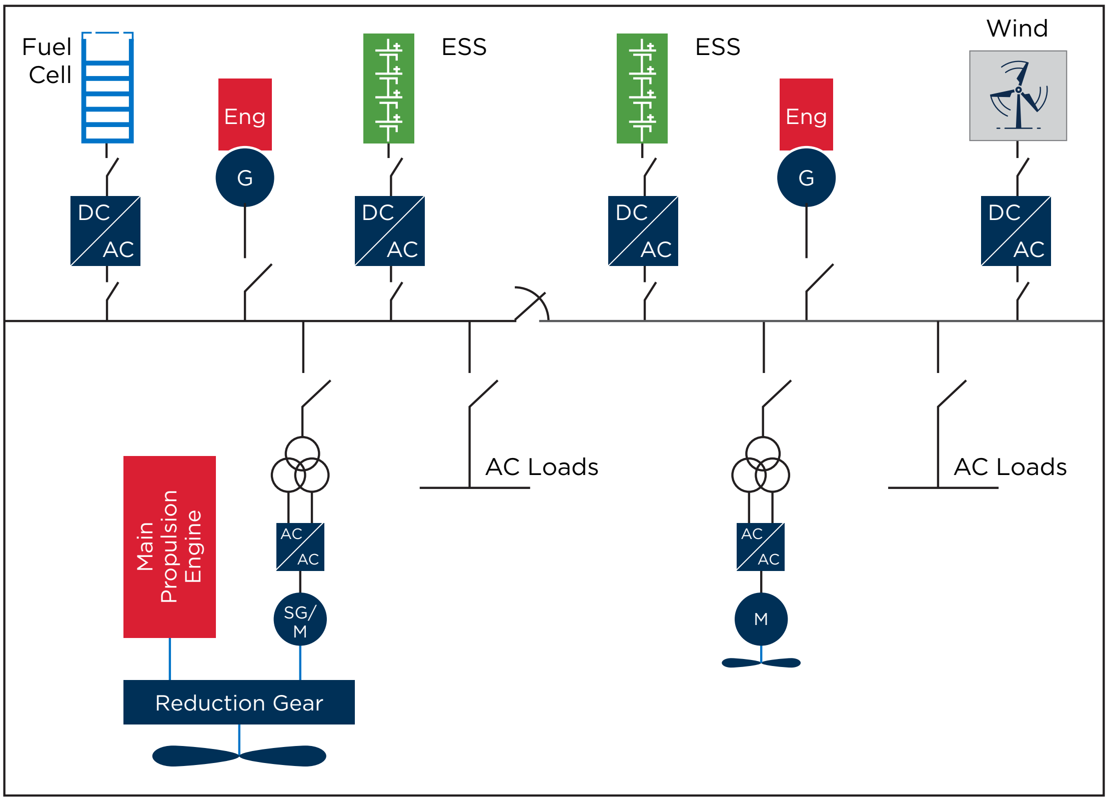


Figure 4: Typical Hybrid Electrical Power System.

Whichever renewable energy source ultimately gains favor in the OSV community, it can be expected to play a significant role in lowering the collective footprint of the world's hard-working support vessels.

OPERATIONAL ENHANCEMENTS: HULL FORMS AND COATINGS

The diversity of the conditions in which OSVs operate makes the selection of an optimal hull design far more complex than for typical ocean-going cargo vessels.

Owners must strike the right balance between the need for the OSV to operate in heavy weather with adequate seakeeping and maneuvering ability and demands to streamline the vessel's hull to reduce resistance and fuel consumption.

Furthermore, as the mission of an OSV could evolve over its lifetime, a hull-form designed with future market requirements in mind may improve the chances of keeping the ship working throughout its lifecycle.

Existing OSV hull forms range from the traditional vertical and bulbous bow hull forms to more recent Axe-bow and X-bow forms.

In recent years, the growing use of computational fluid dynamics and robust algorithms have made it easier to optimize the designs of specific hull forms. These advanced desktop-evaluation techniques efficiently search through the thousands of design options that best suite the ship's intended operating profile. A model test then verifies the performance expectations.

Energy-saving devices (ESD) can help to either correct the energy efficiency of a sub-optimal hull form or augment an optimal – or nearly optimal – design by improving the effectiveness of the propulsion unit(s). These devices, which include wake-equalizing ducts, flow-separation alleviators and pre-/post-swirls, have been widely used and can be optimized to be compatible with specific hull forms and propulsion designs.

Managing the roughness of the hull and propeller also can help to improve fuel efficiency. Frictional resistance on the wetted surface of the hull and its appendages can contribute a significant amount of a ship's resistance.
Keeping the underwater portions of the hull and appendage surfaces smooth by applying the appropriate coatings and periodic cleaning helps to minimize frictional resistance. The coating must be applied properly, monitored and managed to maintain its best qualities.

In addition to the hull surface, the performance of propellers also can be degraded by surface roughness. Periodic cleaning and polishing of the propeller and applying an anti-fouling coating on the propeller blades can prove to be cost-effective solutions.

All these measures - optimizing hull forms, coatings and ESDs – should be seen as small steps towards more efficient operations, and in the transition towards lower carbon shipping.

INTEGRATED OPERATIONS

The nature of offshore operations is shifting as the industry slowly moves away from its traditional role of extracting fossil-based energy resources towards more sustainable forms of power. This means changes are also afoot for its marine workhorse, the offshore support vessel (OSV).

To remain viable, the OSV of tomorrow will have to be designed ‘smarter’, cleaner and more operationally flexible. This will require designs for ships that are capable of serving both the traditional and newer sectors – such as wind-power and space exploration, more artificially intelligent and kinder to the environment.

It is a big challenge, one that will require better connection to the on- and offshore ecosystem of assets they support and depend on for information and efficient operational performance.

Stronger and more economical computing power continue to propel shipping into a digital age where new tools make modeling and simulation essential to day-to-day workflows and lifecycle analyses.

The virtual face of those capabilities is the ‘digital twin’, a precise simulation of a specific asset, such as an OSV, that is used to support monitoring and analyses of and decision-making for everything from mission plans to the performance of critical systems during operations. With machine-learning algorithms, the role of a digital twin ultimately may be to propose corrective action for many of a ship’s systems.

New OSVs will operate in highly connected environments, so they will need to be equipped with the types of centralized, high-speed, data-collection and management networks that can share information across the vessel and with external stakeholders whose businesses rely on its efficient operation.

Advanced communication technologies such as 5G will support the emergence of high-speed local area networks that connect the ship to other assets in its ecosystem, such as fellow OSVs, nearby platforms, rigs, windfarm installations and subsea assets, such as remotely operated vehicles.

The ability to share large amounts of data at high speeds with less delay will help each asset to work in concert, while also enabling remote-controlled operations. In short, the OSV’s operational theatre will be more digitally integrated.

Some theaters — such as for offshore wind — are moving into deeper waters, where there are higher seas and more perilous working conditions.

Technologies such as active and passive motion-compensation systems and platforms are helping OSV owners to address those risks, but they may also want to consider new designs with smaller water planes, additional fin and pitch controls and roll-stabilizing systems.

On another safety front, more frequent use of remote-inspection technologies – such as unmanned aerial vehicles, remotely operated underwater vehicles, robotic crawlers, wearable technology (e.g., smart glasses) and Laser Imaging Detection and Ranging products – is destined to improve working conditions for inspection personnel, while supporting less downtime for the ship.

Automated and ‘smart’ technologies are growing increasingly common throughout the offshore industry, bringing many potential benefits for operational efficiency, carbon reduction and cost savings. But they are not with risks.

Each additional sensor or software update will open a new potential gateway into an asset’s critical command and control systems. As an OSV’s systems connectivity and automated functions grow, its security simply must keep pace.

The section contains more information on all of these subjects.

INTEGRATED OPERATIONS: DATA AND SMART FUNCTIONS

Data will be counted among the components that ensure the efficient operations of future OSVs; in some respects, data will metaphorically 'fuel' their day-to-day activities.

With the advancement of digitalization and the IoT (Internet of Things), data will become available from multiple sources. As shipboard equipment evolves to be highly digitalized machines, there will be an abundance of data collected from a myriad of onboard sensors, which will collect operational and performance-related data.

The future OSV will be equipped with a centralized, high-speed, data-collection and management network that will collect and share data and information throughout the vessel, and with all stakeholders who depend on its efficient operation.

The future OSV will be operating in a highly connected environment. Higher speeds, lower latencies and cheaper satellite communications will enable the future OSVs to be constantly connected to its onshore fleet manager allowing near real-time exchange of data and information.

The advancement of localized communication technologies such as 5G cellular technology will allow the creation of high-speed local area networks between the future OSV and other assets it is working together with in the field such as other OSVs, nearby platforms, rigs, windfarm installations or subsea assets such as Remotely Operated Vehicles (ROVs). The ability to share large amount of data at high speeds and lower latencies will enable each asset to work in-concert and also allow remote control operations.

Nonetheless, data is only an ingredient. The real value of data lies in the ability to process the data using physics-based or machine learning and artificial intelligence (AI) techniques to decipher and provide insights to improve the safety, efficiency and performance of the vessel's operations.

The Smart Functions enabled by the use of data can be categorized into the following:

- Health State Awareness
- Asset Efficiency and Operational Performance
- Crew Assistance and Augmentation

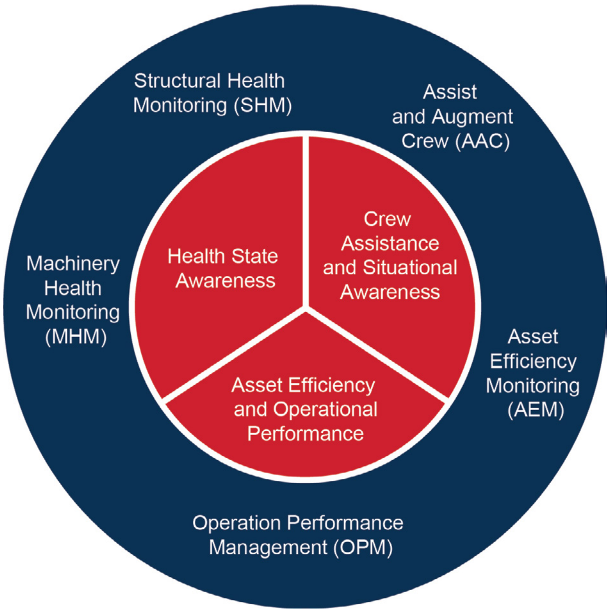


Figure 5: Smart Function Categories

HEALTH STATE AWARENESS:

The health state of structures and machinery is crucial to the future OSV's safety, integrity and operability. Health state awareness is improved via the following:

- Structural health monitoring
  Monitors structural loads, responses, and health conditions to assess the structural integrity, provide structural health awareness, and help minimize the potential of structural damage and failure.
- Machinery health monitoring
  Monitors the health state and operational conditions of onboard machinery and systems to detect operation and condition anomalies and predict the onset of any form of condition degradation and impending functional failure.

Informed insights and awareness of the vessel's health state will contribute to the enhanced safety of the vessel, optimized performance, minimized downtime and efficient maintenance planning for the vessel.

ASSET EFFICIENCY AND OPERATIONAL PERFORMANCE:

Two main factors contribute to the performance of an equipment, system or vessel during its lifetime:

- The efficiency of equipment, systems, or vessels in performing its function based on inherent design and manufacture characteristics, and the current operational readiness status (presence of degradation and status with respect to prescribed maintenance)
- The operational efficiency of equipment, systems, or vessels to achieve optimum performance through adjustment of operational parameters within the design envelope, system and plant management (human-machine interaction, behavioral and operational planning aspects).

Accordingly, the following two Smart Function categories define these areas:

- Asset Efficiency Monitoring (AEM): Assesses equipment, system, or vessel efficiency and provides maintenance and tune-up activity triggers to maintain or improve efficiency levels. Examples of asset efficiency include ship water resistance (determined by hull design and hull cleanliness) and engine efficiency. AEM is often offered in tandem with a health monitoring function, as it usually monitors efficiency.
- Operational Performance Management (OPM): Monitors, manages, and analyzes equipment, systems, or vessel operational parameters and performance data. The results provide guidance and recommendations for operators and onboard crew to optimize the way the equipment, system, or vessel is operated and managed. Examples of OPM functions include voyage optimization, route planning and power plant balancing.

AEM focusses on the inherent design characteristics as well as assuring proper maintenance, whereas OPM targets the behavioral aspects and human-machine interaction.

CREW ASSISTANCE AND AUGMENTATION:

Vessel operations rely on crew members to satisfy and meet the demand for growing regulatory reporting requirements, and meet an industry demand for increased monitoring and transparency. Accordingly, the following Smart Function category aims to reduce onboard crew workload and potential human errors by use of data-driven applications that include auto-logging, reporting, and also enhanced situational awareness:

- Crew Assistance and Augmentation (CAA): Assists crew reporting and other onboard activities through automatic data collection, electronic logging, data processing, fusion, and analysis, and report generation. CAA-related Smart Functions can be either a standalone function or integrated with the health monitoring and performance management functions. For example, auto-logging and reporting are a common feature often incorporated within an OPM function. Enhanced situational awareness can also come from increased sensing and analytics capacity that augments the crew's ability, such as night vision, obstacle detection, collision avoidance, and assists the crew in vessel operations.

With the increase in the use of and reliance on data, high quality data will be essential to obtain accurate analytical results and to cultivate confidence in relying on these functions to aid in decision making. Data quality assessment, monitoring and control are key elements in the data flow associated with such data-centric functions as shown in the following diagram.

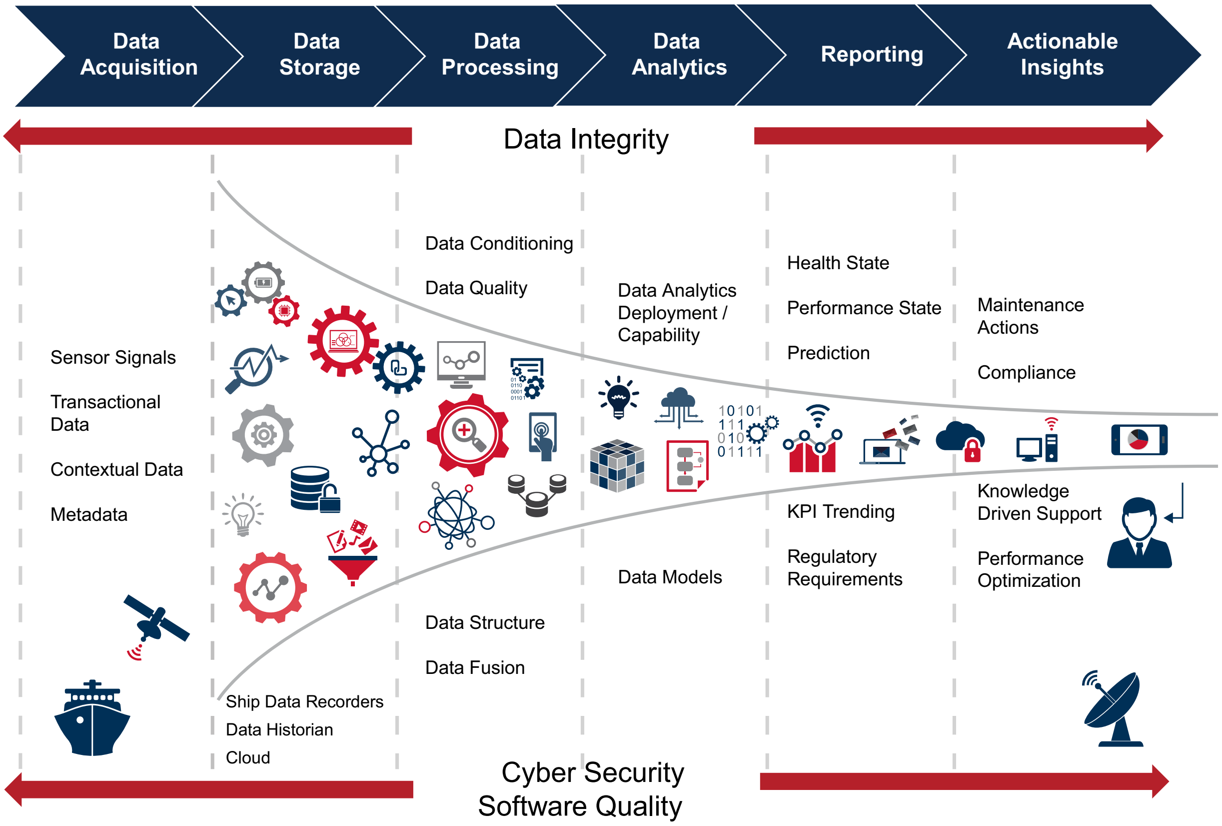


Figure 6: Data Flow

A function is defined as a group of tasks, duties and responsibilities necessary for ship operation, safety of life at sea or protection of the marine environment.

In order to investigate the concept of smart, semi-autonomous and autonomous functions, we need to look to the thought process of humans when undertaking a task. This thought process can be described in the following operational decision loop in Figure 7:

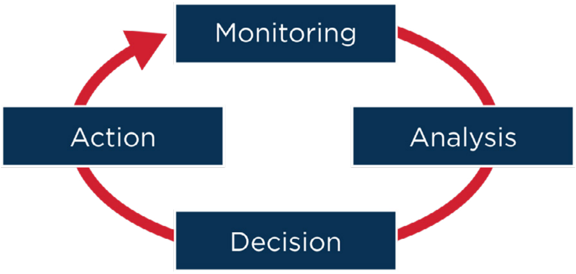


Figure 7: Operational Decision Loop

- First, Monitoring is the process of a person observing the situation by measuring and collecting parameters.
- Then, Analysis is when someone analyzes the information gathered based on his or her knowledge, experience and skills.
- Decision is the next stage where one considers the possible options. He or she then makes a decision on the most appropriate course of action.
- And finally, Action is where the person consciously carries out the decision made in the earlier step.

Table 1 shows the autonomy levels based on the involvement of systems or machines in the operational decision loop. Smart functions are functions which augment human capabilities by assisting during the Monitoring and Analysis phases. A smart function may make recommendations based on analysis of operational or system data, but the final decision rests with the human operator.

With semi-autonomy, the function can choose from multiple options in both pre-defined and unexpected scenarios. Once the decision is made, the system or human needs to follow up with appropriate actions to achieve the intended objective. These actions can be taken by the human, a combination of human and system, or solely executed by system automation.

An autonomous function will be one where all four steps in the operational decision loop will be carried out by the system. The roles of humans will be supervisory with the option to intervene and override the actions being carried out by the system.

Autonomy Levels		Integration and Application to Operational Decision Loop			
		Monitoring	Analysis	Decision	Action
1	Smart	S	S	H	H
2	Semi-Autonomous	S	S	S/H	S/H
3	Autonomous	S	S	S	S
Notes: H - Human, S - System					

Table 1: Autonomy Levels

The Smart-to-Autonomy levels are summarized as follows:

1) Smart: System augmentation of human functions. The system provides passive decision support, such as in the form of health or performance anomaly detection, diagnostics, prognostics, decision / action alternatives, and / or recommendations.
2) Semi-Autonomy: Human augmentation of system functions. System operation builds upon a smart foundation and is governed by a combination of system and human decisions and actions.
3) Full-Autonomy: No human involvement in system functions. The system makes decisions and takes action autonomously. Humans perform a supervisory function and retain the capability to intervene and override actions made by the system.

INTEGRATED OPERATIONS: APPLICATION OF SMART-TO-AUTONOMOUS FUNCTIONS

Due to the diversity and complexity of offshore operations, the future OSV will utilize a mix of manual, smart, semi-autonomous and fully autonomous functions. In the near to medium term, the human operator will still be required.

Some operations will require the skills, experience and dexterity of human operators and cannot easily be replaced by machines and automation. Some operations on the other hand may require the ability of computer software and systems to process huge amounts of data in a short period of time (possibly in the magnitude of micro or milliseconds). These operations will be most suitable to be carried out by semi-autonomous or autonomous functions. Additionally, semi-autonomous and autonomous functions will prove its value in undertaking tasks which are repetitive or dangerous, thus freeing up skilled human operators to focus on more complex and value-added tasks.

As smart, semi-autonomous and autonomous functions become prevalent in the industry, this will raise key issues which needs to be addressed. These issues are:

- Software Testing
- Connectivity
- Cyber security
- Regulations

Software is a key component in delivering smart, semi-autonomous or autonomous functions. Software reliability will be critical in enabling the safe operation of the function. Where various systems are working together to deliver the function in an open-ended operational environment, current testing requirements may not be sufficient to study the emergent behaviors. Therefore, much thought is to be given to the verification and validation regimes to thoroughly test and understand the software before its implementation.

Connectivity will be a critical enabler. The data infrastructure in the maritime realm is still lacking in terms of coverage and required latency. Data infrastructure will need to be improved and made affordable.

The industry has expanded its safety focus beyond the traditional hull, mechanical and electrical areas to cover software and cybersecurity. Safety of operations is heavily dependent on the software operating as it is designed to and the vessel’s operational technology (OT) systems being free from external interference (malicious or not).

The availability and necessity for smart, semi-autonomous and autonomous functions to constantly be connected via satellite or cellular communications greatly increases the cyber vulnerability of the vessel.

Cybersecurity can no longer be considered on the periphery of safe operation discussions, but it has to sit at the core of it.

Existing regulations must evolve from the current prescriptive equipment-based framework to an adaptable goal-based framework for the effective verification and validation of such functions. In this regards, extensive work is currently underway at the IMO. Amongst others, the IMO has completed the IMO Maritime Autonomous Surface Ships (MASS) Regulatory Scoping Exercise and are targeting to introduce a MASS Code by 2025.

INTEGRATED OPERATIONS: SIMULATION AND DIGITAL TWINS

The digital age is producing many tools that can support a shipowner's transition to low- or zero-carbon operations.

With a continuous enhancement in computing power and lower costs for using computing resources, modeling and simulation have become essential to the workflow of product designs. With tomorrow's OSV operator facing more connected operating environments, shipbuilders are increasingly employing simulation throughout the lifecycle of a product – from design, through operation, to decommissioning.

With advanced simulation technologies such as finite element analysis (FEA) and computational fluid dynamics (CFD), the OSV sector's traditional best practices and engineering are being enhanced to improve decisions throughout a product's lifecycle.

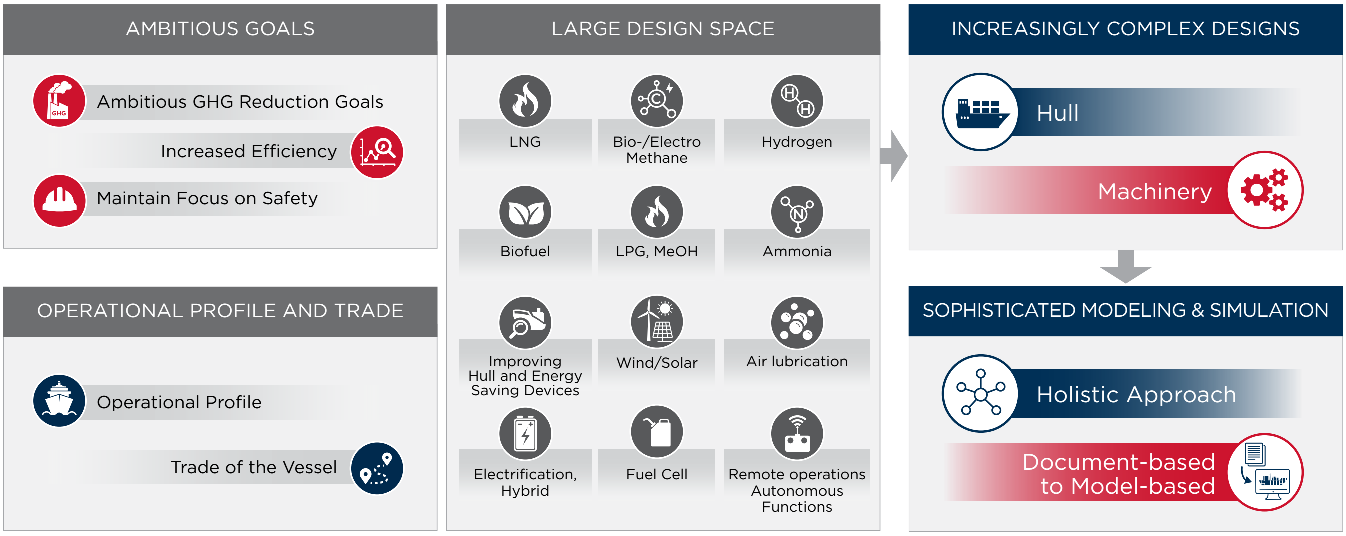


Figure 8: Increasingly complex designs and ambitious goals require sophisticated simulation

While simulation can refer to structural FEA, CFD, etc., the discussion among shipowners and their designers is focused on the multi-domain, physics-based simulation models. These models apply multiple physics-based disciplines in the same environment to produce holistic studies that help to assess machinery systems, hull-form performances and structural analyses against company and vessel mission requirements, or regulatory emission standards.

Using a virtual environment, simulation allows the studies to be conducted earlier in the design process, leading to future cost and time savings.

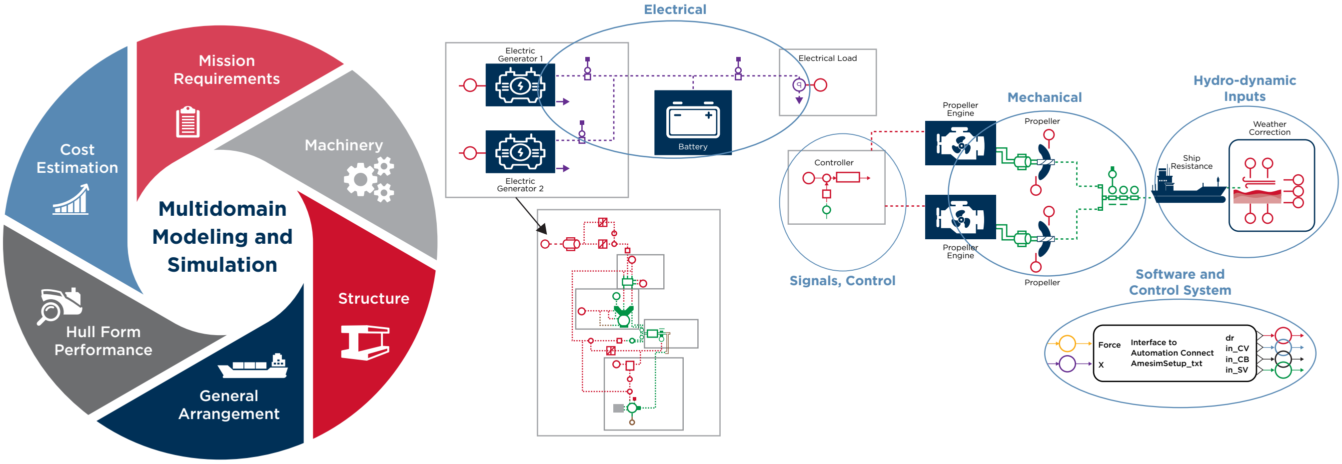


Figure 9: Multi-domain modeling and simulation account for various vessel systems

Today's engineers can create simulation models to assess the performance and reliability of: an OSV's complex computer-based systems; system designs utilizing alternative fuels; energy-saving devices; and innovative technologies such as air lubrication, wind-assisted propulsion, wind/solar power generation, batteries and fuel cells. They can also validate system configurations to supplement physical testing.

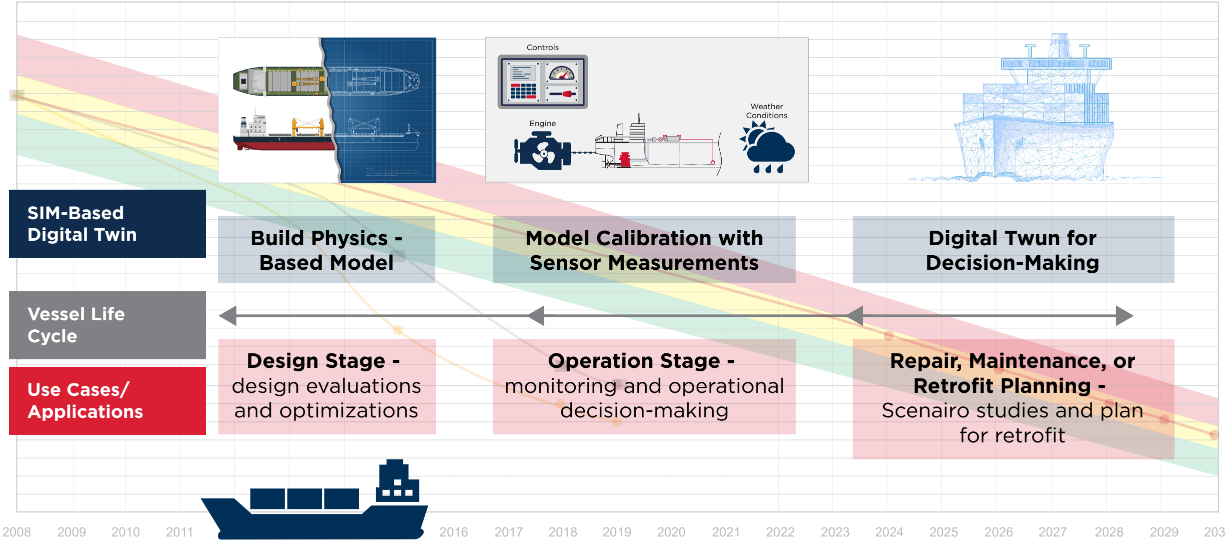


Figure 10: Digital Twins can support the vessel life cycle with SIM modeling connected to sensor data

One major contribution that simulation provides is to 'close the loop' by creating 'digital twins' of future OSVs. The essential elements of a 'digital twins' include: a virtual representation (simulation model); a physical realization (an asset); and a transfer of data/information (connected) between the two. Digital twins are an extension of model-based design with real-time data fed into the system model.

In future OSV applications, the digital-twin platform be able to offer: assistance for mission-planning decisions; real-time logging/monitoring; insights on systems performance; Hardware-In-Loop (HIL) testing (which simulates conditions that would be impractical to replicate); and other information models. By using machine-learning algorithms, it can also propose potential corrective actions for complex systems.

Through powerful multi-physics, multi-domain modeling and simulation, shipbuilders can assess complex vessel systems designs, explore changes to future OSV operations and virtually test and validate vessel systems.

Modeling and simulation will support the future construction of OSVs by delivering solutions and assessing design or operational changes earlier in the process, leading to time and cost savings throughout the vessel lifecycle. And, as operation efficiencies improve, so too is a ship's environmental performance.

INTEGRATED OPERATIONS: VOYAGE PLANNING

Using data from the Automatic Identification System (AIS) has made it possible for the wider maritime industry to operationally benefit from knowing details such as the estimated time of arrival, the port, its draughts and navigational speeds.

This, however, is not always the case for offshore support vessels (OSV) because the typical signal is likely to contain fewer data points and errors due to shorter transits and unique operating modes.

That said, there are systems onboard such as those for alarms and monitoring that provide sufficiently rich data sets that go beyond supporting the simple tracking of vessels and into the key metrics of each operating mode. Deeper analyses of the data on vessel positions, operational conditions and the physical environments of any operation often reveal information that will enhance the probability of making effective decisions on vessel utilization.

More efficient communications between vessels and ports and/or the offshore assets being serviced by an OSV would optimize vessel operations to the benefit of the entire value chain.

Because many software applications exist specifically to address an individual vessel's voyage plan, they only create a short-term fix. Whereas a connected ecosystem that aggregates vessel-specific data and external data sets that can provide historical perspectives will present a more detailed picture for instantaneous decision-making.

When 'real-time' data is made available to support analytics and decisions, a vessel's voyage can be made incrementally more efficient over time from the perspectives of fuel consumption and its utilization. This, of course, requires varying degrees of systems connectivity.

Though some owners have started the digitalization journey, the focus at times can be on asset uptimes. Looking at the efficiency of ships' voyages in terms of broader asset-utilization metrics benefits owners and charterers; for example, it builds confidence that decisions to apply new technology have been taken with a view to the efficiency of the whole system.

Modernizing the ways in which a ship captures data can help the owner/operator overcome the limitations of AIS.

INTEGRATED OPERATIONS: SMART MAINTENANCE

With emerging technologies such as virtual reality, augmented reality and 'smart' data portals entering the market, 'smart maintenance' is set to revolutionize the future of Offshore Support Vessels (OSV).

Smart maintenance regimes use instrumentation and software to support advanced levels of condition monitoring and related functionalities with or without shore-based support. These tools can be used to monitor the current health of assets and make maintenance decisions based on real-time data.

Smart maintenance can enhance a range of strategies used in vessel upkeep, such as 'condition-based maintenance' (CBM) and 'smart functions' (see more detailed definitions below). The digital technologies that power 'smart' regimes can be used to hasten the transition to CBM from traditional, calendar-based maintenance strategies. They help owner-operators to detect when and where maintenance is needed to assure their ships run dependably, safely and efficiently.

1) Under a CBM regime, maintenance is performed after the results of monitoring activities are analyzed to determine when a part needs to be replaced, or other corrective action is required. This can include periodic or real-time condition-monitoring activities.
    a. Condition Monitoring uses various technologies to determine the condition of equipment (or their internal components) at a specific moment in time, using minimalistic or non-invasive methods.
    b. Real-time monitoring uses permanently installed sensors to capture and transmit data for analysis and identify trends that help to monitor the condition of assets and their components instantaneously.
2) 'Smart' functions use operational and application data to support analytics and decision-making. Equipment, systems and services are installed to continuously collect, transmit, manage, analyze and report data to enhance awareness of an asset's condition, provide operational assistance, optimize operations and offer decision-making support.

Smart maintenance supports OSV owners by improving their ships' availability and reliability and lowering the total cost of ownership.

INTEGRATED OPERATIONS: REMOTE INSPECTION TECHNOLOGIES (RIT)

OSV and other maritime operators face challenges conducting surveys and inspections that can also limit the amount of downtime for the vessel and minimize the exposure of personnel to hazardous areas.

The implementation of RIT can help surveyors and inspectors to access potentially hazardous locations during their work duties. There are different RIT methods that support this objective, including: unmanned aerial vehicles, remotely operated underwater vehicles, robotic crawlers, wearable technology (e.g., smart glasses) and Laser Imaging Detection and Ranging.

Simply put, using RIT to conduct potentially hazardous inspections is safer for surveyors and inspectors. When working at height, they face the risk of falling and getting severely injured. In confined spaces, there are the risks associated with toxic atmospheres, fires, and explosions.

In addition to personal safety, using RIT also can reduce the costly and potentially damaging preparations that are sometimes needed before vessels can be inspected, including cleaning and ventilating. They also have the potential to limit the demand for or the number of required workers, and access tools, such as ladders, staging, ropes and elevated work platforms.

This in turn can reduce any damage to the vessel caused by these activities, risks to workers and the downtime and cost of installing these support tools.

Applying advanced and emerging ‘smart’ technologies will help to detect an OSV’s potential operational and maintenance problems earlier, save costs and protect workers.

OPERATING IN HIGH SEAS: STATION-KEEPING AND CREW COMFORT

New innovative designs for offshore support vessels (OSV) and their transfer systems promise to minimize the adverse effects of working in high seas for operators, including challenges with consistent vessel positioning and minimizing the impact and effect of motion.

To improve integrated operations in the high seas, the industry has long been seeking solutions for fast, safe and reliable crew and component transfers, especially for offshore wind and multi-purpose support vessels. Maritime technology is now advancing to offer those, and the solutions below are in varying stages of development and industry application.

Motion-compensation techniques are effective ways to decouple a vessel's motion from its lifting operations.

Passive, active and semi-active motion-compensated lifting systems and gangways comprise some of the solutions for increasing OSV operability in the high seas. The passive-compensation systems are relatively simple in design and operation, while active-compensation systems need sensors to measure motion, and any compensation activity is dynamically controlled.

To optimize the integrated operation, especially for planning and decision support, time-domain numerical simulations of the lifting operation can play an important role in finding a solution.

DP systems and compensated gangways are the primary ways to keep OSVs in a workable position. Their reliability continues to be improved by new advanced-protection techniques and the development of activity-specific operational guidelines. The main advantage of motion-compensated gangways is that they increase the tolerance on the OSV's positions, while also increasing high-seas operability when used in tandem with a DP system.

A motion-compensation platform minimizes the motion effects of the vessel on the platform and improves the motion behavior to maximize the crew's ability to work. The technologies for both active and passive compensative systems are currently available. Their components can be moved onto, or removed from, compensation platforms to minimize motion.

Solutions for minimizing the motion include new designs for ships with small water planes. Small-water area vessels are often equipped with fin and pitch controls to minimize the roll and pitch motions. This technology improves their operations by decreasing motion, reducing ship weight and offering larger deck spaces to carry parts and consumables.
Roll-stabilizing systems, such as fins and anti-roll tanks, also work to minimize motion. In general, bigger vessels are more stable in high seas than smaller ones.

Vessels with docking systems can be hooked up to offshore platforms or units. Once attached, they are stable and able to maintain the desired position for operations. This process maximizes station-keeping and motion performances during integrated operations.

OSVs, which perform and expanding number of roles, typically require DP systems with redundancy (to DP2 and DP3 standards) to operate in proximity to other offshore structures. The future OSVs adopting minimum motion designs and installed with motion compensated cranes and gangways have the potential to provide solutions for fast, safe and reliable high seas transfers of crew and component.

INTEGRATED OPERATIONS: IMPROVING HABITABILITY

A unique aspect of the maritime industry is that workers are often required to live at their workplaces (onboard ship). While this is shared with other industries, such as offshore oil and gas, the seafarer's living conditions are unique.

In addition to the psychological strain of living away from home for extended periods, seafarers are also subjected to ship motions such as pitching, rolling, slamming and, quite possibly, less-than-favorable ambient conditions involving vibrations, noise, lighting, and temperature. Each of these conditions can take a toll on their daily health, safety, and performance, but a good habitability design can lessen these concerns.

Habitability can be broadly defined as the acceptability of conditions such as ambient environmental qualities (noise, whole-body vibration, indoor climate, and lighting), as well as the physical, spatial and the outfitted characteristics of the seafarer's accommodations.

The main goals of designing for habitability are to provide an onboard environment that will help to enhance human performance and mental alertness (thus reducing the potential for human error), reduce fatigue and improve the quality of life.

Designing ships and crews' quarters to habitability goals can improve productivity, morale, safety and comfort, while decreasing the potential for fatigue and human error.

Reports from the International Maritime Organization (IMO) indicate that seafarer fatigue is a contributing factor in many maritime accidents (MCS/Circ.565). In fact, the causal relationship between human error and maritime accidents has been documented by the IMO. It jeopardizes ship and seafarer safety (MSC 71/INF.8; MSC 69/INF.16; MSC 68/INF.15; MSC 69/INF.15).

Looking at habitability from the human-factors and ergonomics perspectives, designing for a better ambient environment is central to improving a worker's performance of tasks such as communicating on the bridge, viewing control-room displays, or resting and trying to sleep. Conversely, poor habitability designs can adversely affect physical and psychological health at a potentially high cost to the individuals, owners and industry.

The main ambient factors of habitability, include:

- **Noise** – Habitable noise levels are critical because inhospitable levels can degrade vigilance during watchkeeping tasks, interfere with complex mental tasks, interrupt or delay the onset of sleep and otherwise interfere with rest.
- **Whole-body vibration** – Controlling levels of vibration can establish a safer environment and help to limit the erosion of human performance. This includes motion sickness, vibration-induced injuries and illnesses, and motion-induced instabilities and interruptions. Disruptive vibration levels also can alter a worker's perception (e.g., reading text and instruments, depth perception) and influence control movements (e.g., tactile sense, head/hand movements and manual tracking).
- **Indoor climatic qualities** – The objective is to provide suitable conditions to facilitate human performance and eliminate influences that increase expenditure of energy, decrease work capacity, reduce the ability control hand/arm movements, or decrease cognition.
- **Lighting** – Vision is essential transferring information and assuring safety. Poor lighting levels limit a worker's ability to perform visual tasks, cause distraction, perceptual confusion (such as misreading a display) and may lead to a failure to detect visual targets. Improper lighting also can contribute to eye fatigue, human error, unsafe conditions and increase reaction/response times.

Sometimes small adjustments, those that are often taken for granted on land, can make a measurable difference in the habitability of seafarers. Recent improvements include provision of an internet service so seafarers can stay connected with family and friends. Another example is the provision of a computer room or library where seafarers can learn new vessel systems/processes to help advance their education and support career advancement.

Good vessel habitability – which includes the design, placement, and arrangement of the onboard spaces where seafarers live and work – is essential to recruiting and retaining the top seafarer talent that give maritime companies a competitive advantage.

INTEGRATED OPERATIONS: CYBER SECURITY

Automated and 'smart' technologies have become increasingly prominent across the offshore industry, bringing many potential benefits for operational efficiency, carbon reduction and cost savings.

They are not without risks, however. Each additional sensor or software update provides a new potential gateway into an asset's command and control systems. As an offshore support vessel's (OSV) systems connectivity and automated functions grow, their security must keep pace.

An OSV's integrated operations will include many automation-enabled functions that directly support and impact the success of its mission. The safety of any operations controlled by automated systems requires a robust security strategy that assures reliability and builds the operator's confidence in them.

ABS's CyberSafety notations (CS-1 and CS-2) provide a workable program onboard any vessel. Their emphasis on human processes as part of a viable security program take advantage of human nature, and the natural desire to accomplish duties as defined. The objectives of the security program for cyber-enabled systems includes eight facets.

- The ship or organization must have a designated program for cybersecurity. Someone must be in charge.
- The company (ship) must have a policy document about cyber-related systems, written and distributed to staff.
- Incident response requires personnel assignments, especially casualty control for safety-critical automation systems. A team must be able to control malfunctions in all systems that contain or use software, especially those which are safety critical.
- Inventories and diagrams must be compiled and kept for all automation systems that affect a ship's capabilities or mission.
- Risk assessments must be recognized practices; they must be consistently carried out, along with risk-management exercises. The ship or company must conduct regular risk assessments that include cyber-enabled systems as part of the considerations onboard the ship; this is in line with the International Maritime Organization 2021 cyber-risk requirements.
- Risks are managed in accordance with an onboard risk-management system. This can be a procedural guide or document, or a full cybersecurity risk-management system. Where policy lays out expectations, procedural guidance will help crews to understand ways of avoiding cyber risks in their automation systems.
- Training for onboard cybersecurity and cyber-enabled systems should be regularly conducted for crew, visitors and vendors, at levels appropriate to their access to the systems. This can include regular cyber 'hygiene' for crew and visitors, and/or deeper topics for managing remote access to systems and procedures for software updates, etc., for maintenance crew and engineering personnel.
- Management of change is a program maintained and managed by the crew. Changes to any cyber-enabled system – whether in hardware, software, or firmware – must be approved by the designated authorities at the company and/or onboard the ship. No software changes should occur unless the captain and chief engineer, at a minimum, understand the implications of the changes, especially the potential for disruption if the update proves incompatible.

Cybersecurity depends primarily on human activities. Once the ship and shipowner are organized, the crew will be better prepared to protect the cybersecurity of their vessel.

ABS SUPPORT

The demand for flexible operations will redefine how future offshore support vessels (OSV) are viewed and conceptualized.

As changing market drivers and advances in technology create opportunities for a specialized OSV fleet, it will become increasingly critical to balance those new dynamics with traditional demands for safe and sustainable operations.

Integrating new fuels and power sources will introduce new types of risk that will need to be fully assessed.

In anticipation of developments in OSV design, equipment and systems, ABS is investing now in updating and expanding our guidance for these vessels, giving shipowners and operators confidence that they can continue to look to us for leadership.

ABS plays an important role in helping to understand the risks and providing guidance every step of the way.
From concept to decommissioning, we offer the services and solutions that support every stage of the OSV lifecycle, including:

- Risk assessments (such as HAZID, HAZOP, FMEA)
- Regulatory and statutory compliance
- Qualification of new technologies
- Lifecycle and cost analyses for alternative fuels
- Vessel/fleet benchmarking, including the identification of options for improvement
- Strategies for adopting alternative fuels
- Techno-economic studies
- Greenhouse-gas rating services
- Emissions certifications
- Remote control and autonomous functions development
- Cyber-safety notations and assessments

As the demands on OSVs change for everything from operational performance to environmental compliance, you can count on support from ABS.

CONTACT INFORMATION

GLOBAL SUSTAINABILITY CENTER

1701 City Plaza Dr.
Spring, Texas 77389, USA
Tel: +1-281-877-6000
Email: Sustainability@eagle.org

NORTH AMERICA REGION

1701 City Plaza Dr.
Spring, Texas 77389, USA
Tel: +1-281-877-6000
Email: ABS-Amer@eagle.org

SOUTH AMERICA REGION

Rua Acre, nº 15 - 11º floor, Centro
Rio de Janeiro 20081-000, Brazil
Tel: +55 21 2276-3535
Email: ABSRio@eagle.org

EUROPE REGION

111 Old Broad Street
London EC2N 1AP, UK
Tel: +44-20-7247-3255
Email: ABS-Eur@eagle.org

AFRICA AND MIDDLE EAST REGION

Al Joud Center, 1st floor, Suite # 111
Sheikh Zayed Road
P.O. Box 24860, Dubai, UAE
Tel: +971 4 330 6000
Email: ABSDubai@eagle.org

GREATER CHINA REGION

World Trade Tower, 29F, Room 2906
500 Guangdong Road, Huangpu District,
Shanghai, China 200000
Tel: +86 21 23270888
Email: ABSGreaterChina@eagle.org

NORTH PACIFIC REGION

11th Floor, Kyobo Life Insurance Bldg.
7, Chungjang-daero, Jung-Gu
Busan 48939, Republic of Korea
Tel: +82 51 460 4197
Email: ABSNorthPacific@eagle.org

SOUTH PACIFIC REGION

438 Alexandra Road
#08-00 Alexandra Point, Singapore 119958
Tel: +65 6276 8700
Email: ABS-Pac@eagle.org