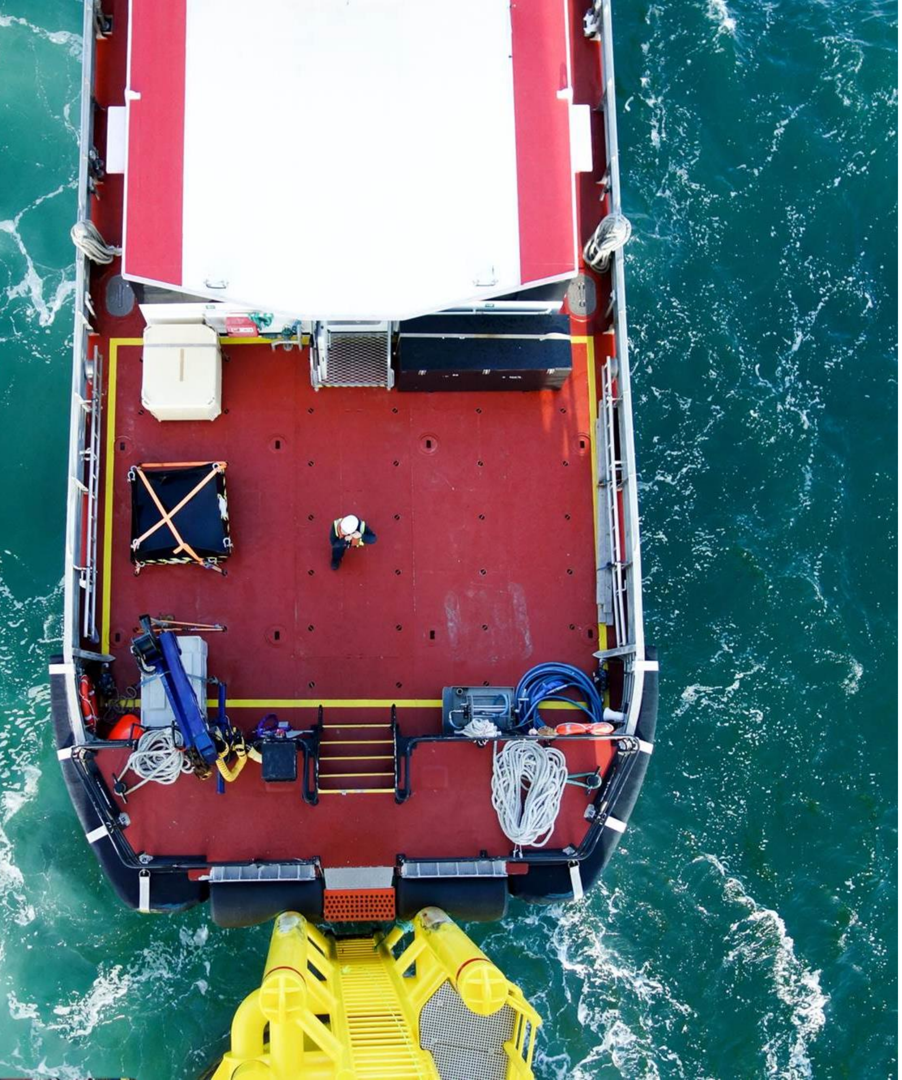
CARBON TRUST & CLASS NK

Decarbonization of offshore wind support vessels webinar

Agenda

1. Offshore wind service vessel decarbonisation overview
2. SOV Introduction and Market Summary
3. SOV Decarbonisation Overview
4. CTV Introduction and Market Summary
5. CTV Decarbonisation Overview
6. Offshore wind support vessel charging



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Offshore wind service vessel decarbonisation overview

OSW support vessel emissions in context

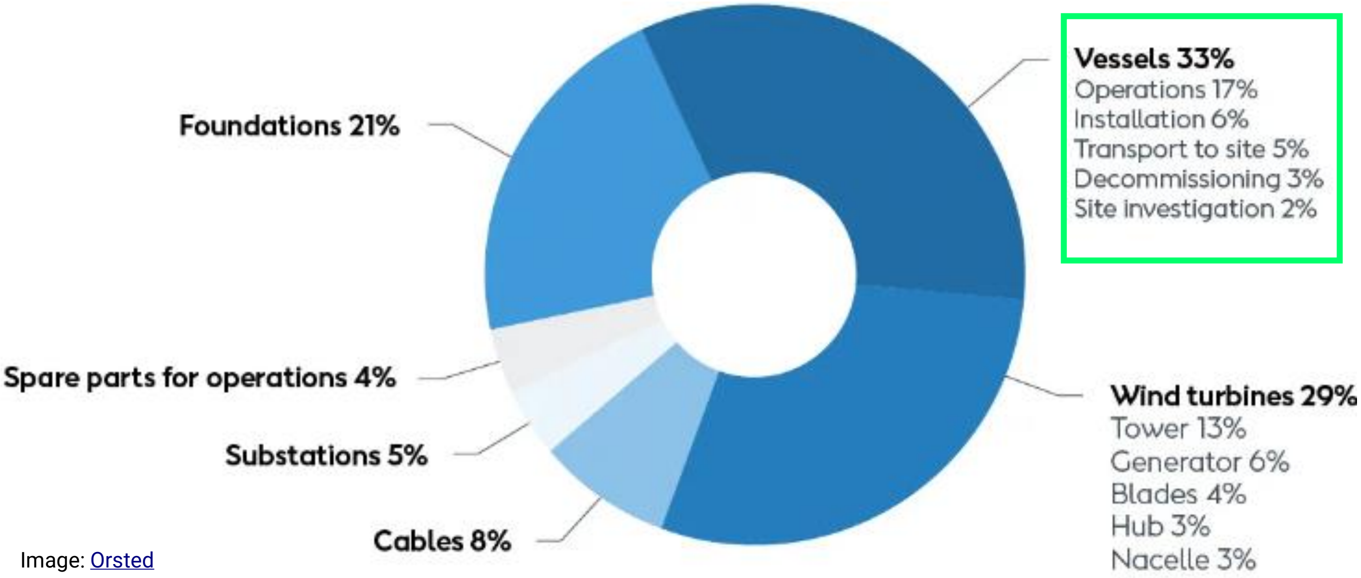
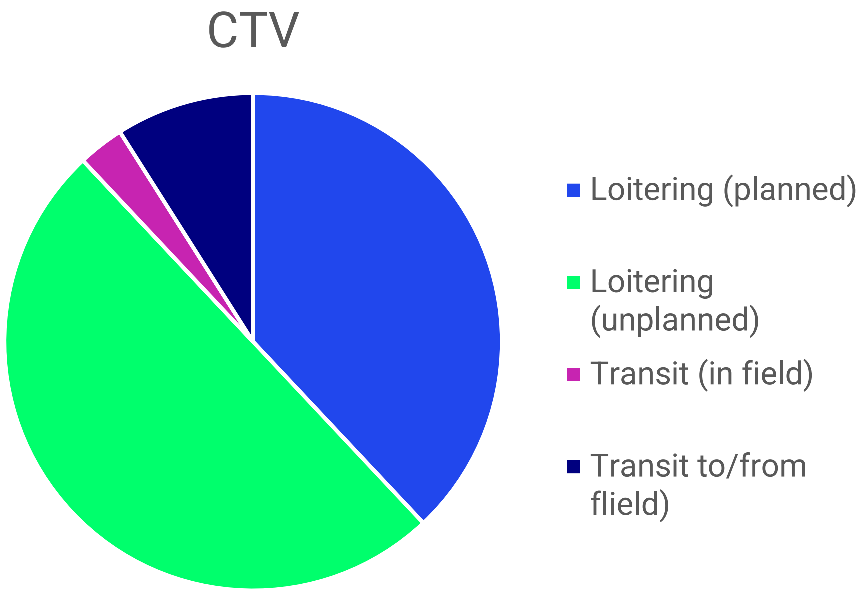


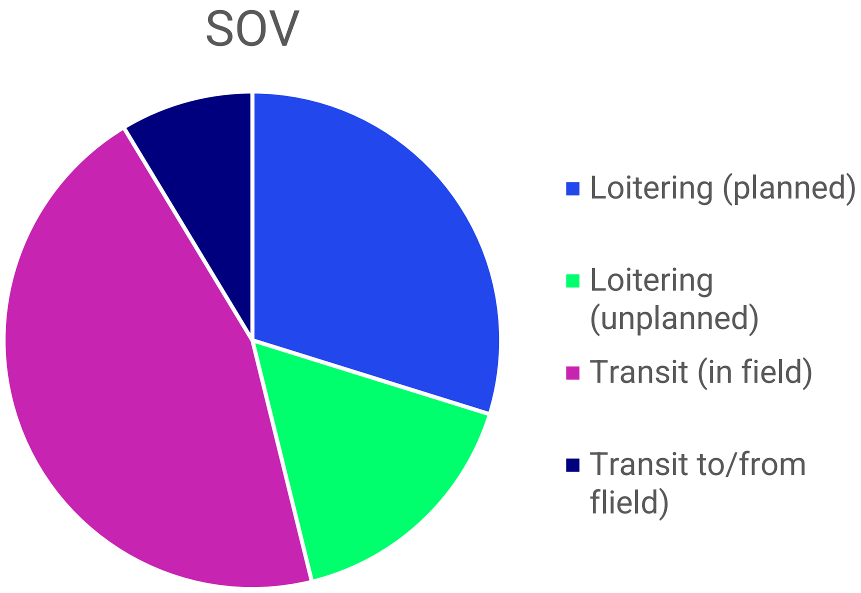
Image: Orsted

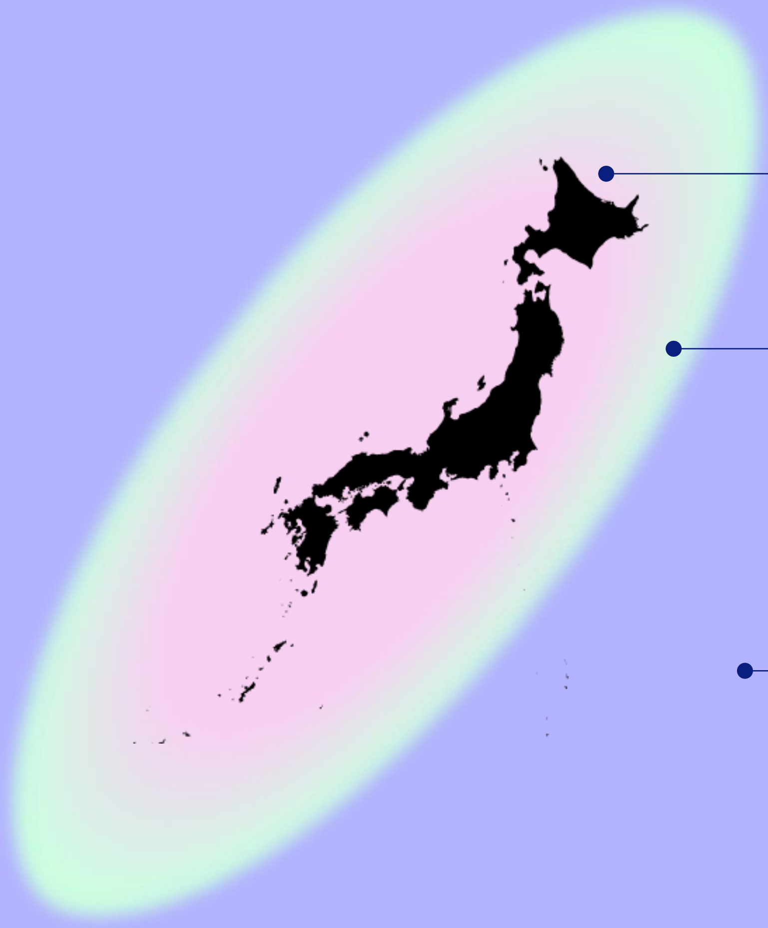
LCA modelling of an entire offshore wind farm (courtesy of Orsted) identified that vessels are responsible for around 33%, (or one third*) of the full lifecycle emissions from an offshore wind farm development

*Please note: emission values differ greater depending on specific windfarm criteria (e.g., distance to sore, construction type etc…)

Emissions per vessel type







Electric Propulsion:

- No conversion loss
- Lower CAPEX cost
- Less range
- Longer replenishment time
- Less safety concerns

Hydrogen or Methanol:

- Small conversion loss
- Medium CAPEX cost
- More range
- Conventional replenishment time
- Some safety concerns

Ammonia:

- More conversion loss
- Higher CAPEX cost
- High range
- Conventional replenishment time
- More safety concerns

Integrated approach to new energy for OSW support vessels

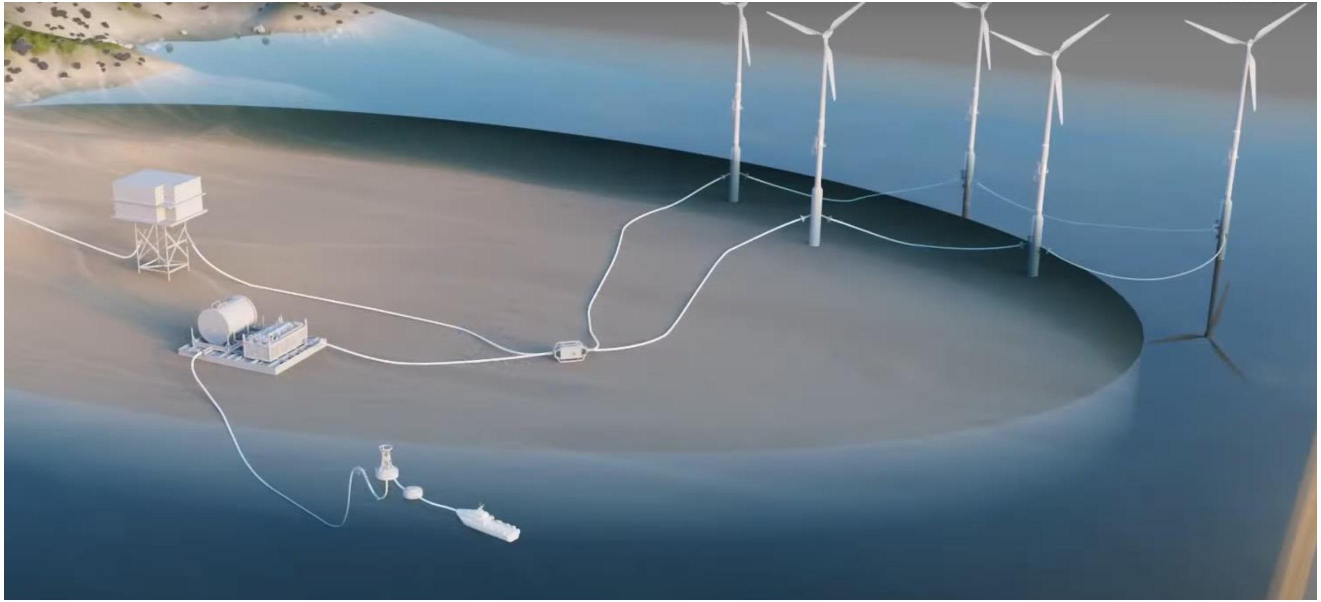


Image: Verlume integrated electric system

To maximise the efficiency of vessels utilising new energy sources a more integrated approach to new energy sources may be required

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SOV Introduction and Market Summary

SOV Introduction

Service operations vessels (SOV) have become the dominant vehicle for offshore wind farm maintenance, due to their size, ability to travel longer distances, and capacity to remain in the field for long periods of time. They can provide floating operations and maintenance base in the field for up to four weeks. As offshore windfarms are now being located further offshore, SOVs are now being used in place of Crew Transfer Vessels (CTVs) and because SOV's are typically purpose-built in accordance with the charter and site requirements it means the vessel can be optimised to operate within the site conditions.

SOV design overview			
Hull types	Bulbous Bow	Widley utilised	Reduces the size of the bow wave by creating a second bow wave that is out of phase with each other
	X-Bow	Widley utilised	Allows for even force distribution, improved safety and passenger comfort, reduced fuel consumption
	X-Stern	Widley utilised	This is an X-Bow installed at the aft and bow, as market research showed that 70% of in field operation occur backwards.
Hull materials	Aluminium, fibreglass (rarely), steel		
Size	Length: 68m – 90m Beam: 17m – 20m		
Cargo type	Personnel, small to medium turbine components, tools, daughter craft and crew accommodations.		
Transfer methods	Via daughter craft, helicopter or using a motion compensating walk to work gangway system.		
Propulsion type	Azimuth Thruster		360-degree rotation
	Manoeuvring Thrusters		More accurate manoeuvrability when in field and allows the ship to dock in ports without the assistance of other vessels
	Voith Schneider Propeller (VSP)		Magnitude and direction of thrust to be determined and controlled in real time and precisely

SOV Market Overview

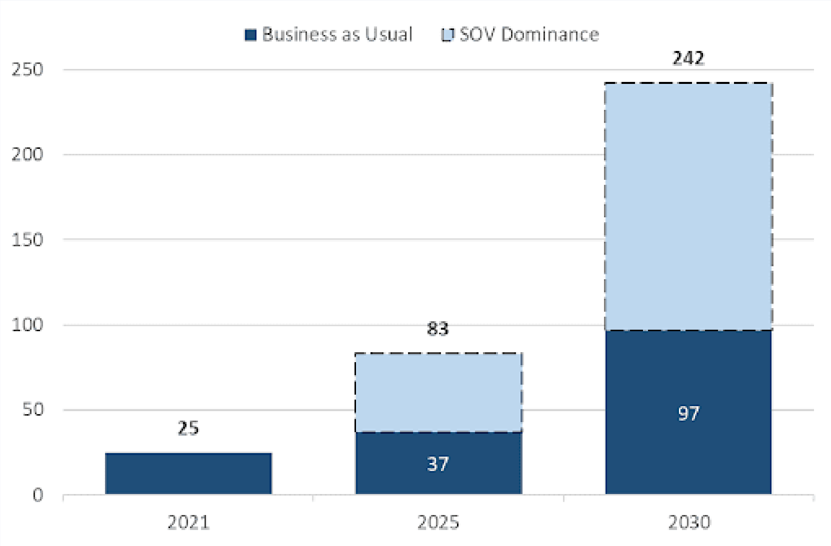

Chart: SOV demand for offshore wind O&M
No. of SOVs | North Sea | 2021 – 2030

Image: [Spinergie]

- Currently, the SOV market is centred predominantly in Europe, which is largely due to the number of new offshore wind farm projects in construction
- Demand for SOVs has **increased by 20% year on year between 2016 and 2020**
- There are currently 14 vessels under construction and 7 new builds in the pipeline for European wind projects. Outside of these there are currently two SOVs in construction: one is planned for operation in Taiwan and another in the US. Currently there are 32 SOVs in operation in Europe.
- To safely, efficiently and cost-effectively support the installation and maintenance of offshore wind farms around the world, SOVs are increasingly in high demand. The number of SOVs required to support O&M campaigns of planned global offshore wind projects is predicted continue to increase to 2030.

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SOV Decarbonisation Overview

Hydrogen Co-Combustion SOV’s

- Hydrogen is being explored as a potential energy source to support with decarbonisation. With its **high availability and handling capabilities hydrogen has significant potential reduce emissions**.

- Edda Brint & Edda Goelo are two 82.9-metre-long SOV’s that have been recently delivered for operations in Scotland and France. They have accommodation capacity of up to 60 people, a motion-compensated gangway system, and **feature a hydrogen-ready propulsion system** that allows for future installation of zero-emission hydrogen technology.

- The Elevation Series of vessels which have been designed by designed by Damen in collaboration with Windcat and CMB.TECH are 6 Hydrogen-Powered SOV’s. They are 87-metre-long vessels with capacity to accommodate 120 people on board and will be equipped with **dual-fuel hydrogen technology** to support the reduction of CO2 emissions.

Elevation series

Edda Goelo

Edda Brint

Hydrogen PEM SOV’s

- Both Louis Dreyfus Armateurs (LDA) and IHC have unveiled SOV designs using liquefied hydrogen is another Hydrogen SOV’s.

- The IHC selection of liquefied hydrogen and **the power generation system has been designed around its operational profile t**o maximise emission reduction potential. Insights regarding possible improvements were gained by analysing the operational data of various SOVs in the North Sea.

- **Low temperature proton exchange membrane fuel cells have a higher efficiency than internal combustion engines** and require less fuel. The vessel T60-18 concept has been designed to offer sufficient space below deck to store the required liquefied hydrogen without affecting the warehouse capacity or accommodation areas.

- LDA estimates that their liquid-hydrogen SOV, **would be able to operate 95% of the time with zero carbon emission,** with the vessel only releasing water during standard operations. Estimated that the result would be a reduction of 4,000 tonnes in CO2 released per year.

[IHC T60-18]

[LDA SOV concept]

Methanol SOV

- In April 2022, Esvagt and Ørsted decided to invest in what the companies described as the world's first SOV that can operate on green fuels. A month later, Cemre Shipyard received an order to build the hybrid, methanol-fueled SOV.
- The NB1094 SOV will be **powered by batteries and dual-fuel engines**, capable of sailing on renewable e-methanol, produced from wind energy and biogenic carbon, which will lead to a yearly emission reduction of approximately 4,500 tonnes of CO_2.
- The 93-metre-long vessel will provide accommodations for 124 persons and will be built according to DNV classification rules. With a depth of 8 metres and a width of 19.6 metres.
- **Once commissioned later in 2024, the SOV will service Hornsea 2** (the world's largest offshore wind farm) located off the UK's Yorkshire coast in the North Sea. A second sister SOV will be ready for launch in 2026, where it will operate out of Ørsted's UK East Coast Hub.

Esvagt NB1094

Electric SOV

Bibby Marine eSOV

- Bibby Marine Services has placed an order for a new service operation vessel (SOV) to be built by Gondan Shipbuilders in Spain with the delivery of the vessel scheduled for 2026.

- The eSOV, will have a powerful battery system and dual fuel methanol engines for back up, along with associated shore-charging facilities.

- To facilitate zero-emission operations, the eSOV will feature high-voltage offshore charging facilities for rapid recharging. With the capability to operate solely on battery power for over 16 hours between charging cycles.

- The project is supported with £19 million funding from the Zero Emissions Vessel and Infrastructure (ZEVI) competition, out of a total build cost of £29 million.

- ZEVI funding has been provided by the UK Department for Transport (DfT) and delivered by Innovate UK. ZEVI is part of the Department’s UK Shipping Office for Reducing Emissions (UK SHORE) programme, a £206 million initiative focused on developing the technology necessary to decarbonise the UK domestic maritime sector.

Bibby eSOV

SOV Design Considerations

	Hydrogen PEM SOV	Hydrogen Co-Combustion	Methanol SOV	Electric SOV
Design philosophy	Proposed vessels using PEM have been optimised to include the required liquefied hydrogen tanks without impacting upon storage capacity.	Adjustment to deck/storage capacity or revised personnel capacities to support the inclusion of additional hydrogen technology capability.	Adjustment to deck/storage capacity or revised personnel capacities to support the inclusion of additional methanol technology capability.	Battery sizing, capacity and weight would be determining factor to the potential use case for vessel ballasting. However, redundancy diesel capacity would also impact upon vessel capacity and size.
Equipment	Installation of liquefied hydrogen tanks and suitable safety systems.	Hydrogen bunkering storage capacity (in addition to diesel systems)	Methanol bunkering storage capacity (in addition to diesel systems)	Installation of a reciprocal connector for offshore and onshore charging.
Operational Methods	**Port bunkering capacity will be key** to be able to support the operations of the vessel.	**Port bunkering capacity will be key** to be able to support the operations of the vessel.	**Port bunkering capacity will be key** to be able to support the operations of the vessel. As well as the production of e-methanol.	**High capacity (~4MW) offshore charging** in the field will be required to support the vessel's operation.

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CTV Introduction and Market Summary

CTV Introduction

CTV design overview			
Hull types	Monohull	Moderately utilised	A monohull is a type of vessel that has only one hull. This has become a rare hull type for CTV's, after being seen as the firs hull type to be utilised.
	SWATHS	Moderately utilised	Small waterplane area twin hull is a catamaran design but differs to Catamaran by having most of the displacement below the water line.
	Catamaran	Widley utilised	Most common hull type, approximately 90% of CTV's. A catamaran is a conjoined ship composed of more than two slender hulls connected horizontally. The hulls are connected by deck bridges, and each has an independent propulsion device.
	Trimaran	Not widely utilised	A trimaran is a multihull boat consisting of a main hull and two smaller outrigger hulls, which are attached to the main hull by transoms. This is a rare hull type for CTV's.
Hull materials	Aluminium, fibreglass (rarely), steel		
Size	Length: 15m – 36m Beam: 5m – 11m		
Cargo type	Personnel, small to medium turbine components, tools		
Transfer methods	Push on directly to the turbine		
Propulsion type	Waterjets		High speed – 36% of CTV's use these
	Forward facing propellers		Used for economy – 6% of CTV's use these
	Fixed pitch propellers		Oldest form of propulsion – 37% of CTV's use these
	Controllable pitch propellers		Highest propeller efficiency – 21% of CTV's use these

CTV Market Overview

- In **2018 in Europe 350 CTVs were available and 321 of these vessels secured contracts** for at least part of the year. Most of these vessels (77%) are fully classed, meaning they can work further offshore than the MCA Cat 2 vessels that require closer proximity to a safe haven.

- Estimated **that in 2022, over 500 CTVs secured contracts for offshore wind projects in Europe** and over three thousand CTVs working on offshore wind projects globally.

- The global expansion of offshore wind development has resulted in growth of the crew transfer market. Global Crew Transfer Vessel for Windfarm Market size was valued at USD 89.51 million in 2023, registering a compound annual growth rate (CAGR) of 3.35% during the forecast period 2024-2032, and **the market is projected to be worth USD 109.05 million by 2032**.

- in 2022 catamaran vessels had the largest market share across hull types at 67.74%.

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CTV Decarbonisation Overview

OWA Supported Vessels

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Low Emission Vessel Competition

CWind Pioneer

Hydrocat 48

Grace Darling Daughter Craft

RAptor 2400

Innovator support

ESNA Seapuffin 1

Wallaby 18

Case study

Tidal Transit Retrofit E-CTV

- Tidal Transit will retrofit a diesel-powered Mercurio 20-meter vessel, Ginny Louise, with over two megawatt-hours (MWh) of battery capacity, electric motors and propulsion pods
- e-Ginny E-CTV will be able to service wind farms within 20 miles offshore by plugging directly into a wind turbine
- The project is supported with £6.3 million funding from the Zero Emissions Vessel and Infrastructure (ZEVI) competition, as part of Innovate UK and the Department of Transport’s strategic plan to develop, deploy and operate clean maritime solutions

Image / content: Offshore Engineer

CTV Design Considerations

	Hydrogen CTV	Hydrogen Co-Combustion	Hybrid Electric	Full Electric
Design philosophy	Proposed vessels using hydrogen as the sole fuel type. Sizing of tanks will be key so as not to inhibit the vessel design and proposed operation. Sufficient ballasting would need to be considered.	Hydrogen injection system to a dual fuel engine. Limited design changes compared to a conventional CTV. Loss of foredeck and subsequent cargo space due to the need for hydrogen tanks.	Potential loss of foredeck and subsequent cargo space storage capacity. Potential reduction in personnel capacities to **support the inclusion of additional battery capacity alongside ICE.**	**Battery sizing, capacity and weight would be determining factor** to the potential use case for vessel ballasting.
Equipment	Hydrogen bunkering storage capacity.	**Hydrogen bunkering storage capacity** (in addition to diesel systems)	Installation of a reciprocal connector for offshore and port charging.	Installation of a reciprocal connector for offshore and port charging.
Operational Methods	**Port bunkering capacity will be key** to be able to support the operations of the vessel as offshore refuelling is not currently viable. Sizing of tank capacity will need to be capable of supporting the expected operation profile of the vessel.	No fundamental changes to the vessel's main engine are required, with the engine capable of being switched back to diesel fuel without any modifications if hydrogen is not available. the vessel can continue to run on diesel	Due to diesel engines on board the charging requirement would be less. As a result, opportunity for faster port and in field charging due to reduced battery capacity and size.	High capacity (~1/2MW) offshore charging in the field will be required to support the vessel's operation as well as port charging. However, port charging capacity could be lower due to vessel being in port overnight.

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Offshore wind support vessel charging

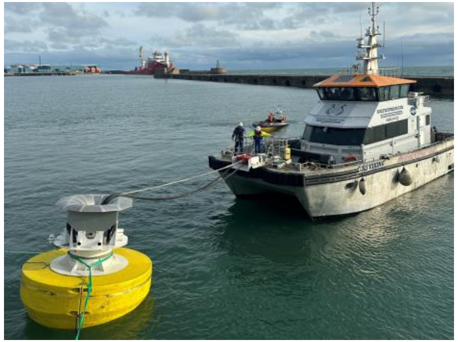
OSW Vessel Charging

- The shift to electric vessels will be key step to help decarbonise offshore wind farm operations but to utilise hybrid electric and full-electric vessels to their maximum potential the **ability to charge both onshore (at port) and offshore** directly from the wind farm is necessary.

- It is a challenge to develop, deploy and demonstrate safe and reliable offshore charging systems for the first time. Especially given that any solution is going to be required to operate in salt water at the surface, in the splash zone and sometimes in air.

- Several different connector developers are working on different solutions such as Oasis Marine and MJR Power however sizing and capacity is likely to be up to 2MW for CTV's and larger for SOVs (~4 MW). **Charging requirements will however differ between CTV and SOV**

- The OWA undertook the **Offshore Charging Standarisation (OCS)** project which aimed to provide recommendations for the standardisation of charging battery-powered electric and hybrid electric CTVs by developing a published outline universal connector design (pictured) providing a basis of design for the universal offshore charging connector.



CTV Port Charging Requirements

- Current development work has been focused upon offshore charging, but it is going to be important that **port charging capabilities are better understood** so that the ports can provide the required power facilities to future hybrid and fully electric vessels.

- Currently Crew Transfer Vessel (CTV) berths **at ports tend to have small scale shore power facilities** of 16 to 32-amp capacity, which will not be adequate to charge the new generation of hybrid vessels that will be partially or fully reliant on batteries for propulsion.

- If we see significant **increases in the number of hybrid and electric vessels** there needs to be **considerable development to the installed port charging facilities** to support this greater demand.

- Assessing demand is challenging and requires well documented assumptions that are informed by multiple stakeholder views.

- Effective infrastructure upgrades require good stakeholder engagement, and an understanding of the wider energy needs of the local infrastructure.

- Whilst there is some development in the fields of chargers and power management systems, there are currently no major technical barriers to upgrading infrastructure. The biggest barriers are risk (**uncertainty in future demand**) and commercial (**who will pay for the upgrades**).

DC electric charging station - Plymouth Sound National Marine Park

Q&A

Thanks for listening