Setting a Benchmark for Decarbonising O&M Vessels of Offshore Wind Farms

25/02/2021

Anthony Gray

CATAPULT
Offshore Renewable Energy

The paper

- This study aims to provide an estimate of annual vessel usage during the O&M phase of modern and future offshore wind farms and therefore define a benchmark for the associated fuel emissions.

- It is not intended to be a comprehensive Lifecycle Assessment (LCA) as it does not account for embodied carbon, however, the final result may feed into future LCA calculations.

- Two reference offshore wind farms of different sizes and distances to shore are used for the analysis to investigate emissions produced by Crew Transfer Vessels (CTVs) and Service Operation Vessels (SOVs).

Link to paper: https://ore.catapult.org.uk/analysisinsight/setting-benchmark-decarbonising-om-vessels-offshore-wind-farms/

Why focus on decarbonisation?

- It is clear that offshore wind power is much less carbon intensive than other forms of electricity generation.

- However, the processes of developing, constructing, operating, and maintaining (O&M) an offshore wind farm each incur a carbon footprint from embodied carbon of materials and equipment, as well as live emissions produced by vessels.

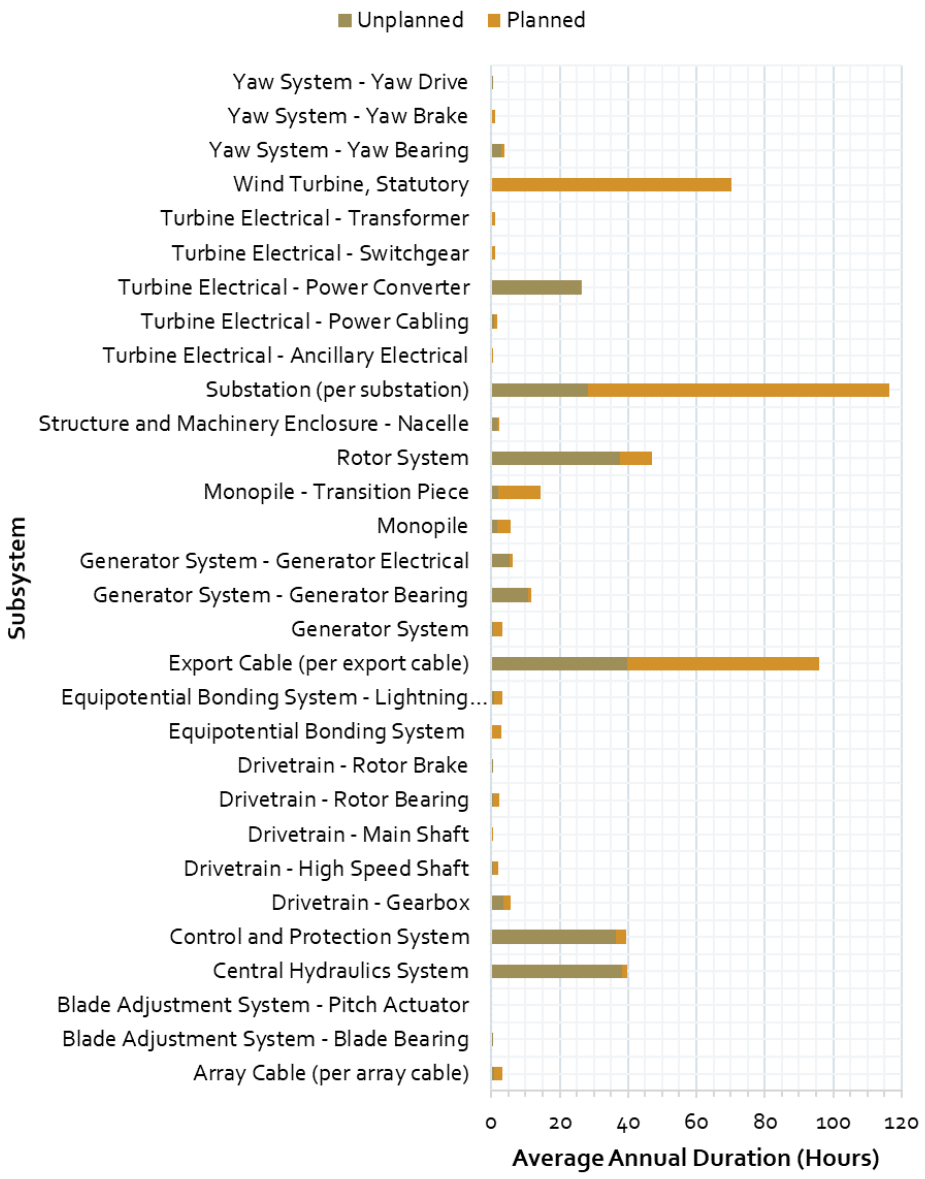
- This needs to be minimised to speed up the process of reaching Net Zero targets.

- The cost of offshore wind has dropped dramatically in the past few years. As a result, other metrics and Key Performance Indicators (KPIs) are expected to start playing a larger part in defining the performance of offshore wind farms. One of these new KPIs is likely to be the carbon footprint, as the 'race to Net Zero' comes to the fore.

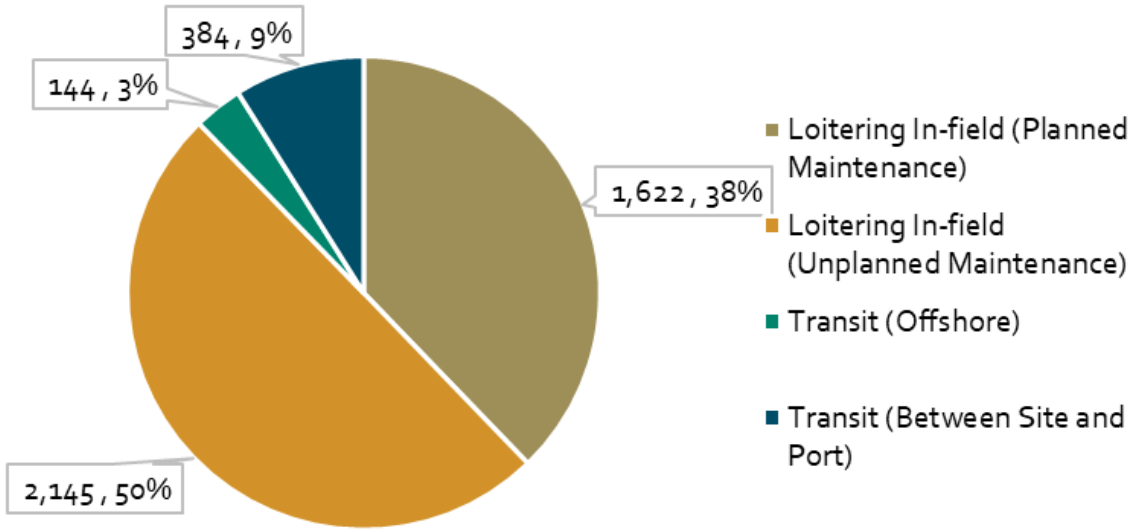
Emissions intensity of existing forms of electricity (Source: Bruckner et al. 2014)

Methodology

- Bottom-up modelling of O&M tasks that occur on the wind farm assets (e.g. turbines, cables etc.)
    - Assumed average annual duration of O&M activities in each subsystem (per turbine, unless stated otherwise), used for this study >
- Used the number of transfers stated in the SPARTA portfolio review for 2018/19 (i.e. 6.81 personnel transfers per turbine per month) to inform the number of transits undertaken by vessels
- High-level adjustments were made to ensure the bottom-up modelling represents realistic operation of vessels
    - Transit time
    - Personnel transfer optimisation
    - SOV resupply missions to port



Scenario 1 – small wind farm, near shore, CTV-based O&M



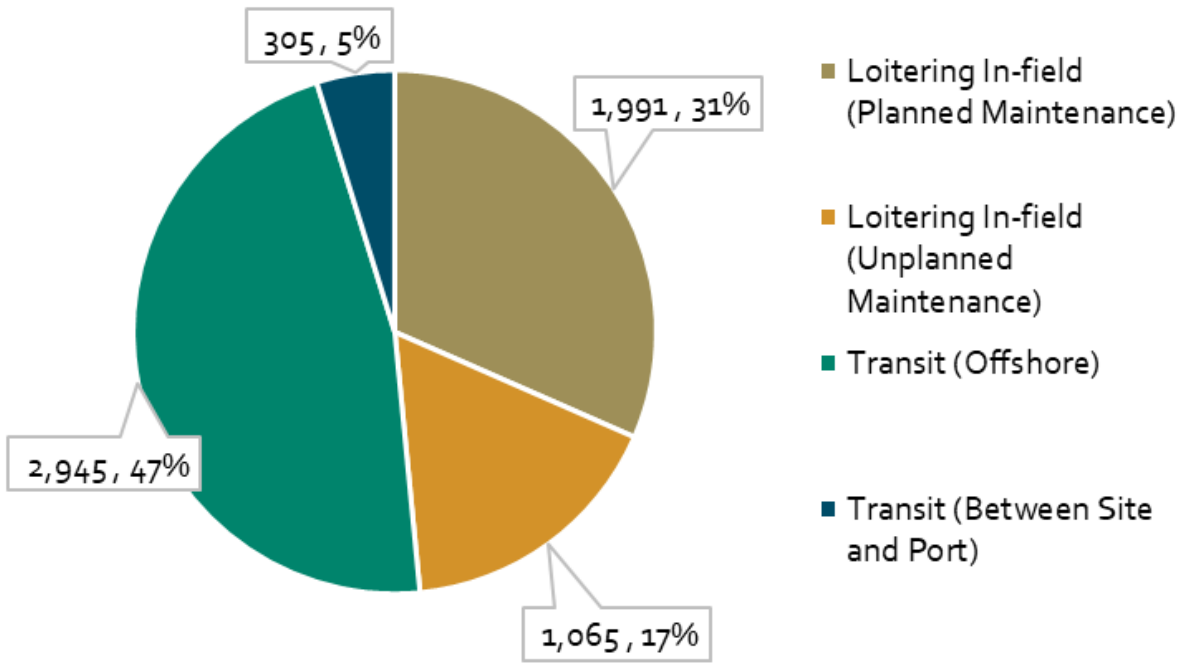
CTV annual usage, including transit times (all in hours) for scenario 1

Parameter	Units	Scenario 1
Primary O&M Vessel Type	text	CTV
Turbine Size	MW	3.6
Turbine Numbers	#	50
Site Capacity	MW	180
Distance from Port	km	20

Key site parameters for scenario 1

CTV Typhoon Tow (Source: CWind)

Scenario 2 – large wind farm, far-from-shore, SOV-based O&M



SOV annual usage, including transit time (all in hours) for scenario 2

Parameter	Units	Scenario 2
Primary O&M Vessel Type	text	SOV
Turbine Size	MW	12
Turbine Numbers	#	100
Site Capacity	MW	1,200
Distance from Port	km	130

Key site parameters for scenario 2

SOV Windea Jules Verne (Source: GE)

Methodology continued

- To calculate carbon emissions produced during the O&M phase of the reference offshore wind farms, the usage estimates needed to be combined with vessel specifications in terms of fuel type and fuel consumption, and emissions metrics from BEIS.

MGO Emission Metric	Units	Per Tonne	Per Litre
Carbon Dioxide Equivalent	kg CO_2e	3,249.99	2.775
Carbon Dioxide	kg CO_2	3,205.99	2.738
Methane	kg CH_4	0.81	0.001
Nitrous Oxide	kg N_2O	43.20	0.037

Conversion factors for emissions from Marine Gas Oil (Source: BEIS)

- We have assumed that the reference vessels in this study, CTVs and SOVs, use Marine Fuel Oil (MFO) and Marine Gas Oil (MGO), respectively, as the primary source of fuel.
    - Although some CTVs are capable of also using MGO following appropriate adjustments
    - The fuel consumption of SOVs when loitering in-field is deemed to be lower than that of CTVs as they often have hybrid electric power systems

Vessel Type	Crew Transfer Vessel (CTV)	Service Operation Vessel (SOV)
Primary Fuel	MFO	MGO
Secondary Fuel	N/A	Battery Electric
Fuel Consumption per Hour, Transiting	320 litres/hour	1,000 litres/hour[ii]
Fuel Consumption per Hour, In-field/Loitering	130 litres/hour[iii]	120 litres/hour[i]
Transit speed (average)	23 knots[ii] (42.6 km/hour)	12 knots[ii] (22.2 km/hour)

Assumed vessel specifications

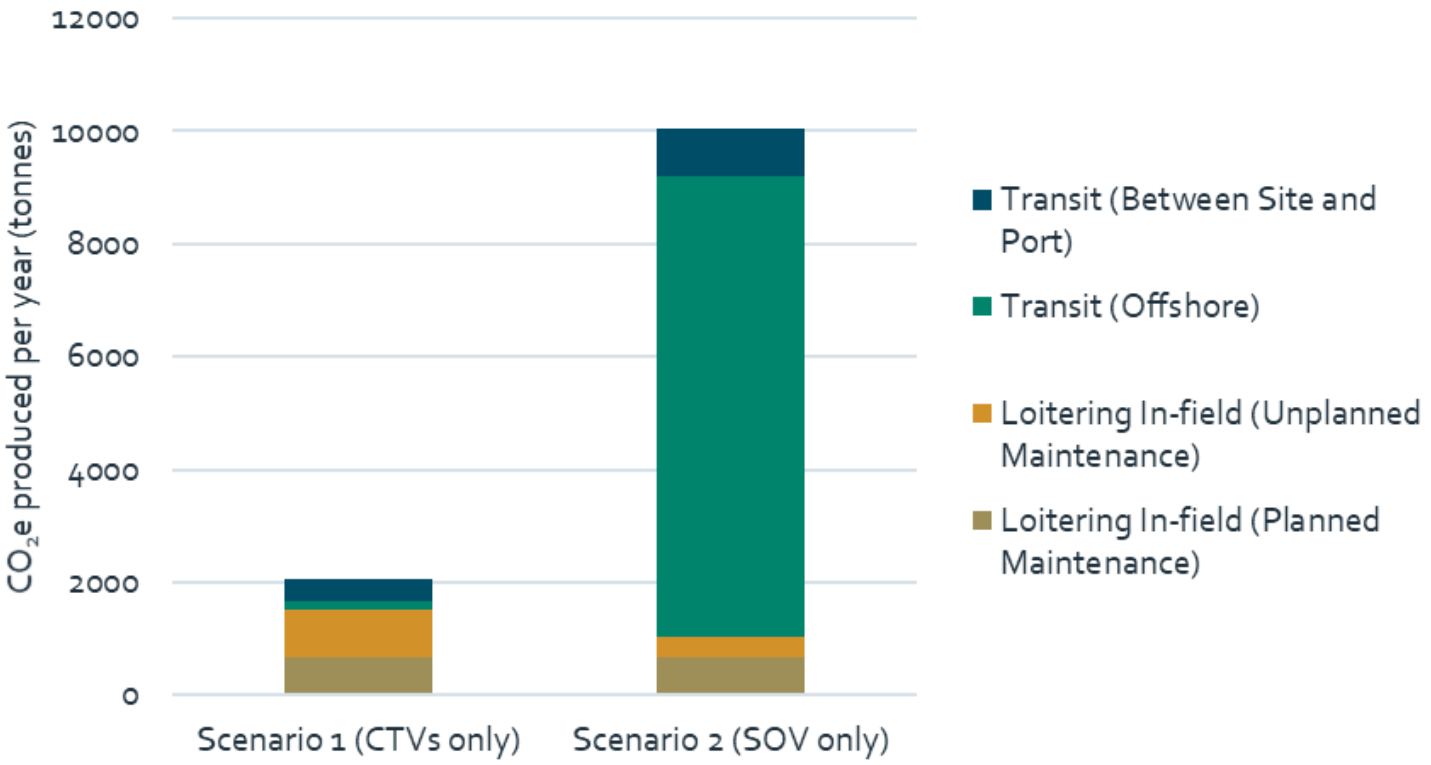
[i] Acta Marine (2019). Specification Sheet: Acta Orion, DP2 Offshore Support Vessel. Available from: https://www.actamarine.com/vessels/46/Acta-Orion.
[ii] DTOceanPlus (2020). Vessels Database. Deliverable D5.7. Logistics and Marine Operations Tools.
[iii] CWind (2020). Specification Sheet: CWind Endurance Swath, Crew Transfer Vessel. Available from: https://cwindprod.wpengine.com/wp-content/uploads/2017/07/CW_Endurance_Datasheet_012.pdf.

Annual Emissions

- Scenario 1 - CTVs are utilised for a total of 4,295 hours for the wind farm per year and produce 2,060 tonnes of carbon dioxide equivalent (CO2e) per year.

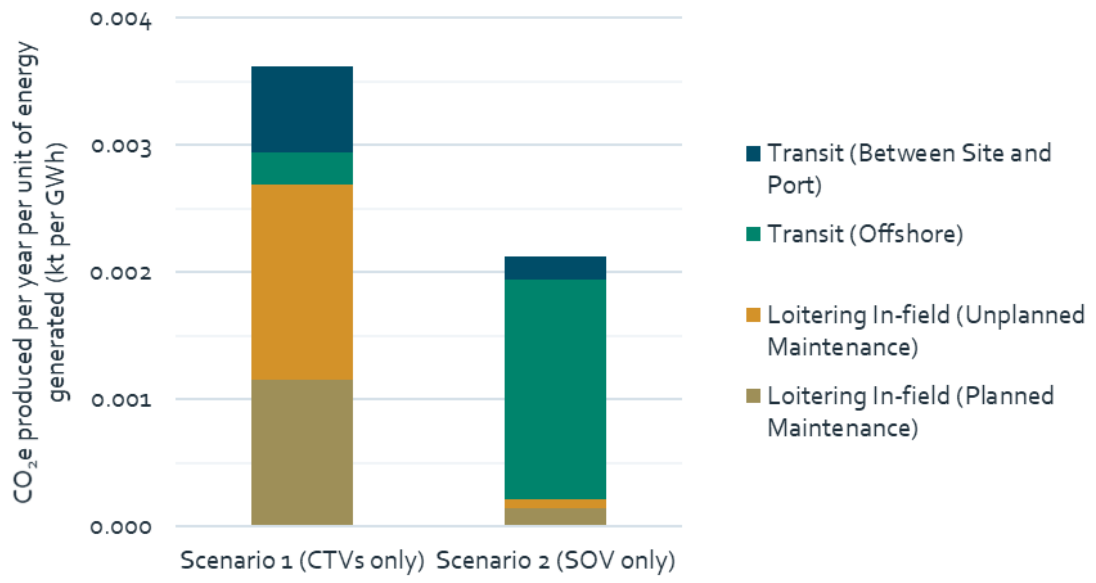
- Scenario 2 - The SOV is utilised for 6,305 hours per year at the wind farm and produces 10,040 tonnes of CO_2e per year.

- But total emissions isn't the only useful metric – many studies present emissions intensity (i.e. emissions per unit of energy generated)



Primary vessel (i.e. CTV or SOV) emissions (CO2e) caused during different phases for the two scenarios

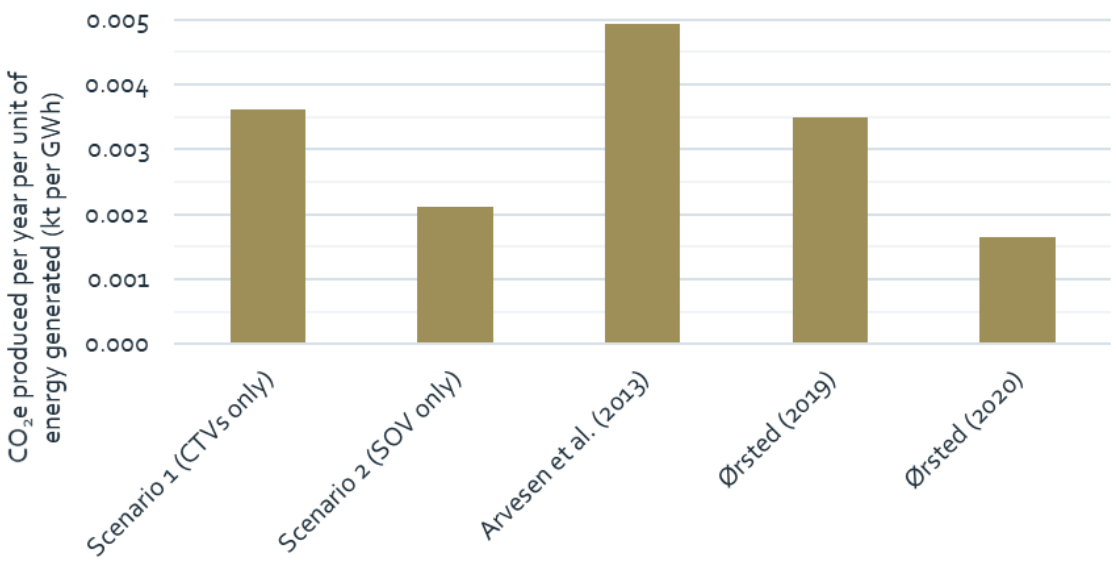
Annual Emissions per GWh



Primary vessel (i.e. CTV or SOV) emissions (CO2e) per GWh caused during different phases for the two scenarios

- Scenario 1 – total emissions equate to the CTVs producing 3.6 tonnes of CO2e per GWh of energy generated by the wind farm per year.
- Scenario 2 – total emissions equate to the SOV producing 2.1 tonnes of CO2e per GWh of energy generated by the wind farm per year.

- Comparable to other data sources >
  - Including Ørsted's annual reported figures for 2019 and 2020



Vessel emissions (CO2e) per GWh for the two scenarios compared to two other data sources

Contact us

Email us: info@ore.catapult.org.uk
Visit us: ore.catapult.org.uk

Engage with us:

GLASGOW | BLYTH | LEVENMOUTH | GRIMSBY | ABERDEEN | CORNWALL | LOWESTOFT | PEMBROKESHIRE | CHINA