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A PARAMETERIZED MODEL FOR THE EVALUATION OF MARINE OPERATIONS' IMPACTS DURING THE INSTALLATION STAGE OF OFFSHORE WIND FARMS



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[1] A. Arvesen, C. Birkeland, and E. G. Hertwich, doi: 10.1021/es304509r.

[2] Sacchi, et al., 2019, doi: 10.1016/j.renene.2018.09.020.

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INTRODUCTION & OBJECTIVE

- Offshore wind farms are exposed to stronger and more constant winds than onshore ones thus producing more electricity.
- They require **offshore activities** for the **installation** phase related to up to **28% of total Greenhouse Gas (GHG) emissions [1]**.
- Previous LCA studies **lack a detailed modelling** of the installation stage.

The **objective** of this research is to **refine** the life cycle impact assessment of offshore wind farms by including an **extensive modelling of the on-site installation and assembly**. Environmental impacts beyond climate change will hereby be explored.

REFERENCE SCENARIO

- Offshore windmill capacity **6MW**
- Distance to shore **12km**
- **Monopile** foundations
- **Separate parts** preassembly method
- **Diesel and Heavy Fuel Oil** installation vessels



<https://images.google.com/>



Heavy lift vessel



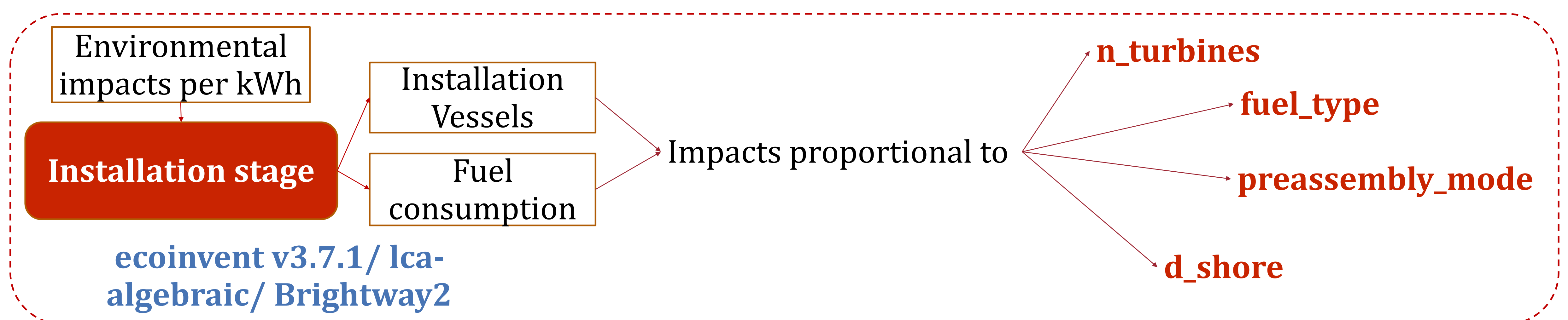
Jack-up vessel



Supply vessel

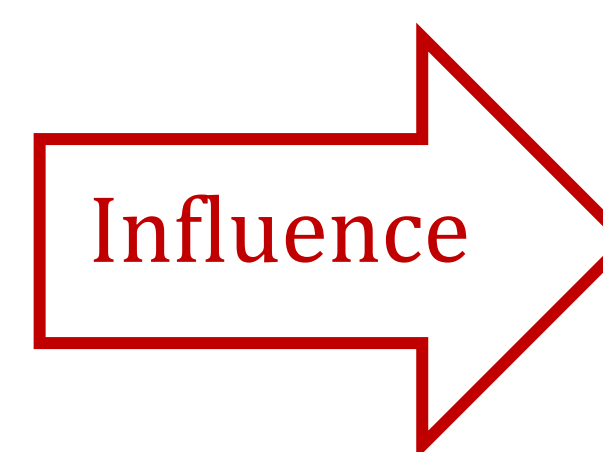
MATERIALS AND METHODS

Refinement of a parameterized Life Cycle Assessment model with detailed installation phase



Parameters:

- **d_shore**: Distance to shore
- **n_turbines**: Number of turbines
- **fuel_type**: type of fuel
- **preassembly_mode**: The pre-assembly method



Number of vessel lifts
The fuel consumption
Number of installation days

General framework of the parameterized model for the installation stage extended from the original parameterized model of Sacchi et al. [2]

PRELIMINARY RESULTS & DISCUSSION

Functional unit : 1 MW of installed capacity

Example of the influence of the **fuel_type** parameter on the variation of a selection of impacts assessment categories

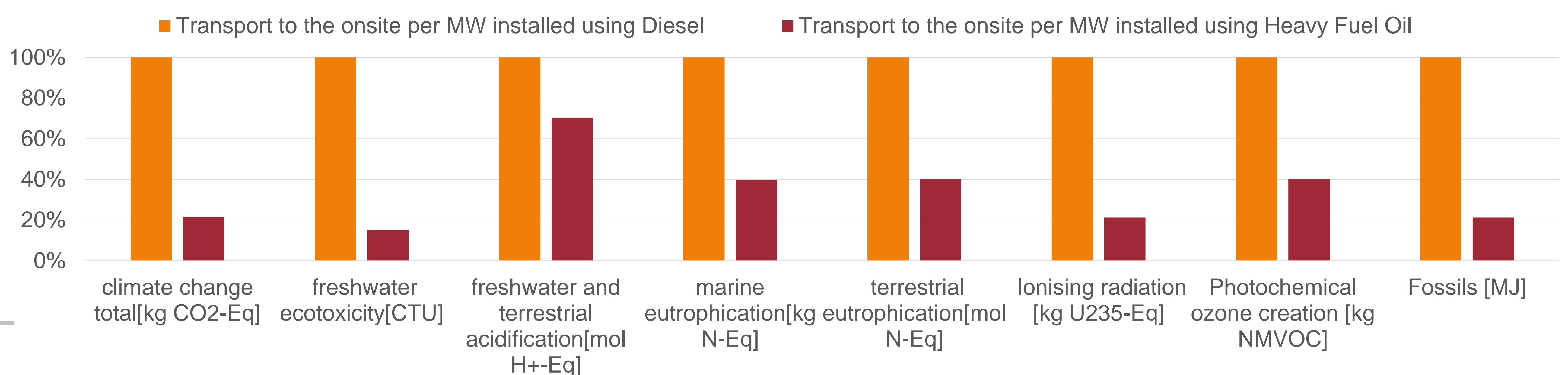


Fig 1. Environmental impacts of the transport to the offshore site : Relative results with respect to diesel fuel type (=100%)

- The whole model evaluates 16 impacts categories using the ILCD impact assessment method.
- The type of fuel consumed influences mainly the **8 impacts categories** shown above (Fig 1), and especially fossils depletion, climate change, freshwater ecotoxicity and ionising radiation:
- **Heavy fuel oil has 80% less contribution** to these impacts than diesel.

Example of the influence of the **preassembly_mode** parameter on the fuel consumption of installation vessels

- The choice of pre-assembly method influences **the total fuel consumption** per MW installed (Fig.2).
- The main factor responsible is the number of installation days. In fact, The separate parts method requires approximately **0.95 day per MW installed** while the rotor star method requires **3.55 days per MW installed**.

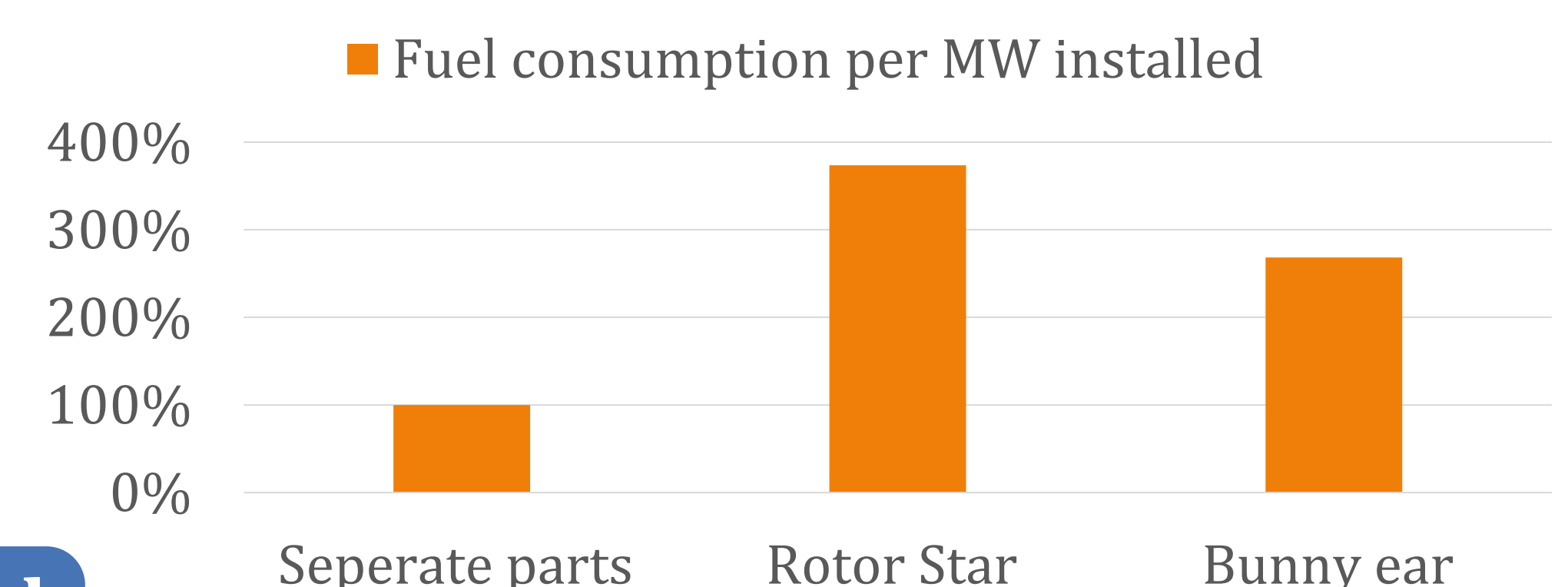


Fig 2. Fuel consumption per MW installed: Relative results with respect to the separate parts (=100%)

Extensive modelling of the installation phase of offshore wind farms is important for representative LCA results