

RENTEL OFFSHORE WIND FARM

Life Cycle Carbon Footprint
and Limited Life Cycle Analysis



1. GENERAL FINDINGS

1.1 Rentel direct CO₂ emissions amount to 1,1g CO₂/kWh and 160 times less compared to Belgian Electricity mix (170g CO₂/kWh).

1.2 Total life cycle CO₂ emissions (cradle to grave) of the Rentel wind farm amount to 171.298 ton CO₂. The Rentel wind farm would produce 21TWh over 20 years. This results in a 8,2g CO₂/kWh life cycle emission.

1.3 In the different life cycle stages, materials are the main contributor due to emissions during extraction and production. Steel (59% of total life cycle emissions) is by far the biggest contributor. The emissions related to manufacturing (3%) are small. Installation contributes 22%, while operations & maintenance constitutes 9% of the total life cycle CO₂ impact. In this study we assume that materials are recycled after 20 years. This results in an emissions end-of-life offset of net 45% (vessel fuel dismantling emissions subtracted).



1. GENERAL FINDINGS

1.4 DEME direct CO₂ emissions (22.389ton) are almost all caused by vessel fuel (98%). Rentel life cycle CO₂ emissions from vessel fuel for the wind farm installation (set-up) reduced by 47% compared to Thornton for an equal functional unit: delivering electricity to 300.000 households.

1.5 The top 10 Rentel life cycle emissions are dominated by steel from monopiles (42%) and wind turbine parts (42%), followed by the combined vessel fuel 22,2% (installation: 9% subcontractor vessels and 8,6% company owned vessels, dismantling: company owned and subcontractor vessel fuel 4,6%). Transition pieces (14%), operations & maintenance (8,8%), 220kV export cable (7,5%) and the transformer structure (2,4%) complete the top 10.

1.6 DEME direct CO₂ emissions amount to 13% of the Rentel total life cycle CO₂ emissions.



2. RENTEL DIRECT CO₂ EMISSIONS



160 times less direct CO₂ emissions (operations & maintenance) from the Rentel wind farm versus Belgian electricity mix of 170g CO₂/kWh (2016, EEA).



2.1 AVOIDED DIRECT CO₂ EMISSIONS

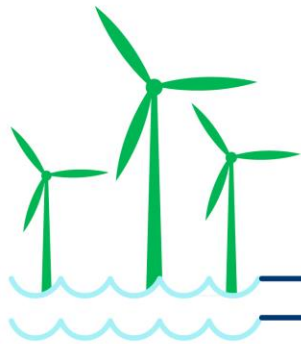
3.600.000t
of CO₂ savings⁽¹⁾

370.00
cars off the road for
20 years⁽²⁾



OR

400.000
electric powered
cars for 20 years⁽³⁾

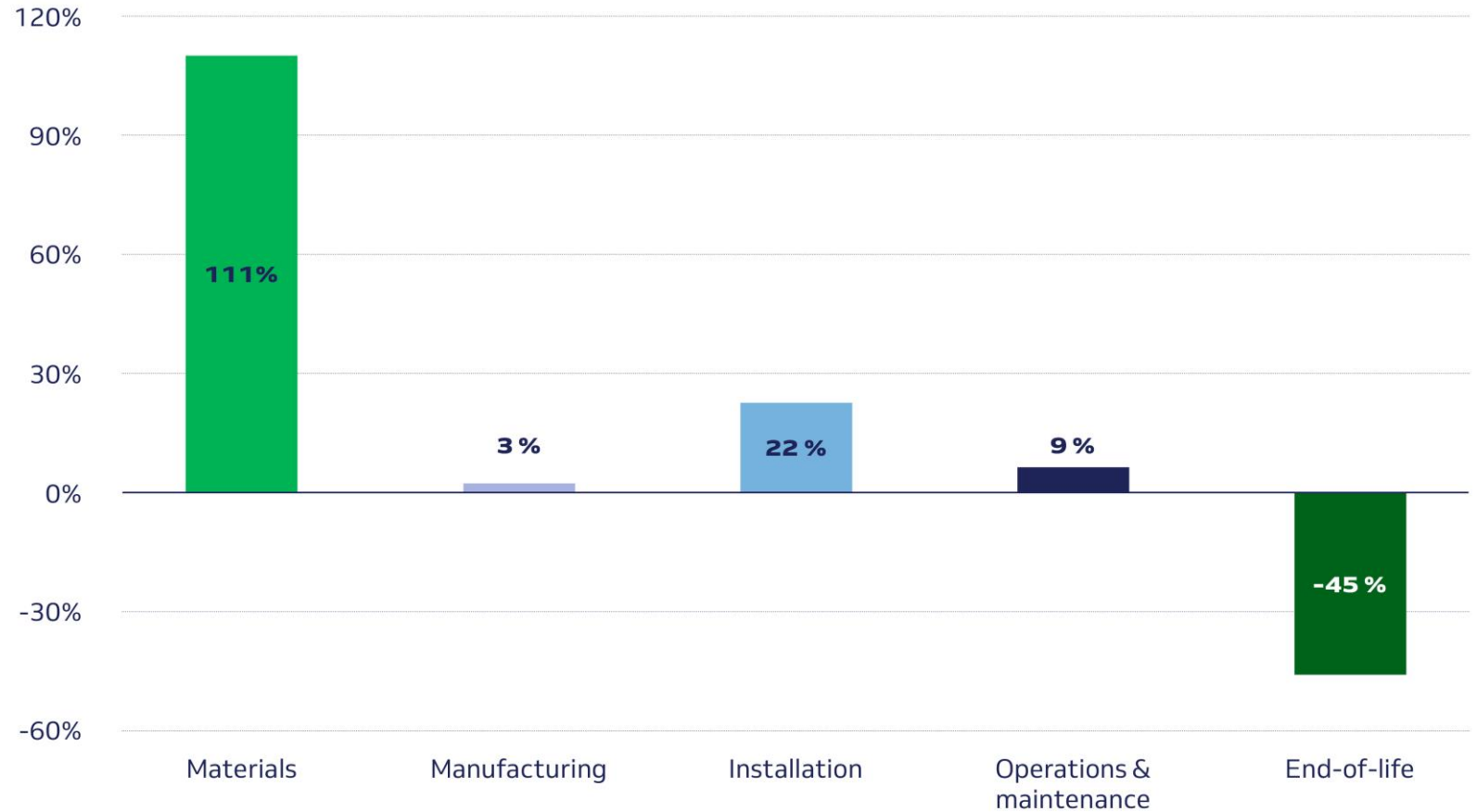


- (1) Total ton CO₂ savings compared to Belgian electricity mix during lifetime (20 years) of Rentel wind power plant (2016, EEA)
- (2) Rentel avoided emissions expressed in number average new Belgian cars: 116gCO₂/km (source, Vlaamse Milieu Maatschappij, 2017), 15.000km/year (source: FOD Mobiliteit en vervoer), 39% higher CO₂ emissions than indicated by car manufacturers (International Council on Clean Transportation, ICCT, 2017)
- (3) Rentel power production expressed in number average electric cars: 17kWh/100km (source: Tesla), 15.000km/year (source: FOD Mobiliteit en vervoer)



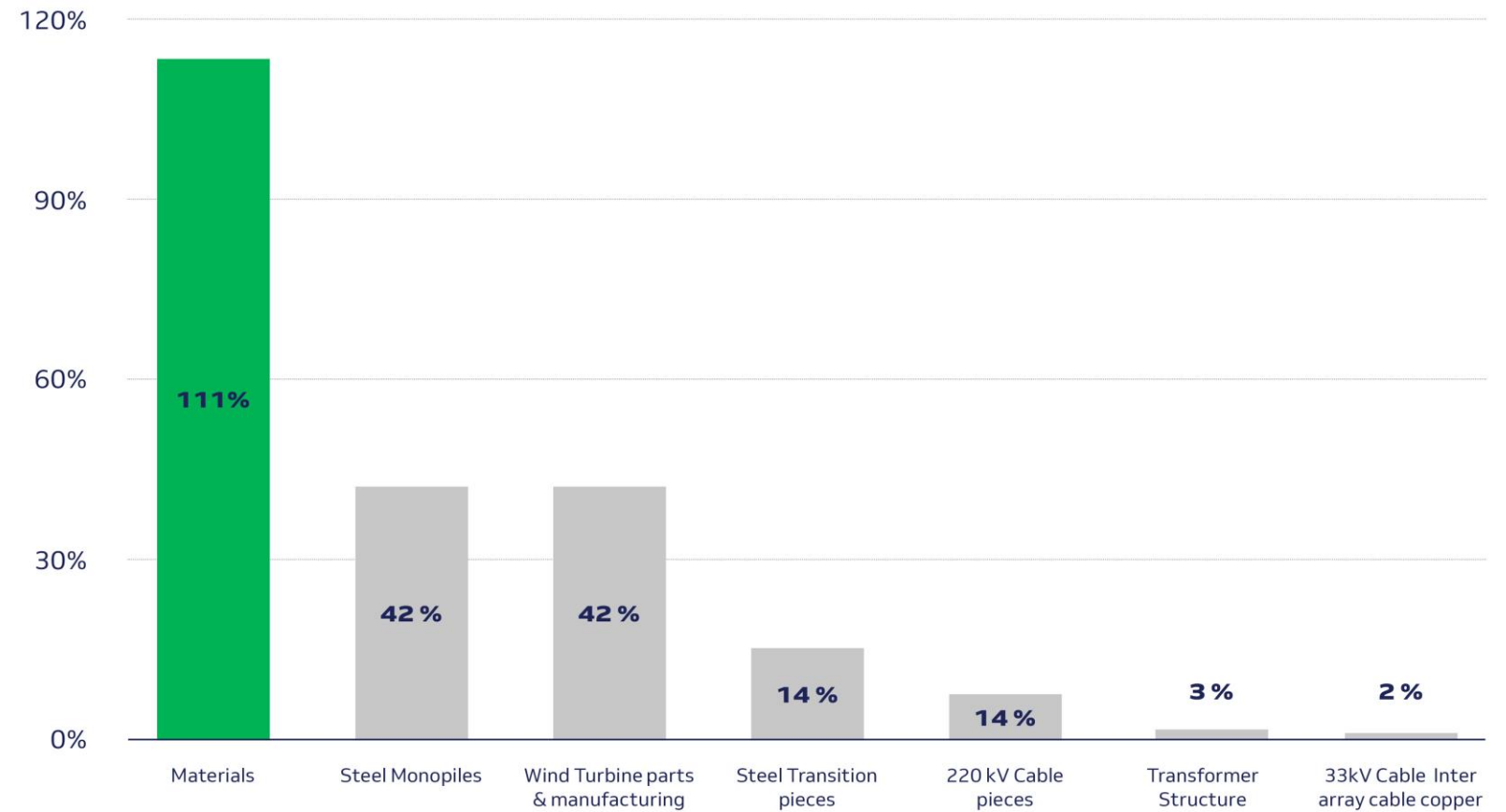
2.3 RENTEL IMPACT LIFE-CYCLE STAGES

% of Total Rentel Life Cycle CO2 emissions (171.298). End-of-life – 45% represents the netto % of the end-of-life cycle stage (-49% = recycling, +4% = dismantling emissions).



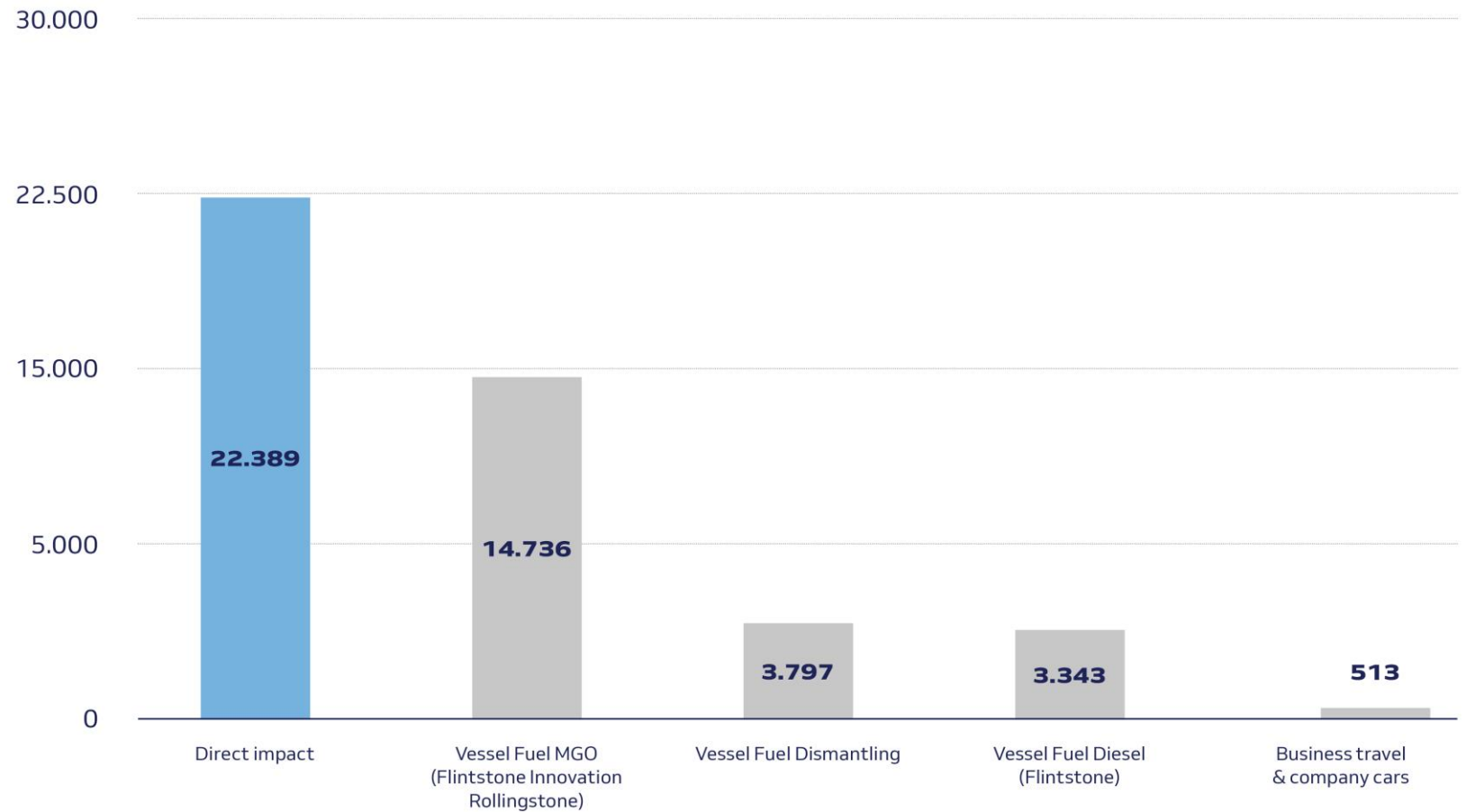
2.3.1 IMPACT MATERIALS

% of total Rental life cycle
CO₂ emissions



2.4 TOP 4 DEME DIRECT CO₂ EMISSIONS

Ton CO₂% direct emissions (scope 1) of DEME in Total Rental Life Cycle Emissions (171.298 ton). DEME direct emissions related to the installation (set-up) and dismantling.



3. FROM THORNTON TO RENTEL

The 2012 Thornton (<http://www.c-power.be>) study resulted in a life cycle emission calculation of 437kTon CO₂ or 19gCO₂/kWh. The Rentel study resulted in a life cycle emission calculation of 171kton CO₂ or 8,2g CO₂/kWh. Comparison seems obvious, we have no scientific base to compare the two studies except for the vessel fuel emissions for the installation of the wind power plants. Based on the high quality direct vessel fuel data we can conclude that:

- Rentel emissions from vessel fuel for the wind power plant installation (set-up) reduced by 47% compared to Thornton for a same functional unit: delivering renewable power to 300.000 families per year.
- **Emissions and materials** The cable CO₂ emissions are lower for Rentel. This is due to a 30% lower total cable distance of 92 km (same data quality used for export cable as Thornton) resulting in 11kton CO₂ (-36%) lower emissions.



3. IMPROVEMENT SUGGESTIONS

There are 'four scenarios' of what DEME could do to reduce the offshore wind farm life cycle carbon footprint.

Scenario 1: Reduce impact of steel by design

Scenario 2: Explore offshore recycling business

Scenario 3: Replace zinc for metal protection

Scenario 4: Track vessel installation fuel per installed MW renewable offshore energy capacity

Questions can be sent to CO2@deme-group.com

