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Carbon Negative Biotruck Expedition to Mali

A. Baseline Scenario and Actual Emissions

The base line for the analysis is based on the actual distance that the truck travelled, 8,153km and that the Landcruiser travelled, 312km, assuming that both used fossil diesel giving a baseline emission of 5.11tCO2e for the actual road journey. The use of biodiesel eliminates these fossil diesel emissions but there are nevertheless some remaining emission sources associated with the expedition as set out below:

1. The emissions arising from the manufacture of the biodiesel were calculated to be 0.23tCO2e and represent the total absolute level of emissions generated by Ecotec to manufacture their special climate friendly biodiesel from waste cooking oil and waste chocolate. This calculation is based on the following assumptions:

    - Wastes used to generate the biodiesel were assumed to have a zero carbon footprint at the point of generation and their footprint for Ecotec started with the process of collection journeys to transport the wastes to the Ecotec plant;
    - Ecotec collected waste cooking oil from local businesses using biodiesel-fuelled vans and collected other raw materials (sodium hydroxide and waste chocolate) using conventional fossil diesel fuelled vehicles;
    - Ecotec fermented waste chocolate sugars to produce bioethanol in their own premises;
    - Heat for fermenting/distilling the bioethanol and processing the biodiesel was generated from the combustion of biodiesel (negligible emissions within the limitations of the current analysis);
    - Power for processing of the biodiesel was generated in a diesel generator burning biodiesel (negligible emissions within the limitations of the current analysis); and
    - "Overhead" CO2 generation from the operation of Ecotec facilities such as lighting, heating, office and staff transport has been assumed to be covered within their conventional processing business footprint (negligible emissions within the limitations of the current analysis).

2. The emissions associated with the sea crossings from Portsmouth to Cherbourg and from Malaga to Tangier early on in the journey were calculated to be 0.116tCO2e in total. This calculation is based on the following assumptions:

    - Sea voyage carbon was calculated from the tonnage shipped, the shipped distance and the intensity per unit of weight and distance;
    - The sea freighted weight was derived using manufacturers data on vehicle weight and estimated tonnage of the entire package of goods in a conservative framework;

- The sea crossing distances were taken from a web-based sea voyage calculator (http://e-ships.net/dist.htm);
- The sea crossing carbon intensity per tonne kilometre was taken from OECD publication (http://www.oecd.org/dataoecd/14/3/2386636.pdf).

3. The emissions arising from the use of fossil fuel on the expedition were calculated to be 0.05tCO2e in total based on 10 litres of petrol and 10 litres of diesel being used. Fossil fuel was required firstly due to the biofuel "freezing" during the crossing of the Pyrenees in very cold weather. Secondly, it was only possible to load 1,900 litres of biofuel and this was all consumed before the end of the journey requiring the use of fossil fuel.

4. The emissions arising from the return air journeys of the two members of the expedition were calculated to be 1.18tCO2e. This calculation is based on:

- the distance between Timbuktu and London Heathrow airports (3868km based on http://www.airrouting.com/aviation_tools.htm);
- an extra allowance to account for indirect routing/delay (9% based on http://www.defra.gov.uk/environment/climatechange/uk/carbonoffset/pdf/carbon-offset-codepractice.pdf);
- a factor to account for carbon dioxide emissions per passenger kilometre (0.0737kgCO2/passenger kilometre based on the more conservative of the long haul economy flight emissions factors in http://www.defra.gov.uk/environment/climatechange/uk/carbonoffset/pdf/carbon-offset-codepractice.pdf) ; and
- a radiative forcing factor (1.9 based on http://www.defra.gov.uk/environment/climatechange/uk/carbonoffset/pdf/carbon-offset-codepractice.pdf).

The total emissions for the expedition based on the above calculations are 1.58tCO2e. **However it is worth highlighting that the expedition demonstrated that the emissions for the actual road journey from using biodiesel were only 4.5% of the emissions that would otherwise have been emitted if fossil diesel had been used (i.e. 0.23/5.11*100). There is no reason why this reduction should not be achievable by motorists in the United Kingdom.**

B. Emission Reductions Resulting from the Expedition

The mission set out to offset the above emissions in order to make the expedition truly carbon negative. This was achieved by:

1. The expedition donating the biofuel plant used on the expedition for waste cooking oil conversion in Mali. The emissions reduction in Mali due to the operation of the biofuel plant for waste cooking oil conversion for one year is calculated to be 7.94tCO2e and assumes that:
    - The Mali plant will operate on waste cooking oil but with petrochemically-derived methanol and sodium hydroxide (NaOH). References indicate that this combination of raw materials leads to a 70% reduction in CO2 compared with fossil diesel (http://www.theoildrum.com/node/2976)
2. The re-use in Mali of waste goods from the UK in particular two Toyota diesel landcruisers and the consequent avoided emissions from the manufacture of these new vehicles. The emission reductions from reusing these waste goods is calculated to be 8.64tCO2e and is based on:
    - Renault's published figures on its estimates of the greenhouse gases released in the entire supply chain from the manufacture of its family cars. These figures were used, on an average tonnage basis, to calculate the emissions from the production of two heavier Toyota 4x4s;
    - Emissions saved from the flatbed lorry, also rescued from scrap and left in Africa, which were discounted to give a conservative net savings figure; and
    - Emissions saved from the transport of sundry recycled goods in the 4x4s to Mali which were discounted to give a conservative net savings figure.

C. Assumptions

A number of assumptions have been made in order to calculate the above figures. The main assumptions are that:

1. The supply chain and processing greenhouse gas impacts for biodiesel production in Mali will be the same as for the situations from which emission factors were derived in academic studies;
2. The emissions from the everyday operations of the Ecotec factory have been amortised and covered within the footprint of the plant's main biodiesel production and have not been included in the Biotruck fuel footprint;
3. The chocolate waste for producing the bioethanol for the plant is transported from Birmingham in one return trip of a standard Ford

Transit van running on fossil diesel;

4. The chocolate waste post fermentation is composted or used as animal feed rather than being landfilled;
5. Renault's analysis of supply chain emissions from vehicle production does not take into account potential emissions savings from recycling vehicles at the end of their life;
6. The greenhouse gas impacts from the original manufacture of the biodiesel production plant itself, either for the plant in Preston or for the Mali equipment, have not been taken into account;
7. The greenhouse gas footprint for the manufacture of NaOH for use in the Ecotec plant has been assumed from published web data;
8. The greenhouse gas impacts of upstream raw materials, plant, packaging etc for any raw materials in the waste oil and bioethanol impact analysis, including those for NaOH have not been taken into account and are likely to be negligible;

   The greenhouse gas impacts of supplies used for the expedition, other than for the biodiesel, have not been taken into account and are assumed to be covered by the carbon footprint of a normal western lifestyle.

D. High Level Summary of Emissions Savings from Carbon Negative to Timbuktu

The following table summarises the analysis:

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D. High Level Summary of Emissions Savings from Carbon Negative to Timbuktu

Category of emission	Tonnes CO2 released ("-" represents a saving from the baseline)	High level assumptions
Total emissions from production of biodiesel in Ecotec plant	0.230	Assuming waste oils collected in biodiesel vans, but NaOH and waste chocolate collected with conventional biodiesel.
Emissions from sea voyages: Southampton-Cherbourg, Malaga to Tangier	0.116	Assuming 40 grams CO2 per tonne-kilometer sea freight intensity over 147 nautical miles.
Emissions from use of diesel in France and at end of journey	0.05	10l of petrol and 10l of diesel used.
Emissions from return air journeys by members of the expedition	1.18	Assuming 3868km flight distance from Timbuktu to London Heathrow, a 9% allowance for indirect routing/delays, an emissions factor of 0.0737kgC02 per passenger kilometer and a radiative forcing factor of 1.9 times the CO2 impact.
Total Expedition Emissions	**1.58**	
Emissions saved in Mali from biodiesel production compared to fossil fuel	-7.94	One year of production saving 70% of the CO2 compared with fossil diesel, using waste oil, conventional methanol and NaOH.
Emissions saved from lifetime extension of 4x4s instead of manufacture of new	-8.63	Assuming 5 year lifetime extension of two Toyota 4x4s.
Total Emission Reduction	**-16.57**	
Net reduction in GHGs due to expedition	**-14.99**	Difference between emitted and saved CO2 figures.