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ME 499 Fall 2013 Term Project

Introduction

This term project paper includes the results of each task assigned and answers for each of the question asked. Calculations are done in the worksheet attached, and references for certain values required in calculations are displayed in the references section of this paper.

Task 1

First, the total operating hours that uses MWFs is calculated by the formula below:

$$16\frac{hrs}{day} * \frac{251 days}{yr} * .6 = 2409.6\frac{hrs}{yr}$$

Then, the reference flows are then obtained for CO2, LN2 and vegetable oil used. Calculations are done in the worksheet.

$$sCO2\ Ref.Flow = \frac{21686.4kg}{yr}$$

$$LN2\ Ref.Flow = \frac{48192kg}{yr}$$

$$Soybean\ Oil\ Ref.Flow = \frac{21686.4kg}{yr}$$

Task 2

The environmental impacts of the sCO2 life cycle assessment due to transportation are shown below:

TRACI 2	LN2	sCO2
GWP	3.18E+04	1235.375
OZDP	0	0
SMOG	5139.977	199.5967
ACIDP	8305.794	322.5324
EUTP	9.163043	0.355821
RESP	32.78829	1.273242
ECOTX	0	0
ENER	429299.3	16670.65
WATER	0	0

Task 3

The life cycle environmental impacts for sCO2 and LN2 based on market-allocation are shown below. The results are broken down by life cycle stage.

	LN2		C02		
	Production	Transportation	Production	Transport	Use
GWP	20861.95	3.18E+04	11141.86	1235.375	397.3544
OZDP	0.001221	0	0.00044	0	1.53E-05
SMOG	856.5415	5139.977	506.6847	199.5967	19.87064
ACIDP	4894.248	8305.794	3559.008	322.5324	130.4346
EUTP	155.8344	9.163043	36.74612	0.355821	1.280421
RESP	21.87376	32.78829	10.76875	1.273242	0.464145
ECOTX	25591.99	0	8538.878	0	296.7624
ENER	142166.4	429299.3	173828.9	16670.65	5835.739
WATER	4.236077	0	1877.64	0	3.019955

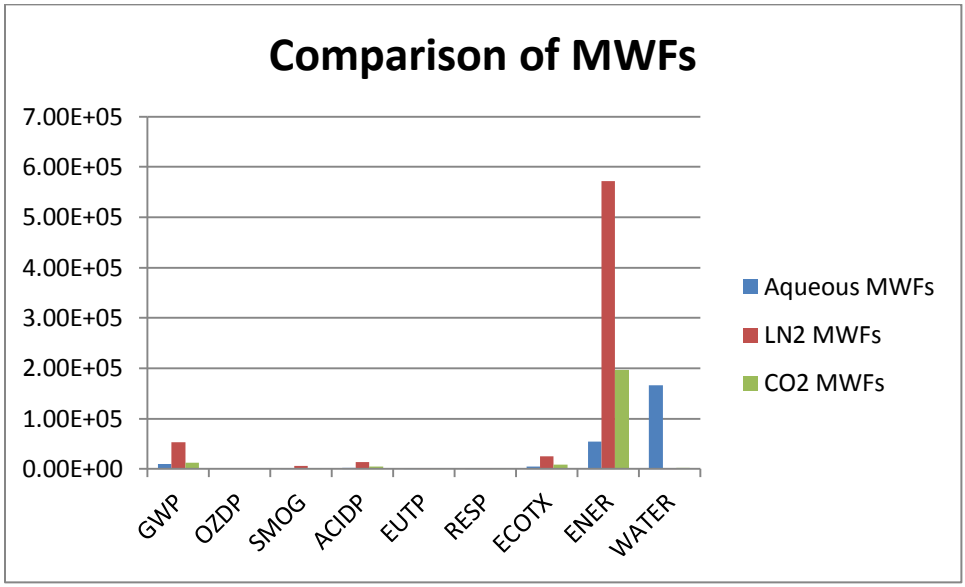
Task 4

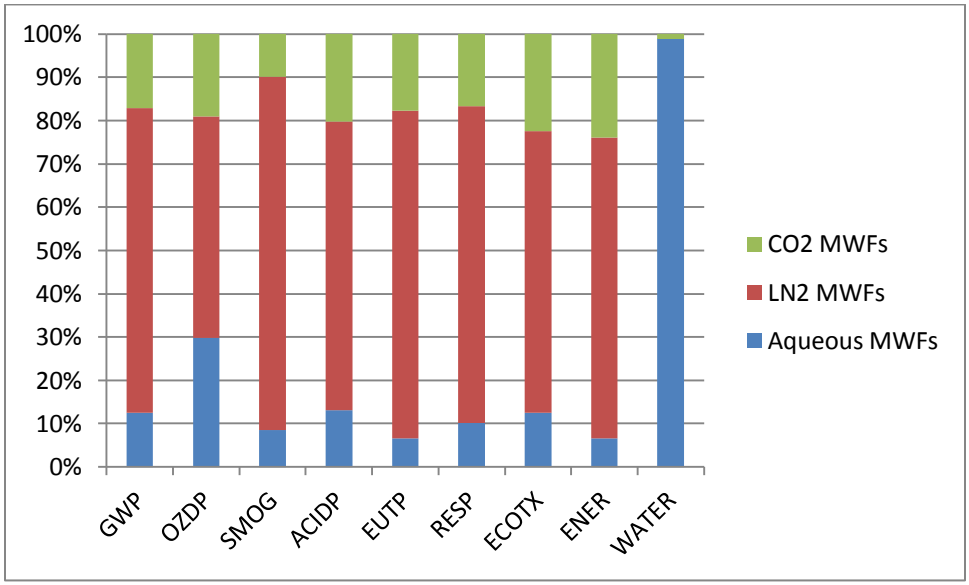
The production emissions of SCO2 based on price allocation are shown below.

	Production
GWP	7073.101
OZDP	5.28E-05
SMOG	417.667
ACIDP	2326.954
EUTP	6.663445
RESP	1.794507
ECOTX	1024.665
ENER	119873.8
WATER	1386.533

Question 1

The environmental impacts comparison of the MWFs can be seen in the bar chart below:

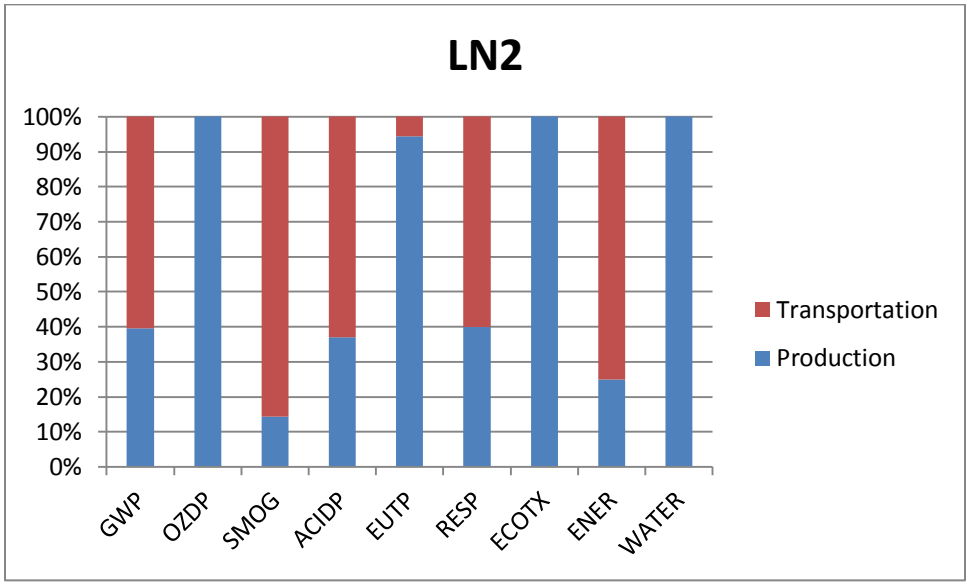




Based on the graphs, aqueous MWFs produces the least GWP, Smog, ACIDP, EUTP, RESP, ECOTX, and ENERGY but produces the most WATER. For LN2, it produces the most impacts in all categories but the least for WATER, and for CO2, its OZDP emission is the least, and is in between LN2 and Aqueous MWFs for others.

Question 2

The breakdown for the total impacts based on life cycle stages and MWFs are presented below:



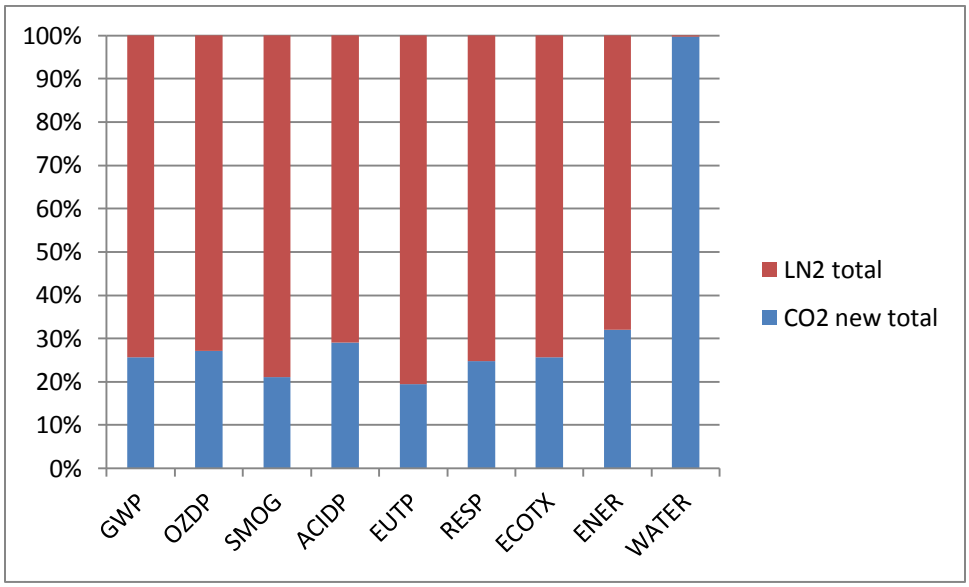
*Production means *Material Extraction, Production, Transportation to Distributer*

For LN2, the transportation life cycle stage contributes most in the environmental impact since it dominates 5 of the 9 impact categories.

For CO2, the production life cycle stage contributes the most impact.

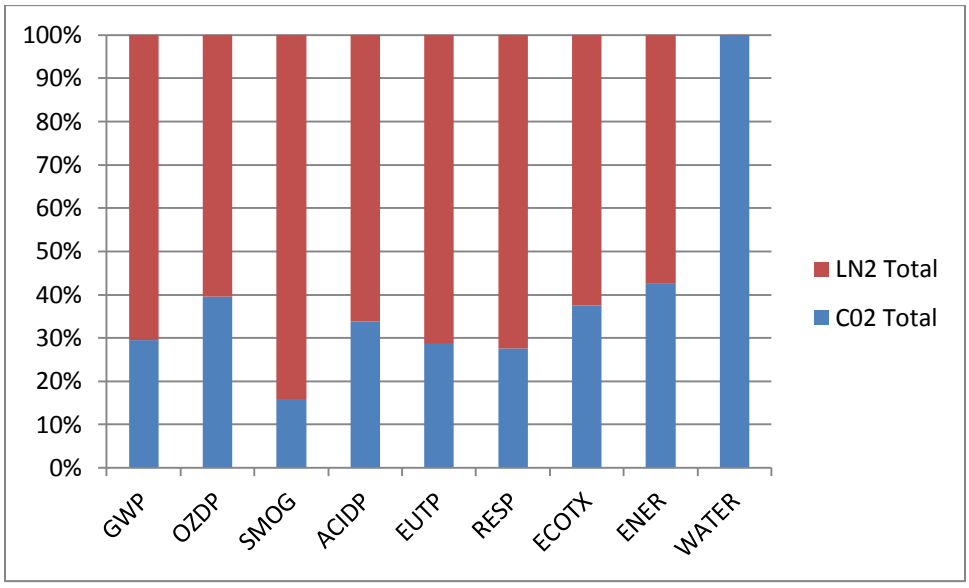
Question 3

The change of location would affect the transportation life cycle environmental impact for sCO2, thus increasing the total emissions for sCO2. The comparison to LN2 can be seen below, and based on the comparison, LN2 still gives out more emissions than sCO2.



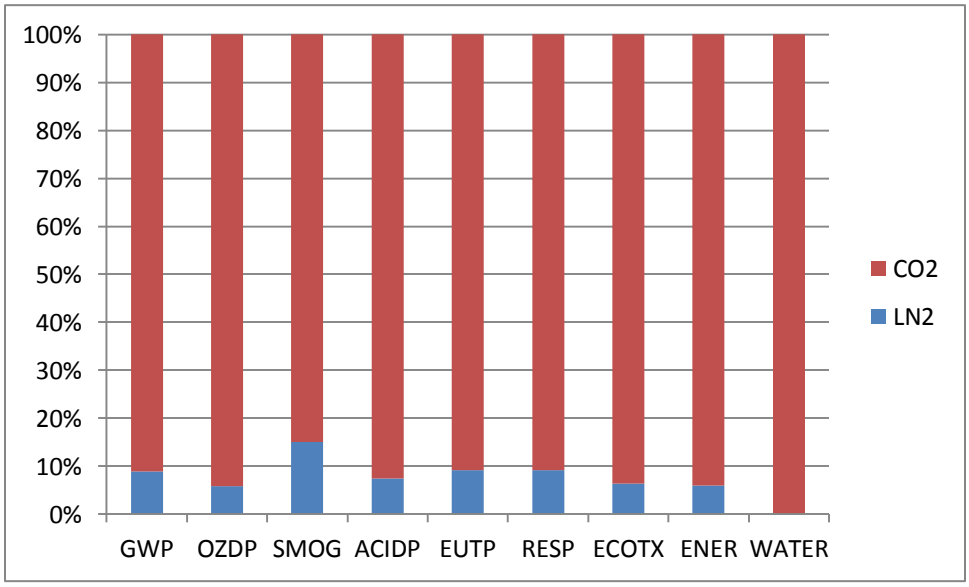
Question 4

The switching to a fossil fuel burning plant increases the production life cycle emissions of sCO2. The comparison to LN2 is shown below.



Question 5

The new rates affect the life cycle environmental impacts of each MWFs, and a comparison of their values are shown below. Based on the comparison, LN2, has lesser emissions than CO2



Question 6

The table below depicts the comparison of the environmental impacts given by one person and each MWFs.

		Person	LN2	sCO2
GWP	kg CO2 eq.	8700	52675.09	13136.91
OZDP	kg CFC-11 eq.	0.103	0.001221	0.000455
SMOG	kg O3 eq.	2.779	5996.519	784.6917
ACIDP	mol H+ eq.	1.457	13200.04	4106.57
EUTP	kg N eq.	3305	164.9975	38.48672

Based on this comparison, the MWFs have a higher environmental impact than an average person. However, considering the ratio of one facility to the number of people who works or stay around the facility, the environmental impacts caused by the MWFs would be much smaller than a population of humans, which could be at least 5000 for a tiny rural area.

Question 7

	Aqueous MWFs	CO2 MWFs	CO2 relative to Aqueous %
GWP	9396.46476	12774.59	35.95099
OZDP	0.00071147	0.000455	-35.9974
SMOG	621.832707	726.1521	16.77611
ACIDP	2595.51009	4011.975	54.57366
EUTP	14.2766427	38.38236	168.8472
RESP	7.58439425	12.50614	64.89301
ECOTX	4932.49645	8835.64	79.13121
ENER	53884.2625	196335.2	264.3647
WATER	166493.361	1880.66	-98.8704

The relative magnitude of sCO2 MWF to aqueous MWF in % can be seen on the most right column of the table above. The usage of sCO2 as a MWF would be getting emission credit for OZDP and water. In this case, the credit would be given to both the factory using sCO2 as a MWF and the producer of Ammonia whose process created the CO2, but with a higher weightage for the former. This is because the factory took initiative to use an alternative MWF compared to current MWFs, and although the ammonia producer supplies the CO2, he or she would still be producing the CO2 anyway with or without the demand from the factory.

References

1. Density of Vegetable Oil - http://wiki.answers.com/Q/How_many_gallons_of_soybean_oil_are_there_in_a_metric_ton
2. Density of sCO2 - http://www.peacesoftware.de/einigewerte/co2_e.html
3. Density of LN2 - http://www.peacesoftware.de/einigewerte/stickstoff_e.html