ZERO WASTE EUROPE

Making GHG accounting work for climate - recommendations for accounting methodology for Recycled Carbon Fuels

Policy Briefing

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Making GHG accounting work for climate - recommendations for accounting methodology for Recycled Carbon Fuels

What is the Issue?

This report presents Zero Waste Europe's response to the European Commission's (EC) proposals on potential greenhouse gas (GHG) emissions from so called 'recycled carbon fuels' (RCFs). The current draft GHG accounting methodology for RCFs uses the concept of 'emissions avoidance' via the term 'e_i' = **emissions from inputs and their diversion from existing use**. It proposes to subtract hypothetical emissions 'savings' from diverting plastic waste from being incinerated.[1] This is worrying because:

The authors of the draft methodology seem to think that re-using fossil carbon by turning it into fuel is better than burning it directly. In practice, **the life cycle of 'recycled carbon fuels' incurs tremendous *additional* energy expenditure above and beyond baseline scenarios of direct combustion, even with energy recovery, as this report shows**. Moreover, 'e_i' is a relative measurement which does not fit with the absolute EU target of attaining carbon neutrality by 2050 and limiting global warming to 1.5 degrees as recommended by the IPCC.

Simply put, by converting the fossil carbon into fuel, the absolute emissions are merely delayed, and *in addition* they now have *extra* processing emissions on top. These energy demands are continuous, and too high to be met by renewables or merely burning some of the product.

Currently there is heavy promotion of the plastic to fuel concept without full disclosure of the true energy costs. Vested interests use 'carbon conversion' as an efficiency metric despite this being misrepresentative - it shamelessly discounts the overall processing and post-processing energy costs, and hence true GHG emissions intensity.

To assist with the EC's requirement to attain credible auditing of process energy use and GHG savings, this report demonstrates why 'e_i' is an inappropriate metric for transitioning to sustainability, and highlights limitations in the currently drafted REDII formula. We show the real emissions of RCF and a comparison of emissions from direct combustion. We then submit recommendations to enable a more accurate determination of GHG emissions intensity for RCF in accord with the stated ethos of the EC's guidance to the waste framework directive of:[2]

> ***"encouraging the best overall environmental outcome over the whole life-cycle or products and services"***
>
> European Commission guidance to the Waste Framework Directive

[1] Edwards, R., Padella, M., O'Connell, A., Prussi, M., Scarlat, N. 2020. Draft methodology for assessing greenhouse gas emission savings from renewable liquid and gaseous transport fuels of non-biological origin (RFNBOs) and recycled carbon fuels (RCF), JRC of the European Commission, 18th June 2020.

[2] European Commission: Guidelines on the interpretation of the R1 energy efficiency formula for incineration facilities dedicated to the processing of municipal solid waste according to Annex II of Directive 2008/98/EC on waste.

Quantification of True GHG Emissions for Recycled Carbon Fuels

Our submission uses real data from regulatory permits and environmental auditing of the Regenyx (nee Agilyx) Plastic to Fuel Plant in Tigard, USA.[3,4] The plant processed polystyrene into a 'styrene oil' which was shipped off-site for 'energy recovery'. The data refers to post-commissioning operations. Few facilities of this kind exist and independent data is extremely rare.

The draft REDII formula input parameters are currently ill-defined and there is much scope for inaccurate accounting. Difficulties also arise when trying to apply the 'per fuel' common denominator both retrospectively to determine a reference case where no fuel is produced and to hypothetical future scenarios. It also permits scope for by-passing true emissions, for example when essential RCF upgrading occurs outside the plant boundary, and determining which variables to choose. See Table 1 and the following text:

Draft Parameter		2018 g CO_2/MJ fuel	2019 g CO_2/MJ fuel
e_i	Emissions from supply of inputs [including GHG impact of diverting that input from its existing use]	-776 (-1551)	-134 (-268)
e_p	Emissions from processing	531	36
e_{td}	Emissions from transportation and distribution	n/k	n/k
e_u	Emissions from combusting the fuel in its end use	87[5]	87
e_{ccs}	Emissions savings from carbon capture and storage	n/a	n/a
e_{rc}	Emissions saved by recycling carbon	n/a[6]	n/a
E	**Total emissions from the use of the fuel**	**-158 (-933)**	**-12 (-146)**

Table 1. The Regenyx (nee Agilyx) Tigard plant GHG emissions intensities calculated using the draft REDII formula. Values in parentheses are GHG intensity when 50% of product carbon is lost to upgrading (see text).

Note in Table 1 the tremendously high processing costs in comparison to the emissions from combusting the feedstock (described below). Note also the potential for duplication of accounting between the parameters e_u, and e_i and the 'negative' emissions intensities!

The use of e_i significantly distorts and underestimates the true increases in GHG intensity of RCF. As can be seen from Table 2 the process actually resulted in **69%** (2018) and **27%** (2019) **more GHG emissions** (see Appendix Eq.1).

[3] Agilyx Tigard Facility, 2019, Annual Report, ACDP No. 34-9514-SI-01, 13th February 2019.
[4] Environment Protection Agency, 2020, Toxic Release Inventory, document number 1318217471349.
[5] Values of e_i are identical due to this parameter being on a 'per MJ fuel' basis. It is merely the emissions per fixed unit of product based on the 1:1 ration between LHV of styrene and RFM of CO_2.
[6] We have been told that this only relates to RNBFs.

	2018	2019
Reference Scenario: kg CO_2/kg feedstock combusted	3.38	
Regenyx (nee Agilyx): kg CO_2/kg feedstock processed	5.70	4.28
Change in CO_2 emissions compared to reference	**+69%**	**+27%**
Regenyx (nee Agilyx): kg CO_2/kg styrene produced	51.0	6.61

Table 2. The Regenyx (nee Agilyx) Tigard plant GHG emissions in comparison to reference scenario.

The plant was also found to emit **1220g CO_2/MJ Fuel** (2018) and **83g CO_2/MJ Fuel** (2019). This excludes emissions from the ultimate combustion of the product (see Appendix Eq.2).

When the combustion of product fuel is included in the calculation, the total GHG emissions were actually **1307g CO_2/MJ Fuel** (2018) and **169g CO_2/MJ Fuel** (2019) (see Appendix Eq.3).

It is important to also note that the raw data **underestimates the true GHG emissions** because:

1. They exclude total plant electricity consumption and process diesel fuel for two generators stated as operating on-site (data not available).

2. They exclude GHG emissions from RCF upgrading. Upgrading of RCF is considered as essential for vehicular applications, with estimates that 53% of product carbon would be lost in oil upgrading and 48% in gas upgrading.[7] Table 1 shows how upgrading outside the plant boundary can distort the true GHG emissions intensity of the RCF process in comparison to the true emissions.

Additional Observations and Recommendations

The current approach, using 'e_i', is too problematic. We feel that two separate points need particular clarification:

- Diversion from existing use/reference sources only gives an answer in relative terms to one specific scenario. The methodology needs to account for all emissions to the atmosphere.

- Discounting the fossil fuel use offset by the production of RCF should not be given a 'credit'. Though the formula is extremely unclear about specifics, any such factor must be removed because in reality there is no evidence that this type of substitution takes place.

The current formula discounts emissions from the feedstock's fossilised origin. Since plastics are valorised to become energy, **the climate impact of their production should also be allocated to the input of RCF, rather than them being considered as waste from an LCA perspective meaning zero GHG burden**.

[7] Seidl, L.G., Mamani-Soliz, P., Lee, R.P., Meyer, B. 2020. Chemical Recycling Technology Overview and Current Developments, NK2 Chemical Recycling Workshop, 25th February 2020, Freiberg, Germany.

Setting the baseline for appraisal of change in GHG emissions intensity is not adequately addressed by the draft methodology. **A precautionary approach of taking the least favourable/conservative formula baseline must be implemented** to achieve highest GHG mitigation. This must be validated by actual emissions data.

The methodology must ensure that all supplementary fuel input routes are included (e.g. as with the WFD 'R1' formula), and that the process boundary is set accordingly to encompass upgrading for final fuel combustion. **Particular caution must be used when considering processes which purport to use fuel to create new plastics**, since reconversion uses additional energy and always results in some degradation – plastic cannot be recycled indefinitely.

The term 'e_i' assumes 'additionality' yet **there is no evidence that RCFs actually displace fossil fuels**: rebound effects and equivalents of Jevons' paradox refute this premise. The approach taken by the draft methodology is therefore too simplistic with the true GHG emissions not adequately addressed by the formula nor the current 'rigid' and 'elastic' approach to inputs.

The draft methodology with respect to RCF is not workable or compatible with established GHG emissions targets, and **potentially undermines the higher tiers of the waste hierarchy by discouraging 'reduce and reuse' behaviour**. We recommend that no credit be given to displacement of emissions with respect of RCF as this can lead to improper accounting and the potential of greenwashing of waste-based fossil fuels.

The implications of 'e_i' are very difficult to understand, complicated, and **not evidence based**. We suggest a different approach is taken by the working group, and a complete scrapping of the e_i – based methodology. Ultimately we all want fuels that are genuinely low carbon.

Appendix

Year	Feedstock (Polystyrene)		Product (Styrene Oil)		Natural Gas for Processing	
	kg	MJ	kg	MJ	m3	MJ
2019	5.81×10^5	2.27×10^7	3.76×10^5	1.47×10^7	2.65×10^5	1.14×10^7
2018	1.97×10^5	7.67×10^6	2.20×10^4	8.57×10^5	2.32×10^5	9.96×10^6

Table 3. Raw data from the Regenyx (nee Agilyx) Tigard plant used in calculations

GHG emissions were calculated by converting the mass and volumetric outputs in Table 3 to a molar bases (assuming stp for CH_4 density of 0.717 kg/m^3) and multiplying by molar mass. Carbon combustion stoichiometry for C_8H_8 and CH_4 to CO_2 is 8:1 and 1:1 respectively. LHV of styrene was taken as 39 MJ/kg, and LHV of CH_4 = 43 MJ/m^3. Natural gas was assumed as 100% CH_4 which was considered a reasonable assumption based on the remaining balance being predominantly other hydrocarbons.

Eq. 1

Eq.1: $$\frac{gCO2_{RCF} - gCO2_{Reference\ (combustion)}}{gCO2_{Reference\ (combustion}} \times 100$$

where $$gCO2_{Reference\ (combustion)} = \left(mol_{feedstock}\right)(8)\left(RFM_{CO2}\right)$$

and $$gCO2_{RCF} = \left(mol_{product\ and\ byproduct}\right)(8)\left(RFM_{CO2}\right) + \left(mol_{natural\ gas}\right)\left(RFM_{CO2}\right)$$

Eq. 2 and Eq.3

The plant's yields (conversion efficiencies) were 11% (2018) and 65% (2019). The fate of the 89% and 35% waste/unconverted fossil carbon were not disclosed but must be accounted for by either combustion on- or off-site, or released as GHG emissions through the process. Thus:

Eq.2: $$\frac{\left(mol_{by-product}\right)(8)\left(RFM_{CO2}\right) + \left(mol_{natural\ gas}\right)\left(RFM_{CO2}\right)}{\left(mass_{product}\right)\left(LHV_{C8H8}\right)}$$

Eq.3: $$\frac{\left(mol_{product}\right)(8)\left(RFM_{CO2}\right) + \left(mol_{by-product}\right)(8)\left(RFM_{CO2}\right) + \left(mol_{natural\ gas}\right)\left(RFM_{CO2}\right)}{\left(mass_{product}\right)\left(LHV_{C8H8}\right)}$$

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Zero Waste Europe is the European network of communities, local leaders, businesses, experts, and change agents working towards the same vision: phasing out waste from our society. We empower communities to redesign their relationship with resources, to adopt smarter lifestyles and sustainable consumption patterns, and to think circular.

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