

Allocating Recycling Benefits in Lifecycle Assessment for Plastics: Categorization and Use of Product Property Specifications as per Value Chain



Ministry of Economic Affairs
and Climate Policy

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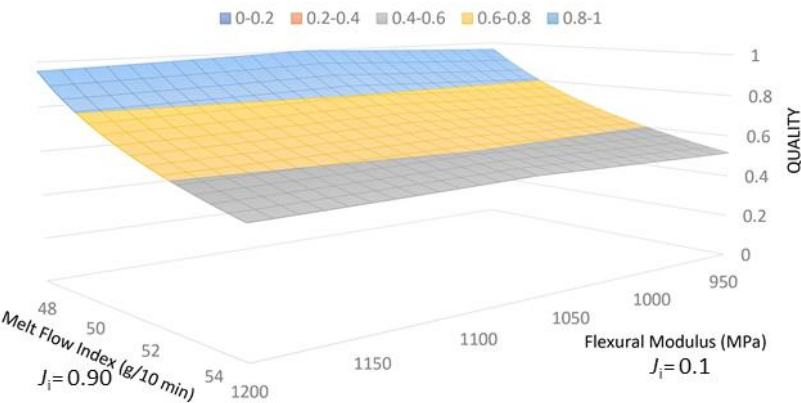
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PROJECT OBJECTIVES

- Development of a model for the quality assessment of recycled plastic based on material properties
- A single value parameter based on the quality model which can be used for the allocation of recycling credits in LCA

Method

Parameter	Definition
I_{Sample}	Sample property value (such as the value of tensile strength or impurity content)
I_{Ideal}	Ideal property value (such as virgin grade tensile strength)
I_{Max}	Maximum acceptable value for a property for a specific application
I_{Min}	Minimum acceptable value for a property for a specific application
X_i	Dimensionless parameter, showing the normalized deviations of I_{Sample} from I_{Ideal}
J_i	Relative importance or weighing factor
ξ_i	Quality of recycled plastic in respect to one single property
ξ_q or ξ_{total}	Aggregated quality parameter or the total quality for recycled plastic



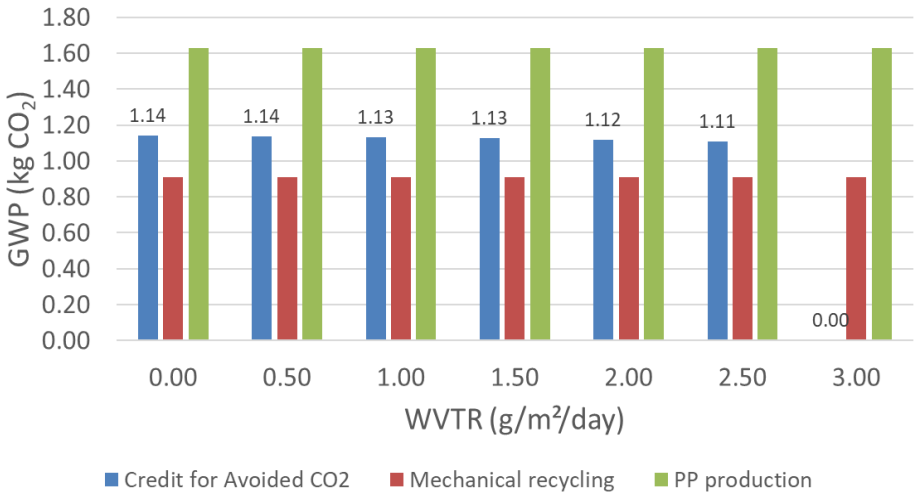
$$\xi_i = 1 + \left(1 - \frac{1}{(1+X_i)^{J_i}}\right) \text{ with } \xi_i > 1, \quad \xi_i = \frac{1}{(1+X_i)^{J_i}} \text{ with } \xi_i < 1$$

Results: use case

Properties	J	I_{ideal}	I_{min}	I_{max}
Gloss (60°) (GU)	0.04	90.00	80.00	100.00
Haze (%)	0.04	13.00	0.00	15.00
Tensile strength MD (MPa)	0.04	58.00	50.00	193.00
Elongation at break MD (%)	0.04	475.00	425.00	860.00
E-Modulus MD (MPa)	0.12	1,325.00	1,200.00	2,000.00
E-Modulus TD (MPa)	0.12	1,250.00	1,100.00	2,000.00
CoF inside	0.04	0.32	0.29	0.36
CoF outside	0.12	0.30	0.28	0.38
WVTR (g/m ² /day)	0.04	2.20	0.00	2.50

Properties	J	I_{ideal}	I_{min}	I_{max}
Gas Permeability (cc/m ² /day)	0.04	2,700.00	0.00	3,200.00
Heat seal initiation temperature (°C)	0.10	85.00	85.00	100.00
Heat seal final temperature (°C)	0.05	160.00	150.00	160.00
lead, cadmium, mercury and hexavalent chromium (total in ppm)	0.12	0.00	0.00	100.00
Odor	0.12	0.00	0.00	6.00

Behavior of PP production, mechanical recycling and avoided products (kg CO₂/kg PP)



Conclusions:

- The quality model developed manifests the effect of material property on the quality of the recycled plastic in regard to a target application.
- The model uses 1) a range of selected properties, 2) minimum and maximum permissible value per properties, 3) an ideal value (or range) and 4) an importance factor (J) and estimates a single score.
- The single score for the quality can be used for using right substitution factor for the avoided products in LCA studies.

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