ECEPLAST
SUSTAINABLE
PACKAGING INNOVATORS

Simplified Carbon Footprint for the comparison of the environmental performance of different packaging by Rete Clima®

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Rete Clima® is a no-profit Organization that supports Corporates and Municipalities in their concrete environmental actions, with the aim of promoting the sustainability and contrasting the climate change. Believing that the climate change is the greatest environmental risk of today, Rete Clima® proposes activities specifically devoted to assess and to manage the CO_2 emissions connected with the production and consumption chains: the specific purpose is decreasing their climatic footprint towards our Planet.

Rete Clima® also operates scientific popularization to inform and to sensitize citizens about the environmental and climate risks we have to face today.

More details at the website: www.reteclima.it

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a) INTRODUCTION: THE ENVIRONMENTAL CONTEXT

This document performs the **preliminary and simplified assessment** of the **greenhouse gases** (**GHG**) connected to **production and disposal** of the structural materials of two different types of **packaging** (i.e. cardboards and plastics): this document also introduces some indications about the **environmental logics** and the **methodological bases** of the comparative evaluation hereinafter illustrated.
This assessment is framed in an wider logic of "**eco-evaluation**" of the production processes, finalized to understand the environmental charges generated from the production of goods and to define the following actions of **"eco-planning"** of the **production cycle**: the final aim of this process, in fact, is to identify and to start actions of management (in terms of **reduction and offset**) of the **environmental charges** connected to the same cycle.
Such comparative evaluation has been developed with particular reference to the amount of the **CO_2eq** [1] **emissions** in atmosphere, with the specific purpose to be able to understand in what measure the different products are responsible of the **climate change**, the greatest today's **environmental risk**, and to act for their **mitigation**.

In reference to the non-sense debate around the human origin of climate change, we need to underline that the Climate Sciences agree that mankind is the first important cause of this phenomenon, with particular reference to the **consumption of petroleum and fossil fuels**. Particularly, as affirms the **V° Report of evaluation** of the Intergovernmental Panel on Climate Change (IPCC, 2014), it is "*extremely probable*" that more than half of the atmospheric temperature increment observed since 1951 to 2010 has been **directly generated by the human actions** toward the climate (i.e. greenhouse gas emissions, aerosol and land use change): this awareness confirms the **urgency to act to reduce the human GHG** (Green House Gases) in atmosphere, in every productive context.

As already introduced, however, the reduction and the offset of the greenhouse gases (**carbon management**) needs a propaedeutic phase of quantification of the same GHG (**carbon assessment**) realized with different steps according to the type of system in analysis (essentially Products or Organizations), as shown in Figure n.1:

***Figure n.1**: chain of carbon assessment, carbon management and communication performed by Rete Clima®*

[1] The **CO_2eq** is the measure of the total **carbon footprint of a product**, process or service: It represents **the weight amount of carbon dioxide (CO_2) and other greenhouse gases (CH_4, N_2O, HFC, etc.)** associated with a product (good or service) along its **entire life cycle**, and it is therefore a measure of the real and complete contribution and the overall activities of the human **global greenhouse effect**.

It's important to remember the **Recommendation of the European Committee** of April 9th 2013 ("COMMISSION RECOMMENDATION of 9 April 2013, on the use of common methods to measure and communicate the life cycle environmental performance of products and organizations") that underlines the importance of the analyses of **PEF** (Product Environmental Footprint) and of the **OEF** (Organizational Environmental Footprint); these analyses however have to be achieved following **official methodologies and recognized standard**, in order to allow a suitable **communication of the environmental performances** of Products and Organizations.

b) FROM LCA (LIFE CYCLE ASSESSMENT METHODOLOGY) TO THE CFP (CARBON FOOTPRINT OF PRODUCTS)

The **Life Cycle Assessment methodology** is a technical tool aimed to assess the **environmental charges** of a product along its whole life cycle, from the extraction of raw materials for its production until the end of its life (as reported in Figure n.2).
With this methodology the production cycle is analyzed to identify all the **production inputs** and the relative **environmental outputs**, with the purpose to quantify the environmental charge of the product connected to different "**categories of impact**" (i.e., for example: primary energy consumption, effect shuts, acidification, eutrophication, ozone depletion, photochemical smog, refusals, etc.): the final aim is to portrait a complete "**environmental picture**" of the production life cycle of goods "**from cradle to grave**".

***Figure n.2**: the life cycle of a good, assessed by using LCA methodology*

The LCA, a methodology able to define an "**echo-budget of system**", was codified in the '90 by ISO (International Organization for Standardization) within a pool of technical standards, i.e. ISO 14040, 14041, 14042, 14043: this whole series of standards was subsequently joined in two principal texts (i.e. **ISO 14040:2006** and ISO **14044:2006**) that today represent important technical tools and strategies for promoting the **sustainable development in Corporations**.

The standard ISO 14040:2006, in particular, defines the 4 steps of articulation of LCA, i.e.:
1) **Definition of the objectives** and the field of application of the study (Goal and scope definition)
2) **Inventory** (Life Cycle Inventory)
3) **Evaluation of the impacts** (Life Cycle Impact Assessment)
4) **Interpretation** and improvement (Life Cycle Improvement)
These steps have also been taken into consideration as general reference for this document's structure.

The standard **ISO 14040:2006** has codified the **LCA's definition** as follows: "*Life cycle assessment (LCA) is the compilation and evaluation of the inputs, outputs and the potential* ***environmental impacts*** *of a product system throughout its life cycle*".
This definition has varied from the original version historically proposed by **SETAC** (Society of Environmental Toxicology and Chemistry) in 1993: "*Life Cycle Assessment is a process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and materials used and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing, extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling, and final disposa*l".

The selection of a single "impact category": GWP-100 years

Even if the LCA methodology considers different "impact categories" along the life cycle of products, **only one category** is usually taken into account: this practice is oriented to obtain a **detailed and specific assessment** about the impacts on an unique "environmental sector-target", for defining specific further **management measures**.

In particular, today is frequently considered the category "**GWP-100 years**" (Global Warming Potential - 100 years) measured in terms of CO_2eq: this indicator represents the contribution to the greenhouse effect increment specifically due to the **increment of GHG concentration** in atmosphere (along an time frame of 100 years). Choosing to consider only this category means assessing the CFP (**Carbon Footprint of Product**), that represents the contribution of the life cycle of a particular product towards the global warming.

Developments of the accounting processes of CO_2

The **chain of assessment the CO_2eq emissions** is evolving very fast, the proposed approaches are various and subject to several publications: some principles regarding the accounting and modeling are generally and universally accepted but an inherent component of subjectivity related to the choice of the methodology to be adopted, the selection of system boundaries, the completeness of the evaluation, the functional unit of reference still persists.

The leader Institutes in the world of standardization (i.e. ISO), however, have recently turned to

the coding of a specific preliminary specification oriented to the qualification of the **CFP as a global and unique indicator**.

Today in the ISO-world there is an **Technical Specification** referred to the CF of products (i.e. **ISO/TS 14067:2013**, already certifiable), which defines the principles, requirements and guidelines for the quantification and reporting of the CFP: this specification is based on methodological logics expressed by standard International reference for the **LCA**, such as the above mentioned ISO 14040 and ISO 14044 for the quantification stage, and ISO 14020, ISO 14024 and ISO 14025 (on environmental labels and declarations) for the communication phase of the environmental CFP.

The current technical specification ISO/TS 14067:2013 is therefore the first technical step for creating a real standard specifically devoted to the analysis of **single impact category "Global Warming Potential"**, representing the **balance of greenhouse gases net emissions** along the life cycle of a product.
If the starting point is therefore the quantification of the emissions from products through Carbon Footprint, the ultimate goal is oriented to **manage GHG** through their **reduction and offset**, developing alternative protocols that can guarantee the same performance in terms of efficiency of the system but at the same time reduce (even to zero) its footprint on the climate. This option is also feasible through **material substitution** towards more environmental friendly and lower impact materials.

c) SCOPE AND BOUNDARIES OF THE STUDY

The simplified assessment in this report has been made in coherence with the **logical bases of the LCA methodology**: these evaluations are devoted to obtain a **quantitative comparison** between the **environmental performance** of two different products (paper packaging and plastic packaging), with particular reference to the **CFP** of the (only) few most important life cycle steps of their constituent materials.

In fact, especially considering that this is only a **simplified assessment**, this document quantifies the CFP along only certain and specific phases of the packaging life cycle, such as the production and the disposal of cardboard and plastic.
This is technically consistent because the stages of production and disposal (of papers and plastics) are the **most easily standardized processes** among the whole life phases of packaging, also according to the technical literature related to the process of industrial production and disposal of the materials.

It's obvious that in future **more extensive evaluations** within a different and specific study could be released, but in that case the assessment of the specific supply chain of the two packaging Companies will be needed, considering all the **peculiar phases of the processes** (such as logistics, transport, energy, ...etc.) along the steps set in Figure 2: this future and potential evaluation will be figured out in a complete logic of LCA, which represents the technical principle inspiring the

ISO/TS 14067:2013 as well as the ISO 14025:2010 (devoted to codify the **EPD - Environmental Product Declaration**).

As for the actual work, the strength of this assessment lies in the production of a **simple and actionable tool** that allows the comparison of the two products on the basis of their **environmental performance**, allowing to offer to the final customer of this products' the parameter of **"environmental friendliness" as a way of choice** and preference.
On the other hand, the weak point of this evaluation is the absence of a comprehensive assessment of the entire life cycle of the products, not representing all the environmental values along the life cycle. This assessment, although logically built on the same basis of the most complete studies (i.e. in reference to the technical indications of the ISO standard and to the methods and calculation software) is also not certifiable, because it doesn't perfectly fulfill the formal and substantial criteria expressed by the standard ISO itself.

d) INVENTORY ANALYSES

As above mentioned, this simplifies assessment considers as "**system boundaries**" only the phases of production and disposal of the materials constituting the packaging: the GHG emissions of these phases were calculated by using the **methodology CML 2001** (update: April 2013), a methodology normally used in the assessments of the LCA conducted on a professional level, used in the software **GaBi 6** (GaBi 6 Software-System and Databases for Life Cycle Engineering, Thinkstep, LBP University of Stuttgart, Copyright, TM. Stuttgart, Echterdingen).
The **environmental assessments** were made on the basis of the data related to two different types of packaging (respectively cardboard and plastic); the data, provided by Eceplast Srl and identifying the type and weight of the materials, were summarized in a content table as follows:

plastic bag		paper bag	
Dimensions:		**Dimensions:**	
Width	3.115 mm	Width	3.300 mm
Height of flap side	950 mm	Height of flap side	1.100 mm
Height of flap	150 mm	Height of flap	400 mm
Total weight	966 gr	Total weight	2.190 gr
Composition of layers:		**Composition of layers:**	
A. 1 LDPE film: 950 x 3.115 mm, 65 micron of depht (light blue, printed red), 55 gr/mq B. 1 LDPE film: 800 x 3.115 mm, 65 micron of depht (light blue, printed red), 55 gr/mq C. 1 pluriball sheet: 950 x 3.115 mm, 85 gr/mq D. 1 pluriball sheet: 950 x 3.115 mm, 85 gr/mq E. 2 PE foam sheets: 1.600 x 3.115 mm, 30 gr/mq		A. 1 sheet 3.390 x 1.880 mm recycled kraft paper, 90 gr/mq B. 2 sheets 3.390 x 1.800 mm recycled fluting paper, 110 gr/mq C. 1 sheet 3.390 x 1.800 mm coated paper 60 gr/mq D. 2 strips 45 x 1.100 mm havana coated paper, total weight 14 gr	

If we reconstruct analytically the weight of the two types of packaging on the basis of the weight data of the structural materials, the values that will emerge will respectively amount to **1,102 g for the plastic bag** and **2,296 g for the cardboard bag**.
As agreed we have decided to use as parameter respectively the value of **966 g/plastic bag** and **2,190 g/ cardboard bag**, the data that the company provided as value "total weight", in order to reassign the values for each component of the structural materials.

e) DATA ANALYSES: COMPARATIVE CARBON FOOTPRINT

The first step of the evaluation was to precisely identify the contribution (expressed in weight) of each element constituting the layers of the two different packaging, in order to apply to that value the specific **GHG emission coefficients** calculated using dedicated technical software.

The analytic weights of materials are presented in subsequent table:

	weight	relative weight of component in 1 bag
plastic bag		
film 950 x 3.115 mm LDPE	55 g/mq	142,68
film 800 x 3.115 mm LDPE	55 g/mq	120,15
2 sheets 950 x 3.115 mm pluriball (PE)	85 g/mq	441,01
2 sheets 1.600 x 3.115 mm foam PE	30 g/mq	262,15
TOTAL WEIGHT OF 1 PLASTIC BAG		**966**
paper bag		
sheet 3.390 x 1.880 mm recycled kraft paper	90 g/mq	547,07
2 sheets 3.390 x 1.800 mm recycled fluting paper	110 g/mq	1.280,38
sheet 3.390 x 1.800 mm coated paper	60 g/mq	349,19
2 strips 45 x 1.100 mm havana coated paper	-	13,35
TOTAL WEIGHT OF 1 CARDBOARD BAG		**2.190**

Subsequent Figure n.3 shows the **flow of plastic production**, in order to highlight the general methodological context used for the assessment of the specific **coefficient of GHG emissions**:

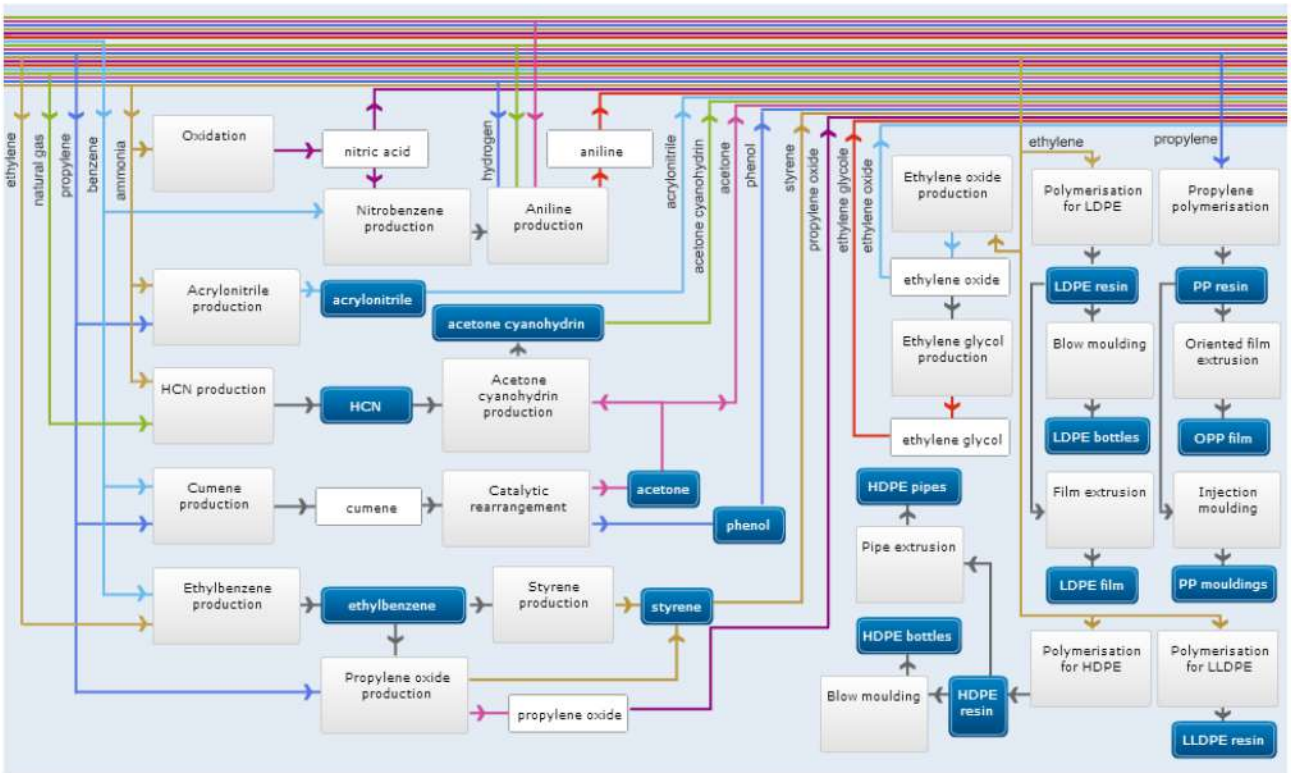

***Figure n.3**: flow diagram - Process data set: Polyethylene film (PE-LD); technology mix; production mix, at producer – Source: GaBi 6*

Thanks to a **software simulation of the data** in the previous Figure, a summary table of the overall data of CFP (Carbon Footprint of Product) related to the phases of production and disposal of the materials composing the two types of packaging is presented in Figure n.4:

COMPONENT	WEIGHT (g)	DATABASE	EMISSION PER BAG: PRODUCTION + DISPOSAL (kgCO2eq)
PLASTICS			
film 950 x 3.115 mm LDPE	142,68	LDPE: Polyethylene film (PE-LD)	0,695
film 800 x 3.115 mm LDPE	120,15	LDPE: Polyethylene film (PE-LD)	0,585
2 sheets 950 x 3.115 mm pluriball (PE)	441,01	LDPE: Polyethylene film (PE-LD)	2,148
2 sheets 1.600 x 3.115 mm foam PE	262,15	HDPE: Polyethylene High Density Granulate (HDPE/PE-HD)	1,069
TOTAL	**966,00**		**4,496**
PAPER			
sheet 3.390 x 1.880 mm recycled kraft paper	547,07	Kraft paper unbleached	0,639
2 sheets 3.390 x 1.800 mm recycled fluting paper	1.280,38	Corrugated cardboard	0,530
sheet 3.390 x 1.800 mm coated paper	349,19	Kraft paper one-sided coated	0,346
2 strips 45 x 1.100 mm havana coated paper	13,35	Paper woody uncoated + LDPE: Polyethylene film (PE-LD)	0,037
TOTAL	**2.190,00**		**1,553**

***Figure n.4**: summary table indicating the weights of the various components and total emission values (production + disposal) - Source: elaboration of Rete Clima®*

NOTES TO TABLE OF FIGURE n.4:

- the "pluriball" was considered as exclusively composed by LDPE;
- the coated paper was considered as composed for 50% by paper and for 50% by DPE;
- no GHG emission has been assessed with the exception of the principal materials: any further evaluation will be object of eventual subsequent studies;
- the low-value emission of recycling fluting paper is motivated by the high percentage of recycled pulp, which significantly reduces the emissions of the production phase;
- in the absence of further specific information about the environmental destiny of products at the end of their life, a "medium" emissivity coefficient has been selected among the different ways of degradation of materials.

The final considerations of this simplified assessment are clear: even if the **cardboard package** is much heavier than the plastic one (more than double in weight), the **significantly lower emission** of paper materials determines a **more positive environmental performance** than the plastic one.

Even if intuitively the cardboard packaging has a **best "environmental quality"** if compared to a plastic one, the use of technical databases and software for the modeling the environmental production cycle flows **fully confirms** this logic by allowing to state:

- plastic bag (weighing 0,966 kg) has a preliminary carbon footprint of **4.5 kg CO_2eq**

- cardboard bag (weighing 2.3 kg) has a preliminary carbon footprint of **1.55 kg CO_2eq**

determining about **3 times difference value of the GHG emission** between the two bags.

Analysing the output data of the calculation software and taking as (only) example the **cumulative emissions data (production + disposal) of the LDPE**, Figure n.5 shows how both in the production phase (red column) and during disposal (blue column) the **CO_2** represents actually the biggest emission quantity among all the greenhouse gases, constituting as the **first and most important climate-changing gas** (that even the IPCC identifies as the **primary responsible for the global warming**).

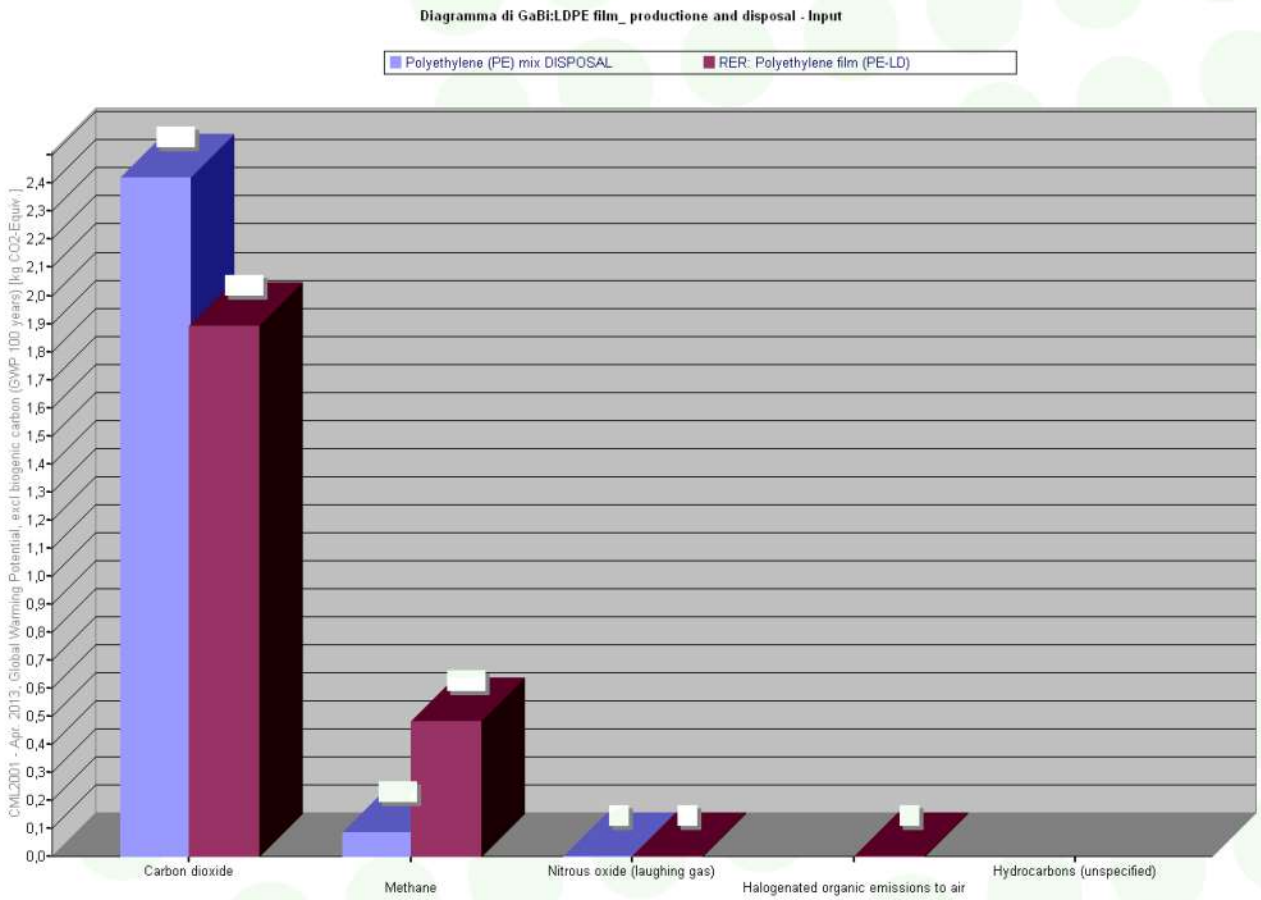

***Figure n.5**: GHG emissions composition inside production and disposal phases of LDPE - Source: GaBi 6*

This model then returns an important indication, giving evidence that the **CO_2** represents **the most important GHG contribution** in terms of quantity (respect of the other GHGs), **even in the life cycle of plastics**.

We also have to consider that the CO_2 produced along this life cycle is virtually and entirely **originated from fossil carbon**, i.e. the carbon initially contained in the **oil extracted from ground** which constitutes the source of production of plastics: the atmospheric emission of this carbon in oxidized form (CO_2) implies then a **net increase in the concentration of atmospheric carbon**, which increases the **anthropogenic greenhouse effect**.

f) CONCLUSIONS

Despite the higher weight of the paper (due to the increased use of material) the simplified evaluations above described show a **lower GHG emission value** in case of packaging made of paper, as further proof of its **best environmental performance** if compared to that of plastics.

The **better environmental compatibility** of the paper bags emerges even considering the easy recyclability of the material, both from the technical point of view and from the energetical point of view, in relation to the limited use of energy required for the different steps of the **recycling** process itself.

From the environmental point of view it's necessary to consider that, as already introduced, the **paper bag is part of the closed biotic carbon cycle** (see Figure n.6) that origins and ends itself above the ground line, and therefore avoids the **taking out of fossil carbon from the geological compartment** (as it instead happens in the case of production of plastic, increasing in this way the concentration of "**anthropic CO_2**" in atmosphere):

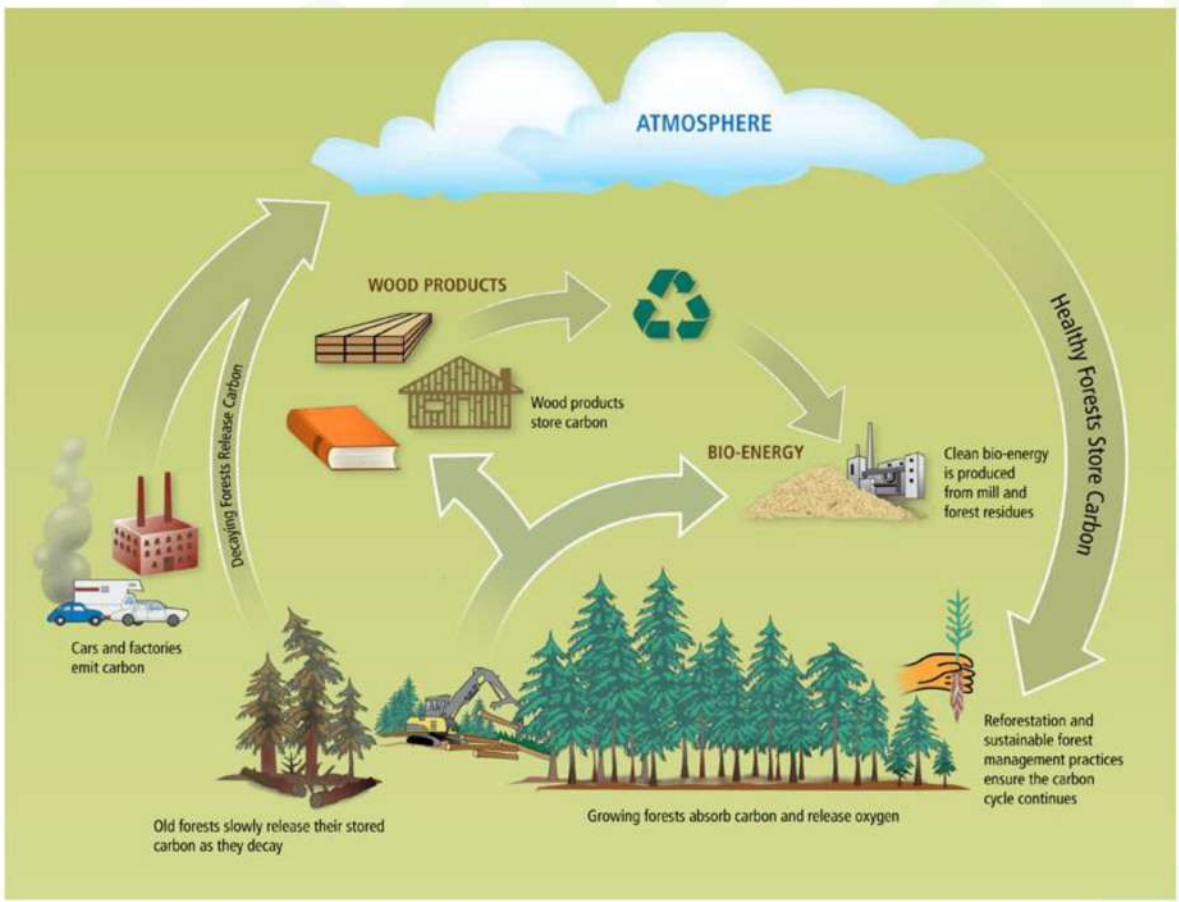

***Figure n.6**: carbon cycle (close to the atmosphere) – source: Web*

Rete Clima® really cares about the spread of wooded areas and wants also to underline that the cardboard is obtained through **management of green areas**, which provide a wide range of

positive and multifunctional environmental benefits towards the forestry location as well as the global climate. This represents an overall "gift of nature", both in a step of "standing wood" (forest) and in a step of HWP (Harvested Wood Products), in order to give a wide range of high environmental value products.

Areas for improvement: carbon assessment & carbon management

At the end of this simplified evaluation, which has offered interesting opportunities for discussion at an high value technical level, we recommend two different options of improvement:

• Carbon assessment: in-depth analysis of the present study through a **more detailed CFP**, i.e. a CFP specifically declined on the actual situation of the Company and settled according to certifiable standards, with specific reference to the **ISO/TS 14067:2013** or to the standard **UNI EN ISO 14025:2010** (for the construction of an **EPD** - Environmental Product Declaration).
The logic of the modeling of the production cycle would be "from cradle to grave" or "from cradle to gate": at this stage Rete Clima® could support the efforts of Eceplast Srl during the realization of the **in-depth analysis**, as well as with the possible **certification procedures** carried out by an independent Institute of certification.

• Carbon management: **neutralization of the GHG emissions** linked to sold bags, to get **zero CO_2 emission** products ("carbon neutral"). At this stage Rete Clima® could support the efforts of Eceplast Srl in neutralizing emissions through either a national offset portfolio (see: https://translate.google.it/translate?sl=it&tl=en&js=y&prev=_t&hl=it&ie=UTF-8&u=http%3A%2F%2Fwww.reteclima.it%2Fcompensazione-di-co2-carbon-offset-mediante-progetti-forestali-nazionali%2F&edit-text=) or a mixed one (national + international), with a wide range of actions even extended to support the **communication of the carbon offset**.
Among these actions we can also offer the release of a "**zero CO_2 emission" registered trademark**, of a the **traceability code** and of **Qr code** (in vector format: all marks and codes are directly usable on packaging).

Certain of the scientific accuracy of the data generated, we are glad to have supported you in understanding the real **environmental performance of your products**, with particular reference to the quantification of their **emissions of greenhouse gases** that are the leading cause of the ongoing **climate change**.

We remain at your disposal for any possible request,
best regards.

Rete Clima® – no profit
greener, better, together

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