POLITECNICO MILANO 1863

DIPARTIMENTO DI INGEGNERIA CIVILE E AMBIENTALE

la Fabbrica della Bioenergia

AWARE Assessment on WAste and REsources

EVALUATION OF THE PERFORMANCES OF PAPER AND BIOPLASTIC BAGS IN THE MANAGEMENT OF FOOD WASTE

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Pillole di circolarità e decarbonizzazione
Le attività del Gruppo AWARE
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Framework of the research

The organic fraction (mainly constituted by food waste) is the most important municipal waste stream separately collected in Italy

Year 2018 ➡ ≈ **6,300,000 tonnes** of organic waste

Different bag typologies, have an influence on the household storage and on the collection. Moreover, their interaction with the food waste treatment processes can be different

➡ Materials currently employed for food waste collection bags in Italy:

- **56.2% bioplastic**
- **0.5% paper**
- **43.3% plastic** (not suitable for the subsequent treatments)

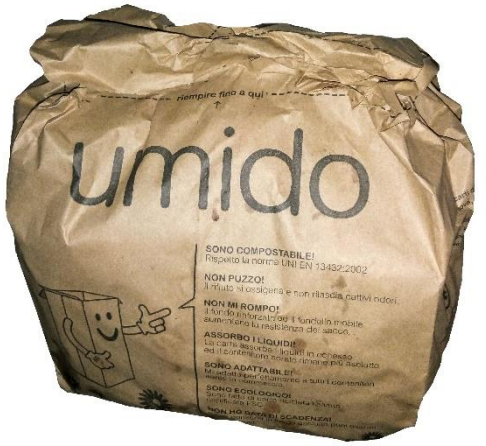
ISPRA data - Istituto Superiore per la Protezione e la Ricerca Ambientale. 2018. Rapporto rifiuti urbani 2018.

CIC data - Consorzio Italiano Compostatori. 2017. Accordo di programma tra Assobioplastiche, CIC, CONAI, Corepla. Resoconto sintetico delle attività di Monitoraggio. Conference proceedings “DICHEPLASTICA6”. Milano, 9 october 2017.

Examined bag typologies

- **Bioplastic** bags:
  - specifically designed for the food waste collection
    → DEDICATED
  - conventional shopping bags that can be re-used for the collection of food waste
    → SHOPPER

- **Bags made of recycled paper** with reinforced cartonboard bottom manufactured for the food waste collection



Household storage analysis

Evaluation of the waste weight loss for paper and bioplastic bags
(more than 140 domestic tests performed in parallel)

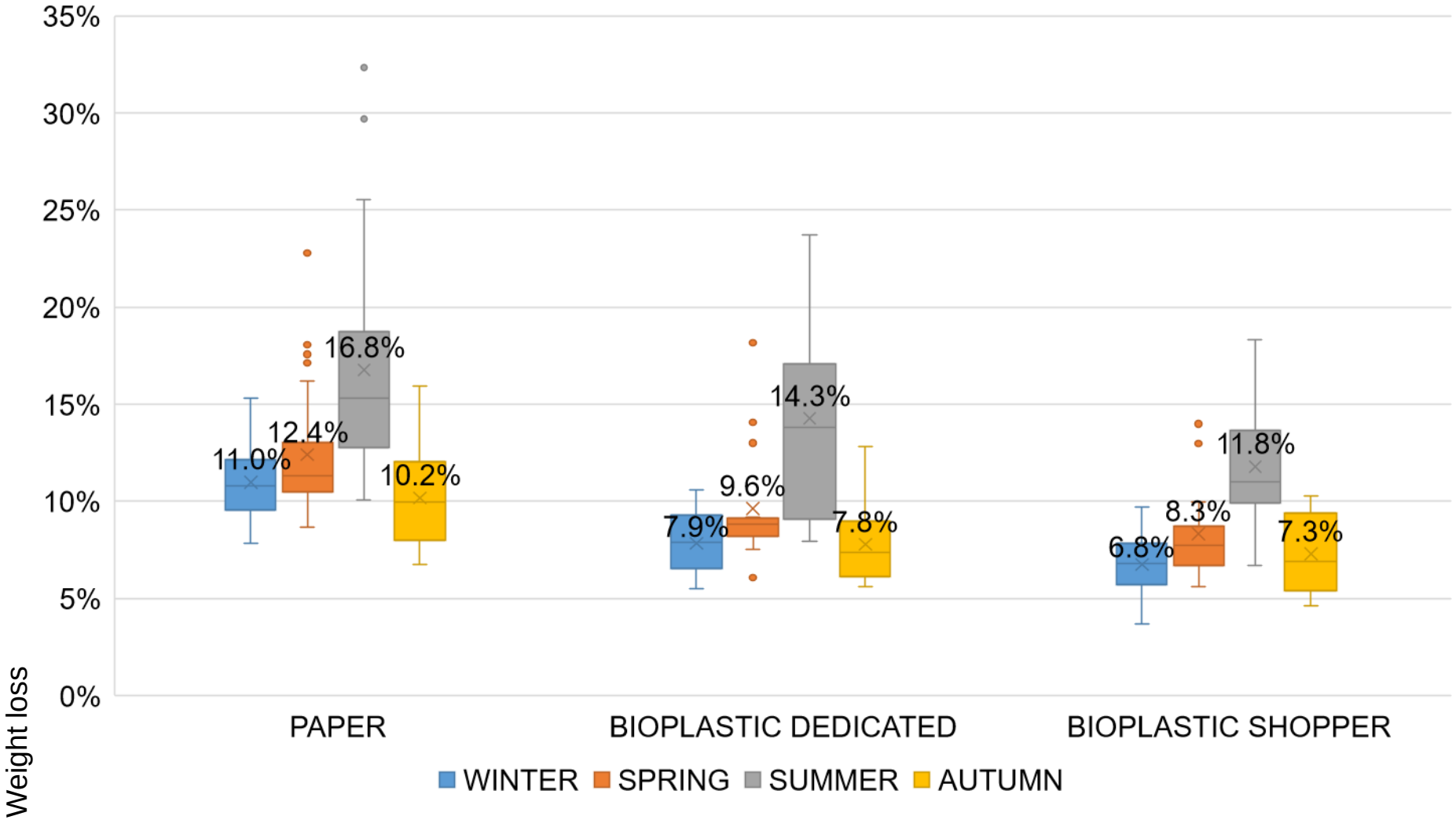
Before each bag filling:

- homogenisation of generated food waste;
- subdivision of food waste in two portions with the same weight;
- discharge of the two portions in the paper and in the bioplastic bag

After the end of each test (120 hours), the weight loss with respect to the inserted waste is evaluated

This aspect affects the amount and potentially the quality of waste that is subsequently collected, transported, and sent to treatment plants

Household storage analysis - results



WINTER: +40% (paper vs dedicated) +63% (paper vs shopper)
SPRING: +29% / +49% **SUMMER: +17% / +42%** **AUTUMN: +31% / +39%**

Food waste treatment analysis

In the last years, an increase of the amount of food waste sent to integrated (anaerobic + aerobic) or anaerobic treatment was observed in Italy:

1,630,000 tonnes (2015) → 2,390,000 tonnes (2017) **+ 47%**

This amount has gone over the amount of food waste sent to aerobic treatment (composting):

1,900,000 tonnes (2015) ⇔ 1,920,000 tonnes (2017)

↓

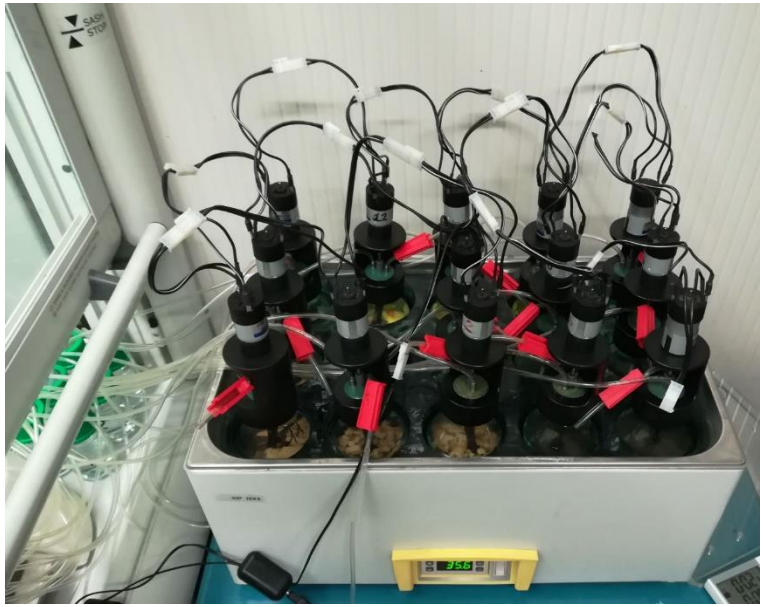
Evaluation of the collection bag influence on the anaerobic digestion process

ISPRA data - Istituto Superiore per la Protezione e la Ricerca Ambientale. 2018. Rapporto rifiuti urbani 2018.

Food waste treatment analysis - BMP tests

Evaluation of the anaerobic degradability of collection bags

BMP (Biochemical Methane Potential) tests



Evaluation of:

- the potential biomethane production under anaerobic conditions
- the degradation kinetics

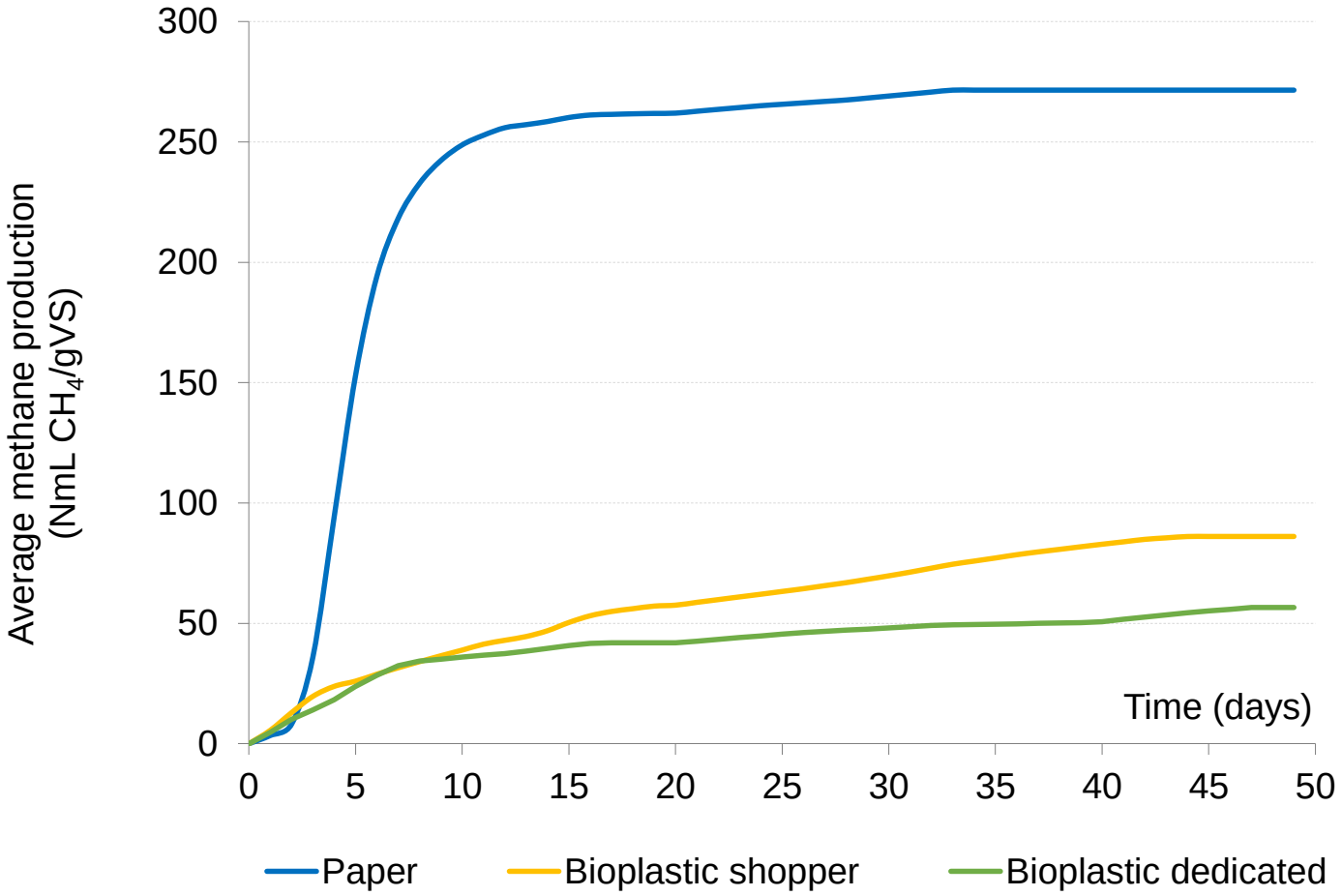
Two different **TEMPERATURE** conditions:

- mesophilic (35° C)
- thermophilic (50° C)

SUBSTRATES cut in square pieces of 0.5 cm side:

- paper bag
- bioplastic dedicated bag
- bioplastic shopper bag

BMP tests - mesophilic conditions - results

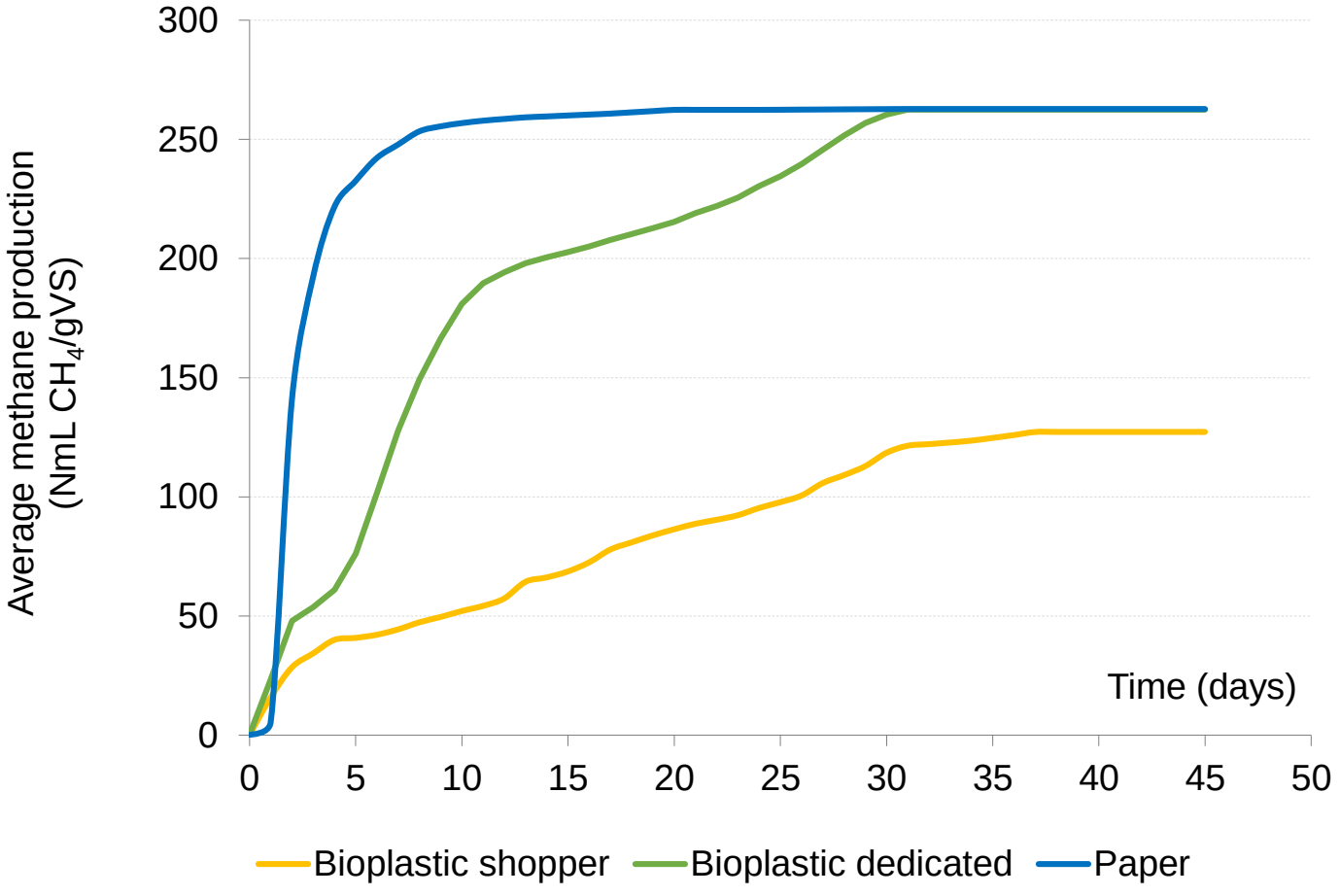


Significant difference between the two examined materials

Kinetics → paper: 90% BMP in the first 10 days

Bioplastic vs paper	Bioplastic shopper	Bioplastic dedicated
	-68%	**-79%**

BMP tests - thermophilic condition - results



final BMP of paper and bioplastic dedicated bags very similar (but different kinetics)

important difference between paper and bioplastic shopper bags still observed

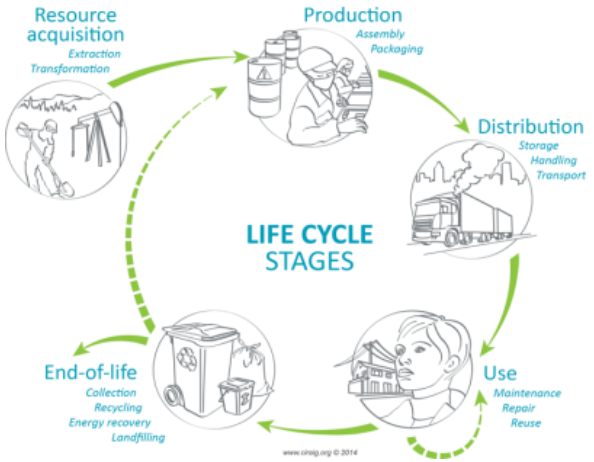
Bioplastic vs paper	Bioplastic shopper	Bioplastic dedicated
	-51%	**-0.1%**

LCA - goal/functional unit

Evaluation of the environmental performances of the overall food waste treatment chain

LIFE CYCLE ASSESSMENT
methodology

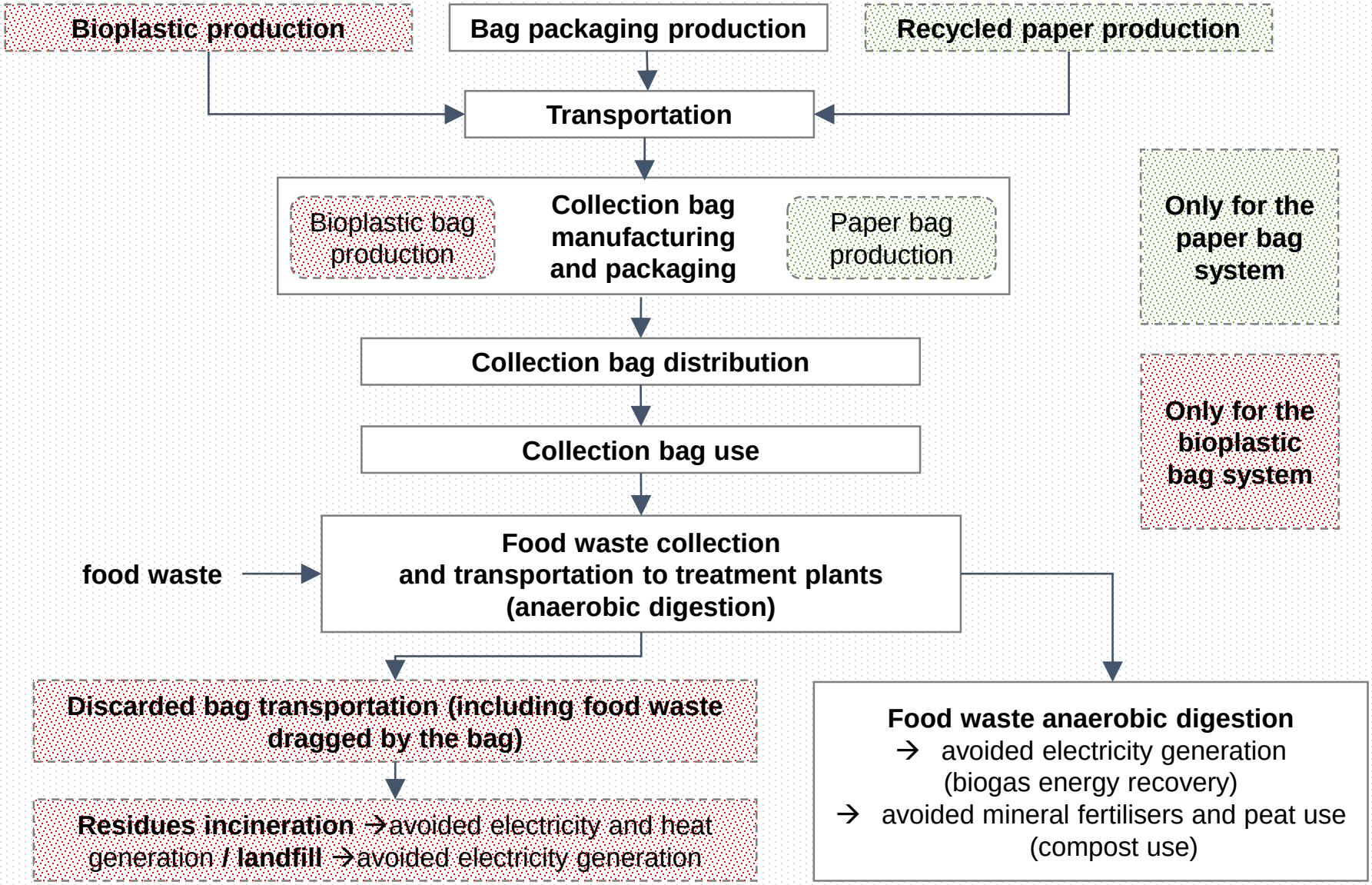
Comparative study for the two typologies of collection bag
(paper and bioplastic dedicated / shopper)



FUNCTIONAL UNIT: ***the management of 1 ton of food waste generated (i.e. inserted into the collection bag) at the household***

Non-compostable materials discarded together with food waste by mistake are excluded because their amount is assumed not to be affected by the different compared bags

LCA - system boundary



LCA - results

Impact category	BIOPLASTIC DEDICATED vs REC. PAPER * EPD approach (Environmental Product Declaration)	BIOPLASTIC DEDICATED vs REC. PAPER * PEF approach (Product Environmental Footprint
Climate change	+19%	+12%
Ozone depletion	+44%	+28%
Ionising radiation, human health	+150%	+84%
Photochemical ozone formation	+20%	-1%
Respiratory inorganics	+18%	-13%
Human toxicity, non-cancer effects	+117%	-3%
Human toxicity, cancer effects	+66%	+47%
Acidification	+92%	+12%
Eutrophication, aquatic freshwater	+78%	+16%
Eutrophication, aquatic marine	+104%	+77%
Eutrophication, terrestrial	+28%	-3%
Ecotoxicity freshwater	+107%	+70%
Land use	+452%	-53%
Water use	+1350%	+231%

Potential impact change = (Bioplastic system - Paper system) / |Paper system|

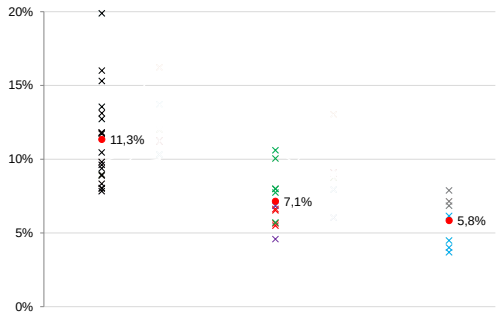
BIOPLASTIC DEDICATED vs PAPER

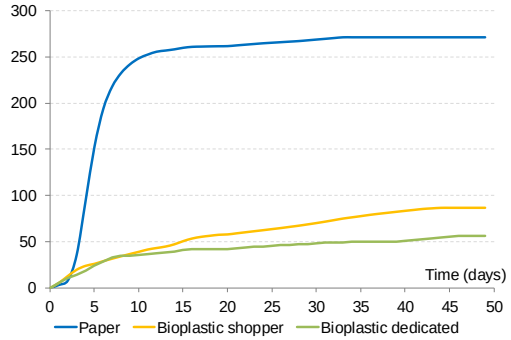
Relevant **impacts increase for all the impact categories** (EPD approach)

Impacts increase for most of the impact categories (PEF approach)

Conclusions

Tests (household storage + BMP) and LCA results:
different behaviour between paper and bioplastic bags





IMPACT CATEGORY	REC. PAPER vs BIOPLASTIC DEDICATED	REC. PAPER vs BIOPLASTIC SHOPPER
Climate change	-18%	-23%
Ozone depletion	-26%	-31%
Human toxicity, cancer effects	-21%	-24%
Human toxicity, non-cancer effects	-61%	-69%
Particulate matter/Respiratory inorganics	-12%	-14%
Ionising radiation, human health	-48%	-57%
Photochemical ozone formation	-11%	-14%
Acidification	-26%	-32%
Eutrophication terrestrial	-16%	-22%
Eutrophication - aquatic freshwater	-26%	-34%
Eutrophication - aquatic marine	-39%	-48%
Ecotoxicity (freshwater)	-38%	-42%
Land use	-79%	-83%
Water scarcity	-73%	-78%
Resource use, minerals and metals	-14%	-5%
Resource use, energy carriers	-29%	-36%
Cumulative Energy Demand	-37%	-44%

Future steps:
evaluation of the influence of the collection bag typology on the full scale anaerobic digestion process

Plastic and bioplastic bags are penalising when food waste is sent to a wet or semi-dry anaerobic digestion process

They must be generally removed before the digestion dragging a considerable amount of organic substance due to bags shape

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AWARE
Assessment on WAste and REsources

THANK YOU FOR YOUR ATTENTION

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