LIFE Project Number

LIFE13ENV/FR/001483

LIFE PROJECT NAME

Innovative sorting process plastic recycling

LAYMAN'S REPORT

With the contribution of the LIFE financial instrument of the European Community

LIFE13ENV/FR/001483

Background

Waste from electrical and electronic equipment (WEEE) is the fastest growing waste stream in the EU, with a growth rate of 3 to 5% per year.
The WEEE stream faces two central problems: the disposal of WEEE to landfills, and the suboptimal recycling and recovery of WEEE by techniques that release or generate harmful substances to the environment. Moreover, only one third of WEEE is reported as being separately collected and appropriately sorted. The sorting process demonstrated in this project will high reduce the environmental impact of recycling WEEE.
EU regulation requires that WEEE containing BFRs be separated out of the recycling stream, because of concerns about these chemicals. Moreover, the recycling of WEEE is a major challenge for the environment and the circular economy: the new WEEE Directive sets ambitious recycling and recovery rates valid from 2019 and the European Commission intends to put an end to the landfill of all recyclable materials in 2030.
However, only 12% of the plastics collected in the WEEE sectors are now recycled and produce low quality by-products. The conditions of success for the secondary valorization of plastics derived from WEEE are in the improvement of sorting technologies for recyclers.

INSPIRE4LIFE objectives

INSPIRE4LIFE project's goal is to demonstrate at **pre industrial** scale an innovative **automated sorting** process aiming to **improve quality** of recycling and reuse of **large plastic pieces**.
The **technical objectives** of the INSPIRE4LIFE project are:

- The development of an **automatic sorting process**
- **Increasing the recycling rate** of **large plastic parts**, including **black** ones
- **Improving** the **quality** of recycled plastics, in particular by **eliminating substances** that are currently **prohibited**
- The **increase** in the **use** of **recycled plastic** for the manufacture of products

The **social objectives** of the INSPIRE4LIFE project are:

- The **creation** of **new jobs in Europe** for:
    - The manufacture of sorting machines
    - Research and innovation around these new plastics
    - Recycling plastics (companies carrying out the collection, sorting, transport of these materials)

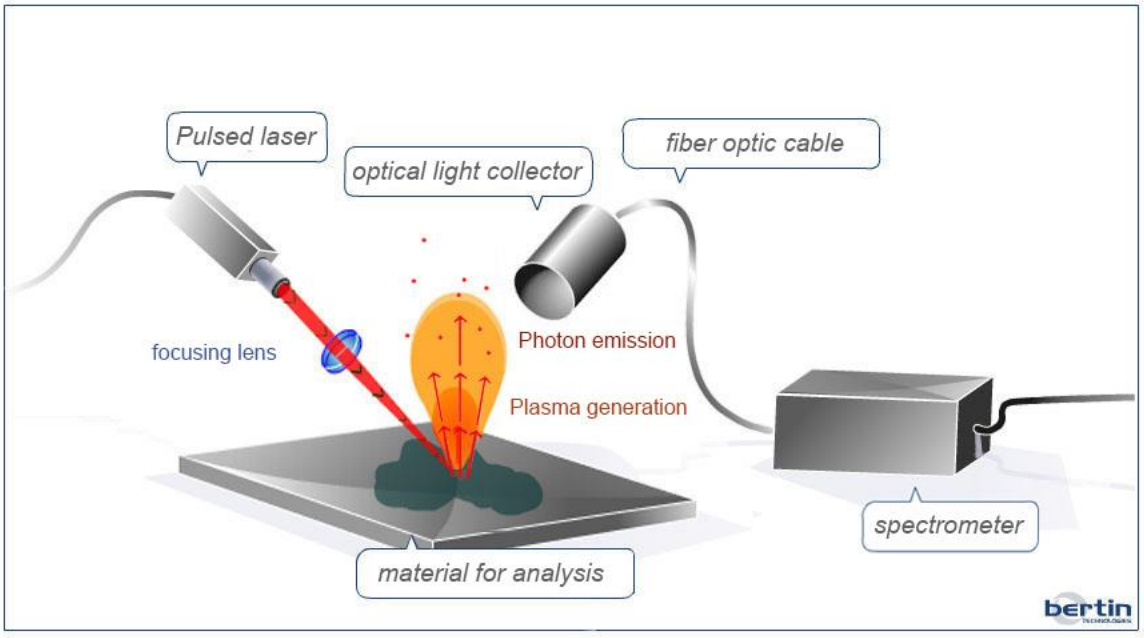
  Indeed, until today, the end of life of plastics is mainly supported by Asian countries. The INSPIRE4LIFE project will therefore help to redirect these jobs in Europe.
- The **improvement** of the **treatment conditions** of these plastics. At present, it can be performed in poor hygiene and safety conditions.

The **environmental objectives** of the INSPIRE4LIFE project are:

- The **improvement** of the **end-of-life Eco profile of plastics**,
- **Improving** the **identification** of compounds that are toxic to humans and the environment, such as **bromine derivatives**,
- The **improvement** of **knowledge** around the recycling of plastics through the creation of new LCA data,
- The **reduction** of the **extraction** of exhaustible **virgin resources**.

Approach and Results achieved

Supported since 2014 by the LIFE + program, the INSPIRE4LIFE project "Innovative sorting process recycling" aims to develop a new process for sorting polymers, especially black polymers, to improve their recycling rate in Europe.
The developed process, called Quantom InLine, uses **LIBS** (Laser-Induced Breakdown Spectroscopy) to both **identify the polymer**, enabling sorting of the WEEE plastics, and **to detect the presence of brominated flame retardants (BFRs)**, enabling exclusion of contaminated materials from the recycling streams.



Principle of LIBS technology, © Bertin Technologies

Moreover, the Quantom InLine is **fully automated**, operates even on **coloured or black plastics** and displays the following performance:

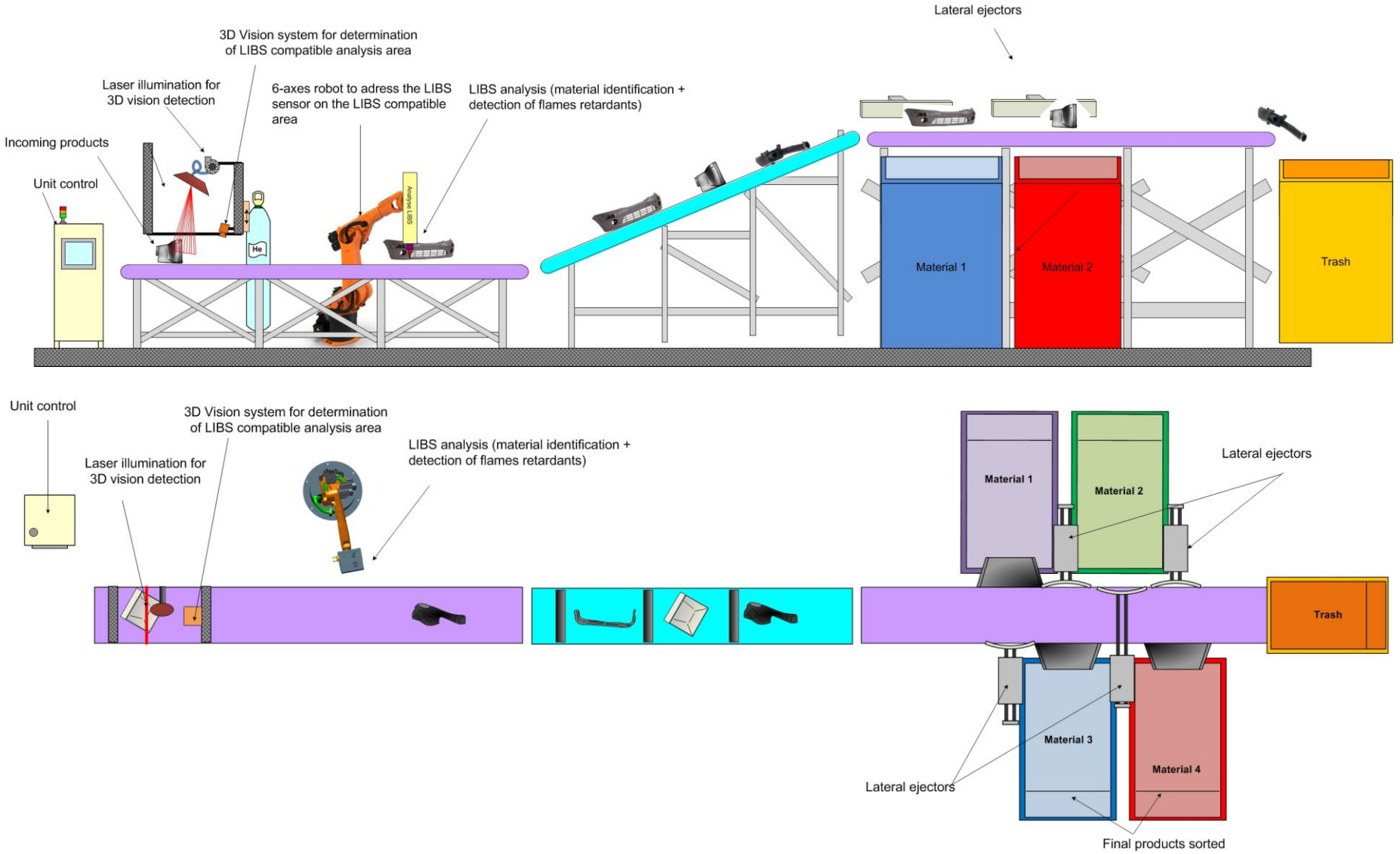
Performances	
Polymer determination accuracy	> 97%
Sorting capacity	12 items / minute
Waste format	Up to 150cm * 80cm
Tonnage	Up to 1.3 ton / hour (based on an average weight of 1.8kg waste)
Detection of Brominated, Chlorinated, Phosphorous flame retardants	Detection limit typ. 1% by weight of the element: P, Br or Cl
Polymer recognition	ABS, ABS-PC, HIPS, HIPS-PPE, ABS-PMMA, PVC, PA, PP-PE, PPT

Quantom InLine installed in the recycler site, July 2018

Totally automated, Quantum InLine can sort black and brominated plastic waste quickly and efficiently

The overall architecture and macro operation of the machine is as follows:

- A vision station makes a 3D photograph of the part to be analyzed;
- An algorithm determines a "clean" area that is flat, without holes, without labels, on which the LIBS sensor can perform a reliable analysis;
- The X, Y, Z coordinates of this area are addressed to the robot;
- The robot docked the sensor on this area. This position is maintained during scrolling of the part on the conveyor, to perform the LIBS analysis;
- The analysis output is sent to the PC pilot, which allows the product to be ejected in the target container (depending on the type of plastic, or if there is any Brome presence).



Synoptic diagram of a sorting line equipped with the Quantom InLine system

The resulting secondary material was then tested by Rescoll engineers to characterize and then valorize the recycled material.
The demonstration trials have successfully produced **3D printing filaments from 100% recycled HIPS** (sorted, shredded and mechanically re-extruded).
Therefore, Quantom InLine allows fast processing of large plastic pieces in input (after dismantling), and lead to obtain a high quality recyclate in output, immediately reusable by compounders to produce a 100% recycled based secondary product.

It has been pointed out that the mechanical properties of printed test pieces with virgin material and recycled material are relatively similar. We can therefore conclude that **a virgin HIPS wire spool can easily be replaced by a recycled HIPS wire spool without loss of mechanical properties**.

HIPS recycled filament & printed coupons

This conclusion offers an encouraging way for the recycling of recycled material in the form of a filament dedicated to 3D printing.

Waste from WEEE

HIPS 3D printer filament

Sorting with Quantom InLine

Moreover, Quantom InLine is not limited to the WEEE plastics, it can apply to metals for example to determine the type of metal, but also the shade or alloy (aluminum grades for example). The uses of LIBS technology are not limited to the field of recycling. It can be used in many sectors such as nuclear, defense or the mining industry.

Environment impacts

A comparative life cycle analysis (LCA) was performed to assess the environmental suitability of the Quantom InLine sorting technology in comparison to current solutions.
As a reminder, the purpose of this study was to assess the environmental impact of three end-of-life management scenarios of TV and PC plastic back covers of flat screens coming from the WEEE sector. The three "enhancing" scenarios selected for this study were:

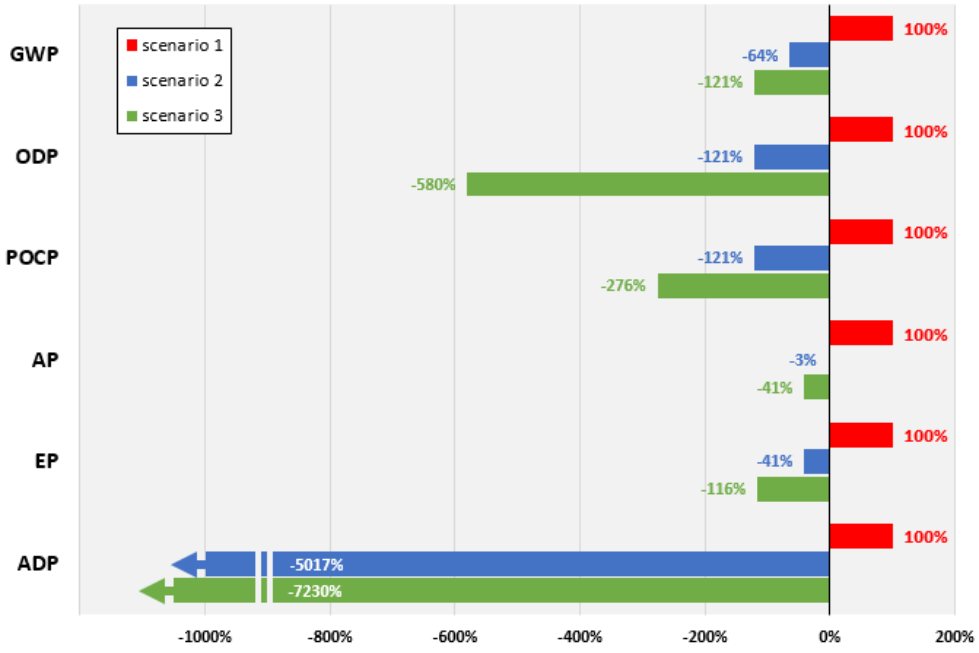
- Scenario 1: incineration with energy recovery in municipal incinerator,
- Scenario 2: sorting by flotation and density techniques representative of the sorting process most used in Europe for this type of plastics,
- **Scenario 3**: sorting by the **Quantom InLine technology** developed in the frame of INSPIRE4LIFE project.

The environmental benefit of recycling has been clearly demonstrated in relation to incineration with energy recovery

The environmental impact of Quantom InLine's innovative sorting technology is minor that this of current sorting technologies

The advantage of Quantom InLine's innovative sorting technology lies in the fact that **more material is recovered.** For 50 tons of sorted waste, scenario 2 allows to recycle 18 tons of ABS and HIPS against 30 tons of ABS, HIPS and ABS-PC for Quantom InLine scenario.

Evolution of the environmental impact of Scenarios 2 and 3 according to scenario 1 reference (percentage change in impacts compared to Scenario 1 reference)



Socio economic effects

The deposit of plastics from screens coming from the WEEE sector was studied in detail during the project. The lack of techniques for detecting the presence of flame retardants and isolating the plastics that need to be selectively treated, the high potential for economic return of WEEE plastics in the circular economy, and the analysis of competing sorting technologies confirm that LIBS is positioned very favorably for use on a continuous sorting line of this kind of waste.

Here below are summarized the key figures gathered on this application and which make it possible to assess the market potential:

- Market potential: 100 000 tons of plastics from WEEE Screens (excluding computer screens, tablets, computers) to be recycled per year minimum in Europe by 2019
- The capture rate via the recycling chain set up by the eco-organisms represents approximately 1/3 of the deposit estimated at present
- Market growth rate: 3 to 5% per year
- Recycling capacity of plastics from WEEE (all WEEE combined) in Europe is currently limited to 250 000 tons / year.
- About 100 WEEE plastic processing sites in Europe

The analysis of the economic impacts related to the equipment developed within the INSPIRE4LIFE project shows that in 3 years we can hope:

- a significant increase in the sorted quantity of plastic material from WEEE Screens
- a clear improvement in the detection of plastics containing BFRs
- the disappearance of previously sorted plastics destined for energy recovery.

These impacts are in full compliance with the increasing targets for the collection, recycling and recovery of WEEE regulated by the WEEE Directive and the regulatory changes to the RoHS Directive on flame retardants.

These impacts translate directly into economic growth for the recycler who will have put in place the analysis equipment and will be concretized by:

- an increase in turnover and added value on resold sorted recycled raw materials and
- an increase in the customer base.

The impact of the project on employment in the next 2-3 years is estimated between 1 and 3 equivalent full-time at the recycler site (without counting jobs created or maintained at Bertin Technologies). Thanks to the development of a prototype V1 and a possible next realization of a second version of the equipment, the project is considered highly replicable. It can therefore be assumed that each implementation of Quantom InLine equipment will have similar benefits, both from an economic and social point of view.