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Technical monitoring on optical sorting and textile recognition technologies at a European level

Summary

February 2020

Terra

Experts en solutions circulaires

CONTENTS

Introduction

This study was carried out by Terra from September to December 2019 for the following purposes:

- To establish a state of the art on technologies used for textile recognition and sorting.
- List the projects and development in progress in this area in Europe and consolidate feedback.

All documents available were analysed and around thirty interviews were also carried out. These interviews were conducted with European organisations having different profiles:

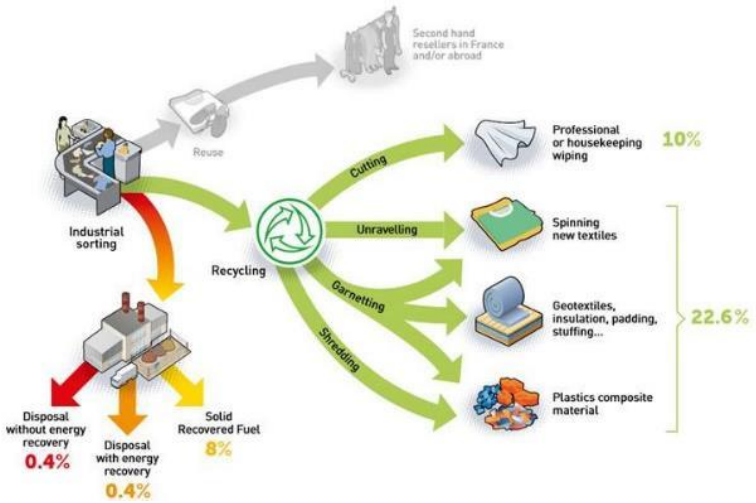
- Technology suppliers.
- R&D centres
- Operators.
- Project owners.

State of the art on technologies used for textile recognition and sorting

Background

Collected textiles are manually sorted in order to determine their **reuse** potential. The reused portion accounts for 59% of the CLF (clothing, linen, footwear) collected. The fraction that cannot be reused either undergoes:

- Material recovery (rags, non-woven textile, etc.).
- Or energy recovery. Less than 1% of CLF are destroyed.



Possible fate of used textiles (Source: Eco-TLC 2018 Activity Report)

Necessity to develop recycling

The **quantity of textiles collected is increasing** but the **portion that can be reused is decreasing**.

At a European level this trend is continuing for various reasons:

- Decrease in the quality of clothing placed on the market.
- Development of sales amongst private individuals upstream, which is increasing the amount of wear and tear of the items collected in self-deposit collection banks.
- The requirement to carry out selective collection of textiles even those that cannot be reused in Europe by 2025.

Some countries where a part of the textiles for recycling have been exported, are also starting to close their borders.

Consequently, it would seem essential to create **new outlets** for textiles that cannot be reused and to **develop their recycling.**

Material and colour sorting

Textile recycling is still limited. One of the obstacles in its development is the absence of reliable material characterisation methods for the fraction intended for recycling.

The majority of applications that can integrate recycled textiles **require the different materials to be separated upstream.** The sorting of textiles is therefore an **essential block** in the recycling chain.

For certain types of recycling **colour sorting** is also required. For example, in order to avoid having to dye the recycled material.

Materials used for textiles

A **multitude of materials** exist and not just one (see table below). The prerequisite for sorting is therefore to **identify the composition** and chemical structure of these materials.

Fibre types	Examples
Synthetic **polymers**	Polyester, polyamide, acrylic, elastane
Cellulose fibres	Cotton, viscose, linen
Protein-based fibres	Wool, cashmere, silk

The technology that is being sought

To separate textiles, a material **recognition system** that is:

- Reliable.
- Fast.
- Non-destructive.
- Economical.

is necessary.

The exclusively manual sorting of materials (by feel and reading labels) does not meet these criteria. Therefore this report focuses on technologies that may be more suitable.

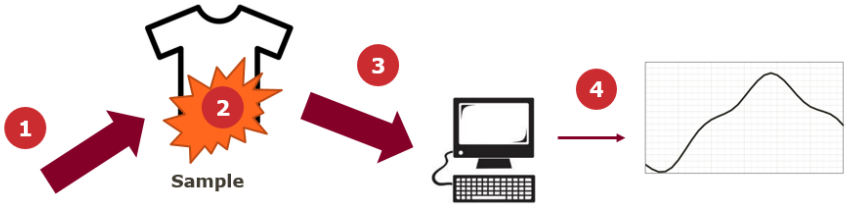
This material sorting is only considered for textile fractions that have been judged as not being reusable after an initial manual sorting operation.

Material recognition

Most of the equipment allowing textiles to be recognised is based on the **spectroscopy principle**.

Spectroscopy, User guide

A **spectrometer** is an instrument that can analyse a sample's composition.



How spectroscopy works

It works as follows:

1. An electromagnetic wave is sent to the sample to be analysed.
2. The wave and the sample's chemical structure interact (molecule, atom, bonds, etc.).
3. The wave is measured after having interacted with the sample.
4. A spectrum is produced.

The spectrum represents the sample's chemical signature.

Therefore, the **spectrum's comparison** of an item's unknown composition with **a reference spectra database** of pre-recorded samples enables the composition of the item analysed to be determined.

Sorting categories

Therefore, during the development of a new materials recognition system (textiles in this case) it is necessary to have a **library** of material **samples.** These samples:

- Correspond to the desired sorting categories
- Are scanned with the same type of spectrometer as the one that will be used subsequently for sorting.

They constitute the **reference base**.

A **sorting category** may correspond to:

- A pure material (e.g. 100% cotton).
- A mix of materials (e.g. 50/50 Cotton/polyester).
- A family of materials which are close (e.g. cellulose fibres).

It is necessary to have several dozen representative reference samples for each category to be sorted.

In summary

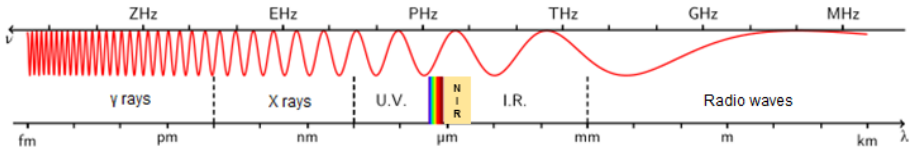
In summary, the development of an automated material recognition system requires:

- A sample library of known materials.
- A spectrometer.
- A recognition model or algorithm.

Near infrared (NIR)

Currently, **spectroscopy using near infrared waves** appears to be the most relevant for use in textile recognition.

This is commonly called **NIR**.



Electromagnetic spectrum domains (Source: Wikipédia)

A technology already used in Europe...

All main projects that are working on textile material sorting identified in Europe (see following section) exclusively use this technology for material recognition.

... suitable for textiles

This is indeed suitable for the chemical composition of textiles because the different materials **can be differentiated** using near infrared.

....for waste sorting

Materials used in textiles are chemically **close to those of packaging.** To illustrate, polyester is found in PET bottles and paper and cardboard are made from cellulose.

Near infrared has been used for several dozens of years for sorting packaging. It can also be found in plastic and waste electronic and electric equipment sorting operations.

Automated sorting technologies based on near infrared are therefore **totally compatible with operating conditions** in waste **sorting**.

... and fairly inexpensive

Compared to other spectroscopic technologies, near infrared remains relatively inexpensive.

NIR equipment type	Price (order of magnitude)
Spectrometer	€15-25 K
Optical sorting machine	€150-200 K

Feedback on textiles

Generally, stakeholders who are working on textile recognition using near infrared technologies are confident in its potential to **perform efficient and effective textile sorting.**

However, this application is **still in a developmental phase**. Indeed, no industrial-scale material sorting units yet exist in Europe (see projects section below).

As for all recent applications, **challenges** still remain.

Pure and blended materials

According to the majority of the stakeholders interviewed **good results** in the detection of **pure materials** (100% cotton, 100% polyester, etc.) are obtained.

Identifying blends is by nature, **complex.** Moreover, thousands of different blends exist in the textiles placed on the market.

Therefore the main focus in the different European projects focus **is on detecting pure materials.** Less feedback is available about the blends. However, in these projects this is an area of ongoing development.

An important point to note is that even systems only aiming at sorting pure materials must be able to identify blends as an "unknown" material. They must not identify blends as one of the dominant materials with the risk of polluting the pure sorted fraction.

Materials in low proportions

The fact that a material is present in **very low proportions** (a few percent) within a blend **complicates its identification.** This is very frequently the case with **elastane** in textiles.

Some companies appear to be able to distinguish pure material containing a low quantity of elastane (above 3-5%). However, in some cases this may be impossible. For example, if elastane thread is twisted in with cotton thread.

Materials that are close

Some materials are **chemically** very **close**. A classic example is that of **cotton and viscose**, as both are cellulose based.

Although it is more complex for two very chemically different materials, it appears that cotton and viscose can de differentiated by NIR. It can, however, be assumed that this viscose/cotton mix is still very difficult to differentiate.

Surface technology

Near infrared spectroscopy only analyses a material's surface. Pieces having a non-uniform 3D structure risk being wrongly identified.

This is typically the case with "double layered" clothing. However certain coatings or thread or weave structures may also have an influence on the material's identification.

Dark colours

In regards to colours, some **dark pigments** (e.g. carbon black) may **hinder or make material detection impossible** by absorbing all infrared waves.

Compared to plastics, however, this type of use is less frequent in textiles. Some black materials can indeed be correctly identified using NIR. This is explained by the use of different pigments.

Various treatment processes

The treatment processes that textile materials have undergone during their manufacture could potentially have an impact on their recognition in near infrared.

We can indeed draw the analogy between certain treatment processes (e.g. coating, waterproofing) and the problem of mixes in a low proportion or weak surface detection.

Sorting quality

Lastly, the question regarding the **level in the quality of the fraction** sorted and the **impurity ratio tolerated** is crucial because sorting is a

trade-off between the quantity and the quality of the sorted fraction.

The level of impurities tolerated in the sorted fraction **depends on its outlet** and targeted application. The work on sorting quality is therefore carried out in partnership with recycling/preparation/integration operators of the sorted materials, taking into account their specifications.

Other types of spectroscopy

A great number of methods and material recognition systems based on spectroscopy apart from NIR, exists.

Examples

Given the chemical composition of textiles it should be possible to use other material recognition technologies.

A few are cited below:

- Raman.
- Mid infrared (MIR).
- Terahertz.
- NMR (nuclear magnetic resonance).

Limits

However, these technologies appear to be currently more difficult to envisage short-term for textile sorting.

The main limits are as follows:

- The equipment is more expensive than infrared.
- Few studies exist and little research is carried out on the recognition of textiles.
- They are used little or not at all for waste sorting type activities.

Therefore information is still missing in order to be able to judge the mid/long-term relevancy of these technologies in regards to textile sorting in addition to, or replacing, near infrared.

RFID

Another technology is beginning to be explored by certain companies (see following section) for sorting textiles: radio-identification or RFID (Radio Frequency Identification).

This is completely different identification approach from near infrared spectroscopy.

Principle

RFID is a method based on radio-labels enabling information to be stored and recovered remotely.

RFID labels are implanted into the product. They generally contain an identifier which allows a certain amount of information on the product to be found thanks to an external data base (serial number, manufacturing date).

Today, RFID labels are increasingly being used in the clothing industry for logistical, shop inventory or anti-theft purposes.

Use in textile sorting

If all clothing placed on the market had an RFID label, this technology could be used to textiles. **Information on the composition (and colour) of textiles would be included** in the microchip or the information system during manufacturing.

If, at the end of its service life, the item of clothing still has its RFID chip, this can be read remotely with a suitable reader. The information on the RFID chip would then enable textiles to be reliably and quickly sorted by composition and colour.

Material sorting technology would be very simple and inexpensive.

Challenges

This is, therefore, a completely different paradigm because the information must be included in the product when it is marketed.

This implies overcoming numerous challenges for generalised use:

- Use by all brands.
- Standardised RFID protocols and information formats.
- Data management.
- Robustness of the RFID chip (resistance to washing and wear and tear).
- Socio-cultural acceptance.
- etc.

Is this a mid- or long-term solution?

In summary, this is a **solution that can only be envisaged mid- to long-term.** Indeed, clothing at the end of its service life collected by the CLF industry in the next ten years:

- Has already entered the market for the majority.
- Does not contain RFID labels suited to sorting.

Additional technologies

During the undertaking of this state of the art on sorting and recognition technologies applicable to waste, other technologies were identified. These could be complementary to an infrared sorting approach.

Sorting by colour

Sorting by colour does not present with any specific problems in technical terms because colour can be identified by a simple camera. The issue lies in the choice made in the number of colours and shades to be sorted.

Artificial intelligence

The use of robots using artificial intelligence for waste sorting is in full boom. This equipment based on standard cameras, **recognises objects and shapes**.

These types of technologies could be envisaged in addition to material sorting in order **to detect certain types of clothing**:

- Items that are unwanted on a material sorting line (e.g. double layer jacket, etc.).
- Or, on the contrary, very specific sorting (e.g. white cotton T-shirt).

Metal sorting

Metal sorting systems are widely used in the recycling sector.

Type of metal	Sorting equipment
Ferrous metals	Overband
Non-ferrous metals	Machine using induction technology/Eddy current separator

For textiles, such systems may allow **hard metallic points** to be identified and possibly separated in textile streams.

Recognition of prohibited substances

Some substances found in the collected textiles may currently be **prohibited in certain applications** (e.g. REACH) and must therefore be removed from the sorted materials.

For example, this is the case for bromide in the plastics industry. To identify brominated plastics, X-ray fluorescence or spark spectrometry can, for example, be used.

If the textile recycling industry grows significantly, the use of such technologies may be envisaged for textiles.

Conclusion on technology

Today textile sorting is **still in its developmental stages** because it is not yet undertaken operationally on a large scale in Europe. However the following has been observed:

- **Significant progress** has been made over the last two years.
- Awareness on how important this area is.
- The willingness of certain operators to invest.

In the short-term	The most suitable recognition technology for textiles in optical sorting appears to be **near infrared spectrometry (NIR)** This is indeed suitable for textiles, is relatively affordable and is above all already mature and benefits from significant feed-back on the sorting of other materials for recycling.
In the mid-term	As an addition or as a replacement, other technologies among those mentioned could be used.

Ongoing projects and developments in textile sorting in Europe

Mapping of main projects

Through this study several European projects already working on textile sorting were identified.

The projects cited below are those whose information is publicly available and appear to be the most advanced.

Main European projects on material sorting identified and associated suppliers of material recognition technologies (in yellow).

SIPTex

The SIPTex project (Swedish Innovation Platform for Textile sorting) is a Swedish project for textile sorting.

Country	Sweden
Techno.	NIR + colour
Supplier	TOMRA
Project leader	IVL (research institute) Sysav (waste management operator)
Other partners	About twenty partners: brands (H&M, IKEA, etc.), sorting operators (Boer), recycling operators (re:newcell), environment agency, chemical agency, etc.
Funding	Swedish innovation Institute (Vinnova): ◆ SIPTex 2 : €0.8 M ◆ SIPTex 3 : €2 M.

The SIPTex project started in 2015 with a **preliminary study** (SIPTex 1). It then continued from 2016 to 2018 (SIPTex 2) with the construction of a **pilot unit** at Avesta that was operational for 12 months. An **optical sorting machine, TOMRA**, was used for the tests.

Since 2019, the project has taken on a new dimension with the construction of **an industrial scale textile sorting unit** at Malmø (SIPTex 3). This should be operational in 2020 and should progressively achieve a **capacity of 16,000 tonnes per year.** The sorting unit will be funded for the first two years by the Swedish innovation agency but the objective is for it to be profitable in the mi- term.

Fibersort

The Fibersort project is an Interreg European project whose purpose is to **develop a Fibersort sorting machine**. Its purpose is also to communicate on textile recycling and to bring together different stakeholders.

Country	The Netherlands
Techno.	NIR + coulour
Supplier	Valvan
Project leader	Circle Economy
Other partners	Sorting operators (Smart Fibersorting, a Wieland Textiles subsidiary), collection operations (ReShare, Salvation Army) and recycling operators (Worn Again, Procotex).
Funding	Subsidy of €1.9M from the EU for a total budget of €3.38 M.

The project started in 2016. It should end in March 2020 with a public presentation of the final version of the pilot installed at Wormever (suburbs of Amsterdam).

The Valvan machine is comprised of:

- A spectrometer at the beginning of the treatment line that identifies the material and colour.
- A long conveyor belt with sorting bins alongside and a lateral blower system.

The pilot can currently sort 45 different categories (materials/colours). It has been gradually improved with the installation of robots to automatically supply the line, the addition of colour sorting and the improvement and identification of materials. This project then plans to identify textile structures (weave/knit) too.

Telaketju/LSJH

Telaketju is a network and group of projects which, since 2017, aims at developing a **textile recycling stream in Finland**.

Country	Finland
Techno.	NIR + colour
Supplier	Spectral Engines
Project leader	LSJH (public waste management operator)
Other partners	Research Institute, universities, collection operators, recycling operators, etc.
Funding	Multiple projects with different funding. Subsidy of € 1.5 M from Business Finland for the LSJH sorting unit.

Among the various projects Telaketju, the applied sciences university in Lathi have built and carried out tests on an automated sorting line (REISKAtex project).

By using this experience, the operator LSJH now has a project to build a textile sorting unit in the south west of Finland. LSJH are working with Spectral Engines sensors for this. In 2019, they developed a textile recognition model. In the first instance They plan to use spectrometry to **assist manual sorting** and to undertake tests. Then, the sensor will be **integrated into the automated sorting machine.**

In the long term and in particular to meet the selective textile collection European requirement in 2025, they wish to extend their material sorting system to all regional waste management operators in Finland.

RESYNTEX

The RESYNTEX project is an important multipartner project and funded by the EU aiming to develop **chemical recycling** of several textiles. This project includes a sorting part lead by Soex.

Country	Germany
Techno.	NIR + colour
Supplier	LLA Instruments
Project leader	Soex (textile sorting operator)
Other partners	Chemists, universities, brands, etc.
Funding	RESYNTEX total budget: €11 M

During the RESYNTEX project a small sorting line prototype with a conveyor belt and spectrometer was developed. This is test equipment and the textiles supply and separation parts were not automated.

The RESYNTEX project ended in spring 2019. Soex is continuing to develop the prototype.

Other projects

The projects described above are funded by national organisations or the European Union. A certain amount of information about them is therefore publicly available.

Some other companies who are developing textile sorting projects in Europe **exist** but are of a more confidential nature.

Other operators can be cited such as the sorting operator **Koopera** who has material sorting projects and is funded by the Spanish Basque region. The use equipment by the German manufacturer, **Iosys** and its distributor, GUT.

RFID projects

Several European projects are exploring the possibility to use **RFID technology** described above for sorting textiles.

In particular, these projects meet the challenges cited further above.

Decathlon/4RFID

In France, Decathlon widely used RFID chips in all its logistics chain. It currently leads the RFID project, selected in the Eco TLC 2018 Innovation Challenge.

Tex.IT

The Swedish project **Tex.IT** covers about twenty Swedish companies and the Boer Group. It is funded by the Swedish innovation agency and covers the 2018-2021 period.

Others

Other European companies are exploring the possibility of using RFID to provide information to clients who are increasingly asking for traceability on clothing origin and composition. Some projects then extend this use to sort end-of-life clothing.

In particular, the Berlin start-up "**circular fashion"** can be cited and who propose **RFID labels for integration into clothing.** These provide the user with information about the item of clothing (production, materials, cleaning instructions, etc.) and enable the reverse logistic to be ensured.

Technology suppliers

Identification of technology suppliers

This study has enabled suppliers who can provide sorting recognition technology for textiles to be identified.

For these to be better known by the French players in the CLF industry some are described here (in alphabetical order). They have various profiles due to either their positioning or type of equipment offered.

These suppliers have been selected for their known participation in projects on textile materials. This list is not exhaustive. Indeed a large number of European spectrometer or sorting machine suppliers base their technology on near infrared.

Iosys

Iosys is a company belonging to Dr. Timur Seidel who designs and manufactures NIR spectrometers mainly for the recognition of plastics.

Its flagship product is the mIRoGun, a mobile spectrometer. They have a standard textile database that their designer is ready to improve upon request.

The company GUT markets Iosys equipment.

Country	Germany
Technology	NIR
Equipment type	Laboratory, mobile or small sorting line spectrometers with standard data base.
Link with textiles	Equipment used by Koopera in Spain. Textile projects excluding clothing.
Contact	Site : http://www.gut-stuttgart.de/fr.html Distributor: ◆ Name: GUT GmbH ◆ Contact person: Georg Goetzelmann (French speaker) ◆ Email: info@gut-stuttgart.de

LLA Instruments

LLA Instruments is a German manufacturer based in Berlin and specialised in spectrometers and hyperspectral imagery for industrial uses. In particular they provide their solutions to integrators who manufacture optical sorting machines.

The LLA Instruments technology is used on the Soex pilot line which was developed during the RESYNTEX project.

Country	Germany
Technology	NIR + colours
Equipment type	Spectrometers and hyperspectral cameras. Optical sorting machine manufacturers integrating these solutions.
Link with textiles	Technology used in the RESYNTEX project.
Contact	Site : https://www.lla-instruments.com/ Distributor in France ◆ Name: Polytec ◆ Email: e.dzamastagic@polytec.fr

Pellenc ST

Pellenc ST is a French company based in Provence.

Pellenc ST designs, manufactures and markets waste sorting machines. These machines are particularly present in a great many packaging sorting centres in France.

They are comprised of:

- A high speed conveyor belt (several meters per second),
- A spectrometer scanning the belt widthways,
- Ejection nozzles at the end of the belt separating materials into 2 or 3 categories.

Country	France
Technology	NIR + colours
Equipment type	Optical sorting machinery
Link with textiles	Trials conducted in 2013 on textiles.
Contact	Site : https://www.pellencst.com/fr/ Contact : ◆ Contact: Marc Minassian (Sales Director France) ◆ Email: m.minassian@pellencst.com

Spectral Engines

Spectral Engines is a Finnish sensor designer and manufacturer. Its technologies are the results of research by the Finish Research Institute, VTT.

They develop custom-made solutions with clients around these sensors. They also provide these to integrators who use them in their equipment (e.g. sorting).

The company Spectral Engines works in particular with LSJH in Finland for textile sorting (within the framework of Telaketju projects).

Country	Finland
Technology	NIR + colours
Equipment type	Sensors
Link with textiles	Technology used by LSJH for sorting textiles in Finland. Sensors with textile recognition integrated into washing machines
Contact	Site : https://www.spectralengines.com/ Distributor in France ◆ Name: Acal BFi ◆ Contact person: Grégoire Saget ◆ Email: gregoire.saget@acalbfi.fr ◆ Site : https://acalbfi.com/fr/

TOMRA

TOMRA is one of the world leaders in optical sorting technologies for waste recycling.

They have been working on textiles since 2015 and a TOMRA machine was used during 12 months for the SIPTex 2 project.

TOMRA optical sorting machines work in a similar way to those of Pellenc ST.

Country	Norway
Technology	NIR + colours
Equipment type	Optical sorting machinery
Link with textiles	Equipment used in the SIPTex 2 project Several confidential projects on textiles.
Contact	Site : https://www.tomra.com/fr-fr/sorting/recycling French subsidiary: ◆ Contact person: Sylvain Merhand ◆ Email: sylvain.merhand@tomra.com

Valvan

Valvan is a Belgian constructor who manufactures baling machines and the semi-automatic sorting (for reuse) of textiles for many years.

They have been developing for several years now the Fibersort, an optical sorting machine for textiles. This development is part of the European project with the same name.

The Fibersort is comprised of:

- Robots that feed a long conveyor belt (optional),
- A spectrometer at the beginning of the belt with single point scanning of the material,
- Sorting bins arranged the length of the belt with a lateral blower system.

The Fibersort therefore differs from standard waste optical sorting machines. It sorts a great number of categories with a single spectrometer. However, the sorting rate is lower (about 1 item per second) and the conveyor belt is longer.

Country	Belgium
Technology	NIR + colours
Equipment type	Optical sorting machinery
Link with textiles	Equipment developed with the Fibersort project.
Contact	Site : http://www.valvan.com/ Contact : ◆ Contact person: Maurits Vandeputte (French speaker) ◆ Email: maurits.vandeputte@valvan.com

Lessons learnt from the European projects

Technology used

Putting aside projects using RFID technology, all material sorting projects identified in Europe use near infrared technology (NIR) to recognise textiles, combined with a colour recognition sensor.

More or less automated sorting

To a greater or lesser extent, most projects are aiming for advanced automation in the different textile sorting steps (supply, identification, separation). The level of automation can also be linked to the maturity of a project.

Several sorting visions

However there are several visions of automated textile sorting:

Model	Stream sorted[1]	Sensor/categories	Examples	Rate	Invest. [2]
Automated	Whole items	A: one long machine with multiple sorting categories	Fibersort	+/++	++
		B: several machines each one sorting 2 or 3 fractions	SIPTex; packaging sorting centres	+++	+++
	Small items	More like case B	--	+++	+++
Semi-automated	Whole items	Affixed or mobile spectrometer for manual sorting in several categories	--	+	+

1) Entering stream. 2) Investment per line

Multi stakeholder projects

Generally several types of stakeholders are involved in the major European textile sorting projects. They are described hereafter.

Project leader

The project leader, where the pilot or industrial unit is installed, is generally an existing textile sorting centre (sorting for reuse purposes) or a standard waste management operator.

Technology supplier

The identification part of materials or automated sorting operations require advanced technical skills and technology suppliers are therefore essential partners in these projects.

Recycling operators/ integrators

Potential textile recycling operators and integrators are also regularly present in these projects because the sorting quality level is adjusted according to their requirements. Textile sorting is indeed inseparable from downstream outlets.

Brands

Textile brands are increasingly interested by this type of project to ensure that the recovery of their products at the end of their service lives is improved and that there is a supply of recycled textiles. They can also help with their knowledge on textile sources.

Technical or organisational support

Lastly it is common for these projects to be supported by engineering consultancies, universities or R&D centres in order to provide additional technical expertise or as project coordinators.

Public authority funding

All the projects cited have been the subject of significant public authority funding. An ambitious sorting trial generally requires one or several million Euros. The most currently found funding partners are:

- The European Union
- Regional authorities
- Innovation or environment agencies.

Ambitious projects lasting several years

Some of the projects described are very ambitious and have reached an advanced stage of development.

Several phases

These advances have however required several years of development and generally projects go through different stages.

A preliminary study enables the project to be precisely scoped:

- Type of sorting.
- Material targeted.
- etc.
- Size of project.
- Partner search.

Pilot

The pilot stage is essential, and may in particular enable:

- A library of reference samples to be established corresponding to the categories to be sorted and define these sorting categories.
- Calibrate the equipment, improve the material recognition models, define the adequate quality level, etc.
- Test the equipment's material identification abilities upstream and downstream.
- Check the sorting efficiency and reliability by sampling and carrying out laboratory tests on the sorted materials.
- Define economic models.

Industrialisation

Lastly, once the technology has been developed, some projects include the construction of industrial scale sorting plants with a high level of automation. Significant work on outlets for these sorting units is required in order to ensure that they are economically viable.

Conclusion

Technologies

Textile sorting for recycling requires technologies recognising these materials.

In the short-term, **near infrared spectroscopy** (NIR) appears to be **most relevant**. Indeed, all the European projects identified on textile sorting are examining this. It has also been used for many years for sorting packaging, materials which are chemically similar to textiles.

Textiles do however have **obstacles** regarding their correct identification, such as, for example:

- The existence of different blends.
- The presence of very low proportions of some materials (e.g. elastane).
- The use of certain pigments which could hinder identification.
- The 3D structure of some items of clothing (e.g. multilayers, coating, etc.).

Even if significant progress has been made over the last two years, optical sorting of textiles is still in its **developmental stage**. Indeed, an industrial-scale textile sorting unit does not yet exist on a European scale.

More long-term, **RFID** technology, which is a different additional approach, could be used for end-of-life textile sorting. Other recognition technologies by spectroscopy could also be envisaged depending upon the state of their development for textiles.

Projects

Several **projects in Europe** are examining textile sorting. The main known projects have been described:

- SIPTex (Sweden)
- Fibersort (Netherlands)
- Telaketju/LSJH (Finland)
- RESYNTEX (Germany)

The following points result from the analysis of these European projects :

- The projects have **several stakeholders** including project leaders, suppliers, recyclers, brands, funding entities, etc.
- Recognition using NIR is generally combined to that of **colour**.
- It is important to build a reliable and exhaustive **reference sample** library for good material recognition.
- **Public funding** is necessary for projects whose budget is greater than one million Euros.
- Several years may be necessary and a **pilot phase** is essential.
- It is essential that **outlets are taken into account** in order to define sorting categories and quality as well as to ensure profitability of future operations.
- Different approaches exist in regards to the **level of automation** in material sorting.

Lastly, suppliers of material recognition and sorting technologies that can be applied to textiles have been identified:

- Iosys/GUT
- LLA Instruments
- Pellenc ST
- Spectral Engines
- TOMRA
- Valvan