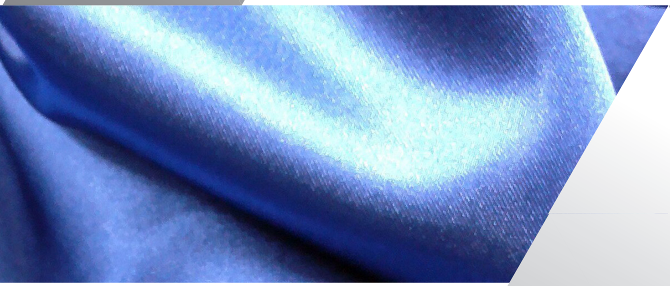
TECHNOLOGIES AND SERVICES FOR INNOVATION AND SUSTAINABILITY



NEXT TECHNOLOGY
TECNOTESSILE
SOCIETA' NAZIONALE DI RICERCA R. L.

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TECHNOLOGIES

SERVICES

About us

MISSION

Promotion

Promote our role in applied Technological Research, performed in collaboration with enterprises under the National/Regional Programmes and the European Commission Framework Programmes.

Development

Develop knowledge and ideas leading to the creation of new products and new processes engaging companies and other relevant stakeholders at regional, national and European level.

Networking

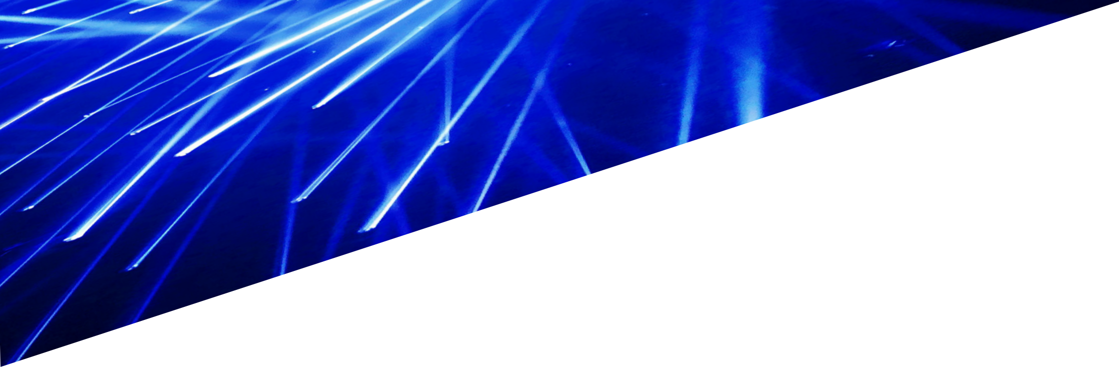
Create strategic partnerships between companies and suppliers of scientific knowledge, as Research Centers and Universities, both at National and European level.

OUR HISTORY

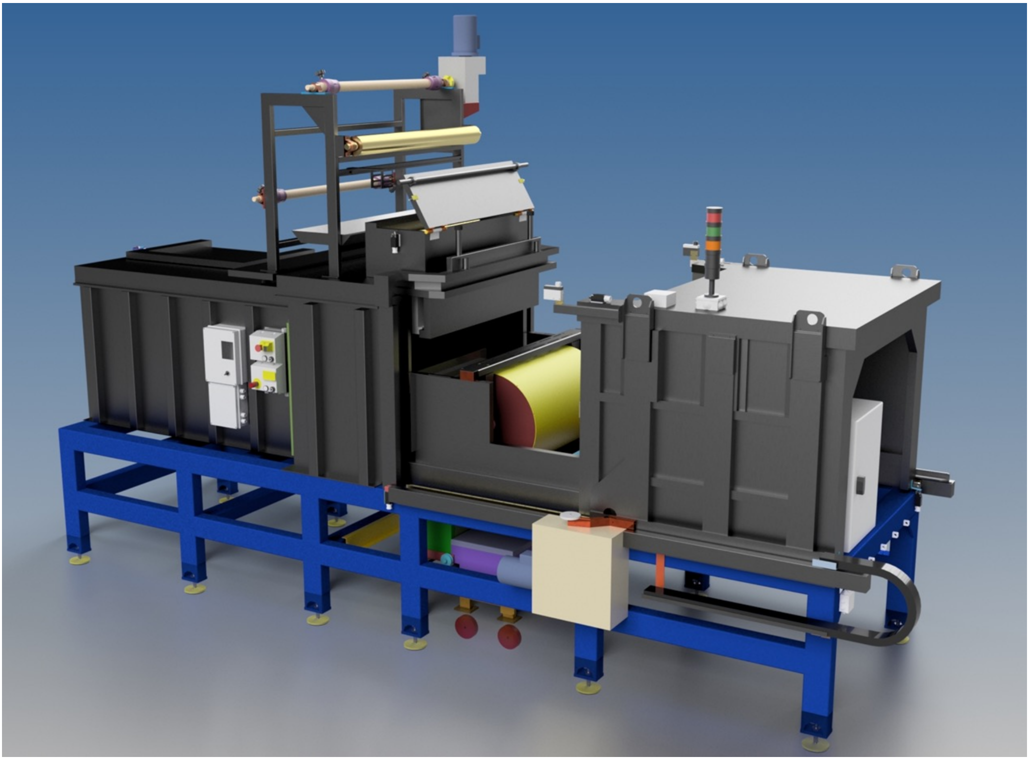
Next Technology Tecnotessile (NTT) was founded in Prato in 1972 as public/private research organisation recognized by the Italian Ministry of University and Research (MUR). The company operates in synergy with European, National and Regional organizations for technological innovation and to improve the competitiveness in sectors like textile, clothing, textile machinery and logistics for over 50 years.

Next Technology Tecnotessile has consolidated a vast network of collaborations with the most important industrial companies, universities, research centres through the assiduous participation in R&D activities and technology transfer projects at national and European level. Furthermore, since 2011 NTT is the managing body of Tuscany Fashion Cluster, supporting the competitiveness of companies of fashion key sectors of the regional manufacturing economy.

The activities of NTT are also validated by its laboratory located in Monsummano Terme and Prato: the CEQ – Centro Eccellenza Qualità. Lab activities offer testing and calibration services for different manufacturing sectors.



Electron beam machine



Electron beam is a low-energy electron accelerator machine. The technology enables the emission of electrons at different energy values to irradiate the surface of different materials: as a results, surface modifications can be achieved, through the conversion of electrical energy into electric current.

APPLICATIONS

The electron irradiation process allows the modification of chemical and physical properties of polymeric materials improving product quality. In our laboratories, the electron beam is used for the following applications:

- Polymerization of monomers for incorporation into textiles
- Vulcanization of adhesive laminates
- Vulcanization of adhesives
- Testing of polymeric materials
- Development of prototypes
- Improvement of composite mechanical strength
- Sterilization

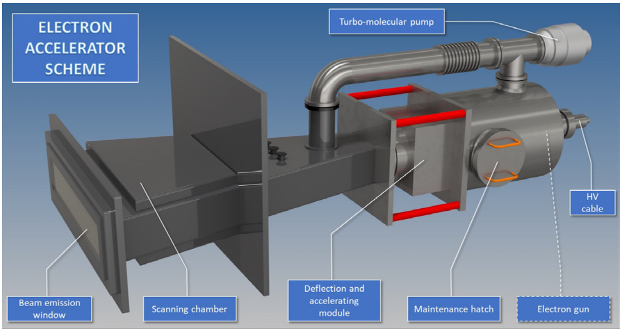
PECULIAR CHARACTERISTICS

Electron beam technology is safe, accurate, easily controlled and in contrast to radioactive sources can be switched on/off.
The electron beam energy and the output power can be modulated over a wide range. Electron accelerator-based technology for modifying the material surface is more environmentally sustainable than chemical methods because it does not require solvents or toxic agents.

TECHNICAL DETAILS

An electron accelerator runs through the emission of a stream of electrons generated by thermionic emission from a cathode. This beam is properly deflected as it occurs inside a cathode ray tube of analogic television. Electrons are subjected to energy in the range of 0.15 to 10 MeV; the emitted radiation, depending on the desired applications, indicatively is registered from a minimum of 10 kGy to a maximum of about 500 kGy. Two typologies of electron beam irradiation mode can be identified: scanning and no scanning.The machine located in NTT represents a single triode system with tungsten cathode and Wehmelt cylinder in high vacuum chamber. The maximum voltage is 300kV with a maximum current of 30 mA. The emitted electron beam is controlled in amplitude and height by an X/Y beam deflection device that provides a useful scan at the 75 x 700 mm output window. The electron beam flows from the vacuum machine to the environment through a 10 μm-thick titanium foil, which allows the high vacuum to be kept in the cathode area, offering no resistance to beam stream. The vacuum system is a dual-pump structure, consisting of a turbomolecular pump and an additional rotational pump that allows vacuum conditions to be rapidly achieved and maintained within both the electron accelerator and the scanning system. High voltage is produced through a series of transformers with an average frequency of about 35 kHz and amplifier. The high voltage section is in a tank containing hermetically sealed oil for transformers.

The system includes a water-cooling unit, which is needed to refrigerate the electron beam exit window, the vacuum system and the transformer. The accelerator is shielded with a composite structure consisting of a 4-millimeter-thick stainless steel sheet (support function), a lead layer (average thickness 35 millimeters), and an additional 2-millimeter-thick stainless steel sheet that prevents contact of lead oxides with the materials in the treatment chamber. The sizing of the shield structure was calculated considering the worst working conditions (V= 300 KV, I= 30 mA). Shielding is needed to screen the X-rays emitted as a result of irradiation.The electron gun is integrated into a protective structure made of stainless steel and lead, equipped with suitable devices for continuous processing of flexible materials.



E-beam machine scheme

Electron beam machine located in Next Technology Tecnotessile

When high-energy electrons irradiate a sample, energy transfer to the chemical bonding electrons of the material starts. The final effect is the generation of free radicals and consequently the increasing chemical reactivity of the treated sample. As a result, chemical-physical processes such as crosslinking, grafting and curing of treated materials are enabled. The presence of free radicals in the polymer chains increases functionalization of different groups, thus it is possible to modify the surface of the polymeric material, consequently improving mechanical and thermal properties.
The beam energy varies depending on the field of application, as well as the typologies of materials to be treated.

DAEDALUS

Semi-automatic machine for the selection and sorting of post-consumer textile materials/garments

Color

White
Yellow
Brown
Red
Blue
Green
Grey
Black
Multicolor

and more

Structure

Warp-Weft
Warp-Knitted
Weft-Knitted
NC

Composition

Wool
Polyester
Polyamide
Cotton
Viscose
Wool Blends
Cotton - Elastane
Polyester - Elastane
Polyamide - Elastane

Others

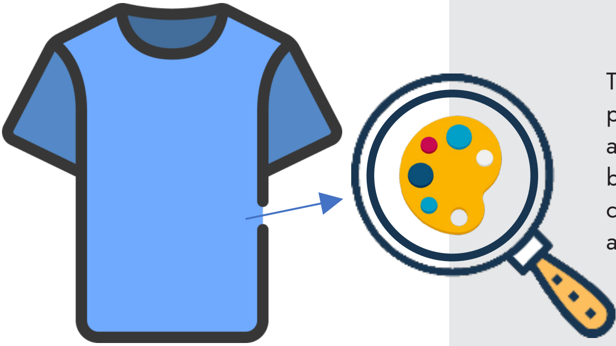
Sorting of textile based on color, fabric structure and fiber compositions

> 60 garments/min

Simultaneous Analysis

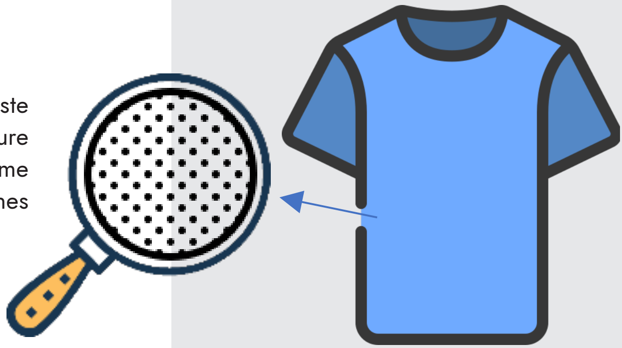
Composition and colors classes have been chosen according to arbitrary criteria and can be tailoring to a customer's needs. A machine training phase is required to acquire set of standard samples. Once the learning algorithm has a sufficient set of data to ensure the required level of reliability, the system is ready to start the selection process.

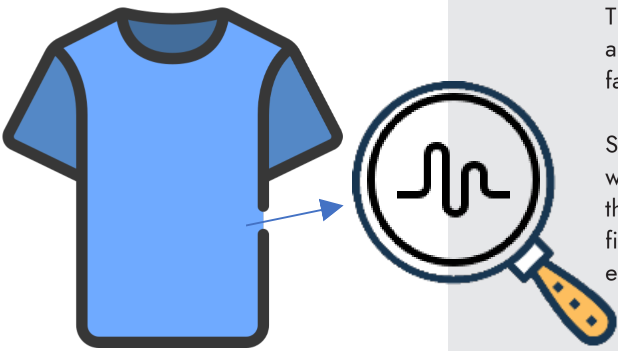
WORKFLOW



The operator checks the presence of accessories such as buttons, zippers, pins, etc. to be removed. A specific camera captures an image of the samples and determine the color

In the meantime, the textile waste is also exposed to the structure sensor, that captures a frame from the samples and determines the structure of the fabric





The textile waste is enlightened and exposed to the sensor for fabric composition identification.

Spectrum acquisition takes place with a hyperspectral camera, that takes ‘snapshots’ of visual field and acquires a spectrum for each pixel in the frame

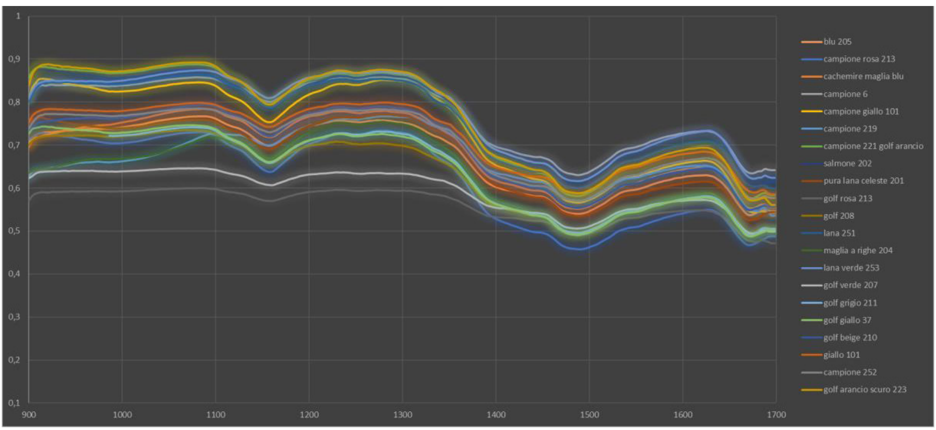
COMPLETE TAILOR MADE SYSTEM

This system is fully customizable in terms of composition and colors to be classified. The system acquires the entirety of the garment (or the fabric clipping) and displays on the monitor the reconstruct image.

The recognition takes place through a comparison between the analyzed textile waste and the set of data acquired during machine learning training phase. This methodology has two important advantages:

The machine can be trained, at any time, to recognize new colors or composition classes.

More the system is enriched with data, more precise and reliable it becomes in its response.

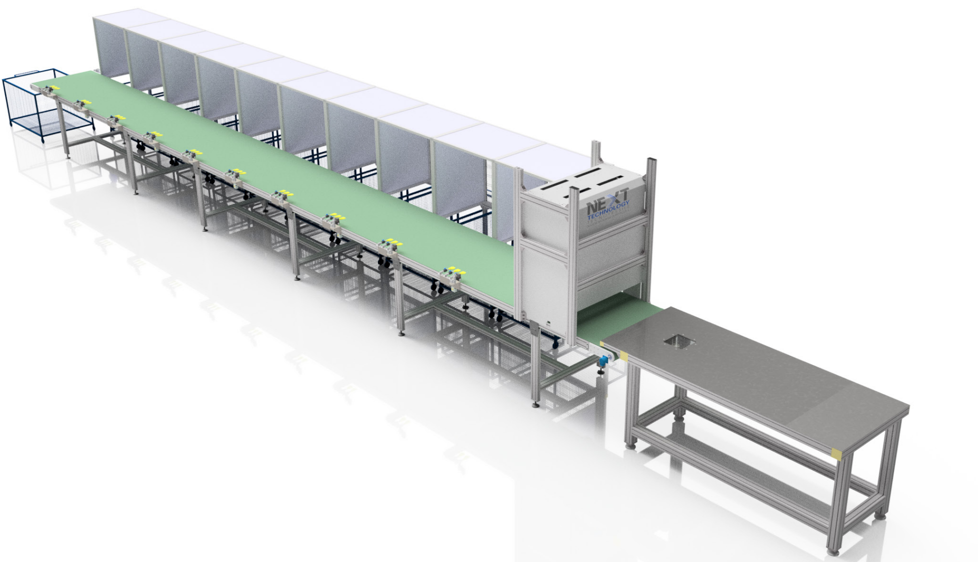


Spectra of tested wool garment.

After the recognition the system can be provided with modular unloading cells, served by a single conveyor belt that conveys the analysed fabrics. The modularity of this part allows to add or remove unloading stations. These variations imply an adjustment of the development of the conveyor belt. The single cell consists of a several shelters, each of which contains a specific class. The fabrics movement from belt to specific basket can be obtained by means of a jet of compressed air.

This system has considerable advantages:

- Rapid intervention
- High-speed conveyor belts
- Relatively simple machine system
- No complex maintenance
- No moving mechanical part
- Can be equipped with a delta robot or a robot arm



Plasma Technology

INTRODUCTION

For many years, research centres around the world have been studying the development of plasma technology at industrial scale, since it has low environmental impact and it is potentially able to give tested material surface a great functionality.

Plasma can functionalize the surface of different materials, regardless of composition and shape, with a well-defined energy range. Therefore, different lines of development of plasma technology according to its final industrial application have been established.

Next Technology Tecnotessile developed plasma technology with the aim of renovating the processes of textile finishing and surface modification.

DESCRIPTION OF TECHNOLOGY

Plasma is considered the fourth state of matter, the most reactive. It is a partially ionized gas composed of a combination of electrons, positively and negatively charged particles, neutral atoms and molecules. All of them are capable of triggering chemical and physical reactions on polymer surface and therefore produce alterations of the properties and morphology both temporarily and permanently. The main interactions that can occur between plasma and polymers are the degradation (or etching) of the external surface of the polymer, grafting of atoms in the plasma, generation of radicals in the polymer chain and polymerization.

Next Technology Tecnotessile has two different machines, one operating at low pressures (cold plasma) and one operating at atmosphere pressure.

Vacuum Plasma

Low-pressure plasmas are a highly mature technology developed for the microelectronics industry.

The low pressure machinery of Next Technology Tecnotessile consists in a vacuum chamber and high vacuum pumps operating between 10^2 e 10^3 mbar.

The gas released into the chamber is then ionized by a high frequency generator.
The main advantage of cold plasma technology is the reproducibility.

Atmospheric pressure plasma

Next Technology Tecnotessile, as research project activity, has studied and created an industrial prototype of an atmospheric pressure plasma machine (Next Plasma), installed in the laboratory in Prato. The atmospheric pressure plasma prototype is capable of continuously treating fabrics or similar materials (such as paper and polymeric films) with a maximum height of 50 mm and a variable speed from 2 to 20 m/min. An AC electronic generator, working between 30 and 100 kHz, controls the ignition discharge. This results in ionized gas and a multitude of discharge arcs forming between the electrodes. Generally, these non-uniform micro-discharges do not have the potential to generate an inhomogeneous treatment.

As the fabric slides between the electrodes, one or more mixed technical gases are blown in, to favor the formation of the plasma cloud and to obtain different functions on the material. The Next Plasma machine consists of a series of cylinders for fabric positioning and feeding and a large diameter cylinder (counter-electrode) on which the high voltage powered electrodes work. The counter-electrode is covered with an insulating material, which forms the dielectric barrier. Each electrode is connected to the process gas distribution network. The use of the electrodes as gas diffusers and injectors allows the generation of a uniform plasma on the side of the electrode facing the tissue. This allows the machine to treat not necessarily both material surfaces.

APPLICATIONS

Plasma technology allows modifying the surface of various typology of materials. Consequently, a wide number of applications are derived. Some examples divided in categories are reported in the following table.

SURFACE CLEANING	SURFACE ACTIVATION	FUNCTIONAL GRAFTING
Easier removal of sizing agents	Better adhesion between materials	Anti-felting/shrinkage of woolen fabrics
		Grafted plasma polymerization for the production of fabrics with oleophobic, hydrophobic or stain resistant machine washable finishes
Removal of surface hairiness in yarn		Silicone coating of airbag fabrics using cross-linked silicone (polyorganosiloxanes)
	Hydrophilic enhancement to improve wettability and dyeing	Prevention of rapid color change in fabrics
Scouring of cotton, viscose, polyester and nylon fabrics		Engagement of anti-flame functionality

ADVANTAGES

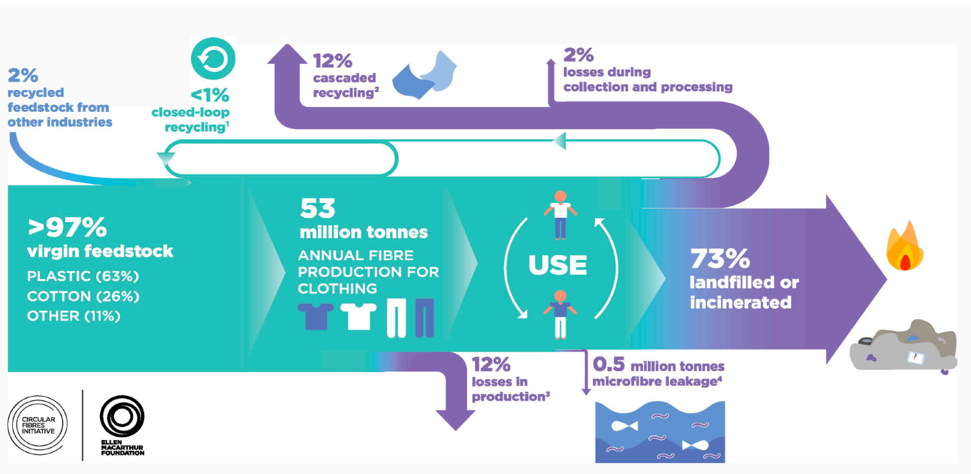
Plasma offers the advantages shown in the following table, compared to conventional chemical processes for finishing and functionalization of textile and polymeric materials.

	PLASMA TECHNOLOGY	TRADITIONAL WET-FINISHING
Treatment type	**No wet chemistry involved. Treatment by excited gas phase**	**Water-based**
Energy exchanged	Electricity – only free electrons heated (<1% of system mass)	Heat – entire system mass temperature raised
Reaction type	Complex and multifunctional; many simultaneous processes	Simpler, well established
Reaction locality	Highly surface specific, no effect on bulk properties	Bulk of the material generally affected
Technological impact	Great potential, field in state of rapid development	Very low; technology static
Energy consumption	Low	High
Water consumption	Negligible	High

Technology for the selective removal of thermoplastic fibers from natural and synthetic mixed fabrics

INTRODUCTION

Nowadays, the world is facing the growing concern for environmental, social, energetic and water sustainability, which is due to the excessive consumption of natural resources and to the increasing emissions of greenhouse gases. Textiles industry is facing up several difficulties, since it generates a remarkable environmental footprint, from natural fibers cultivation to the synthetic fiber and finished fabric production, up to landfill disposal of post-consumer items. More than 15 kg of textiles waste per person is produced every year in the European Union (EU). Textiles waste generation is problematic because landfill and incineration are the main final destinations of these materials, both in EU and out of EU.

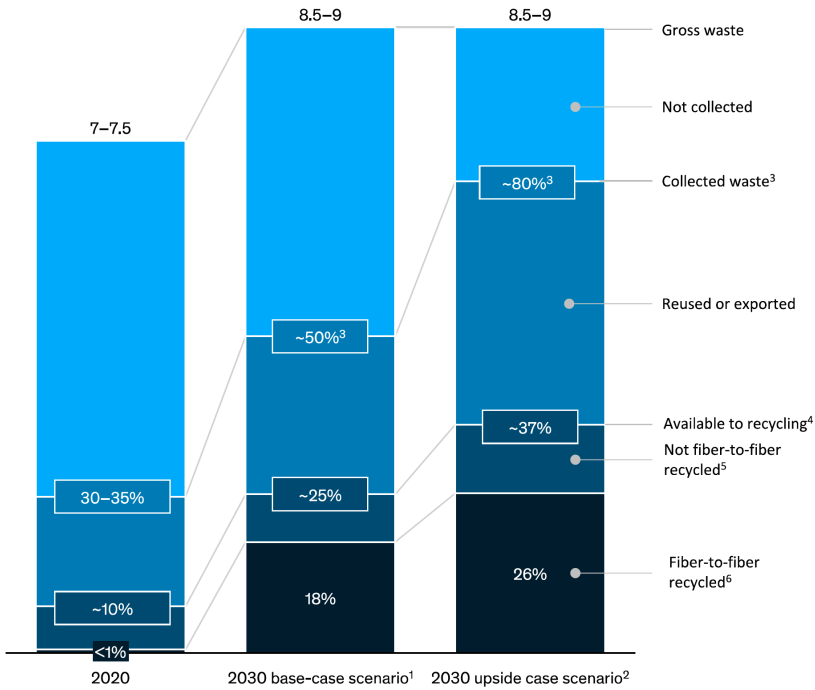


Source: Ellen MacArthur Foundation, A new textiles economy: Redesigning fashion's future, (2017, http://www.ellenmacarthurfoundation.org/publications)

In order to reduce the environmental impact of the textile industry, a transition towards a circular economy is needed, in view of reuse and recycling of textiles waste, aiming to create a sustainable industry, transforming waste in value.

Textile recycling rate worldwide is very low. In EU, only 30-35% of discarded fabrics is collected. The remaining is disposed in landfill or incinerated. One of the most sustainable solutions is fiber-to-fiber recycling, which allows the transformation of textile waste in new fibers, which will be successively used for new garments or other textile products.

Fiber-to-fiber recycling technology responds the need of limiting the environmental impact and GHG emissions related to the production of new garments, facing up the challenge of discarding end-of-life waste. However, nowadays less than 1% of textiles waste is recycled with fiber-to-fiber process. EU intends to rise this percentage up to around 30% by 2030.



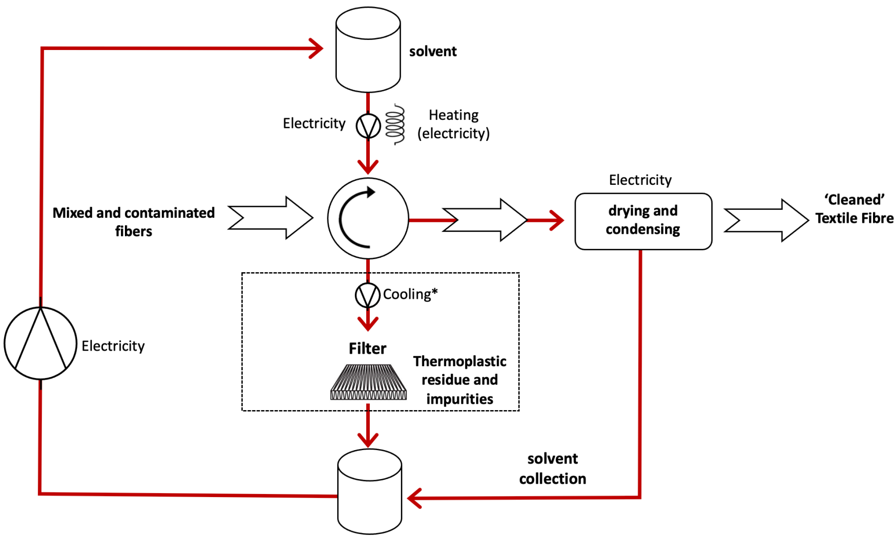
Source: McKinsey & Company (2022). Scaling textile recycling in Europe—turning waste into value

TECHNOLOGY

The fiber-to-fiber recycling process has very stringent application requirements. Mixed fibers and impurities affect and limit the recycling process. Some thermoplastic fibers are considered as contaminants in mixed textiles and represent an obstacle for fiber-to-fiber recycling of fabrics as they make usually the process not applicable.

To respond to the increasing need of textile garment recycling, Next Technology Tecnotessile realized a technology that allows the selective separation of thermoplastic fibers from natural and synthetic mixed fabrics, by thermal treatment with solvent. The process has been tested with an operational capacity of 5 kg of fabric per batch and treatment processes have been developed for different types of fabrics with mixed fibers.

For each type of fabric, the developed technology allows the selective removal of more than 96% of thermoplastic fibers from mixed textiles, obtaining a product with a high degree of purity, enough to be recycled and reused. Moreover, this technology allows the recovery of the extracted fibers, which have properties suitable for being introduced into the recycling chain.



Scheme of the plant

NEXT OBJECTIVES

The research and development group of Next Technology Tecnotessile is working on the optimization of the technology, in order to make it suitable for industrial scale-up.

The research aimed at improving the following aspects:

- Selective thermoplastic fibers removal efficiency in other types of mixed fiber fabrics
- Efficiency of recovery and purification of the solvent and the extracted elastomer
- Energy efficiency of the process
- Validation of the physical and chemical properties of recovered materials

Life Cycle Assessment

INTRODUCTION

Life Cycle Thinking is a way of thinking about the economic, environmental, and social impacts of a product or process throughout its lifecycle.

Within this framework, there are three main methodologies for assessing sustainability as a whole:

1) Life Cycle Assessment (LCA): is a standardized methodology that evaluates the environmental impact of products or processes throughout their life cycle. The study is based on a comprehensive assessment of the materials, energy consumption, and emissions to the environment (water, air, soil, waste) generated by all the processes involved in the "life" of the product or service being assessed, from the extraction of the natural resources needed to produce it to the treatment of waste end-of-life.

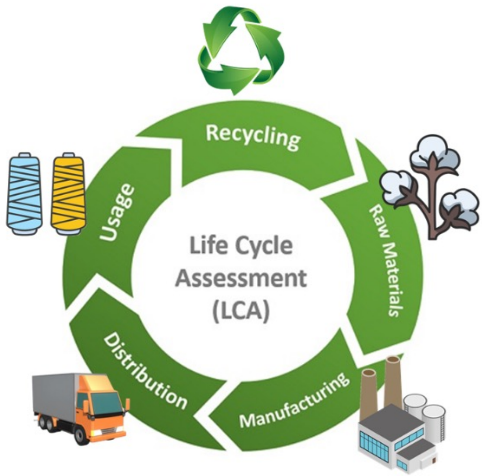
   The Carbon Footprint (CF), which measures the greenhouse gases generated by the consumption of energy and materials during the life cycle of a product or service, is one of the impact categories evaluated in the LCA.
   The results of the CF assessment are expressed in units of weight (kg or tons) of carbon dioxide equivalent (CO_2eq).

2) Social Life Cycle Assessment (S-LCA): is a technique for assessing social impacts (and potential impacts) by evaluating the social and socio-economic aspects of products and their positive and negative impacts throughout their entire life cycle, including raw material extraction and processing, production, use, reuse, maintenance, recycling and waste disposal.

3) Life Cycle Costing (LCC): it takes into account the life cycle costs of a product incurred by the actors involved, including externalities. This analysis complements the LCA, considering the costs of product development, materials, energy, machinery, labour, waste management, emission control, transport, maintenance and repair, etc.

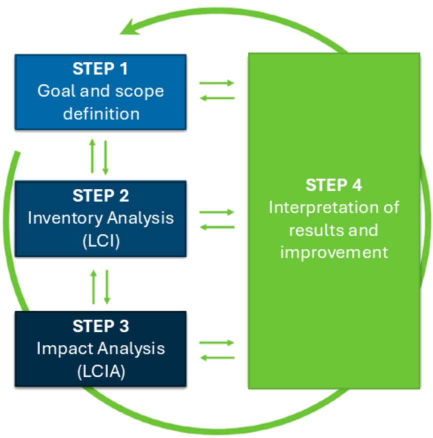
THE METHODOLOGY

The main purpose of LCA is to guide a wide range of actions aimed at improving the sustainability of products and processes, as it helps to understand the environmental impacts generated. Once the "system boundaries" (i.e. the field of analysis) have been defined, an LCA study makes it possible to measure the environmental impacts generated by the various production processes, to identify those with the greatest impact and thus to understand the environmental performance of each production cycle. The aim is to manage the calculated impacts by implementing measures to reduce and offset them. The use of LCA techniques also makes it possible to select production methods and materials with a lower environmental impact. LCA techniques are also the basis for eco-design, the development of products and production processes for greater eco-efficiency.



The relevance of LCA techniques lies mainly in their innovative approach, which consists in being able to evaluate all phases of a production process "from the cradle to the grave". Among the tools created for the analysis of industrial systems, the LCA has therefore assumed an important role in recent years, growing strongly as national and international technique.
The LCA is internationally standardized by the ISO 14040 and 14044.
The structure of a Life Cycle Assessment study is based on the following main phases:

1) Goal and scope definition
2) Inventory Analysis (LCI)
3) Impact Analysis (LCIA)
4) Interpretation of results and improvement



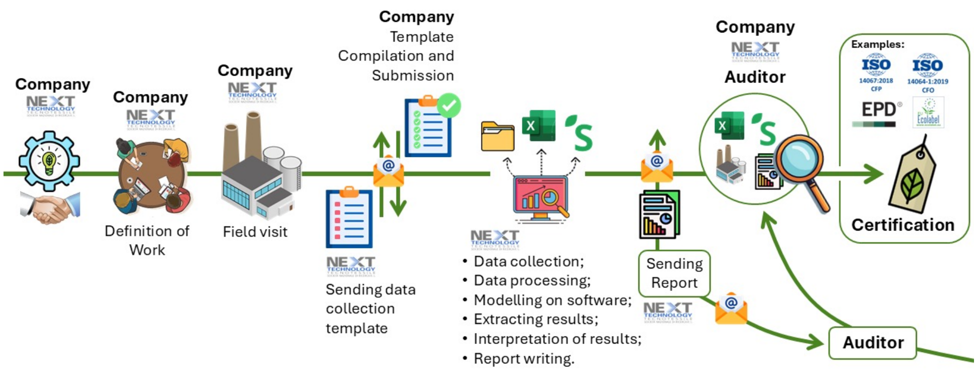
PURPOSE

- To Improve the green reputation of the company
- To Promote an environmental marketing activity of the product
- Monitor and take corrective action to reduce the environmental impact of its products and processes over time: a strategic planning tool for the company
- Communicate the company's environmental policy to the market with an internationally recognised technical tool
- It is a fundamental support for the development of Environmental Labeling schemes, such as:
  - Environmental labels Type I (like EU Ecolabel) - ISO 14024
  - Environmental self-declarations Type II - ISO 14021
  - Environmental Product Declarations (EPD) Type III - ISO 14025

THE SERVICE

The professional support of NTT's specialists enables LCA studies to be carried out that are focused on the specific results that the client wishes to achieve.
The first phase of our support projects is aimed at defining the context and objectives in order to focus the activities and related commitments to achieve the result. Once the scope and purpose of the LCA study have been defined, our specialists work in close synergy with the client to obtain the data and carry out an accurate reporting of the product/process. The result is a detailed document (LCA study report) capable of highlighting both the advantages and limitations of the process being evaluated. This allows the customer to have a clear vision of potential developments in terms of environmental and economic improvement.

Process for Environmental Certification



If the customer is interested in obtaining a specific environmental certification, NTT's specialists provide technical advice; furthermore, NTT provides advice and relationship management with companies that provide inspection, verification, analysis and certification services (external audit for obtaining environmental certification).
Here are some of the main certifications:

- Carbon Footprint of Organization (CFO) - ISO 14064-1
- Carbon Footprint of Product (CFP) - ISO 14067
- Life Cycle Assessment (LCA) verified - ISO/TS 14071
- Environmental Product Declaration (EPD) - ISO 14025
- Measuring and Evaluating Corporate Circularity - UNI/TS 11820
- EU Ecolabel - ISO 14024

In addition, NTT provides technical support for:

- Drafting of Sustainability Reports according to ESG (Environmental, Social and Governance) principles
- Digital Product Passport (DPP) according to the Ecodesign Regulation for Sustainable Products (ESPR)

Measurement of Circularity

THE METHODOLOGY

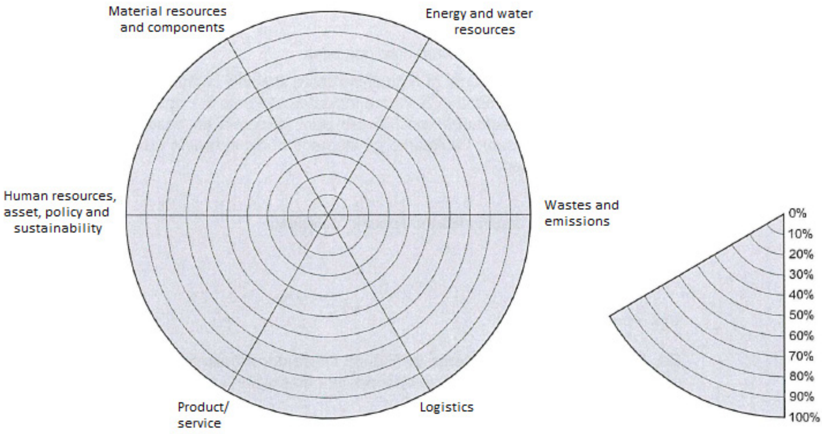
The circular economy is an economic model playing a key role for the implementation of ecological transition and the objectives of the National Recovery and Resilience Plan.

An important step in the pathway towards a circular economy has come with the publication of the technical specification UNI/TS 11820 "Measuring circularity - Methods and indicators for measuring circular processes in organizations". The methodology was developed based on UNI 057 Technical Commission, dealing with the development of standards on the circular economy in which the Ministry of the Environment and Energy Security also actively participated. The manufacturing companies must be able to certify the circularity of the products placed on the market, defining the overall sustainability, to allow the consumer to make an informed choice.

The UNI/TS 11820 technical specification will lead to the development of the ISO 59020 standard, which will provide an effective tool for circularity evaluation at an international level for companies and other organizations, contributing to the achievement of the objectives of the UN 2030 Agenda, in line with the ESG rating (Environmental, Social and Governance).

The UNI/TS 11820 technical specification defines a set of circular economy indicators suitable to measure, by mean of 100-based measurement system, the level of circularity of an organization or group of organizations, including Public Administrations. The requirements contained in the specification are applicable to all organizations, regardless of type or size, supplied products or provided services.
In detail, UNI/TS 11820 defines how to collect information useful for circularity measurement and provides a set of useful indicators (71 in total) to verify the effectiveness of organization own strategies.

The indicators are applicable at the MICRO level (single organization, local authority) and MESO level (group of organizations, inter-organizations, industrial or territorial clusters, industrial areas and districts, production and material supply chains, territories, regions, metropolitan areas, provinces). They are divided into 6 categories: material resources and components, energy and water resources, waste and emissions, logistics, product and service, human resources, assets, policies and sustainability.



a) Radar graph for the representation of circularity levels of indicator categories

b) Scale of the percentage values of the graph in figure a)

Example of radar chart representing results obtained from circularity measurement of a productive organization, as output to the calculations of its levels of circularity on the 6 categories of indicators.

THE SERVICE

NTT specialists, members of the UNI 057 "Circular Economy" technical committee, enable the measurement of circularity in accordance with UNI/TS 11820.

Organizations that decide to evaluate their circularity can obtain several benefits, including:

- Immediate reception of the numerical and graphic representation of the level of circularity
- Dissemination on the market of circularity result in a credible and reliable way
- Pursuit of concrete actions and achievement of measurable results
- Support for the development of the strategic circular economy model
- Improved positioning of the organization or group of organizations on the market
- Obtaining guarantees of credibility on the activity carried out thanks to independent third-party verifications

Once the level of circularity has been calculated, the organization can assess the conformity of the achieved level with respect to the provisions of the technical specification, by carrying out the following activities:

- Self-assessment by the organization itself
- Evaluation by the customer of the organization interested in this level of circularity
- Assessment by an independent body, accredited in accordance with UNI CEI EN ISO/IEC 17029 and UNI EN ISO 14065, as it is the verification of an assertion of circularity

The verification declaration is valid for a maximum of one year from the date of issue of the declaration itself.

CLIMA:
Sustainable Machinery Certification

INTRODUCTION

New regulations and new environmental legislation have accelerated the change in the entire textile supply chain, which is now more than ever sensitive and attentive to sustainability.

Italian textile machinery manufacturers, involved in the various textile manufacturing segments play a major role in this change.

They provide technology solutions capable of:

- Reducing or eliminating the emission or the use of dangerous substances in production processes
- Ensuring greater water saving and improved energy efficiency in production processes
- Enabling post-consumer material recycling

In this context, the Italian seal "CLIMA – Committed to Low Impact Machinery" was issued as a green certification signed by ACIMIT, the association of Italian textile machinery manufacturers.

Since no internationally recognized standards exist for classifying the energy and environmental performance of textile machinery, ACIMIT is promoting the CLIMA as a tool to identify these performance standards. The parameter chosen to measure the eco-efficiency of the labelled machinery is the quantity of equivalent carbon dioxide emissions produced during operation (Carbon Footprint - CFP).

The CLIMA serves as both a quality guarantee and a tool to showcase excellence and innovation in Italian technology. It is a distinctive brand that enhances the competitiveness of Italian companies, even on a global scale. Recognition of achievements in technological excellence, including sustainability, is one of the key strengths of the Italian textile machinery sector.

THE SERVICE

Next Technology Tecnotessile can help companies to obtain CLIMA certification. Our service consists in assisting in all the steps necessary to measure the energy and environmental performance of the machines, calculated in relation to a production cycle defined by the manufacturer for the labelled machines. Next Technology Tecnotessile also assists in the compilation of the necessary documentation and the input of the data obtained into the ACIMIT tool for CLIMA certification.

- Identification of the machines to be certified and their technical specifications
- Analysis of the design data and definition of the standard reference work cycle
- Measurement of the energy consumption and calculation of the consumption of consumables (e.g. gas, oil, grease, etc.) during the standard work cycle and for scheduled maintenance
- Phonometric measurement of the noise generated by the machinery in operation
- Compilation of the required documentation
- Calculation of the carbon footprint (CFP)

All activities are carried out in collaboration with the technical team of the applicant company.

For more information:

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