

Trash-2-Cash

Design-driven innovation turning textile waste into new materials for high-value products.

trash2cashproject.eu

The project

Trash-2-Cash is a consortium of designers, material scientists, social scientists and industry partners who worked together to make new high-quality materials from waste textiles. This ground-breaking collaboration resulted in six master case 'stories', with new materials and products, using three state-of-the-art technologies:

Cellulose Regeneration

Polyester De-Re-Polymerisation

Polymer Chain Extension Upgrading

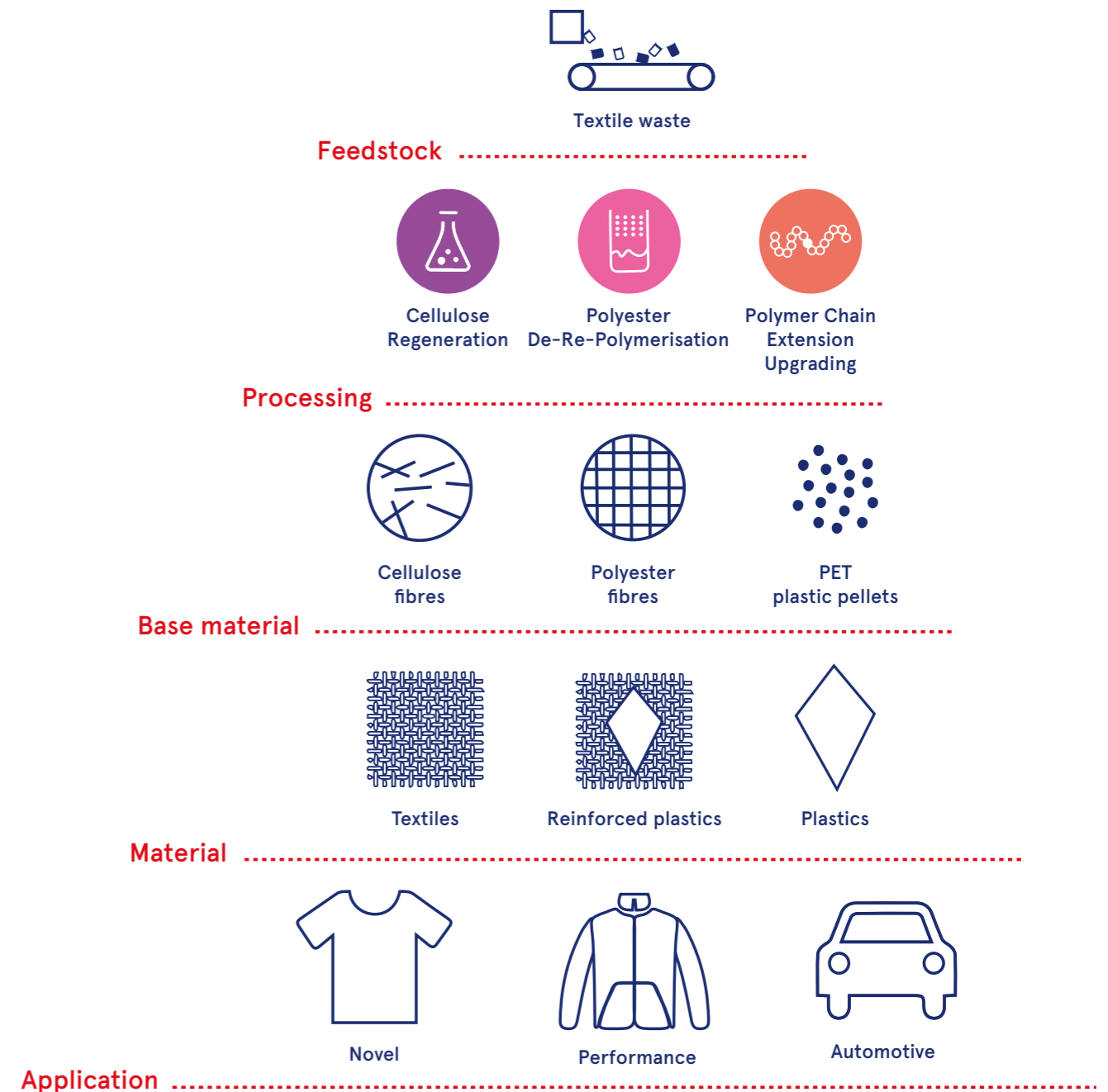
TRASH-2-CASH (FROM WASTE TO VALUE)

One resource that's becoming more abundant is waste. The idea of recycling textile waste has been popular for decades, but current mechanical methods often produce poor quality fabrics suitable only for industrial applications, such as insulation, and the

upcycling of pre-consumer textile waste into products (without reprocessing) is impossible to scale-up. Trash-2-Cash supports a new model where textile waste is regenerated chemically, resulting in new textiles and plastics that are as good as virgin materials but with much lower environmental life cycle impacts.

WORKING TOGETHER

Trash-2-cash was a project driven by collaboration. Based on future design scenarios, designers and scientists decided on the characteristics of the new materials together which ensured they were design- and market- ready from the outset. Experts from across the EU supported manufacturing, life cycle assessment (LCA), consumer behaviour, circular business models, and automated waste-sorting technologies to ensure the materials are circular and fit-for-purpose. This innovative collaboration took place through 12 interdisciplinary workshops over 3.5 years, using new facilitation techniques, design thinking and life cycle tools. The results include a diverse range of material innovations demonstrated through the six master case stories, a new methodology for Design-Driven Material Innovation, and many new partnerships and directions for continuing this exciting work.





Design-Driven Material Innovation

THE CHALLENGE

Making new high-quality materials and products from waste is a complicated process. Scientists understand the technologies needed to make the physical change, but the new materials must be as good as (or better than) those used in existing products. Consumer culture and trends are rapidly changing and new materials need to reflect our evolving tastes but they need to meet the needs of consumers, or they'll just end up being incinerated. Designers think about materials differently to scientists. They think about the experience, how it feels, how it looks and how it can be shaped in its product application. By connecting up inspiring aspects of the world around them, designers can see new ways of doing things and help producers understand what's desirable and meaningful for consumers. Within T-2-C designers worked with scientists and engineers at the beginning of the material development phase to help steer and define the characteristics of new materials and products.



THE INNOVATION

The Trash-2-Cash project was set up to test the notion that scientific material development driven by design decision-making could produce new materials that are market-ready and desirable. If that wasn't challenging enough, the new materials and products also need to be circular (recyclable as well as recycled) and have a low impact on the environment. So, the collaboration isn't just designers and scientists, but also includes experts in manufacturing, life cycle assessment (LCA), consumer behaviour, circular business models, and automated waste-sorting technologies. Over the 3.5 years the project partners have spent together, they have learned how to talk each other's language. Not only the Swedish, Finnish, French, Spanish, Italian or English dialects, but also the languages of their working worlds. From fibre scientist to fabric manufacturer to academic textile design researcher; from industrial designer to life cycle scientist; new methods for understanding each other, sharing knowledge and working together have been developed. Trash-2-Cash is committed to sharing this new way of working. The tools and methods will be available at eutrash2cash.com at the end of November 2018 when the White Paper is published. Hear more from the collaborators on the Trash-2-Cash podcast on iTunes.





3 MATERIAL STREAMS

Cellulose Regeneration

Polyester De-Re-Polymerisation

Polymer Chain Extension Upgrading



Cellulose

Cellulose Regeneration

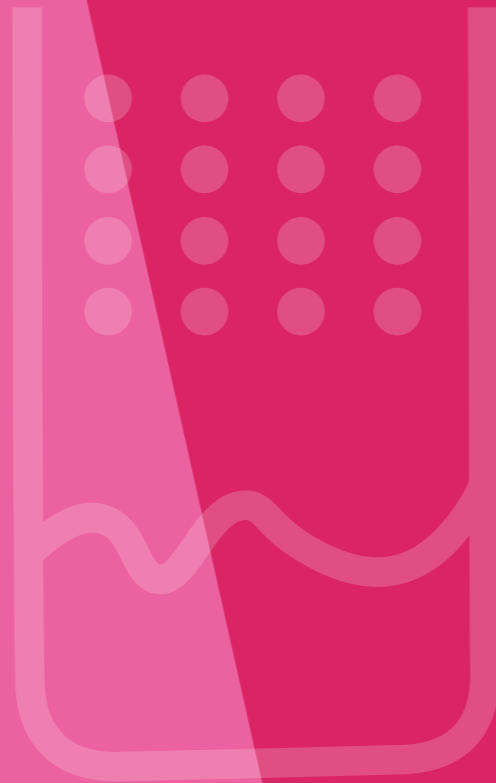
Cotton is a very popular fibre, loved for its cool, crisp feel. It's used in your jeans, t-shirts, shirts, pyjamas, bedsheets... But as the population and standards of living increase, the demand for cotton cannot be met. Growing cotton requires a lot of land, water and energy, as well as harmful pesticides.

But we also have a huge amount of cotton-rich textile waste, a resource that is going to incineration because we don't currently have the technologies to recover the material so that it can be made again into high-quality yarns, textiles and clothes.

Ioncell-F technology can change this, by converting cotton-rich textile waste into new cellulosic fibres that can be used in jeans, t-shirts, shirts... Actually all of the things cotton is used for.

After a specific pre-treatment and refinement process, a low-impact ionic liquid dissolves the cotton fibres, removing other materials such as polyester, which can then also be recycled separately and used again to make new fibres. It is a sustainable closed-system, which means that almost all chemicals are recovered. An environmentally-friendly process which allows us to use waste cotton as a raw material and save the valuable resources that would have gone into the production of virgin cotton.

Polyester



Polyester De-Re-Polymerisation

Polyester is one of the most common fibre types, used on its own to make silk-like blouses and dresses, or in combination with cotton and other natural fibres to help make clothes easier to care for and last longer.

Polyester, in theory, should be easy to recycle. But when it's in your old trousers, with sweat, dirt, dyes and other unknown substances polyester becomes very difficult to make back into high-quality fibres for new clothes.

This means that tonnes of polyester-rich clothes are sent to landfill each year- a waste of valuable resources which could be recovered and substituted for virgin polyester.

What if we could turn mixed, dirty, post-consumer waste polyester textiles back into new fibres, with exactly the same properties as virgin polyester?

In Trash-2-Cash scientists have found a way of 'de-polymerising' waste polyester textiles - basically completely deconstructing the material back into its basic elements at a molecular level. This low-temperature technology means that the valuable polyester molecules can be taken away from all the other unwanted substances and built back up - 're-polymerised' - into new, virgin-like polyester fibre.

Polymer



Polymer Chain Extension Upgrading

PET (polyethylene terephthalate) is the plastic used to make water bottles. You've probably also heard that these bottles can be recycled into polyester polar fleece for jackets and blankets. But the process is hardly ever reversed, meaning that tonnes of polyester clothes go to landfill because there is no way of turning those fibres back into high-quality materials.

What if we could turn polyester textiles back into high quality PET plastic? We could then recover the resources and replace some virgin plastics – a win-win for us and the environment.

This is exactly what our scientists have been working on in Trash-2-Cash. They have used a 'melt-mixing' process using chain extension agents to convert the mixed polyester waste into recycled PET plastic pellets that can then be used in injection moulding to make new plastic parts, for example for use in cars.

The new technology results in a material with a higher molecular weight than conventional plastic recycling processes, which means that it is higher quality and can be used in many different applications including the decorative areas of the car, rather than hiding beneath virgin plastics.



6 MASTER CASES

O°Shirt

R³ Coat

ReAct Base-layer

Denim NATure Jeans

Fashion Fascia

Reborn - Reworn Jacket



0° Shirt

THE CHALLENGE

Cotton is a popular choice for menswear, but increased demand has resulted in huge environmental impacts in its production. The Trash-2-Cash designers wanted a fabric with a soft luxurious feel that, like cotton, is also cool to touch. Ideally this new material would not only save cotton production by using waste materials instead, but also use fewer processes in its production and create less waste during garment manufacture. Designers wanted it to be valued by its owner and kept for longer, and when it finally is no longer useful it can be recycled. In other words a shirt as close to 0° impact on the planet as possible. Not much to ask!

THE INNOVATION

Trash-2-Cash scientists used a low-impact method to regenerate waste cotton into new loncell-F fibres. Instead of bleaching away the colour (which would have added an environmental impact) the colour was left in, meaning that the blue textiles that went into the process produced pale blue fibres. These were woven by Trash-2-Cash manufacturers into a luxurious soft fabric with a beautiful drape. The Trash-2-Cash designers used zero-waste pattern-cutting techniques to ensure there were no offcuts left after the tailored shirt had been constructed. Additionally, an innovative colouring service then allows the owner to re-colour their shirt over its lifetime, prolonging its life until it is finally recycled.

Our goal was to design a shirt that had as close to a 0° impact on the environment as possible. The result is a shirt made from loncell-F fibres, a material produced from waste cotton textiles. Its pale blue colour comes from the blue cotton feedstock, meaning no bleaching was needed, further reducing the material's impact.



R³ Coat

THE CHALLENGE

Raincoats are currently made from PVC plastic or synthetic rubber-coated fabrics that cannot be recycled. To address this, the Trash-2-Cash designers wanted a high-performance textile for children's rainwear which could take a bold print design. It needed to be recycled and recyclable, rainproof and also breathable.

THE INNOVATION

Using the 'de-polymerisation – re-polymerisation' technology, the Trash-2-Cash scientists have been able to produce recycled polyester fibres from blended polyester-cotton and pure polyester waste textiles. From these fibres, a high-performing and printable textile was manufactured. To make it waterproof, the Trash-2-Cash scientists adapted a self-healing material usually used to make sealants for the aerospace industry. The result is a flexible, resin-coated fabric that's waterproof and recyclable – a surprising innovation! Breathability was achieved by laser-cutting tiny air holes into the fabric.

The R³ Coat is made from recycled materials, is recyclable and breathable. To make sure the materials get back to where they need to be for recycling at end of life, an innovative business model has been developed based on renting, not owning these raincoats.



ReAct Base-layer

THE CHALLENGE

Performance layers are a fairly recent addition to our wardrobes, they cleverly wick away moisture to keep skin dry. Currently, this type of garment tends to be made from virgin polyester using fossil crude oil as a raw material. Cellulosic fibres however, are incredibly soft on the skin and have a natural cooling effect, but they also hold onto moisture rather than wick it away. So the challenge was to make a cool, moisture-wicking, loncell-F fabric from waste cotton, which was also soft, quick-drying and recyclable.

THE INNOVATION

To do this, Trash-2-Cash fibre scientists needed to make the fabric 'hydrophobic', which literally means 'water-fearing'. This could have been achieved using current finishing processes that apply additional chemical treatments to the fabric. However, to develop a low-impact garment, the scientists instead used a breakthrough technology that put the moisture management properties directly into the fibres at a molecular level to produce hydrophobic fibres.

Performance layers are soft and functional, wicking moisture away from the wearer's skin. But unfortunately the materials currently used for mid-layer garments have large environmental impacts. This alternative mid-layer material made from recycled cotton has hydrophobic properties added to the fibre, ensuring sustainability does not compromise performance.



Denim NAture Jeans

THE CHALLENGE

To produce a high-performance fabric, manufacturers often blend comfortable cotton with hardwearing polyester. Poly-cotton is the most common material composition in clothing, used in jeans, shirts, t-shirts and uniforms. To make jeans stretchy elastane is added which, Trash-2-Cash researchers confirmed, cannot be detected by textile sorting technologies and pollutes the fibre regeneration process. For the Denim NAture Jeans, Trash-2-Cash designers wanted a fabric that was not only made from waste textiles but also fully recyclable at the end of its useful life. Yet they didn't want to compromise on comfort or performance. That meant that researchers not only needed to find a way of regenerating the textile waste into new fibres but also find something stretchy to replace elastane.

THE INNOVATION

Trash-2-Cash fibre scientists have found a new, sustainable method for separating polyester and cotton so that they can be used again in new yarns for new clothes. Some of that polyester can also be made into a stretchy alternative to elastane, meaning that the Denim NAture Jeans are made from waste materials but are also recyclable when they are no longer useful. To prolong their useful life these jeans would be sold with a patch repair kit and free end-of-life collection to ensure that the material is recovered and recycled.

Polyester-Cotton blends are the most common materials used in clothing. Elastane, added for the manufacture of stretchy jeans, seriously disrupts textile waste sorting and recycling. Denim NAture Jeans are made from yarn that is both recycled and recyclable. Trash-2-Cash researchers have replaced the troublesome elastane with stretchy, recycled polyester, and used an innovative elastic weave structure, ensuring that the comfort and performance of the garment is maintained.



Fashion Fascia

THE CHALLENGE

Currently, cars are mostly manufactured with virgin materials, including composites (combinations of materials) that can't be recycled. Recycled materials are mostly unattractive and remain hidden. New regulations coming into force will require car manufacturers to use more and more recycled and recyclable materials; this will mean using them in the visible areas of the car where aesthetic standards are higher. The Trash-2-Cash automotive designers turned their attention to the car interior, where recycled materials could be an eye-catching feature. They focused on the central console and door inserts – the decorative areas by the gearshift and door handles. The designers wanted the new materials to add an individual touch and be luxurious, as well as being made from recycled materials and fully recyclable at the end of their useful life.

THE INNOVATION

Trash-2-Cash scientists and designers explored a variety of material innovations using T2C recycled polymers and fibres, laser etching, an innovative recyclable epoxy resin and textile print design. In one example recycled PET pellets from old fleece dressing gowns have been injection moulded to produce a central console panel for a car interior. Customisable laser etching adds to the surface decoration, removing the need for additional treatments. In several other experiments a creative print design approach was used to finish different non-woven recycled polyester textiles and then encapsulate them in the new recyclable resin. This set of experimental samples extends this approach even further, reworking recycled polyester wadding with industry-ready finishes, to add value through design. These innovations have produced a number of distinctly different but beautiful decorative fascia pieces, showing new material directions for cars of the future.

By law, cars of the future will be increasingly required to use recycled and recyclable materials in their production. The Trash-2-Cash recycling technologies allow the proposal of new modes for manufacturing visually appealing, high-quality automotive interior plastics using recycled plastic pellets, recycled textiles and recyclable resin.



Reborn – Reworn Jacket

THE CHALLENGE

Polyester fleece was a breakthrough new material when first produced in the 1980s as an alternative to wool. Since then, it has become a popular and inexpensive choice for children's clothing due to its warm, quick-drying, easy-care properties. It is now known that during washing polyester fleece causes damage to the environment by shedding microscopic plastic particles into the waterways, polluting the oceans and the entire food chain, and causing untold damage to the health of many living creatures, including us. In Trash-2-Cash, the designers asked if fibres fine enough to replicate the soft warmth of polyester fleece could be developed by the fibre scientists. The fabric needed to be made from textile waste and be recyclable at the end of its useful life. Most importantly any fibres that broke away from the fabric during washing would need to biodegrade when released into the natural environment.

THE INNOVATION

Trash-2-Cash fibre scientists were able to modify the loncell-F technology to regenerate cotton waste into new, super-fine fibres that replicate the softness of polyester fleece but without the plastic pollution. The manufacturers knitted and brushed the biodegradable fabric to produce a super-soft natural fleece-like fabric perfect for a baby. The non-bleached, colour-retaining technology also used in the 0° shirt was used again here, making this a super-low-impact alternative to polyester fleece. The Reborn – Reworn fabric is naturally soft and warm next to delicate skin without polluting us and our oceans with micro-plastics, a life-saving jacket for the future of our children.

Polyester fleece was revolutionary in the 80's but is now known to be hugely harmful to the environment due to the shedding of microplastic particles. This natural fleece is made of soft and warm micro-fibres, produced from recycled cotton textiles, that will not accumulate in the environment.



Dutch Design Week

20 - 28TH
OCTOBER 2018

Exhibition and final results seminar



Podcasts

Here at Trash-2-Cash, we love podcasts. We like funny ones, serious ones, and inspiring ones. We like hearing people talk about their passions, and the opportunity to delve deeper than a blog post allows. So, we decided to start podcasting too.

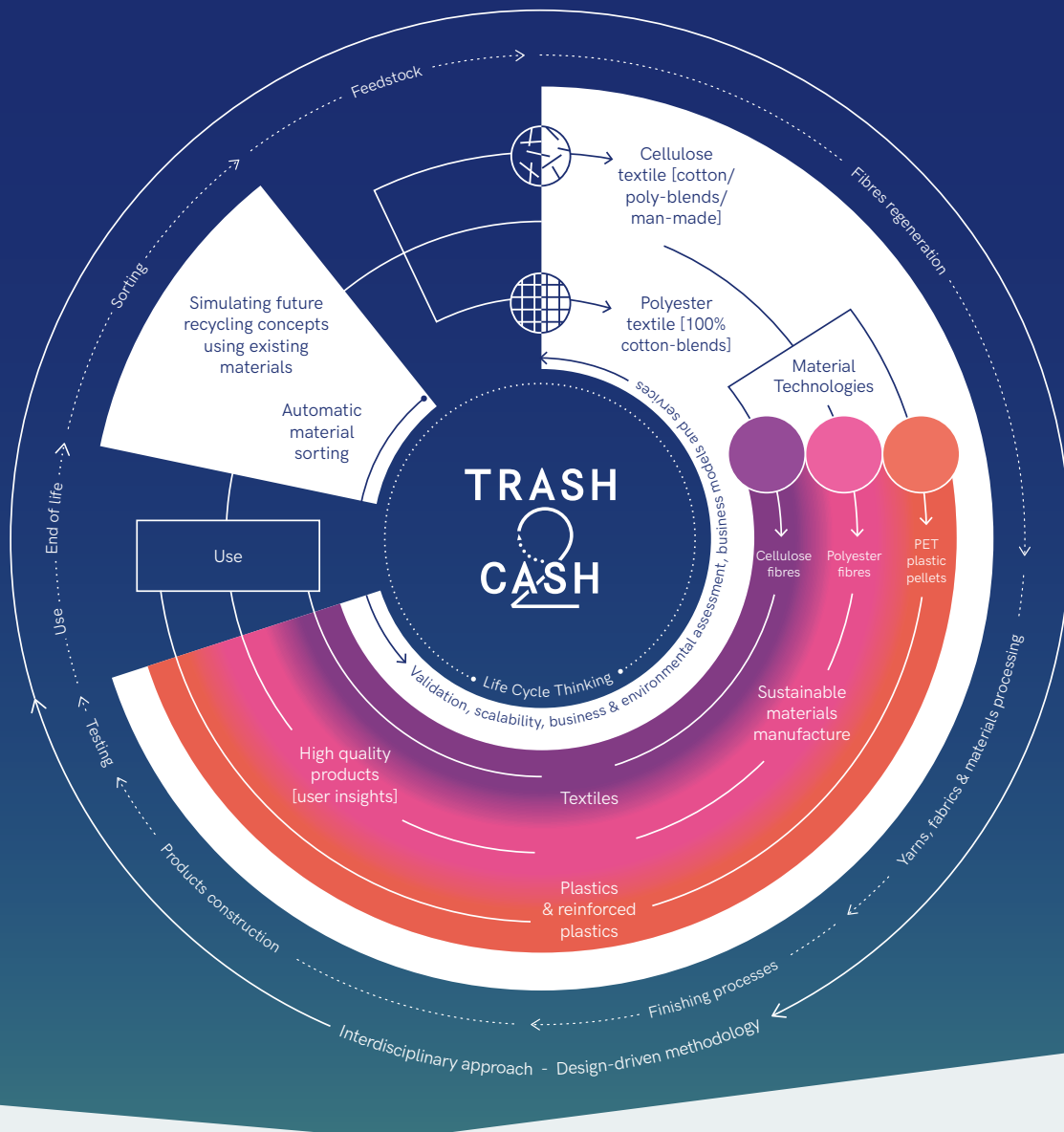
At first our podcast series explored the people, methods and tools involved in the Trash-2-Cash (T2C) project, setting up the 'big picture' of our world. Once we reached the outcomes phase of the project we began to host in-depth discussions about the impact these will have on the world.

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OUR PARTNERS





To find out more visit

trash2cashproject.eu



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