# White paper on:

## "Is there still a future for polymer-based fibres for textile applications post COP26?"
## A testimony from the nonwovens industry.

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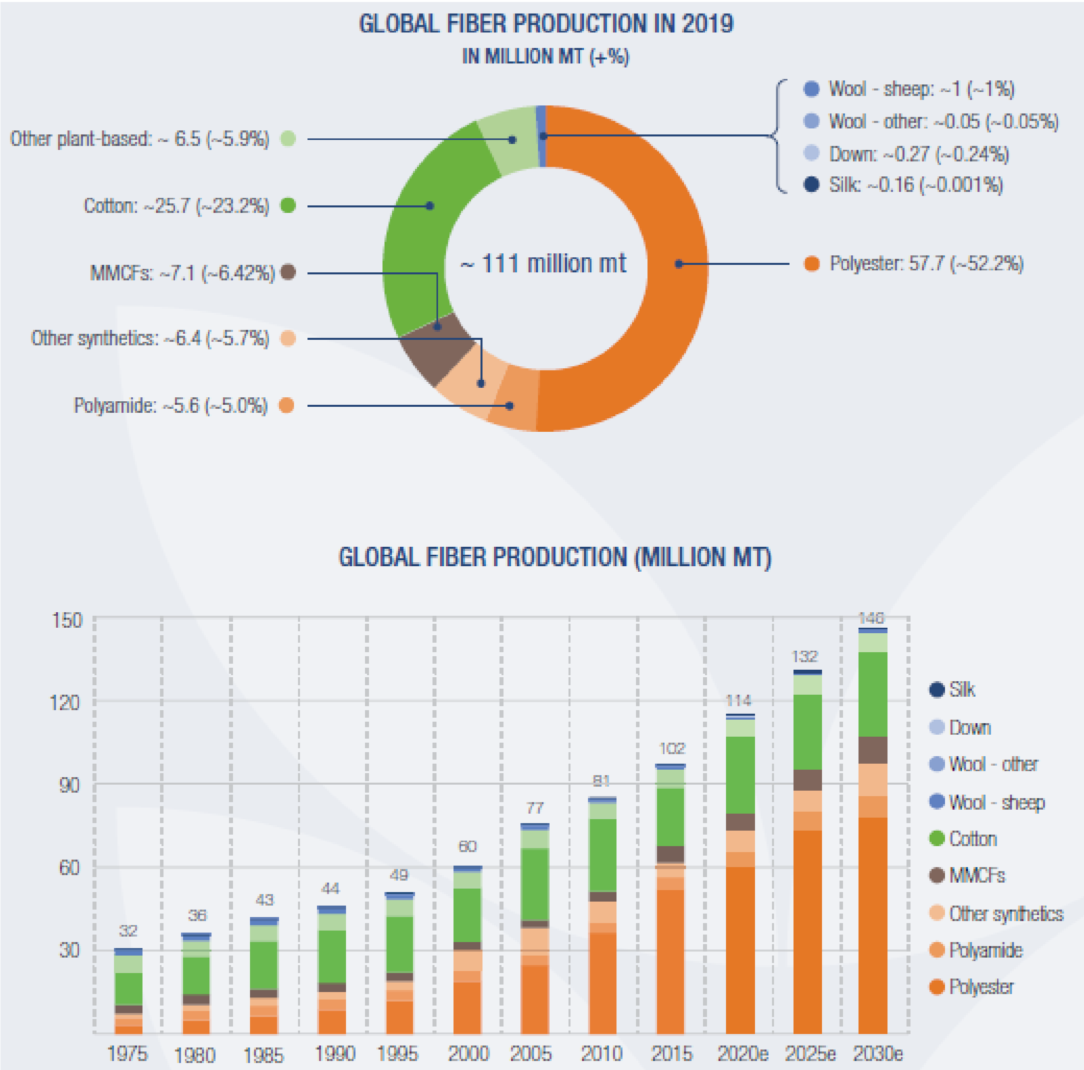
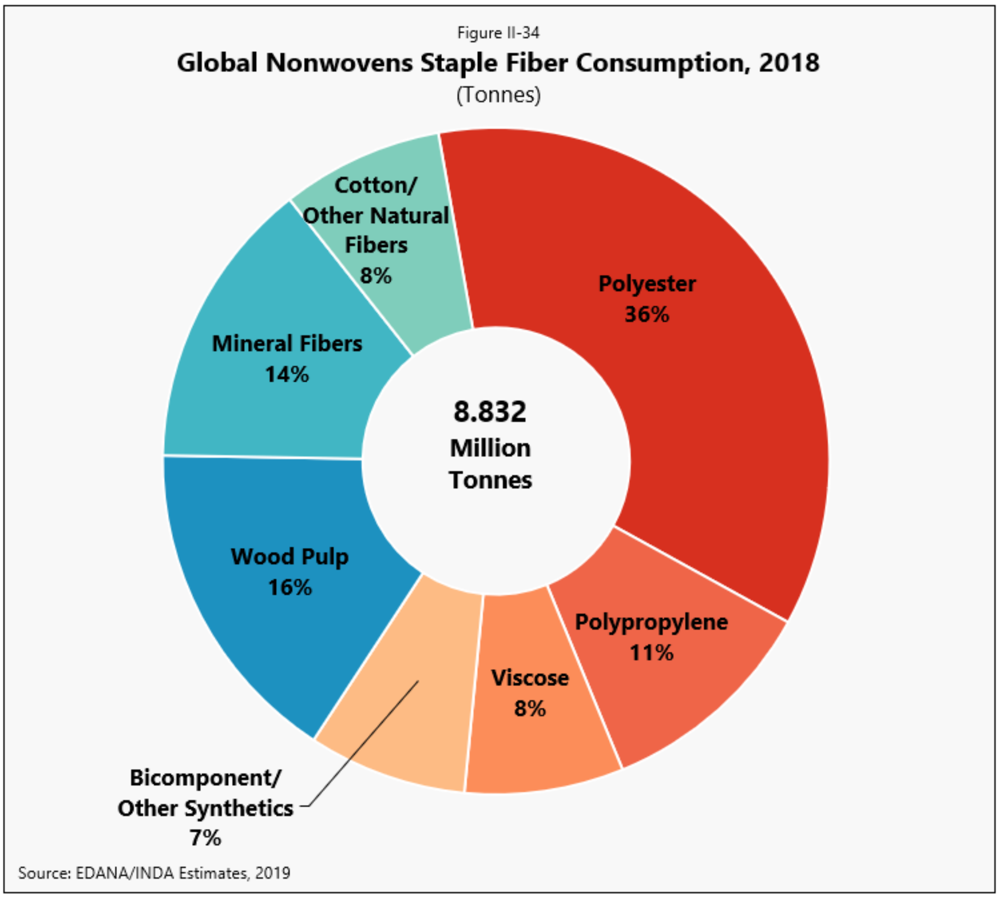
## 2) Polyester fibres are indispensable to cope with the world's future textile needs.

The global textile fibre market is enormous. The latest full market info dating from 2019 confirms the global textile fibre production to have been a staggering 111 million tons business. Of that total vast number, polyester fibres did represent a share of 52,2%, or 57,7 Mio Tons. The next biggest category is then claimed by cotton fibres with a share of 23,2% or 25,7 Mio Tons.




As you can see from the above graph (**Ref 1**), fiber production has more than doubled in the last 20 years and is expected to increase by another 30% by 2030 to 146 Mio Tons if business as usual continues.

Textile fibres are used in traditional textiles and in nonwoven applications. Despite the fact that the nonwovens sector is increasing fast with a total global production of fibre based nonwovens in 2018 of 8,8 Mio Tons (**Ref 2**), of which 36% was polyester based (=3,2 Mio Tons). Expectation is that by 2025 the nonwovens sector will consume about 4.2 Mio Tons of Polyester staple Fibre, with a share of 38% on all fibre types. So, it is clear that the traditional textile polyester fibre end-use remains very predominant, with a production of over 54 Mio Tons in 2019.




It is impossible with the current technological and economical state of affairs to find suitable and more sustainable alternative fibres to substitute these >50 Mio Tons of polyester fibres. A solution to substitute such vast volumes will also not be found within the foreseeable future.
Therefore we have no other choice than to try to cope with the use of polyester, and try to find more sustainable ways of dealing with it.
However, we could definitely try to change our buying behaviour and increase therewith the lifetime of garments significantly for instance. Wearing a piece of clothing for 100 cycles or even much more, instead of getting rid of it after 10 cycles, can contribute enormously to the environment.

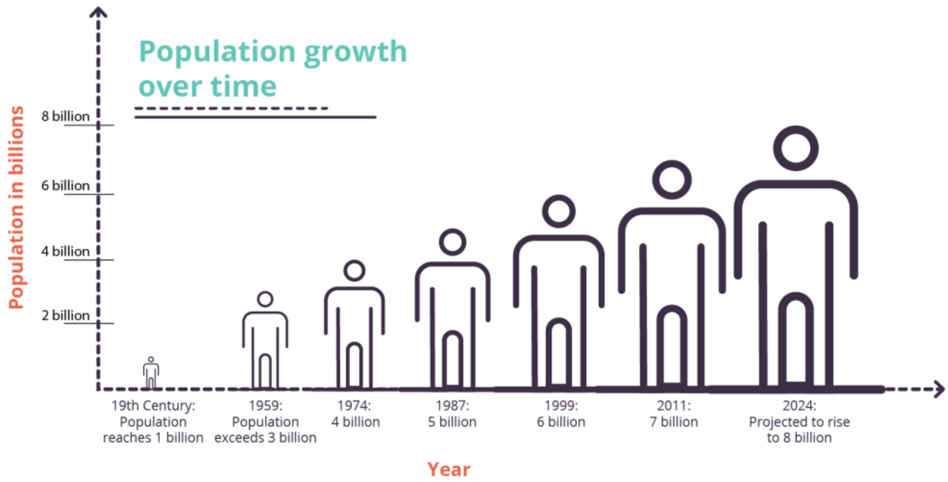
**3) <u>Plastics in general and polyester fibres in particular are not necessarily bad.</u>**

Over the latest years there have been many publications appearing explaining how bad the use of polyester is for the environment and for public health.
Let me list a few of the negative impact remarks:

- Virgin polyester fibre has a high carbon footprint, approximately 4 kgs CO2e/kg of fibre
- Polyester is toxic because it contains Antimony, phtalates, and other hazardous chemicals
- Polyester fibres will not biodegrade. (it can take up to 2500 years before half-life is reached)
- Polyester fibres do produce microplastics when landfilled or finally end up in the ocean
- …

Actually, what I want to do, is focus on all of the positive points of polyester:

- Polyester fibres are a very economic friendly (cheap) alternative, when compared to all of the other manmade and natural fibres. As our world population grows to over 7 billion and no end is in sight for the rise, we need to be able to dress the global population just like we need to nurture them. Unfortunately a big percentage of the global population is poor or relatively poor, therefore they need cheap clothing alternatives, something polyester can offer them. (**Ref 3**)




- Polyester fibres have excellent technical characteristics compared to many alternative synthetic and natural fibres. It is a strong fibre, with high tenacity, with very low shrinkage because of the high melting point, relatively easily dyeable with good colour fastness. Therefore it is possible to manufacture garments with it, or textiles for other applications, that could have a long lifetime.
- Polyester is a fully recyclable product. Post-consumer PET bottles are recycled into Polyester staple fibres and nonwoven products on their turn made from Polyester fibres, can again be fully recycled into new fibres using the correct technology.
- The full environmental impact of synthetic fibres in general and polyester more specifically is actually better than those of natural fibres, and Recycled Polyester Staple Fibre is much better placed than all the other synthetic fibres . With full environmental impact is meant looking at all environmental dimensions of materials sustainability, and not only looking at GWP (Global Warming Potential or Carbon Footprint). One should consider also:
    - Eutrophication or over-fertilisation of water bodies (marine, freshwater and terrestrial)
    - Water-use
    - Hazardous chemistries involved, or ecotoxicity
    - Land-use

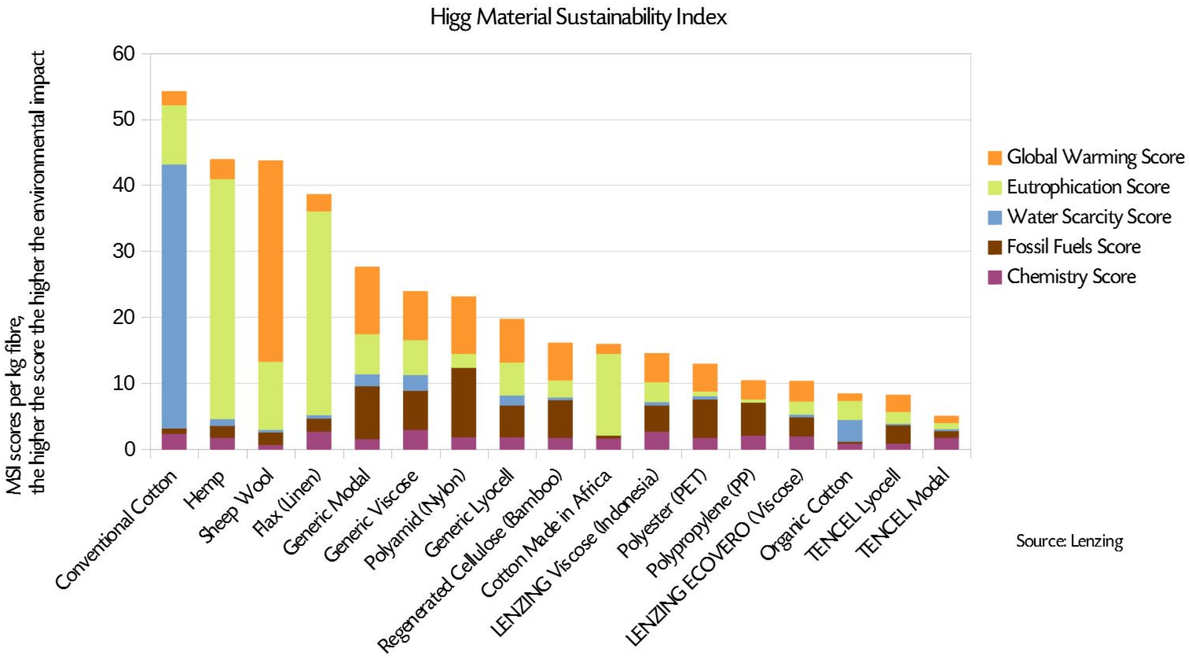
Under point (4) we will discuss more in detail about this.

## 4) Environmental dimensions of Materials Sustainability (Higg MSI)

As said above, GWP (global warming potential) or Carbon Footprint as commonly known, is a too simplistic approach to describe a product's full sustainability impact on the environment.
In order to find a way how to tackle this, the apparel and footwear industry, have developed since a number of years a specific Materials Sustainability Index or MSI that incorporates 5 environmental impact factors. They call this Index the Higg MSI or Higg Materials Sustainability Index.
The 5 factors that Higg MSI is taking into account are:

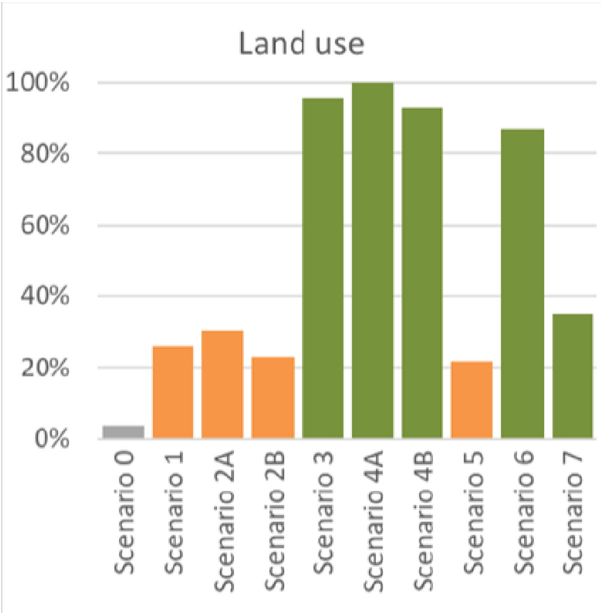
- Global Warming Score
- Eutrophication Score
- Water Scarcity Score
- Fossil Fuels Score
- Chemistry Score

Is this a perfect Index? No, because some factors like Land-Use is not taken into account, but it does give a fairly interesting view on total sustainability already. (**Ref 4**)



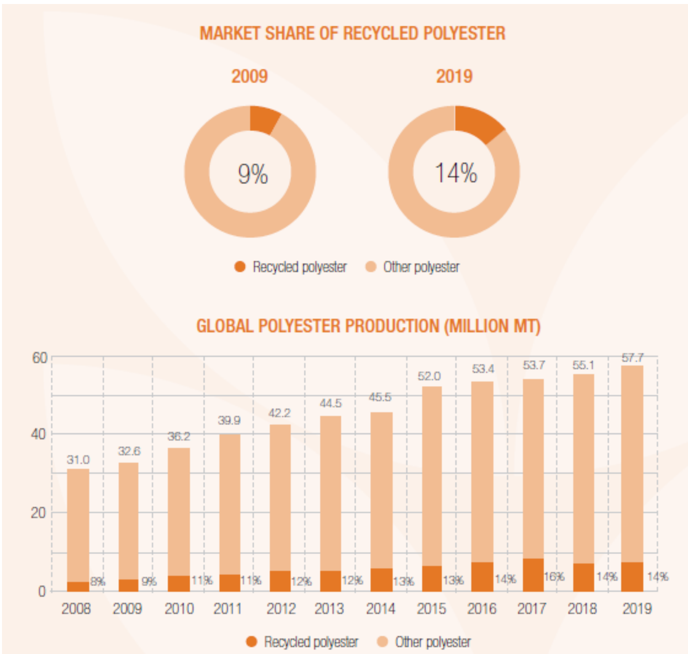

If one then would look at where recycled PET would fit into this graph: the GWP of R-PET (recycled PET) is < 30% of the GWP of V-PSF (virgin Polyester), so it would shift much more to the right on this graph, probably just before organic Cotton.

More specifically on Land-use: also there V-PET is having very low impact, certainly when compared to all natural fibres, and definitely also when compared to bio-PET being produced from sugarcane of corn for instance. (See graph below whereby Scenario 0 stands for V-PET compared with all other scenario's being some form of bio-PET, with Scenario 7 for instance being PLA) (**Ref 5**)




## 5) <u>Share of recycled polyester fibres being produced</u>

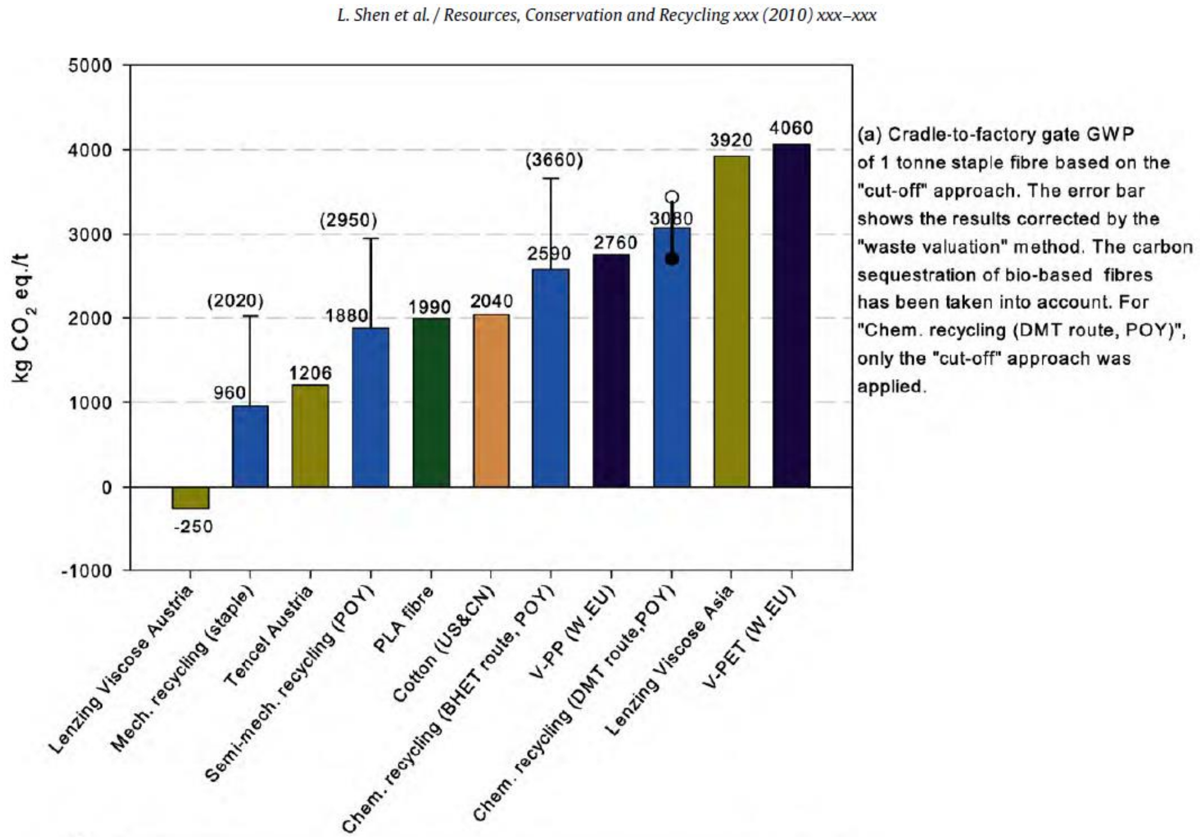
Let us focus a bit more now on the amount of R-PET or recycled polyester fibres that are actually being produced today.
As you can see from the below graph (**Ref 6**), the share of recycled polyester in 2019 was about 14%. With a total production of 57,7 Mio Tons in 2019, this means 8,1 Mio Tons of R-PET being produced each year.
If we make a distinction between filament and staple fibre, the production of staple fibres was 20,2 Mio Tons and filament 37.5 Mio Tons. The recycling rate was much higher with staple fibres than it was with filament. Staple fibres did have a recycling share of around 30%, so 6 Mio Tons and filament did only have a recycling share of barely 6%, so 2,1 Mio Tons.



R-PSF or recycled Polyester Staple Fibre is mainly used in 3 sectors, on one hand the fiberfill sector, which comprises fillings for quilts, pillows, where it is directly blown as such into the finished product. Secondly there is a big use in the nonwoven sector, where the fibres are carded and then bonded together using different bonding techniques into nonwoven textile products for many different end-uses like there are: living and building applications, filtration applications, hygiene applications, automotive applications, …Thirdly the balance is used in the spun-yarn sector.
The estimated R-PSF consumption in both the fiberfill sector and the nonwoven sector is each 900 KTon, so a total of 1,8 Mio Tons, leaving 4,2 Mio Tons of R-PSF being used in the yarn sector.

## 6) <u>Carbon Footprint impact</u>

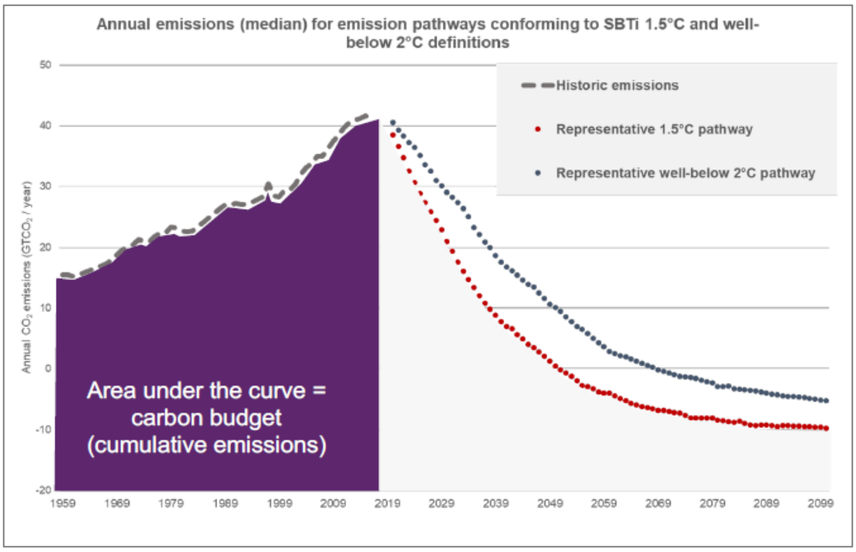
Still one of the most discussed environmental impact factors is the GWP (global Warming Potential) or often referred to as carbon footprint. The GWP does not only cover CO2, but all Greenhouse gases. These include Methane, Nitrous Oxide, Perfluorocarbons, hydrofluorocarbons, and even water vapour.
Some of these GHG's have a much bigger global warming potential relatively seen over a 100 year time period vs others. If CO2 has a factor 1, then Methane (CH4) has a warming potential of factor 25, and nitrous Oxide (N2O) has a warming potential factor of 265…(the fluorocarbon product groups are >10.000)
When LCA's are calculated, all of these GHG's are taken into account, and generally the outcome is then referred to as the Carbon Footprint of a certain product.
Here we will focus of course on the Carbon Footprint of several types of fibres. (see graph)




The Carbon Footprint data in this graph (**Ref 7**) has been calculated according to the Cradle to factory gate principle based on the cut-off approach, as this is the most commonly used method for carbon footprint calculations on fibres.

It is for instance also possible to calculate Cradle to Grave, including the end-of-life phase of the product, where then mainly the system expansion approach is used. We will discuss a bit more about this methodology later in this paper when we will focus on full circular and biodegradable polyester solutions as more sustainable methods for nonwovens going forward.

But how big exactly is the carbon footprint of the entire polyester fibre industry vs the total global GHG emissions?




As one can see, the total Cumulative GHG Emissions in 2019 were around 42 Bn Tons of CO2e (GTons). (**Ref 8**)
If we now know that there are 57,7 Mio Tons of Polyester fibre being produced with 8,1 Mio Tons being R-PET, we can easily calculate what the share of the Polyester industry is:
V-PET fibre has an approximate climate impact of 4,06 kgs CO2e/kg fibre and R-PET fibre is 0,96 kg CO2e/kg fibre.
Simple math arrives at a total environmental impact for the global Polyester Fibre industry of 210 Mio Tons of CO2e, equaling 0,5% of the global overall impact, still an impressive number.

## 7) <u>Paris Agreement and EU Green Deal</u>

It is clear that all of us need to do efforts in order to counter the increase of cumulative emissions into the atmosphere. We need a framework to know which targets should be met. Therefore we need to look at legislation and worldwide agreements first.
Everything starts with the Paris Agreement. What exactly is this?

The Paris Agreement is **a legally binding international treaty on climate change**. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5 degrees Celsius, compared to pre-industrial levels, before the end of the century.

The EU Green Deal is describing the EU pathway towards being compliant with the Paris Agreement. Basically it means: **Become climate neutral by 2050 and reduce GHG emissions with 55% by 2030.**
https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf

## 8) SBTi ambitions and standards

Now that we have a framework agreement we need to work towards, we also need to find a good methodology that will guide us to establish the right pathway for our industry. This is what SBTi is founded for.
What and who is SBTi exactly?

**https://sciencebasedtargets.org/companies-taking-action#table**

- Founded in 2015 after Paris Agreement
- Partnership between
  - CDP (non-profit organization with HQ in Berlin)
  - WRI (World Resources Institute)
  - WWF (World Wildlife Fund)
  - UNGC (United Nations Global Compact)
- Over 2000 companies subscribed to it already

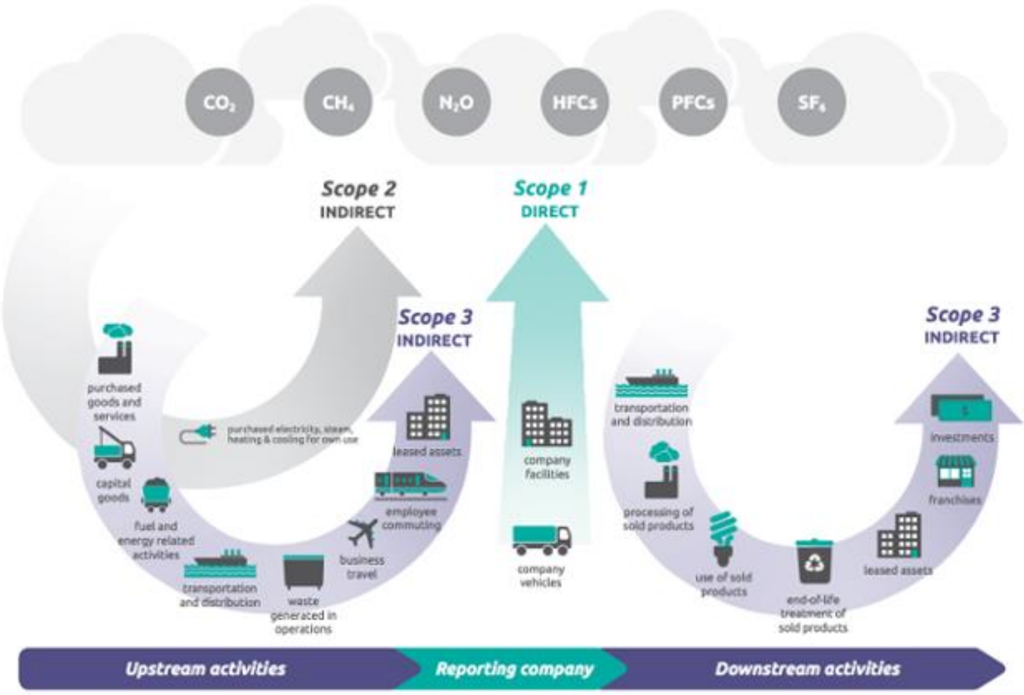
What SBTi basically does, is providing companies with tools (and auditing them), how to calculate their pathway towards net zero.
They have for the moment still three different standards which one can enroll into:

- SBTi Version 4.2 which is still active until 14th of July 2022
- SBTi Version 5 which will become mandatory from 15th of July 2022
- Net Zero Standard which not only describes short to medium term pathways, but also the long term pathway towards 2050.

They use 3 different Target ambitions and apply them to the different scopes for carbon footprint calculations:

- 2°C Target Ambition, which means reducing your carbon impact YoY with 1.23% (LARR or Linear Annual Rate of Reduction)
- WB2C Target Ambition, which means a LARR of 2.5%
- 1.5°C Target Ambition, which means an LARR of 4.2%

A reminder of what exactly mean the different Emission scopes in carbon footprint calculations: hereby we refer to the GHG Protocol. https://ghgprotocol.org/ (**Ref 9**)




Differences between the SBTi Standard Version 4.2 and the version 5 is basically that they use different Target Ambition settings for the different Emission Scopes. (**Ref 10**)

## SBTi CRITERIA V4.2 (CURRENT) vs V5 (NEW 1.5°C STRATEGY)

OVERVIEW OF CHANGES TO NEAR-TERM SBTs

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

| WHAT? | SBTi V4.2<br>Valid until 14 July 2022 | SBTi V5<br>From 15 July 2022 |
|---|---|---|
| **AMBITION** | **Scope 1 & 2:** Min. well-below 2°C<br>**Scope 3:** 2°C | **Scope 1 & 2:** Min. 1.5°C<br>**Scope 3:** Well-below 2°C |
| **TIMEFRAME** | 5-15 years | 5-10 years |
| **BOUNDARY** | **Scope 1 & 2:** 95%<br>**Scope 3:** 2/3 | |

Note: the SBTi encourages companies to align with the highest level of ambition as quickly as possible

The recently launched new Zero Standard from SBTi applies for short term (up to 10 years) to the SBTi V5 targets, and for long term goal setting, they apply the Target Ambition of 1.5°C also for Scope 3 Emissions.

## 9) The life cycle perspective

As it seems unavoidable that we all will need to try to live with polyester fibres used in garments and other textile products for the foreseeable future, we will anyway have to try to reduce the environmental impact of synthetic fibres in order to coop with the goals set at the Paris Agreement.

One of the possible huge impact factors we have to look at is the life cycle perspective of a textile product, for instance a garment.

As our global population is growing very fast and therefore our needs for textiles and especially garments is very large, we need to try to extend the lifetime of such garments, as this will reduce very significantly the environmental impact.

One important aspect in this is developing the garments using fibres with the highest mechanical strength for the supposed use. We have already seen that in many instances polyester outperforms other synthetic fibres and definitely natural fibres. By doing so, this will automatically lengthen the lifespan of a textile product.

But another very important factor to look at, is our spend behaviour. We are living in a consumption society with often an unstoppable urge for new things.

Let us look what the environmental impact is of a piece of garment where we extend the lifecycle of that product from 30 washing cycles to 60 washing cycles, so using the garment twice as long as we used to do. As you can see from the below graph, the environmental impact halves, as could be expected. (**Ref 11**)

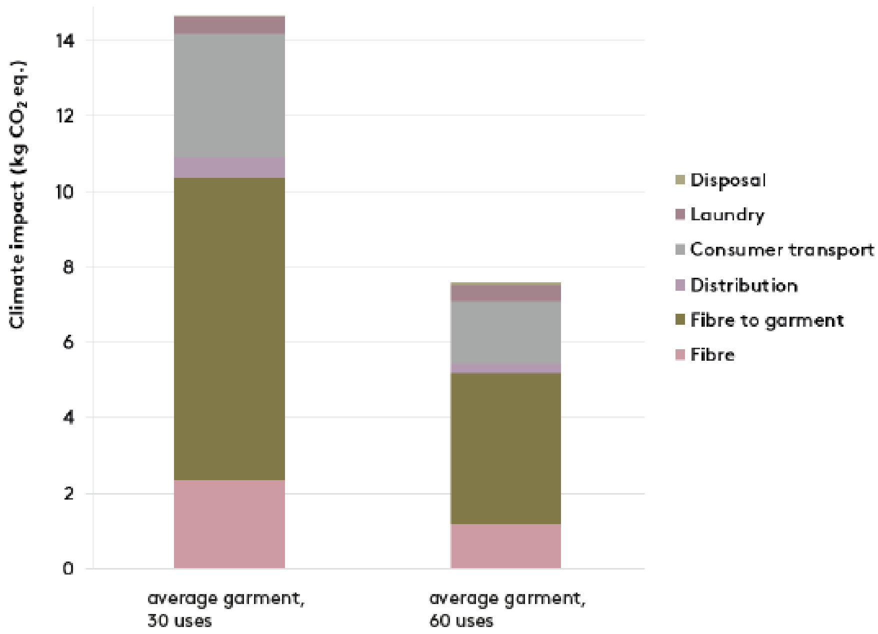



Figure 7. Climate impact expressed as kg CO2 equivalents and calculated for a hypothetical average garment of 0.5 kg. A doubled life length, from 30 uses of the garment (left) to 60 uses of the garment (right), decreases the climate impact by 52% - from 14.7 to 7.6 kg CO2-equivalents. Modified from Roos et al. (2015).

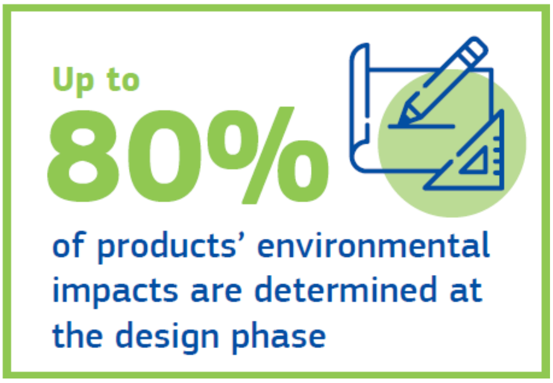
## 10) The Circular Solution

A second mitigation strategy would be to go full steam for the circular solution.
Within the polyester fibre industry, as we have seen, already about 14% of the total polyester fibre supply chain is being recycled, mainly by converting post-consumer PET bottles from the packaging industry into PET flakes, where one can produce R-PET fibres with.
The R-PET fibres produced as such are having excellent physical characteristics, and are therefore fully comparable with their V-PET counterparts for many different applications, especially in the nonwovens and fiberfill sector.
Tensile strength, elongation, shrinkage, are all within required tolerances in order to obtain high quality finished products.
The reason why it is so easy to convert post-consumer PET bottles into R-PET fibres comes because of the fact that the intrinsic viscosity (IV) of the PET polymer used to produce PET bottles with, is higher than the IV needed to produce fibre. Each time a polymer is molten for making extrusion possible, the IV drops a bit, but in the case of PET bottles being molten, the IV is still good enough to extrude into fibres.
Stating the above, would also mean that it would be difficult to re-use PET polymer multiple times, as without any technical intervention, the IV would drop below a certain point where it is not possible anymore to extrude fibres.
However, since a number of years, also this technical hurdle can be overcome because of the SSP technology (Solid State Polymerisation). By using SSP, the IV of a product is lifted up again, so that multiple times recycling is made possible.

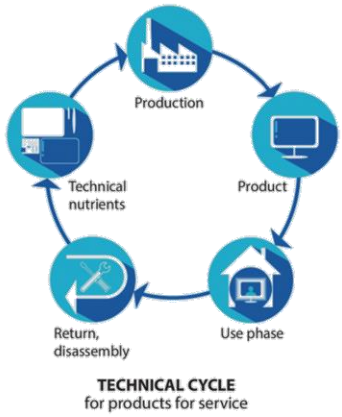
As the PET packaging market (PET bottles), is more and more becoming aware themselves of their environmental impact, they are steadily increasing the percentage of recycled polymer used to produce PET-preforms, which are ultimately blown into new PET bottles. Some of the brands are putting a lot of marketing efforts in order to persuade the consumers to buy more eco-friendly bottles (= higher percentage of recycled content). Some of them are even launching PET bottles already made out of 100% recycled content.
Therefore, as one can imagine the supply chain of the R-PET fibre industry is coming seriously under strain, as this feedstock chain is slowly but certainly drying up.
As such, significant efforts are currently underway to find new feedstock sources.

A very important feedstock source is the Post-Industrial/Post-Consumer textile product waste itself.
To give an example:
The mattress industry in Europe only is getting 30 Mio pieces back from consumers. Today, most of these are either incinerated or landfilled, but since recently, mattress producers start initiatives to try to recycle them.
It all starts from the development phase. When a mattress is developed using only 2 products, being steel springs in the core and the cover being made out of 100% polyester fibres, this would be a much easier to recycle product than more hybrid structures. The steel springs are recovered, and new steel is made with it. The same is done with the 100% mattress cover, which consists out of the mattress ticking and the nonwoven stitched to it. This cover is then zipped together using a PET zipper. This 100% PET-based mattress cover can then be re-used, by shredding it, repelletising it, or produce PET popcorn by agglomerator technology. These pellets or popcorn can then be extruded again in order to obtain new fibres, which on their turn can then again be used to produce new nonwoven, that could be use in new matresses. This is a real circular project.
Just for reference: this market segment for Europe only, gives a nice new feedstock chain. If all of the new developed mattresses would be made according to this new idea, then 30 Mio covers each

counting for 2 kgs of PET could be recovered, representing 60 KTon of PET. Imagine what it would mean globally.
This is just one example. We all need to be inventive enough to find cases like that. Think of textiles used in the automotive industry that could be recovered, using a new eco-design that makes it fully recyclable. PET carpets could be redesigned, acoustical and thermal insulation products,… there are numerous possibilities that will emerge in the coming years.
Important here is that our R&D departments start to work according to a new principle, which is called **DFE** or **Design For Environment**, as the environmental impact of a new product is determined at the design phase. (**Ref 12**)




The Circular industry will have an influence at our textile industry that will be of increasing importance, making sure at the end, that we will consume much less virgin PET, with significant positive effects on climate change. (**Ref 13**)



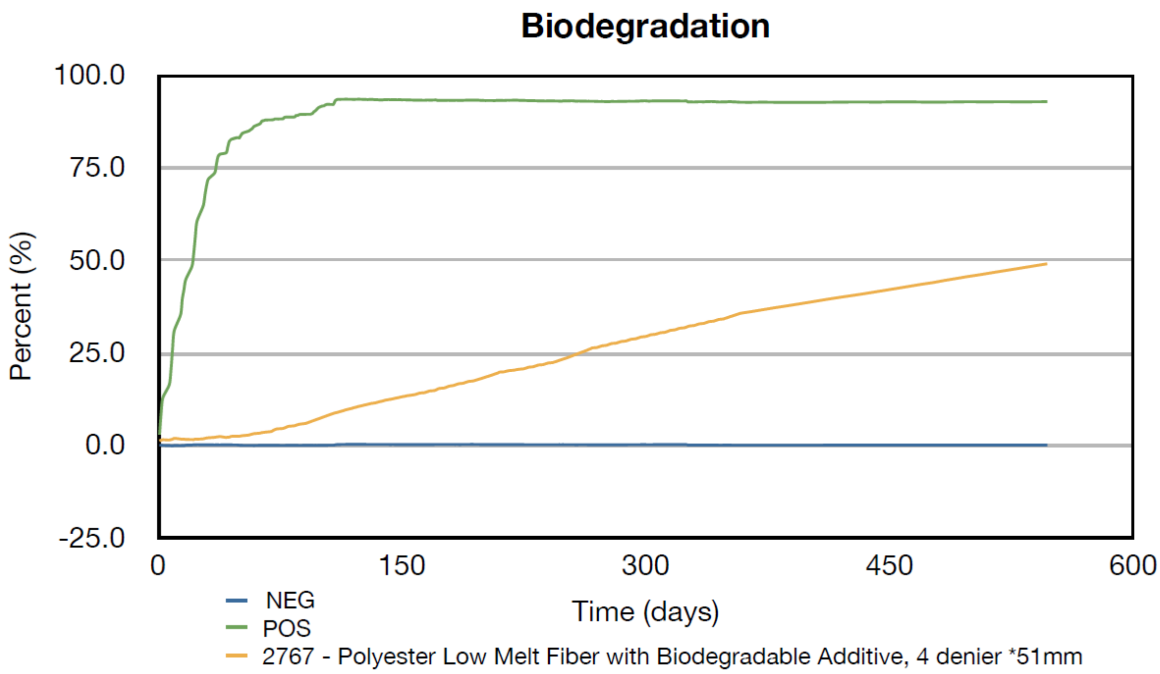

## 11) <u>Biodegradable polyester</u>

A further solution is to be found in using biodegradable polyester fibre going forward.
Every material in that is found in nature is biodegrading at different paces, and in the case of synthetics and polyester more specifically this process is taking an awful long time.
Depending on the study this half-life of polyester varies from several hundreds of years to >2500 years.
In recent times, there are additives available, with which, when added to the melt of polyester at minor percentages (typically around 1%), this makes the polyester polymer to decay or biodegrade under specific conditions at a much faster rate, typically >90% after 3 years or so.

The typical and worldwide accepted standard for biodegradation of polymers is the ASTM D-5511 or similar ISO 15985. This is the standard for anaerobic biodegradation of plastic materials under high solids anaerobic digestion condition.
This is a standard that simulates ideal landfill conditions. As each specific landfill is however different in conditions, the results should be considered with some precautions. However, it is the best known alternative for simulating reality nowadays.
As testing under these conditions takes effectively a long time, and progress on biodegradation for a certain product is monitored constantly and checked every 3 months or so, it is a work of patience.
We ourselves have started testing biodegradable polyester fibres specifically developed according to our specifications since about 18 months now, and the below graph shows the biodegradation so far after 547 days, showing an adjusted biodegradation of 52,8%. (**Ref 14**)

| | | | | |
|---|---|---|---|---|
| * Adjusted Percent Biodegraded (%) | | 0.1 | 100.0 | 52.8 |

* Outside of the ASTM D5511 method and on the assumption that the positive control (Cellulose) will fully biodegrade, all value have been proportionally adjusted.




It is not really possible to extrapolate as there is no guarantee the curve will continue to behave like it has over the past months, but assuming it will, we will effectively reach a 90% biodegradation rate after 900 days, just 2,5 years.
We also produced nonwovens already using these biodegradable polyester fibres and the test result, although being only 4 months into the test, we are on track to meet the same percentages like the individual fibres.

Let us give somewhat more explanation on the effective additive used here, as there seems to be a lot of confusion going around on additives used in many so-called biodegradable fibres that would be photo-degradable, oxo-degradable or oxo-biodegradable. These latter types of biodegradability are cause of concern not to fulfill the SUP Directive of the EU (Single Use Plastics Directive), as they would be harmful for the environment as microplastics would remain.

The additive that we have used is of a different kind and does clearly not belong to the abovementioned categories. Ours is a proprietary additive which when added to normal resins can encourage the biodegradation of the plastic material by a reaction with enzymes created by microorganisms. This technology allows microorganisms to produce CO2 and CH4, both of these are the result of the consumption of the plastic. The technology allows the microbes to consume the plastic product in all active microbial environments. (**Ref 15**)

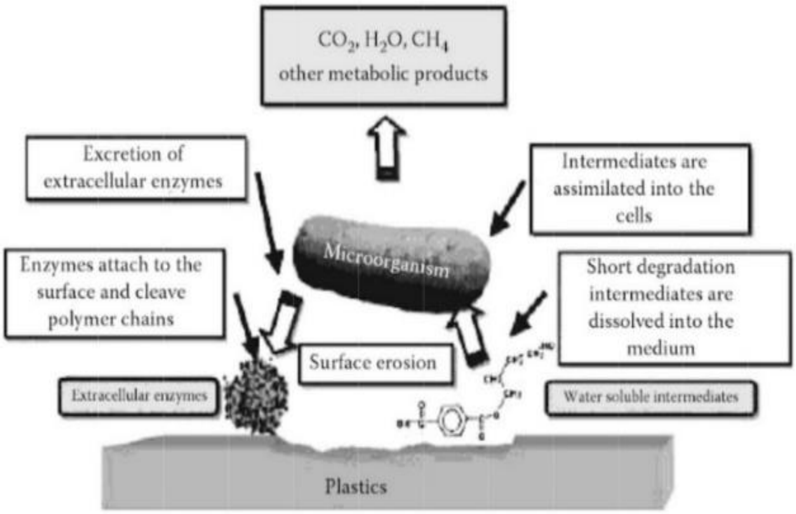



**Figure 6.1** General mechanism of plastic biodegradation under aerobic conditions. (From Mueller, R.J., Biodegradability of polymers: Regulations and methods for testing, in *Biopolymers*, Steinbüchel, A., Ed., vol. 10., Wiley-VCH, Weinheim, Germany, 2003.)

## 12) <u>The ultimate solution</u>

In order to mitigate our Carbon Footprint as an industry (ours being nonwoven textiles), the ultimate goal would be to combine each of the three abovementioned principles.

This means, work simultaneously on:

- The life cycle perspective: limiting our spend behaviour and thereby increasing the lifetime of our products
- The circular solution: Use post-industrial and preferably post-consumer textile waste as feedstock
- Biodegradable polyester fibres: Shift the complete product portfolio away from regular polyester fibres to biodegradable polyester fibres, using the described additives in the first place, making sure the post-industrial and post-consumer waste that we would get back would therefore also be biodegradable.

The result of this combination of three principles would enable us to ultimately only have Carbon Footprint data where Scope 3 is nihil or at least negligible, leaving only the own Scope 1 and Scope 2 emissions.
If on top of that we work on Scope 2 becoming completely climate neutral, by only using renewable energy sources, then we would be only left with our own Scope 1 emissions.

Therefore I would call the above described as: “**The Ultimate Solution”**.

If each company could work on trying to find their own Ultimate Solution, the world can become a better place, in any case a much more environmentally friendly place, fit for generations to come, to have a great and sustainable life on this beautiful planet Earth.

## 13) <u>Sustainable Product Portfolio of the TWE Group</u>

As TWE Group, we have taken up our responsibility and developed our new sustainable Product Portfolio, which we've branded:

We've produced three different product families:

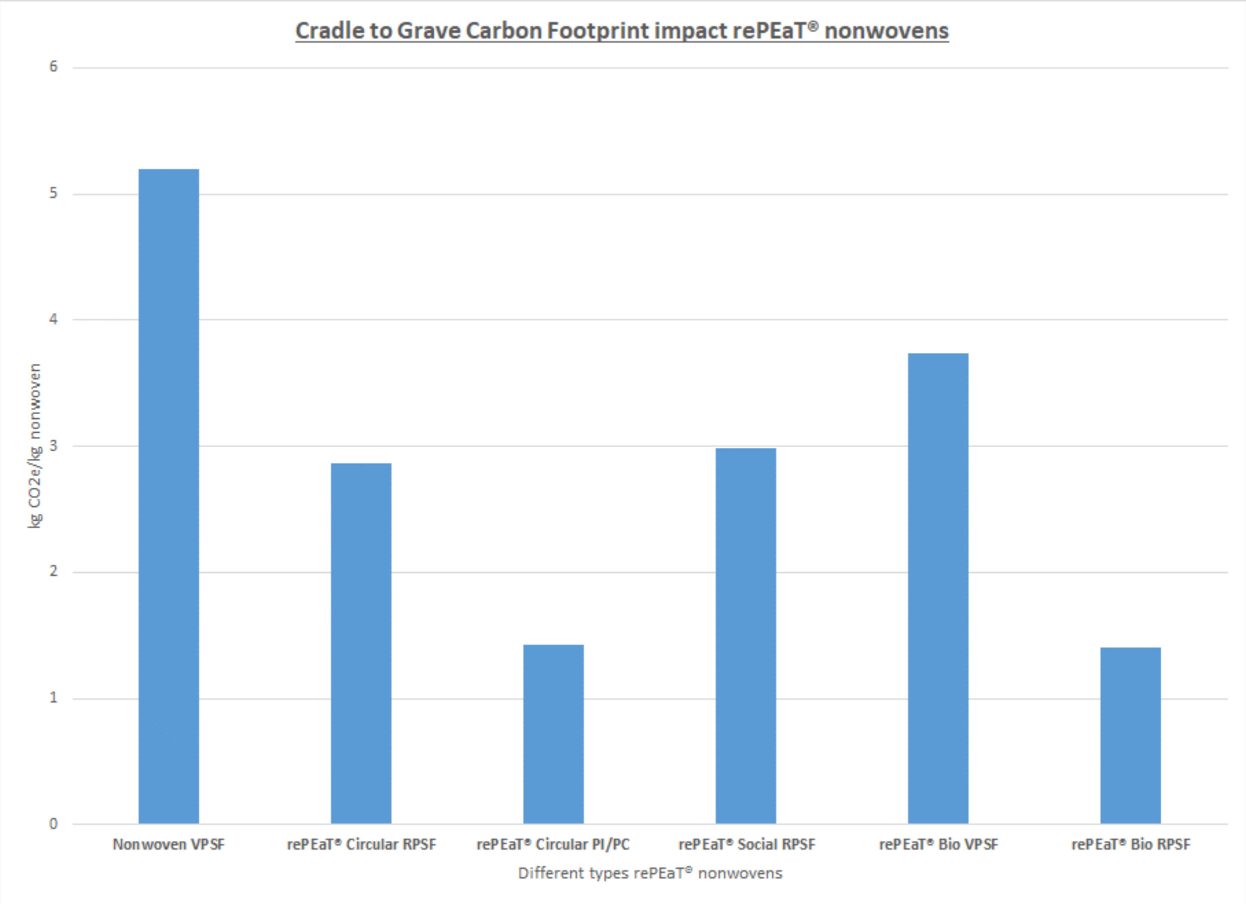
- rePEaT® Circular: here we work on two levels:
    - Increase the percentage of recycled fibres in our blends
    - Full Cradle to Cradle

- rePEaT® Social: we serve both environmental and social goals:
    - Recover ocean-bound plastics
    - Provide income for people in developing countries

- rePEaT® Bio: Options are
    - Use of biopolymers with focus on biodegradable polyesters
    - Offer natural fibre solutions

More info can be found on our website: https://www.twe-group.com/en/sustainability/

In order to have more material data on what the abovementioned sustainable products effectively mean regarding our climate impact, we did calculate their carbon footprint based on the Cradle to Grave principle using the systems expansion approach: (**Ref 16**)




| Glossary: | | |
|---|---|---|
| | **Nonwovens VPSF:** | **Nonwovens with virgin Polyester Fibre content** |
| | **rePEaT® Circular RPSF:** | **Nonwovens with recycled Polyester Fibre content** |
| | **rePEaT® Circular PI/PC:** | **Nonwovens with Post-Industrial/Post-Consumer waste content** |
| | **rePEaT® Social RPSF:** | **Nonwovens with Social Plastics® recycled fibre content** |
| | **rePEaT® Bio VPSF:** | **Nonwovens with Biodegradable Virgin Polyester Fibre content** |
| | **rePEaT® Bio RPSF:** | **Nonwovens with Biodegradable Recycled Polyester Fibre content** |

## 14) Conclusion

Whether we like it or not: because of the high need for affordable textiles in the foreseeable future, it is inevitable to use polyester fibres as there simply is no valid alternative available on the market, especially when looking at the enormous demand requirements.

As was stated in the foregoing, polyester as a polymer and therefore also polyester fibres, are not as bad for the environment as many might think, when compared to other alternative fibres, including biopolymers and even natural fibres.

However, we all do have our duty to play on climate impact, meaning working towards the goals as set at the Paris Agreement regarding Greenhouse Gas Emission reductions.

Therefore, we encourage each industry and individual to work towards finding their own "**ultimate solution**", just as we at TWE Group have incorporated our new sustainable product portfolio into our company strategy, which works on the circular solution and incorporating biodegradable polyesters, not forgetting taking into account social aspects too.

If on top of that we are all conscious about our role we can play in limiting our consumption, whereby we would work on the lifecycle perspective, we will contribute our fair share to climate change.

I am persuaded humanity is resilient enough to cope with the huge challenges lying ahead of us. Together, we can and will succeed!

**15) References**


- **Ref 1**: Global Fibre Production Chart, Preferred Fiber and Materials report 2020, Textile Exchange, June 2020
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