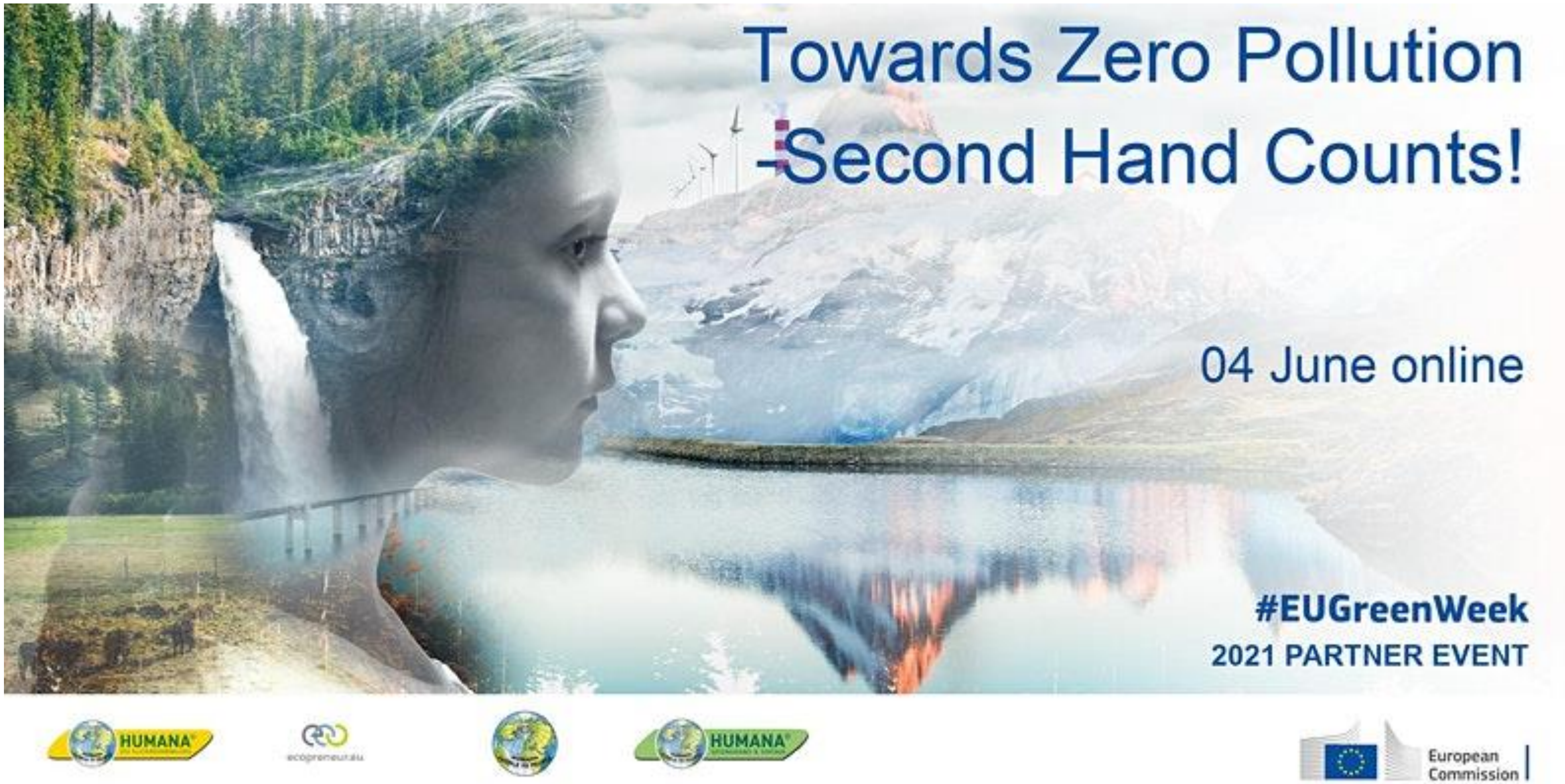

Conversion factor for CO_2 benefit of clothes reuse

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Preconditions

It is complicated. Even if everything concerning textiles were well documented, which it isn’t, there would still be many conditions to consider for the calculation.
To mention a few:

- Which fiber-types are we talking about?
- Which phases of the “life” of textiles do we consider?
- Textiles from where?
- Which reuse share can we count on?
- Which year is the most recent with reliable research data?

<u>Using a few basic preconditions</u>:

1. ONE convertion factor! Not different factors for different types of textiles.
2. We consider the production phase only. The use phase, transport, and how the textiles are discarded in the end will be similar for a new item and a reused item.
3. The data used as the basis must be as “EU” as possible, assuming that such are among the most reliable.

Having found a convertion factor, we still have to include 2 preconditions in our calculation:

- The share of the clothes that are reused
- The replacement rate.

Finally, the CO_2 benefit also depends on the CO_2 emission arising from the collection and sorting of the reused items. This emission is specific for the different actors and is not considered here.

CO_2 emissions from production of textiles

"Textiles and the environment in a circular economy", November 2019

Eionet Report - ETC/WMGE 2019/6 **European Environment Agency**, European Topic Centre on Waste and Materials in a Green Economy

3.1.3 Greenhouse gas emissions

In 2015, greenhouse gas emissions from textiles production amounted to 1.2 billion tonnes CO_2-eq, more than international flights and shipping combined (Ellen MacArthur Foundation, 2017). These greenhouse gas emissions occur all over the world and from many economic sectors, including agriculture, the textile industry and the distribution sector. According to JRC (2014), 51 per cent of the total impact of textiles on climate change occurs in the production phase, 44 per cent in the use phase, and 5 per cent is due to transport. The climate change impact during the use phase is caused by the use of detergents, washing drying and ironing, each contributing an equal share of around 25 per cent of the total impact from the use phase.

The production of textiles is characterised by high greenhouse gas intensity of, depending on the fibre, 15–35 tonnes CO_2-eq. per tonne of textile produced. This is much more than the 3.5 tonnes of CO_2-eq. needed for the production of 1 tonne of plastic, or 1 tonne of CO_2-eq. for 1 tonne of paper (Eunomia, 2015).

"A new textiles economy: redesigning fashion's future", Ellen MacArthur Foundation, 2017
Appendix B.2: Resource use and negative externalities associated with material flows.

"Environmental Improvement Potential of textiles (IMPRO Textiles)", January 2014
European Commission Joint Research Centre, JRC scientific and policy reports

Calculation

Cotton production for textiles + plastic-based fibres production for textiles + other fibres production for textiles =
≈ 18 million tonnes + ≈ 45 million tonnes + ≈ 9 million tonnes = 71 million tonnes

Production of 71.000.000 tonnes of fibres cause emission of 1.200.000.000 tonnes CO_2-eq or
Production of 1 Kg of fibres cause emission of 16,9 Kgs of CO_2 eqvivalent

CO_2 emissions from production of textiles

Data sources

"A new textiles economy: redesigning fashion's future"
Ellen MacArthur Foundation, 2017
Appendix B.2: Resource use and negative externalities associated with material flows.

INPUT		STEPS FOR CALCULATION	VALUE	UNIT	COMMENT	SOURCE
CO_2e EMISSIONS - FIBRE PRODUCTION PHASE		Cotton production for textiles	18	million tonnes		
		x				
		GHG emissions for cotton production	4.7	kg CO_2e/ kg fibre		McKinsey analysis
		=				
		Total GHG emissions for cotton production for textiles	86	million tonnes CO_2e		
	+					
		Plastic-based fibres production for textiles	45	million tonnes		
		x				
		GHG emissions for plastic-based fibres production	11.9	kg CO_2e/ kg fibre		McKinsey analysis
		=				
		Total GHG emissions for plastic-based fibres production for textiles	530	million tonnes CO_2e		
	+					
		Other fibres production for textiles	9	million tonnes		
		x				
		GHG emissions for other fibres production	4.7	kg CO_2e/ kg fibre	Assumed same as the lowest of cotton / plastic-based	Conservative assumption
		=				
		Total GHG emissions for other fibres production for textiles	40	million tonnes CO_2e		
	+					
CO_2e EMISSIONS - TEXTILE PRODUCTION PHASE		Total fibres produced for textiles	71	million tonnes		
		x				
		GHG emissions for yarn production, dyeing, weaving and knitting	9.6	kg CO_2e/ kg fibre		McKinsey analysis
		=				
		Total GHG emissions for yarn production, dyeing, weaving and knitting	550	million tonnes CO_2e		
	=					
TOTAL		Total GHG emissions in textiles production	1.2	GT CO_2e		

"Environmental Improvement Potential of textiles (IMPRO Textiles)"
European Commission Joint Research Centre
JRC scientific and policy reports, January 2014
Chapter 3: Results of the baseline scenario, 3.1 Overview, page 70

Chapter 3

Figure 26 present the share of each life cycle phase over total impacts according to each of the midpoint and endpoint indicators.

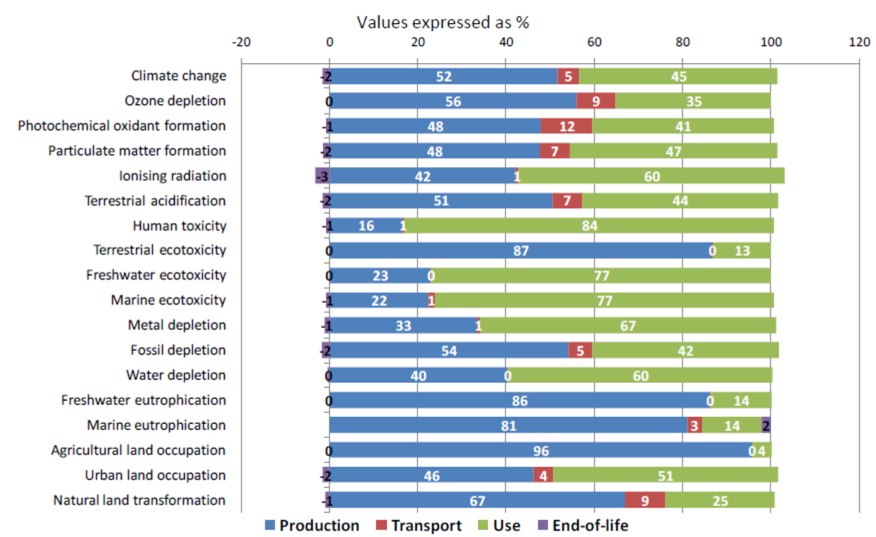


Figure 26: Environmental impacts of textile consumption in the EU-27 according to the midpoint indicators of ReCiPe

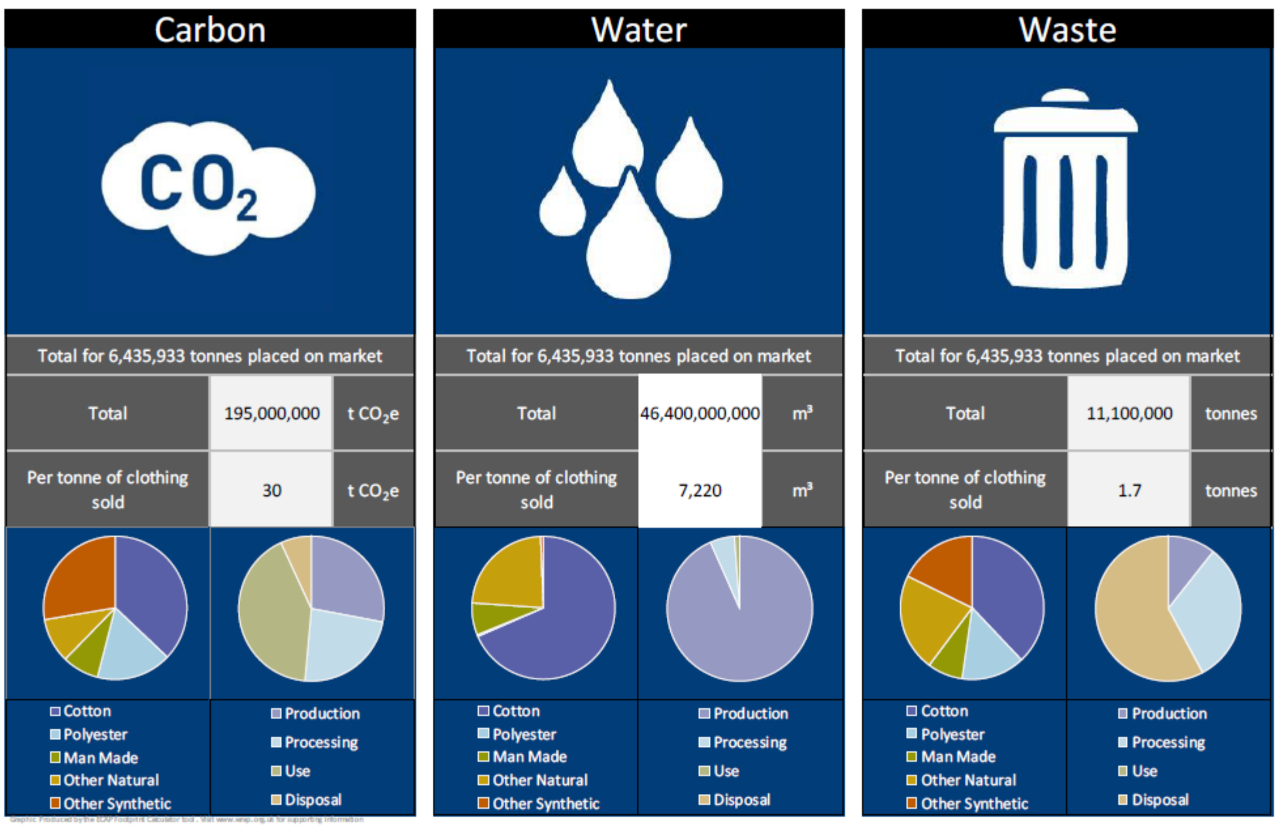
CO_2 emissions from production of textiles
Data sources

"Mapping clothing impacts in Europe: the environmental cost"
The European Clothing Action Plan (ECAP), December 2017

I include this study because it is strictly European, because ECAP was very professionally driven by the Dutch EPA (Rijkswaterstaat), and to compare my CO2 convertion factor with another similar factor.

5.1 The footprint of clothing produced for the EU, page 26

Figure 6: Carbon, water and waste footprints of clothing consumed in the EU in 2015



ECAP's convertion factor is 30 (tonnes of CO2 eqvivalent per tonne of clothing placed on the market).

However, this is for the complete life cycle of the textiles (= production + processing + use + disposal). Looking at the Carbon part of the above diagram, the cirkel diagram showing the division of CO2 emission on the 4 phases has a little more than half allocated to Production + Processing. Assuming that Production + Processing in this study corresponds with Production in the JRC study, ECAP ends on ≈ **15 Kgs of CO2-eq per Kg of textiles PRODUCED** (= in the production phase) which is not so far from the **16,9 Kgs**.

Replacement rates

Replacement rates can be calculated for a multitude of conditions. The one we are interested in concerns the answer to this question: **Would you have bought a similar item new, if you hadn't found it in a second-hand shop or -market?**

The report "Exports of Nordic Used Textiles - Fate, benefits and impacts", Nordic council of Ministers, 2016, writes concerning Replacement rates:
2.3.2 Global net environmental impacts and benefits. Methods and assumptions (page 74)
A very important variable in the model is the substitution rate assumed for reused textiles. This is the degree to which a reused item replaces the purchase (and thus the production) of an equivalent new textile product. This is an important factor in determining overall benefits; the higher the replacement rate, the higher the environmental benefits of reuse.

.....

Displacement rates depend on a wide range of factors. A high substitution factor is expected where a purchase is a result of a concrete need and/or where the secondhand product is relatively expensive for the purchaser. A low substitution rate could be expected where the purchase is spontaneous and/or the price of the second-hand product is perceived to be insignificant.

Overview of Replacement Rates in 5 different studies:

	Study	Repl. Rate Europe	Repl. Rate Africa / Asia
1	"Environmental benefits from reusing clothes" Laura Farrant, 2008	60 75	85
2	"Study into consumer second-hand shopping behavior to identify the re-use displacement effect", WRAP, 2012	28	
3	"Replacement rates for second-hand clothing and household textiles - a survey study from Malawi, Mozambique and Angola", HPP, 2016		45
4	"Exports of Nordic Used Textiles - Fate, benefits and impacts", NCM, 2016	30	50
5	"Replacement rates for second-hand clothing and household textiles - a survey study from Berlin", HPP, 2018	55	

- I will disregard the rate for Africa / Asia of study #1 because it is based on assumption.
- I will also disregard both rates from study #4 because they're assumptions based on the other studies.
- The average rate for Europe, based on the other studies, is **54,4 %**
- For Africa / Asia we have one valid rate from study #3: **45 %**
- Clothes collected by HPP is distributed approximately with 1/3 in Europe and 2/3 in Africa / Asia.

Our calculated replacement rate will then be (54,4 x 1/3) + (45 x 2/3) = **48,1 %**

Conclusion & method

We need

- CO_2 factor **16,9**
- Replacement rate **48,1 %**
- Real / documented **local reuse share, f.ex. 75%**

Question: A collector collected 1.000 tons of original clothes. How much CO_2 emission did that save?

Answer: 1.000 tons x **75 %** x **48,1 %** x **16,9** = 6.097 tons

= quantity of original clothes X **reuse share** X **replacement rate** X **CO_2 factor**
= quantity of original clothes X **convertion factor**

1 Kg of clothes collected saves 6,1 Kgs of CO_2 emission
(*before considering the CO_2 footprint of the collection itself*)