Waste 2 Resources

Life Cycle Assessment Summary Report

22% Recycled Nomex Polar Fleece

Prepared for Oratex

ORATEX

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Summary

ORATEX 78% VIRGIN/22% RECYCLED NOMEX FIBRE PROVIDES

14%

REDUCTION IN CARBON FOOTPRINT COMPARED TO 100% VIRGIN NOMEX FIBRE

&

19%

REDUCTION IN RESOURCE EXTRACTION IMPACT COMPARED TO 100% VIRGIN NOMEX FIBRE

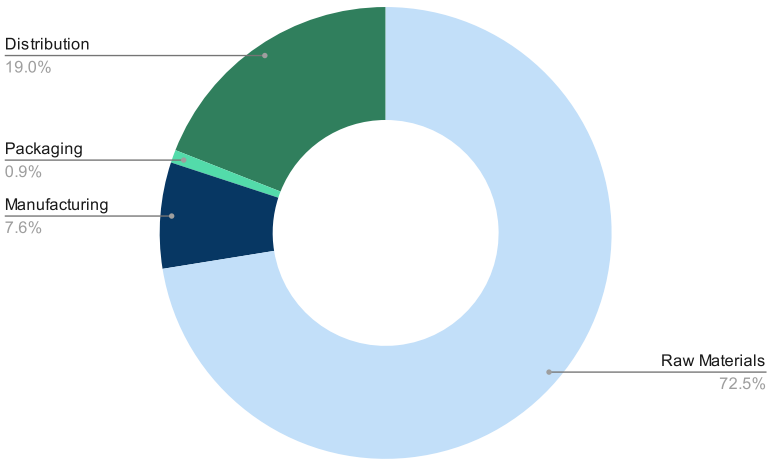
The life cycle study results indicate that 78% virgin / 22% recycled Nomex fibre has a carbon footprint of 4.42 kg CO_2 eq per recycled Nomex garment. The primary contributing stages are raw material extraction and distribution.

4.42 kg

CO_2 EQUIVALENT PER RECYCLED BLEND NOMEX GARMENT

135 g

REDUCTION IN SOLID WASTE GENERATION COMPARED TO 100% VIRGIN NOMEX FIBRE



Goal

The goal of this study is to compare the life cycle environmental impacts of Nomex polar fleece containing 22% recycled content. For this study, the environmental impact measured is carbon footprint to inform the product's potential contribution to climate change.

This study analyses the following scenarios:

Scenario 1: 22% recycled / 78% virgin Nomex T462 fibre used in garment production
Scenario 2: Modeling the same garment production using 100% Nomex T462 fibre.

Scope

This study used life cycle methodology to quantify the carbon footprint (global warming potential) in terms of greenhouse gas emissions. In life cycle assessment, global warming potential is used to describe the carbon footprint, expressed in kilograms of CO_2 equivalent or kg CO_2 eq.

The emissions included in this study are for recycled and virgin Nomex T462 fibre production, distribution to the production facility, production and packaging of the 22% recycled / 78% virgin Nomex T462 garment product, distribution from Quebec, CA to within Canada and USA , and disposal at end of life.

Product System

This life cycle assessment study compares the carbon footprint of 22% recycled / 78% virgin Nomex fibre for use in garment production with 100% virgin Nomex fibre used in the same application.

The recycled Nomex polar fleece included in the study comprises a blend of recycled and virgin Nomex fibre. The two raw materials are processed to produce 2.4 m^2 of fabric weighing 0.612 kg. The study models the requirements of a garment requiring 2.4 m^2 of fabric for the two different material types.

Figure 1: Exemplary model of Nomex garment

Functional Unit

A functional unit is required to compare the life cycle environmental impacts of the recycled Nomex fibre garment to the virgin Nomex fibre garment. **The functional unit used for this study is 2.4 m² of 22% recycled / 78% virgin Nomex material used to produce one Nomex polar fleece garment.**

System Boundary

This study considers the impact of the Nomex fibre from resource extraction to end-of-life. In other words, it considers the impacts associated with raw material processing and production, distribution, and disposal, as shown in the figures below. The differences modelled in the study are for raw material processing, and all other stages remain the same.

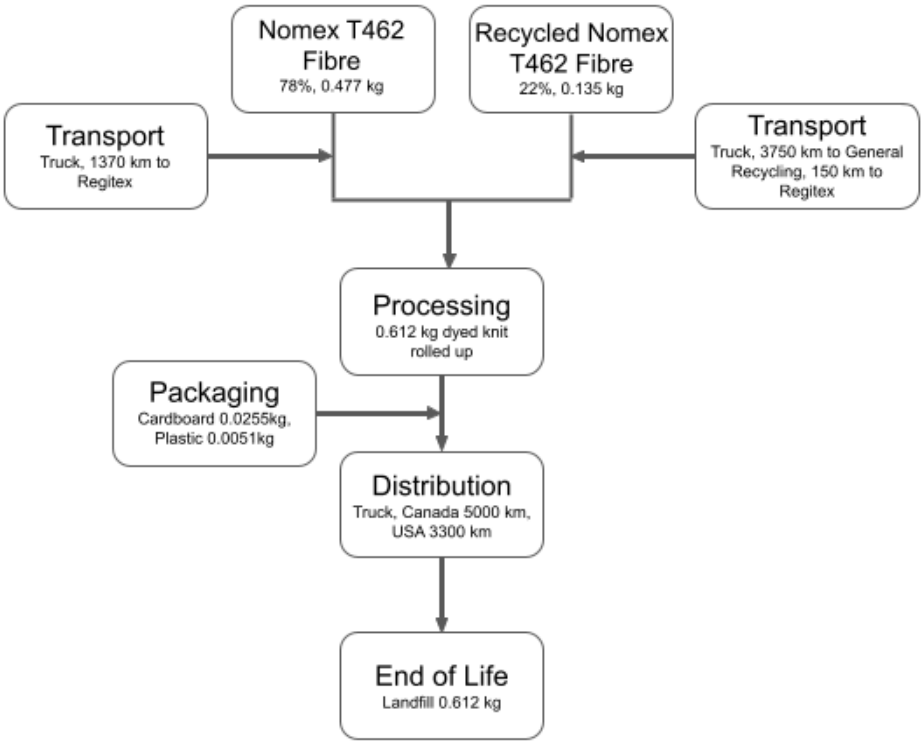


Figure 2: System boundary of Scenario 1, Regular Nomex Polar Fleece

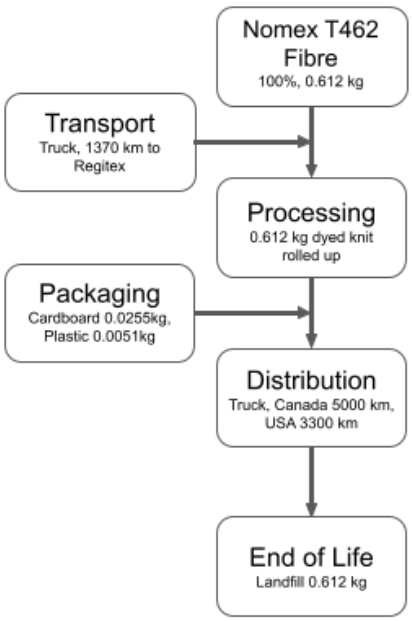


Figure 3: System boundary of Scenario 2, 100% Nomex Polar Fleece

End of Life Modelling

In studies where recycled content is part of the product, a few approaches can be considered. The most common practice is the "cut-off" principle, which distinguishes the first life (virgin product) and the second life (recycled product) as separate systems. This means the post-consumer waste from the first life does not bear any environmental burden when used as the feedstock in the second life (Shen et al., 2010). The LCA results of this study are based on the cut-off method. This means that the environmental impact of the production of Nomex garments to be recycled (first life) is separate from the recycled Nomex production (second life).

The "life" of a product comprised of recycled content begins when the material enters the recycling stream, likely at a material recovery facility (MRF). In the case of the recycled Nomex, the second life begins at the collection center in Alberta and the taken to General Recycling for shredding. The cut-off principle is also applied at the end of a material's second life. Meaning the boundary of the second life is drawn when it enters the recycling stream.

Results

Primary data provided by Oratex was used to determine the carbon footprint of the 22% recycled / 78% virgin Nomex fibre blend. The recycled Nomex fibre life cycle data was used to model scenario 2 to assess the carbon footprint of 100% virgin Nomex The total carbon footprint of both materials is shown in Figure 5.

The primary difference between Scenario 1 and 2 is the raw material life cycle stage. As such, scenarios 1 and 2 were modelled the same for manufacturing, packaging, distribution and end-of-life stages.

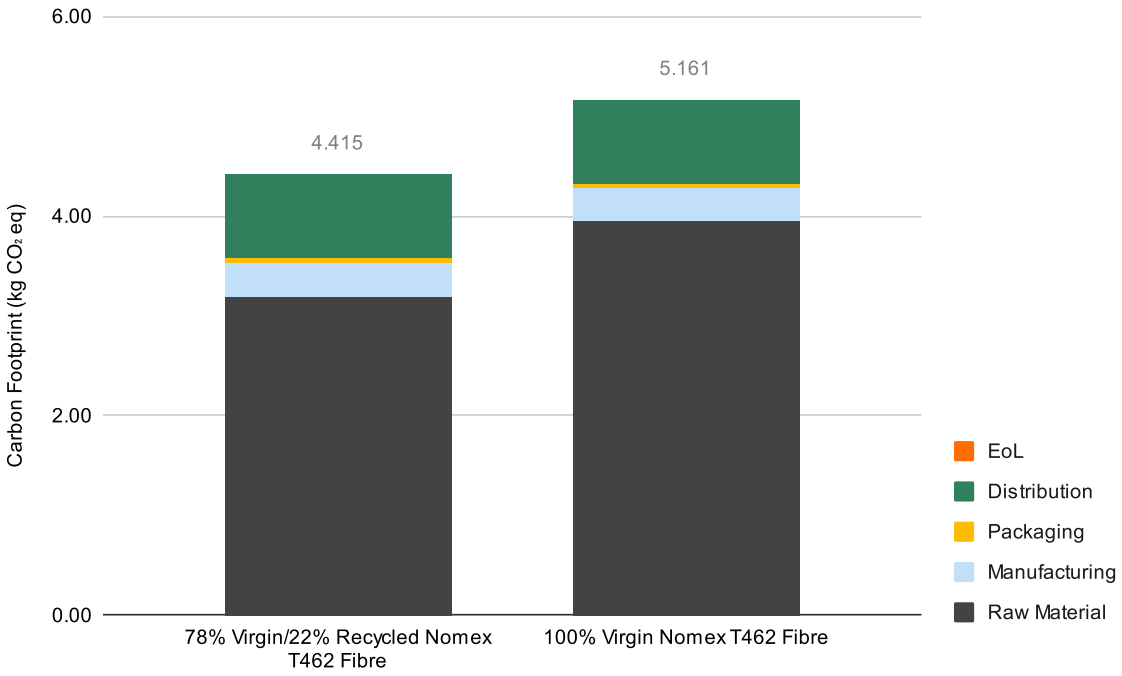


Figure 5: Total carbon footprint of 22% recycled Nomex and 100% virgin Nomex for 2.4 m² of fabric to produce one Nomex polar fleece garment.

The study results show that the raw materials required for the 78% virgin / 22% recycled Nomex T462 fibre have a 19% lower carbon footprint than the 100% virgin Nomex T462 fibre for producing a Nomex polar fleece garment, as shown in Figure 6.

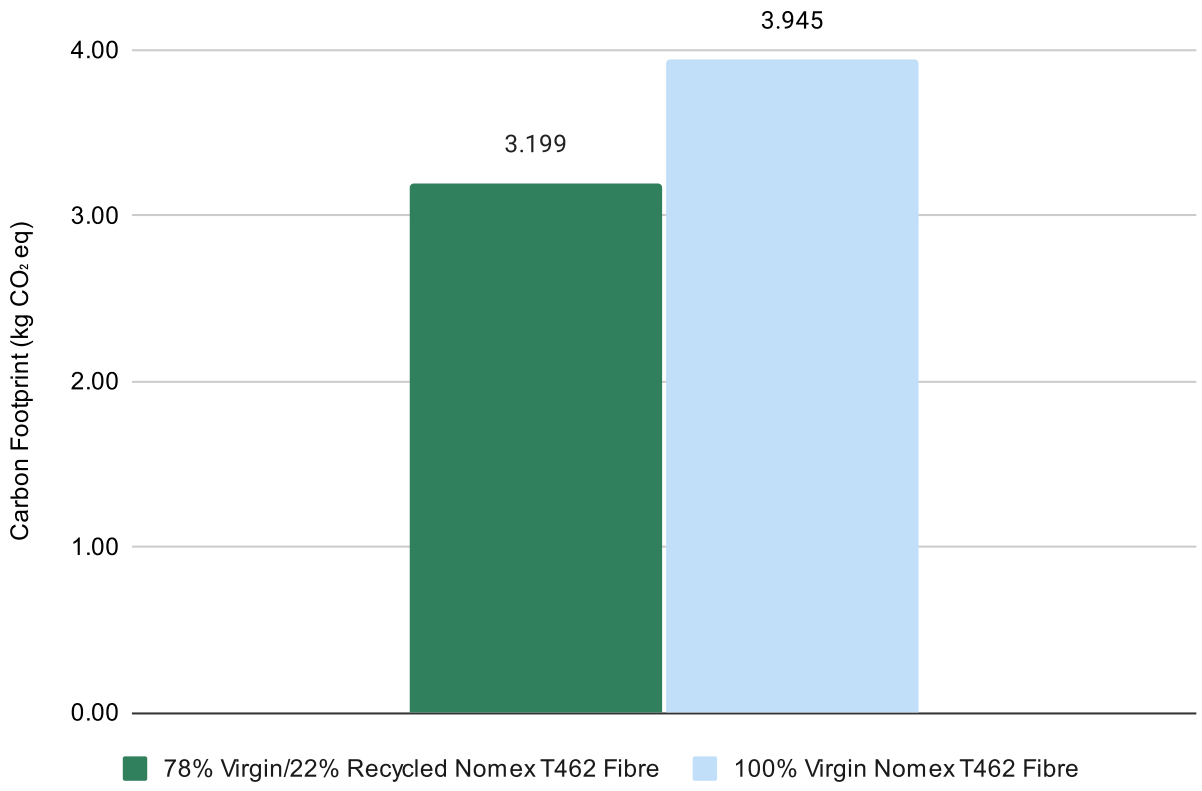


Figure 6: Carbon footprint of raw materials of 78% virgin / 22% recycled Nomex T462 fibre and 100% virgin Nomex T462 fibre for 2.4 m^2 of fabric to produce one Nomex polar fleece garment.

A Nomex fibre blend analysis was carried out to determine the carbon footprint of the Nomex polar fleece garment with increased recycled content. The results indicated that with every 1% increase in recycled content, the carbon footprint decreased by 0.036 kg CO_2 eq or approximately 1%. In the initial assessment of 85% virgin/15% recycled Nomex polar fleece (June 2022), the carbon footprint of the raw materials stage was calculated at 3.41 kg CO_2 eq or approximately 6% more than the 78%/22% blend in this report.

Recycled Nomex material is collected in Edmonton, CA, and transported 3,750 km to General Recycling in Quebec for shredding and processing into yarn. At the time of writing, General Recycling was operating the Nomex shredding process at a 50% capacity or 175 kg/hr. At this capacity, the carbon footprint per the study's functional unit is 0.0011 kg CO_2 eq. If the processing capacity were increased to the maximum of 350 kg/hr, the carbon footprint of the Nomex shredding step would decrease by 50% to 0.00055 kg CO_2 eq.

A comparative analysis was completed to determine the impacts of manufacturing Nomex polar fleece garments at four locations, including Quebec, California, North Carolina, and Germany. Table 1 summarizes the emission coefficients used to measure the impacts at each location.

Table 1: Electricity Grid Emission Coefficients

Manufacture Location	Emission Coefficient[1] (kg CO_2 eq/kWh)
Quebec, CA	0.0015
Germany	0.3387
California, USA	0.2055
North Carolina, USA	0.2941

[1]Source: Climatiq

The manufacturing process was modelled the same for each location. Carbon emissions were determined for each site using regional electricity grid data. The study indicated that the manufacturing location with the lowest carbon footprint was Quebec, CA. This is because Quebec uses renewable hydroelectricity, while fossil fuels primarily generate the other three locations' electricity. The results are summarized in Figure 7 below.

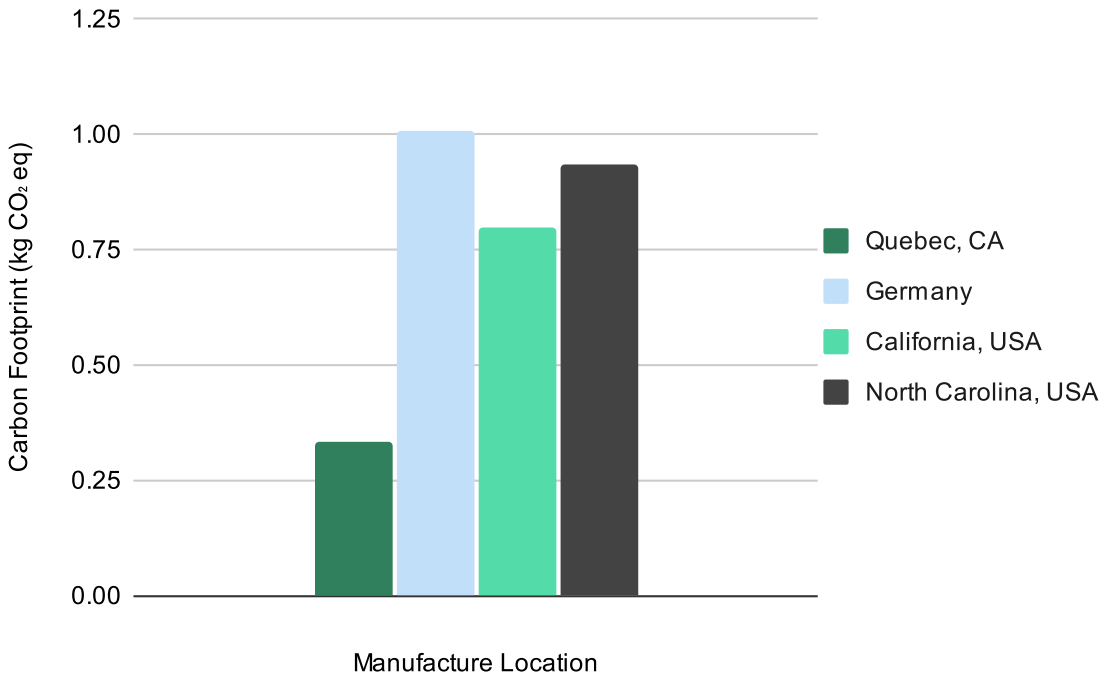


Figure 7: Carbon footprint of manufacturing locations producing 2.4 m^2 of fabric to produce one Nomex polar fleece garment.

Assumptions

General assumptions were made in the absence of representative data to allow a fair comparison between both scenarios.

- The manufacturing and application of each Nomex polar fleece garment were the same in each scenario.
- It was also assumed that the recycled raw materials distribution distance was 3,750 km from Alberta to Quebec.
- For scenario 1, it was assumed that the average life span of the garment was the same as in scenario 2.
- In both scenarios, it was assumed the products end up in a landfill at the end of their lives.

Recommendations

1. It is recommended that the life span of the recycled Nomex fibre blend be confirmed to see how the study results change, if at all. This would confirm the accuracy of the carbon footprint compared to the 100% virgin Nomex fibre.
2. It is also recommended that the distribution distance be determined to assess the carbon footprint and confirm the accuracy of the transportation emissions.

Sources

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