Carbon Footprint of Consumables at Sports Events

Contextualizing CO_2 Drivers and Material Choices Using Race Bibs and Timing Transponders as Examples

Executive Summary

Sports events are increasingly expected to transparently assess and reduce their CO_2 emissions. In doing so, event organizers make decisions across a wide range of areas—from mobility and energy to logistics and consumables. This paper puts the CO_2 impact of selected measures into context and uses race bibs and timing transponders to demonstrate the importance of taking a holistic view.

The examples of commonly used materials show that individual components may be highly visible while accounting for only a limited share of an event's overall footprint. At the same time, race bibs perform essential functions during a competition. Environmental considerations should therefore always be assessed alongside functionality, reliability, and practical suitability.

Methodological Transparency

All CO_2 values for race bibs and timing transponders were calculated transparently across the relevant life-cycle stages. Published LCA data was used for comparison products and is identified accordingly.

The Importance of Environmental Sustainability in Sports

Sustainability in sports has long since become more than a peripheral issue. Sports events bring together mobility, infrastructure, material use, and energy consumption within a short period of time and in one location. They therefore exemplify many of the challenges faced by modern sustainability strategies. At the same time, they attract considerable public attention and provide an opportunity to make sustainable action visible.

The environmental footprint of sports events results from a wide range of individual factors: participants travelling to and from the event, the operation of event sites, logistics, and the production and use of materials. In practice, event organizers must weigh these factors against one another and prioritize measures—often within economic, organizational, and safety-related constraints.

Dominant Emission Drivers at Running Events

Studies and sustainability reports from major running events consistently show that participants travelling to and from the event account for the largest share of CO_2 emissions. By comparison, emission sources directly related to event operations contribute significantly smaller shares to the overall footprint.

The 2024 BMW BERLIN-MARATHON Sustainability Report states that approximately 92% of the recorded CO_2 emissions are attributable to the mobility of participants and other visitor groups. Accommodation accounts for 7%, catering for 0.5%, and energy for 0.1%.

EMISSION CATEGORY	SHARE
Mobility	92 %
Accommodation	7 %
Catering	0.5 %
Energy	0.1 %

Source: BMW BERLIN-MARATHON (2024).

Consumables at Sports Events

Consumables are a visible part of sports events and are therefore frequently considered in sustainability discussions. However, their contribution to the overall CO_2 footprint depends heavily on the material, the duration of use, and the context in which they are used. It should therefore be assessed in relation to other emission drivers.

The following criteria are particularly relevant when evaluating consumables:

- ✓ **Sustainable raw materials:** Use of recycled or bio-based materials
- ✓ **Resource efficiency:** Reduced material waste
- ✓ **Durability:** Use of robust and long-lasting materials
- ✓ **Recyclability:** Possibility of straightforward recycling

An initial point of reference is provided by comparing the carbon footprints of selected materials.

Textiles (starter bags, T-shirts, giveaways): CO_2 emissions from material production

MATERIAL	CO_2 EMISSIONS DURING PRODUCTION (KG CO_2 EQUIVALENTS PER KG OF MATERIAL)	ADVANTAGES	DISADVANTAGES
Polyester	4.5 kg CO_2 equivalents per kg	• High tear resistance • Long service life • Well suited to repeated use • Recyclable	• High CO_2 emissions during production
Cotton	2.5 kg CO_2 equivalents per kg	• Biodegradable • Comfortable to wear	• High water consumption • Use of pesticides, depending on the cultivation method
Bamboo	1.6 kg CO_2 equivalents per kg	• Renewable raw material • Fast-growing	• Relatively short service life • Chemical processing is often required • More expensive

The differences shown relate exclusively to material production per kilogram. In practical applications, the CO_2 impact and sustainability of textiles are also determined by factors such as the amount of material used, service life, frequency of use, and reuse.

Race Bibs

CO_2 Emissions from Material Production

MATERIAL	CO_2 EMISSIONS PER SHEET (2 × 45 CM)	ADVANTAGES	DISADVANTAGES
Tyvek 75 g/m²	36.6 g	Pure HDPE, 100% recyclable; highly tear-resistant	Manufactured entirely from fossil fuels, resulting in high consumption of non-renewable resources.
Pretex 120 g/m²	45.7 g	Primarily made from cellulose; more tear-resistant than paper due to its coating	In most cases, the material would have to be treated as mixed waste
Teslin 134 g/m²	41.8 g	Highly tear-resistant; the use of 60% silica as a filler reduces the amount of PE required	Teslin can be recycled, but its high filler content makes recycling more difficult and requires the use of a high-intensity mixer

Tyvek—Functional, Robust, and CO_2-Efficient

When selecting material for race bibs, event organizers essentially have three material options. The comparison shows that the CO_2 emissions per race bib amount to only a few grams. Despite being manufactured from fossil-based raw materials, Tyvek has a comparatively low carbon footprint per item.

In addition to its carbon footprint, a race bib performs an essential function during a competition. It provides clear participant identification, securely holds the timing transponder, and remains reliably legible under varying weather conditions and physical stresses.

Tyvek is characterized by high tear resistance and dimensional stability, allowing it to meet the typical requirements placed on race bibs during competition. Tear resistance and dimensional stability reduce the risk of damage or failure during the event and therefore contribute to process reliability. When considered as a whole, Tyvek combines functional reliability with a low CO_2 impact per race bib.

Against this background, the choice of race bib material is less a question of individual grams of CO_2 and more a matter of balancing material use, functionality, and reliability under real competition conditions.

Carbon Footprint of a Tyvek Race Bib (RACE RESULT, DIN A5)

The carbon footprint of our race bibs is calculated and transparently reported across the main life-cycle stages. This allows emission drivers to be identified and potential areas for improvement to be evaluated in a targeted manner. The value is broken down as follows:

LIFE-CYCLE STAGE	CO_2
Raw material	8.72 g
Printing	0.48 g
Transport to the RACE RESULT production and printing site	0.22 g
Total	**9.42 g**

Comparison of Typical CO_2 Orders of Magnitude

To provide better context for the CO_2 emissions of individual consumables, a comparison with other typical consumables can serve as a point of reference. The following examples are not intended to evaluate or equate different products. They are provided solely to illustrate the order of magnitude of CO_2 emissions per item.

PRODUCT	CO_2 EMISSIONS PER ITEM	DATA BASIS
Tyvek race bib	**9.4 g**	Internal calculations
RACE RESULT passive transponder	**7.5 g**	Internal calculations
Disposable paper cup (0.2 l)	Approx. 20–40 g	LCA*
Disposable plastic cup (0.2 l, PP or PET)	Approx. 10–30 g	LCA*
Barrier tape (10 m, LLDPE)	38 g	Manufacturer information**
Banner (2 × 3 m, recycled PET)	3,350 g	Manufacturer information***

** Life-cycle assessments (LCAs) are used exclusively to provide context for typical orders of magnitude. Actual emissions vary depending on the material, weight, and manufacturing process. Source: Moretti et al. (2021)*

*** Reference product: LLDPE barrier tape, 80 mm × 500 m, product weight 1.25 kg (https://www.kaiserkraft.de/markieren-und-kennzeichnen/markierungsbaender/absperrband/extrem-robust-beidseitig-bedruckt/p/M16929269/?srsltid=AfmBOoozASLxZ5dAs0zSYZUDcJsG8b-xAXgaCL9Pgjk_Kcl1pbWVFH6o)*

**** https://www.weserflaggen.de/wp-content/uploads/2023/04/CO₂-footprint_DE.pdf*

End of Life: Context and Current Reality

The recyclability of a material describes its technical suitability for recycling. Actual recycling, however, also depends on collection, sorting, and the availability of suitable recycling infrastructure.

Tyvek is technically recyclable.

- ✓ Based on practical experience to date, only approximately 5–10% of used race bibs are returned. They are collected in containers placed in the finish area.
- ✓ Before recycling, the transponder and its foam spacer must be removed manually.
- ✓ There is currently no nationwide post-consumer recycling infrastructure for used Tyvek race bibs in Germany.

Disposable and Reusable Transponders in Their Usage Context

The environmental assessment of timing transponders depends not only on the technology but, above all, on the actual usage model. Reusable transponders can only offset their greater production impact when they are reliably reused across many events. Modern passive disposable transponders, by contrast, already have a comparatively low carbon footprint during production and do not require return logistics.

Classification of Production Emissions from Timing Transponders per Item

		
Name	ChampionChip	UHF transponder
Type	Reusable transponder for running events	Disposable product
Attachment	Attached to the shoe	Affixed to the back of the race bib
CO_2*	12 g	7.5 g

**CO_2 emissions from material production, excluding use, return transport, and disposal*

Contextualizing the Carbon Footprint

- ✓ The ChampionChip has a production carbon footprint of approximately 12 g per item.
- ✓ The passive disposable UHF transponder examined, including its foam spacer, has a carbon footprint of approximately 7.5 g per item.
- ✓ The environmental advantage of a reusable system only emerges once a sufficiently high number of actual reuses has been achieved.
- ✓ Return rates and transport and logistics processes also affect the overall footprint.

Assessment in the Usage Context

Reusable transponders can be environmentally beneficial when ...

- ✓ high rates of reuse are actually achieved,
- ✓ reliable return rates can be ensured,
- ✓ additional logistics emissions remain low.

Passive disposable transponders offer advantages when ...

- ✓ events are open-entry or held only once,
- ✓ returns and reuse are difficult to ensure from an organizational perspective,
- ✓ a simple and robust event process is the main priority.

Context

The environmental comparison between disposable and reusable transponders cannot be decided in general terms. For many running events, modern passive disposable transponders represent an environmentally and organizationally sensible solution due to their low production footprint and the absence of return logistics.

Guidance for Event Organizers

- ✓ Prioritize measures according to their actual impact on the overall footprint.
- ✓ Always assess material choices together with functionality and reliability.
- ✓ Use reusable solutions only where high return rates can actually be achieved.
- ✓ Include logistics and transport emissions in the assessment.
- ✓ Transparently document assumptions and system boundaries.

Conclusion

The considerations presented here show that the carbon footprint of sports events is largely shaped by a small number of dominant factors—particularly participant mobility. Consumables such as race bibs, transponders, or banners are visible and relevant, but their contribution to the overall footprint is on a significantly smaller scale.

When assessing individual materials and systems, a context-based approach is therefore essential. Isolated material values are insufficient when they are not considered alongside service life, frequency of use, logistics, and functional requirements. Particularly for essential competition components such as race bibs and timing systems, reliability, process security, and practical suitability are key elements of a sustainable overall solution.

Sustainability in the event environment therefore does not mean optimizing every individual element to the greatest possible extent. Instead, the available measures should be prioritized in relation to their actual impact. This contextualization creates transparency and enables informed decisions that take both environmental and functional requirements into account.

Summary

- ✓ Mobility is the dominant emission driver at sports events.
- ✓ Consumables make a comparatively small contribution to the overall footprint.
- ✓ Material choices should always be assessed in their usage context.
- ✓ Functionality and reliability are important assessment criteria in sustainability decisions.

References

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