FLOW IMPACTS

Material and carbon footprint assessment
of Flow Festival 2022

Research report

FLOW IMPACTS; Material and carbon footprint assessment of Flow Festival 2022

Acknowledgements

This report was prepared by D-mat ltd. and funded by the NextGenerationEU fund via Business Finland. We would like to thank the NODUS Research Group for Sustainable Design at Aalto University, the ORSI project of the Finnish Strategic Research Council and the University of Helsinki for supporting the research.

Suggested citation

Ursula Rinta-Jouppi, Annastina Saari, Hilma Leppioja, Michael Lettenmeier. 2023. FLOW IMPACTS; Material and carbon footprint assessment of Flow Festival 2022. D-mat ltd., Finland.

Authors

Ursula Rinta-Jouppi (D-mat ltd.)
Annastina Saari (D-mat ltd.)
Hilma Leppioja (University of Helsinki)
Michael Lettenmeier (D-mat ltd., Aalto University)

Contributing authors

Jari Kolehmainen (D-mat ltd.)
Anri Liikamaa (D-mat ltd.)
Antti Karjalainen (D-mat ltd.)

Reviewers and additional contributions

Tuomas Kallio (Flow Festival Ltd.); Katariina Uusitupa (Flow Festival Ltd.); Tuomas Karppinen (Flow Festival Ltd.); Suvi Kallio (Flow Festival Ltd.); Salla Lahtinen (D-mat ltd.); Freja Schalin (D-mat ltd.); Daniel Leiviskä (D-mat ltd.); Siiri Saarnikko (Flow Festival Ltd.); Eeva Palmén (Flow Festival Ltd.); Mikael Karkkonen (Flow Festival Ltd.).

Layout

Annastina Saari (D-mat ltd.)

Executive summary

Flow Festival is a leading European music and arts festival held yearly in August in the Finnish capital of Helsinki. The festival has a strong emphasis on sustainable and value-based event production. Flow is an internationally acclaimed festival with a content-driven program hosting around 150 acts in 2022, from the biggest stars in current music to indie favourites, cult classics and experimental music and arts. The festival is known for its responsible values, outstanding culinary selection, spectacular festival area, and ambitiously sustainable festival production. Hence, the particularly urban setting and international character of the festival make it special in the broader context of music festivals – as well as in regards to environmental sustainability challenges.

This report presents the methodology and the results of the material and carbon footprint assessment of Flow Festival 2022. Based on the results of the footprint calculations, we present sustainable solutions that aim to decrease the amount of natural resources consumed and the climate impacts caused to organise the festival.

The overall material footprint for Flow Festival 2022 was 7,780 tonnes and the carbon footprint 2,760 tonnes kg CO_2e. This corresponds to a material footprint of 86 kg and a carbon footprint of 31 kg CO_2e per visitor day. The carbon footprint is equivalent to 6% of the average consumption-based emissions in the city of Helsinki for a 3-day period. The footprints per visitor day roughly equal to the lifestyle material and carbon footprints of an average Finn for one day.

The footprints of the festival were assessed for nine different categories that the consumption of different items for the festival were allocated to. Out of these categories, the visitors category, including visitor travels and accommodation, had a share of 73% in both footprints. The main reason behind this huge share is the considerable amount of travelling by both domestic and international visitors to and from the festival.

With a share from 4% to 10% in either of the footprints' most relevant categories were food and beverages, organiser logistics, stage production and properties. Relevant items for the footprints of these categories were, amongst others, beverages, the flights of artists and their crew, the stage structures, and the ground improvements before the festival.

Although Flow Festival Ltd. has implemented an environmental program for more than 10 years already, we identified numerous options to further decrease the festival's footprints. For a part of these options, the effects were quantified. The study shows that there is a remarkable potential but also still a huge need for reducing the festival's footprints in order to develop people's leisure activities to be in line with global targets for environmentally sustainable consumption.

Table of contents

01

INTRODUCTION

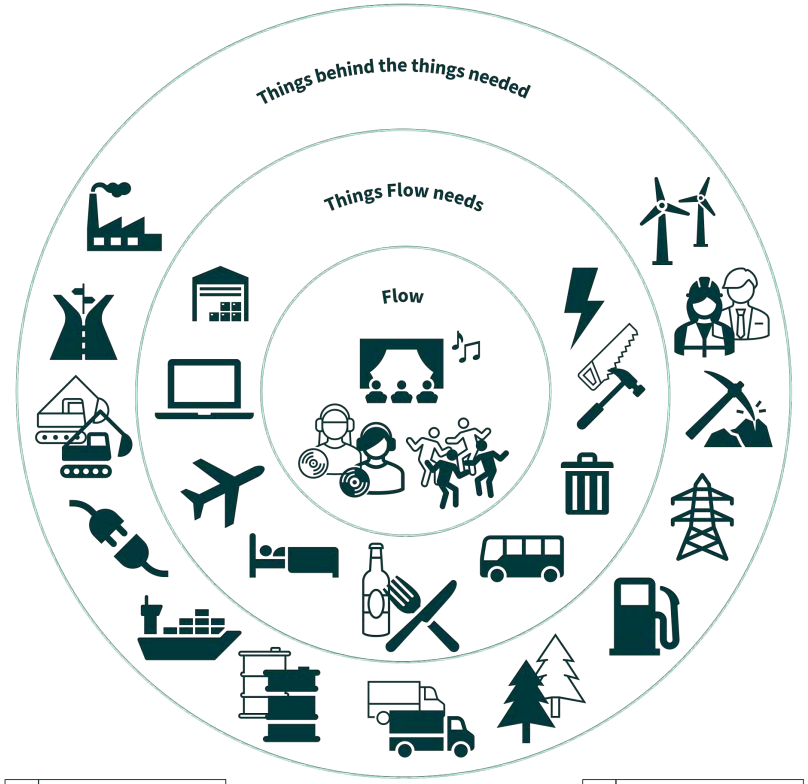
Leisure time activities contribute to counterbalance between the many pressures modern people are facing. However, as all consumption also leisure activities, such as music festivals contribute to the increasing pressure on natural ecosystems, the solution of which has turned out more and more urgent, especially in relation to global warming and biodiversity loss. In industrialised countries, leisure activities make up a big share of lifestyle footprints. In Finland, for example, they contribute 6% to the average lifestyle carbon footprint, and leisure-related travelling another more than 15% (Akenji et al., 2021).

The share of 6% for leisure activities might appear moderate but the 540 kg of carbon footprint for leisure activities equals to 22% of the lifestyle carbon footprint we can afford in 2030 if we want to keep within the aspirational target of limiting global warming to 1.5°C in comparison to pre-industrial levels, as set by the Paris Agreement in 2016 and reconfirmed in the climate conference in Sharm el-Sheikh in November 2022. In order to keep global warming at an acceptable level, we thus have to consider how the production and consumption of leisure activities can reduce the related carbon footprints. In addition, also other environmental aspects should be considered because biodiversity loss, for example, is considered a problem of similar dimension as climate change but it is a lot more difficult to express in terms of lifestyle-related indicators.

Flow Festival is a leading European music and arts festival held yearly in August in the Finnish capital of Helsinki. The festival has a strong emphasis on sustainable and value-based event production. Flow is an internationally acclaimed festival with a content-driven program hosting around 150 acts in 2022, from the biggest stars in current music to indie favourites, cult classics and experimental music and arts. In 2022, Flow Festival hosted over 160 artists and reached a record 90,000 visitor days, with 48,000 unique visitors. The festival is known for its responsible values, outstanding culinary selection, spectacular festival area, and ambitiously sustainable festival production. Flow is driven by the idea that creating a high-quality, comprehensive festival experience and working towards a more sustainable future can and should be mutually inclusive. The festival has assessed and compensated its carbon footprint since 2009, in addition to numerous other parts of its ambitious environmental programme.

In 2021, this work was taken up a notch as a more extensive research project into the sustainability of the festival was launched in collaboration between Flow Festival Ltd. and D-mat ltd. This research has for the first time captured the material footprint in addition to the carbon footprint of the festival, and advanced the calculation of carbon footprint to include more indirect emissions related to the festival as widely as possible. This provides a more comprehensive view into the environmental impact of Flow Festival than earlier, and presents the opportunity to reduce the environmental impacts holistically with new solutions targeting the key hotspots in terms of the festival's sustainability.

This report presents the methodology and the results of the material and carbon footprint assessment that D-mat ltd. has executed for Flow Festival 2022. For us to enjoy a festival like Flow, there is a whole chain of material flows required. As any kind of consumption, also Flow Festival has its inputs, outputs and their environmental impacts. These can be seen in Figure 1.1. This research



Natural resources	Inputs
	Fossils
	Minerals
	Biomass
	Soil
	Water
	etc.

Environmental damage	Impact	
	Climate change	Ozone layer
	Resource depletion	Nutrification
	Biodiversity loss	etc.
	Toxic effects	

Emissions	Outputs
	GHG emissions
	Other emissions into air
	Waste
	Noise
	Water emissions
	etc.

Figure 1.1: Flow Festival's natural resources use, environmental damage and emissions. In highlight what is taken into account in this report.

aims to discuss not only the greenhouse gas emissions in the form of carbon footprints, but also to further identify the main material flows in terms of material footprints. Based on the results of the footprint calculations, we present customised sustainable solutions that aim to reduce both footprints and by so decrease the climate impacts caused and the amount of natural resources used to organise the festival. These solutions are to further guide the planning and execution of future Flow Festivals.

02

FOOTPRINT ASSESSMENT METHODOLOGY

Footprint indicators are used to illustrate the links between consumption and the use of natural resources and related environmental impacts (Lettenmeier, 2018). Footprints are related to both consumption and production because they are based on the life-cycle of the products and activities assessed.

The **material footprint** assesses the material flows of products, activities and lifestyles as a whole and illustrates the total use of primary natural resources by humans and thus also measures the success of the circular economy. In other words, it aims to quantify general human pressure on nature instead of single environmental problems. It is typically expressed in tonnes or kilograms of natural resources, e.g., kilograms per capita per year (kg/cap/yr). The idea of the material footprint is to understand the reasons behind global environmental degradation, since any material extraction and use always entails environmental impacts. One of these impacts is climate change from greenhouse gas emissions, measured by the carbon footprint, but the material footprint represents also other known and yet unknown environmental problems related to the use of natural resources in general. (Lettenmeier, 2018; Schmidt-Bleek, 2000)

The **carbon footprint** measures the total amount of greenhouse gas emissions caused by for example individuals or events and it is expressed in carbon dioxide equivalents (CO_2e). At present, the carbon footprint is probably the most popular indicator covering the whole life cycle of products and activities. Carbon footprinting has been widely adopted on product level and is increasingly used also to report the climate impacts of products, services, individuals, companies and public entities.

Footprints are calculated by multiplying the amount of consumption of, for example, a material, product or activity, by a specific intensity factor. An intensity factor is the sum of material inputs or greenhouse gas outputs, respectively, associated to the unit of consumption; per kilogram of material or product, per piece of equipment or per kilometre travelled, depending on the characteristics of the respective item. As many items used in the festival are reusable in subsequent festivals or other occasions, the footprints were divided by estimated items' lifetimes, and only the portions spent for this particular festival were accounted for. The approach is further described below.

The overall assessment process entailed following stages:

1. Definition of scope and central assumptions
2. Collection of consumption data
3. Collection of material and carbon intensity data
4. Footprint assessment
5. Analysis and identification of hotspots

To illustrate the size of the material and carbon footprints in an understandable and comparable unit, we express the footprints of the festival per **visitor day**. This is calculated as the total material and carbon footprints of the festival divided by the amount of day tickets sold. The number of sold day tickets was 90,000 in 2022 and the number of unique visitors was 48,000. If a visitor has attended the festival all the three days, this results in a three times bigger share of the total footprint than a visitor that has attended the festival only for one day.

In order to make the general calculation procedure described above feasible, the scope of the calculations have to be determined and a number of assumptions have to be set.

2.1 Scope and central assumptions

The footprint calculation is based, in principle, on any use of goods, materials, or services, as well as any other activities required for organising and performing Flow Festival. In order to produce both meaningful and realistic results, boundaries for what is taken into account in the calculations and what is left out were set at the start and refined in the course of the project. The consumption aspects and items that were left out of scope can be found in Appendix 1. The items included in the scope of the calculations are not listed here in detail but are summarised in the results in Appendix 2. Relevant details are also mentioned in section 3 in the category-wise presentation of the results.

Since sufficient data does not always exist or is not always available, or the interpretation of the data and the activities is not always unambiguous, several assumptions had to be made. The results can depend greatly on assumptions, e.g., what different products' life cycles consist of and how large is the share of their footprint that must be allocated to Flow Festival. Especially in the case of technical infrastructure, such as audio technology, specific material inputs for different products were sometimes impossible to find. More on the assumptions can be read in this report.

Since this research is based on the best data available and necessary reasoned assumptions have been conducted, the calculations are precise to an adequate degree to give a sound estimate of the 2022 Flow Festival material and carbon footprints. The calculations are particularly well suitable for a comparison of the different consumption categories' impacts on the total footprints.

2.2 Consumption data

The consumption data has been collected in close collaboration with Flow Festival Ltd. and its main partners. While the organisers have a clear perception of the festival's consumption, considerable efforts were still required in collecting detailed data and in developing the systematics to arrange the numerous consumption items into the most useful and logical categories.

The consumption data includes a specific **'usage by Flow'** factor for any item that was also used for other purposes than Flow Festival 2022. The 'usage by Flow' factor is calculated by dividing the number of days an item is rented (or used otherwise) by the festival (including the construction and disassembly periods) by the number of days the item is rented out during its useful life. For example, 0.6-0.8% of the material and carbon footprints for cables were allocated to Flow Festival 2022 due to the efficient use of cables during their useful life and the festival renting them only for a short period of time. In contrast, the consumption of transport and food has a 'usage by Flow' factor of 100%. We were able to find out specific 'usage by Flow' factors for most products in the stage production category and most of the buildings on the

festival site under the properties category. As the ‘usage by Flow’ factor has a remarkable impact on the final material and carbon footprints, considerable efforts were made to receive as realistic and plausible usage values as possible.

A **visitor survey** was conducted during the festival. The central idea of the survey was to get a better understanding of the visitor behaviour and consumption before, during and after the festival and consequently form a more comprehensive picture of the visitors’ share in the material and carbon footprints. The survey consisted of ten questions which were sent randomly to visitors that were logged into the Flow Festival 2022 mobile application. The results of the survey are presented more thoroughly in the analysis of the visitors category and the survey questions are given in Appendix 3. The response rate to the survey varied from 3.6% to 8.8%, depending on the question. This means at least 1,700 respondents out of 48,000 unique visitors. The overall response rate can be considered relatively low but well sufficient for its purpose.

2.3 Intensity data

The material and carbon intensity data were collected mostly from life cycle databases, scientific articles and other specific sources. All sources of and their use for the intensity factors can be found in detail in Appendix 4.

The material footprint is originally based on the MIPS concept (material input per service unit) developed by Schmidt-Bleek and colleagues in the early 1990s (Schmidt-Bleek, 2000; Schmidt-Bleek, 2009). The footprint assesses the material flows of products, activities and lifestyles as a whole and illustrates the total use of primary natural resources by humans. It is typically expressed in tonnes or kilograms, e.g. kilograms per capita per year (kg/cap/yr). In this report, we take into account the abiotic and biotic total material inputs (TMI). The biotic inputs are the renewable resources, such as crops and livestock, while the abiotic inputs originate from non-renewable sources, such as minerals and fossil fuels. Topsoil erosion in agriculture and forestry has originally been calculated as a part of the total material requirement or total material consumption (TMR and TMC). However, there is limited data on erosion intensity factors, so including erosion in the calculations would have meant huge additional efforts that would almost solely have been related to food consumption in the visitors category. Some studies are also limited to the so-called raw-material input (RMI), which also can be called material footprint but does not include unused extraction of materials in its scope. In this study, we calculated the material footprint according to the MIPS concept (see Lettenmeier et al., 2009; Liedtke et al., 2014) because including unused extraction can be seen as essential in environmental terms.

On a larger scale, the idea of the material footprint is to understand the reasons behind global environmental degradation, since any material extraction and use always result in related environmental impacts. One of these impacts is climate change from greenhouse gas emissions but the material footprint represents also other known and yet unknown environmental problems related to the use of natural resources in general. Therefore, it can provide a fairly good overview of whether a particular aspect can be considered sustainable or not. In addition, when assessed over a longer time period, the material footprint is also a measure for analysing the success of the circular economy.

The material intensity factor can be defined as the amount of material that is required to produce a service or a product (e.g. kg/km). Most of the material intensity factors used in this work are from Wuppertal Institute (2014), Kotakorpi et al. (2008), Lähteenoja et al. (2006), and Mostert & Bringezu (2019). A part of the data used was generated by the research team by using life cycle software and databases.

The carbon intensity factor, expressed in carbon dioxide equivalents per unit of consumption (e.g. kg CO_2e/ kWh), assesses the total climate impact of a given item. The carbon dioxide equivalents include also other greenhouse gas emissions expressed with the same global warming potential as one metric ton of carbon dioxide. Since the total climate impact, including all cradle-to-use, is assessed, not only direct emissions are taken into account but also indirect emissions. For example, in the case of car driving not only the emissions during the use, but also emissions caused by the production of the vehicle and the share in building and using roads and other infrastructure required are included in the intensity factor. Most of the carbon intensity factors used in this report are from the Ecoinvent database versions 3.7.1 and 3.8 (Wernet et al., 2016) and more specific sources for Finland-specific intensities. In some specific cases with carbon intensity factors unavailable, the air consumption according to the MIPS concept (see Schmidt-Bleek, 2000; Lettenmeier et al., 2009) was used as a proxy for the carbon intensity.

03

FLOW FESTIVAL 2022 FOOTPRINT RESULTS

In this section, we will discuss the material and carbon footprints of the festival. In addition, we will analyse the footprints through different consumption categories in order to shed more light on the differences between them. The following data categorization was performed together with Flow Festival Ltd. in order to compose the data into meaningful consumption categories from an event organiser's point of view.

The overall material footprint for Flow Festival 2022 is 7,780 tonnes and the carbon footprint 2,760 tonnes kg CO_2e, as seen in Table 3.0.1. The number of total visits, or visitor days, was 90,000 and the number of unique visitors was 48,000. From a visitor's point of view, the material footprint is 86 kg and the carbon footprint 31 kg CO_2e per visitor day. The majority of the total material footprint consists of abiotic resources and they cover 7,520 tonnes, or 96.7% of the total. The biotic resources account for 260 tonnes, or 3.3% of the total material footprint.

The single most significant contributor to the material and carbon footprints is caused by the visitors category. It contributes a total of 73% of both the material and carbon footprint. The reason behind its huge share of the total footprints is the considerable amount of travelling by both domestic and international participants. This is not necessarily a surprising result, as it is very typical for festivals and other leisure events and activities to have high footprints from visitors' travelling (see, e.g., Häkkinen et al., 2000; Autio & Lettenmeier, 2002; Luoto et al., 2008; Veuro et al., 2008; Best Foot Forward & LOCOG, 2010). For Flow Festival, the footprint is quite moderate as most (84%) of its visitors arrive from Greater Helsinki. However, due to the COVID-19 pandemic, the number of international visitors fell for the 2022 festival compared to previous years.

Table 3.0.1: Flow Festival 2022 total material and carbon footprints for each category.

CATEGORY	MATERIAL FOOTPRINT	%	CARBON FOOTPRINT	%
1. Site production	182 t	2.3	45 t CO_2e	1.6
2. Stage production	350 t	4.5	108 t CO_2e	3.9
3. Partner production	220 t	2.8	34 t CO_2e	1.2
4. Properties	362 t	4.6	59 t CO_2e	2.2
5. Organiser logistics	142 t	1.8	283 t CO_2e	10.3
6. Consumption	185 t	2.4	30 t CO_2e	1.1
7. Food and beverages	570 t	7.3	170 t CO_2e	6.2
8. Visitors	5,712 t	73.4	2,006 t CO_2e	72.8
9. Other	59 t	0.8	21 t CO_2e	0.8
Total	**7,780 t**	**100**	**2,760 t CO_2e**	**100**
Per visitor day	**86 kg**		**31 kg CO_2e**	

In absolute terms, the resulting values for the material footprint are higher than for the carbon footprint. The material footprint includes many kinds of material resources, like ores and overburden from mining, earth excavation for infrastructure, fossil fuels, and biomass, out of which only a part – mainly the use of fossil fuels in different stages of the life cycle of materials, products and activities – contributes to the carbon footprint of the event.

In order to give some proportion to the abstract footprint values of 7,780 tonnes of material and 2,760 tonnes of CO_2e, Table 3.0.2 provides a comparison of the total footprints with other meaningful examples. The total material footprint of Flow Festival 2022 equals to almost 4 million and the carbon footprint to 14 million car kilometres. The carbon footprint is equivalent to 1.1% of the yearly direct emissions and 0.4% of the yearly consumption-based emissions in the city of Helsinki. The footprints per visitor day roughly equal to the lifestyle material and carbon footprints of an average Finn for one day.

Table 3.0.2: Flow Festival 2022 material and carbon footprint results in comparison to other footprint and emission values. Source: own compilation, Akenji et al. (2021), City of Helsinki (2022), Kotakorpi et al. (2008).

PRODUCT	MATERIAL FOOTPRINT	UNIT	CARBON FOOTPRINT	UNIT
Flow Festival 2022 total footprint	**7,780**	**tonnes**	**2,760**	**tonnes CO_2e**
Equivalent to car driving	3,800,000	km	14,000,000	km
Equivalent to yearly average lifestyle footprint of appr.	190	Finns	280	Finns
Share of 3 days of Helsinki City consumption-based emissions	-		6	%
Flow Festival 2022 footprint per visitor day	**86**	**kg/ visitor day**	**31**	**kg CO_2e/ visitor day**
Equivalent to car driving	43	km	160	km
Equivalent to average Finn's lifestyle footprint of appr.	1	day	1	day

3.1 Site production

The site production category comprises mostly of the items and production required to build the festival area. This includes all sorts of infrastructure, toilets and waste management, and tents and containers included in these points. However, the stages and partner points (also including tents and containers) were separated into their own categories to help analyse their impact. In addition, the logistics of the items were calculated under organiser logistics and partner production. The total material footprint of the site production category is 182,000 kg and carbon footprint 45,000 kg CO_2e. The biggest material footprint inside the category comes from the electricity infrastructure (56,200 kg) and the biggest carbon footprint from the site lights (13,400 kg CO_2e) as seen in Figure 3.1.1.

The **infrastructure** includes all festival-related elements and building structures, such as fences and roadblocks, gates and different kinds of minor structures, water, electricity, network and IT infrastructure, and site lights (see Figure 3.1.2). The basic structures mostly consist of steel (45 tonnes) and concrete (125 tonnes). Even if they weigh a lot, their impact on the total footprints of basic structures is still fairly small, since their overall life cycle is long and Flow Festival contributes to their usage by only a relatively small share.

The site lights include all the lights, control systems and safety wires needed to light up the festival area of almost 12 hectares. They have a large impact compared to stage audio, video and lights which are very similar categories. This

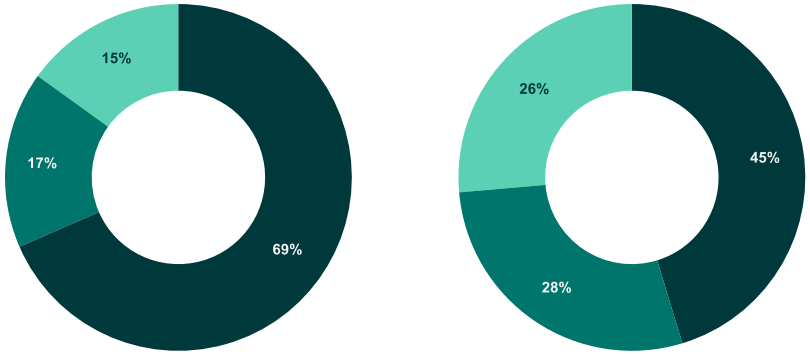


Figure 3.1.1: Material and carbon footprint of site production.

is because a large part of the site lights have a higher ‘usage by Flow’ factor (7%) according to the suppliers that have been contacted.

Electricity infrastructure includes generators (62,000 kg) and cables (10,000 kg) used to build the electricity infrastructure for the site. In this subcategory, the ‘usage by Flow’ is so low that even if there is much material, it does not result in especially large footprints. For festivals in general, the area greatly affects what kind of additional electricity infrastructure is needed. Regarding the Suvilahti area, it does not provide sufficient electricity infrastructure for Flow Festival.

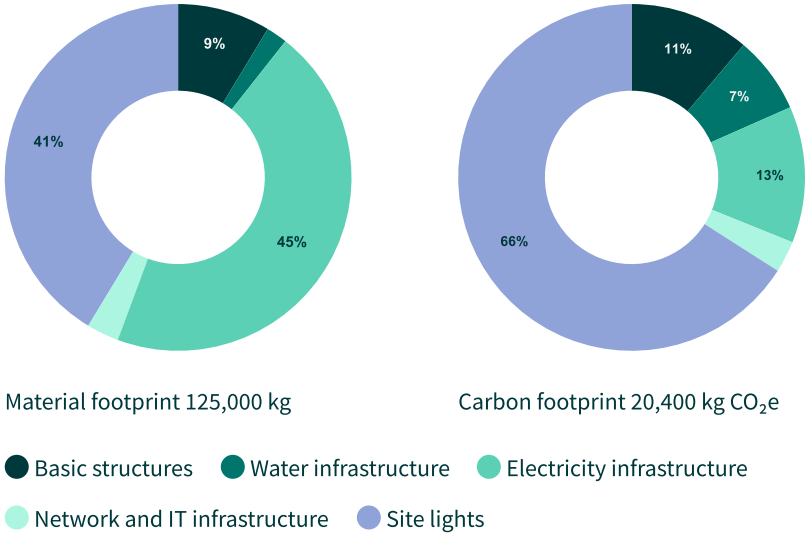


Figure 3.1.2: Material and carbon footprint of site production infrastructure.

The subcategory of **toilets and waste management** includes 538 units of different types of toilets, mostly Bajamaja® Original (302 units), some Bajamaja® Fresh (99 units) and Bajamaja® Pisuaari Kross (65 units), special toilets for the disabled, as well as the septic tanks required for the toilets.

The toilets cause 14% of the material footprint and 26% of the carbon footprint in the site production category. The material and carbon intensity of materials used in portable toilet facilities are relatively low, and the high total footprint originates from the large total weight, of 140,000 kg, of toilet facilities. It was assumed that these toilets consist mostly of HDPE plastic, and some of them also contain steel. The footprint for one toilet is fairly small, but when they are all added together they contribute by a significant share to the footprint of the site production category. The excrement is excluded from calculations and the transportation of all the toilets are located in the organiser logistics category.

Regarding garbage, there were garbage compactors for bio-waste, energy waste and cardboard. The reason for the small footprint in the subcategory of garbage bins and compactors is that it includes only the containers used to store the waste, whereas the waste itself and also the waste management is allocated to the consumption category.

The **tents and containers** included in the site production are those used for e.g., cloak rooms, food and bar services and main gate, to mention a few. The tents are assumed to be on average 83% aluminium and 17% PVC plastics. Aluminium is used in the tent structures and PVC in the tent covers. Neither of the materials are very material nor carbon intensive, but especially the total amount of aluminium used in tents is rather large. Hence, the tents and containers account for 15% and 26% of the total material and carbon footprints of the site production category.

3.2 Stage production

The stage production consists of stages and backstages. The stages include technical infrastructure such as audio, video and lights equipment, building structures and tents and coverings, such as stage roof, wall coverings and tarpaulins. The backstage includes showers, toilets and the containers and tents

required to build the backstage. The total material footprint for the stage production is 350,000 kg and carbon footprint 108,000 kg CO_2e. The structures subcategory causes the largest material (217,000 kg) and carbon footprint (76,400 kg CO_2e) in the category (see Figure 3.2.1).

The **technical infrastructure subcategory** includes all audio, video and lights equipment used in stage production. The differences in their material and carbon footprints are caused by multiple factors, but mostly their different amounts of equipment with high material and carbon footprint intensities and their 'usage by Flow' factors. Figure 3.2.2 shows the final allocations of the footprints. Interestingly, the stage light category results in the smallest footprints even if it is the biggest category in pure mass. There are in total 63 tonnes of lighting equipment, whereas there are 36 tonnes of video equipment and 30 tonnes of audio equipment. The differences in their total footprints stem from the fact that the categories consist of different amounts of more advanced technology and the lights category includes significantly less of these. The lights category also includes the most cables, chain hoists and trusses, adding up to 43 tonnes, with significantly low material and carbon intensities. A big part of the final footprints are also explained by the material and carbon intensities of the item that the category consist of to the most part. In the case of audio it is the different types of speakers and stage monitor systems, for video the LED-screens and for lights the stage lights. The speakers, stage monitor systems and the LED-screens have significantly higher material and carbon intensities than stage lights. In addition, the weighted average 'usage by Flow' factor for the video equipment is almost twice the one of audio or lights. More detailed values used in the calculations of technical production can be found in Appendix 5.

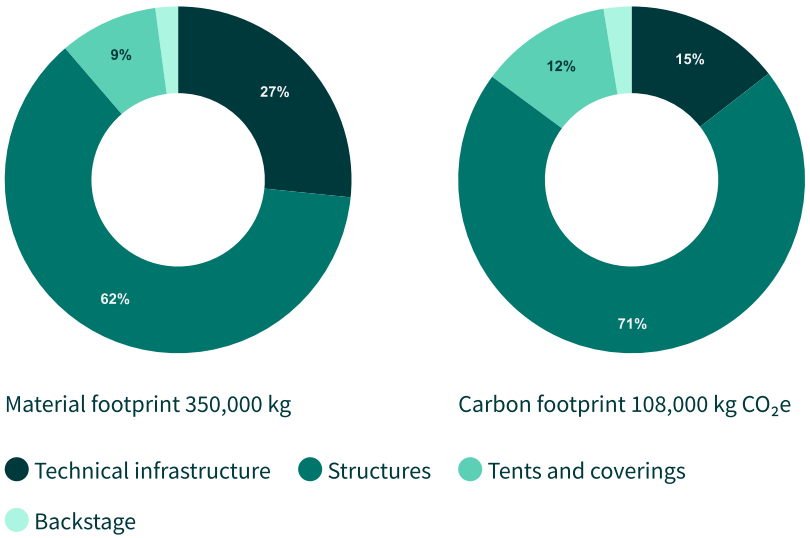


Figure 3.2.1: Material and carbon footprint of stage production.

The material compositions of the different electrical appliances were in great part achieved from field experts. Still, the material footprint for electrical appliances is strongly determined by the amount of logical integrated circuits. Although their share is rather small in the whole device, even a slight change in their amount or material intensity affects considerably the total material footprint of the device. Attaining information of the structure of a device on this level of detail is very demanding if not practically impossible in many cases. When more detailed modelling of an electrical appliance was not possible or reasonable, the electrical appliances were modelled as an 'average consumer electrical appliance'.

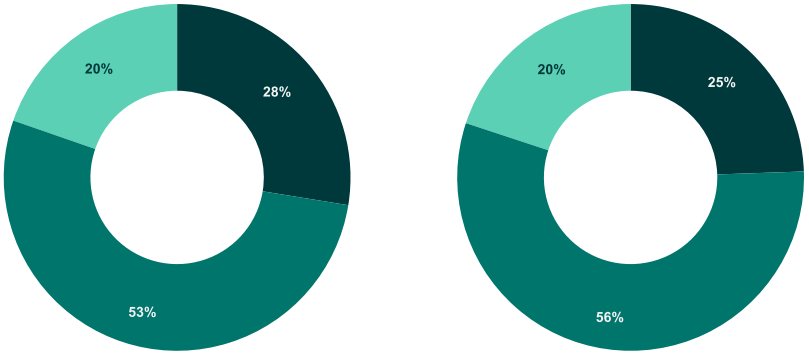


Figure 3.2.2: Material and carbon footprint of stages' technical infrastructure.

The stage **structures** cause a large part of both footprints in the category of stage production: The material footprint adds up to 62% and the carbon footprint 71%. These structures include a lot of steel and a smaller amount of aluminium. These metals have mostly moderate material and carbon intensity factors, and the high total footprints of this subcategory is due to their huge amount. For example, the Main Stage's structures weigh appr. 425 tonnes in total.

In addition to structures and technical infrastructure, **tents and coverings** cause 9% of the material footprint and 12% of the carbon footprint in the stage production category. Tents and coverings have moderate material and carbon footprints due to their low 'usage by Flow' factor of 2.3%, which was used for all tents. Most of the tents are assumed to be 83% aluminium and 17% PVC plastics, where aluminium determines most of the footprints also because it has remarkably higher intensity factors than PVC. The Red Arena's Valhalla tent, weighing roughly 60,000 kg, stands out in the footprints for stage tents and coverings with its material footprint of 22,500 kg and carbon footprint of 9,300 kg CO_2e.

The **backstage** mostly consists of different types of tents and containers and plays a very small role in the overall footprint as well as in the footprint of the stage production category, with only 7,400 kg (2% of the category) for the material footprint and 2,800 kg CO_2e (3%) for the carbon footprint. This is due to the small absolute amount of containers and tents used for the backstage and their low 'usage by Flow' factor. Moreover, the backstages subcategory does not contain the electronic components or furniture used in the backstages, since these are included in the other category.

In total, Flow Festival has nine stages in varying sizes and styles. Figures 3.2.3 and 3.2.4 show the **differences in the stages' footprints** for the five biggest stages. Here, energy use, transport to the festival, backstages and DJ equipment have been excluded. It is important to note that the stages play their fair share in the footprints of energy consumption and transportation. In general, the more audio, video and lights a stage has, the more it consumes energy and the more massive a stage is the more transportation it requires. In addition, there can be a huge difference between the number of visitors who get to enjoy a stage and it should be taken into account when comparing stages. In other words, smaller stages fit less viewers and vice versa.

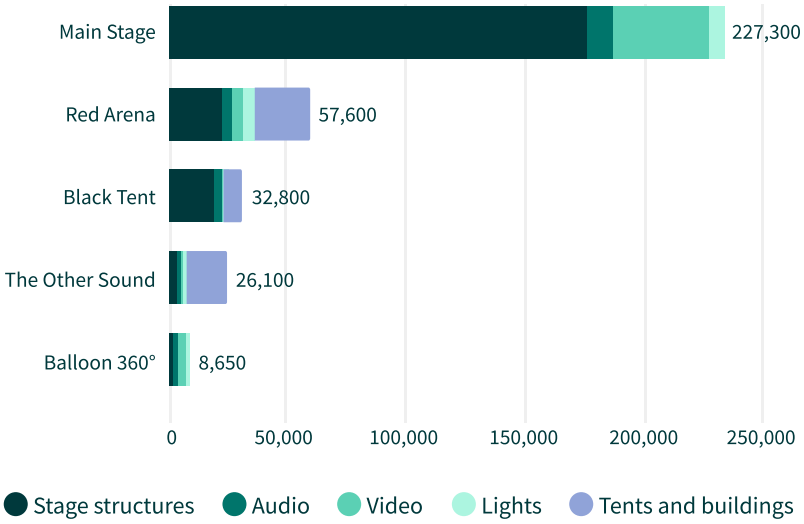


Figure 3.2.3: Comparison of the five biggest stages' material footprints (kg), excluding energy consumption, transport to the festival, backstages, instruments and DJ equipment.

When it comes to the structures and tents, it should be pointed out that these are structures brought to the area by Flow Festival Ltd. The Other Sound, that is in one of Suvilahti's buildings, shows how even the use of a building always has an impact, especially shown in its material footprint. The Other Sound uses 1600 m^2 of building space resulting in 18,100 kg in material footprint and 740 kg CO_2e in carbon footprint. Still, as the building already is in the area it would be strange to not use it, but these should be taken into account if a new building for events is to be planned for an area.

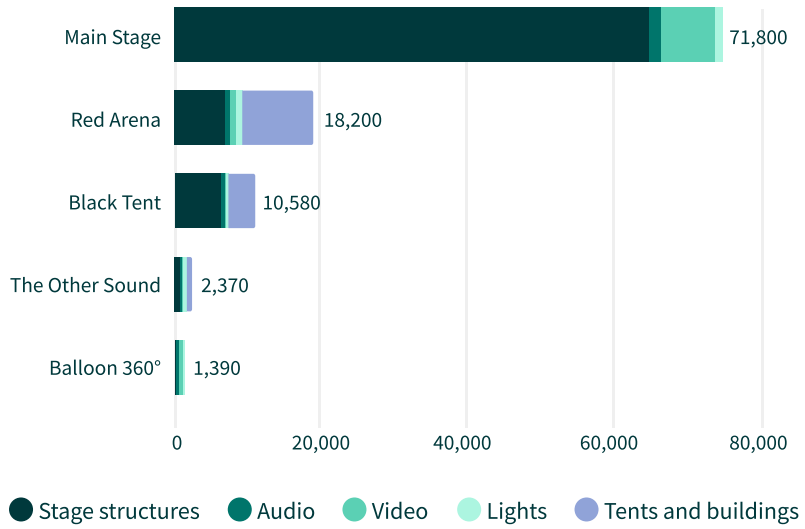


Figure 3.2.4: Comparison of the five biggest stages' carbon footprints (kg CO_2e), excluding energy consumption, transport to the festival, backstages, instruments and DJ equipment.

The Main Stage, with its huge mass, stands clearly out in all of the categories of the comparison. Especially when it comes to video production, the Main Stage's around 60 m wide LED-screens show their true colours. Red Arena and Black Tent are also big stages, but nothing compared to the Main Stage in terms of mass.

3.3 Partner production

The partner production consists of all production-related logistic activities that are carried out by different partners, as well as the structures needed to build partner points. Most partners at Flow Festival are related to food and bar services, but there are a dozen other partners from different fields, such as technology. The total material footprint for this category is 220,000 kg and the carbon footprint 34,000 kg CO_2e (see Figure 3.3). For both footprints, the biggest cause is land transportation of equipment, with a material footprint of 162,100 kg and a carbon footprint of 26,700 kg CO_2e.

As mentioned, the biggest share in the total material and carbon footprint in the partner production category is caused by **logistics**. The total amount of logistics kilometres is 43,600 km including only land freight. The land freight consists mainly of driving with passenger cars, vans and different sized lorries, most of which run on fossil fuels. The large footprints associated with car transportation originate from the high carbon footprint from fuel combustion and the high material consumption required to build roads, which is included in their material footprint. Thus, logistics cover most of the partner production category.

For the partner logistics, the calculations include both delivery and potential return of the products. The return logistics of those products that were delivered straight to another festival or for other purposes after the use of Flow Festival, were not included in the calculations. The return was in these cases concluded to be the receiving party's responsibility and hence out of scope. In other words,

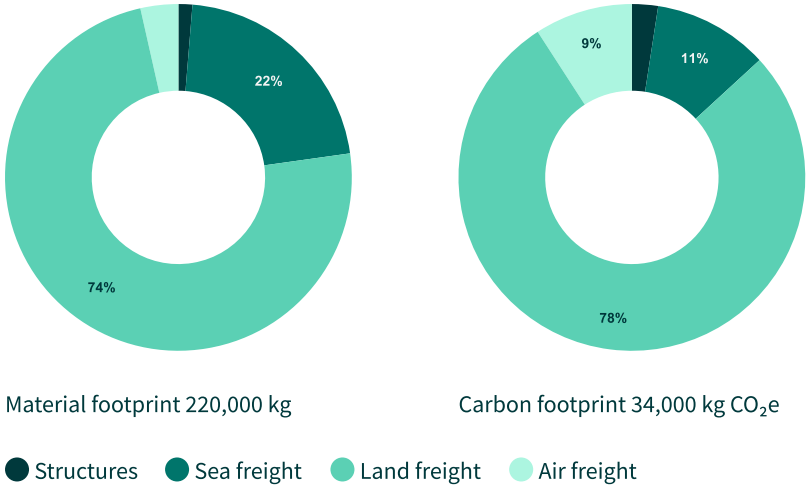


Figure 3.3: Material and carbon footprint of partner production.

if the product was not returned to its owning company, the return trip was excluded from the calculations.

Most partners in the food and bar services sector do not bring their own **structures** to the festival area as they are provided by Flow Festival Ltd. and therefore are not included in this subcategory. The rest of the partners outside the food and bar services do bring their own structures, of which they are responsible for in means of chosen materials and their amounts. Flow Festival Ltd. can guide these partners to choose environmentally friendly materials etc. but in the end, the decision regarding the structures is made by the partners themselves. For these partners, we have assumed an average of 2,000 kg of

material for structures and that the products are used on average for 200 days during their useful lifetime. These assumptions are rough since more precise data was not available. As all of the partners have a small role in the whole of structures used for the festival, their total impact is also rather small. The material footprint for the partners' structures is 2,800 kg and carbon footprint 830 kg CO_2e.

3.4 Properties

Properties include the festival site and buildings, the offices and storage that are owned by Flow Festival Ltd., as well as the ground improvement and site machinery required to finalise the festival site for the event. The total material footprint for the properties category is 362,000 kg and the carbon footprint 59,000 kg CO_2e (see Figure 3.4). The highest share in the material footprint comes from the ground improvement before the festival (207,300 kg) and the highest share in the carbon footprint from the all-year-round storage that has to be heated during the winter season (31,500 kg CO_2e).

Ground improvement contributes 206,300 kg of the material footprint and 8260 kg CO_2e of the carbon footprint of the properties category. Ground improvement includes turfgrass, crushed stone and some decorative pebbles brought to the festival site. The material and carbon intensities of these materials are actually really low, and the rather high total footprints are caused by the remarkable amount of crushed stone used to level the area. The difference in the intensity factors causes the differences of material and carbon total footprints, however

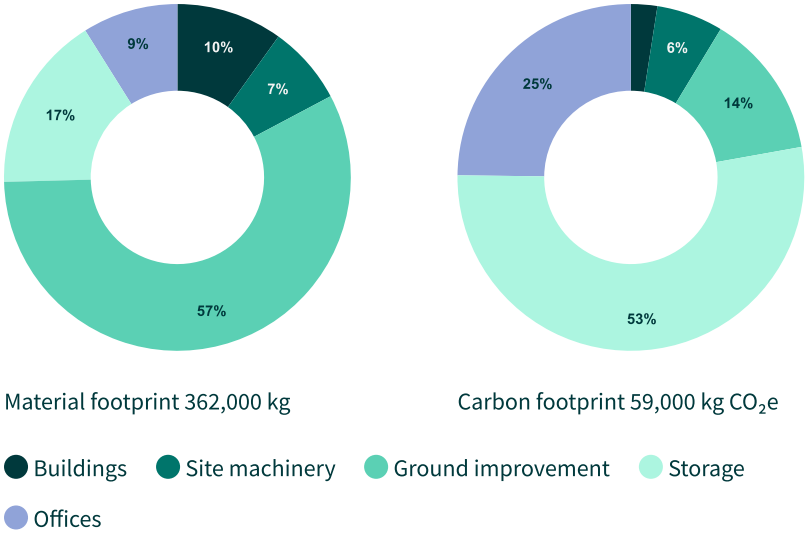


Figure 3.4: Material and carbon footprint of properties.

the chemicals have been excluded from the footprint assumptions due to insufficient data.

Site machinery, such as big trucks, scissor lifts and cranes, have been included in the properties category, since it depends on the site and type of the property what kind of site machinery is needed. Site machinery stands for a material footprint of 26,500 kg and a carbon footprint of 3,700 kg CO_2e.

In total, Flow Festival Ltd. rents 4,800 m^2 of space from the Suvilahti area **buildings** for the festival site. The 'usage by Flow' factor has been collected for

most of the buildings straight from the renting party. The overall 'usage by Flow' factors are quite low for all buildings except for the newly renovated Tiilikello building. Therefore, the share of these buildings in the footprints of the properties category are rather decent, as their usage for the festival's purpose is very low. The footprints of the properties are based on a study regarding the material footprint of some of the buildings owned by the University of Helsinki (Sinivuori, 2004) and KotiMIPS (Kotakorpi et al., 2008).

Flow Festival Ltd.'s office is a 190 m^2 space located close to the festival area. It accounts for 32,200 kg for the material and 14,700 kg CO_2e for the carbon footprint in the properties category. It is heated with district heating and powered by wind electricity, which both have moderate (heat) or even very low (wind power) carbon intensities. The office space itself does not have a big impact on the material footprint but due to its all year round use and heating it causes the second biggest impact for the carbon footprint in the category of properties.

For storage purposes, Flow Festival Ltd. has a 400 m^2 share of a heated building and a few containers for all year storage that are mostly used for decorations and other yearly utilised goods. This space accounts for 59,600 kg for the material and 31,500 kg CO_2e for the carbon footprint in the properties category. As the storage building is rather sizeable and heated all year round, its carbon footprint becomes the largest inside the category of properties.

3.5 Organiser logistics

The organiser logistics category includes air, sea and land freight of festival equipment and items that were delivered by Flow Festival Ltd. Other festival-related logistics are included in the partner production category. However, the partner production category also includes items delivered to build the festival area, but these are done in cooperation with different subcontractors and hence allocated to the partner production category. Additionally, the organiser logistics includes the travelling of artists, their crew, and their and Flow Festival staff's accommodation. The total material footprint of the category is 142,000 kg and the carbon footprint 283,000 kg CO_2e. The biggest footprints are caused by the flights of artists and their crews, which dominates the whole category (see Figure 3.5). Its material footprint is 87,200 kg and carbon footprint 269,600 kg CO_2e.

As mentioned, the main contributor for the footprint of the organiser logistics category comes very clearly from the logistics of **artists and their crew**. This subcategory consists mainly of flights to Helsinki-Vantaa Airport, most of which are scheduled flights and only three private charter flights that have been organised by Flow Festival Ltd. for the artists. Regarding travelling distances, only 1% of the artists and crew scheduled flights arrive from outside Europe, whereas 30% are scheduled flights from within Europe. It is also noteworthy that some artists also have quite a bit of crew accompanying them, which is very evident from their total number: Out of 980 people in the artists and crew subcategory, only 160 are performers while 820 are mainly crew members.

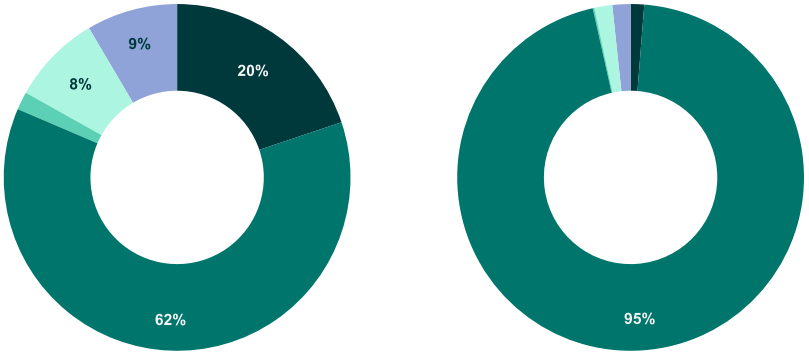


Figure 3.5: Material and carbon footprint of organiser logistics.

The effects of flying become visible especially in the carbon footprint, as greenhouse gas emissions of flying are remarkable and flying usually means travelling long distances. In this footprint assessment we have used a carbon intensity coefficient for flying (0.34 kg CO_2e/pkm) calculated for the 1.5-Degree Lifestyles -research (Akenji et al., 2021), which includes the warming potential of the contrail and water vapour resulting from air travel in high altitudes. On the contrary, flying is not so material-intensive, as the need for built infrastructure is relatively low in the case of flying, which shows in the footprint when comparing it to the carbon equivalent. The material intensities of the different modes of transportation are from the Transport MIPS study (Lähteenoja et al., 2006).

Especially charter flights have a huge impact on both the material and carbon footprints, since the material and carbon intensity of flying is not divided by multiple passengers, as it usually is with scheduled flights. However, most artists who arrived at Flow Festival by flying chose a scheduled flight. Only the inbound flight to Finland is included in the footprint for Flow Festival, as the outbound flight to the next festival or tour is categorised to be out of scope and belong to the next event's footprint.

Other means used to travel by artists and crew include bus, car and ferry, of which car transportation is mostly from the airport to the hotels or the festival area. In addition, a large part of the artists performing at Flow Festival are local Finnish artists who typically arrive to the festival area from nearby locations. Therefore, as their logistics are not controlled by Flow Festival Ltd., their footprints are excluded here.

The **freight of items and production**, and the **accommodation of artists, crew and Flow Festival staff** show mainly in the material footprint, but are still rather small compared to the total footprint of organiser logistics because the flights of artists and crew dominate this category. The material and carbon intensities for a hotel night are from the Household MIPS research (Kotakorpi et al., 2008). Here, only hotel nights are taken into account and e.g. staff and artists accommodating at home are not included.

3.6 Consumption

In this section we discuss direct consumption of energy, municipal waste management and water consumption. The total material footprint for the category is 185,000 kg and carbon footprint 30,000 kg CO_2e. While energy, especially fuels, is the main cause for the material footprint (171,800 kg), it causes just a bit less than half of the carbon footprint, which is more heavily affected by waste (15,900 kg CO_2e) (see Figure 3.6). The more precise consumption and the resulting material and carbon footprints can be seen in Appendix 6. Here, only energy, fuels, water and waste consumption are taken into account and all physical infrastructure needed for the consumption, such as generators and waste compactors are included in the site production category.

At the festival area, **energy** mainly came from generators (appr. 94%, LPG not included), as the area does not have a sufficient electricity network for the festival's purposes. Usually, a double set of generators are used in case the primary ones stop working. The generators work with Neste biofuels (Neste MY Renewable Diesel™ and Neste MY Polttoöljy™).

What comes to grid electricity, it has a remarkably lower material and carbon intensity than electricity produced by the generators, even when the generators are powered by biofuels. This is due to the wind power purchased by Flow Festival Ltd. from the municipal network, which has very low material and carbon intensities. However, this is a very risky way of powering the festival, as the grid power might cut off and cause tremendous damage for the festival. The food services and outdoor space heaters also use liquefied petroleum gas

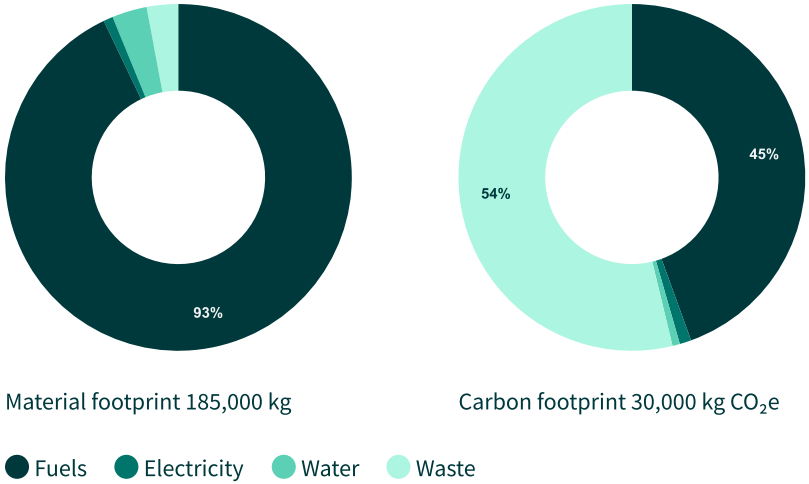


Figure 3.6: Material and carbon footprint of consumption.

(330 kg) as a source of energy, but it has a minimal impact on the total footprint.

For **waste**, only the impact of the waste management was calculated as the material itself is taken into account in other parts of the assessment. The waste subcategory footprints do not include toilet waste, since it is immediately taken care of by the toilet provider. As can be seen in Appendix 6, the material footprint of the subcategory of waste is small compared to other items, and the numerical value of the carbon footprint of waste is actually larger than the material footprint. This is a result from the "input-based" nature of the material footprint. The material footprint and consumption are typically allocated to actual products themselves, and in the moment when a product becomes

waste, no big amounts of material resources are typically consumed if landfill disposal is excluded from the waste management options. Hence, the material input for waste arises mostly from the additional materials needed in the waste treatment, for example in or for sorting and treatment facilities, and these are small.

Regarding **water** consumption, a total of 602,000 litres was consumed during the festival. This resulted in a low share of the footprints. Water, especially in Finland, has very low carbon and material intensities, which is the reason behind the small total material and carbon footprints.

3.7 Food and beverages

The total material footprint for the food and beverages category of Flow Festival 2022 is 570,000 kg and the carbon footprint 170,000 kg CO_2e. Out of different participants and organisers, the visitors have the biggest food material (288,200 kg for food and 249,200 kg for beverages) and carbon footprint (66,100 kg CO_2e for food and 96,800 kg CO_2e for beverages) due to their huge amount (see Figure 3.7). They are also the main group for beverage consumption. The carbon footprint for the beverages consumed by the visitors is greater than the footprint for their food, whereas their material footprint for beverages is slightly smaller than their footprint for food. The footprints of utensils, plates and glasses were also added to the total footprint of food and beverages, but were not visualised separately as their contribution to both footprints is very small.

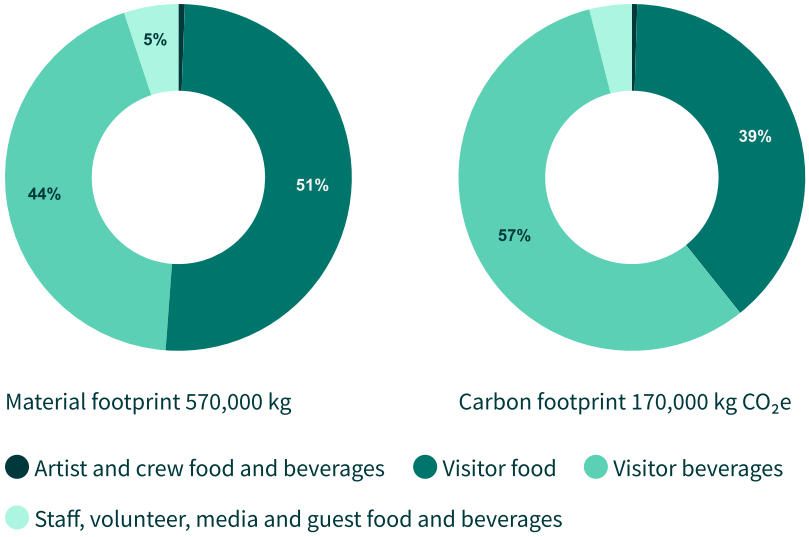


Figure 3.7: Material and carbon footprint of food and beverages.

Of the **food** servings, vegan meals had the biggest share in the total material and carbon footprint for food as they were the most sold meal type. However, they had the lowest meal specific material and carbon footprints, whereas fish meals had the highest and the vegetarian meals were in between. The differences between the meals can be seen from Table 3.7.1. In the 2022 festival, no red meat, pork or chicken meals were served. In addition, 50% of the meals served were vegan. The meals footprints were built on average meals (Finnish Food Authority, n.d.; Flow Festival, n.d) and are assumed to weigh on average 400 grams. No utensils or plates are included in the meals material and carbon footprints, but their impact is added to the category's total footprints.

Table 3.7.1: Footprints and amounts for meals consumed by visitors in 2019 and 2022.

MEAL TYPE	NUMBER OF PORTIONS CONSUMED		PER MEAL MATERIAL FOOTPRINT	PER MEAL CARBON FOOTPRINT
	2019	2022		
Vegan	Included in vegetarian meals	50,000	2.0 kg	0.4 kg CO_2e
Vegetarian	46,000	31,000	2.7 kg	0.6 kg CO_2e
Fish	8,300	21,000	3.2 kg	0.8 kg CO_2e
Meat	37,000	0	4.8 kg	1.5 kg CO_2e
Total	**92,000**	**102,000**		

The differences in the footprints of vegan, vegetarian, and fish meals can be explained by their material and carbon intensities. The meal ingredients, such as soy protein, cheese, and fish have unique material intensity factors: both are smaller for, e.g. soy than for fish. Also, for example, the intensity factors for cheese are rather high (material intensity factor 11 kg/kg and carbon intensity factor 13 kg CO_2e/kg) and as the vegan meal does not include cheese, the footprints of the vegan meals are smaller than for vegetarian and fish meals.

Regarding **beverages**, we have calculated only the footprints caused by visitors, as they are the main audience for drinks. The total material footprint of beverages was 249,200 kg and the carbon footprint 96,800 kg CO_2e. Out of different beverages, beer had the biggest total material and carbon footprints and it was also the second most consumed beverage, just after wine, which was the most sold beverage. However, the material and carbon footprints of a portion of wine are the smallest compared to other portions of alcoholic beverages. The differences between the beverages can be seen from Table 3.7.2.

Table 3.7.2: Footprints and amounts for beverages consumed by visitors in 2022.

BEVERAGE	NUMBER OF PORTIONS CONSUMED	PER PORTION MATERIAL FOOTPRINT	PER PORTION CARBON FOOTPRINT
Wine (120 ml)	110,800	0.15 kg	0.14 kg CO_2e
Beer (330 ml)	103,000	0.9 kg	0.35 kg CO_2e
Long drink (330 ml)	71,100	1.0 kg	0.3 kg CO_2e
Cider (330 ml)	22,400	0.9 kg	0.5 kg CO_2e
Spirits (40 ml)	53,800	0.3 kg	0.15 kg CO_2e
Champagne (120 ml)	12,400	0.15 kg	0.14 kg CO_2e
Soft drinks (330 ml)	49,700	0.55 kg	0.06 kg CO_2e
Total	**423,200**		

3.8 Visitors

Emissions from visitor travels were among the highest footprints of the whole festival, even though most visitors come from Greater Helsinki. There were 48,000 visitors at Flow Festival 2022, which is one of the reasons why the visitor travels cover such a huge share of the total festival footprint. Similar results can be seen in other mass events as well. Transport was one of the main contributions in emissions and natural resource use in the London 2012 Olympic Games and Paralympic Games as well as in the FIS Nordic World Ski Championships 2001 in Lahti (International Olympic Committee, 2018; Neopoli oy, 2001). The whole material footprint of the category is 5,712,000 kg and carbon footprint 2,006,000 kg CO_2e (see Figure 3.8.1). Especially the subcategory of travels from outside Greater Helsinki has a heavy effect on the category's footprints, as it causes 86% of the material footprint and 94% of the carbon footprint of the visitors category.

The share of where visitors travelled from to the festival can be seen in rough in Table 3.8.1. The most visitors come from Helsinki (72% of all visitors) and Espoo (6.7% of all visitors), which shows the urbanity of the festival. Visitors arriving from different parts of Europe came especially from Estonia, Germany and the UK. The 2022 footprints for travels outside Greater Helsinki are comparably small to festivals or other events that have a bigger share of visitors coming from far away. However, the COVID-19 pandemic has had an impact on the amount of international visitors, as their amount has decreased drastically compared to previous years. Whether the amount of international visitors will rise back to its previous numbers is yet to be seen.

Figure 3.8.1: Material and carbon footprint of visitors.

Table 3.8.1: Share of visitors on the basis of their arrival destination.

VISITORS FROM	%
Greater Helsinki	84.0
Rest of Finland	12.0
Europe	3.6
Outside Europe	0.4

Both travels to and from the festival are included, since it can be assumed that most people travel to Helsinki specifically for Flow Festival and since travelling inside Greater Helsinki to the festival area and back to the place of accommodation is here allocated all as Flow Festival Ltd.'s responsibility.

Figures 3.8.2 and 3.8.3 show the kilometres travelled by different travel modes and their total footprints for visitor **travel outside Greater Helsinki**. The 16% of visitors arriving from outside Greater Helsinki stand for a comparably big part of the visitors' footprint. This is due to the long distances travelled and the fact that nearly all of the long distance travel modes have a comparably high carbon and material footprint. For the carbon footprint, trains are an exception,

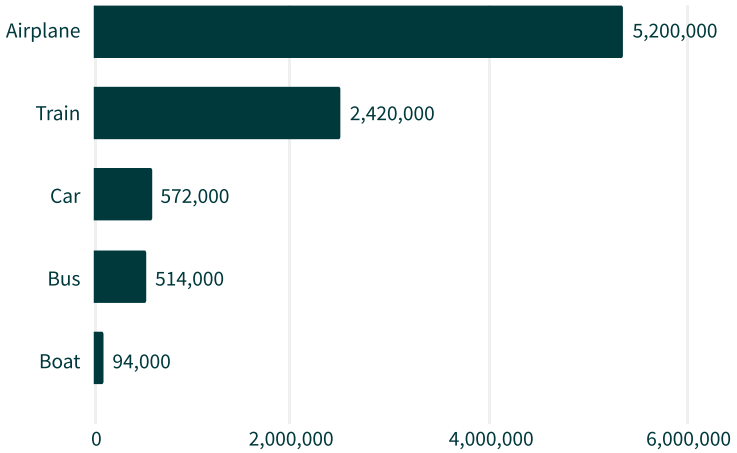


Figure 3.8.2: Visitor travel (km) outside Greater Helsinki.

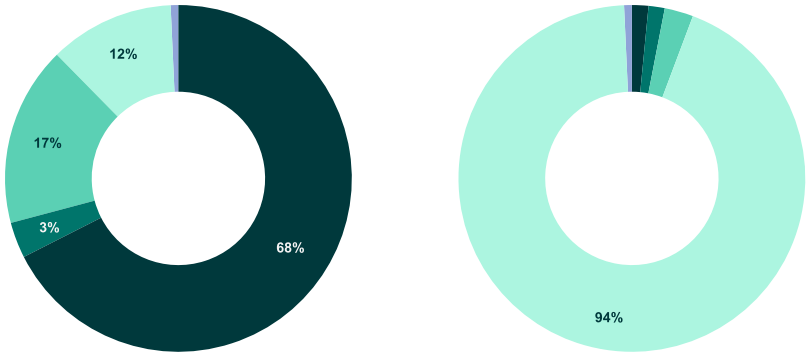


Figure 3.8.3: Material and carbon footprint of visitor travel outside Greater Helsinki.

as their footprint is exceptionally low in Finland. Then again, the material footprint of train travelling is very high due to the high need of constructions and low usage rate e.g. compared to roads. The intensity factors are specific to Finland, where the usage rate of train racks is lower than in Central Europe, since most of the train travelling in the case of Flow Festival happened in Finland.

Figures 3.8.4 and 3.8.5 show the distances travelled by different travel modes, excluding the negligent footprints of bicycles and electric bicycles, and their total footprints for visitor **travel inside Greater Helsinki**. These include a way to

and from the festival for each visitor day. It can be seen that transport modes with low material and carbon footprints, public transport, walking and bicycle, are popular at Flow Festival. This is likely due to the central location of the festival and the extra bike stations and strengthened public transport during the festival. As for public transport, the metro (50%) was the most used in terms of distance. Behind the metro came the bus (30%), tram (10%) and train (10%).

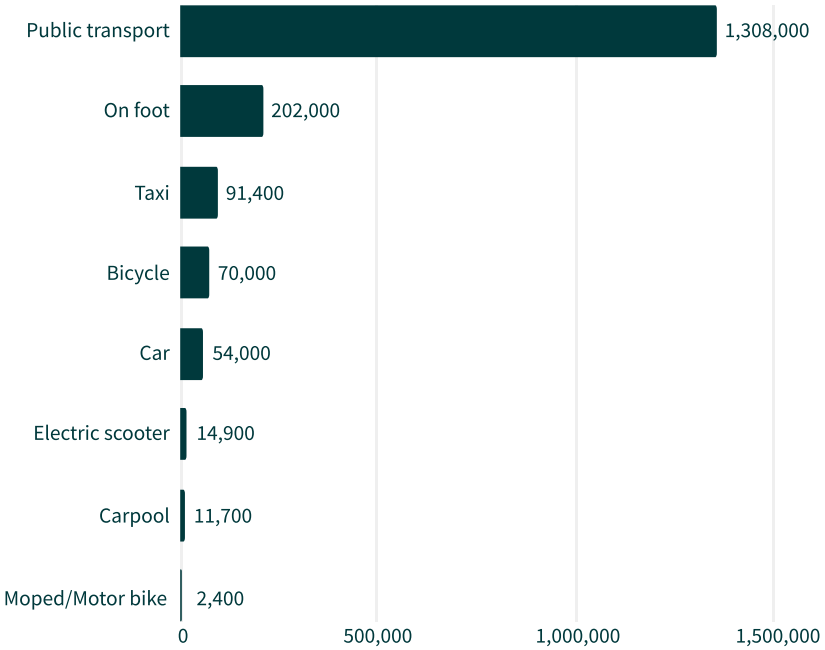


Figure 3.8.4: Visitor travel (km) inside Greater Helsinki.

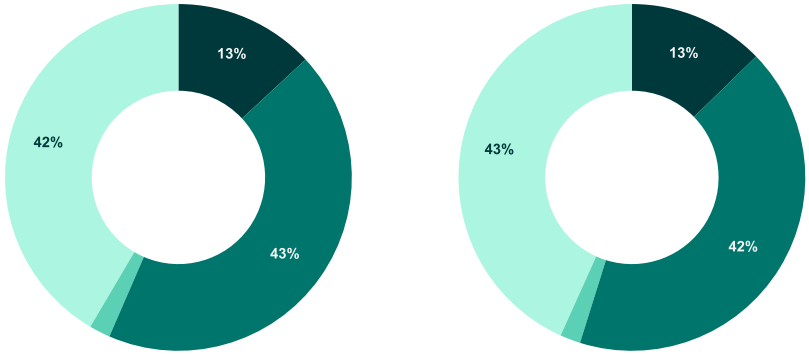


Figure 3.8.5: Material and carbon footprint of visitor travel inside Greater Helsinki.

Some differences in travel modes between day and night were detected. Walking (+15%) and taxis (+65%) increased towards the night, whereas the use of electric scooters (-23%), car pooling (-14%) and public transport (-16%) decreased. Others stayed approximately the same in terms of travelled distances.

The material and carbon footprint for **accommodation** for visitors is clearly higher than for artists, their crew and the festival's staff. However, only 10% of the visitors stayed in a hotel or rented an apartment for the duration of the stay, as many of them come from Greater Helsinki. 79.4% of the visitors slept at home

and 10.5% at a friend's apartment. The material and carbon footprints for sleeping at home or at a friend's place is assumed to be zero, because the visitors' accommodation is assumed to not affect the footprint of the aforementioned locations, e.g. in terms of heating. What comes to a night in a hotel, it has a material footprint of 45 kg and a carbon footprint of 18 kg CO_2e (Kotakorpi et al., 2008). Renting an apartment or a room through a private renting service is assumed to have half of the footprint of a night spent at a hotel. Data on visitor accommodation is based on the visitor survey executed during the festival through the Flow Festival 2022 application.

3.9 Other

The other category causes the smallest footprint of all the festival categories. It includes decorations, merchandise and other minor articles such as passes, wristbands, toilet paper and similar in addition to furniture. The amount of these have been collected as precisely as possible, and when sufficient data has not been available assumptions have been made. The total material footprint for the category is 59,000 kg and carbon footprint 21,000 kg CO_2e (see Figure 3.9).

The **decorations** include lighter materials and products used at the festival, such as different fabrics, all sort of furniture, paints, flowers and plants. No lighting is included here, since they are in the site lights subcategory. Flow Festival uses mostly recycled or reused materials in their decoration and uses them year after year, which lowers their footprint significantly. Decorational

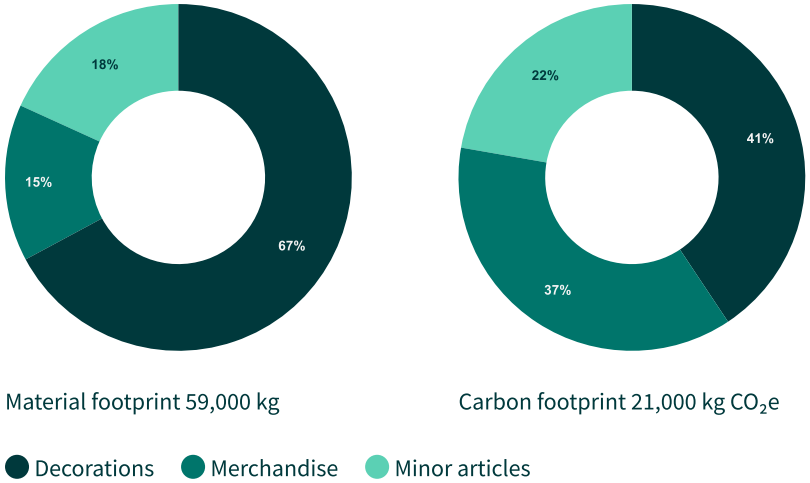


Figure 3.9: Material and carbon footprint of the category other.

fabrics such as upholsteries, banderoles and matting are for the most part produced only for Flow Festival, whereas 61% of the furniture is rented.

Flow Festival's **merchandise** consists mainly of t-shirts (1900 pcs) and tote bags (1500 pcs), of which most go to the festival's volunteers. In addition, the selection includes hoodies, long sleeves, socks, caps and drinking bottles. Overall, merchandise is mainly used as gifts for the festival's volunteers.

The **minor articles** subcategory includes wristbands, paper products (such as different types of signs), and cleaning, sanitary and first aid gear. The

subcategory's footprint is derived for the most part from the wristbands (66% of the material and 83% of the carbon footprint) and paper products (24% of the material and 3% of the carbon footprint). For paper products, the material footprint is especially high when compared to the carbon footprint because the production of paper is more material intensive than carbon intensive.

04

HOTSPOT IDENTIFICATION

Based on the material and carbon footprint assessment (see Appendix 2) for the total footprint results, several hotspots were identified. These hotspots will shed more light on the biggest causes for both footprints. In addition, they provide a foundation for formulating sustainable solutions that aim at reducing both of the festival footprints in the future (see section 5). Hence, in this section, the top 4 categories responsible will shortly be discussed for both footprints. In addition, the results of the footprint assessment will be analysed from another perspective where visitor travel emissions are left out in order to shed more light on those categories that Flow Festival Ltd. has a more direct impact on. This approach will also be utilised with the sustainable solutions to emphasise the role of the festival production.

Top 4 categories of the material footprint:

1. Visitors 73.4%
2. Food and beverages 7.3%
3. Properties 4.6%
4. Stage production 4.5%

These categories make up 90% of the total material footprint for the festival.

Top 4 categories of the carbon footprint:

1. Visitors 72.8%
2. Organiser logistics 10.3%
3. Food and beverages 6.2%
4. Stage production 3.9%

These categories make up 93% of the total carbon footprint for the festival.

The biggest hotspot in both footprints is the **visitor travels** both to and within Greater Helsinki. It stands for appr. 73% of both the total material and carbon footprints of the visitors category. As mentioned in the analysis of the footprint assessment, the footprint amounts might however be even small compared to many other similar events, since most of the visitors come from within Finland and especially Greater Helsinki and do not travel long distances to Flow Festival. In addition, the share of visitor travel in 2022 might not be well representative due to the exceptionally low number of international visitors compared to previous years, due to the COVID-19 pandemic.

The 2.8% of the visitors who flew to Helsinki for the festival stand for as much as 59% of the kilometres travelled outside Greater Helsinki and 94% of the carbon footprint for all travelling from outside Greater Helsinki. This illustrates the high climate impact of flying. The material footprint for flying is relatively moderate, therefore the material footprint for travelling from outside Greater Helsinki is mainly dominated by train travel. The latter is due to the huge share of built infrastructure in the material footprint for long-distance train travelling in Finland (see Lähteenoja et al., 2006).

As travelling decisions are typically made independently, Flow Festival Ltd. can not directly influence the travelling or accommodation of its visitors. Therefore, we have also considered scenarios where the footprints of visitor travel and accommodation have been excluded in order to better highlight the effect and ratio of other categories in the festival production that can be more easily affected by the festival provider (Table 4.1. and sections 5.2-5.7).

The **food and beverages** consumed at the festival area form a consumption category that results in a distinct impact on the total footprints. When excluding the category of visitors, the food and beverages category make up 28% of the total material footprint and 23% of the total carbon footprint (see Table 4.1). This is a significant result since there were only vegetarian, vegan and fish meals served at Flow Festival 2022, which has already significantly decreased the festival's material and carbon footprint for food from earlier years (see Table 3.7).

The **organiser logistics** category has a huge impact especially on the carbon footprint. This is due to the high climate impact of flying. When excluding the visitors category, the organiser logistics category – mainly consisting of the transportation of a total of 980 artists and crew members to the festival – caused 7% of the total material footprint and 39% of the total carbon footprint, thus having the highest share in the festival carbon footprint.

For **properties**, the single largest share in especially the material footprint comes from ground improvement. Ground improvement in itself is a material-demanding activity, especially because of the huge amount of crushed stone required. It stands for 10% of the total material footprint when the category of visitors is excluded. The need for ground improvement depends largely on the type of site the festival operates on. In Suvilahti, each year a lot of ground improvement is conducted in the form of fixing the ground with chemicals, adding gravel and other stone material, and covering some areas with turfgrass.

The **stage production** category also counts for a decent part of the festival's footprints. When excluding the visitors category, the stage production makes up 17% of the total material footprint and 15% of the total carbon footprint. This is also a category that the festival organisers have more influence on. Although the markets for different types of festival-specific technologies are not very broad and the pace of development is fast, the festival organisers themselves are the ones making the final decisions for acquisitions.

Table 4.1: Total material and carbon footprints of Flow Festival 2022 excluding the category of visitors (visitor travels and accommodation).

CATEGORY	MATERIAL FOOTPRINT	%	CARBON FOOTPRINT	%
1. Site production	182 t	8.8	45 t CO_2e	6.0
2. Stage production	350 t	16.9	108 t CO_2e	14.4
3. Partner production	220 t	10.6	34 t CO_2e	4.6
4. Properties	362 t	17.5	59 t CO_2e	7.9
5. Organiser logistics	142 t	6.8	283 t CO_2e	37.7
6. Consumption	185 t	8.9	30 t CO_2e	3.9
7. Food and beverages	570 t	27.5	170 t CO_2e	22.7
9. Other	59 t	2.9	21 t CO_2e	2.8
Total	**2,070 t**	**100**	**750 t CO_2e**	**100**
Per visitor day	**23 kg**		**8 kg CO_2e**	

05

SUSTAINABLE SOLUTIONS

In order to propose the best and most suitable solutions, the following sustainable solutions (summarised in Appendix 7) were co-created in a workshop together with Flow Festival Ltd. The workshop allowed the different participants to utilise their own expertise in both sustainability and event production. The workshop consisted of three sections: initial brainstorming of potential sustainable solutions both individually and as a group, critical assessment of the results of the brainstorming, and finally, deciding the quantifiable solutions.

The quantification of the sustainable solutions is intended to provide a more wholesome picture of the reduction potential different solutions can have to the material and carbon footprints. Therefore, each solution has its own scale where more or less change can be realised, depending on the rate of implementation and other conditions. Only the direct impacts of the specific solutions are calculated. If a reduction also has further effects – e.g. reducing the amount of specific items can also result in smaller electricity consumption and logistics requirements – these further impacts are not included in the calculations.

In general, the sustainable solutions aim to either decrease the amount of consumption or the material and carbon intensities of the items consumed. The sustainable solutions are specific for Flow Festival, which means that the steps Flow Festival Ltd. has already taken to reduce their material and carbon footprints are not emphasised here. These include, for instance, collaboration between Nordic festivals in artists' production, collaboration with the local public transport provider and a decision to make the whole Flow Festival 2022 meat-free.

When discussing the proposed solutions, the category of visitors has been excluded from the total footprint for most of the solutions in order to better highlight both each category's size and the solution's effect on it without the visitor footprints heavily dominating any results. As already mentioned in the hotspot analysis, the visitors category is more difficult to influence from the organisers' point of view, and therefore it also makes sense to look at the other categories without the effect of the visitors category.

5.1 Encourage visitors to travel more sustainably

Visitor travels cover most of the total material (71%) and carbon (70%) footprints of the festival. The great number of visitors attending the festival results in large footprints, but the transport modes play a huge role as well. Reducing either the travelled distances or the material and carbon intensities of the travel modes leads to a reduction in the footprints.

If a greater share of the visitors travelled to Greater Helsinki by train or by bus rather than by car, the material and carbon footprints would decrease significantly (see Table 5.1). Those who came to the festival by car were mostly from different parts of Finland and would have had a possibility to travel by train or bus at least for most part of their trip. Flow Festival Ltd. can make the choice of taking a bus or a train more attractive by collaborating with train and bus companies to, for example, offer discounts on certain routes for customers with the festival ticket.

Additionally, many of the visitors travelled to and from their accommodation and the Flow Festival area by car, taxi or similar. This could be discouraged by cooperating with the local public transportation provider even more closely and including a public transport ticket to the festival ticket. Also, encouraging and facilitating car pooling would decrease the total distances travelled by car. If all taxi and car travelling were switched to public transport, the festival footprints would decrease notably (see Table 5.1).

Table 5.1: Sustainable solutions for visitors.

	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF FLOW'S TOTAL FOOTPRINT	
SUSTAINABLE SOLUTION	**MATERIAL FOOTPRINT**	**CARBON FOOTPRINT**	**MATERIAL FOOTPRINT**	**CARBON FOOTPRINT**
50% of car driving in Finland switched to bus and train	170 t	16 t CO_2e	2.2%	0.6%
50% of taxi and car rides inside Greater Helsinki switched to public transport	143 t	8.4 t CO_2e	1.8%	0.3%

5.2 Reduce the need for and intensity of artist logistics

Artists are an essential part of a music festival, however the transportation of artists, crew and their equipment requires travelling long distances, usually by airplane. There are a few ways to decrease artist transportation and logistics footprints, either by choosing a travel mode with a lower material and carbon intensity, or by minimising the travelled distances.

Charter flights have high footprint values since their footprints are not divided by the hundreds of passengers such as for a scheduled flight. Therefore, if all charter flights (appr. 4500 km in the case of Flow Festival 2022) could be switched to scheduled flights, especially the carbon footprint of the festival would decrease greatly (see Table 5.2). This could be justified to the artists by the high impact charter flights are causing or by choosing artists that are able to and willing to take scheduled flights.

In order to reduce the travelled distances, Flow Festival Ltd. could further prefer local artists who do not need to travel long distances to participate in the festival and further collaborate with festivals in Northern Europe to optimise the artists' travels. If the distances flown on scheduled flights could in this way be reduced by 50%, the reduction in the carbon footprint would be a remarkable 7.8% when the visitors category is not taken into account (see Table 5.2).

Table 5.2: Sustainable solutions for artists' transportation.

SUSTAINABLE SOLUTION	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
No charter flights	48 t	150 t CO_2e	2.3%	20%
50% less scheduled flights	19 t	58 t CO_2e	0.9%	7.8%

5.3 Reduce the need for items and equipment logistics

When combining data from two categories, the partner production and organiser logistics, and taking into account the logistics of items transported by both Flow Festival Ltd. and its partners, the total material footprint becomes 250,000 kg and carbon footprint 37,000 kg CO_2e. In combination, this plays a relevant role especially in the material footprint since it stands for 12% of the total material footprint when the visitors category is not taken into account. In order to reduce the impact of the logistics of items, Flow Festival Ltd. can reduce the distances the items are transported, reduce the amount of items that are transported or, in some cases, choose a transport mode with lower material and carbon intensities. Concrete examples include renting more items – such as the Main Stage – from a closer location, preferably Finland, to reduce the transport distance of the delivery. The components of the Main Stage, with a mass up to 400,000 kg, come from Germany by land and sea freight, since similar stages are not found in Finland. If Flow Festival Ltd. could construct the Main Stage out of structures that can be found in Finland and the transported distances could be decreased by 75%, the total material footprint would decrease by 73,000 kg and the carbon footprint by 10,000 kg CO_2e (see Table 5.3). This clearly indicates that, when possible, items should be rented from as close as possible. Another option is to reduce the amount of e.g., decorations or different kinds of stage lights in order to reduce the need for transportation. If Flow Festival could be constructed with 25% less freight for different items, the material footprint

Table 5.3: Sustainable solutions for logistics.

SUSTAINABLE SOLUTION	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
Rent the Main Stage components from Finland	73 t	10 t CO_2e	3.5%	1.4%
25% less freight	61 t	7.6 t CO_2e	3.0%	1.0%

would be reduced by 61,000 kg and carbon footprint by 7,600 kg CO_2e (see Table 5.3).

5.4 Increase vegan and vegetarian options

For the food and beverages category, Flow Festival Ltd. has already done quite a reduction in their footprints, since no meat meals were sold at Flow Festival 2022. Still, even more can be achieved by, e.g., increasing the share of domestic vegetarian and vegan food or decreasing the amount of food and especially beverages consumed. For example, if all food served during the festival were 100% vegan, this would lower the material footprint by 55,000 kg and the carbon footprint by 18,000 kg CO_2e (see Table 5.4).

It should be stated that the consumption of alcoholic beverages at Flow Festival is not so high when compared to other festivals. Still, alcoholic beverages are consumed in significant volumes and their total footprint stands for 44% of the whole food and beverages category's material footprint and 57% of the carbon footprint. Soft drinks and beer have slightly lower material and carbon footprints per litre than heavier alcoholic beverages, but they are in general also consumed in larger volumes. Therefore, the greatest impact to the material and carbon footprints can be achieved by encouraging visitors to consume less, especially when it comes to alcoholic beverages.

Nevertheless, if 50% of all alcoholic beverages were switched to, e.g., soft drinks, the material footprint would be reduced by 41,000 kg and the carbon footprint by 39,000 kg CO_2e (see Table 5.4). A lesser consumption of alcoholic beverages could be achieved by selling alcohol in fewer spots, boosting the prices based on the drinks' material and carbon footprints, reducing the visibility of alcoholic drinks or by including more options with lower footprints.

Table 5.4: Sustainable solutions for food and beverages.

	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
SUSTAINABLE SOLUTION	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
Full-vegan festival	55 t	18 t CO_2e	2.7%	2.4%
50% of alcoholic beverages switched to soft drinks	41 t	39 t CO_2e	2.0%	5.3%

5.5 Reduce the material needed for or number of stages

The biggest shares in stage production are the structures and equipment used in audio, video and lighting. Structure materials themselves are not necessarily material or carbon intensive but they are used in large amounts, whereas electrical appliances are very material and carbon intensive. The footprints in this category can be reduced either by reducing the amount of items or by using items with a longer lifetime, thus leaving a smaller 'usage by Flow' factor allocated to Flow Festival.

Table 5.5: Sustainable solutions for stage production.

	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
SUSTAINABLE SOLUTION	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
20% less structures	43 t	15 t CO_2e	2.0%	2.0%
20% less electrical appliances	19 t	3.1 t CO_2e	0.9%	0.4%

The amount of material used for structures could be reduced either by reducing the amount of structures in stages or reducing the number of stages. It can be questioned whether all special lighting effects or large LED-screens are necessary for the experience. Reducing the amount of structure materials by 20% (tents not included) would cut Flow Festival's material footprint by 43,000 kg and its carbon footprint by 15,000 kg CO_2e (see Table 5.5).

Electrical appliances including audio, video and light equipment make in total 27% of the material and 15% of the carbon footprint for stage production. Using 20% less audio, video and lighting equipment would cut the festival's material footprint by 19,000 kg and its carbon footprint by 3,100 kg CO_2e. Note that the extension of the lifetime of used audio, video and light equipment by 25% would yield equal. Flow Festival Ltd. can support the extension of the electrical appliances life cycles by choosing appliances with a longer life cycle and not upgrading for the latest models each year. However, the lifetime of electrical appliances is also affected by the actions of the device renters and the device quality, hence we refrain from the option in the latter Tables. All in all, when the amount of structures and technical equipment is reduced, also the need for electricity infrastructure and logistics are reduced, resulting in even larger reduction potentials.

5.6 Reduce the amount of ground improvement

Ground improvement is a surprisingly central activity at the site and results in significant material footprints. Gravel extraction can have considerable

Table 5.6: Sustainable solutions for ground improvement.

SUSTAINABLE SOLUTION	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
50% less stone material	71 t	0.12 t CO_2e	3.4%	0.02%
No turfgrass	38 t	4.1 t CO_2e	1.9%	0.5%

environmental impacts in terms of, e.g., groundwater and biodiversity, although its climate impact usually remains low. The footprints of ground improvement can be reduced by either reducing the amount of stone material and turfgrass brought to the area or possibly by using more sustainable alternatives for ground improvement. If, for example, the gravel is not from virgin material, its footprint can be considered much lower. However, it is important to note that ground improvement can also be crucial in making the site safe. Therefore, more sustainable alternatives would be worth exploring.

Reducing the amount of stone material in ground improvement by 50%, or alternatively using at least 50% recycled stone material has a reduction potential of 71,000 kg of the material footprint (see Table 5.6). Refraining from using turfgrass would cut the material footprint by 38,000 kg. A reduction in the pure mass of stone material and turfgrass also reduces the logistics footprint.

5.7 Switch to smaller storage with less carbon intensive heating

It is beneficial to reuse the same items year after year. Furthermore, if it is not possible to rent these items in or out, it is sound to keep them in storage. However, if there is a choice between buying new or renting, renting is usually the more sustainable option since the product will in this case be used to a much greater extent.

When it comes to the ‘usage by Flow’ factor, it seems to be more difficult to decrease for items owned by Flow Festival Ltd. than for rented ones. As an

Table 5.7: Sustainable solutions for storage.

SUSTAINABLE SOLUTION	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF TOTAL FOOTPRINT EXCLUDING VISITOR CATEGORY	
	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
50% less storage	30 t	16 t CO_2e	1.4%	2.1%
Reduce the heating in storage spaces by 5 °C	9.4 t	6.9 t CO_2e	0.5%	0.9%

example, for fabrics owned by Flow Festival Ltd. it is estimated that they are used for 10 years, which leads to a 'usage by Flow' factor of 10% for one festival – whereas a rented product very often has a 'usage by Flow' factor of around 1%. Regarding storage space, a 50% smaller storage would result in a footprint reduction of 30,000 kg of material and 16,000 kg CO_2e (see Table 5.7). Similarly, if the temperature of the storage spaces could be reduced by 5°C during the heating season, a reduction of 9,400 kg in material footprint and 6,900 kg CO_2e in the carbon footprint could be achieved (see Table 5.7).

5.8 Other sustainable solutions to be considered

In the sustainable solutions workshop a great variety of possible solutions were identified and discussed. Not all of them could be assessed and analysed more closely, and their impact can be seen as minor to the ones listed above. Still, even small reductions can be important when trying to maximise the footprint reductions. For that purpose, we present below a list of a few alternatives for inspiration:

- Spending fewer nights at hotels by e.g., encouraging visitors to sleep at friends' homes
- Reduce the amount of merchandise sold by Flow Festival Ltd. or no merchandise
- Offer only recycled or second-hand merchandise
- More renting, less owning, e.g., more rented utensils, plates and glasses
- Nothing new: aim for having as little new as possible
- Replace concrete ballasts with water ballasts
- Use grid electricity instead of generators
- Use less packaging material
- Encourage a higher degree or quality of recycling, by e.g., people guiding at recycling points
- Compress more waste to reduce the need for waste transportations
- Include partner production to Flow Festival environmental guidelines
- Heat office and storage spaces by renewable district heating
- Open Flow Festival to additional users by, e.g., increased streaming or TV broadcasting (also afterwards)

06
CONCLUSIONS

In this report, we provide the results (see Appendix 2) from a research on the material and carbon footprints of Flow Festival 2022. The material footprint of the three-day festival amounted to appr. 7,780 tonnes and the carbon footprint to appr. 2,760 tonnes CO_2e. This means a material footprint of 86 kg and a carbon footprint of 31 kg CO_2e per visitor day at the festival, of which the carbon footprint is equivalent to 2% of the average consumption-based emissions in Helsinki during one day. Both material and carbon footprints of a visitor day are roughly equivalent to the lifestyle material and carbon footprints of an average Finn per day.

The carbon footprint of a visitor day excluding visitors' travel, food and drinks amounts to 6.6 kg CO_2e. When this is compared to an approximate carbon footprint target for cultural activities of 33 kg CO_2e in 2030 (25% of the present 130 kg per person in a year, see Akenji et al., 2021), 60% of the yearly average carbon budget for cultural activities would be eaten up by spending three days at Flow Festival. Therefore, decreasing the festival's carbon footprint would allow people to spend additional time with cultural activities. The visitors' food and drinks consumption has a carbon footprint of 1.8 kg CO_2e per visitor day. This almost exactly equals the daily carbon budget of food and drinks in 2030 (see Akenji et al., 2021). Eating also elsewhere during the festival day would thus still require further reductions in the festival's carbon footprints for visitors' food and drinks. Increasing the vegan share in the food served and decreasing the amount of alcoholic drinks sold could help to meet the average carbon budget for food and drinks for 2030. The average carbon footprint for visitor travels amounts to an average of almost 22 kg CO_2e per visitor day. This is slightly more than twice the present lifestyle carbon footprint of personal travelling per day and more than 17 times the average daily carbon budget for travelling in 2030 (see Akenji et al., 2021). This shows that also travelling should be heavily addressed by the festival's organisers in order to decrease the overall footprints of the festival.

The footprints of the festival were assessed for nine different categories the consumption of different items for the festival were allocated to. Out of these categories, the visitors category, including visitor travel and accommodation, had a share of slightly over 70% in both footprints. With a share from 4% to 10% in either of the footprints other relevant categories were food and beverages, organiser logistics, stage production and properties.

A comparison of the results for the material and the carbon footprint to each other show both similarities and differences. While the share of the visitors category (73%) is equally significant in both footprints, other categories may differ in terms of relevance. For example, the category organiser logistics caused only 7% of the material footprint but 39% of the carbon footprint when the category of visitors was excluded, which is caused by the high carbon emissions of charter flights. Ground improvement in the category of properties represents 10% of the material footprint but only 1% of the carbon footprint of the categories excluding visitors due to the relatively huge mass of primary gravel extracted. Looking at the material footprint in addition to the carbon footprint thus can help identify additional aspects that are crucial for improving the overall sustainability of the festival. However, even the material footprint does not reveal all possible environmental aspects a festival can have. For example, Flow Festival uses relatively huge amounts of PVC plastic, especially in tents. PVC is rather low in material and carbon intensity but can be a relevant source of air pollution when burning or when being incinerated after its end of life.

Before the study, we would have expected that electrical appliances and infrastructure would contribute to the material footprint of the festival to a higher extent because of the highly material-intensive metals they contain. For example, it was anticipated that the 28 tonnes of cables would have had a much larger share of the total material footprint but this was not the case. The reason for their relatively moderate material footprints is that most of these devices and infrastructure have a long durability and are rented by Flow Festival Ltd. for a limited period of time. However, the 'usage by Flow' factors used are partly based on assumptions and although these assumptions were well reasoned during the research, their alteration still could impact the results significantly.

What comes to the visitors category's results, they show that the festival participants' decisions, especially on their ways of travelling, can largely affect a festival's footprint. Similar results have been obtained in earlier studies on mass events. For the festival organisers, there are only limited options to influence visitors' travelling. However, there are other remarkable categories that can be affected by the festival organisers in order to reduce both of the festival footprints. The related options include but are not limited to, for instance, the reduction of flights in artists' and equipment's logistics, further increasing the share of plant-based food offered at the festival, reducing ground improvement that is based on primary gravel materials, and improving the longevity of equipment used.

Regarding the material and carbon footprint reduction potential, while the effect of individual measures may appear small, the aggregated footprint reduction potential of the sustainable solutions quantified in this study is roughly in the order of 10%. This shows that there are different, viable options when it comes to reducing a festival's footprint. However, the total of 10% does not take into account possible overlaps or potential multiplier effects with other measures. On the other hand, there are still many viable options also outside the quantified solutions and several solutions studied still have scaling potential.

In relation to the consumption-based greenhouse gas emissions in Helsinki, the carbon footprint of Flow Festival 2022 appears moderate. However, the approximate equivalence of an average Finn's footprint per day with the footprints of one visitor day shows that the footprints are not neglectable. In the light of the footprints of Flow Festival 2022, the sometimes made argument that experiences are immaterial and therefore favourable from an environmental point of view cannot be signed without reservation. As one day spent at Flow Festival on average consumes 86 kg of material resources and produces 31 kg of greenhouse gas emissions, there is definitely a need to reduce such footprints in order to dematerialize and decarbonize the festival.

Moreover, with the average Finns' material footprint to be reduced to a quarter by 2050 and the carbon footprint to a quarter already by 2030, music festivals have their own responsibility to reduce their footprints, and all possible efforts should be made. Flow Festival Ltd. has been determined to reduce its environmental impact through its own environmental programme for more than ten years already and this is a path worth pursuing. Due to high internal interest towards decreasing its environmental impact, it is important to note that Flow Festival Ltd. has already implemented different types of sustainable options. These include e.g. mandatory vegan meal options for the food partners and switching from diesel to biodiesel.

When analysing the prevailing trends, the size of festivals and other mass events has tended to grow over the years. This has meant more visitors, more artists, more equipment, etc. Faced with the need to reduce the footprint of leisure activities in order to achieve climate and other one-planet consumption targets, it is worth asking whether festivals could also be smaller and more local in the future. At least, this could potentially help reduce the carbon footprint of visitors, as visitor travel has a significant impact on the overall footprint of the festival despite the fact that around 40% of Flow Festival visitors walk to the event. Moreover, although the sustainable solutions presented in this report were ideated specifically for the purposes of Flow Festival, we hope that they can be widely utilised also for other similar events and festivals and inspire organisers, artists, partners, and other stakeholders to develop their own solutions that can help people enjoy great experiences with ever-decreasing environmental footprints.

REFERENCES

Akenji, L., Bengtsson, M., Toivio, V., Lettenmeier, M., Fawcett, T., Parag, Y., Saheb, Y., Coote, A., Spangenberg, J.H., Capstick, S., Gore, T., Coscieme, L., Wackernagel, M., Kenner, D., & Kolehmainen, J. (2021). *1.5-Degree Lifestyles: Towards A Fair Consumption Space for All. Hot or Cool Institute.*

Amienyo, D., & Azapagic, A. (2016). Life cycle environmental impacts and costs of beer production and consumption in the UK. *International Journal of Life Cycle Assessment,* 21, 492–509. https://doi.org/10.1007/s11367-016-1028-6

Autio, S., & Lettenmeier, M. (2002). *Ekotehokkuus – Business as Future: Yrityksen ekoteho-opas* [Eco-efficiency – Business as Future: Eco-efficiency guide for businesses]. (Dipoli-raportit/Dipoli-reports C, ympäristökoulutus). TKK Koulutuskeskus Dipoli. https://www.ekotuki.net/sites/beta.ekotuki.net/files/julkaisut/tiedostot/Ekotehokkuusopas.pdf

Best Foot Forward & LOCOG. (2010). *London 2012: Carbon footprint study – Methodology and reference footprint.* London Organising Committee of the Olympic Games and Paralympic Games [LOCOG]. https://library.olympics.com/Default/doc/SYRACUSE/69866/carbon-footprint-study-methodology-and-reference-footprint-london-2012-london-organizing-committee-f?_lg=en-GB

BIER. (2012). *Research on the Carbon Footprint of Spirits.* Beverage Industry Environmental Roundtable [BIER]. https://www.bieroundtable.com/wp-content/uploads/49d7a0_7643fd3fae5d4daf939cd5373389e4e0.pdf

City of Helsinki. (2022, January 26). *Helsinkiläisten kulutuksen hiilijalanjälki selvitettiin ensimmäistä kertaa.* Helsingin ilmastoteot. Retrieved December 7, 2022, from: https://helsinginilmastoteot.fi/ilmastoteot/helsinkilaisten-kulutuksen-hiilijalanjalki-selvitettiin-ensimmaista-kertaa/

CONCITO. (2021). The Big Climate Database. (Version 1) [Data set]. Retrieved January 10, 2023, from https://denstoreklimadatabase.dk/en

Finnish Food Authority. (n.d.). *Foodstuffs*. Ruokavirasto [Finnish Food Authority]. Retrieved September 23, 2022, from https://www.ruokavirasto.fi/en/foodstuffs/

Flow Festival. (2022). *Eat & Drink.* Retrieved September 23, 2022, from https://www.flowfestival.com/en/services/food/

Häkkinen, S., Hämäläinen, R., Laitinen, K., Lettenmeier, M., & Ruti, L. (2000). Mäkihypyn ekologinen selkäreppu [The ecological rucksack of ski jumping]. *Ympäristö ja Terveys*, 7-8/2000, 44-49.

International Olympic Committee. (2018). *Carbon Footprint Methodology for The Olympic Games.* https://stillmed.olympic.org/media/Document%20Library/OlympicOrg/IOC/What-We-Do/celebrate-olympic-games/Sustainability/IOC-Carbon-Footprint-Methodology.pdf

Kotakorpi, E., Lähteenoja, S., & Lettenmeier, M. (2008). *Household MIPS - Natural resource consumption of Finnish households and its reduction* (The Finnish Environment 43en/2008). Finnish Ministry of the Environment. http://hdl.handle.net/10138/38343

Lähteenoja, S., Lettenmeier, M., & Saari, A. (2006). T*ransport MIPS - The natural resource consumption of the Finnish transport system* (Suomen ympäristö 820en). Finnish Ministry of the Environment, Environmental Protection Department. http://hdl.handle.net/10138/40631

Lee, D.S., Fahey, D.W., Skowron, A., Allen, M.R., Burkhardt, U., Chen, Q., Doherty, S.J., Freeman, S., Forster, P.M., Fuglestvedt, J., Gettelman, A., De León, R.R., Lim, L.L., Lund, M.T., Millar, R.J., Owen, B., Penner, J.E., Pitari, G., Prather, M.J., Sausen, R. & Wilcoxm,L.J. (2022). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. *Atmospheric Environment 244*. https://doi.org/10.1016/j.atmosenv.2020.117834

Lettenmeier, M. (2018). *A sustainable level of material footprint — Benchmark for designing one-planet lifestyles* [PhD dissertation]. Aalto University. https://aaltodoc.aalto.fi/handle/123456789/31300

Lettenmeier, M., Rohn, H., Liedtke, C., Schmidt-Bleek, F., Bienge, K., Urbaneja, D.M. & Buddenberg, J. (2009). *Resource productivity in 7 steps — How to develop eco-innovative products and services and improve their material footprint*. Wuppertal Institute [Wuppertal Spezial No. 41]. https://wupperinst.org/a/wi/a/s/ad/110

Liedtke, C., Bienge, K., Wiesen, K., Teubler, J., Greiff, K., Lettenmeier, M. & Rohn, H. (2014). Resource use in the production and consumption system — The MIPS approach. *Resources* 3(3), 544-574. https://doi.org/10.3390/resources3030544

Luoto, K., Lähteenoja, S., & Lettenmeier, M. (2008). *LiikuntaMIPS - Liikuntaharrastusten luonnonvarojen kulutus* [Natural resource consumption of leisure time sports activities] (National Consumer Research Centre publications 4/2008). National Consumer Research Centre. https://helda.helsinki.fi/handle/10138/152390

Mostert, C., & Bringezu, S. (2019). Measuring Product Material Footprint as New Life Cycle Impact Assessment Method: Indicators and Abiotic Characterization Factors. *Resources*, 8(2), 61. https://doi.org/10.3390/resources8020061

Neopoli Oy. (2001). *Suurtapahtuman materiaalivirtaselvitys* [Material flow survey for a major event] (Final report 28.12.2001).

Pusenius, K., Lettenmeier, M., & Saari, A. (2005). *Luonnonvarojen kulutus Suomen tieliikenteessä (TieMIPS)* [Natural Resource Consumption of Finnish Road Transport (Road MIPS)] (Publications of the Ministry of Transport and Communications 54/2005). Finnish Ministry of Transport and Communications. http://urn.fi/URN:ISBN:952-201-408-7

Schmidt-Bleek, F. (2000). *Luonnon uusi laskuoppi – Ekotehokkuuden mittari MIPS* [Nature's new calculus – Eco-efficiency indicator MIPS]. Gaudeamus.

Schmidt-Bleek, F. (2009). *The Earth: Natural Resources and Human Intervention.* Haus Publishing.

Scrucca, F., Bonamente, E. & Rinaldi, S. (2018). Chapter 7: Carbon Footprint in the Wine Industry. In S. S. Muthu (Ed.), *Environmental Carbon Footprints - Industrial Case Studies* (pp. 161-196). Butterworth-Heinemann. https://doi.org/10.1016/B978-0-12-812849-7.00007-6

Sinivuori, P. (2004). *Kahden Helsingin yliopiston rakennuksen luonnonvarojen kulutuksen selvittäminen MIPS-laskennan avulla* [Pro gradu]. University of Helsinki. https://helda.helsinki.fi/handle/10138/18920

Veuro, S., Lähteenoja, S., & Lettenmeier, M. (2008). *Vapaa-aikaMIPS - Vapaa-ajan harrastusten luonnonvarojen kulutus* [LeisureMIPS - Natural resource consumption of leisure time activities]. (National Consumer Research Centre publications 5/2008). National Consumer Research Centre.

VTT. (2017). LIPASTO - Transport emission inventory. [Data set]. Technical Research Centre of Finland [VTT]. Retrieved September 23, 2022, from http://lipasto.vtt.fi/en/inventaarioe.htm

Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016). The ecoinvent database version 3 (part I): overview and methodology. *The International Journal of Life Cycle Assessment*, 21(9), 1218–1230. http://link.springer.com/10.1007/s11367-016-1087-8

Wuppertal Institute. (2014). *Material intensity of materials, fuels, transport services, food*. https://wupperinst.org/uploads/tx_wupperinst/MIT_2014.pdf

APPENDICES

Appendix 1: List of items that are out of scope.

OUT OF SCOPE	SPECIFICATION
Visitor consumption outside the festival area	E.g., food, beverages and clothes consumed outside the festival area. Even if the consumption took place during and because of the festival, there is first of all no data on this consumption and second of all it is difficult to clearly state whose responsibility it is.
Area without Flow Festival	The festival is organised on an area that previously was mainly used for energy production in a power plant. A considerable part of the area has contaminated soil, which means that residential use of the area would be possible only at very high efforts and costs. Because of this background and history, building up the area for its original purpose is out of the scope of the festival use. However, the efforts in the year 2022 for utilising the area for the Flow Festival, like ground improvement, are within the scope of the calculation.
The artists' own equipment and everything the artists brought to the area	It was not possible to receive comprehensive data over these equipment. However, their impact can be assumed relatively small because they are mostly reused at other events, and their amount can be considered relatively small in comparison to the equipment and structures set up by the festival's organisers – both taken into account in the calculations.
Staff, volunteers and media transportation and accommodation	They are outside the influence of the festival organisers and, in addition, relatively small compared to the transportation and accommodation of artists and visitors.
Communication and marketing	They were considered of small relevance in relation to the other aspects of the festival. Also, sufficient data is difficult to gather.
Artists' and some products' travel from the festival to their next destination	During the summer season, some artists and some festival equipment travel from festival to festival. Therefore, the artists' transportation from Flow to their next destination was left out of scope to avoid double counting. The same applies for rented products if they went straight away to their next renter.

Transport from factory and disposal of rented items	The scope includes transportation of rented items from storage, other venues or elsewhere, to Flow festival site, but does not include the original shipping from factory, or the end-of-life disposal. These once-in-a-lifetime activities have negligible impact on the whole footprint, especially with technical devices, where material requirements are high, biological decomposition does not happen, and recycling efforts usually take place.
Some minor scale consumption	When sufficiently precise data was not available, some minor scale consumption has been left out of the calculations. The biggest of these are ten art installations at the festival area. Where the footprints of products had to be calculated based on the materials they contain without ready-made calculations or consumption data from elsewhere, some aspects have been omitted due to missing data, e.g., production energy or minor material components such as coatings.

Appendix 2. Total material and carbon footprints of Flow Festival 2022.

CATEGORY		MATERIAL FOOTPRINT	% of category	CARBON FOOTPRINT	% of category
1. Site production		**182 t**	**2.3**	**45 t CO_2e**	**1.6**
Infrastructure	Basic structures	10.8 t	5.9	2.3 t CO_2e	5.1
	Water infrastructure	2.5 t	1.4	1.5 t CO_2e	3.3
	Electricity infrastructure	56.2 t	30.8	2.6 t CO_2e	5.8
	Network and IT infrastructure	3.8 t	2.1	0.6 t CO_2e	1.3
	Site lights	51.6 t	28.3	13.4 t CO_2e	29.9
Toilets and waste management	Toilets	25.5 t	13.9	11.7 t CO_2e	26.0
	Garbage bins	0.9 t	0.5	0.8 t CO_2e	1.7
	Compactors	3.7 t	2.1	0.2 t CO_2e	0.5
Tents and containers	Food and bar services, gates, wristband exchange and shop tents and containers	27.5 t	15.1	11.8 t CO_2e	26.4
2. Stage production		**350 t**	**4.5**	**108 t CO_2e**	**3.9**
Stages	Technical infrastructure	93.0 t	26.6	15.7 t CO_2e	14.5
	Structures	217.1 t	62.1	76.4 t CO_2e	70.6
	Tents and coverings	32.1 t	9.2	13.3 t CO_2e	12.3
Backstage	Backstage, shower and toilet tents and containers	7.4 t	2.1	2.8 t CO_2e	2.6

3. Partner production		**220 t**	**2.8**	**34 t CO_2e**	**1.2**
Structures		2.8 t	1.3	0.8 t CO_2e	2.4
Logistics	Sea freight	47.3 t	21.5	3.7 t CO_2e	10.7
	Land freight	162.1 t	73.7	26.7 t CO_2e	77.7
	Air freight	7.8 t	3.5	3.1 t CO_2e	9.1
4. Properties		**362 t**	**4.6**	**59 t CO_2e**	**2.2**
Festival site	Buildings and constructions	35.8 t	9.9	1.5 t CO_2e	2.5
	Site machinery	26.5 t	7.3	3.7 t CO_2e	6.2
	Ground improvement	207.3 t	57.3	8.0 t CO_2e	13.5
Storage	All year storage buildings and containers	59.6 t	16.5	31.5 t CO_2e	53.0
Offices		32.2 t	8.9	14.7 t CO_2e	24.8
5. Organiser logistics		**142 t**	**1.8**	**283 t CO_2e**	**10.3**
Freight of items and production	Land freight	28.1 t	19.8	3.6 t CO_2e	1.3
Artists and crew transportation	Flights	87.2 t	61.6	269.6 t CO_2e	95.2
	Other	2.4 t	1.7	0.4 t CO_2e	0.1
Accommodation	Artists and crew	11.9 t	8.4	4.7 t CO_2e	1.7
	Staff	12.0 t	8.5	4.8 t CO_2e	1.7
6. Consumption		**185 t**	**2.4**	**30 t CO_2e**	**1.1**
Energy	Fuels	171.8 t	92.9	13.2 t CO_2e	44.5
	Electricity	1.6 t	0.9	0.3 t CO_2e	1.1
Water	Water	6.0 t	3.3	0.2 t CO_2e	0.7
Waste	Waste	5.4 t	2.9	15.9 t CO_2e	53.8

7. Food and beverages		**570 t**	**7.3**	**170 t CO_2e**	**6.2**
Artists and crew	Food	3.4 t	0.6	0.8 t CO_2e	0.5
Visitors	Food	288.2 t	50.6	66.1 t CO_2e	38.8
	Beverages	249.2 t	43.7	96.8 t CO_2e	56.8
Staff, volunteers, media, guests	Food	29.0 t	5.1	6.7 t CO_2e	4.0
8. Visitors		**5,712 t**	**73.4**	**2,006 t CO_2e**	**72.8**
Accommodation	Accommodation	187 t	3.3	75 t CO_2e	3.7
Travels	Travels outside the Greater Helsinki	4,915 t	86.0	1,891 t CO_2e	94.3
	Travels inside the Greater Helsinki	610 t	10.7	40 t CO_2e	2.0
9. Other		**59 t**	**0.8**	**21 t CO_2e**	**0.8**
Decorations	Banderolls, signs, fabrics, furniture, sunshades etc.	39.9 t	67.2	8.5 t CO_2e	40.6
Merchandise		8.7 t	14.6	7.8 t CO_2e	37.1
Minor articles	Passes, wristbands, toilet paper etc.	10.8 t	18.2	4.7 t CO_2e	22.2
Total footprint per festival		**7,780 t**	**100**	**2,760 t CO_2e**	**100**
Total footprint per visitor day		**86 kg**		**31 kg CO_2e**	

Appendix 3. Visitor survey questions and number of answers.

QUESTION		ANSWERS
1	Where are you travelling from?	1707
1.1	If from outside Greater Helsinki: How are you arriving to Helsinki?	1701
2	How did you arrive to the Flow Festival area?	4233
2.1	If you used public transport: What type of public transport ticket did you use?	4233
3	How did you leave the Flow Festival area?	3971
4	Where did you stay during the Flow Festival?	3616
5	What's your main diet?	2137
6	Do you drink alcohol?	4218

Appendix 4. Sources and their main purposes in the footprint assessment from most to least used. Sources are listed in the report references.

SOURCE	CATEGORIES, SUB-CATEGORIES AND ITEMS APPLIED ON
Ecoinvent database v.3.7.1 and 3.8 Wernet et al. (2016)	All categories: ● Most of the carbon intensity factors ● Appr. 50% of the material, energy and transport requirements in the production process of an item for consumption
Wuppertal Institute material intensities Wuppertal Institute (2014)	All categories: ● Most of the material intensity factors
Household MIPS Kotakorpi et al. (2008)	Visitor accommodation: ● Material intensities Food and beverages: ● Alcoholic beverages material intensities
Transport MIPS Lähteenoja et al. (2006)	Organiser logistics: ● Material intensities for different transport modes Visitor travels: ● Material intensities for different transport modes
Research article on material intensities of basic elements Mostert & Bringezu (2019)	All categories: ● Material intensities of more specific elements
Experts contacted	Especially stage production: ● Specific material compositions and use days for different items
1.5-Degree Lifestyles -research (Akenji et al., 2021)	Travels and transport: ● Airplane carbon intensity
RoadMIPS Pusenius et al. (2005)	Travels and transport: ● Carbon intensities for road infrastructure
Lipasto-database VTT (2017)	Travels: ● Ferry carbon intensity

Research on the Life cycle environmental impacts and costs of beer production and consumption in the UK Amienyo & Azapagic (2016)	Food and beverages: ● Alcoholic beverages carbon intensities
Research on the Carbon Footprint in the Wine Industry Scrucca, Bonamente, & Rinaldi (2018)	Food and beverages: ● Alcoholic beverages carbon intensities
Research on the Carbon Footprint of Spirits BIER (2012)	Food and beverages: ● Alcoholic beverages carbon intensities
The Big Climate Database CONCITO (2021)	Food and beverages: ● Alcoholic beverages carbon intensities
Finnish Food Authority (n.d.2022)	Food: ● Average components for meals

Appendix 5. Technical infrastructure details.

SUB-CATEGORY biggest item category	**AUDIO** speakers and stage monitor systems	**VIDEO** LED-screens	**LIGHTS** stage lights
Total mass	30.0 t	36.0 t	63.0 t
More advanced technical devices, other than biggest product category	6.3 t	5.8 t	1.9 t
Biggest item category: mass	20.0 t	27.0 t	17.0 t
Biggest item category: material intensity	105 kg/kg	80 kg/kg	34 kg/kg
Biggest item category: carbon intensity	20 kg CO_2e/kg	16 kg CO_2e/kg	8 kg CO_2e/kg
'Usage by Flow' factor weighted average	0.6%	1.3%	0.8%

Appendix 6. Energy, water and waste consumption and total material and carbon footprints for Flow Festival 2022.

CATEGORY	AMOUNT CONSUMED	MATERIAL FOOTPRINT	CARBON FOOTPRINT
Energy			
Neste MY Renewable Diesel™	13,500 l	76.3 t	5.8 t CO_2e
Neste MY Polttoöljy™	16,700 l	94.9 t	7.2 t CO_2e
Liquified Petroleum Gas	330 kg	0.6 t	0.2 t CO_2e
Electricity (wind)	18,200 kWh	1.6 t	0.3 t CO_2e
Water			
Tap water	602,000 l	6.0 t	0.2 t CO_2e
Waste			
Wood and tree	7.0 t	0.6 t	0.2 t CO_2e
Carton and paperboard	4.8 t	0.5 t	0.6 t CO_2e
Bio waste	9.7 t	0.05 t	0.2 t CO_2e
Mixed waste	9.6 t	1.5 t	5.2 t CO_2e
Metal waste	0.5 t	0.2 t	0.02 t CO_2e
Construction waste	11.6 t	2.2 t	0.3 t CO_2e
Waste-to-energy	4.1 t	0.5 t	9.3 t CO_2e
Total		**185 t**	**29.6 t CO_2e**

Appendix 7. List of all quantified sustainable solutions.

SUSTAINABLE SOLUTION	FOOTPRINT REDUCTION POTENTIAL		REDUCTION OF FLOW FESTIVAL'S TOTAL FOOTPRINT	
	MATERIAL FOOTPRINT	CARBON FOOTPRINT	MATERIAL FOOTPRINT	CARBON FOOTPRINT
50% of car driving in Finland switched to bus and train	170 t	16 t CO_2e	2.2%	0.6%
50% of taxi and car rides inside the Greater Helsinki switched to public transport	143 t	8.4 t CO_2e	1.8%	0.3%
REDUCTION OF TOTAL FOOTPRINT excluding VISITOR CATEGORY				
No charter flights	48 t	150 t CO_2e	2.3%	20%
50% less scheduled flights	19 t	58 t CO_2e	0.9%	7.8%
Rent the Main Stage components from Finland	73 t	10 t CO_2e	3.5%	1.4%
25% less freight	61 t	7.6 t CO_2e	3.0%	1.0%
Full-vegan festival	55 t	18 t CO_2e	2.7%	2.4%
50% of alcoholic beverages switched to soft drinks	41 t	39 t CO_2e	2.0%	5.3%
20% less structures	43 t	15 t CO_2e	2.0%	2.0%
20% less electrical appliances	17 t	3.1 t CO_2e	0.9%	0.4%
50% less primary stone	71 t	0.12 t CO_2e	3.4%	0.02%
No additional turfgrass	38 t	4.1 t CO_2e	1.9%	0.5%
50% less storage	30 t	16 t CO_2e	1.4%	2.1%
Reduce the heating in storage spaces by 5 °C	9.4 t	6.9 t CO_2e	0.5%	0.9%