A Novel Measure of Event-Specific Emissions in the Live Music Touring and Festival Industry

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I. Introduction

Human government and business interventions to assist with the monitoring of sustainable development practices have recently been the focus of several industry-specific research programs. Such interventions attempt to reduce the likelihood and severity of the various potential negative consequences of human-driven climate change, countering the continuing increase in greenhouse gas (GHG)-based emissions contributions to climate change across the developed world. A notable industry with quite limited research to-date is live music, particularly music touring, which is today the most economically significant component of the music industry.

In the UK, live music first outperformed music recording sales in 2008. It is currently estimated to be worth tens of billions (USD), globally. The industry is one of few with a long tradition of, largely musician-led, commitment to sustainable travel and event planning practices, and investment in programs like urban renewal and carbon offset credits. Its continued interest in such programs reflects a market that is uniquely interested in the transparency and authenticity of climate change mitigation efforts. However, despite sustained sentiment and many cases of individual-level financial investment, the music industry has been one of many sectors to find limitations brought about by carbon finance schemes lacking efficacy, transparency, or trustworthiness, occasionally resulting in claims of "greenwashing" and reduced public trust in the likelihood of genuinely successful investment in climate change mitigation.

Little empirical study has addressed the measurement and continued assessment of emissions throughout the music touring industry. Only two studies have quantitatively assessed event-specific emissions outputs, both relying on small samples and requiring further estimation of key variables, beyond initial data collection. Several other studies have qualitatively or theoretically addressed some of the many challenges that underlie methodological, measurement, enforcement, or even social issues related to sustainability and compliance to sustainable

development goals within the industry. These did not, however, empirically test their predictions regarding event structure or organisation-based variables, emissions standards, and reduction or compliance initiatives.

Studies that have reported emissions estimates are generally also yet to provide bounds within which such estimates can be considered and further specified using real-world data. Additionally, most empirical inquiry has failed to report specifically which variables were able to be collected, from where those variables had real-world data, and which needed to be simulated or estimated (as well as how such estimation proceeded.). This trend is one of several current practices in the study of sector-specific emissions more generally, of which the touring sector is our current case study, that challenges and hinders efforts by individual actors, such as firms or policymakers, to confidently assess the efficacy of interventions and appropriately plan modifications based on real-world findings.

This conceptual paper delves into the complexities of accurate and repeatable measurement of GHG emissions taking place throughout the process of managing, attendance, and staging of music touring events. It also focuses on the necessity of deriving real-world data for empirical study creatively, by engaging various key industry stakeholders, including artists, venue owners, and attendees, in the process of studying their events. Different strategies for making events more sustainable are explored in discussion, as well as the full cost of proactively "Balancing" (see appendix A) the full scope 1 and 2 emissions of touring events through reforestation financing efforts.

The current manuscript also attempts to provide a continuously available and updating tool for event organizers to assess emissions based on limited and easy-to-access variables, based on estimates which we specify in the development and testing of our measure. It also seeks to open a forum for organizers to provide data that can allow the measure to improve in accuracy over time. The authors believe that such an "open-access" measure is the only way to attempt to resolve some of the issues we have found in the previous literature, as data availability and quality currently remain much too limited to consider this measure to be based on appropriate estimate parameters and continuously reliable when used across-time, without any direct engagement with the industry. One solution, discussed in appendix B, is a consistent data repository where festivals and event organizers can provide information regarding each of their events.

The paper concludes with an analysis of a variety of future research needs in the context of sector-specific analyses of GHG emissions, using the music touring industry as a continued case study. This includes investigation of the long-term effects of sustainable practices within the live music industry and identification of best practices for industry stakeholders hoping to individually assist, at each level of analysis. By addressing these challenges in participating alongside empirical inquiry, the live music industry can hopefully become one of many culturally and socially crucial industry sectors to play an important role in the broader effort to combat climate change through the promotion of sustainable development and emissions reduction.

II. Methods

The boundaries of the analysed touring events encompass all processes relevant to GHG calculations across various touring-related activities. Based on expert assumptions which determined that roughly 20% of emissions stem from activities associated with musical performers and approximately 80% originate from activities linked to the venue and attendees, the significance of key unknown variables include venue emissions, attendee emissions, and the number of attendees. This research manuscript focuses on estimating these variables across all music touring event classes.

Venue emissions are determined based on energy intensities per square meter (kWh/sqm) and waste intensities per attendee (gCO2/attendee), using geographically and temporally appropriate emission factors for energy sources. Electricity and natural gas are both assumed to be used, based on common industry practices. The entire daily energy consumption at the venue is allocated to the event, including setup and dismantling activities, even if the event occurs only partially within the day.

To ensure practicality and relevance, venues are categorised into small, medium, and large, as well as specific types such as arenas, amphitheaters, stadiums, and festival sites. Distinctions are made based on requirements and activities typical for each category. Intensity factors for emissions calculation are selected accordingly, drawing from sources such as CIBSE (2021) and BEIS & MeetGreen (2014).

For events held in small, medium, and large venues, intensity factors from CIBSE (2021) and BEIS & MeetGreen (2014) are used. For arenas, amphitheaters, and stadiums, a combined sports center intensity factor from CIBSE (2021) is chosen, given their common hosting of large sports events. The same waste intensity factor as for other venues is applied. Festival sites are treated similarly to stadiums due to their comparable capacity. Since the precise number of attendees is unknown at the start of ticket sales but the event's balancing cost must be determined, an estimate is derived based on the average attendance capacity of each venue, as defined by Live DMA (2018) and Baskerville, D. & Baskerville, T. (2019).

Event Boundaries

The boundaries of the event will describe the entire event processes which need to be considered for the GHG Calculations. Each of these processes consist of one or more activities. Through experience Balance.Eco found that emissions associated with events arise approximately 20% from activities associated with the band and 80% from activities associated with the venue and attendees (fig. 1).

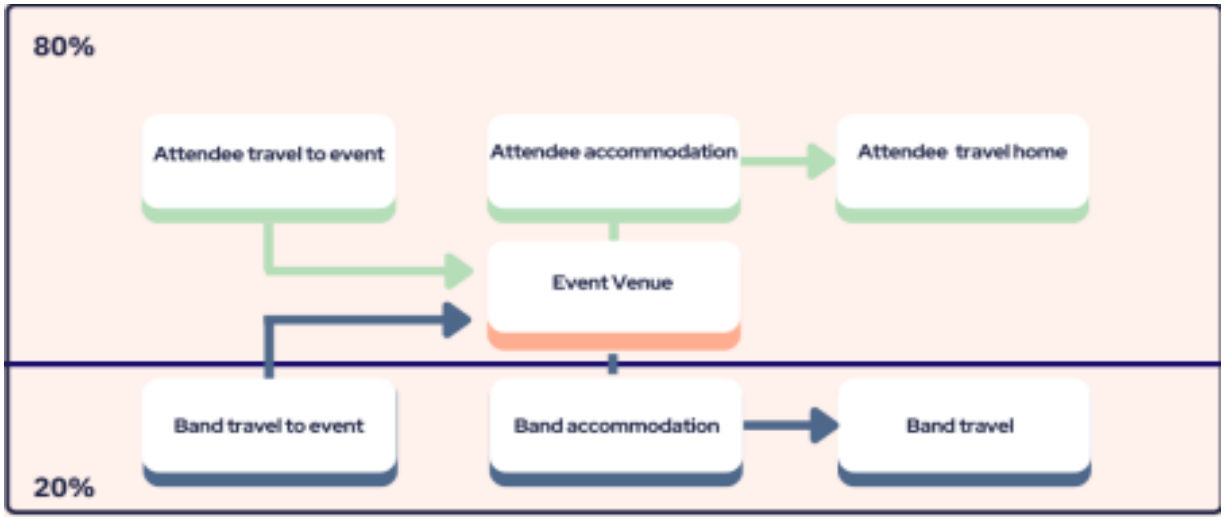

Fig 1: Event activity boundaries

Based on figure 1, emissions associated with the event are calculated by applying the following

equation:

$$(Attendee\ emissions + Event\ venue\ emissions) * 120\%$$

In order to balance the event, we then need to apply the cost of balancing and determine the number of attendees to the event to calculate the balancing cost per ticket as seen in the equation below:

$$\frac{(Attendee\ emissions + Event\ venue\ emissions) * 120\% * Cost\ of\ balancing}{Number\ of\ attendees}$$

While the current cost of balancing per tonne is known, even though this can vary due to changes in the market, the unknown variables are venue emissions, attendee emissions, and the number of attendees. The following sections will address these unknown variables and how to estimate them.

Venue-specific emissions

Emissions associated with the venue where the event is held are calculated based on energy intensities in kWh per sqm (CIBSE 2021), waste intensities in gCO_2/attendee (BEIS, MeetGreen 2014) and the geographically and temporally appropriate emission factors for those energy sources where available. We assume that both electricity and natural gas are being used. These intensity emissions factors are based on annual use of the venue. As the venues' purpose for that day is assumed to be solely the staging of the event, we allocate the full day of energy consumption to the event to include any set up and dismantling that needs to be done for the event even if the event only takes place for part of the day.

In order to use practical and sensible assumptions a distinction between small, medium, and large

venues and arenas, amphitheatres, stadiums, and festival sites is made as requirements/activities for these might differ. We define the size of a venue as described in Live DMA (2018) and Baskerville, D. & Baskerville, T. (2019). Based on that distinction the following intensity factors have been selected to calculate the emissions associated with the event venue. For events held in small, medium and large venues the CIBSE (2021) Theatre intensity factors and the BEIS & MeetGreen (2014) waste intensity factor for events are used.

For events held in arenas, amphitheatres, and stadiums the CIBSE (2021) Combined sports centre intensity factor has been chosen as these venues do often host large sports events as well or are purposely built for sports events. The BEIS & MeetGreen (2014) waste intensity factor for events is also used for arenas, amphitheatres, and stadiums. Festival sites have been deemed the same as stadiums considering the similar capacity they hold.

Since the number of attendees will not be known at the start of the ticket sale, but the cost of balancing the event needs to be added at that time, an estimate is made based on the average attendance capacity of each venue (Table 1). This average attendance is calculated based on the capacity range as described in Live DMA (2018) and Baskerville, D. & Baskerville, T. (2019).

Table 1: Attendee capacity	**Attendees**		
	Minimum	**Maximum**	**Average**
Festival Sites	10,000	120,000	65,000
Stadiums	30,000	120,000	75,000
Amphitheatres	5,000	30,000	17,500
Arenas	5,000	20,000	12,500
Large	1,000	5,000	3,000
Medium	400	1,000	700

Small	50	400	225

Since all venues differ in size but need to at least offer enough space for attendees to safely visit the event, we estimate the floor area based on the attendee capacity of these venues and a 2.5 attendee per square metre crowd density. This is an average of low crowd density to mosh-pit density as described by Event Economics (2022). Additionally, we have added 25% floor space for non-concert space such as washrooms, bar, backstage, and cloakroom to determine the venue's floor area.

Table 2: Average event venue floor area	**Floor area (sqm)**	
	Attendee (sqm)	**Venue (sqm)**
Festival Sites	26,000	32,500
Stadiums	30,000	37,500
Amphitheatres	7,000	8,750
Arenas	5,000	6,250
Large	1,200	1,500
Medium	280	350
Small	90	113

Attendee Emissions

Attendee emissions are defined as the emissions associated with travel and accommodation. Travel to and from events can be done by different modes of transport and this needs to be taken into account to determine attendee emissions.

Attendee Travel

A 2015 Ticketmaster survey found that the average distance traveled to attend an event was 43 miles, while about 10% of ticket buyers will travel over 100 miles. However, we assume that people visiting small concerts do this mainly in the city they live, or a nearby city, therefore we assume they travel the average UK commuting distance of 9 miles. People visiting a medium or large size event will travel an average return distance of 86 miles, based on the 43 mile one-way distance of the Ticketmaster survey. We assume that the 10% of attendees traveling more than 100+ miles will do this only for large events, as well as events in arenas, amphitheatres, stadiums, and on festival sites. Therefore, we have calculated the return distance for large events as.

$$((43 * 90\%) + (100 * 10\%)) * 2 = 97.4 \text{ miles}$$

Event	**Average return distance (miles)**
Festival	97.4
Stadium	
Amphitheatre	
Arena	
Large event	
Medium event	86
Small event	18

Table 3: Average return distance travelled to an event

One additionally relevant note is that for multi-day festivals the attendee will not travel the average return distance multiple times, as it is expected that the attendee will camp at the festival as well.

Main modes of transport

There are various modes of travel that an attendee can take (DfT, 2019). We do assume that for small events, where the average return travel distance is 18 miles, attendees will mainly take public transport, cycle, or walk. For medium and large events, we assume that attendees would in addition to the above-mentioned modes also drive by car, or even fly in. Emissions associated with the attendees' transport will be calculated by applying the mode appropriate BEIS (2021) emission factors. Table 4 shows the assumed transport modes taken for each event type.

Modes of transport	Small event	Medium event	Large event
Car	1%	43%	48%
Train	2%	28%	26%
Bus	60%	19%	17%
Metro/Tram	4%	3%	2%
Underground	18%	5%	4%
Bike	5%	0%	0%
Walk	11%	0%	0%
Airplane	0%	1%	2%

Table 4: Modes of transport to travel to an event

Attendee accommodation

On some occasions an attendee will have an overnight stay. This will be attributed to the attendee's emissions. We assume that those flying to a concert will take an overnight stay. In case an attendee decides to stay longer in the city of the event only one overnight stay will be allocated to the concert. To account for emissions associated with an overnight stay we will apply the BEIS (2021) hotel emissions factor. For attendees flying to a festival no hotel emissions are considered as these attendees are assumed to camp at the festival site.

Use of Emissions factors

Emissions factors and assumptions are temporal and regionally sensitive, meaning they differ per region but also can change year upon year. Therefore, the emission factors used in the calculator on which the results are based will become outdated. Moreover, modes of transportation used will change over time and it would be advisable to review the ratios of transport used and amend these when updates are available as well. The sources used for the calculator and mentioned throughout this methodology will regularly update their factors and assumptions as well. Subsequently the calculator should be updated each year with the most up to date factors and assumptions to derive the most accurate results.

III. Results

Table 5, below, displays the emissions associated with each of the individual event aspects, the total event emissions, and the emissions per attendee that, multiplied by the balance cost, can be added to the ticket price to enable a balanced event. Emissions per attendee have been rounded up to ensure that the complete event is balanced.

Event size	Venue emissions*	Attendee emissions*	Artist Emissions*	Event emissions*	Emissions per attendee*

Small	56	455	102	613	3
Medium	175	10,642	2,163	12,980	19
Large	748	55,682	11,286	67,716	23
Arena	4,068	232,008	47,215	283,291	23
Amphitheatres	5,695	324,811	66,101	396,608	23
Stadiums	24,408	1,392,049	283,291	1,699,748	23
Festival	21,154	1,188,190	241,869	1,451,212	23
Festival – 2 days	42,307	1,188,190	483,737	1,714,234	27
Festival – 3 days	63,461	1,188,190	725,606	1,977,257	31
Festival – 4 days	84,614	1,188,190	967,475	2,240,279	35
***All emissions in kgCO_2e**					

Table 5. Results

Our research finds that venue and attendance emissions at festivals are consistently higher than nearly every other event type, including for both single-day festivals events. Stadiums are the only event type to encounter higher emissions than festivals in some categories (i.e. venue and attendee emissions) but not others (i.e. artist and total event emissions, depending on event duration.) The emissions per attendee at festivals are also more likely to be higher than every other event classification, especially for multi-day festivals. These findings are discussed in the context of the initiative to both reduce and "Balance" all emissions sources from music touring events. Our findings imply that the increasing popularity of multi-day music touring events (typically considered as festivals) pose a challenging risk to efforts to limit GHG emissions by event organisers and are likely to require further research to determine where reductions are most

possible. Additionally, we hope that the publication and subsequent availability of this methodology will simplify the accounting of, and increase efforts against, GHG emissions arising from the production and attendance of music touring events. These results are presented in tables 6 and 7, below.

Table 6

Event size	Venue emissions*	Attendee emissions*	Artist Emissions*	Event emissions*	Emissions per attendee*
Small	56	455	102	613	3
Medium	175	10,642	2,163	12,980	19
Large	748	55,682	11,286	67,716	23
Arena	4,068	232,008	47,215	283,291	23
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***All emissions in $kgCO_2e$**					

Table 7 (fire regulations used to establish occupancy bounds)

Event size	Avg floor area (m^2)	Avg # of attendees	$kgCO^2e$ venue	$kgCO^2e$ attendees	$kgCO^2e$ Artist	$kgCO^2e$/event	tCO^2e/event	$kgCO^2e$/ attendee
Festivals	32,500	65,000	12,619 1%	1,188,190 82%	240,162 17%	1,440,971 100%	1,441	23
Stadiums	37.500	75,000	14,560 1%	1,392,049 82%	281,322 17%	1,687,931 100%	1,688	23
Amphitheatres	8,750	17,500	3,398 1%	324,812 82%	65,642 17%	393,852 100%	394	23
Arenas	6,250	12,500	2,427 1%	232,009 82%	46,887 17%	281,322 100%	281	23
Large Venues	1,500	3,000	355 1%	55,682 83%	11,207 17%	67,244 100%	67	23
Medium Venues	350	700	83 1%	10,643 83%	2,145 17%	12,871 100%	13	19
Small Venues	112.5	225	27 5%	455 79%	96 17%	578 100%	1	3

IV. Discussion

This research manuscript represents an evolving research methodology. As we obtain additional data some analyses based on assumptions will be updated and increasing granularity will be possible for venues and other event-specific categories. Currently, if all assumptions were able to be modeled with appropriate data, Balance expects that the findings would not change by more than 10%, in either direction.

Further research will allow for these assumptions to be replaced with real data, increasing the accuracy of this methodology.[1] Since publicly available data is very limited and therefore adds uncertainty to the model, partnership with industry leaders to acquire such data and improve the methodology–before an eventual formal submission for journal peer-review and publication–is a

[1] Balance Eco Ltd. will account for the cost of any extra emissions, should updated figures yield a higher emissions total for values calculated with the current methodology. Please see Appendix A for more information about Balance Eco Ltd's sustainability policy advocacy and research.

necessary and important step for this research and for the eventual practical application of our findings.

Future research should also examine the economic implications of adopting sustainable development practices and how these practices may influence audience beliefs about touring and, more generally, event participation. Additionally, there is a need to develop additional measures for assessing the variety of “greening”, or sustainability-geared, initiatives in the live music industry, as some may continue to be prevalent on the basis of assumptions, in lieu of adequate testing across sites, venues, and varying event structures.

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