Making industrial exhibitions green

A literature research on the LCA of physical and virtual industrial exhibitions

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Abstract

The meetings, incentives, conferences and exhibitions (MICE) industry is considered among the most wasteful, and growing environmental concerns call for a total transformation of how the sector operates. Information and communications technology (ICT) is believed to be able to substantially reduce human-induced emissions by supporting the dematerialisation of industry events, such as exhibitions and conferences.

This whitepaper aims to provide a comparison between the emissions resulting from physical and virtual industrial events. It offers a comprehensive and critical literature review on the environmental impact of physical exhibitions, trade fairs, conferences and other large-scale industrial events. It also investigates the literature available on the environmental impact of ICT and virtual industrial events.

List of abbreviations

AR	Augmented Reality
CO_2-eq	Carbon Dioxide Equivalent
ICT	Information and Communications Technology
ISO	International Organization for Standardization
LCA	Life-Cycle Assessment
MICE	Meetings, Incentives, Conferences and Exhibitions
VR	Virtual Reality

Introduction

Industrial exhibitions are key marketplaces, where businesses can showcase their latest products and solutions to a broad audience, extending market penetration and generating sales. The proven success of trade fair events as essential sales, marketing and communications tools have led to an ever-growing popularity of shows and fairs globally.

For example, while 2195 exhibitions were reported in continental Europe[1] in 2008, involving nearly 656,000 exhibitors and 53.8 million visitors (UFI, 2010), in 2018 the number of tradeshows organised in the same area exceeded 2670, bringing together over 735,500 exhibitors and 75.4 million visitors (UFI, 2019).

Despite their importance, conventional industrial events have substantial environmental impacts. In effect, these gatherings are energy and resource-demanding, plus they are responsible for emissions in all environmental compartments; air, water and soil.

Nonetheless, the growing environmental concerns that are revolutionising several aspects of our daily lives do not seem to have affected the MICE industry. In fact, industrial event organisation strategies continue to be rather linear in their approaches. This, despite the effort of regulatory bodies, such as the International Organization for Standardization (ISO), which released ISO 20121:2012 (ISO, 2015) standard guidelines on sustainable event management, containing requirements and guidance.

As emerged from a UK-based survey conducted at a sustainability-focused exhibition, with questions for exhibitors and visitors, only 53% of respondents were aware of the fact that exhibitions have a significant impact on the environment and only 8% considered exhibition stands to have a significant environmental impact (Newton et al., 2014).

While conventional industrial events remain unchanged, novel alternatives to these setups are beginning to develop. Emerging trends in ICT, namely virtual reality (VR) and augmented reality (AR), can offer a “digital twin” of physical exhibitions and shows.

Various researchers and regulatory bodies, such as the European Commission and the United Nations, have high expectations for ICT as a gamechanger in tackling climate change. In particular, it is believed that ICT can help support the creation of a sustainable future by substantially reducing human-induced carbon dioxide (CO_2) emissions (European Commission, 2008; UNFCCC, 2015).

Accessible from anywhere in the world by using an Internet connection, virtual events could substantially reduce business travel, slashing energy and resource use as well as emissions in all environmental departments. However, it is important to characterise the environmental footprint of virtual industrial events and compare it to physical ones in order to make sure that the dematerialisation of the MICE sector offers a truly sustainable alternative.

This whitepaper presents the findings of a systematic review of quantitative studies on the environmental impact of large-scale business-related events, particularly physical and virtual industrial exhibitions. Based on the data obtained, it draws an objective comparison of the two alternatives in order to determine which one results in lower anthropogenic emissions.

[1] Countries included in the report: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Finland, France, Germany, Hungary, Italy, Luxembourg, Moldavia, Monaco, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, Ukraine.

Quantifying the environmental impact of physical industrial events

The ISO 20121:2012 standard proposes several approaches to assess the sustainability of an event. One of these methods consists of conducting a life-cycle assessment (LCA). This is a systematic inventory and analysis of the environmental effects caused by a product or process, starting from the extraction of raw materials, production, use, up to disposal and waste treatment.

Currently, there is a limited body of LCA and quantitative research on the environmental impact of general events and exhibitions, even fewer resources focus on industrial-related activities. Even more, most of the studies available limit their the investigation to specific phases, such as preparation of the event, event execution, pre- or post-event activities, such as travelling to and from the venue.

As a number of research projects concluded that travelling can account for up to 96.3% of the total carbon footprint of an event (Hischier and Hilty, 2002), several studies evaluated solely the carbon emissions associated with travel activities to events and conferences (Achten et al., 2013; Caset et al., 2018; Desiere, 2016; Kuonen, 2015; Lou et al, 2015; Spinellis and Louridas, 2013; Stroud and Feeley, 2015).

Assessing the impact of visitors and organisers

To our knowledge, the only complete cradle-to-gate LCA that includes all stages of an event was conducted by Neugebauer et al. (2020). The publication from Neugebauer et al. (2020) provides a good indication of the potential environmental impact of an industrial-related conference. While the research looks at an international scientific conference, rather than industrial events, the two share a similar structure.

In comparison to the study from Hischier and Hilty (2002), whose LCA focuses on an international symposium, it includes conference rooms, hotel overnight stays and catering within its system boundaries. Contrarily to the research on CO_2 emissions caused by a conference, Mankaa et al. (2018), it assesses the environmental impact associated with the preparation of the event.

According to the LCA provided by Neugebauer et al. (2020), a three-day conference with 800 attendees has a carbon footprint of 455 tonnes of CO_2 equivalents (CO_2-eq), corresponding to an average of 0.57 tonnes CO_2-eq per participant. The main contributors to these emissions are travel activities, which accounts for a total of 378 tonnes CO_2-eq or 0.47 tonnes CO_2-eq per attendee. These are followed by hotel overnight stays (39 tonnes CO_2-eq in total) and catering (20 tonnes CO_2-eq, 0.25 tonnes CO_2-eq per individual).

Assessing the impact of buildings and exhibitor stands

When looking at the environmental impact of industrial exhibitions, the most relevant study comes from Toniolo et al. (2017), which investigates the environmental impacts associated with the preparation, usage, and dismantling of an event. In particular, the LCA provides an insight into the life-cycle of exhibitor stands and their associated emissions. However, the research focuses on the organisation of a trade show, thus it does not include travelling activities, hotel overnight stays, catering nor printed materials, such as conference flyers and brochures.

The findings from Toniolo et al. (2017) reveal that a three-day fair with 120 exhibitors and 11,600 m^2 of occupied surface can generate 75.5 tonnes CO_2-eq, 50.6% of which come from heating and lighting of the venue, for a total of 38.2 tonnes CO_2-eq. The second greatest contributor to the environmental impact of the preparation of a fair is the assembly of spotlight bars and carpets (over 20% of total emissions). This activity was followed by the assembly of electronic equipment, which is responsible for over 15% of total CO_2-eq.

What does this data mean for physical industrial exhibitions?

While the LCA methodologies used in the studies here presented present some differences, it is possible to combine their key results in order to provide a comprehensive estimate of the environmental impacts of an industrial exhibition. More precisely, it is possible to use the figures on visitor- and organiser-related activities from Neugebauer et al. (2020) with the building and stand preparation tasks from Toniolo et al. (2017).

To obtain more realistic figures on the number of attendees to a three-day, 11,600 m^2 fair with 120 exhibitors, it is possible to incorporate the event data from UFI (2019). We identified all exhibitions that lasted three days, with similar floor space and comparable number of stands. The resulting average number of visitors for such events was identified as 11,734, which is nearly 15 times higher than the attendees of the scientific conference considered by Neugebauer et al. (2020).

As less visitors are likely to spend the night out for exhibitions, we used the total emission data from Neugebauer et al. (2020) for hotel overnight stays. Instead, we used the same amount of CO_2-eq per capita as estimated by Neugebauer et al. (2020) for travelling and catering.

Based on these assumptions, a three-day, 11,600 m^2 fair with 120 exhibitors can generates over 5922 tonnes CO_2-eq, or 1974 tonnes CO_2-eq per day. Supposing that all 2670 exhibitions that took place in continental Europe last year (UFI, 2019) had a similar output, the regional MICE industry could be responsible for nearly 15 million tonnes CO_2-eq in 2018.

Activity	Emissions	Source
Travelling	0.47 tonnes CO_2-eq per participant	Neugebauer et al. (2020)
Catering	0.25 tonnes CO_2-eq per participant	Neugebauer et al. (2020)
Hotel overnight stays	39 tonnes CO_2-eq	Neugebauer et al. (2020)
Exhibition	75.5 tonnes CO_2-eq	Toniolo et al. (2017)

Table 1 - Combination of key data on emissions caused by industrial events

Quantifying the environmental impact of virtual industrial events

Many qualitative studies highlighted how ICT could reduce the environmental impact of events. However, the number of research documents that quantitatively assessed the environmental impact of virtual industrial events is scarce. One of the key reasons behind this lack of data is the inherent methodological challenges associated with estimating the emissions from ICT (Coroama et al., 2012; Coroama and Hilty, 2009; Coroama and Hilty, 2014; Hilty, 2010; Hilty et al. 2009; Pohl et al., 2019).

Furthermore, most of the available studies on MICE activities focus on virtual meetings, such as Coroama et al. (2015), Mallon et al. (2007), Takahashi et al. (2006), Takahashi et al. (2008), Toffel and Horvath (2004). Except for the early work by Coroama et al. (2012) on how the combination of decentralised conferences and ICT, not much attention has been given to virtual industrial events.

Currently, the most up-to-date and comprehensive analysis of ICT's carbon footprint is provided by Belkhir and Elmeligi (2018). The study looks at the environmental impact associated with electronic devices, namely computers, smartphones and tablets, infrastructural facilities, such as data centres, and communication networks.

Assessing the impact of ICT devices

According to the findings of this research, one desktop computer causes more emissions than notebooks, tablets or smartphones. More precisely, with a minimum useful life of 5 years, a desktop computer requires a maximum production energy of 628 kg CO_2-eq. Its use phase energy is estimated at a maximum value of 116 kg CO_2-eq per year and its lifecycle annual footprint accounts for 241 kg CO_2-eq maximum. Based on these figures, the daily impact of a desktop computer is approximately 1.3 kg CO_2-eq, while the hourly emissions are 54 g CO_2-eq.

The lifespan of CRT and LCD displays is comparable to what evaluated for computers. Their maximum production energy is set at 200 and 95 kg CO_2-eq, respectively. This means that the daily emissions are between 0.05 and 0.11 kg CO_2-eq, while hourly maximum is 4.6 g CO_2-eq. In addition, the assessment on use phase energy and lifecycle annual footprints indicates a maximum total of 230 kg CO_2-eq per year. This can be converted in 0.6 kg CO_2-eq per day or 25 g CO_2-eq per hour. Therefore, the daily impact of a screen can reach up to 0.71 kg CO_2-eq (29.6 g CO_2-eq per hour).

Assessing the impact of data servers and communications networks

The calculations aforementioned do not take into account the emissions associated with data centres, hosting the information for virtual exhibitions platforms, and communications networks. It is not possible to use the data on these aspects from Belkhir and Elmeligi (2018), as the figures provided are global. Thus, to estimate these contributors to CO_2 emissions, we relied on the figures provided by Hischier et al. (2015).

The study assesses the impact associated with data transfer when using internet services. It concludes that production, use and end-of-life of desktop computers are responsible for approximately 40% of the devices' total environmental impact per 1 MB of data downloaded. The biggest contributor to the emissions is Internet infrastructure and its components, which accounts for up to 60% of the total environmental impact per 1 MB of data downloaded.

Based on the figures on hardware's environmental impact from Belkhir and Elmeligi (2018), using one computer with a screen results in 2 kg CO_2-eq per day (84 g CO_2-eq per hour) emissions, which corresponds to 40% of total emissions. Internet services would account for 3 kg CO_2-eq per day (0.1 kg CO_2-eq per hour).

Therefore, one virtual exhibition visitor using one computer with one screen would generate up to 5 kg CO_2-eq per day, or 0.2 kg CO_2-eq per hour. The environmental impact of 11,734 visitors for a virtual trade fair with 120 exhibitors, as estimated in the previous section, would be approximately 58.67 tonnes CO_2-eq per day (2.4 tonnes CO_2-eq per hour). This is more than more than a hundred times lower than what estimated for a physical event

Activity/Equipment	Emissions	Source
Computer	1.3 kg CO_2-eq per day per device	Belkhir and Elmeligi (2018)
Screen	0.11 kg CO_2-eq per day per device	Belkhir and Elmeligi (2018)
Internet Services	5 kg CO_2-eq per day per device	Hischier et al. (2015)

Table 2 - Combination of key data on emissions caused by virtual events

Case study: IndustryExpo Virtual Exhibition

IndustryExpo Virtual Exhibition is an online industrial trade fair that hosts a range of exhibition stands, mostly in the engineering sector. To estimate the environmental impact of creating and maintaining the online platform, a questionnaire was submitted to the team working on IndustryExpo Virtual Exhibition to gather information on the dimensions of the trade fair, how many MB would be downloaded when visiting it, how many pieces of hardware equipment are used to run the platform and average energy consumption.

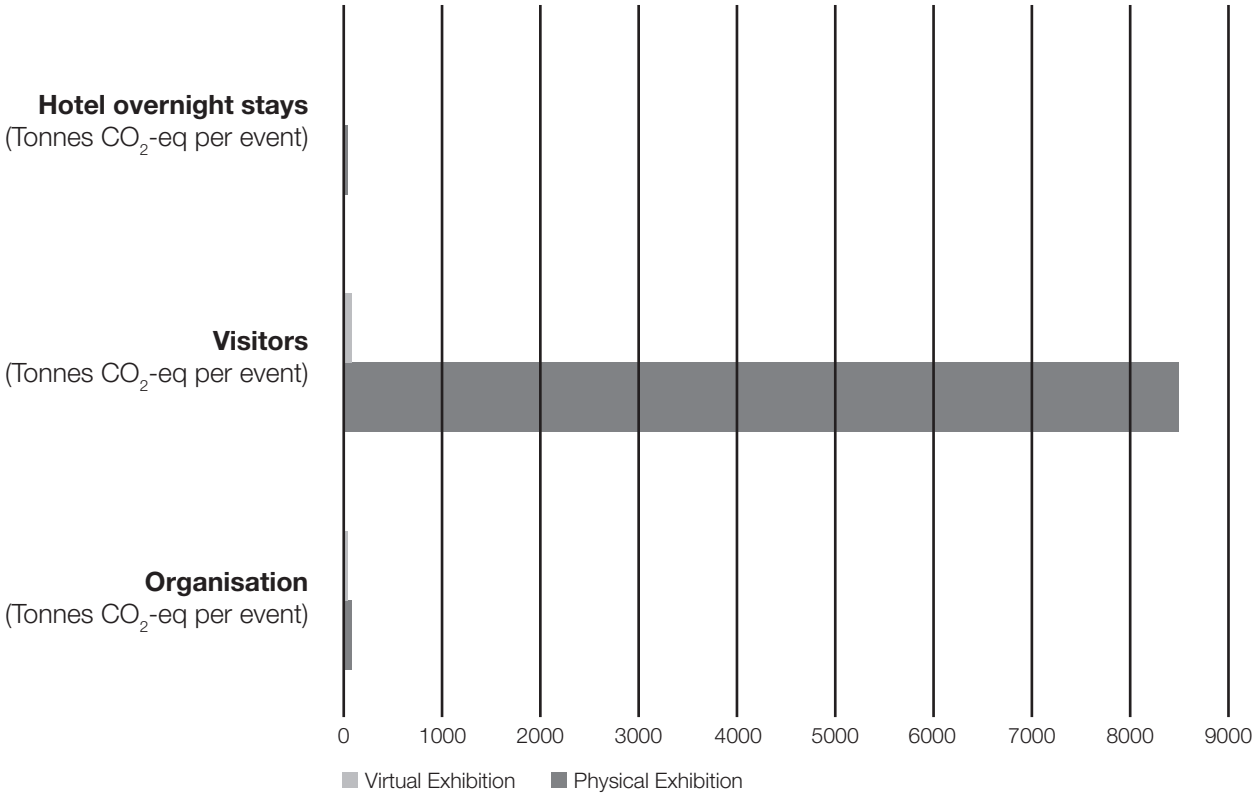
As a result of this survey, it emerged that the hall and all the stands in the virtual exhibition are rendered out to real physical dimensions. Currently, the platform features approximately 50 stands and occupies a "digital" floorspace of 37,628 m^2.

When accessing the exhibition IndustryExpo webpage, one of the most data demanding, visitors would download 3.2 MB of data. For comparison, the login page requires 0.5 MB.

The team working on the platform is composed by three 3D artists and two developers. Each of them uses one desktop computer and three LCD screens. In addition, they utilise a render rig. Therefore, based on the calculations from Belkhir and Elmeligi (2018), the hardware would account for 18.45 kg CO_2-eq per day, or 6.7 tonnes CO_2-eq annually. When including Internet services, as estimated by Hischier et al. (2015), total emissions reach 46.1 kg CO_2-eq per day (16.8 tonnes CO_2-eq per year).

The figure provided by IndustryExpo team on total annual energy use for this set up is 27,766 kW, which accounts for 7.86 tonnes CO_2-eq per year (21.5 kg CO_2-eq per day). Therefore, the total environmental impact associated with the preparation of IndustryExpo virtual exhibition would be 67.6 kg CO_2-eq per day, or 24.7 tonnes CO_2-eq per year. The yearly figure is three times lower than the 75.5 tonnes CO_2-eq calculated by Toniolo et al. (2017) on the emissions associated with the organisation of a three-day trade fair.

Figure 1 - Summary of findings on emissions caused by physical and virtual industrial exhibitions



Conclusions

Conventional physical industrial exhibitions are responsible for a large volume of CO_2 emissions and efforts should be made to reduce their environmental impact. Dematerialisation of industrial events by leveraging ICT provides a sustainable alternative. The figures presented in this whitepaper as a result of a thorough literature review offer an insight into the potential reductions that are achievable by shifting from physical to virtual exhibitions.

The preliminary findings from this whitepaper should be further investigated by conducting a comprehensive cradle-to-gate LCA on the environmental impact of physical and virtual industrial exhibitions.

About the author

Dr. Chiara Civardi, PhD is a technical writer with extensive experience in environmental impact assessment, exposure and hazard assessment of chemicals as well as sustainable technologies. She holds a PhD from ETH Zurich with a doctoral dissertation on “Assessing the effectiveness and environmental risk of nanocopper-based wood preservatives”. During her PhD she published 8 peer-reviewed articles that have been cited several times and won numerous awards, such as 3rd Prize PhD Award from the International Academy of Wood Science (IAWS), Gareth Williams Scholarship Award from Arch Chemicals Inc. and the International Research Group on Wood Protection (IRG/WP), and Ron Cockroft Award from IRG/WP.

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