

SUSTAINABILITY AND ASSISTED REALITY

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Eric Abbruzzese
Research Director

realwear

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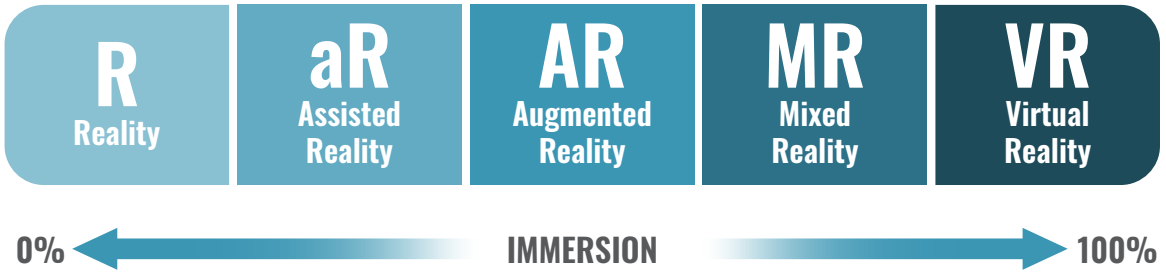
CARBON EMISSIONS, SUSTAINABILITY, AND ASSISTED REALITY

Over the past few years, enterprises have been turning to digital solutions for their challenges: Internet of Things (IoT), Artificial Intelligence (AI), Extended Reality (XR), and more. The XR "spectrum" presents limitless opportunities for companies across applications and use cases, but Assisted Reality (aR)—a lighter XR experience as shown below—has proven most popular for enterprises thanks to its usability across rugged environments and capability in high value use cases. As a result, Assisted Reality has especially stood out as a key element of this digitization, helping to drive workforce efficiency. Using an aR device can enable hands-free data access and seamless connectivity for workers on the frontline and otherwise.

Remote assistance has stood out among a handful of valuable aR use cases (training, step-by-step work instruction, and remote Testing, Inspection, and Certification (TIC)) for its rapid Return on Investment (ROI). An aR remote assistance solution can reduce the amount of travel necessary, as in the case of connecting to remote experts using aR at a downtime event. Added benefits like improved employee safety and increased workflow efficiency compound value, especially in combination with the other high-value aR use cases throughout an organization.

The Extended Reality (XR) Spectrum

(Source: ABI Research)



Beyond financial and operational benefits, sustainability benefits of aR should not be overlooked. While travel cost and downtime reductions are significant benefits of remote assistance, so is the positive environmental impact stemming from them. Travel cost is easy to understand, although the specific costs and potential benefits of aR can vary depending on many factors: operational scale, average amount of travel, type of travel, number of travelers, distance traveled, and total time traveling. These can all correlate not only with costs to the business, but also with emissions and overall sustainability. If work previously requiring travel can be accomplished without travel, that is obviously a more sustainable enterprise.

Time to market is rapid for aR remote assistance, meaning both business and environmental benefits can be seen almost instantly. Existing remote enablement options have been too limited to feasibly supplant required on-site personnel, especially in complex working environments and with complicated workflows. Hands-free aR is the first technology to truly be able to enable remote operation in these situations.

If anything is holding back sustainability efforts, it is not a lack of importance or potential. Recently, RealWear conducted a survey of its customers to understand their sustainability desires and potential usage of RealWear Head-Mounted Displays (HMDs) to support efforts. A total of 183 respondents worldwide contributed (executive, sales/marketing, frontline workers, Information Technology (IT), and operations roles were surveyed), covering small and large companies across industries. Some of the most illustrative data include:

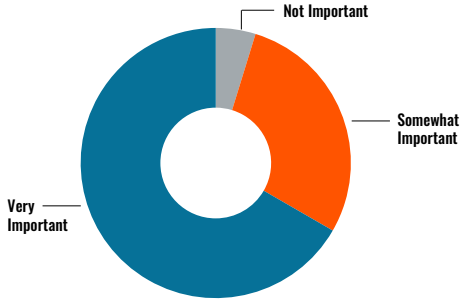
- **Sustainability is universally important across the RealWear customer base.** A significant 93% of respondents stated that sustainability is either somewhat or very important to their role (62% very important, 31% somewhat important). This must be backed up with action, which many organizations are doing. However, this shows that sustainability is not just top-level marketing, but beginning to be engrained across organizations as part of business operations.
- **Companies are mature enough to embark on an XR strategy, along with their digitization efforts.** In terms of organizational maturity for digitization, 45% of respondents stated their organization is very mature, and 47% stated their organization is somewhat mature. Only 8% stated their organization was not mature. If companies had sustainability goals, but lacked the digital technologies to reach those goals, then projects would prove unsuccessful and wasteful. Increasing sustainable efforts with a mature digital platform helps increase potential success.
- **Each potential event or incident carries a significant travel burden, affecting more than just a single employee.** Over 20% of respondents stated that nine or more employees are required on-site for a regular downtime or maintenance event. Nearly 30% stated that nine or more employees are required on-site for a regular training event.

- **More use of RealWear aR devices will result in a more positive environmental impact.** Among the respondents, 85% stated that employees travel more than once per year for events that could be handled remotely with the right hardware. Over 30% state that employees travel 10 or more times per year. Additionally, fewer than 10% of employees are already using RealWear devices. This shows there is a large addressable base for aR, and therefore an equally large, positive sustainability impact through travel reduction.

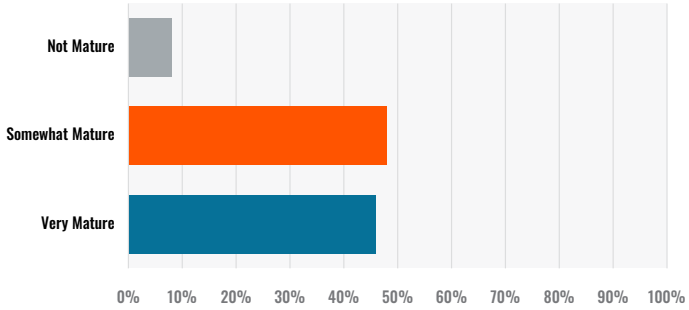
RealWear Sustainability Survey Results

(Source: RealWear, Breaking Down Air Travel Emissions)

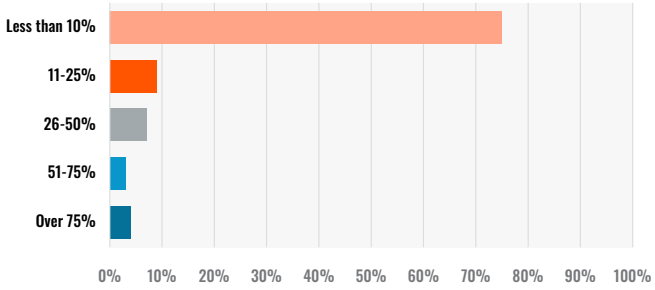
How important is sustainability to your role?



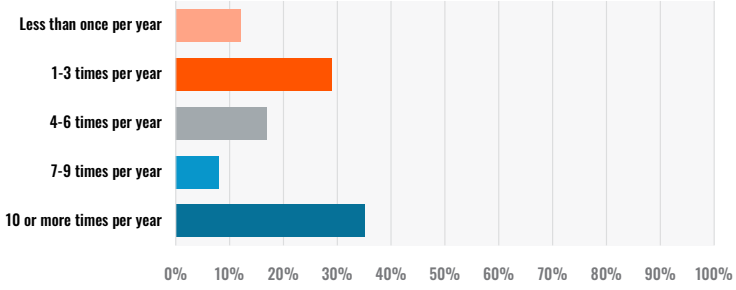
How mature is your organization in terms of digitization?



What % of traveling employees are already using RealWear HMDs?



How often are employees traveling for events that could be handled remotely?



While not the leading cause of total greenhouse gas emissions, air travel is a significant contributor. Air travel is also incredibly common, with many flights being necessary—the Air Transport Action Group (ATAG) suggests that 80% of Carbon Dioxide (CO_2) emissions are from flights longer than 1,500 Kilometers (km). This is notable, as in these cases, there is no practical alternative to air travel. Simply not flying has not been an option—personnel are needed on-site as machine experts, trainers, managers, etc. With government regulations and private efforts, greenhouse gas emissions have been trending downward in some key areas. The European Union (EU) surpassed a 2020 emissions reduction target of 20%, reaching 31% lowered emissions in 2020 versus 1990. However, future projections show that 2030 target emissions will not be met at the current pace. The European Environment Agency states that COVID-19 did impact 2020 numbers; however, 2019 also showed significant reduction.

As there are so many variables to consider, it can be helpful to first take an averaged scenario as a baseline example of emissions and potential reduction. The following estimates use data from the U.K. Government's Department for Business, Energy & Industrial Strategy greenhouse gas reporting for 2022.

Take a single travel event for one employee on an international round-trip flight: average ticket class (averaging economy, business, and first class), and 4,000 km of total travel, CO_2 emissions traced to that single traveler are approximately 400 Kilograms (kg). If that single travel event can be avoided using aR, then an instant emissions reduction of 400 kg can be expected. Extrapolating additional travelers, trips, and/or distance can give a reliable estimate of additional emissions and potential emissions reduction.



For a larger-scale and longer-term example, assume 40 people required travel events in a year that could be addressed through aR. With the same aircraft type, distance, and average ticket class, emissions reach over 16,000 kg of CO_2 emissions. This grows exponentially if booking in business or first class and with longer distance traveled. If those 40 travel events were booked using first class, then emissions total nearly 50,000 kg—per passenger emissions are estimated based on total emissions divided by total passengers, so less dense passenger seating leads to greater per passenger emissions.



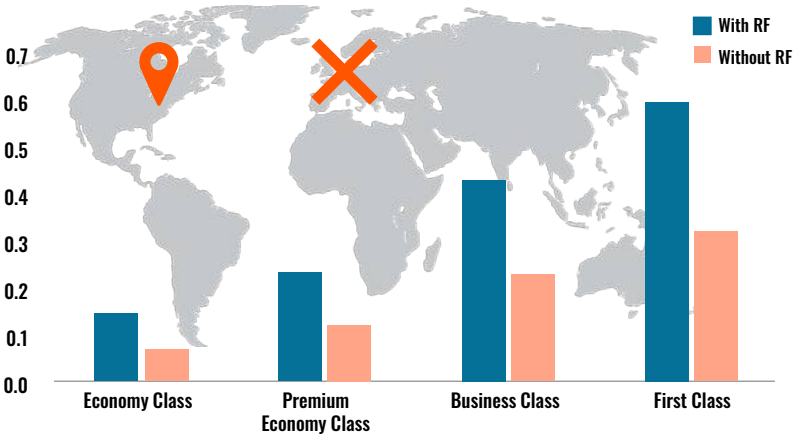
However, CO_2 is not the entire story. Air travel has a more significant emissions impact as the emissions are created high in the atmosphere. This phenomenon is known as radiative forcing, and emissions can reach nearly 2X over standard estimates. Factoring in radiative forcing, the above single trip, single traveler example can reach estimated emissions of over 750 kg of CO_2 emissions versus 400 kg. The 40 first-class bookings total 100,000 kg, rather than 50,000 kg.

Some argue that per passenger emissions are unreliable and unhelpful, as the flight will happen whether a passenger is booked or not. This is only partially true, as airlines operate flights based on demand, and if demand is not enough to profitably fly a segment, then the segment will eventually not be flown. Therefore, any reduction in passengers can correlate to a measured emissions impact, and thus a potential reduction.

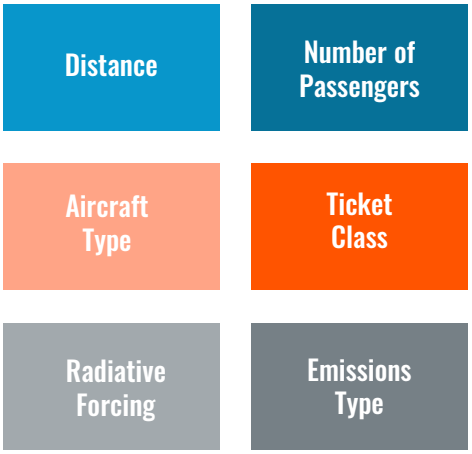
Average Emissions and Variables to Consider

(Source: UK Department for Business, Energy and Industrial Strategy, ABI Research)

Average CO_2 per km for Long Haul (1,500km+) Flight



Emissions Variables



On the left, the chart shows average CO_2 emissions per passenger per kilometer for a flight over 1,500 km. The difference between ticket classes is shown, along with the impact of factoring in radiative forcing. On the right, six primary variables that impact total emissions and potential reduction are shown.

There are also non-CO_2 emissions to consider. Total emissions in kilograms is not much higher accounting for these (1% increase or less on average), but the environmental impact may be significant—there is uncertainty around exactly how impactful these Nitrogen Oxides (NOx) are, and it is being actively researched.

Emissions reduction aligns perfectly with the increasing enterprise focus on sustainability and many companies' Corporate Social Responsibility (CSR) initiatives.

Sustainability in Action: *Stellantis is a global automotive manufacturer housing Fiat, Chrysler, Dodge, Jeep, and many other brands. The company has prioritized sustainability, with a commitment to reach carbon net zero by 2038 through its entire supply chain ("well to wheel"). The company has invested €30 billion specifically for electrification, and already sold nearly 400,000 Low Emission Vehicles (LEV) in 2021, growing 160% from the previous year. Supporting that effort, the company has begun deploying RealWear aR devices to reduce travel needs, while improving quality control and project review efforts. The devices are currently in use across 23 sites globally in factories and dealerships.*

€30 billion electrification investment

400,000 low emissions vehicles sold in 2021

23 sites using RealWear and scaling

STELLANTIS

Impact beyond Flight—Assisted Reality

The positive sustainability impact is not limited purely to travel reduction either. This paper has discussed air travel in detail, but air travel is only a portion of total travel-related emissions. Land vehicles (e.g., trucks and cars) make up the majority of emissions, according to the International Energy Agency. If an air travel event is avoided, thanks to remote assistance, so is any land travel to and from airports, hotels, and worksites. Outside of travel, aR can help reduce errors and overall downtime, which can help cut scrap from interrupted operations. Another element is energy usage—improved maintenance thanks to aR can keep machines operating within optimal parameters between downtime events, reducing wasted energy usage while operating. Lost Production Factor (LPF) is a common measurement of this efficiency over the lifetime of a unit, especially in wind energy. Less downtime, more energy produced.

Sustainability in Action: *Vestas is a sustainable energy solutions company focused on wind energy and responsible for 130 Gigawatts (GW) of energy production. On top of the obvious clean energy product portfolio, the company has committed to be carbon neutral by 2030 and reduce CO_2 emissions by nearly 50% in the same time frame. Vestas has reached an LPF of 2.88, meaning the company is operating at over 97% overall energy production efficiency. Vestas turned to RealWear to help combat both a retiring workforce and a process shift towards digitization—the company expects 30% of its workforce of 25 thousand to retire in the next decade. RealWear's HMD strengths in difficult conditions, thanks in part to a focus on full voice control, enables Vestas to both share and capture knowledge on site, minimizing upcoming retirement impact while ensuring high safety and success rate for workers.*



Some consideration around the physical aR hardware's environmental impact is also worthwhile. Existing devices, such as smartphones and tablets, can be used for many enterprise applications, including remote assistance—albeit in a more limited capacity. aR can act as a value add for these devices, but also can outright replace them in many cases. Low field failure rates, especially with ruggedized devices like RealWear Navigator™ 500 will have a longer life span than tablets or mobile devices, while delivering greater benefits. Avoiding overprovisioning and overlap among these devices limits unnecessary device manufacturing and waste. RealWear Navigator™ 500 is also modular, which can extend device life span further by enabling ad hoc hardware upgrades, rather than outright replacement—this limits electronics waste, while maintaining the same positive sustainability impact.

SUMMARY AND RECOMMENDATIONS

Over the past few years, the financial and operational benefits of using aR are becoming well known, as is the sustainability impact alongside. Remote assistance via aR is a potent, quick to implement use case with a significant positive impact. True sustainability efforts must be far-reaching beyond just travel reduction, but interim steps moving toward those broad sustainability improvements are necessary and are easily value-proven with available emissions data and possible travel reductions.

- **Sustainability is a journey, so have realistic timelines and expectations.** It takes time and resources to move the needle, and while air travel is not responsible for the majority of global emissions or overall environmental impact, it is a notable and addressable element. Additionally, many efforts that put operations first can still have a positive environmental impact—more energy-efficient operations will save money and reduce energy usage.

- **Weave sustainability strategies throughout both internal and go-to-market efforts**. The importance of environmental protection will only increase over time, so those with early and concerted efforts stand out. As customers increasingly value sustainable partners, existing relationships are strengthened, and new opportunities are more plentiful. Many governments are embracing sustainability as a core tenet, and winning governmental favor similarly expands opportunity.

- **Consider environmental impact at all points of an organization.** Travel reduction is only one facet. aR can help reduce machine and workflow downtime, reduce scrap rate, keep energy efficiency high, and more. Of course, there are significant efforts that aR never needs to touch as well—moving to low-emissions vehicles and machines, using AI for simulation/modeling where possible, ensuring sustainability through the supply chain, etc.

Sources:

1. U.K. Government Department for Business, Energy & Industrial Strategy greenhouse gas reporting *(https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022)*
2. ICAO carbon emissions calculator *(https://www.icao.int/environmental-protection/Carbonoffset/Pages/default.aspx)*
3. European Environment Agency greenhouse gas emission trends *(https://www.eea.europa.eu/ims/total-greenhouse-gas-emission-trends)*
4. U.S. Environmental Protection Agency (EPA) overview of greenhouse gases *(https://www.epa.gov/ghgemissions/overview-greenhouse-gases)*
5. Air Transport Action Group (ATAG) emissions figures *(https://www.atag.org/facts-figures.html)*
6. International Council on Clean Transportation (ICCT) CO_2 emissions from commercial aviation *(https://theicct.org/publication/co2-emissions-from-commercial-aviation-2013-2018-and-2019/)*
7. International Energy Agency (IEA) transport sector CO_2 emissions by mode *(https://www.iea.org/data-and-statistics/charts/transport-sector-co$_2$-emissions-by-mode-in-the-sustainable-development-scenario-2000-2030)*

Emissions Methodology:

The primary data source for emissions calculations was the U.K. Government Department for Business, Energy & Industrial Strategy greenhouse gas reporting. This breaks out flight emissions data with variables, including flight distance, ticket class, emissions type, and radiative forcing impact. Data units are in emissions per kilometer per passenger. Multiplying this conversion factor by distance returns a kilogram per passenger impact for that distance and class of travel.

Published September, 2022

157 Columbus Avenue

New York, NY 10023

+1.516.624.2500

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