

Towards carbon footprint measurement of the ERA Congress: five key strategies for greener events

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The urgency of climate change has prompted institutions worldwide to reassess their carbon footprints, and the scientific community is no exception. Large-scale medical congresses, such as the European Renal Association (ERA) Congress (Table 1), contribute substantially to carbon emissions. Nonetheless, these larger events provide immense value by fostering collaboration, networking, knowledge exchange and professional development. As a first step towards measuring carbon emissions, an estimation of the carbon footprint of air travel for ERA22 in Paris and ERA23 in Milan estimated at 1691 tons and 5808 tons of carbon dioxide equivalents (CO₂e), respectively [1]. These estimations had some limitations, as they excluded airport transfers and stopovers and were based solely on direct flights. Additionally, for ERA23, a higher number of participants lacked country of origin data, requiring assumptions based on average air travel [1]. Recognizing these limitations and reaffirming our commitment to sustainability, at ERA24 in Stockholm, we aimed to establish a more comprehensive and objective measurement of greenhouse gas (GHG) emissions. At this edition, ERA formalized its commitment by calculating the CO₂e associated with all the activities of the annual Congress. The first ERA24 Sustainability Report (available at: https://www.era-online.org/wp-content/uploads/2024/07/ERA-2024_Sustainability_Report_Short.pdf) has guided us to new strategies to reduce the environmental impact and create a lasting positive legacy [2]. The methodology followed the Greenhouse Gas Protocol, identifying and quantifying emissions across preparation, implementation and post-event stages (avail-

able at: https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf).

An overview of the results obtained from ERA24 in Stockholm is shown in Fig. 1. The CO₂e emissions per person were 2.083 tons CO₂e, with the main source being participants' travel, accounting for over 89% of the total carbon footprint. In total, 7187 attendees traveled a total of 65.2 million kilometers. This equates to 1627 trips around Earth. While scientific congresses require substantial resources, in-person events play a crucial role in the scientific community [3]. This article presents five key strategies to minimize the environmental impact among their challenges and limitations of the ERA Congress while preserving the benefits of in-person meetings and promoting a greener event.

RETHINKING VENUE AND ENERGY USE

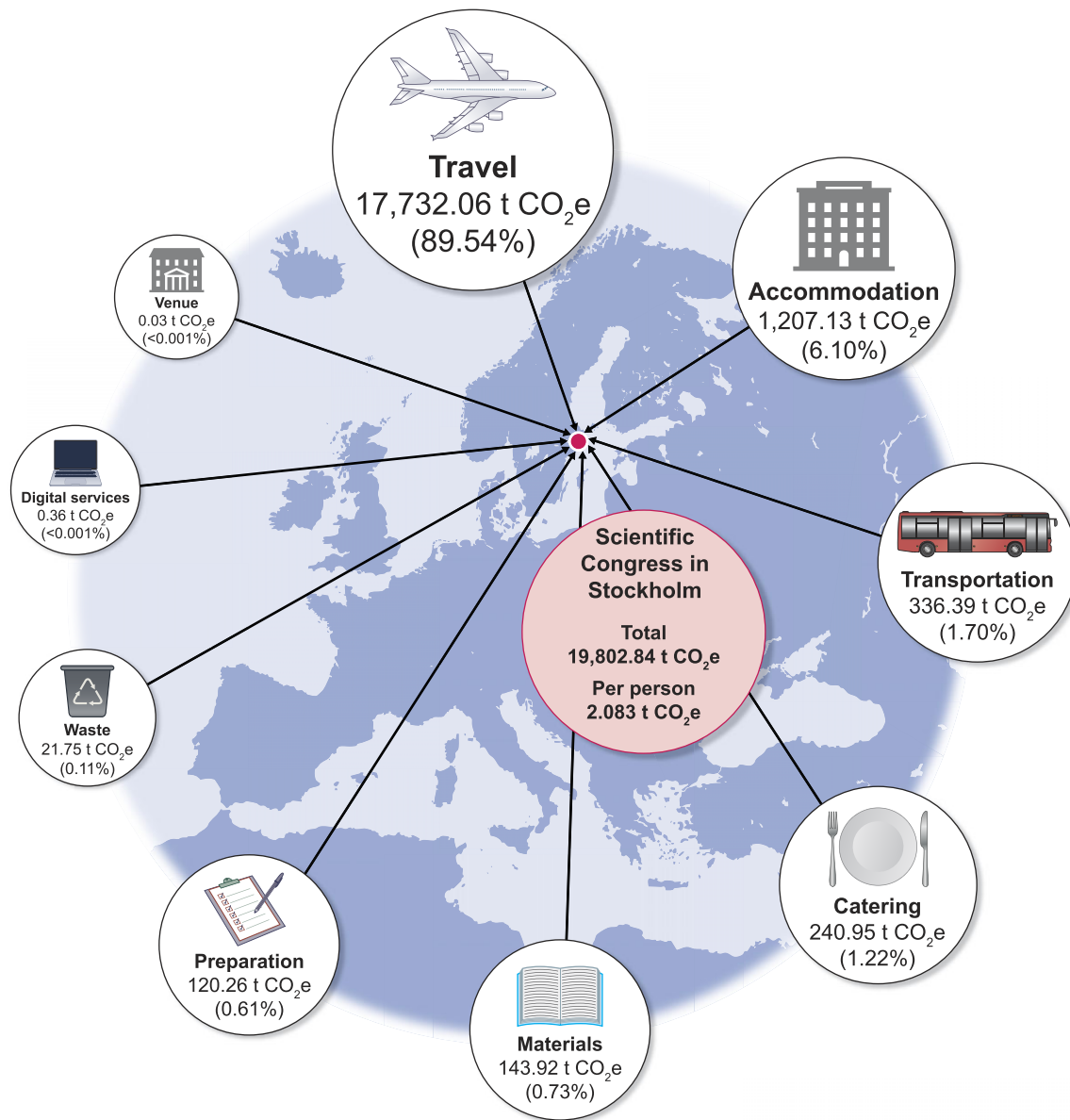
To reduce environmental impact and improve operational efficiency, venues with an environmental management system (EMS) are recommended. EMSs are structured frameworks, such as the European ECO-Management and Audit Scheme (EMAS) and ISO 14001, that help an organization implement cleaner production strategies through defined processes and practices [2, 4, 5]. For ERA24, the venue was certified by ISO 20121, using for example only renewable energy alongside district heating. Thus, CO₂e from the chosen venue were negligible (0.03 tons CO₂e) thanks to

Received: June 23, 2025. Accepted: October 28, 2025

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Table 1: ERA Congress attendance (2022–25): onsite and virtual participation.

Congress/city	Total number of attendees	Number of attendees onsite	Number of attendees on-line/remote
ERA Congress 2022 ERA22/Paris	5872	5967	1493
ERA Congress 2023 ERA23/Milan	9361	8860	501
ERA Congress 2024 ERA24/Stockholm	7674	7145	529
ERA Congress 2025 ERA25/Vienna	10 114	9487	627

**Figure 1:** Carbon footprint of the ERA Congress in Stockholm: breakdown by emission source.

renewable energy use and efficient waste management. Energy-efficient venue design is key, as appropriately sized and adaptable spaces reduce waste. Features like reusable room dividers, automatic lighting and energy-efficient heating, ventilation, and air conditioning systems further limit energy consumption. For ERA25 held in Vienna, the venue had a green event certification in accordance with the European Union Ecolabel which certifies

products and services with low environmental impact across their lifecycle. In the hospitality sector, it ensures that certified accommodations meet high standards in terms of energy efficiency, waste reduction and water conservation [6].

Although the exhibition area is assessed using similar sustainability criteria as the scientific sessions and its carbon footprint is smaller than major contributors like travel or accommodation,

the number of exhibitors can still represent a substantial component, and further analysis could provide valuable insights for future events.

While certifications such as ISO 14001 or the European Union Ecolabel are EMS and sustainability certification schemes, they are indirect measures that help estimate and guide efforts to reduce impact. Their criteria can and should be updated as knowledge and technology evolve. Additionally, the proliferation of schemes and risks of greenwashing may affect stakeholder confidence, underscoring the need for clearer standards, financial incentives and independent verification [6].

SUSTAINABLE TRANSPORTATION

While travelling to conferences plays a significant role in the life of an academic, it is often the largest contributor to an event's CO₂e [3], and our Congress is no exception [7, 8].

Therefore, it is essential to choose a well-located and well-connected city, one that is easily accessible by low-emission transport options such as train travel, and which also supports sustainable local mobility through public transport, walking and cycling [9]. Among five European cities hosting a political research conference, Hamburg reported the lowest per-capita GHG emissions [9]. Similarly, emissions from the San Diego meeting were up to 38% higher compared with Toronto [10], supporting the idea that more centrally located venues can significantly reduce emissions.

To reduce emissions, ERA25 in Vienna encouraged their attendees to use the train and public transport, opting for lower-carbon travel alternatives, such as high-speed rail or carpooling, when feasible, offering a special discount to reach the Congress city and the venue by train. For those who must fly, choosing non-stop flights instead of multi-leg journeys and opting for airlines that invest in carbon offset programs can help reduce their environmental impact [10]. While not a primary solution, carbon offset programs can help mitigate unavoidable emissions, and have been suggested as one of the key interventions for a sustainable and carbon-neutral event [5]. ERA has been financially supporting local sustainability projects, including the Forestami Project: <https://forestami.org/en/> in Milan (ERA23), Fly Green Fund: <https://flygreenfund.se/en/era/> in Stockholm (ERA24) and DonauCleanUp: <https://www.donaucleanup.org/de> in Vienna (ERA25).

While accessible cities can reduce the travel-related carbon footprint, some ERA Congress locations, such as Stockholm, are not easily reachable by train from most European countries. ERA Congress venues are selected many years in advance based on multiple factors, including capacity of the venue, number of hotel accommodations, infrastructure (including transport) and sustainability (of the venue, the hotels, etc.), with accessibility by low-carbon transport considered but not as the sole criterion. Future planning will further prioritize accessibility in order to minimize the environmental impact.

SUSTAINABLE OR ECO-FRIENDLY ACCOMMODATION

Selecting environmentally responsible hotels is another way to support sustainability in large-scale events. The hospitality industry, tourism activities, particularly accommodation and transportation, are responsible for approximately 8% of global CO₂e [11]. Our data showed that accommodation was the second-largest source of GHG emissions (1207.13 tons CO₂e). While implementing accommodation sustainability measures for ERA24 in Stockholm proved challenging, primarily due to the high volume

of attendees arriving simultaneously and the limited availability of hotels near the venue, accommodation sustainability remains a critical focus for future events.

Conference organizers can contribute by partnering with eco-certified hotels, encouraging attendees to book sustainable accommodation, and suggesting lodging within walking distance of the venue or easily accessible by public transportation. Nowadays, hotels may adhere to environmental certifications such as ISO 14001, Green Key, LEED and EarthCheck, which provide hotels with a structured framework to reduce their environmental footprint by focusing on energy efficiency, water conservation, waste management and resource optimization [6].

Since ERA24 in Stockholm, ERA has identified eco-certified hotels in its website to allow delegates to choose such hotels for their stay.

REDUCING WASTE AND RESOURCE CONSUMPTION

The scale of waste generated at large congresses is often staggering. Printed materials, disposable packaging, single-use plastics and catering waste are some of the contributors to this problem.

ERA has made strides toward sustainability by transitioning to digital platforms for materials such as the scientific programme and eliminating printed posters. Since 2023, ERA has adopted several measures to reduce waste and resource consumption, including replacing plastic badges with eco-friendly badge holders made of sulfate cardboard, recycling lanyards by reusing those from previous years, encouraging the use of refillable coffee cups and water bottles, and disposing of waste through separate collection systems provided at the congress venue, banning single-use plastic. However, reducing plastic use requires careful consideration. Recent evidence has focused on life-cycle assessment (LCA) as a tool to measure environmental impacts across all stages of a product's life. An LCA of 16 plastic alternative products found that 15 of them had higher GHG impact than plastic itself. This finding highlights the need to carefully examine plastic reduction policies to avoid unintentionally increasing CO₂e by shifting to more emission-intensive alternatives [12].

Another challenge is reducing waste throughout the entire food supply chain, from production to consumption, considering economic, health and environmental impacts [13]. A recent study assessing food waste at three scientific events in Spain reported a total of 104.4 kg of food waste, an amount that could feed approximately 74 people [14]. Food waste accounts for 8%–10% of global GHG emissions [13]. The market value of this loss is estimated at a staggering EUR 132 billion. Therefore, in a world where 733 million people faced hunger in 2023, equivalent to 1 in 11 people globally, the impact of food waste is not only an economic issue but also an ethical and sustainability concern [15].

The ERA Congress involves a complex logistic to manage catering, staff meals, symposium lunches, dinners, and food and beverages provided at the exhibition hall.

As part of its commitment to sustainability, ERA24 ensured that food leftovers were properly managed and sent to the city of Stockholm, where they were converted into biogas to be used as fuel for buses, trucks and cars [13]. When safety regulations allow, another valuable option is to donate the leftovers [2]. A similar strategy was implemented by ERA25. From our perspective, a key barrier is obtaining accurate data from the venue on the amounts of food leftovers donated, used for biodiesel or otherwise recovered. Such information is essential to effectively monitor and evaluate waste reduction efforts.

STRENGTHENING HYBRID AND VIRTUAL OPTIONS

In-person conferences (along with publications and various other media) are a cornerstone of academic innovation. In-person meetings enhance networking, career visibility and collaboration, offering connections and exchanges that virtual settings struggle to replicate [3]. The main alternatives to in-person meetings are virtual and hybrid formats. Virtual conferences take place entirely online, while hybrid conferences combine both in-person and virtual participation. Although there are several perceived disadvantages of virtual and hybrid formats, such as lack of informal and social exchange, challenges in building professional relationships online, screen fatigue and technical issues, virtual conferences can reduce GHG emissions by up to 94%, while hybrid formats can cut them by 60%–70% [16].

For over 10 years, ERA has adopted the hybrid format. Despite the higher economic costs associated with this format, it supports sustainability efforts and ensures broader accessibility particularly for those with health issues, visa barriers, caregiving duties, limited funding or in remote locations. It also saves time and money, increases attendance and diversity, particularly in terms of gender, geographic location and career stage, and ensures global participation without compromise [16]. In ERA24, 529 participants attended virtually generating a total of 0.36 tons CO₂e, which included emissions from the website (0.0672 tons CO₂e) and virtual participation (0.2910 tons CO₂e), based on 10 h of viewing using an average European CO₂e for each person [9]. Nonetheless, the difference between onsite and virtual attendance is substantial, a fully virtual format would still generate a notable CO₂e footprint, as on-site components remain essential. ERA addresses this by using local suppliers and providing high-quality streaming and recordings.

LESSONS FROM ERA24, THE ROAD AHEAD AND CONCLUSIONS

The ERA24 Congress took meaningful steps toward reducing its CO₂e, a process started already at ERA23, but there is room for further improvement. The experience of ERA25 must still be analyzed to assess its progress and identify new opportunities.

The challenge of hosting sustainable medical congresses is complex, but solutions exist. By embracing low-carbon travel options, optimizing energy use at venues, reducing waste and strengthening virtual accessibility, the ERA Congress can lead by example in sustainable event management. Excluding ERA22 in Paris (which was affected by COVID-19 restrictions at the time), the vast majority consistently attended onsite (Table 1). Large medical organizations and participants share the responsibility of reducing the environmental impact of events, organizers should offer sustainable options, while participants should make environmentally conscious choices. As a medical society, we must also reiterate our commitment to the global health of our population, recognizing that environmental sustainability and human well-being are deeply interconnected. As discussions continue, it is imperative that sustainability remains at the forefront of congress planning so that we can meet, without overheating the planet.

ACKNOWLEDGEMENTS

The Sustainable Nephrology Task Force is an official body of the ERA.

AUTHORS' CONTRIBUTIONS

P.P. wrote the manuscript. M.F., I.L., A.J.P., G.D., A.C.F., S.G., S.K. and M.H. were responsible for the critical revision of the manuscript. The final version of the manuscript was seen and approved by all authors.

CONFLICT OF INTEREST STATEMENT

M.F. is Executive Director of ERA. A.C.F. is member of the ERA Council. The other authors declare no conflicts of interest.

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