Studio Olafur Eliasson

Carbon footprint report // March 2021

Julie's Bicycle
CREATIVE · CLIMATE · ACTION

earth speakr

alison tickell

founder & director, Julie's Bicycle

We are nature, and in this time of climate crisis everything matters, and that includes digital impacts. This collaboration reminds us to take action, but also that culture has an extra part to play, connecting us to ourselves and Mother Earth, in short, art matters too.

Earth Speakr artwork

Olafur Eliasson has established himself as an artist and innovator at the forefront of exploring the links between art, technology, environment and sustainability.

Eliasson created an artwork on the occasion of the German Presidency of the Council of the European Union 2020 from July to December 2020 with the support of the German Federal Foreign Office. The result was *Earth Speakr*, a digital platform that invites young people to speak up for the planet and the future they want, and to make their messages heard.

The artwork has been co-created with children and young people. It consists of a playful app, an interactive website, AR (augmented reality) experience and audio-visual presentations in the 24 official languages of the European Union.

Earth Speakr facts and figures July to December 2020:
- 495,000 downloads of the *Earth Speakr* App
- 10,000+ messages created in over 60 countries
- 110+ local events and workshops
- Connection with 140 million people in the EU including via social media and advertising
- 2.5 million messages heard

Julie's Bicycle and Studio Olafur Eliasson have collaborated over several years to understand the environmental impacts of a number of art works (*Waterfall*, Tate Modern 2019; *Ice Watch*, Tate Modern and Bloomberg London, 2018; *Ice Watch*, during the 2015 global climate talks in Paris).

Julie's Bicycle's work with Studio Olafur Eliasson to understand the climate change impact of *Earth Speakr* is our fourth collaboration, this time looking at both physical and digital impacts from October 2019 to December 2020, covering the development phase and first six months of the artwork.

The digital footprint was developed with advice and support from experts on digital technology and sustainability from the University of Bristol: Chris Preist, Professor of Sustainability and Computer Systems and Daniel Schien, Senior Lecturer in Computer Science both with the Department of Computer Science, who provided pro-bono advice, and Paul Shabajee, Research Fellow. Chris, Dan and Paul are part of the team involved with DIMPACT, a collaboration between computer scientists and eleven media companies helping the media industry understand and manage the significant carbon impacts of digital content.

We can't simply say that a digital artwork has a higher or a lower impact than a physical or material artwork. No two artworks are the same and most will be a mix of some physical or material and digital elements and involve at least some travel.

What we can say is this:

- Flying remains the environmental big hitter. Not flying, or at least flying much less, is crucial.
- Online meetings have a much lower impact when replacing meetings for which people would have travelled longer distances, especially by plane.
- The bigger the screen or device, the higher the energy use.
- When choosing electronic devices (computers, screens, tablets, phones) — as a business, as individuals - don't consider only energy use. Consider also environmental and social impacts from manufacturing to disposal.

- Physical materials can still have a significant impact — choose reclaimed or recycled and locally available where possible.
- Choose refurbished and remanufactured devices.
- Keep devices in use for as long as possible.
- Ask tech companies and digital service providers for more and better reporting. Some still don't report publicly on energy use, source and impacts. Some do, but we are only just starting to see the emergence of reporting tools to help customers determine the impacts of the services they use.
- Build energy efficiency in the design of digital artwork and culture from the start and make it part of the brief for designers and developers.
- Tell your digital audiences what you are doing to understand and reduce digital impacts and what they, as 'consumers', can do.

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claire buckley

programme lead, Julie's Bicycle

Calculating *Earth Speakr's* carbon footprint has been a pioneering, complex and detailed piece of work. It is the result of a unique collaboration between Studio Olafur Eliasson, Julie's Bicycle and experts from University of Bristol's Department of Computer Science. While the final footprint is, in the grander scheme of things, not huge, the insights gained not only inform our understanding of the impacts of digital culture but also what we can do about it. And we are now, for the first time, in a position to explore how to make this approach more easily replicable for the creative and cultural community.

earth speakr
carbon footprint

29.1 tonnes
CO_2e gross[1]

Pie chart: 41%, 31%, 23%, 4%, 2%, 1%

(minus 0.4 tonnes for Studio Olafur Eliasson electricity on a renewable contract)

28.7 tonnes CO_2e net

Travel

11.9 tonnes CO_2e

73,200 km by plane
14,600 km by train
47 hotels nights

Materials, phones + screens

6.6 tonnes CO_2e

Workshop kits, 38 screen stands, 74 screens and 14 smartphones for outreach and audio-visual installations
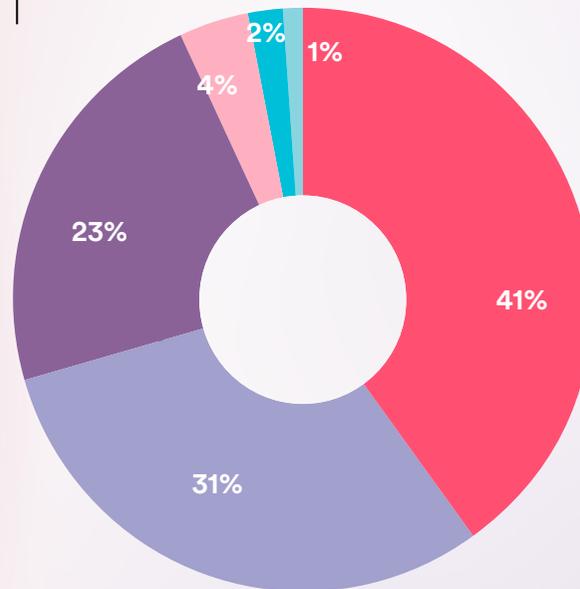
Freight

1 tonne CO_2e

Transporting 8.5 tonnes of screens and stands by truck and 0.1 tonnes of workshop kits by air for outreach and audio-visual installations

Website + App

8.9 tonnes CO_2e

Estimated 25,000 kWh of electricity use to store, serve, transmit, access, view and use the website, the App and their content

Work devices

0.5 tonnes CO_2e

Estimated 1,900 kWh electricity use by Studio Olafur Eliasson and AKQA computers to develop and maintain the website and App

Online meetings

0.2 tonnes CO_2e

Estimated 500 kWh of electricity use for 2 regular weekly online meetings March to December 2020

[1] CO_2e stands for carbon dioxide equivalent. Different activities emit different greenhouse gases (GHGs). For example, burning fossil fuels releases carbon dioxide, methane and nitrous oxide. For a given amount, different GHGs trap different amounts of heat in the atmosphere, a quantity known as the global warming potential. Carbon dioxide equivalent or CO2e is a way of expressing all GHGs in a single unit.

footprint

equivalent

29.1 tonnes
CO_2e gross
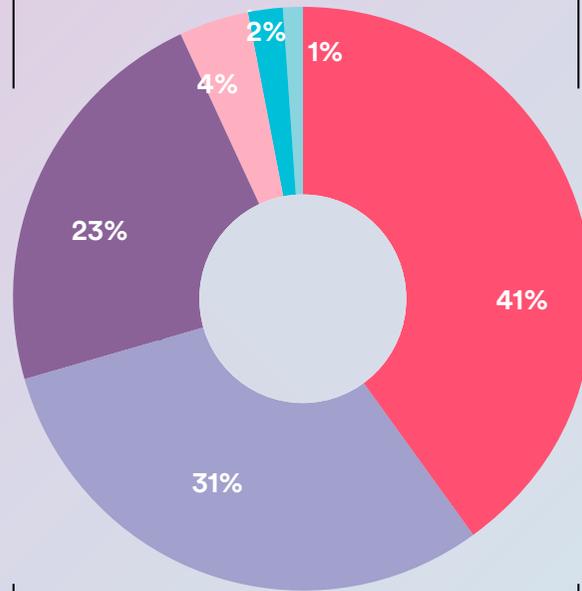
11 / people flying from San Francisco to Berlin return
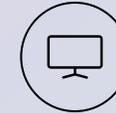
146 / people flying from Berlin to Brussels return

22,385 / people travelling Berlin to Brussels return by train

83 / 55" TV screens powered for a year in Germany

19,440 / smartphones charged in Latvia over a year

10 / UK households powered and heated over a year

41%

31%

23%

4%

2%

1%

How does Earth Speakr's climate change impact compare with that of other physical artworks?

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Earth Speakr had a similar carbon footprint to the *Waterfall* installation at Tate Modern in 2019 and a significantly lower footprint than *Ice Watch* London 2018. It is not a like-for-like comparison, and there will have been some digital footprint associated with the physical artworks, especially *Ice Watch* which has its own website, but it is telling all the same. While the impacts of a digital artwork may be much less tangible, and we might assume that they would be much lower than those of a physical artwork, this comparison shows that this is not necessarily the case. We need to be aware of and act on the impacts of digital culture too.

Ice Watch London 2018 — 55 tonnes CO$_2$e

Impact	tonnes CO$_2$e	% of total
Materials	0	0
Power	1	2
Travel	9	16
Freight	45	82

Waterfall Tate Modern 2019 — 30 tonnes CO$_2$e

Impact	tonnes CO$_2$e	% of total
Materials	18	60
Power	6	20
Travel	4	13
Freight	2	6

Earth Speakr 2020 — 29.1 tonnes CO$_2$e

Impact	tonnes CO$_2$e	% of total
Materials	6.6	23
Work devices	0.5	2
Travel	11.9	41
Freight	1.0	4
Website + App	8.9	31
Online meetings	0.2	1

Images (l-r): Jason Sutcliff, Anders Sune Berg, Lars Borges

Earth Speakr

Environmental highlights

Less travel, more online meetings

Earth Speakr involved partners and collaborators in many different countries.

From the start, in October 2019, Studio Olafur Eliasson took steps to minimise travel impacts.

- International meetings were grouped over a number of days to reduce individual trips.
- People were encouraged to use train instead of plane for travel within Europe.
- Online meetings replaced in-person meetings where possible, a conscious decision at a time before the Covid-19 crisis normalised online meetings.

Online meetings avoided 25 tonnes CO2e from air travel

56 online meetings were held October 2019 to March 2020, with 4-5 people on average per meeting. 70% of meetings involved people based in Denmark or the UK. Had the meetings taken place in person and these people flown to Berlin, a further 164,400 kilometres would have been flown, generating a further 25 tonnes CO_2e.

Purchasing refurbished smartphones

Studio Olafur Eliasson purchased 12 refurbished iPhones for use during *Earth Speakr* outreach activities. A refurbished phone has up to 50% less impact than a new one, as it needs less materials, resources, manufacturing etc than a new one and the impacts are spread over a longer period of time as the phone life has been extended.

Energy efficient website design features

AKQA, the design and communications agency, worked with Studio Olafur Eliasson on developing the *Earth Speakr* App and website and the systems and architecture which lie behind.

AKQA identified a number of design features to make the website more energy efficient using the ecometer.org tool, e.g. using as few plugins as possible.

Donating display screens

Studio Olafur Eliasson purchased 74 display screens for audio-visual installations in Berlin and Brussels to share the *Earth Speakr* messages over six months.

60 screens have already been donated, 50 to the Pelicano Foundation a Belgian children's charity and 10 to the ReDI School of Digital Integration, a German non-profit focused on digital skills and inclusion. 5 more screens will be donated and the remainder will be kept by Studio Olafur Eliasson for future use in installations presenting the artwork.

Studio green electricity

Studio Olafur Eliasson in Berlin, where much of the work on *Earth Speakr* has been done, runs on green electricity, purchased under an energy supply contract with a Renewable Energy Guarantee of Origin certificate.

Earth Speakr

What we've learnt

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	A few facts and figures	What we've learnt..	So...
Travel	Flying is one of the most energy-intense forms of consumption and one of the most inequitably distributed, with no clear pathway to zero carbon on the timescales needed 1% of the world's population emits 50% of CO_2 from commercial aviation 11% of people flew in 2018 and 2-4% flew internationally	Flying is still the big hitter environmentally Despite the steps Studio Olafur Eliasson took to reduce travel impacts pre-Covid and having no travel between March and December 2020, travel, and flying in particular, was still *Earth Speakr's* biggest impact Online meetings have a much lower impact if replacing meetings for which people would have travelled longer distances, especially by plane If replacing meetings which would have involved local travel only, especially via public transport, then the difference in impact will be negligible There's little public information about the energy use, source and impacts of online meeting services	Keep flying to an absolute minimum Use train where possible for inter-city and European travel Replace inter-city and international travel with online meetings where possible Ask online meeting service-providers to report on energy use, source and impacts, what they are doing about it and what users of their services can do
Materials	Manufacturing 1 tonne of steel with an average recycled content of 59% generates about 1.5 tonnes CO_2e Manufacturing 1 tonne of timber from virgin sources generates about 0.5 tonnes CO_2e	Materials still have a significant impact — while the stands made for *Earth Speakr* audio-visual installations were a small element, manufacturing the steel and wood used to make stands made up about 10% of the total footprint	Make more informed choices about materials and consider: ● how carbon intensive they are to make ● options for using locally available reclaimed or recycled materials or materials with high recycled content ● what will happen to them at the end of their use and how to maximise reuse or recycling

	A few facts and figures	What we've learnt..	So...
Devices	Made up of e.g. rare earth minerals, metals, plastics and glass, consumer electronic products are highly resource intensive and come with a high environmental and social cost. Miners often work in unsafe conditions for unfair wages. Mining can destroy habitats and leave behind toxic wastewater and soil. The products contain hazardous chemicals which pose a range of environmental and health risks. Of the estimated 50 million tonnes of ewaste globally in 2018, just 20% was recycled. And add the folllowing sentence after '20% was recycled': Much of the rest ends up as toxic waste either in landfills or in incinerators, or dangerous informal disassembly operations which are hazardous to people and planet. Smartphones are low energy devices. Most (60-80%) of their carbon impact comes from manufacturing, not use.	Energy use is often the main environmental consideration when choosing devices and not enough attention is paid to the environmental and social impacts of device manufacturing and disposal. Refurbished and remanufactured devices can have up to 50% less impact than new ones — supply of refurbished and remanufactured devices is on the increase. The bigger the device, the higher the energy use — mean power is approximately 2 watts for a smartphone, 10 watts for a tablet, 25 watts for a laptop and 120 watts for a desktop and monitor	Check out the environmental and ethical credentials of device manufacturers and the devices they make — if the information is not publicly available ask for it Keep devices in use for as long as possible and get them repaired where possible to extend their use Look for refurbished and remanufactured options when devices do need replacing Use smaller devices and screens where appropriate to the task as hand Run and charge devices on green electricity
Digital	Technology companies operating large data centres are important investors in and buyers of renewable energy Storing data on the cloud is 60-90% more energy efficient than storing it on local servers 30 minutes video-streaming generates less CO_2e than driving 5 km in a car	More data may mean more energy — digital design determines how power-hungry a digital product, artwork etc. will be The number of green web design and web-hosting services is on the increase There is scope for much greater transparency and accountability on energy use, source and impacts across tech companies and digital service providers — and for tools and reporting which help their customers determine the impact of the services they use. Service-specific reporting for customers is just starting e.g. Microsoft's Sustainability Calculator for Azure services and Google Cloud's Carbon Free Energy Percentage metric.	Build energy efficiency into digital design Ask tech companies and digital service-providers to report on energy use, source and impacts — overall and customer-specific — what they are doing about it and what users of their services can do Tell your digital audiences what you know about and have done on your digital impacts and what they can do

Earth Speakr

Carbon footprint scope

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	What is in scope?	What isn't in scope?
Travel	National and international travel and hotel accommodation by Studio Olafur Eliasson team members, project partners and collaborators paid for by the project October 2019 - March 2020 There was no travel April - December 2020	Local travel within cities by those working on *Earth Speakr* Travel by children and adults who participated in outreach activities
Online meetings	Avoided flights for pre-Covid online meetings October 2019 - March 2020 — assuming that participants not located in Germany would have flown had the meetings been face-to-face Energy use — based on participants devices, data transmission via networks and the meeting service provider's data centre infrastructure — for two regular online meetings (one daily and one bi-weekly) ● daily Studio team meetings ● bi-weekly co-ordination meetings between Studio Olafur Eliasson (Berlin), German Foreign Office (Munich) and AKQA (Copenhagen)	Online meetings held pre-Covid October 2019 - March 2020 Irregular and ad-hoc online meetings March - December 2020
Freight	Shipping of workshop kits, materials, stands and screens: ● workshop kits by air to 18 European cities ● steel and wood for making screen stands by road in Italy ● stands and screens for audio-visual installations by road from Italy to Germany and Belgium ● screens by road after the audio-visual installations back to Studio Olafur Eliasson or to organisations in Berlin or Liege to whom screens were donated	

	What is in scope?	What isn't in scope?
Materials, phones + screens	Embodied carbon associated with materials purchased for *Earth Speakr:* ● steel and wood for the screen stands ● paper for workshop kit art supplies	Waste / end of use All screens and phones purchased for *Earth Speakr* either have been or will be donated to local organisations or kept for further use Stands — scrapped for material recovery
	Embodied carbon associated with the production and transportation of screens purchased for audio-visual installations and phones purchased for testing and outreach: ● 74 screens — 54 x 55" and 20 x 32" ● 14 iPhones — 2 new and 12 refurbished	
	Energy use of 69 screens and 14 phones over the duration of their use for *Earth Speakr* up to December 2020 (5 screens were not used over that time period in the end)	
Work devices	Energy use of Studio Olafur Eliasson and AKQA design and communications agency devices for development and maintenance of the *Earth Speakr* website and App October 2019 - December 2020	Embodied carbon associated with the production and transportation of Studio Olafur Eliasson and AKQA devices used for website and App development and maintenance Studio Olafur Eliasson and AKQA building energy use
Website + App	Data centre — energy use July - December 2020 hosting, storing and serving app, website and content: ● Primary web hosting via Netlify — Google Cloud ● Operational App hosting via Google Firebase and cloud functions ● Media hosting and Content Delivery Networks (CDN) via Cloudinary and a variety of CDN providers ● Map Display Service via Mapbox	Website and App hosting, storing, serving and content and media transmission during the development phase October 2019 - June 2020
	Networks energy use July - December 2020 for data transmission during App download and use and website use: ● cellular networks / mobile data ● fixed line networks: core (the main telecoms infrastructure), access (cabinet to household) and in-home (modems/routers)	Embodied carbon associated with data centre and network infrastructure and equipment and end-user devices
	End-user devices energy use July- December 2020 for viewing and using the website and App	Other *Earth Speakr* digital services: mail server, social media, content moderation service, digital advertising

Earth Speakr

How did we estimate *Earth Speakr's* carbon footprint?

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Travel for project meetings Oct 2019 - Mar 2020		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Short-haul air travel	63 economy flights within Europe	36,740	km	0.15298 kg CO_2e per km	5.62
Long-haul air travel	4 economy flights between USA and Europe	36,416	km	0.14615 kg CO_2e per km	5.32
Train travel	26 train journeys in Germany and Europe	14,634	km	0.0001-0.00497 kg CO_2e per km	0.04
Hotel accommodation	47 nights	47	nights	7.3-40.9 kg CO_2e per night	0.91

11.89 tonnes CO_2e

Freight for audio-visual installations and outreach activities		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Road	8.5 tonnes of materials, stands and screens- 9,800 km	5,450	tonne km	0.14179 kg CO_2e per tonne km	0.77
Air freight	107 kg of workshop kits — 23,900 km	119.34	tonne km	2.20946 kg CO_2e per tonne km	0.26

1.04 tonnes CO_2e

Online meetings project meetings Mar - Dec 2020		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
211 x 0.5 hour daily meetings of the Studio Olafur Eliasson team, 10 people, on BlueJeans	10 people, 10 laptops — 3 of which also had monitors with mean power of 20-80 watts, for a total of 1,054 hours	44	kWh electricity	0.38 kg CO_2e per kWh Germany	0.02
	996 GB data transmitted in total, 0.084 kWh per GB	84	kWh electricity	0.38 kg CO_2e per kWh Germany	0.03
	996 GB data served, 0.027 kWh per GB (electrical intensity assumed from Netflix video streaming x 10 as video-conferencing is less efficient)	27	kWh electricity	0.45 kg CO_2e per kWh Netherlands	0.01
				Subtotal	**0.06**
84 x 1.5 hour bi-weekly co-ordination meetings between Studio Olafur Eliasson, Foreign Office and AKQA, 19 people, on BlueJeans	19 people, 1 smartphone, 18 laptops — 9 of which also had monitors with mean power of 2-80 watts, for a total of 2,402 hours	105	kWh electricity	0.38 kg CO_2e per kWh Germany	0.04
	2,270 GB data transmitted total, 0.084 kWh per GB	192	kWh electricity	0.38 kg CO_2e per kWh Germany	0.07
	2,270 GB data served, 0.027 kWh per GB (electrical intensity estimated from Netflix video streaming x 10 as video-conferencing is less efficient)	61	kWh electricity	0.45 kg CO_2e per kWhn Netherlands	0.03
				Subtotal	**0.14**

0.2 tonnes CO_2e

Materials, phones + screens for audio-visual installations and outreach activities		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Steel — embodied carbon	Steel used to make 38 screen stands	1.6	tonnes steel	1.46 kg CO_2e per kg	2.41
Wood — embodied carbon	Wood used to make 38 screen stands	1.3	tonnes steel	0.493 kg CO_2e per kg	0.64
Paper — embodied carbon	Paper used for workshops-in-a-box materials	4	kg of paper	0.9194 kg CO_2e per kg	0.004
				Subtotal	**3.06**
Display screens — embodied carbon	54 x 55" display screens used over 3-6 months	54	screens	400 kg CO_2e per screen over 60 month lifecycle, 7 kg CO_2e per month	1.85
	20 x 32" display screens used for 5.25 months	20	screens	150 kg CO_2e per screen over 60 month lifecycle, 3 kg CO_2e per month	0.26
Display screens — energy use	10 x 55" screens in use for 6 months in Berlin, 38 in use for 5.25 months in Brussels and 1 in use for 3 months in Berlin	5,610	kWh	0.38 kg CO_2e per kWh Germany	1.16
	20 x 32" screens in use for 5.25 months in Brussels	1,284	kWh	0.15 kg CO_2e per kWh Belgium	0.20
				Subtotal	**3.47**
Smartphones — embodied carbon	New iPhones used over 6 months	2	phones	59.04 kg CO_2e per phone for whole lifeycle of 36 months and half or 29.52 kg CO_2e per refurbished phone	0.02
	Refurbished iPhones used over 3 months	12	phones		0.03
Smartphones — energy use	2 new iPhones over 6 months in Germany	0.52	kWh electricity	0.38 kg CO_2e per kWh Germany	0.0002
	12 refurbished iPhones over 1 month in Greece	0.08	kWh electricity	0.54901 kg CO_2e per kWh Greece	0.00004
				Subtotal	**0.05**

6.5 tonnes CO_2e

Work devices Website and App development and maintenance Oct 2019 - Dec 2020		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Studio Olafur Eliasson devices — energy use	14 devices — a mix of desktops, screens and laptops — used 40-100% for Earth Speakr	850	kWh electricity	0.38 kg CO_2e per kWh electricity Germany	0.32
AKQA agency devices — energy use	40 devices — a mix of desktops, screens and laptops — used to varying degrees for Earth Speakr	1,053	kWh electricity	0.15 kg CO_2e per kWh electricity Denmark	0.16

0.48 tonnes CO_2e

Website + App — data centres storing and serving Website and App content and media		Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Data centre — energy use	Primary web hosting via Netlify - Google Cloud	a few thousand	kWh	Google is main provider and reports power use as net carbon neutral as they match 100% of global electricity use each year with renewable energy Power Purchase Agreements	Likely less than 1 tonne
	Operational App hosting via Google Firebase and cloud functions				
	Media hosting and Content Delivery Networks (CDN) via Cloudinary and a variety of CDN providers				
	Map Display Service via Mapbox				

1 tonne CO_2e

Website + App — networks	Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
Data transmission via cellular networks and fixed line networks: core, access (cabinet to household) and in-home (modems/ routers)				
App downloads — energy use 530,000 downloads including reinstallations — 160 MB - 220 MB each Assumed 10% of downloads via cellular and 90% via fixed line	12,656	kWh electricity	**GB to kWh** 0.5 kWh per GB via cellular 0.006 kWh per GB via core fixed line 0.08 kWh per GB via access and in-home	4.93
App use — energy use 0.9 million user sessions, 3 mins per session, 50 MB transmitted per session Assumed 20% of smartphone sessions via cellular and 80% via fixed line and 5% of tablet sessions via cellular and 95% via fixed line	6,846	kWh electricity	**kWh to CO_2e** 0.37 kg CO_2e per kWh for network data transmission for the website and 0.4 kg CO_2e per kWh for network data transmission for the App — mean weighted average depending on location of App downloads, App use and website use	2.75
Website use — energy use 0.1 million user sessions, 25 MB per session Assumed 20% of smartphone sessions via cellular and 80% via fixed line and 5% of tablet sessions via cellular and 95% via fixed line	449	kWh electricity		0.17

7.84 tonnes CO_2e

Website + App — end users	Quantity	Unit	Conversion factors	Emissions (tonnes CO_2e)
viewing				
App viewing — energy use 0.9 million user sessions, 3 mins per session, 50,000 hours total All viewing via smartphone (2W) or tablet (10W)	176	kWh electricity	0.39 kg CO_2e per kWh — mean weighted by country	0.07
Website viewing — energy use 0.1 million sessions, 3 mins per session, 5,600 hours total 96% of viewing via smartphone (2W), tablet (10W) and 4% via computer (53.5W)	49	kWh electricity	0.36 kg CO_2e per kWh — mean weighted by country	0.02

0.48 tonnes CO_2e

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acknowledgements

about Julie's Bicycle

Julie's Bicycle is a leading non-profit organisation, empowering the arts and culture to take action on the climate and ecological crisis. Founded by the music industry in 2007, Julie's Bicycle now works across the arts and culture, in the UK and internationally, focusing on four themes: justice and fairness; decarbonisation; nature; and circularity and a regenerative economy.

Julie's Bicycle leads strategic responses from the arts and culture sector and develops resources, networks and unique methods to scale and accelerate the movement and transform the conversation. Clients and partners include: Arts Council England, Universal Music, Curzon Cinema Group, Festival Republic; National Theatre, V&A and Somerset House. Working alongside over 2,000 organisations, NGOs and governments worldwide, Julie's Bicycle blends cultural and environmental expertise and delivers research, training, consultancy, policy development and international advocacy.

juliesbicycle.com

earth speakr

The carbon footprint for *Earth Speakr* was prepared by Julie's Bicycle

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Julie's Bicycle

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