Adobe Substance 3D stager

Greenhouse gas emissions, cost, and time savings calculation: Documentation of Methods

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Disclaimer

About Anthesis

Anthesis is the sustainability activator. We seek to make a significant contribution to a world which is more resilient and productive. We do this by working with cities, companies, and other organisations to drive sustainable performance. We develop financially driven sustainability strategies, underpinned by technical expertise and delivered by innovative collaborative teams across the world.

The company combines the reach of big professional services groups with the deep expertise of boutiques. Anthesis has clients across industry sectors from corporate multinationals such as Reckitt Benckiser, Cisco, Tesco, The North Face and Target, and also supports early-stage companies through Anthesis Ventures.

The company brings together 500 experts operating in 40 countries around the world and has offices in Andorra, Brazil, Canada, China, Colombia, Finland, France, Germany, Ireland, Italy, the Middle East, the Philippines, Spain, Sweden, the UK, and the US.

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1 Background

Adobe is interested in understanding the greenhouse gas (GHG), cost and time (GHG-CT) implications of the Substance 3D Stager virtual photography software. As part of this environmental program, they commissioned Anthesis LLC (Anthesis) to conduct a comparative GHG-CT assessment of virtual photoshoots performed on the substance 3D Stager software and of conventional, physical photoshoots.

The main purposes of this project are to:

1. Communicate potential savings to stakeholders; and
2. Inform competitive positioning.

The approach to calculate GHG emissions is based on Life Cycle Assessment (LCA). LCA is a decision support tool that allows quantitative environmental profiles to be generated for different products. It follows a four-stage iterative process, defined in the ISO 14040 standard, and presented in Figure 1.

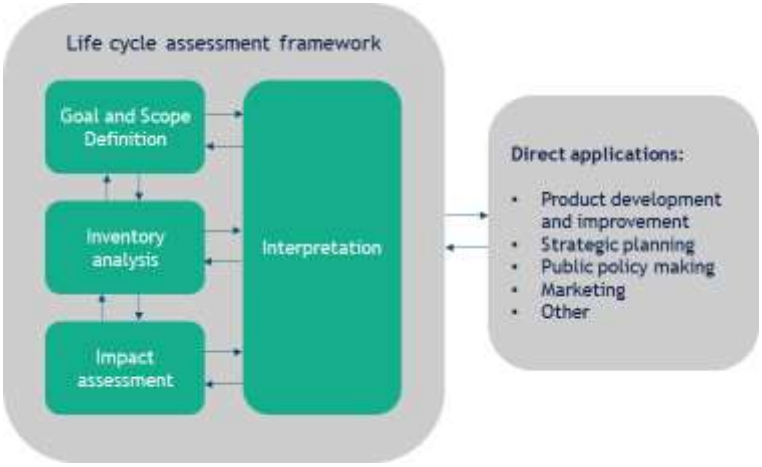

Figure 1: The four stages of LCA as defined by ISO 14040

1. Goal and scope definition: The first stage of LCA is to define the goal and scope of study to understand the objectives and intended applications, the boundaries of what is being assessed and the performance requirement that the product fulfils.
2. Inventory analysis: The second stage is inventory analysis, where an inventory of flows to and from nature is created, usually using a combination of primary and secondary data collected for each unit processes of the product system.
3. Impact assessment: The third stage is impact assessment, which is where inventory data are applied to characterization factors to generate the main results and determine the environmental impacts.
4. Interpretation: The final stage is interpretation, which is where conclusions are drawn, sensitivity and uncertainty analyses are performed, and recommendations made.

The project is divided into three steps:

1. Adobe software GHG-CT footprint;

2. Physical photoshoot GHG-CT modular footprint; and

3. Interactive footprint comparative tool for Adobe customers to input the typical requirements of a physical photoshoot and view the GHG-CT savings from using virtual photography.

The main deliverables of the project are:

- An evidenced-based study to consider the environmental performance of Substance 3D Stager;
- Insights into the 'hotspot' sources of impacts for Adobe's Substance 3D Stager software offering;
- A basis for Adobe to quantify the 'avoided emissions' from its products that fall outside standard GHG inventory; and
- A communicative tool for Adobe's customer to quantify the GHG, time, and cost benefits they will realize through Adobe's software.

In this report, we document the methods employed to develop the tool. Intended audiences for this report are Adobe's team and potential Adobe's customers. It is important to note that this report and tool have not been critically reviewed by independent reviewers and therefore are not ISO 14044-compliant.

2 Scope definition

Two systems are considered in this analysis: A virtual photoshoot using Adobe Substance 3D Stager and Adobe Stock, and a physical photoshoot led by a photo studio. The two systems are assumed to be functionally equivalent: they can deliver the same images to the client. The reference unit of the analysis is 10 virtual images, 5 with white background and 5 with lifestyle/creative background, with a resolution of 1080 px X 1350 px at 72 ppi of one product. This reference unit, also called functional unit, is used to quantify the performances of the photoshoots and to estimate the GHG emissions, cost, and time requirements. All subsequent results are normalized to this reference unit.

To limit the scope of the analysis, 5 products are included: a plastic bottle, a soda can, a computer speaker, a Scandinavian design sofa, and a fashion shoe. Figure 2 presents a visual representation of the 5 products.

Figure 2: Visual representation of the products to be photographed. Source: Adobe Substance 3D Assets

The photoshoots of the products are performed with different backgrounds. The most simplistic background is a white background obtained with a white screen in a studio photo and a simple white background in Adobe 3D Substance Stager. The lifestyle backgrounds represent realistic backgrounds for the products. In this analysis, 3 lifestyle backgrounds are considered: a kitchen, an office, and a living room. Figure 3 presents a visual representation of the lifestyle backgrounds. There are two ways for a studio photo to have a lifestyle background: rent a scene specifically designed for photoshoots, or rent a real scene (e.g., a real functional kitchen in a house). The two scenarios are considered in this analysis.

Figure 3: Visual representation of the lifestyle backgrounds. Source: Adobe Stock.

Each product is matched with a lifestyle background and figure 4 presents the matching.

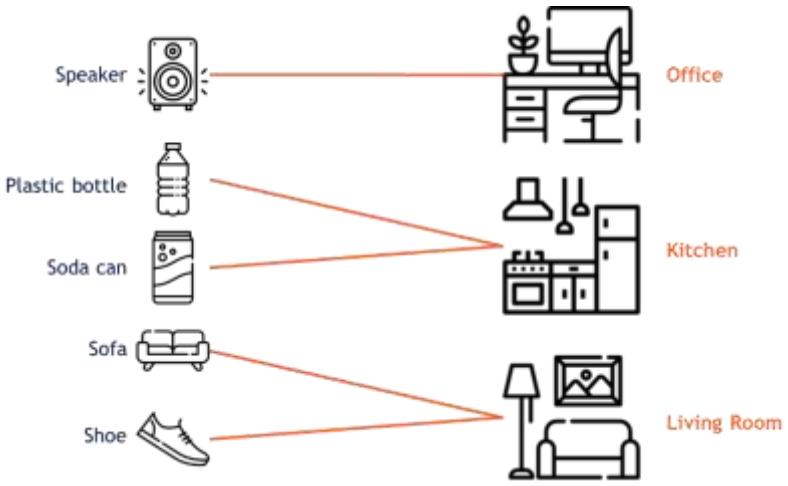

Figure 4: Lifestyle background and product matching

Finally, creative backgrounds are considered for more creative photoshoots. In a studio photo, the creative backgrounds are composed of plywood wall, paint, plastic, wood, and paper. In Adobe 3D Substance Stager, the backgrounds are composed of various 3D assets. Figure 4 provides examples of creative backgrounds by product.

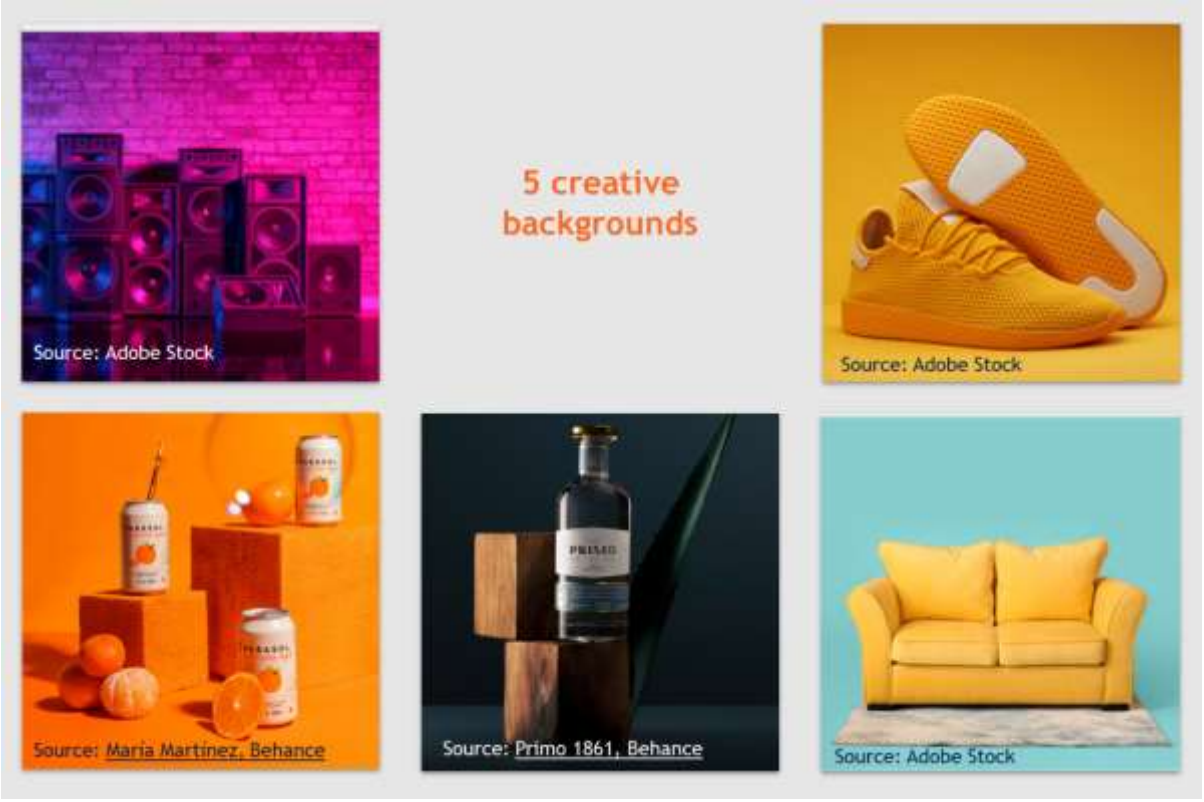

Figure 5: Visual representation of creative backgrounds

The geographical scope of the analysis is in the United States and the temporal scope is in 2022.

3 Time requirements

In this section, we describe the approach to estimate the time requirements of the virtual and physical photoshoots of the products. Time is defined as the "time spent by a company to obtain images of their product".

General assumptions

- We assume that 1 working day consists of 8 hours.

Physical photoshoot

The time requirements for the physical photoshoot include:

1. Time to ship the product (only for large items such as the sofa as it is assumed that the other products are being brought by the team going to the studio photo);
2. Time spent by the team in the studio photo or on site; and
3. Post-production waiting period to produce 10 images of the product.

The assumptions of the time requirements for each product are presented in Table 1. They are based on discussions with professional photographers.

Table 1: Time requirement assumptions for physical photoshoot

	Transport	Background setup	Photoshoot per product per background	Post-production editing
Plastic bottle	-	0.75 days	0.25 days	2 days
Soda can	-	0.75 days	0.25 days	2 days
Speaker	-	0.75 days	0.25 days	2 days
Sofa	2 days	0.75 days	0.25 days	2 days
Shoe	-	0.75 days	0.25 days	2 days

Virtual photoshoot

The time requirements for the virtual photoshoot include:

1. Creation of the 3D model of the product;
2. Setting-up the 3D background; and
3. Processing the 10 images of the product.

The assumptions of the time requirements for each product are presented in Table 2. They are based on discussions with professional virtual artists.

Table 2: Time requirement assumptions for virtual photoshoot

	3D Model creation	Background 3D and processing
Plastic bottle	1 day	2 days
Soda can	1 day	2 days
Speaker	1 day	2 days
Sofa	2 days	2 days
Shoe	2 days	2 days

4 Carbon footprint

The carbon footprint of each system uses a streamlined LCA approach with a focus on carbon.

General assumptions

- 3 people from the manufacturer's team travel 16 miles per working day with a private car to go to the studio photo or photo scene and support the photographer (U.S. average distance travelled by a vehicle trip, U.S. DOT 2017).
- Sofa is transported by truck for 220 miles from the manufacturer's facility to the studio photo or photo scene (U.S. average delivery distance by truck in 2018, U.S. DOT 2018).
- The scene elements last for:
    - Furniture products: 156 photoshoots (i.e., elements used three times a week for 1 years)
    - Kitchen products: 156 photoshoots (i.e., elements used three times a week for 1 year)
    - Small items: 78 photoshoots (i.e., elements used three times a week for 6 months)
- Electricity derives from U.S. average electricity production mixes (0.53 kg CO2 eq. / kWh in 2020, U.S. EPA 2021)
- 2 items of each product are produced for physical photoshoots except for the sofa.

Physical photoshoot

The system boundary for the carbon footprint of the physical photoshoot is presented figure 6.

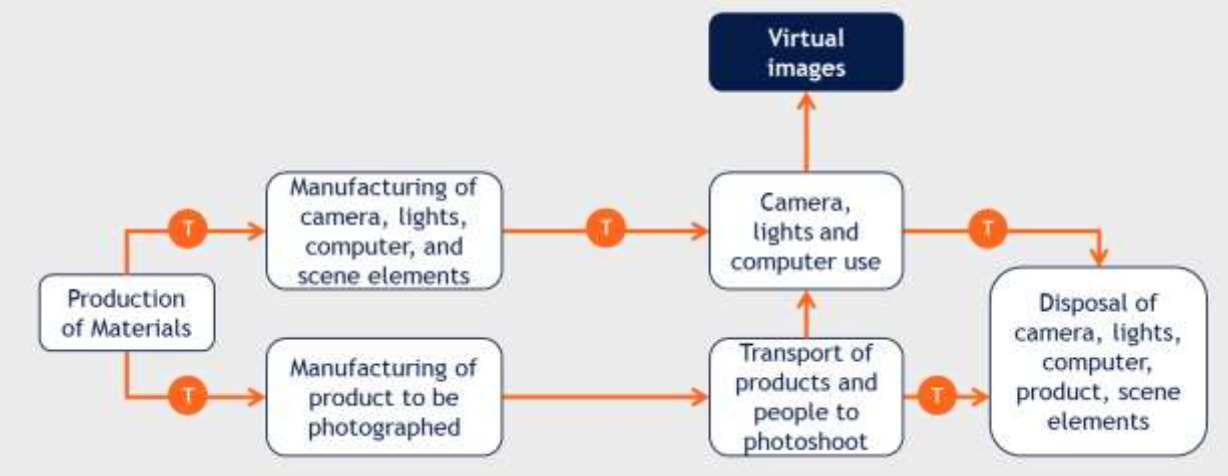

Figure 6: System boundary for the carbon footprint of a physical photoshoot

The cradle-to-grave carbon footprint of the 5 products included in this analysis are presented in Table 3.

Table 3: Carbon footprint of the products

	# of items	CF of Production [kg CO_2 eq. / unit]	Source	Additional material details
Plastic bottle	2	0.14	Kuczenski et al., Study	Made of PET in California. 3.9% recycled content. 73% end-of-life recycling.
Soda can	2	0.0968	The Aluminum Association, Study	Made of aluminum in the U.S. 73% recycled content. 50.4% end of life recycling.
Speaker	2	25	Ecoinvent, GaBi & material composition	Case (80% by weight) made of Polycarbonate. Speaker (20% by weight) made of cone (paper), coil, circuit board, magnet, basket (aluminum) and steel plates.
Sofa	1	134	Fora Form, EPD	Made of wood (49% by weight), polyurethane (36%), textile (4%), steel (3%), and other plastics. Manufactured in Europe.
Shoe	2	28.2	AKU, EPD	Made of leather (27% by weight), rubber (26%), polymer (23%), textile (14%), and others.

The list of equipment needed by the studio photo, along with the cradle-to-grave carbon footprint is presented in table 4.

Table 4: Carbon footprint of the studio photo equipment

	# of items	CF of Production [kg CO_2 eq. / unit]	CF of Use [kg CO_2 eq. / day]	CF of End-Of-Life [kg CO_2 eq. / unit]	Source
Camera	4	6.1	0.003	0.1	ecoinvent
Computer	1	248.5	0.076	3.1	Deng et al., Study
LED lights	4	17.0	0.018	1.67	OSRAM, study
2400 W lights	1	94.1	0.572	0.6	Ecoinvent v3.8, Amazon
White screen	2	5.8	0	0.06	Ecoinvent v3.8, Amazon
Reflectors	4	1.6	0	0.084	Ecoinvent v3.8, Amazon

The cradle-to-grave carbon footprints of the elements included in the lifestyle backgrounds are presented in tables 5, 6, and 7.

Table 5: Carbon footprint of the elements in the office background

	# of items	Lifetime [# of photoshoots]	CF of Production [kg CO_2 eq. / unit]	CF of End-Of-Life [kg CO_2 eq. / unit]	Source
Desk	1	156	18.8	5	Bisley, EPD
Chair	2	156	86.2	0.61	Knoll, EPD
Painting	2	78	0.4	0.00325	Juno, EPD
Plant	2	78	16.6	0.231	WAP, Study
Lamp	2	78	8.9	0.013	U.S. DOE, Study & OSRAM, Study

Table 6: Carbon footprint of the elements in the living room background

	# of items	Lifetime [# of photoshoots]	CF of Production [kg CO_2 eq. / unit]	CF of End-Of-Life [kg CO_2 eq. / unit]	Source
Carpet	1	78	4.9	0.224	Interface, EPD
Coffee table	1	156	13.2	0.748	Mark Product, EPD
Center table	1	156	18.9	8.1	Helland, EPD
Sofa	1	156	134	54.7	Fora Form, EPD
Arm chair	1	156	49.6	13.4	Noma, EPD
Painting	2	78	0.4	0.00325	Juno, EPD

Table 7: Carbon footprint of the elements in the kitchen background

	# of items	Lifetime [# of photoshoots]	CF of Production [kg CO_2 eq. / unit]	CF of End-Of-Life [kg CO_2 eq. / unit]	Source
Dining table	1	156	19.0	8.1	Helland, EPD
Kitchen countertops	2	156	34.9	4.3	USDA, Study
Kitchen cabinets	1	156	240	21.0	Svenheim, EPD
Sink	1	156	21.3	0.04	Ecoinvent v3.8, Database
Grill/oven	1	156	199	0.50	Landi et al., Study
Fridge	1	156	180	14.4	Monfared et al., Study

The lifestyle backgrounds using real spaces (e.g., real kitchen) have no carbon footprint allocated to their production. However, it is assumed that all equipment of the studio is transported to the scene and require an additional vehicle (travelled over 16 miles).

The creative background is assumed to be built exclusively for one virtual photoshoot and consists of:

- 0.1143 m^3 of plywood wall (2 m high, 3 m wide, 0.02 m thickness with density of 620 kg/m^3),
- 1.02 kg of paint (0.17 kg for 1 m^2 of wall),
- 3.9 kg of plastic foam (3 cubes of 30 cm by edge with density of 48 kg/m^3),
- 8.1 kg of wood (3 cubes of 30 cm by edge with density of 100 kg/m^3),
- 1.7 kg of paper (4 m^2 with density of 433 g / m^2).

Carbon footprints of the materials derive from the ecoinvent v3.8 database. The total cradle-to-grave carbon footprint of a creative background is 6 kg CO_2 eq. per background.

Virtual photoshoot

The system boundary for the carbon footprint of the virtual photoshoot is presented in figure 7.

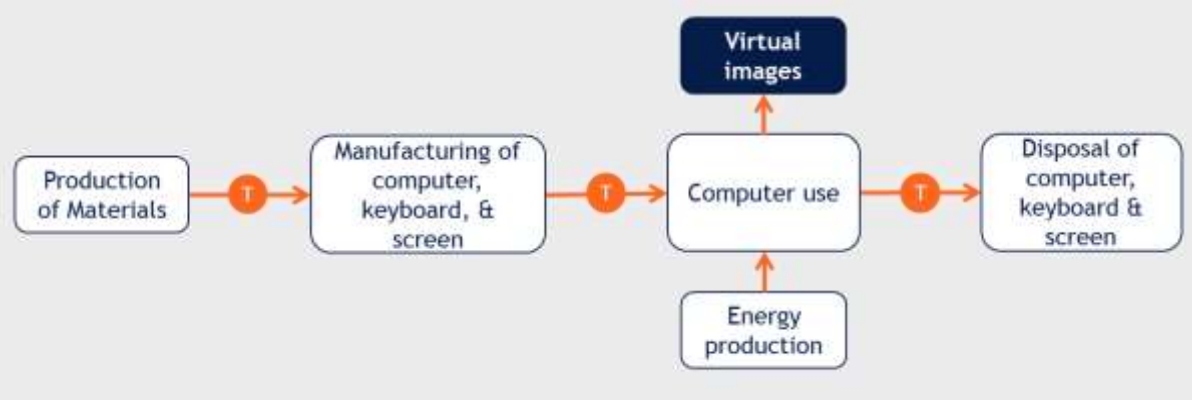

Figure 7: System boundary for the carbon footprint of a virtual photoshoot

The production, use and end-of-life treatment of the computer were considered in the carbon footprint of a virtual photoshoot, as presented in table 8.

Table 8: Carbon footprint of equipment for virtual photoshoot

	# of items	Lifetime [# of days]	CF of Production [kg CO_2 eq. / unit]	CF of Use [kg CO_2 eq. / day]	CF of End-Of-Life [kg CO_2 eq. / unit]	Source
Computer	1	2.9 years = 1059 days	249	0.076	3.1	Deng et al., Study

5 Cost

In this section, we describe the approach to estimate the costs of the virtual and physical photoshoots. Only costs paid by the product's manufacturer are included.

General assumptions

- We assume that the sofa is shipped via a third party whereas all other products are transported with the team going to the studio photo at no additional cost.
- Daily rate for post-production editing is $650 per day.
- The Adobe software is used by one visual artist for 50 photoshoots per year.

Physical photoshoot

Figure 8 presents the different elements included in the costs of a physical photoshoot.

Figure 8: Elements of costs for physical photoshoot

Table 9 presents the daily costs to use a studio photo. Note that the total cost assumes up to 5 products per day. The costs are estimated based on discussions with professional photographers.

Table 9: Cost description of studio photo

	Cost ($)	Comments
Photographer day rate	$ 3,500	All staged backgrounds
Assistant day rate	$ 400	
Stylist day rate	$ 1,000	
Rentals + Props	$ 1,600	
Total	**$ 6,500**	
Location rental	$ 1,200	Additional cost for live location rental
Truck rental	$ 300	
Extra assistant	$ 400	
Total	**$ 8,400**	

Table 10 presents a detailed breakdown of costs by product.

Table 10: Detailed breakdown of costs by product for physical photoshoot

	Production	Transportation	Daily labour per product per day	Post-production editing per day
Plastic bottle	$ 10	-	$ 1,300	$ 650
Soda can	$ 10	-	$ 1,300	$ 650
Speaker	$ 100	-	$ 1,300	$ 650
Sofa	$ 750	$ 600	$ 1,300	$ 650
Shoe	$ 300	-	$ 1,300	$ 650

Virtual photoshoot

Figure 9 presents the different elements included in the costs of a virtual photoshoot.

Figure 9: Elements of costs for virtual photoshoot

The Adobe 3D Substance Stager subscription is approximately $600 per year (at $50 per month) and is assumed to be used for 50 photoshoots per year. There is therefore a flat cost of $12 per photoshoot.

The Adobe Stock subscription is approximately $360 per year (at $30 per month) and is assumed to used for 50 photoshoots per year. There is therefore flat a cost of $7.2 per photoshoot for the background.

Table 11 presents a detailed breakdown of costs by product. Note that the 3D model production costs are estimated based on discussions with 3D virtual artists.

Table 11: Detailed breakdown of costs by product for virtual photoshoot

	3D Model Production	Flat cost per photoshoot	Background cost	Post-production editing per day
Plastic bottle	$ 250	$ 12	$ 7.2	$ 650
Soda can	$ 150	$ 12	$ 7.2	$ 650
Speaker	$ 150	$ 12	$ 7.2	$ 650
Sofa	$ 600	$ 12	$ 7.2	$ 650
Shoe	$ 550	$ 12	$ 7.2	$ 650

6 Scaling factors

To assess the implications of including more than 1 product per photoshoot, we added scaling factors to the analysis. These factors allow us to estimate the greenhouse gas (GHG), cost and time (CT) implications of photographing multiple similar products. The factors scale up the time, carbon and cost impacts. The assumptions are listed below.

Time

- Physical photoshoot

  Photography
  - It takes 0.75 days (6 hours) to setup one background regardless of the number of products, and it takes 0.25 days (2 hours) to the photoshoot of the first product
  - Each additional product being photographed takes 1 hour for a sofa and 30 minutes for a small product (i.e., shoe, speaker, bottle or can).

  Post-production editing

- It takes 0.5 days (4 hours) to setup the post-production parameters for one background regardless of the number of products, and it takes 0.5 days (4 hours) to process the first product
- Each additional photographed product takes 1 hour to be processed per background

- Virtual

  Post-production editing
  - It takes 0.75 days (6 hours) to setup one 3D virtual background regardless of the number of products, and it takes 0.25 days (2 hours) to process and generate pictures from the first product.
  - Each additional product takes 15 minutes to be processed per background

Carbon footprint

- Physical
  - The carbon footprint of producing and disposing a product is multiplied by the number of products
  - The transport of sofa is multiplied by the number of sofas being photographed
  - Use phase of the photography equipment and editing equipment takes the additional time required into consideration
  - All other parameters do not depend on the number of products (e.g., transport of the team to studio photo, studio photo equipment and production of the backgrounds)
- Virtual
  - Use phase of the editing equipment takes the additional time required into consideration

Cost

- Physical
  - Product production cost is multiplied by the number of products
  - Transport cost of sofa includes the additional number of products
  - Photography and post-production editing labour costs takes the additional time required into consideration
- Virtual
  - Post-production editing labour costs takes the additional time required into consideration

7 References

AKU. 2020. Environmental Product Declaration of Bellamont Plus

Bergman et al. 2017. Cradle-to-gate life-cycle assessment of laminated veneer lumber (LVL) produced in the southeast region of the United States. Forest Products Laboratory

Bisley. 2022. Environmental Product Declaration of Desks & Drawers

Deng et al. 2011. Economic-balance hybrid LCA extended with uncertainty analysis: case study of a laptop computer. Journal of Cleaner Production

Ecoinvent v3.8. ecoinvent.org

Forster et al. 2021. The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

GaBi v9.8. Sphera

Helland. 2019. Environmental Product Declaration of Pan Dining table 140 x 80 cm

Interface. 2020. Environmental Product Declaration of Modular Carpet

Juno. 2019. Environmental Product Declaration of Interior Paints

Knoll. 2018. Environmental Product Declaration of ReGeneration Work Chair

Landi et al. 2019. Comparative life cycle assessment of electric and gas ovens in the Italian context: An environmental and technical evaluation. Journal of Cleaner Production

Marathe et al. 2019. Life Cycle Assessment (LCA) of PET Bottles. Recycling of Polyethylene Terephthalate Bottles

Mark. 2021. Environmental Product Declaration of Arris: table

Monfared et al. 2014. Magnetic vs. vapor-compression household refrigerators: A preliminary comparative life cycle assessment. International Journal of Refrigeration

OSRAM. 2009. Life Cycle Assessment of Illuminants. A Comparison of Light Bulbs, Compact Fluorescent Lamps and LED Lamps.

Svenheim. 2018. Environmental Product Declaration of IRIS høyskap 2A4 dører nederst, 3A4 glass dører øverst

The Aluminum Association. 2021. Beverage Can LCA report

U.S. Department of Energy. 2012. Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products

U.S. Department of Transportation. 2017. National Household Travel Survey

U.S. Department of Transportation. 2018. Moving Goods in the United States

U.S. Environmental Protection Agency. 2021. Emissions & Generation Resource Integrated Database (eGRID)

WAP. 2017. Comparative LCA of the Environmental Impacts of Real Christmas and Artificial Christmas trees