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Trends in Glass Sustainability in Small-Scale Artistic Businesses and Practices

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Abstract

As global demand for the high-emissions material of glass increases–especially in renewable energy infrastructure–there is a critical need to rethink and reform current practices. While large-scale industry adapts slowly, glass art presents a unique opportunity for agile innovation and leadership in sustainability. Sustainability in the artistic sector for smaller glass businesses is present in three sectors: production, innovation and themes/discourse. Trends in the increased usage of recyclable glass is most prominent in small businesses, often locally sourced. According to an ongoing survey - completed by glass artists, studios and educational institutions- sustainability practices include: providing any unusable glass waste to construction companies for usage as building material, providing glass offcuts to other local artists that can use the parts for mosaic or fusing, etc. Deterrents included coefficient of expansion (COE), cost and reliability. Innovative approaches include new designs in art itself and even the packaging. Arts allow for more unrestrained experimentation often achieving inconceivable results through the interdisciplinary collaboration with other agencies. Select case studies in this article will examine current trends, innovations, and challenges in sustainable glass-making. It will argue for the essential role of glass artists in shaping a more sustainable future—not only through material practice but also through their ability to engage audiences in critical environmental dialogue.

Keywords

Glass, Sustainability, Environment, Recycling, Independent businesses

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1. Introduction

Art has always been an integral part of glass creation, and to this day it remains essential to the practice. From ancient glass vessels, to religious stained glass elements – the processes of glass remain extensive in its amorphous capabilities in research, structure, aesthetics and innovation. With the climate crisis, sustainable adaptation in glass making processes is a necessity, not an elective. Not only is adaptation necessary for environmental purposes, it is necessary for the growing demand of the material during this "Glass Age"—an unofficial term coined by Corning Incorporated, founded in 1851, for the newer period of human history ruled by the predominant and technologically advancing material of glass. [Morse and Evenson, 2016] There are no exceptions, and thus, artistic sectors have to change their methods of production and modernize their traditions and conceptualizations in accordance with these pressing times. The leading global cause of emissions for the arts industry is the result of visitors' travel, at an estimated 74% (~52 million t CO2e) [Julie's Bicycle, 2021], although transportation of materials or art pieces is also a large contributor in this number. In 2023-2024, Julie's Bicycle reported that audience travel alone would represent 42% (~60 million t CO2e) of total emissions. Excluding visitors travel, the highest emissions impact would be energy 54%, followed by waste 28%. [Julie's Bicycle, 2024] Art is integral for adaptation and for the efficiency of the environmental movement. Art utilizes various methods outside their predetermined intentions or parameters, raises public awareness over complex processes and new innovations to a relatable and coherent level, improves education and understanding. The emissions in relation to the production of art are more difficult to analyze, as the methods diversely vary and change with projects, creating inconsistencies, thus niche examinations are required with glass art - a sector of art that is often omitted from generalized studies. Where does the responsibility of the artist begin and where does it end? The article will further discuss how glass art is used to raise awareness and spread information regarding our current climate and future environmental issues, followed by the examination of the difficulties and advantages met in sustainable practice integration within glass art. This article uses qualitative research, through the collection of available public information and research (prioritizing publications within the past five years), towards more in depth analysis through a public international survey (currently still open), case studies of studios and artists. This methodology was chosen to gain a more thorough perspective of sustainability integration at present times, and any trends found internationally. The study is not geographically limited or restricted as climate change is a global crisis. The artistic processes also hold technological similarities regardless of location.

2. Art as a Tool for Awareness and an Informational Source

"*A question that I sometimes get is: Would you compromise artistically to make a work of art more sustainable? And for me the answer is, no, I cannot make an artwork that I don't consider good, so I wouldn't make a good decision for the climate that leads to a bad artistic outcome. I'd rather, in that case, not make the work at all*." - Olafur Elliasson, SOE

Glass as a decorative and aesthetic material has been parallel to glass as a functional and practical material. From stained glass windows, to decorative vessels, the arts are equally reliant on glass, as sciences and engineering are. The predominant milestone for glass's distinct artistic connection to science and ecology could be "Blaschka Glass Models of Plants"—also referred to as "Glass Flowers"—a collection of nearly–perfect plant glass reproductions. Czech artists Leopold (1822-1895) and his son Rudolf Blaschka (1857-1939) produced ≈4,300 lampworked and painted glass models of ≈780 plant species, commissioned by George Lincoln Goodale (1839-1923), the first director of Harvard's

Botanical Museum, for use in Harvard University lectures. [Harvard Museum of Natural History] These flowers, as well as other glass models made by the pair, were commonly used for educational purposes. They allowed botany students to observe plant structures without the fear of the plants withering, being geographically or seasonally difficult to gather.

Fig. 1: Leopold and Rudolf Blaschka, Glass Flowers, produced 1886-1936, Harvard Museum of Natural History, 2022. Source: Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Glass_Flowers_(00489).jpg] (Retrieved: 5th of May 2026).

A significant divergence in glass's aesthetic vs. practical codependent relationship emerged with Harvey Littleton's (1922-2013) and in part Dominick Labino's (1910 - 1987), '(American) Studio Glass movement' starting in 1962, leading to two distinct developments: 1. the advent of glass as an additional artistic medium within tertiary education institutions, [Adams, E. H., 2011] glass experience no longer depending only on industrial factory spaces or apprenticeships; 2. the popularization of glass as an artistic medium through small-scale individual production, with an increase of independent artists and studios. This resulted in glass gradually expanding beyond the constraints of fixed classifications such as "craft" and "design". So how does subsequent contemporary glass art engage with sustainability and environmental themes?

Firstly, environmental thematic representation (reproductions of nature, metaphorical visualisations and more) and awareness (studio sustainability, information sourcing and sharing, scientific collaboration, etc.) is distinctly apparent for the amorphous material. Environmental art is unequivocally the mediator of the natural world and humanity through artistic medium, utilizing scientific knowledge, evoking emotions and therefore inspiring action or assisting academics. [Chen. 2024] Through The 'Environmental art movement', also active since the 1960s, has an abundance of sub-genres — eco–art, bio–art, land art, sustainable art, recyclable art, awareness art, reclamation art, trash art, climate art –- that consistently explore and dissect environmental themes and concerns. [Stopina, 2025] Glass art or the use of glass as the main medium is no unwilling participant, particularly predominant in bio-art. From land art representatives—such as Robert Smithson's (1938-1973)

intended “Map of Broken Glass (Atlantis)” in 1969 and subsequent smaller models and Peter Hutchinson’s (1930-2025) “Grand Canyon Project” 1968/9; to contemporary artists, such as Olafur Eliasson’s (1967-) “Algae Window” (2020) or “The Last Seven Days of Glacial Ice” (2024), glass is a common companion to name just a few examples. Neon glass in particular offers unique characteristics in the genre of environmental art, often emphasizing themes of nostalgia and consumerism: Mona Hatoum (1952-) “Hot Spot Series”, Andrea Bowers (1965-) “Climate Change is Real” 2017, Mary Ellen Carroll (1961-) “Indestructible Language” 2021 for COP26 etc. Environmental artworks most often aim to raise awareness surrounding existing or endangered environments, ones often unperceived to the naked eye, such as Brandon Ballangée’s (1974-) “Season in Hell” (2010-) that raised awareness over affected and declining avian species, one of the causes of injury being disorientation due to architectural glass.

Fig. 2: Mona Hatoum, Hot Spot, 2006, Rennie Collection, 2007. Source: Wikimedia Commons [https://commons.wikimedia.org/wiki/File:SB8_Hot_Spot_Mona_Hatoum_1.jpg] (Retrieved: 5th of May 2026).

The second strength is the informative / scientific methods artists utilize to deliver their messages. Narrowing down to glass art specifically, Karen LaMonte is an avid participant in sustainability discussions within art. As she creates large-scale sculptures out of glass, metal and other energy intensive materials, she’s been conscious of her impact and has been avidly striving to be carbon-negative. Her cloud series in particular raise specific concerns with climate change and pollution, since carbon emissions amounting to 1,200 ppm can affect the stability of stratocumulus clouds, which help shading and cooling surfaces. [Schneider and Pressel, 2019] The sculptural shapes are created through weather simulations in collaboration with Caltech, modeling accurate cloud forms.

STARworks Glass Studio (2008-) collaborated with environmental and multimedia artist Joseph Rossano (1962-), various salmon or aquatic organizations, and other glassmakers around the world in the creation of mirrored life-sized glass salmons—titled “(The Salmon) School”. This traveling installation raises awareness surrounding the threatened salmon populations and habitats, and was a part of Glass Art Society’s virtual conference live-streamed back in 2021. [*School - Cold Clean Water — Starworks - NC*, n.d.] Created in connection with COP26, the installation—moved from country to country— illuminated this international issue of declining fish populations.

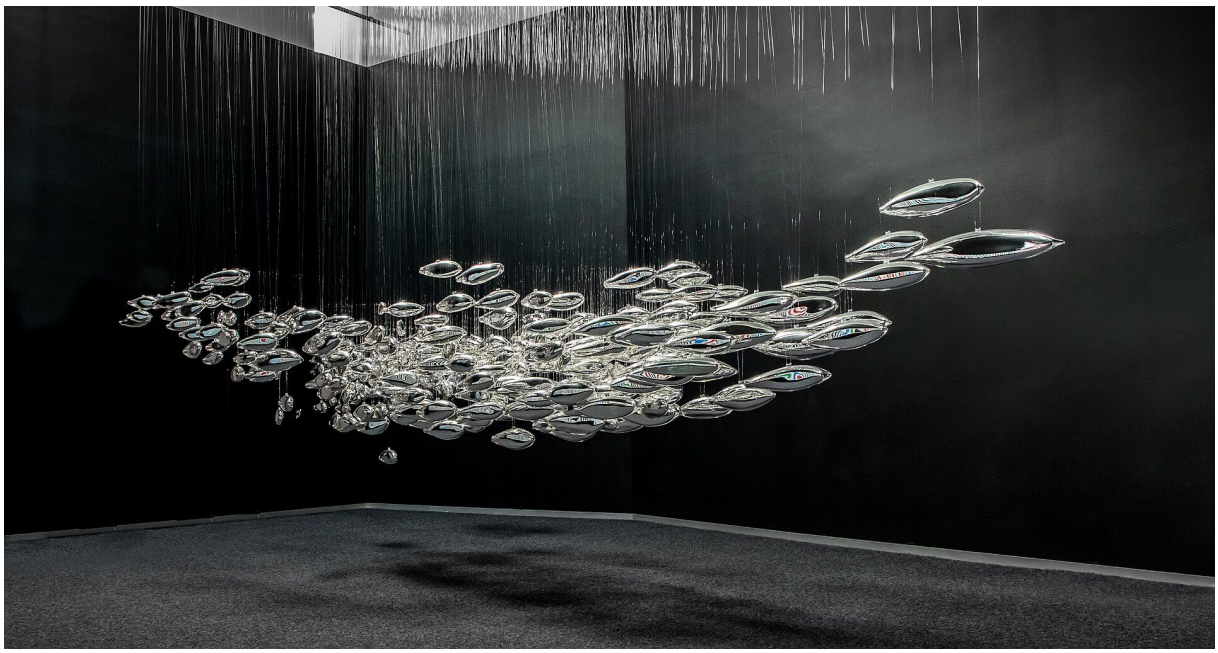

Fig. 3: Joseph Rossano, The Salmon School, 2019, Bellevue Arts Museum. Source: Wikimedia Commons [https://commons.wikimedia.org/wiki/File:SCHOOL_by_Joseph_Rossano_at_Bellevue_Arts_Museum.jpg] (Retrieved: 5th of May 2026).

Lastly, glass art continues the global trend of raising awareness and promoting sustainability, holding itself accountable. There are countless glass exhibitions that are curated around environmental topics and climate change. Few examples include: “Clear Vision: Sustainable Art Glass” at Wagga Wagga Art Gallery, Australia in 2023 that was a part of the Green23 program, consisting of altogether 20 environmentally focussed exhibitions. Other forms of activities were available, and in partnership with “Earth Canvas”, an organisation similar to Cape Farewell, but instead of collaboration with scientists it promotes artistic collaboration with farmers. 2024–2026 exhibition “Greener Glass” at Stourbridge Glass Museum in the United Kingdom, exhibited environmentally sustainable or environmentally themed artworks and promoted an eco-friendly future in glassmaking. Since 2021, Glass Art Society (GAS) has organized annual “Green exhibitions” through its “Green Taskforce / Committee” with sustainability in mind. The exhibition is available digitally, reducing shipping, traveling and being accessible to anyone. [*Green Exhibition – Glass Art Society*, n.d.] Personal exhibitions such as Peter Bremer (1954–)'s 2024 “Ice to Water” exhibited glass sculptures that raise concerns with melting ice caps and disappearing glaciers. Environmental themes and concerns over human relationship with nature could also be found in Ieva Birģele’s (1990–) 2025 exhibition “Trauslais visums (Fragile Universe)”. Thus, glass art, no different to environmental artists, participates in environmental awareness through representation and emotional connection, through innovations and scientific collaborations, and through social awareness and promotion.

3. Integration – Difficulties and Advantages

Sustainable practices are integral for the planet, with art as no exception. Similar to industrialized glass production—glass art's main emission sources are: raw material acquisition, product manufacturing, distribution, maintenance and waste management. All these are further amplified by the emissions caused from the transit involved. Contemporary glass art is also undergoing an aging demographic of patrons and collectors, and due to restricted funds of the small-scale businesses, there is little interest in adapting more sustainable practices. [Chihuly Garden and Glass, Glass Art Society, 2015]. Thus, glass makers face multiple challenges in terms of sustainability - financial instability, lack of access to resources, difference in predominant glass techniques, and artistic restrictions. While glass art being highly energy intensive, is a more difficult practice to convert to an environmentally sustainable practice, it is not impossible. The author has been conducting an international survey as of mid-2025—with an aim of at least 150 participants by the end of 2026—directly aimed at the glass art community, contacting artists, glass art students and educators, independent businesses, galleries, museums and more. The survey, made up of three sections—a brief inquiry of the participants' environmental awareness (knowledge of Intergovernmental Panel on Climate Change, Climate Tipping points etc.), self-reported sustainable practices and business operations (funding, community etc.), followed by a more in-depth section of materials, equipment usage and personal practices. According to this survey, which is currently continuously collected, 53.3% of glassmakers have a secondary income, and 71.4% of participants chose "high costs" as the biggest prevention for them concerning environmental sustainability. [Stopina, 2026] Small-scale production spaces resulting from Littleton's studio movement continue to provide more accessible opportunities for technological innovation, through easier electrization and experimentation of equipment improvement in comparison to industrialized spaces that require massive infrastructure for equipment upgrade. Thus the most common methods to address practices are: autonomous changes, glass art community involvement or governmental interventions.

Glass production typically requires silica, limestone and ash. The resource of silica is being driven thin and unable to naturally regenerate at current speeds, being the second most sought natural resource. [Beiser, 2019] This drives extraction efforts to further damage the environment. The extraction is not alone in its demand, production of glass has been increasing across many fields. In 2023 Solar PV's accounted for 5.4% of global generated energy, [IEA, 2024] but Solar PV production also accounts for the slowly increasing 5% of flat glass production in Europe. Production from raw resources rather than recycled batches has a higher toll on energy usage. Glass's melting stage accounts for more than half of the production's energy use and the forming stage can account for one eighth up to one third of energy use. [Del Rio et al., 2022] To achieve low-carbon glassmaking, transitioning to new, more efficient furnace technologies and upgrading existing equipment is crucial for energy-efficiency, as an increasing amount of technologies use electricity, biofuel and hydrogen energy pathways. In addition, newer models can be more energy efficient, yet frequent changes to equipment is uncommon. One challenge is the financial disadvantage of updating equipment that has an average life of 20 years. This slow evolution could be a contributor towards the lack of pressure for technological developments, especially considering glass industry advancements tend to come in waves. For independent art businesses, a smaller community and thus less collaboration and general investments is also a contributor. Lack of legal mandates and lack of financial resources are main determinants in implementing environmental policies. [Julie's Bicycle, 2021]

Sustainability within the glass art community varies drastically across the different disciplines—glass blowing, kiln work, architectural glass, flameworking— requiring individual inquiry to define trends. When reviewing sustainability documentation, glass blowing facilities receive the most documentation and seem to put the most effort in green-development. This may be due to several reasons: blowing studios are perhaps the most energy intensive considering most equipment runs on a 24/7 energy intensive cycle; there is less pressure to change practices that are considered less energy intensive; glass blowing is a more networked practice, depending on other artists and multidisciplinary collaboration, thus also higher opportunity for discussion and sharing of ideas / practices. Often individual artists may not consider their environmentally conscious choices as important to the general discussion of glass art sustainability. Greenwashing is also prevalent in small-scale independent studios and individual artists, with the preference of carbon credits over actual limitation of emissions, the marketing of “green” products and more.

Glass Art Society has become increasingly involved with advocacy of sustainability. The official GAS website has a “Green + Sustainability” section under resources, that offers links to U.S. Environmental Protection Agency Carbon Calculator, Gallery Climate Coalition (GCC) Carbon Calculator and Crafts Council UK Sustainable Craft Guide, alongside a couple simplified images of carbon production within glass production processes. A resource section for articles and technical papers is provided, but offers no papers. Since 2021, GAS’s organized digital “Green exhibitions” are accessible here as well, although only the most recent “TRACE 2025: An Exploration of Sustainable Glass Art” is available. Several questions arise when observing possibly the most representative ‘green space’ for glass artists, and although the author has reached out, they have not yet responded. Their yearly GAS journals, on the other hand, are very promising sources of artists' sustainable practices and environmental themes. As the main representative of glass artists around the world, GAS had even participated in researching sustainability with a collaborative survey as early as 2015 with Chihuly Garden of Glass, albeit Northern America-centric. Whilst the digital space is lacking, GAS’s yearly journal often sheds light on sustainability, although the most noticeable years for a strong sustainability council and focus were late 2010’s, most likely due to the influence of Eddie Bernard (N/A), who noted that the decreased interest in “green glass” in the attendances in GAS conferences, could possibly be connected to increase and decrease of gas prices. [Waggoner, S. 2012]

Leading innovators include Wet Dog Glass—founded in 1996 by Eddie Bernard, a founding member of New Orleans Creative Glass Institute, a previous board member of GAS, and, in general, a notable figure within the glass (art) sustainability discourse—is a glass equipment manufacturing firm well-known for its electric apparatus globally utilized by artists, professionals and educators. The company consistently continues to research and develop more efficient technology with lowered energy consumption, improved control systems, combustion and safety systems, insulation and heat reclamation etc. Microporous insulating material, up to four times more insulative than ceramic fiber, is used in the thinner parts of furnaces and an inside coating of reflective silver reflects the heat inwards.

Fig. 4:Karen LaMonte, Reclining Dress Impression with Drapery, 2006, www.karenlamonte.com. Source: Wikimedia Commons [https://commons.wikimedia.org/wiki/File:Reclining_Dress_with_Drapery.jpg] (Retrieved: 5th of May 2026)

Previously mentioned artist Karen LaMonte's take on sustainability is through the documentation of her studio's machines' individual energy usage, prioritization of green energy, designing of a heat recuperation system, and the use of glass offcuts for smaller work. She worked towards making up for her past carbon emissions by paying CO2OL effect™ for the overestimated 10,000 tonnes of CO2e (produced in 1990-2022).[Corning Museum of Glass, 2023] The CO2OL effect, or otherwise known as the Cool Effect, is a non-profit founded in 2016,which partakes in a circular economy system and other carbon offset systems. Businesses or individuals are offered the opportunity to offset their carbon footprints by supporting CO2OL effect's carbon projects. [CO2OL Effect, 2026]

Compared to when the Allister Malcom Glass Ltd studio was functioning on gas, switching to electric equipment cut the studios carbon footprint by 8.4 tonnes for the electric lehr or 'annealer', 6.1 tonnes of carbon with the reheating chamber, and by shifting from lead crystal to Bomma cullets the reduced 11 tonnes of CO2 per year.[Allister Malcolm Glass Ltd, 2023] Due to a monitoring device attached to the appliances the studio was able to capture temperature and energy data, identifying heat loss that could be avoided by refilling furnaces with preheated glass nuggets, using night doors or minimizing furnace entrance area using shields prevent heat loss all cuts down on electricity usage. Later the studio, as well as the connected Stourbridge Glass Museum, implemented the use of solar panels for increased 'free' energy.

Lava Glass 2002- in New Zealand claims to be the first net carbon-zero glassblowing studio in the world, with carbon emissions measured by Toituū Envirocare and receiving carbon zero certification from the same company. Toituū Envirocare is a Carbon Disclosure Project and Joint Accreditation System of Australia and New Zealand accredited commercial organization offering expertise regarding sustainable practices. The studio upgraded their main furnace from gas to electric and uses a biodiesel - canola oil - glory hole furnace, divert waste away from landfills, use New Zealand green electricity and participate in carbon sequestration, among other things. [Lava Glass, n.d.] Other quick mentions include: Jackson County Green Energy Park (utilizes reclaimed methane from landfills to fuel studios and heat recuperation systems etc.), Waterfall Arts (glory holes fully run on vegetable oil), Gregory

Alliss's use of CRT glass, Xaquixe (runs on vegetable oils through methane combustion systems), Sarah Hall's use of solar panels in her art installations and others.

In terms of Glass Art PhD research on sustainability, a common research subject involves experimentation with the recycling of waste glass or other waste materials, one example being the 2017 "Recycle. About Sustainability in Glass Craft & Design" a PhD Dissertation by Maria Sparre-Petersen (1967-) at the The Royal Danish Academy of Fine Arts. It is more uncommon to find sources on long-lasting sustainable impact in lowered emissions. The focus is commonly one specific method of technique (ex.glass blowing), and a critical overview of lacking areas, interviews and necessities are often omitted. Thus, with my PhD research, I aim to provide an overview of methodology, so that all methods are included. Glass is extremely distinctive with its potential to be recycled indefinitely without diminishing its durability or purity. Yet, only 19% of municipal solid waste, such as metal, glass, paper, plastics and biodegradable waste are being recycled.[UN Environmental Program, 2024] Recycling also differs by location, led forwards by several Asian and European nations. In the case of glass, recyclability is complicated with the variance in glass chemical compositions. While soda lime glass is fairly easy to recycle physically and economically, specialty glass is becoming increasingly difficult to recycle, with examples such as mirrors, pharmaceuticals, display glass, optical fibers and photovoltaic glass (PV). Chemical additives and different compositions create irregularities in melting points and chemistry, which is why recycling facilities are calling for identifying markers to increase recyclability, in addition to the existing optical identification and digital imaging technologies that are used to enhance glass waste identification. "*While more than 130 million tons of glass were produced worldwide in 2018, only about 21% of it was recycled*" [Del Rio et al., 2022]. Several countries' glass industries indicate that they are dedicated to committing to a net-zero by 2050 especially with growing pressure from consumers for reduced carbon footprints and recycled products, even though the customer is unwilling to pay higher prices for low carbon products. [British Glass, 2024] Consumers are not the only ones required to participate in sustainability practices, considering 87% of glass for recycling is collected by municipal waste, governments have to support an organized network of collection. [Close the Glass Loop, 2025] "Closing the loop" is a very important method to lower the carbon footprint - as higher heat is necessary for melting of raw materials - currently estimated at 85% performance in Europe as of 2022. This involves improvement in glass collection and recycling optimisation. Other important sectors are design and sourcing sectors, since using more recycled material and less raw material (emitting 18% of CO2 emissions),[Del Rio et al., 2022] which needs to be melted at 1200 to 1600 °C, creates less carbon and results in lighter products and due to thermal hardening, they remain durable with less weight in transit. This is a crucial sector for independent studios in particular. Transportation within the nation or within close proximity, as well as being selective with transportation type also reduces significant emissions. Independent studios primarily partake in downcycling of recycled materials. While both downcycling and upcycling is integral to closing the loop, downcycling eventually leads to the final stage of a material - quite commonly construction aggregate recycled from independent studios.

Another aspect of recycling is the "fixing/remodeling" of glass. In stained glass, such practices are integral for the preservation of historic stained glass windows, treating and securing the glass to prolong their lives, yet education regarding restoration is lacking. Similarly, certain hot glass studios offer "restoration" of existing damaged glass items, by reheating and polishing, reheating and resculpting into a new structure, or coldworking the pieces to give them a second life. Such options are often unknown to regular consumers, or out of their price range. Often the defect can become a part of the design. Education wise, many institutions are lacking in dedicated "sustainability, upscaling,

reuse or restoration" lectures, which would be beneficial in the long run. Educational facilities prefer original production to and potentially glass's stigma of broken or damaged being sharp or dangerous prevents it from being seen as a material worth saving. The options for "re-creation" differs drastically between artistic glass production methods. The primary options are: Cast Glass (reattachment via various methods, reuse of glass, removal of damaged part / redesign etc.), Stained Glass (restoration, fusing, individual piece replacement etc.), Blown / Sculpted Glass (reheat + reshape, reuse of glass, reattatchment etc.), Flameworking (reheat + reshape, reuse of glass, reattachment etc.), multimedia (recycling). Conservation and restoration is not only dependent on formal education, it's also bound to ethical and technical constraints. This lack of sustainability integration into higher education is further exacerbated by a lack of designated space for glass art sustainability and the lack of access to or simply the limited research available to students and professionals.

Although there is a lack of a clear consensus and especially a lack of community forums, according to various informational sources, the recurring sustainable changes and choices available for decreasing carbon footprint within the glass arts industry concisely include:

1. Using shared knowledge, learning from case studies and taking advantage of available sources - Julie's Bicycle, GCC, Arts Council England, GAS (after shared accessibility to archives and articles) and artist statements, Artists Commit, Culture for Climate Scotland, Ki Culture, Green Art Lab Alliance, etc.
2. Updating equipment to more energy efficient ones. Prioritize electric machinery.
3. Heat redirection, waste heat recovery (including improved insulation, batch pre-heating etc.) and Greenhouse gas (GHG) capture (Carbon Capture, Utilization, and Storage (CCUS) etc).
4. Reuse or recycle, avoid waste ending up in landfills or becoming unaccounted for. "Unusable" glass can always be used as a construction aggregate.
5. Purchasing locally or choosing the least emissions option (especially in transportation).
6. Choosing renewable energies, preferably, or fuel switch to carbon neutral gas or bio fuels - with future developments, hydrogen.
7. Updating chosen materials to more environmentally friendly substitutes.
8. Dedicating a certain percentage of revenue towards sustainability improvements.
9. Be aware of developments in technology, practices or materials.

Additional note: While not a direct impact on individual emissions, pressure towards government policies and involvement locally may produce higher incentives and implementation of legislations in favor of environmental sustainability.

Additional suggestions and implementations artists and glassmakers use in regards to environmental sustainability according to my PhD survey is: energy monitoring, reuse of older buildings and open air systems to reduce need for mechanical ventilation, prioritizing natural light over electric, insulation and passive cooling, implementation of smart systems and solar panels, and of course, reuse of glass scraps. At the moment, the survey has a total of 43 participants (February 2026), with a goal of at least 150 participants by the end of 2026.

Some common setbacks with green energy can include: solar PV reliance on daylight hours, which fluctuate in certain seasons; solar PV limitations in certain urban or heritage spaces; solar PV limitations due to architectural constraints; limited access to renewable energies in many countries; use of hydrogen gas - which would be a great substitute for flameworkers - is still limited as it is too intense, invisible and its odor being carbon based; lack of governmental or economical incentives and lack of consumer-based demand also deters progress. There is an unwillingness to invest, as payback time

usually consists of a few years, exacerbated by fluctuating markets and energy prices. Another reason for unwillingness to transition is due to tradition and mistrust of new technology. [Spagnolo et al., 2017] It is not only unwillingness, but lack of long-term collaborations between sciences and glass disciplinaries. [Toso, C., 2018] As with the absence of a centralized sustainability-focused platform for glass artists, there is a divide in the business sector conducting research and small scale investment in electric technologies. Increased incentives for decarbonization may encourage inter-firm collaborations, potentially accelerating technological advancement.

4. Summary

Sustainability is still a developing part of human life, and innovations and changes will continue to appear, therefore, there is no one single way of doing things. Adapting to sustainable practices provides economical advantages and this accountability motivates and boosts self-esteem. Often innovation happens when one decides to do something slightly different. This is why having a space to share and learn from is so important. A digital space for a collective to collaborate, share knowledge, case studies and discussions has been mentioned several times as lacking. This would provide a starting point for people who have considered transitioning to sustainable practices. Education relating to such topics has also been raised as a necessity for students and professionals alike.

A promising centralized forum for credible articles and research surrounding glass sustainability was undertaken by Amber O'Brien (N/A) in 2017 through her page "GlassArtEnergy.org", however akin to many similar undertakings, it seems to have been abandoned in 2019. As previously mentioned, glass sustainability is not a niche topic or undertaking, with numerous artists and businesses partaking in this transition. Thus the main issue remains a lack of designated forum, as a large amount of information is reserved for paper publications - Independent Glassblower, Glass Journal, Glass Art Magazine, UrbanGlass Art Quarterly, Neues Glas-New Glass, American Craft, GlasHaus, Modern Glass, New Glass Review, Objectos con Vidrio, and more - remain paywalled, location-based or outdated. As sustainability is an urgent human responsibility, it should have a designated educational space, free from restrictions and accessible for all.

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