

Increasing Sustainability within the Medical/laboratory:  
A Data-Driven Approach to Quantify and Mitigate Scope 3 Emissions

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**Executive Summary:** This report examines Stanford's Scope 3 Emissions within the Medical/laboratory purchasing category, specifically within the overarching category of Purchased Goods & Services. Looking at Stanford's spend data and emissions estimates, I identify that although "Industrial Use Gases" and "Other Healthcare & Medical Services" are the subcategories with the most emissions, they are difficult to act upon. I recommend that laboratories replace ultra-low temperature freezers with Energy Star® accredited freezers to decrease Scope 1 and Scope 2 emissions (as well as associated Scope 3 emissions) and increase energy savings. Additionally, I recommend that laboratory managers review existing literature on lab sustainability, including [Lopez et al.](#) and a [University of Edinburgh report](#). To reduce Scope 3 Emissions, this report recommends that lab managers replace plastic measuring containers with glass containers whenever possible, purchase sustainable labelling supplies, consult sustainable purchasing databases such as [ACT](#) or [Lab Conscious](#), and communicate with suppliers.

Medical/laboratory equipment is quickly emerging as a hot topic within the world of sustainability, primarily due to its immense carbon footprint. Per square meter, a laboratory uses five to ten times more energy than an office building.<sup>1</sup> This is in part due to the widespread usage of energy-intensive equipment such as fume hoods or ultra-low temperature freezers within laboratories.<sup>2</sup> While these specific emissions primarily fall under the Scope 1 and Scope 2 categories, laboratories are also large emitters of Scope 3 Emissions, specifically as it relates to Purchased Goods & Services. For instance, plastic consumption and waste remain a large challenge for laboratories. Across the world, there are 20,500 institutions engaging in some form of biological, medical, or agricultural research, and these institutes dispose of 5.5 million metric tons of laboratory plastic waste each year.<sup>3</sup> Similarly, Banks et al. writes that due to the need to decontaminate laboratory materials, sustainability remains a difficult challenge in the laboratory.<sup>4</sup> With these concerns in mind, this memo takes a data-driven approach to mitigating Scope 3 Emissions within the Medical/laboratory category. In 2021, Stanford engaged a third-party carbon footprinting company named Sievo, which used spend-based emission factors and Stanford's spend data in order to provide the university with a high-level assessment of its Purchased Goods & Services footprint. Through Stanford's procurement data, Sievo's emissions estimates, and research on mitigation measures for emissions from Laboratories, this memo identifies high impact, as well as actionable, subcategories and procurement recommendations within the laboratory. In addition, for completeness's sake, this memo also identifies high-impact categories that are not easily actionable and why they are resistant to change, to inform stakeholders interested in sustainable healthcare procurement.

From the data, I have identified categories that are both actionable and carbon-intensive. Below, I have included graphs illustrating the L4 Categories (which are high-level groupings of purchasing items) that have the highest emissions and the most intense emissions, respectively.

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<sup>1</sup> Laboratories for the 21st Century U.S. Environmental Protection Agency Office of Administration and Resources Management in partnership with the U.S. Department of Energy, "Laboratories for the 21st Century: An Introduction to Low-Energy Design" (2008) 1–9. <https://www.nrel.gov/docs/fy08osti/29413.pdf>.

<sup>2</sup> Greever, C., Ramirez-Aguilar, K. and Connelly, J. (2020), Connections between laboratory research and climate change: what scientists and policy makers can do to reduce environmental impacts. *FEBS Lett.*, 594: 3079-3085. <https://doi.org/10.1002/1873-3468.13932>

<sup>3</sup> Urbina M, Watts A and Reardon E (2015) Labs should cut plastic waste too. *Nature* 528, 479.

<sup>4</sup><https://static1.squarespace.com/static/5d1a23b3a8a60e0001c005ed/t/5ef377d90b03d66a8b675081/1593014244786/The+Sustainability+Challenges+Facing+Research+and+Teaching+Laboratories+When+Going+Green.pdf>

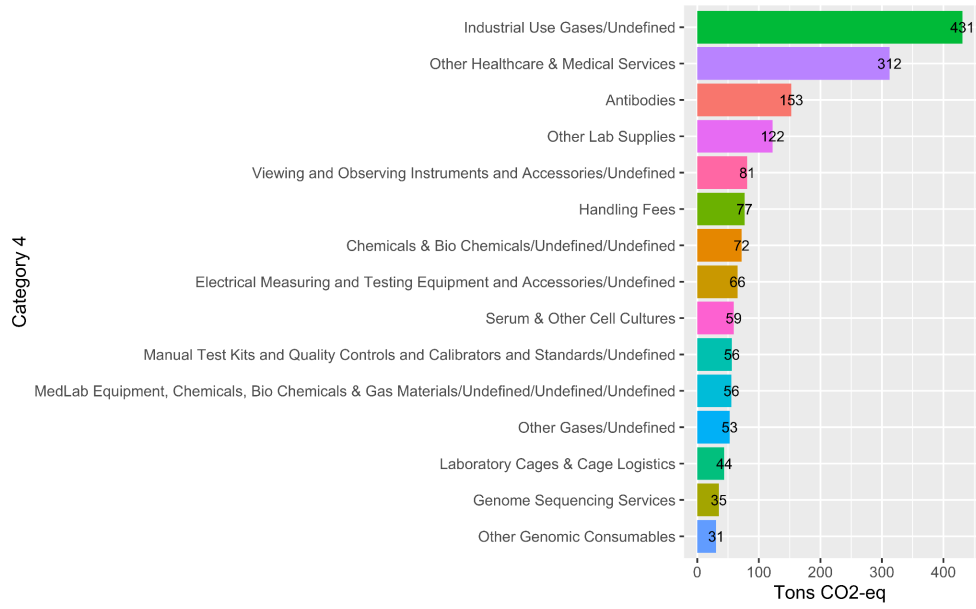


Figure 1: Medical/laboratory L4 categories by carbon emissions output, in metric tons of CO2 equivalent

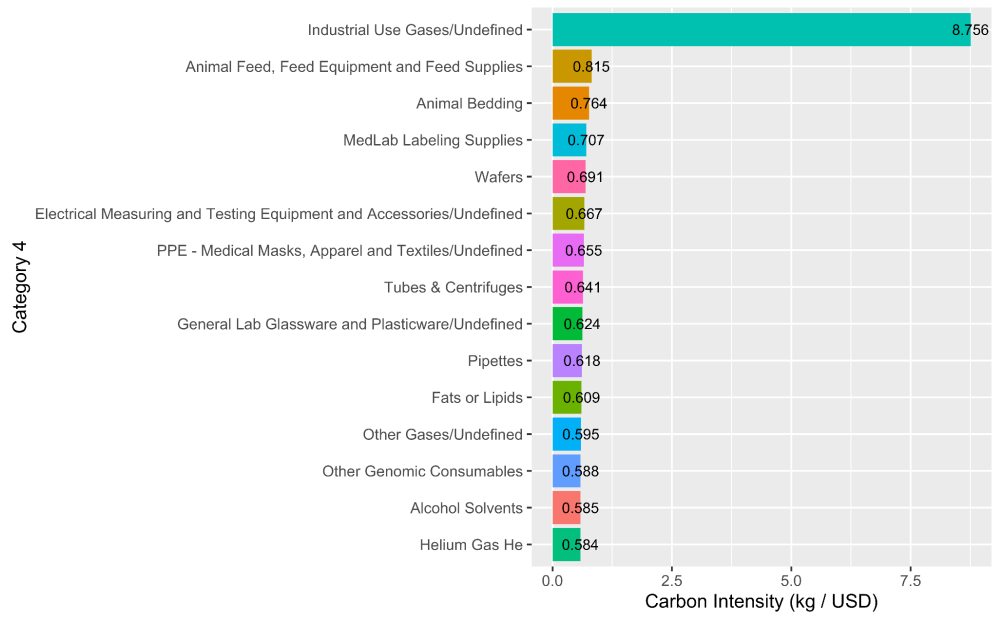


Figure 2: Medical/laboratory categories by carbon intensity, (kg CO2e/USD)

As displayed in the above graphs, “Industrial Use Gases” and “Other Healthcare & Medical Services” are the categories with by far the most overall carbon emissions, with “Industrial Use Gases” also being by far the most carbon-intensive categories by spend. These gases, used in research, often consist of “oxygen, nitrogen, carbon dioxide, and helium.”<sup>5</sup> Notably, this category, although substantial, is difficult to target for sustainability purposes since there are no sustainable alternatives. Similarly, “Other Healthcare & Medical Services” and “Antibodies” are vague, overarching categories for which obtaining granular emissions data is difficult; as such, finding alternatives is also a challenge. In absence of alternatives, laboratories are encouraged to increase efficiency when conducting research and decrease waste. In terms of Scope 1 and 2 emissions, by purchasing higher-efficiency, low-temperature freezers, labs can reduce the amount of energy required to store these gases, as well as other important materials. Furthermore, reductions in these Scope 1 and Scope 2 categories do often reduce the “fuel and energy activities” category within Scope 3 Emissions, which consists of the emissions involved in obtaining and transporting energy resources. EnergyStar, an energy certification program run by the U.S. EPA and Department of Energy, certifies low-temperature freezers as well. Stanford provides rebates for purchasing sustainable ULT (Ultra low temperature) freezers<sup>6</sup>. Other universities have already begun making the shift. UCSF has begun replacing old ultra-low temperature freezers with Energy Star® accredited freezers and have forecasted a reduction in carbon emissions of 8,400 metric tons and savings of \$2 million in energy costs, annually.<sup>7</sup> While these carbon reductions are Scope 2 emissions reductions, they are still worth keeping in mind.

While there are a variety of categories that we can pursue, this memo identifies the most immediately actionable categories for reducing Scope 3 emissions. Previous literature has already undertaken aspects of this task. Lopez et al. identify several action items within the laboratory that are relatively easy ways for lab managers to increase sustainability.<sup>8</sup> These recommendations are listed below and provide an initial foundation for lab managers at Stanford to reduce their emissions footprint:

1. Reduction of tests: audits should be undertaken with the aim to reduce unnecessary testing by removing outdated tests and rejecting unnecessary test requests. **From the**

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<sup>5</sup> <https://cksupply.com/industries/universities-research-laboratory-medical/>

<sup>6</sup> <https://sustainable.stanford.edu/cardinal-green/cardinal-green-labs/energy-programs>

<sup>7</sup> <https://sustainability.ucsf.edu/1.930>

<sup>8</sup> Lopez, J. B., Jackson, D., Gammie, A., & Badrick, T. (2017). Reducing the Environmental Impact of Clinical Laboratories. *The Clinical biochemist. Reviews*, 38(1), 3–11.

**Stanford Sievo emissions data, test-related categories are responsible for over 131 tons of CO<sub>2</sub>-equivalent emissions.**

2. Reduction of serum-separation tubes (SST) [SSTs are tubes used to collect blood serum]: Blood specimens for most tests can be collected using a single SST. This follows from fewer daughter tubes required from more consistent and thoughtful tube collection requirements combined with sequential rather than parallel processing in laboratories. One study showed that an increase in the number of single SST tubes collected per episode from 62.64% in March 2006 to 85.15% in July 2009 meant that 600,000 fewer tubes were used in 2009. While broader than just serum-separation tubes, the Sievo category “Tubes and Centrifuges” is responsible for 0.48 tons of CO<sub>2</sub>-equivalent emissions.
3. Reuse: Laboratories should identify items that can be reused. The reuse needs to be limited to a specific number of reuses to ensure the integrity of materials. A key target will be the reuse of plastic specimen bags that are often discarded after single use. These can be reused without compromising laboratory safety. The same applies to 24h urine bottles.
4. Recycle organic solvents: Xylene and formalin should be targeted for recycling on-site. Laboratories can purchase recyclers for xylene and formalin, such as the [PathTrue™ FormaSolve™ Recycler](#). While there is an initial cost attached to the purchase of the recycler, this has been shown to be offset in about 2 years by cost savings from reduced solvent purchase and waste disposal. Within the Stanford Sievo emissions data, solvents emit over 1.15 tons of CO<sub>2</sub>-equivalent emissions.
5. Reduce and recycle solid wastes: Laboratories can negotiate with suppliers to take back and reuse packaging materials such as Styrofoam and all packaging paper and cardboard products. Electrical and electronic wastes such as fluorescent tubes, batteries, phones, computers, etc. should be recycled or disposed of in accordance with local regulations.
6. Reduce Administrative waste: Several opportunities exist to reduce the usage of materials in administration. Paper usage is a target, and it may be reduced by using both sides. Paper audits should be instituted.<sup>9</sup>

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<sup>9</sup>Lopez, J. B., Jackson, D., Gammie, A., & Badrick, T. (2017). Reducing the Environmental Impact of Clinical Laboratories. *The Clinical biochemist. Reviews*, 38(1), 3–11.

As identified by Lopez et al., not only can decreased consumption of certain items increase sustainability, but it can also lead to cost savings through decreased purchasing. While these six categories are good starting points, lab managers should thoroughly consult Lopez et al. for more detailed instructions and rubrics for mitigating emissions within the laboratory. Similarly, the [Sustainable lab consumables guide](#) prepared by the University of Edinburgh contains many actionable recommendations that increase sustainability within the laboratory.

To quantify and/or decrease Scope 3 Emissions within the Medical/laboratory space, the guide provides four general recommendations:

1. General Lab Glassware and Plasticware: General Lab Glassware and Plasticware is the ninth most carbon intense category by dollar spent at Stanford and has been extensively discussed within literature related to laboratory sustainability. From the Stanford Sievo emissions data, General Lab Glassware and Plasticware emits 9.34 tons of CO<sub>2</sub>-equivalent emissions. Although plasticware is usually used once and discarded, it does offer certain sustainability benefits over glassware.<sup>10</sup> Since plastic is both lighter and requires less packaging when shipping than glassware, transporting glassware may require more fuel to compensate for the extra weight, and increased package waste can also lead to increased embodied carbon waste. Glass containers are often made of borosilicate glass, an incredibly durable glass ideal for experiments, which is a nonrecyclable material and thus means that glassware usually ends up in the landfill at the end of its lifecycle. Manufacturing glassware is also more energy intensive than manufacturing plasticware. The water required to wash glassware after each use is also another environmental concern. On the other hand, plastic labware is often produced using polypropylene or high-density polyethylene materials, which are recyclable. As seen in Figure 3 below (The University of Edinburgh), while glass has a larger carbon footprint in the landfill than plastic, plastic production releases much more emissions than glass production. Thus, my preliminary recommendation is that lab managers purchase glassware whenever possible and ensure that at the end of the glassware's life cycle, the glass containers are appropriately recycled. However, this category also

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<sup>10</sup>

demands further research, particularly into the question of how long a piece of glassware must be used to be more sustainable than the equivalent amounts of plasticware.

Figure 3: Excerpt from University of Edinburgh Sustainable Lab Guide

Material	Method of waste disposal			
	CO <sub>2</sub> e from primary production	Recycling (CO <sub>2</sub> e)	Incineration (CO <sub>2</sub> e)	Landfill (CO <sub>2</sub> e)
Glass (1 tonne)	895 kg	21.8 kg	21.8 kg	26 kg
Plastic (1 tonne) of plastic	3328.4 kg	21.8 kg	21.8 kg	9.3 kg

Useful factors when considering the carbon impact of waste streams:

- On-site or district heat and steam: 0.197326316 kg CO<sub>2</sub>e / kWh
- Water Supply: 0.344 kg CO<sub>2</sub>e / m<sup>3</sup>
- Water Treatment: 0.708 kg CO<sub>2</sub>e / m<sup>3</sup>
- No available data on CO<sub>2</sub>e of chemical decontaminants.

- **Labeling Supplies:** In Figure 2, “MedLab Labeling Supplies” has the fourth highest carbon intensity of any category and also is responsible for 3.43 tons of CO<sub>2</sub>-equivalent emissions. Labeling Supplies represents a relatively easy category to mitigate emissions within, as sustainable labels and supplies, which are responsibly sourced and made of recycled materials, are widespread. There are multiple ways to ensure that purchased supplies are sustainable<sup>11</sup>. Materials could be made from renewable resources and certified by a third party; for instance, [facestocks bearing the Forest Stewardship Council® \(FSC\)](#) certification would be sustainable. Similarly, when looking for sustainable labeling supplies, one should look for supplies made of recycled or compostable materials or lightweight materials (which have a lower carbon footprint associated with transportation).

2. **Sustainable Equipment Databases:** When purchasing new equipment and materials, laboratory managers should consult a variety of databases and resources that compile sustainability data on laboratory equipment. The [ACT \(accountability, consistency, transparency\) program](#) helps lab managers make more informed purchasing decisions, providing an environmental impact factor assessment of a variety of laboratory consumables, chemicals, and equipment, taking into account energy and water use,

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<https://www.resource-label.com/sustainable-recyclable-label-material-selection/#:~:text=In%20terms%20of%20sustainability%2C%20the,%2C%20lightweight%20or%20recycled%2Dcontent.&text=Lightweight%2C%20or%20thin%2C%20label%20materials,less%20material%20than%20conventional%20labels.>

chemical management, packaging, and shipping.<sup>12</sup> Lower scores indicate that a product is more environmentally friendly. More information on ACT can be found on their website. Another useful database for sustainable procurement is [Lab Conscious](#). While this database is less extensive than ACT's, it still is useful for finding sustainable alternatives for various categories, including chemicals and cleaning supplies.

3. Communicate with suppliers: Lab managers should engage with suppliers of medical/laboratory equipment, who recently have begun also looking for ways to mitigate their environmental impacts, in order to discover sustainable alternatives for equipment.

## Conclusion

This memo concludes with summarizing the actionability and estimated total emissions impact of each of the recommendations presented in Figure 4 below. The estimated total emissions category is not a measure of the direct impact of the recommendation, but rather a measure of the total impact of the targeted category.

**Figure 4: Summary table of recommendations**

Recommendation	Actionability	Estimated Total Emissions
Reduction of Tests	Highly actionable	131 tons of CO2-eq
General Lab Glassware and Plasticware	Moderately Actionable	9.34 tons of CO2-eq
Labeling Supplies	Highly actionable	3.43 tons of CO2-eq
Recycle Organic Solvents	Highly actionable	1.15 tons of CO2-eq
Reduction of Serum-Separation Tubes	Highly actionable	0.48 tons of CO2-eq
Reduce and recycle solid waste	Highly actionable	N/A
Use Sustainable Equipment Databases	Moderately Actionable	N/A

<sup>12</sup>