Understanding and Reducing Greenhouse Gas Emissions in Academic Libraries

Ben Goldman

abstract: It is now widely understood that societies must rapidly decarbonize to avoid the worst impacts of future climate change. To contribute to this urgent effort, academic libraries should develop an understanding of the carbon footprint resulting from their activities. This article shares the results of an effort at the Penn State University Libraries to calculate the greenhouse gas emissions generated in one year. It will define the elements of a greenhouse gas (GHG) inventory, explain the context and process for undertaking this effort at Penn State, share findings, and discuss potential implications for academic libraries.

Introduction

The findings of the Sixth Assessment Report of the Intergovernmental Panel on Climate Chage report, released in 2021, were unequivocal: while climate change is most likely irreversible, the severity of its impacts on humanity will depend entirely on the speed at which the world phases out its consumption of fossil fuels.[1] The Paris Climate Accords, ratified in 2016 and signed by 193 countries plus the European Union, represented perhaps the most ambitious global actions yet taken to address greenhouse gas (GHG) emissions, committing signatories (including the United States) to collectively achieving 50 percent reductions by 2030.[2] While the accords have been credited for instigating a noticeable slowdown in emissions, the first "global stocktake" mandated by the treaty in 2023 concluded that countries are making insufficient progress toward these emissions targets, jeopardizing the world's chances of avoiding increasingly dire climate outcomes.[3]

For many people, including today's college students, climate change has served as a backdrop to life since birth, and climate change impacts are more frequent and dramatic every year. A completely understandable emotional response to the planet's current predicament would be dread or paralysis, but understanding the reality of our disap-

portal: Libraries and the Academy, Vol. 24, No. 1 (2024), pp. 7–19

For many people, including today's college students, climate change has served as a backdrop to life since birth, and climate change impacts are more frequent and dramatic every year.

pointing progress toward addressing climate change can also be clarifying. Everybody has an immediate part to play in this effort to urgently reduce emissions. For many librarians, this was already evident and perhaps best embodied by the American Libraries Association's (ALA) core value of sustainability, which asserts that sustainability is central to our professional identities as librarians.[4]

Libraries have made many contributions toward a more sustainable world. Madeleine Charney and Petra Hauke trace the origins of this work to the Task Force on the Environment, formed in 1989 by ALA's Social Responsibilities Round Table and later evolved into ALA's Sustainability Round Table.[5] Broadly speaking, the green library movement has focused on integrating sustainable principles into library organizations and exploring the many ways that libraries can advance sustainability within the communities they serve through education, outreach and advocacy.[6] ALA's Special Task Force on Sustainability, formed in 2015, succinctly defined three sustainability roles libraries can play in society: as catalysts, as conveners, and as contributors.[7] The task force itself was a catalyst for ALA's adoption of sustainability as a core value in 2019. This value statement included language that situates library work within the global decarbonization effort: "they are also leading by example by taking steps to reduce their environmental footprint."[8]

For some organizations, reducing the environmental footprint means moving beyond taking energy efficiency measures to look more directly at quantifying and reducing carbon emissions. In 2019, the Brooklyn Public Library announced it had reduced emissions by 40 percent over 13 years, and publicly stated a goal of reaching net-zero by 2050.[9] A 2020 project in Finland calculated the emissions of 13 public libraries in the city of Helsinki.[10] The Stuart A. Rose Manuscript, Archives, and Rare Book Library at Emory University developed a climate action plan with a stated goal of matching the university's emissions reductions targets.[11] Academic libraries are well-positioned to pursue similar efforts by leveraging the resources available within their institutions. Nearly 400 colleges and universities in the United States have declared carbon neutrality goals, with target dates generally ranging from 2030 to 2050.[12] Ten universities have successfully achieved a status of certified carbon neutrality through actions ranging from investment in renewable energy to purchasing of carbon offsets.[13] Universities that are serious about these commitments have dedicated institutional resources to regularly measuring their emissions in detail. On the surface, the emissions created by academic libraries might seem inconsequential within the broader scale of emissions created by other academic units or activities on campus, but these ambitious institutional commitments warrant a deeper engagement on the topic from academic libraries.

How much energy do academic libraries actually use? Where does it come from? Are some types of activities or spaces more emissions-intensive than others? Can academic libraries leverage available institutional resources to address shared emissions sources? What are our unique professional contributions to our institution's overall

footprint? Answering these questions will help ensure that we are partners in the necessary changes happening globally and within our institutions. With a fuller understanding of emissions, academic libraries will set themselves up for greater resiliency as the impacts of climate change continue to unfold. It may even reveal opportunities for cost savings and other economic benefits.

Can academic libraries leverage available institutional resources to address shared emissions sources? What are our unique professional contributions to our institution's overall footprint?

The case study that follows details how the Penn State University Libraries participated in university efforts to understand and reduce its overall carbon footprint. It defines the elements of a greenhouse gas inventory, explains the context for undertaking this effort at Penn State, describes the process for conducting an inventory of the Libraries' emissions, shares findings, and discusses the professional implications.

Greenhouse Gas Inventories

Organizations wanting to reduce their carbon footprint typically start by creating a GHG inventory, which is a standardized tool for measuring emissions and evaluating progress toward a stated goal. Most organizations utilize the Greenhouse Gas Protocol standard created by the World Resources Institute and the World Business Council for Sustainable Development.[14] The GHG Protocol provides a framework for institutions of all types and sizes—from corporations to cities to whole countries—to conceptualize and quantify their emissions. The GHG Protocol offers a consistent methodology for different organizations to follow, which is especially crucial for successfully implementing cooperative solutions, such as the Paris Accords.

The GHG Protocol establishes a standardized unit of measurement—metric tons carbon dioxide equivalent ($mtCO_2e$)—to uniformly measure the impact of emissions resulting from different types of greenhouse gases. While carbon dioxide (CO_2) represents the largest share of heat-trapping gases in the earth's atmosphere, it is not the only one contributing to climate change. Different greenhouse gases will absorb energy and persist in the atmosphere at different rates (known as global warming potential). Converting greenhouses gases like methane (which is the second most common greenhouse gas in the atmosphere and 25 times more potent than CO_2) to a comparable measurement makes it possible to accurately inventory different types of emissions.

Emissions under the GHG Protocol are classified into three "scopes." Scope 1 groups all emissions from sources that are directly controlled or owned by an organization. This most often refers to electricity generated onsite or emissions from vehicles owned by an institution. Scope 2 refers to emissions (often called indirect emissions) that may be present at the institution but are not generated onsite. The dominant examples of Scope 2 emissions are purchased utilities. Scope 3—sometimes called value chain emissions or simply "everything else"—refers to indirect emissions that occur because of the organization's activity, such as employee commuting, procurement of supplies, or even an organization's financial investments. Scope 3 emissions are the most difficult to accurately measure.[15]

Penn State's carbon reduction goals

Penn State University began tracking its carbon emissions two decades ago.[16] Its most recent inventory, conducted in 2019–2020, documented 369,292 $mtCO_2e$ in emissions, which represented a 42 percent reduction from 2006 levels. Most of Penn State's inventoried emissions come from energy usage, and the university has used a combination of onsite energy conservation, offsets, and power purchasing to make its progress. Initial success in reducing emissions was enabled by purchasing renewable energy credits, which are tradable commodities in the form of certificates representing one megawatt hour of electricity produced from renewable sources, such as solar and wind. The university further advanced its commitments in 2016 by switching the main campus's steam power plant fuel from coal to natural gas, which has a lower atmospheric impact than coal despite still being a significant emissions source. In 2019, Penn State entered an agreement to purchase an estimated 25 percent of its total energy requirements from a 70-megawatt solar array in southern Pennsylvania. By this time, the university had established a carbon reduction target deemed to be consistent with the goals established by the Paris Agreement treaty: 80 percent reductions from 1990 levels by 2050. Recognizing the need for more aspirational outcomes, Penn State's President, Eric Barron, formed a Carbon Reduction Task Force in 2021, which released a detailed plan for achieving 100 percent emissions reductions by 2035.[17]

Penn State's greenhouse gas inventory includes all Scope 1 and 2 emissions but has yet to fully integrate Scope 3. The Scope 3 emissions it does track are mainly from air travel and employee commuting, which accounts for nearly a quarter of total emissions. Seventy-five percent of Penn State's emissions come from energy, a majority of which is purchased. A little over 25 percent is generated onsite at a natural gas-powered steam plant. More than three-quarters of the university's emissions are created at the University Park campus, the flagship location for the Penn State University system, which spans 23 separate campuses across the Commonwealth of Pennsylvania.

While an institution the size of Penn State still has gaps in its accounting, this long-term investment to measure and reduce emissions has helped build out infrastructure and replicable approaches units like the University Libraries can leverage. For example, the University imports all institutional utility bill data into a single system that can be used to generate detailed reports on the energy sources and consumption for each building. Two colleges at Penn State's main campus—the College of Earth and Mineral Sciences and the Eberly College of Sciences—incorporated these data into their own greenhouse gas inventories in 2019–2020. The units were, in certain instances, able to leverage their own data and refine the University-level inventory.

Creating a GHG Inventory of the Penn State University Libraries

The Penn State University Libraries is a large organization with physical locations, personnel, and services that stretch across all Penn State campuses. To give a better sense of the size of its operations: the same year the greenhouse gas inventory was conducted (2021), the University Libraries reported to the Association for Research Libraries having 563 full-time employees, approximately 380,000 visitors, and a collection size of over 10

million volumes, making it one of the largest research libraries in the United States.[18] The physical space used to support this operational scale is complex, encompassing a total of 719,888 square feet in 52 different buildings. Its largest physical presence, unsurprisingly, is found at the University Park campus, which has a student enrollment approaching 50,000. This campus is home to the Pattee and Paterno Libraries complex, the largest and most central library building at University Park, as well as four satellite subject libraries that share space with academic colleges, and three off-campus annex facilities where the library is either the sole or primary occupant. In total, the University Libraries occupy space in 32 different buildings at the main campus, but the overall presence in 28 of them is negligible compared to other occupants, accounting for only 7 percent of the available space. In seventeen buildings, the Libraries occupies less than 1 percent of the building. These are generally classrooms containing media technology that is owned by the Libraries and supported by library personnel. Enrollment at the other 22 campuses ranges from hundreds of students to a few thousand, and most of the affiliated campus libraries share space with other units.

Building on the models developed for the first two unit-level inventories mentioned, the author led an effort to create a formal GHG inventory of the University Libraries. The study was implemented in the summer of 2021 when access to much of the University was limited due to COVID-19 measures. Realizing the pandemic would likely skew greenhouse gas emissions downward from a typical baseline, a decision was made to focus on data from 2019.[19] The inventory itself was created by two undergraduate students who were part of the Penn State Drawdown Research Experience for Undergraduates Program. This annual two-month summer residency program is based in the Penn State College of Engineering and provides students an opportunity to work on different projects that align with the goals of Project Drawdown, a nonprofit organization that advances climate change mitigation research. The author served as faculty mentor for the two students who performed the quantitative analysis, and partnered with them to gather data, calculate emissions, and write a 23-page report detailing the findings.[20]

The two major areas investigated were emissions from utilities and mobile combustion. Utilities included the energy generated at the University Park campus steam plant, purchased utilities such as electricity and natural gas, as well as emissions from water usage. Mobile combustion emissions focused on travel-related emissions and included most employee commuting, business-related air and ground travel, and the emissions from a small fleet of vehicles leased by the Libraries to support the movement of collections to and from the offsite annex facilities. We also included emissions resulting from digital information stored at the university's on-campus data center.

The Libraries' inventoried emissions were calculated to be 11,165 mtCO_2e, which accounted for roughly 2.5 percent of the university's overall emissions during 2019. As a proportion of the overall university emissions, this fell short of the emissions inventoried in the Eberly College of Sciences and the College of Earth and Mineral Sciences (6.36 percent and 4.1 percent of university total emissions, respectively). Ninety-five percent of inventoried emissions came from utilities, with purchased electricity alone accounting for over 56 million kilowatt-hours and contributing 65 percent of greenhouse gas emissions. Library buildings at the University Park campus were likely to have a lower emissions factor due to the energy savings improvements made over the years, whereas

Ninety-five percent of inventoried emissions came from utilities, with purchased electricity alone accounting for over 56 million kilowatt-hours and contributing 65 percent of greenhouse gas emissions.

the various commonwealth campus libraries were found to rely heavily on buying and burning natural gas. The Pattee and Paterno Library complex accounted for one-third of both the Libraries' overall emissions and physical space, which is unsurprising given its size, function, and role as administrative home for the overall library system at Penn State. The most energy-intensive building (understood to be the amount of energy used per square foot) across the libraries was also at the main campus, a 13,000 square-foot annex facility that houses archival collections and the Libraries' conservation program.

Emissions from buildings that are shared with other units were calculated as a percentage of the actual space occupied. For instance, the Engineering Library, which inhabits roughly 9,700 of the available 112,000 square feet in the Hammond Building, was only assigned 8.6 percent of that building's overall emissions. This approach created the possibility of overcounting the Libraries' emissions, particularly in buildings where other occupants were undertaking more energy-intensive activities. The Physical and Mathematical Sciences Library is one such example. Located in a building that also houses a rooftop observatory, planetarium, and materials science laboratories, the library's actual emissions were more than likely a fraction of the percentage of space occupied. In other instances, emissions from utilities were undercounted due to the absence of metering in certain buildings, particularly at Commonwealth campuses where facilities management resources are decentralized. These nuances demonstrate the difficulty of accurately inventorying the system-wide emissions of a large organization that is physically dispersed. Academic libraries with small physical footprints may have an easier time calculating energy usage impacts.

In 2019, Penn State library employees collectively flew over 700,000 miles for a total of 797 flights (multiple flights from a single travel itinerary were counted separately). This created 107 $mtCO_2e$ in emissions, accounting for one percent of the Libraries' overall total. The number of flights and distance traveled were sourced from the library business office, which provides financial and logistical support for employee travel. Since we did not have data on the specific aircraft used for each flight, total emissions per mile were calculated according to standard emissions factors determined by the Environmental Protection Agency (EPA).[21] Over two-thirds of the flights inventoried were classified as medium haul by the EPA (300 – 2,300 miles) and represented the largest share of air travel emissions (55 percent). Notably, despite accounting for only eight percent of the total, flights classified by the EPA as long hauls (greater than 2,300 miles) generated 44 percent of air travel emissions.

Automobile travel was the second highest source after electricity, accounting for 3.36 percent of inventoried emissions. Accurately calculating the emissions from automobile travel requires knowledge of the vehicle make, model, and miles traveled. For library-leased vehicles, we inventoried an exact 12 $mtCO_2e$ emissions based on the easy availability of these data. The total emissions from employee business travel were less

precise. These were estimated to be 5.5 $mtCO_2e$, based on the vehicle type and expected mileage from 52 business trips where employees drove a University-owned fleet vehicle. Data for business trips where an employee used their own vehicle was not available.

At 260 $mtCO_2e$, employee commuting accounted for the bulk of emissions from ground travel. Arriving at this number required usage of EPA's emissions factors because specific data about employees' home addresses, vehicle types, and number of commutes was not available. To approximate the emissions from employee commuting, human resources supplied the home zip codes for 176 de-identified employees at the University Park campus. Mileage for each commuter was estimated by calculating an average distance traveled based on each zip code's maximum and minimum distance from Penn State, with additional weighting for population density, available routes, and emissions factors based on the average number of passenger cars and light-duty trucks in Pennsylvania. While there is a considerable amount of ambiguity in the estimated emissions from employee commuting, these totals likely undercounted the actual emissions, since the number only included data for a fraction of full-time employees. Lacking access to the relevant HR data, this result excluded employees at Commonwealth campuses altogether.

Finally, the GHG inventory included emissions attributed to data storage at Penn State's data center on the main campus. According to calculations provided by data center staff, the University Libraries used approximately 15,000 kilowatts per year to power 165 virtual machines that house the library catalog, the integrated library system, websites, and almost 250 terabytes of digital collections. This accounted for just under one percent of the Libraries' overall greenhouse gas emissions. This number does not include emissions generated from computing, applications or data stored using cloud services.

Discussion

The GHG inventory conducted in the Penn State University Libraries was imperfect in many respects, and through the process we discovered the limits of our ability to fully measure our impact. But it demonstrated that academic libraries can take meaningful steps to evaluate and understand the carbon footprint associated with their activities. Though the emissions inventoried accounted for only a small fraction of the University's overall total, 11,165 $mtCO_2e$ is not insignificant, equivalent to consuming 1,256,329 gallons of gasoline, or burning 12,353,059 pounds of coal.[22]

It might have been simpler (and likely more expensive) to hire a consultant to perform this work, but there is great value in undertaking such an effort internally. Completing this project would not have been possible without the contributions of several library colleagues who met with the project team and ultimately provided data to support its effort. This necessary engagement was an excellent way to raise awareness internally about the effort and its importance. The project also connected the University Libraries with other sustainability stakeholders at Penn State, including members of the Office of Physical Plant, the Sustainability Institute, other colleges' sustainability committees, as well as faculty and students pursuing climate research. We're in the conversation now, and able to benefit from the vast sustainability knowledge within Penn State. Simply attempting a GHG inventory can help an organization understand how prepared it is to

quantify its carbon footprint. This first attempt at counting emissions in the Penn State University Libraries, for example, revealed buildings with inadequate metering and administrative documentation practices that could not easily support understanding the impact of various forms of employee travel.

Getting to the office, keeping the lights on, powering our computers and online resources, providing study rooms and charging stations to students, maintaining climate control collection spaces, keeping abreast of professional trends through conferencing, increasing access to holdings through interlibrary loan (ILL) are all important functions of an academic library and its employees, yet they all have attendant impacts on the environment. Understanding this fact should not devalue these or other activities any more than a GHG inventory can be used to judge the relative merits of different library services, programs or strategies. But it does create an opportunity to reflect on how and why we do things. With a better understanding of the nature of our emissions, we might even examine practices and decisions we take for granted or simply never considered with emissions in mind. At Penn State, the libraries' GHG inventory revealed one such example that required further study.

Getting to the office, keeping the lights on, powering our computers and online resources, providing study rooms and charging stations to students, maintaining climate control collection spaces, keeping abreast of professional trends through conferencing, increasing access to holdings through interlibrary loan (ILL) are all important functions of an academic library and its employees, yet they all have attendant impacts on the environment.

In the Summer of 2022, the author co-mentored a third undergraduate student in the Drawdown Research Experience for Undergraduates Program to look closer at the Science Park Library Annex building, which was found in the GHG inventory to have the highest energy consumption per square foot of any library occupied building. Two-thirds of this 13,000 square-foot building is devoted to high density archival storage for Penn State's Eberly Family Special Collections Library, while a quarter of the building is occupied by a state-of-the-art conservation center. The remaining portion of space inside the building houses mechanical systems. The University Libraries moved into the building in 2018, following an architectural overhaul that prioritized collection conservation standards. Though not LEED-certified, the building's new construction and detailed design plans provided confidence that little energy would be lost to leakage from poor sealing and insulation.

To expand the understanding of this building's energy usage beyond what was previously inventoried (representing a single year), this follow-up project collected and analyzed building data from its official opening in September 2018 to April 2022. Over this period, the building's average energy consumption per month was 34,000 kilowatt hours, accounting for 512 $mtCO_2e$ in greenhouse gas emissions. The trends in energy

consumption were fairly consistent, with highest usage in winter months and lowest in summer, indicating a heavier utility load to heat the space during the coldest parts of the year. Except for a small dip in early 2020, remote work patterns implemented because of the COVID-19 pandemic seemed to have little impact on the overall energy consumption, which makes sense in a building with limited human-occupied spaces.

An examination of temperature and relative humidity (rh) settings data in the archival storage area suggested the source of energy intensity to be the climate control settings. Despite some temporary fluctuations, temperature and relative humidity readings from two data loggers in the space demonstrated a persistent baseline of 60 degrees Fahrenheit and 40 percent rh. These settings will certainly increase the longevity of materials but are also unnecessary. They far exceed the 70 degrees Fahrenheit and 50 percent rh standards accepted within the conservation profession and even exceed the 65 degrees Fahrenheit and 45 percent rh defined in the building's original architectural plans. There is extensive literature on strategies for reducing the energy impact of collections storage environments, and through modeling one potential solution, we found that energy consumption could be reduced by 25 percent without significant expected impacts on materials housed there.[23] Some further study is required, but modification of the annex climate settings offers an example where the GHG inventory revealed an unrealized opportunity for reducing emissions.[24]

What other opportunities might present themselves as a result of conducting a GHG inventory? One area we collected data for but never had an opportunity to assess was the interlibrary loan service. In 2021, Penn State University Libraries reported 60,000 ILL requests, split roughly in half between outgoing and incoming requests. Penn State fulfills requests mostly through UPS and likely utilizes a mix of air and ground transportation. This is an important library service and has proven especially crucial following the impacts of a global pandemic, but it's a service that relies on mobile combustion and requires further study to evaluate opportunities for limiting emissions.[25]

Emissions from interlibrary loan services, being part of an academic library's value chain, would most likely be classified as Scope 3, which can be difficult to pinpoint. Penn State's strategic carbon reduction goals note that the value chain for a university would include students, their parents, alumni, and members of the community in which the campus is situated. Understanding how academic library emissions fit into the ecology of this value chain would take some time and thought, but the GHG inventory is a tool that can help us do that. After working through that process for the Penn State University Libraries, some questions about possible Scope 3 emissions lingered. What does the Libraries' overall procurement environment look like and how might emissions inform purchasing decisions? What is the impact of book and collection purchases broadly? There may be a tendency to view e-resources as more sustainable than print, but what exactly are the emissions generated by the electronic databases and other resources that we subscribe to? And for academic libraries like Penn State's that manage program and collection endowments, how are those funds invested in markets?

There is one source of Scope 3 emissions that academic libraries can act on now: employee travel. As noted above, we likely undercounted the emissions from employee commuting, and yet it still exceeded air travel in emissions. The pandemic normalized remote work for a period, but with offices gradually returning to business-as-usual, op-

The pandemic normalized remote work for a period, but with offices gradually returning to business-as-usual, opportunities for emissions reductions might be missed.

portunities for emissions reductions might be missed. Modest reductions in commuting enabled by remote work opportunities can have significant impacts on emissions. Penn State notes in its carbon reduction plan, for example, that a 16 percent reduction in commuting (equivalent to remote work one day out of every six) would eliminate 9,000 $mtCO_2e$ annually from the university's overall total.

While some have understandably become fatigued by Zoom-based conferences and professional development events, academic libraries can advocate for reducing emissions from air travel—especially, where possible, on long-haul flights. Academic libraries with tenure-track positions could incentivize limiting air travel through tenure and promotion requirements. The topic of carbon-neutral conferences, including support for virtual events, was gaining some traction prior to the pandemic.[26] At the American Library Association's Rare Book and Manuscripts Section (RBMS) annual conference in 2019, the possibility of shifting to a virtual conference model was discussed as part of that year's conference theme on climate change, with arguments made for and against in a setting that was happily removed from any notion of a global pandemic having a say.[27] It is encouraging to see ALA providing leadership on conference travel with its resolution to achieve carbon-neutral conferences by 2025.[28]

Conclusion

While the impacts of climate change are becoming more visible, leading to a greater percentage of Americans acknowledging the risk every year, its causes can remain distant and invisible to us.[29] The energy that makes our livelihood possible is, for the most part, created in remote industrial facilities using processes and materials we have rarely taken a moment to consider, then transmitted across unknown and unseeable distances to warm and illuminate our workplaces. Through nearly every step in the full stream of mechanical functions and chemical transactions that leads to this light and warmth in our libraries, there are microscopic particles we'll never see released into the air where eventually they settle in the atmosphere far above human activity. Some of these particles are excellent at absorbing heat, a fact that humans have well understood for nearly 200 years. How can libraries—or any individual or institution for that matter—affect processes that are both unfathomably small and geologic in scale? We may recognize implicitly that we do, but it can remain difficult to comprehend. A process of quantifying emissions can be a powerful tool for grounding us, creating a more concrete understanding of the role we play in these matters.

What we do with that understanding may prove to be a more difficult task. In her opening plenary at the 2019 RBMS Conference, Bethany Nowviskie challenged attendees to question professional assumptions and consider that the climate crisis may require libraries to change "our ways of working and the lenses through which we view our institutions, consortia, associations, and personal and professional responsibilities as

cultural heritage workers."[30] Put another way, we may take steps to reduce our emissions and still find our contributions toward carbon neutrality insufficient. How will the information professions need to evolve in order to help the world address climate change? The future of libraries is ultimately as riddled by uncertainty as every other societal institution, but steps we take now to understand and reduce emissions will make our profession more resilient, too.

Acknowledgement

I am grateful to have collaborated with an incredibly dedicated group of students in Hudson Wagner, Abbie La Porta, and Emily DiMaio, without whom an understanding of the Penn State University Libraries' greenhouse gas emissions would not be possible. I am also grateful to my friend and colleague, Nathan Piekielek, whose expertise substantially improved these projects. Finally, I would like to acknowledge the many Penn State colleagues who supported these efforts by providing data and advice.

Ben Goldman is the University Archivist of the Eberly Special Collections Library at Penn State University. He can be reached via e-mail at bmg17@psu.edu

Notes

1. International Panel on Climate Change. *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, by the Core Writing Team, H. Lee and J. Romero, eds. Geneva: IPCC, 2023. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf
2. United Nations, *The Paris Agreement* (United Nations Framework Convention on Climate Change, 2016), https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf.
3. Brad Plumer, "Climate Report Card Says Countries Are Trying, but Urgently Need Improvement," *The New York Times* (September 8, 2023), https://www.nytimes.com/2023/09/08/climate/paris-agreement-stocktake.html.
4. American Library Association (ALA) Council, "Core Values of Librarianship," American Library Association, 2019, https://www.ala.org/advocacy/advocacy/intfreedom/corevalues.
5. Madeleine Charney and Petra Hauke, "Global Action on the Urgency of Climate Change: Academic and Research Libraries' Contributions," *College & Research Libraries News* 81, 3 (2020): 114.
6. For a comprehensive overview of publications and online resources on the topic, see the resource guide "Sustainability and Libraries: ALA and Sustainability," at https://libguides.ala.org/SustainableLibraries/sustainability.
7. René Tanner, Rebekkah Smith Aldrich, Monika Antonelli, and Adrian K. Ho, "Libraries as Sustainability Leaders: ALA's Special Task Force," *portal: Libraries and the Academy* 19, 3 (2019): 365–374.
8. ALA Council, "Core Values of Librarianship."
9. Brooklyn Public Library, "New Data Shows Brooklyn Public Library Has Reduced its Green House Gas Emissions by 40 Percent Across the Borough," press release, September 24, 2019, https://www.bklynlibrary.org/media/press/new-data-shows-brooklyn.
10. Leila Sonkkanen, "Bringing environmental awareness of public libraries to the 2020s-project: Case Libraries Carbon Footprint" (paper presentation, 87th IFLA World

Library and Information Congress; Satellite Meeting: Environment, Sustainability and Libraries, Management and Marketing Preservation and Conservation Sections, Cork, Ireland, September 14, 2022). https://repository.ifla.org/handle/123456789/2097.

11. "Climate Action Plan for the Rose Library." Emory Office of Sustainability Initiatives, 2022, https://sustainability.emory.edu/wp-content/uploads/2022/08/Rose-Library-Climate-Action-Plan.pdf
12. This number is based on data found on the website for the Sustainability Indicator Management & Analysis Platform (SIMAP), a carbon accounting tool for higher education institutions. For more information see: https://unhsimap.org/public.
13. Second Nature, "Carbon Neutral Colleges and Universities," https://secondnature.org/climate-action-guidance/carbon-neutral-colleges-and-universities/.
14. Detailed information about the GHG Protocol standard can be found at: https://ghgprotocol.org/.
15. EPA Center for Corporate Climate Leadership, "GHG Inventory Development Process and Guidance," United States Environmental Protection Agency, https://www.epa.gov/climateleadership/ghg-inventory-development-process-and-guidance.
16. All information presented here about Penn State's carbon footprint was sourced from the 208-page "Report from the President's Carbon Reduction Task Force," released in December 2021. It can be accessed online at: https://psu-gatsby-files-prod.s3.amazonaws.com/newsdocuments/PSU-CERTF-Report_5-02-22.pdf.
17. Pennsylvania State University, "Report from the President's Carbon Reduction Task Force."
18. Penn State University Libraries, "Association for Research Libraries (ARL) Statistics FY 2021," *Libraries Statistics and Data,* https://libraries.psu.edu/about/organization-glance/libraries-statistics-and-data.
19. Interestingly, the University includes COVID-19 as a significant source of emissions reductions in its greenhouse gas inventory, accounting for what looks to be around 50,000 $mtCO_2e$.
20. All data and calculations for this project were documented in a spreadsheet that is accessible via Penn State's institutional repository, alongside the final report, which provides a detailed accounting of the methodology employed. For more information, see: https://scholarsphere.psu.edu/resources/a79fafd2-4ea0-43e0-8619-065f758eedd3.
21. EPA Center for Corporate Climate Leadership, "GHG Emissions Factors Hub," United States Environmental Protection Agency, https://www.epa.gov/climateleadership/ghg-emission-factors-hub.
22. The Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator helps make total emissions numbers easier to conceptualize. Penn State University Libraries' 11,165 $mtCO_2e$, for example, is an amount equivalent to driving over 28 million miles using an average gasoline powered automobile or burning 12.5 million pounds of coal. See: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
23. There exist numerous examples of libraries, archives, and museums reducing energy usage in storage environments through sustainability measures. The Image Permanence Institute provides detailed solutions in "IPI's Guide to Sustainable Preservation Practices for Managing Storage Environments," which is available at: https://store.imagepermanenceinstitute.org/sustainable-preservation-practices-guidebook.
24. A detailed report on energy consumption at the Science Park Library Annex can be accessed through Penn State's institutional repository at: https://scholarsphere.psu.edu/resources/8e0b9fa5-d0da-4c22-93ae-e95a328cb0c2.
25. It might be worth revisiting the findings of an OCLC Research report from 2010, which detailed the environmental impact of interlibrary loan practices. See: Dennis Massie, "Greening Interlibrary Loan Practices," OCLC Research (2010), http://www.oclc.org/research/publications/library/2010/2010-07.pdf.
26. The Nearly-Carbon-Neutral Conference model articulated by Ken Hiltner and deployed at the University of California, Santa Barbara, provides detailed guidance on how to

approach conferences in a more sustainable way. For more information, see: https://ejcj.orfaleacenter.ucsb.edu/conferences/.

27. The author served as co-chair of the RBMS 2019 conference, "Response & Responsibility: Special Collections and Climate Change." As part of the sustainability-driven planning for the event, attendees were invited on the registration form to provide their departure city, likely mode of travel and number of carpool riders (if relevant). Eighty percent of the conference's 520 attendees collectively traveled 307,562 miles. In March 2020, the author consulted with climate scientist, Milan Klöwer, who calculated these emissions to be 86.3 $mtCO_2e$. More information about Dr. Klöwer's methodology can be found in his analysis of the emissions generated from travel to the 2019 Fall Meeting of the American Geoscience Union at: https://github.com/ConferenceCarbonTracker/CarbonFootprintAGU.
28. ALA Council, Resolution to Achieve Carbon Neutrality for ALA Conferences, 2021 ALA CD #53. (June 10, 2021), https://www.ala.org/aboutala/sites/ala.org.aboutala/files/content/ALA%20CD%2053%20RESOLUTION%20to%20Achieve%20Carbon%20Neutrality%20for%20ALA%20Conferences%20Final%20Revised.pdf.
29. The Yale Program on Climate Communication has conducted surveys of public opinion on climate change for more than a decade. For more information, see: Jennifer Marlon, Matthew Ballew, Seth Rosenthal, Edward Maibach and Anthony Leiserowitz, "Explore Climate Change in the American Mind," Yale Program on Climate Communication (December 15, 2022), https://climatecommunication.yale.edu/visualizations-data/americans-climate-views/.
30. Bethany Nowviskie, "change us, too," *Bethany Nowviskie* (blog), June 30, 2019, https://nowviskie.org/2019/change-us-too/.