Sustainability Data Dashboard Transparency Plan

Recommendations

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Sustainability Dashboards Transparency Plan
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1. Executive Summary

The University of Chicago records data from its campus utilities and greenhouse gas emissions, which is published through sustainability dashboards on the Office of Sustainability's Reporting Page. These dashboards are comprised of graphs, charts, and other data visualizations. The reporting materials, the dashboards and the reports, supplement the presentation of the University's overall sustainability goals, including its mission to reduce its greenhouse gas (GHG) emissions by 50% by 2030 [1]. The EFCampus team encourages the University to commit to improving the transparency, readability, and digital accessibility of its published data: to ensure that all can access and understand this information.

The contents of this report are two-fold: First, there is an assessment of the University's current dashboards, based primarily on digital accessibility and user-experience research. Second, there are recommendations to improve the existing dashboards and set guidelines for new dashboards.

This report begins with a literature review, which presents the research used to inform the dashboard recommendations. The research draws from various digital accessibility, data visualization, and design sources, collectively describing how to best present the sustainability data.

The literature review is followed by a list of higher-level goals for the University's sustainability reporting. These higher-level goals are a set of broad objectives intended to guide all current and future dashboards, including a list of data-driven questions each dashboard should answer through its visualizations. To establish the feasibility of these goals, the limitations section presents the various barriers to implementing these recommendations. These contain institution-level restrictions, such as data-privacy issues, and technical restrictions, such as software limitations.

The next section details specific recommendations by the EFCampus team for the dashboards, website, and reporting content, accounting for any existing limitations. This section incorporates a list of suggestions and several mock-ups. This section also lays out guidelines for the creation of future dashboards, both regarding content and structure. The primary recommendations in this report can be summarized as follows:

Sustainability Reporting Recommendations

1. Incorporate digital accessibility tools, such as alternative text, accessible color palettes, and hierarchical labeling, in all sustainability reporting materials to include considerations for all users regardless of physical or cognitive disabilities.
2. Improve dashboard content to highlight how the University works towards its sustainability goals year-by-year.
3. Add sufficient context for each graph, image, and website resource to accommodate those unfamiliar with the University's sustainability data. This entails:
    a. Providing unit conversions and defining scientific terms to supplement graphs, either in a central location or on the dashboards.
    b. Describing links and website resources with a short content summary.
4. Create a more navigable Office of Sustainability reporting webpage, thereby reducing the amount of time a user spends navigating the website and increasing the amount of time spent interacting with the sustainability data.

2. Introduction

The University of Chicago community has a growing desire to understand and engage with the University's sustainability data in order to participate in and provide informed input on its Sustainability Plan. The University seeks to reduce its greenhouse gas emissions by 50% by 2030 as part of its most recent sustainability update. Due to a recent increase in data transparency considerations, its sustainability reporting practices and accessibility have become a possible area for improvement. Moreover, making the University's reporting materials more user-friendly and digitally accessible to the general public, particularly University students, could be another focus for updates to the dashboards.

The Phoenix Sustainability Initiative (PSI), a student organization at the University, began preliminary research on the sustainability dashboards in Spring 2022. PSI benchmarked the University's sustainability dashboards against those of peer institutions, scoring on accessibility, design, and data presentation. Their assessment found that the University of Chicago should improve its dashboards primarily in the realms of downloadability, descriptions, and design. This report expands upon PSI's research and provides a list of specific improvements for the GHG Emissions dashboard and the Utility Usage dashboard. An initial evaluation reaffirmed the room for improvement in the areas of digital accessibility, readability, and data transparency in the dashboards. In particular, improving digital accessibility—making online resources easier to use for people with disabilities—across the dashboards and website was deemed a top concern. More information on digital accessibility can be found in Appendix D. User experience, navigability, and accessible information were other key focuses when creating the final list of recommendations.

This report focuses on improving the usability, design, and digital accessibility of the Office of Sustainability reporting resources, including the website, reports, and sustainability dashboards. The goals regarding the dashboards are threefold:

- Usability: Improve the dashboards' navigability and the data's downloadability. This involves making the graphs and data files downloadable in addition to avoiding information overload and using clickable images in the place of links.
- Design: Improve user experience with the dashboards by making them more comprehensible for users without prior knowledge of energy and sustainability while presenting the data in a way that is both intuitive and interactive. This involves adding descriptive labeling and explanations, links to further reporting for more context, relevant filters, and tooltips with more information.
- Digital Accessibility: Create a digitally accessible dashboard—remove any interactive barriers on the dashboards for people with disabilities. This includes building dashboards with a clear hierarchy of headings, alternative text, accessible color palettes, and visible focus indicators that people using a screen reader or keyboard keys can fully access.

3. Annotated Bibliography

The improvements to the University of Chicago's sustainability dashboards were informed primarily by thirteen sources of research pertaining to data graphic theory and digital accessibility. This research builds upon the work of the Phoenix Sustainability Initiative and examines other universities' sustainability dashboards as inspiration for possible changes to the University of Chicago's dashboards. This has culminated in a list of specific suggestions for improving current and future sustainability dashboards.

Edward Tufte's pioneering book *The Visual Display of Quantitative Information* provides a thorough framework for the theory of data graphics. This theory derives from the basic tenet of "showing the data", but explains a complex network of factors that go into making a good data visualization. Among Tufte's most important ideas is the data-ink ratio—the proportion of the amount of ink used in the visualization to the amount of data conveyed. He recommends that this ratio be maximized, thereby increasing the amount of data and decreasing the amount of ink [2]. Additionally, this would eliminate so-called "chartjunk," which are features that take up ink but provide no substantive meaning to the graphic, such as decorations or extraneous markings. He also suggested that graphics be made more generally accessible by labeling them simply and universally, providing explanations of their data, and providing context for them. If these guidelines are followed, the visualization achieves graphic excellence, meaning that "complex ideas [are] communicated with clarity, precision, and efficiency" [2].

Stephen M. Kosslyn's *Graph Design for the Eye and Mind* challenges the rigidity of Tufte's guidelines and provides some of his own graphic design metrics. He explains that the eight psychological principles of effective graphics—a set of tools that describe how our brains interact with visualizations—can be used to create relevant, understandable, and differentiable presentations of data. This ensures that readers are not overwhelmed by the data and can

retain as much of the information presented as possible. In contrast to Tufte's proposition to maximize the data-ink ratio, Kosslyn states that additional ink can be helpful in certain situations where it completes the data visualization; he suggests that data is best retained when the reader possesses sufficient contextualization and background knowledge for a given data graphic [3]. The University of Chicago dashboard recommendations in this report follow Kosslyn's advice more closely since the graphs are meant to be read by a wide audience unfamiliar with the sustainability data, including students.

In addition to the aesthetic structure of the data, the quantity of data presented also heavily influences the data's ability to communicate its meaning effectively to the user. John B. Horrigan's research through the Pew Research Center, titled *Information Overload,* informed the decision on how best to present The University of Chicago's greenhouse gas (GHG) Emissions and utility usage data in a way that did not lead to information overload for readers. Information overload is defined as an excess of information presented in the completion of a task, which often hinders the individual's decision-making process. Horrigan explains that although most Americans like having access to a variety of information, 20% feel that they are often overloaded with it [4]. Horrigan states that information overload is often made worse by the demands that institutions place on consumers to retain information [4]. The University of Chicago is an example of one such institution. In understanding that information overload can cause a consumer to feel burdened by information, the sustainability dashboard suggestions focus on generally making data less overwhelming for consumers, who are the University of Chicago students and faculty.

Improving digital accessibility—which involves the removal of barriers to digital interaction for people with disabilities—is a key step to ensuring that all readers are able to obtain dashboard information fully, equitably, and independently. To better understand digital accessibility best practices, the EFCampus team referenced a number of online digital accessibility guides, as well as resources provided by The University of Chicago's Center for Digital Accessibility [5].

A particularly insightful guide was Storytelling With Data's A*ccessible Data Viz Is Better Data Viz* article, which suggests a list of key practices to improve digital accessibility, starting with alternative text [6]. People with visual impairments will often use screen readers, an assistive technology that can read aloud web elements. An important assistive web element is alternative text, often abbreviated as "alt-text," which is a short description of an image's content embedded in the web code. This allows people who are unable to fully view a webpage to understand any images or data presented online through auditory descriptions. The data visualization article also suggests clear, hierarchical labeling, which helps people quickly access information without having to visually search the page [6]. This entails clear headings with different font sizes and embedded HTML to differentiate between primary titles and subtitles, particularly when read aloud by a screen reader. To make a visualization accessible for people with colorblindness, the article recommends the usage of digitally accessible color palettes, labeling that uses patterns in addition to colors, and direct labeling with relevant values, rather than asking users to match colors between the legend and the graph [6].

Besides recommending alternative text, the article encourages designers to ensure colors clearly contrast on the graph to help those who might have trouble distinguishing colors [6]. This article strongly influenced the decision to highlight digital accessibility in the dashboard suggestions, including the addition of alternative text, improved labeling, and accessible color palettes. Although each of these guidelines improves digital accessibility for people with visual disabilities, it is also important to accommodate those with mobility disabilities.

Whether due to situational, temporary, or permanent disability, some users may have difficulty using a mouse or a trackpad. Therefore, dashboards should be navigable using only keyboard controls. Harvard's Digital Accessibility Office offers a guide on how to improve accessibility for people unable to use a mouse. Many interactive dashboards use mouse-over controls to provide labeling or context, but this functionality is not accessible for those with physical impairments. The same functionality must be accessible using the tab, enter, space, and arrow keys. When using keyboard controls and the tab button, items are selected in a pre-designated order, and that order should be spatially and visually logical. It is also important to include visible focus indicators, which highlight the item selected so the reader knows what to focus on to navigate through the page. For those using a trackpad, the mouse arrow provides this indicator, but there must be an alternative option. Tableau, an interactive data visualization software, offers a guide for making their dashboards align with keyboard accessibility standards, and these controls can be turned on for published dashboards. This software is one of many powerful data visualization tools used to build dashboards.

Lastly, the suggested sustainability dashboard guidelines in this report draw from techniques and design elements implemented in several other university and peer institution dashboards. Peer institution dashboards include those from Harvard University and Princeton University. Additional institutions reviewed include The University of Oregon, Portland State University, and The University of Maryland – College Park. These dashboards influenced many of these new guidelines for the University of Chicago pertaining to dashboard centralization, navigation, and general accessibility. The University of Oregon, Princeton University, and Harvard University demonstrated the value of adding image card links on their sustainability dashboards, increasing navigability and digital accessibility [7][8][9]. On each image card, there is a summary of the statistics stated in the dashboard along with an image of graphs from the dashboard. This provides the user with a helpful preview of the data on the dashboard.

These universities also provided insight on how to access the dashboards for each category of data collected from one centralized webpage. Portland State University used one dashboard with multiple tabs while The University of Maryland – College Park used an infographic with summary statistics and hyperlinks, alongside tabs on the left-hand side of the screen [10][11]. Additionally, Stanford University and Washington University in St. Louis influenced the suggestions for data that could be included in future food and dining dashboards [12][13]. This data includes food suppliers and waste initiatives on campus. Together, these publications and visual resources provided substantial guidance in the development of the University of Chicago sustainability dashboard guidelines outlined in this report.

4. Overall Dashboard Objectives

High-Level Goals:

Below is a compiled list of questions users might be interested in answering when looking at the GHG Emissions dashboards. They are not meant to be addressed directly by the dashboards; rather, they should be answered generally by the data and supplemental explanations. These questions should act as a guide in considering how the University should present the data. Keeping these questions in mind will make for a better user experience, granting users a more complete understanding of the University's emissions goals and their progress towards them. These questions include:

- How have the University's greenhouse gas emissions changed over time?
- How are scopes 1, 2, and 3 defined? How do they differ from each other?
- What are the University's emissions goals? How close is the University to accomplishing them? How will the University get there?
- Which scope subcategories contribute most to emissions? Which locations on campus contribute most to emissions?
- What categories of uses or users contribute the most to campus greenhouse gas emissions?
- How does the University compare to peer institutions in terms of emissions?
- What is the scale of the University's emissions (average, above average, or below average emissions compared to peer institutions?) How can users make sense of the number of MT eCO2 per year that the University emits?

A similar list has been compiled below to list the questions at the foundation of the Utility Usage dashboards. Considering these questions will be vital in providing relevant and helpful information to users, leading them toward a better understanding of the University's energy and water usage and stoking further interest in the University's sustainability policies and goals. These questions include:

- How has the University's usage of energy and water changed over time? Does the change account for the University's growing building footprint and population?
- How are energy and water usage measured?
- Which factors contribute most to energy and water usage? Which locations on campus contribute the most to energy and water usage?
- What types of uses/users contribute the most to energy and water usage?
- Are there any methods of measurement that may provide misleading data?
- Which types of buildings use the most energy and water and why?
- How do energy and water use intensity in the University's buildings compare to that of similar buildings at other universities? To similar buildings in Chicago?
- What is the scale of the University's energy usage (i.e., how does one make sense of the number of MMBTU/year the University uses)?
- How can the University's policies regarding energy help reduce emissions?
- How does water conservation relate to broader sustainability goals? What is the University's energy footprint as it relates to water?

5. Limitations

It is essential to acknowledge the existing limitations on the scope and nature of potential alterations due to University policies when considering the desired final structure and content of the sustainability dashboards. This report will present suggestions for potential changes to the dashboards and website with these limitations in mind.

One notable limitation is the availability of the University of Chicago's data in that much of the University's data is not publicly available or easily downloadable. The University cannot currently share its fiscal data, in particular, with the public on a dashboard. Due to the decentralization of data at the University of Chicago, it can often be difficult to integrate sustainability-specific data with broader University data. The University of Chicago is interested in creating dashboards that explore new concepts such as food purchases, waste diversion, and building energy efficiency mapping, as many other universities have done. However, the decentralization of the University's data makes it difficult to determine what data is available to dashboard creators, and where it is collected and stored. To collect information to create new dashboards, people working on this project in the future will need to aggregate existing data from different departments across the University of Chicago. For example, the University's food services are not run through a single office or vendor, so it would take a significant centralization effort to account for all food and food waste. The EFCampus team found that the available data types and data collection methods at the University of Chicago limit the visualization possibilities for the dashboards. Having reviewed the dashboards of other institutions, the EFCampus team deemed that one of the most effective ways to convey emissions data was through a campus map. However, at the University of Chicago, greenhouse gas emissions are calculated on a campus-wide basis, as opposed to other universities calculating emissions per building, making a map detailing specific buildings unachievable.

There are also limitations to the technology used to create data visualizations. The chosen software affects which ideas the University can implement, as each makes a tradeoff between power and ease of use. Some data visualization software has a simpler format but is more rigid in its functionality, while other software requires technical knowledge but provides a greater range of visualization options. The University's current software has these limitations, as detailed below, but it is important to acknowledge that all software has its limitations. For example, additional programs (the EFCampus team explored Datawrapper and Our World in Data for this project) might require expertise that limits their usability for a dashboard project like this one. The Our World in Data graphing tool is only downloadable from GitHub repositories, for example, and the user must work through back-end visualization code in order to make graphs. Similarly, Datawrapper's file specifications, especially for spatial data, require significant data science and geographic information science knowledge.

The software that the University currently uses for its Utility Usage dashboard has limitations that have restricted the implementation of various features in the current dashboards. The software operates through pre-set widgets, and although this system makes graphs relatively easy to create, it also limits the level of customizability. Within the widgets, dashboard creators are often only able to select which time periods to show data from, not how to show it.

This means that they cannot change color schemes, labels, titles, keys, or graph types. The limitations on what can be edited make it challenging to incorporate suggestions relating to altering the color scheme, developing more descriptive labeling, and making the dashboards more keyboard-accessible.

Currently, the software does not have the capability to include visible focus indicators or change the axis labels on graphs. The color of the axis label also cannot be altered based on the corresponding graph. The software does have a mapping tool that can be useful. However, it does not currently include functionality to create maps (like choropleth and bubble maps) that show utility data about spatial features—it can only show their locations. Furthermore, the software cannot create a map visualizing utilities on campus by building without also including private fiscal data, meaning that the University cannot display a map publicly at all. Lastly, the public dashboards only give users the option to filter by year, so all utility data within a certain time frame will continue to be shown without a utility filter.

The current software used to build the GHG Emissions dashboard offers dashboard creators the ability to change the color of graphs, include secondary indicators, include visible focus indicators, alter the labels and headings, and include keyboard-accessible tooltips. Although these capabilities exist, in addition to online extensions, this software also has certain limitations within its infrastructure. On the dashboard development end, it often takes significant time and effort to wrangle data to make it readable by the software, and then transform the base visualization into something more user-friendly.

Finally, there are technological limitations to the changes that The University Office of Sustainability can make to its website. From research on other institutions, the EFCampus team found centralized dashboards to allow for a more intuitive design and better user experience. The University of Chicago's website follows a specific template that makes centralization of the dashboards difficult. This template includes specifications that there can only be three columns listed on a page, and that all web elements must follow a specific color scheme. There are additional limitations on the size of elements that users can add and how they can be structured on the page (vertical columns instead of horizontal rows). The limitation on the number of columns presents new challenges for, including the University's GHG Emissions dashboards, separated Utility Usage dashboards, sustainability goals, and reporting on one centralized webpage.

6. Implementation-Level Recommendations

In order to address the high-level goals for improving the University's sustainability dashboards and website, the EFCampus team has developed specific areas for improvement. These areas for improvement are listed below, alongside mock-ups that visually display how the improvements can be implemented. These recommendations are separated into those for the Greenhouse Gas Emissions dashboard, Utilities Usage dashboard, potential future dining and food waste dashboards, and the University's sustainability website. See Appendix E: Dashboard References for additional recommendations.

6.1 Greenhouse Gas Emissions Dashboard Recommendations

6.1.1 Greenhouse Gas Emissions Dashboard Areas for Improvement

The suggestions for improvement of the Greenhouse Gas (GHG) Emissions dashboard are organized according to the dashboard goals laid out in the introduction: usability, design, and digital accessibility. For a condensed list of these suggestions, please reference Appendix A: Condensed List of Recommendations.

Regarding usability, the main area for improvement for the dashboard relates to the exclusion of emissions goal reference lines. The Absolute Greenhouse Gas Emissions by Source, Scope, and Fiscal Year does not include a reference to the 2030 emissions goal and can only be filtered by reporting period (not scope). Including a reference to the 2030 emissions goal enables users to understand the University's progress without needing to read the GHG Emissions Inventory Report. The ability to filter by both scope and reporting period would allow users to see specific data and reduce any clutter on the graphs.

The areas for improvement in dashboard design include redundancies in graphing and the methods of visualization chosen. Within the different tabs on the dashboard, there are multiple graphs displaying similar information that appear redundant. These graphs include the stacked bar graphs, percent bubble graphs, and data by location for Absolute Greenhouse Gas Emissions by Source, Scope, and Fiscal Year. To remove any redundancies, it would be helpful to remove the latter two graphs in favor of the first stacked bar graph. As for the Greenhouse Gas Emissions Inventory Organizational Boundary table, it might be difficult for some people to follow due to the quantity of information presented in the table, and it displays information differently than in the rest of the dashboard. Changing the table into a map could aid in visualizing the location of certain buildings and how the University has expanded and changed over time.

Lastly, regarding digital accessibility, the areas for improvement for the GHG Emissions dashboard primarily focus on color contrast and context for uncommon key terms. Currently, each category within a given scope on the Absolute Greenhouse Gas Emissions by Source, Scope, and Fiscal Year bar chart are marked with the same color (e.g., green for all of scope 3). This design makes the user hover over the graph to see which category a given bar refers to. However, some users have disabilities that limit their ability to use a mouse, or otherwise have difficulty accessing a hover-over function. To make the dashboard more accessible for these users, it would be helpful to include different textures, different shades of a color group for each category, or a relabeled key for categories in each scope. Additionally, the current dashboard includes axis labels that are not easily understood. The axis labels might confuse users who are not familiar with certain energy terms, concepts, or abbreviations (ex. MT eCO2, target base year emissions, etc...). In order to make the information in this dashboard accessible for the University's target users, students, it is important to provide clearer axis labels that better describe the quantities measured. Alternatively, providing a key-terms document to supplement the graphs would be helpful. Such a document would explain the more technical elements of the graph without cluttering it with too much text.

6.1.2 Greenhouse Gas Dashboard Mock-Ups

Mock-ups for the Absolute Greenhouse Gas Emissions by Source stacked bar chart and Greenhouse Gas Emissions Inventory Organizational Boundary table, shown below, were created in response to the various areas for improvement listed above. Using this bar chart, it should be possible to remove the percent bubble graph and data by location, presenting the GHG Emissions solely in this format.

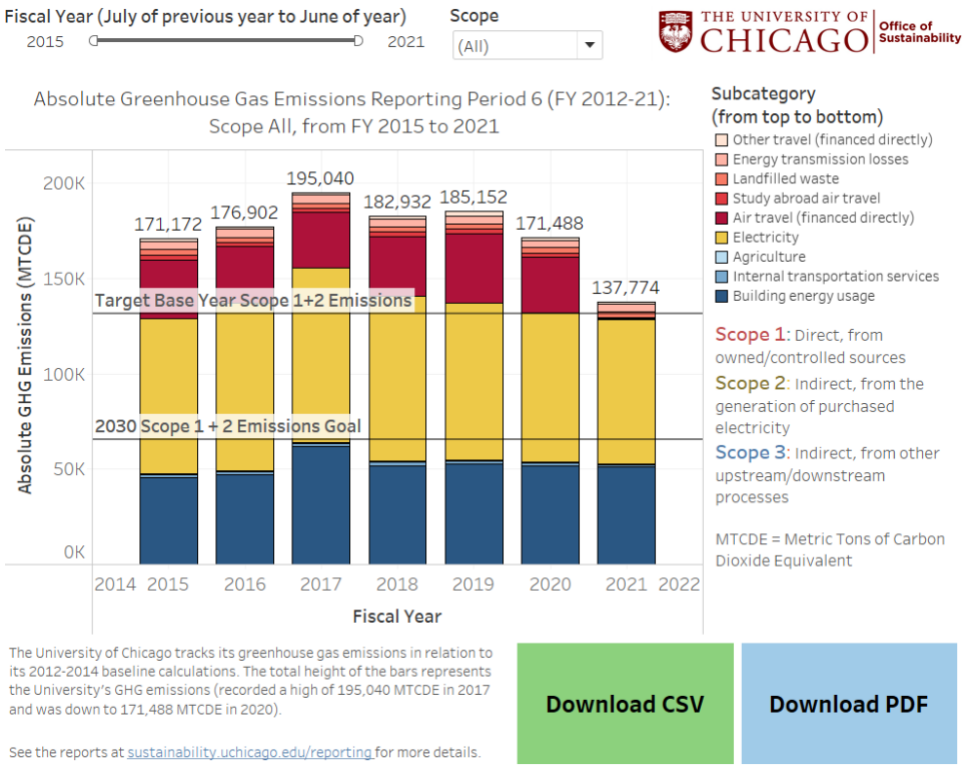


Figure 6.1.1A: Tableau graph of the Absolute Greenhouse Gas Emissions stacked bar graph with suggested implementations (altered filters, color palettes, color key, and downloadability).

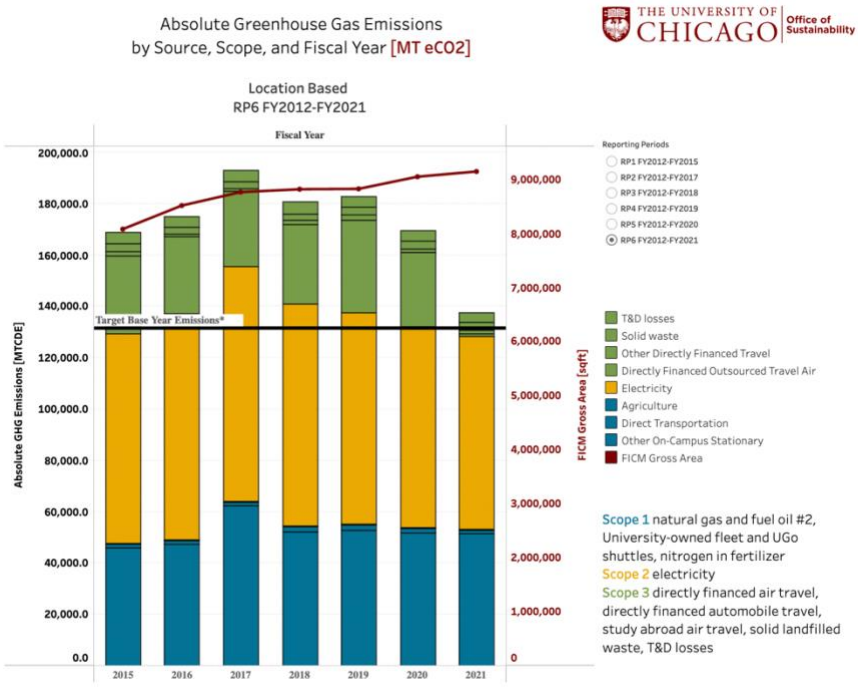


Figure 6.1.1B: Current graph of the Absolute Greenhouse Gas Emissions stacked bar graph on the Greenhouse Gas Emissions dashboard.

Title and Axis Changes

To provide more context on the contents of the graph, it would be helpful to add a feature that changes the title according to the filter suggestions selected, as shown in Figure 6.1.1A. The filters include fiscal year, scope, and subcategory for the scope. Adding title changes would be helpful for those using a screen reader as the filters selected would be read to them and give a more complete understanding of the data on the page. If title changes are not possible, it may be helpful to include subtitles that change with the filter selections to provide more context. These subtitles would function similarly to the initially suggested title change.

2030 Emissions Goal

The stacked bar chart for the Absolute GHG Emissions in Figure 6.1.1A includes a line indicating the Target Base Year Emissions for all scopes, a feature on the current chart. However, this figure also includes an additional line highlighting the 2030 emissions goals for all scopes. This goal line, together with the base year line, would provide users with context for the University's overall emissions goal and the progress the University is making toward achieving it.

Filters

The only clearly available filter on the current stacked bar chart isa filter by reporting period. Although the sustainability report explains the context behind data from different reporting periods, it is not easily understandable from the label on the chart alone. Figure 6.1.1A is made using only data from the most recent reporting period, so it does not a reporting period filter, but if it were, it would be helpful to include a brief elaboration on the differences between reporting periods. The user does currently have the opportunity to filter the data by subcategory in each scope, but it is not immediately apparent that there is an option to do so. To make this filter more obvious for users, Figure 6.1.1A includes a dropdown filter that allows them to filter by both scope and category. In addition, there is a filter that allows the user to choose which temporal scale they would like to see data from.

Data Downloadability

To ensure data transparency for all users, the data and visualizations from the dashboards should be downloadable. On each mock-up included in this report, there are clearly labeled data download buttons for all relevant data types. This is important because it will allow users to access the data for further insights and visualization. Appendix B: Data Downloadability at the end of this report details the importance of data transparency at large institutions.

Labeling for Accessibility

To ensure accessibility for keyboard control users, each category in Figure 6.1.1A is labeled with a different shade of the scope color so that readers can easily use the key to match a category to a bar. Categories in the same scope are also labeled with similar colors, so that the association with scope is maintained. Further, the categories in each scope are labeled from the top of each bar down such that the labeling corresponds to the location of the category in each bar. This would give users who are unable to distinguish between the colors a clearer way to distinguish between the categories.

Context for Information on Dashboard

It is important to provide context or background information for users to understand the data presented on the dashboards fully. To improve the amount of background information included, Figure 6.1.1A includes justifications for the scope groupings, tooltips, and links to relevant reporting on the dashboard mock-ups. The existing stacked bar chart only explains scopes by listing the subcategories within each scope. Adding a separate justification within the key is helpful in communicating what each scope encompasses and where these specific emissions are coming from (direct vs. indirect).

Additionally, tooltips that appear when a part of the bar chart is selected provide the user with information on the scope, subcategory, reporting period, and value selected. Using

Tableau's keyboard accessibility features, these tooltips should be available for those using a keyboard to navigate the dashboard.

Lastly, if the user needs information to supplement what is included in the dashboard, clicking on a link to the sustainability reporting will give more detailed explanations within the sustainability plan and GHG emissions inventory report. In understanding that the primary audience for this reporting is students, it is important to understand that the average student will likely not have time to read through the inventory report in its entirety. To ensure students have access to relevant information in the reporting without requiring them to read through the whole report, these links should be included as hyperlinks that take users to the relevant part of the reporting.

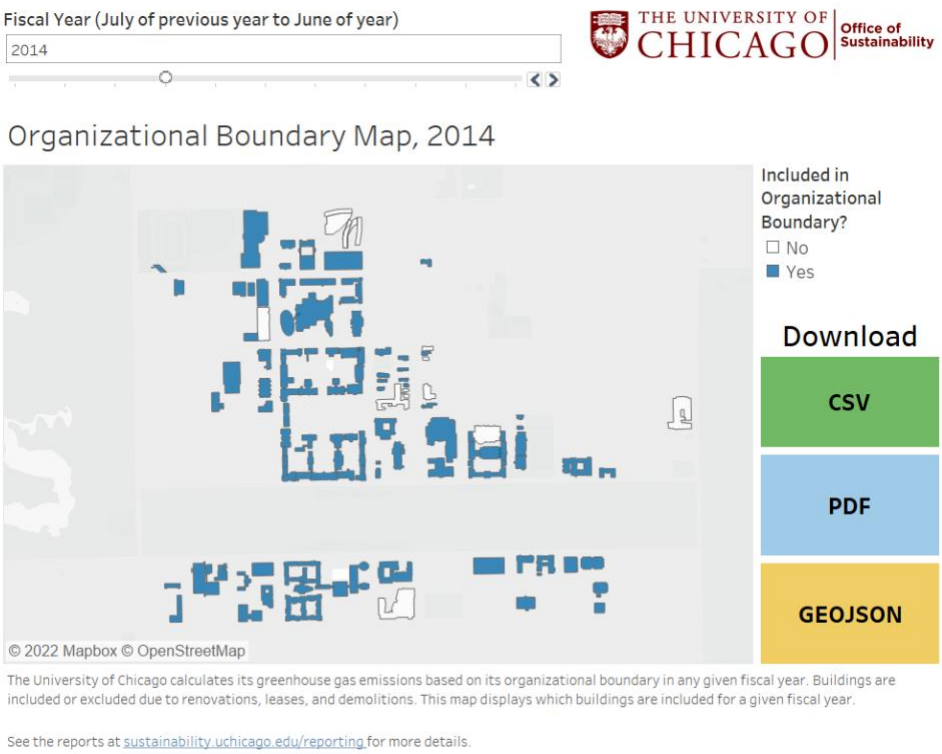


Figure 6.1.2A: Tableau map of Greenhouse Gas Emissions Inventory Organizational Boundary table with downloadability features, filter options, and tooltips.

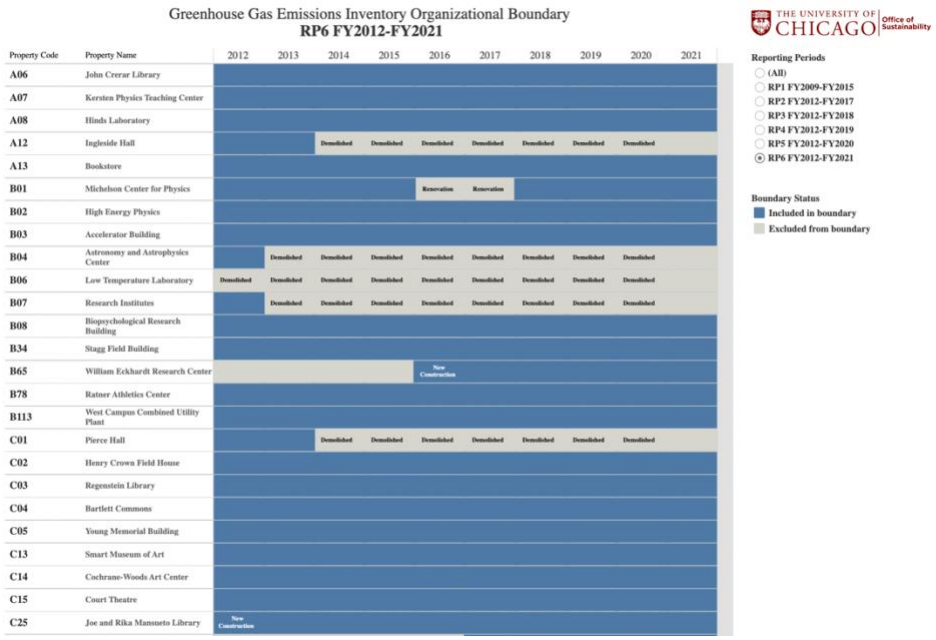


Figure 6.1.2B: Current Greenhouse Gas Emissions Inventory Organizational Boundary table on the Greenhouse Gas Emissions dashboard.

Data Visualizations

Figure 6.1.2A visualizes the Greenhouse Gas Emissions Inventory Organizational Boundary as a map. Using a map in place of the current table is more intuitive for users due to the fact that the information is representing campus buildings. This map includes the option to change the fiscal year shown. Additionally, there are tooltips for each building that provide additional content for users to understand the building name, building ID, whether or not the building is included in the boundary, and why a certain building is not included.

6.2 Utility Usage Dashboard Recommendations

6.2.1 Utility Usage Dashboards Areas for Improvement

Similarly, to develop a list of recommendations for the Utility Usage dashboards, it was necessary to first outline a list of areas for improvements for these dashboards. These areas for improvement were also separated by digital accessibility, usability, and design. For a condensed list of these suggestions, please reference Appendix A: Condensed List of Recommendations.

With digital accessibility, the areas for improvement for the Utility Usage dashboards primarily focus on clearer labeling, visual accessibility, and keyboard accessibility. The current dashboard has labeling that can be difficult to understand, especially for the general public. The axes are often named with reference only to abbreviations or units, without communicating the concepts being measured. Words like “EUI” and units like “DKTHM,” as well as nondescript titles like “Tree Map,” decrease usability and readability. Moreover, the dashboard is difficult to access for those with visual disabilities. The color contrast on some of the graphs could limit

access for people who are colorblind or have difficulty distinguishing between colors. Many distinctions are made solely using color, instead of using secondary indicators, such as differing shapes and patterns. For people whose visual disabilities prevent them from accessing the dashboard visually in any capacity, screen readers are a useful tool. However, when this page is read with a screen reader, it is unintuitive to navigate and has little alternative text to graphs that would provide valuable information. Similarly, the dashboard is difficult to access for people who use keyboard controls instead of a mouse or trackpad. Especially for the dashboard's top bar graph, the lack of a key to explain the meanings of colors limits options for understanding the data to hovering over a point on the screen. In addition, the lack of visible focus indicators on the graphs means that, even if a data element is selected, it is not clear which one it is for someone navigating using a keyboard. See Appendix D for additional information on digital accessibility.

With usability, the areas for improvement relate to context for visualizations and data downloadability. Even though much of the data is available for viewing, there is no aid for the user in terms of contextualizing that data. If trends were put in the context of the University's larger sustainability-related goals, or if links were provided to further resources, the dashboard could function as a more complete, usable source of information. The data that informs the visualizations on the dashboards is also not downloadable. Having data available to the public allows for greater collaboration, community building, and accountability. It also gives others the opportunity to use the data to produce their own insights and help the University better reach its sustainability goals. Overall, easily obtainable sustainability data makes for better usability.

Lastly, the areas of improvement for dashboard design include methods used to display the data visually. Although the dashboard has a significant amount of location-centric data, this data is not displayed in terms of a map. Mapping lends itself to good design features and could be an opportunity to help readers familiar with the campus layout understand the data better. Other design features on the dashboard could be improved as well. The tree map at the bottom of the dashboard has cut-off labeling for natural gas. The links to buildings or utility subcategories do not lead to dashboards displaying relevant data, but instead to internal software login pages. The monthly water use data, although accurate to what is being measured, is perhaps misleading given the differing (bi-monthly) time scale of data collection as well.

6.2.2 Utility Usage Dashboards Mock-Ups

Mock-ups for the Utilities Usage dashboards, shown below, were created in response to the various areas for improvement listed above. The mock-ups include improvements made to existing graphs (EUI, Monthly Water Usage, and Utility Usage Tree Map) in addition to suggestions for creating new visualizations (Monthly Utility Usage by Building). These mock-ups and recommendations were reviewed with the University's energy management information system providers to determine the current and future feasibility of the recommendations.

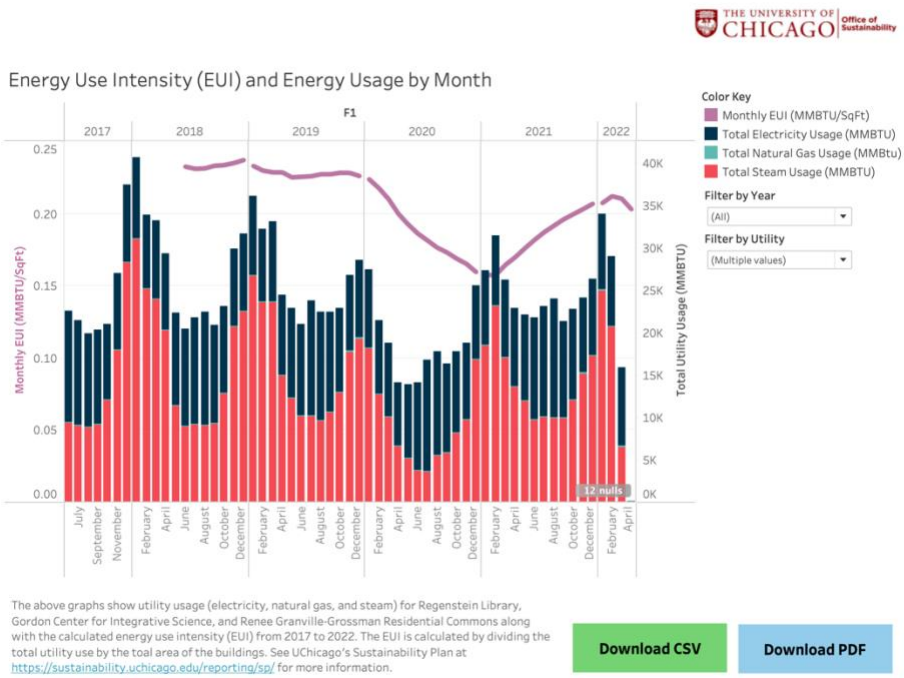
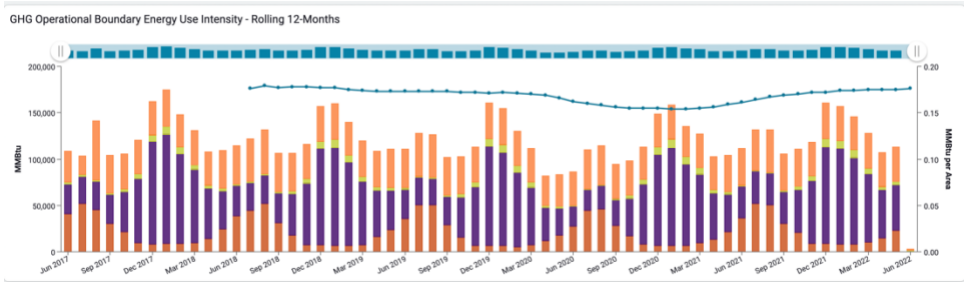


Figure 6.2.1A: Tableau graph of GHG Operational Boundary Energy Use Intensity Graph for Regenstein Library, Gordon Center for Integrative Science, and Renee Granville-Grossman Residential Commons including a color key, altered color palette, and more descriptive labeling.



6.2.1B: Current GHG Operational Boundary Energy Use Intensity Graph on the Utility Usage Dashboards.

Labeling

Rather than labeling axes with units, it is important that the concept being measured on the axis is foregrounded. For example, the axis originally labeled as “Kgal” was changed to “Water Use (Kgal)”. There is also an addition of color coordination between the EUI line graph and its corresponding axis to aid users in interpreting the graph in Figure 6.2.1A. This type of labeling will allow for greater information uptake and understanding for dashboard users. **

**depends on the University’s data collection methods

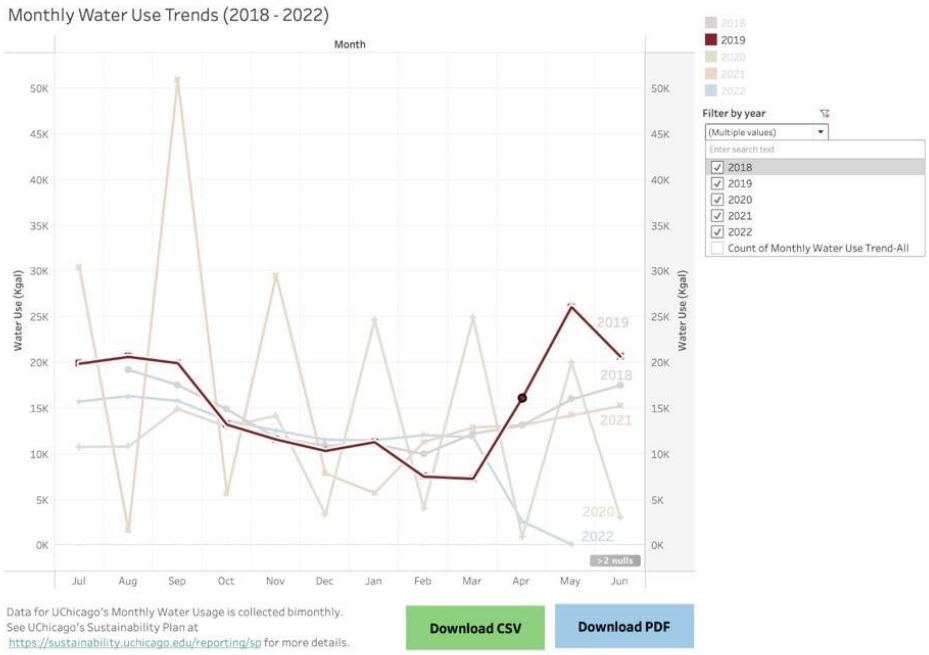


Figure 6.2.2A: Tableau graph of monthly water usage trends with an altered color palette, descriptive labeling, and secondary indicators.

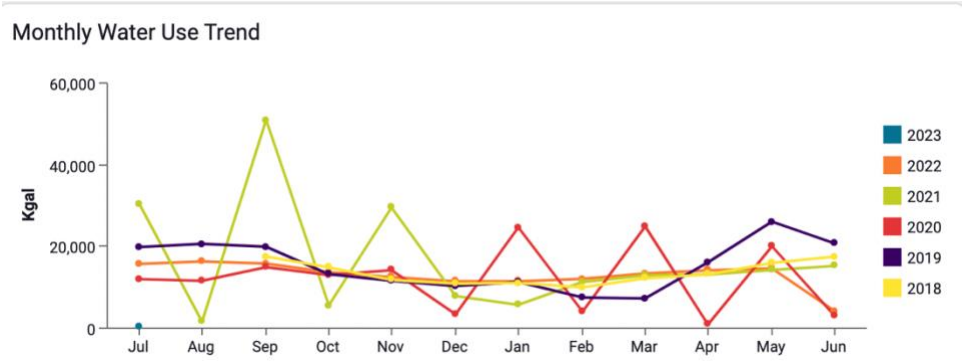


Figure 6.2.2B: Current graph of monthly water usage trends on the University's Utility Usage dashboards.

Context

Although the sustainability reporting and dashboards are on the same website, the connection can be improved by putting a link to reports and sustainability plans directly on the dashboard. Given that the dashboard is meant to encourage users to ask further questions, direct access to the context behind the University's sustainability data streamlines that process. More directly, there is now commentary for the most striking patterns on some of the graphs, including an explanation of the sharp peaks and valleys on the water usage graph mock-up in Figure 6.2.2A.

Visual Accessibility

The orange and brown colors in the current dashboard (Figure 6.2.1B) were quite similar and do not pass a color contrast checker, so the graph is recolored in Figure 6.2.1A using colors that are clearly distinct. Secondary indicators have also been added (different shapes indicating different years on the line graph mock-up) to Figure 6.2.2A to de-emphasize color as a distinguishing characteristic. To further de-emphasize color, there is added direct labeling, locating year labels right next to the line, as opposed to necessitating color-matching with the key. For those using screen readers, rather than visual cues, there are headers and alternative text included in the mock-ups that could guide users toward the most relevant information.

Keyboard Accessibility

There is now a key added to the energy use bar graph in Figure 6.2.1A so that users do not have to use a hover-over function in order to get information about which colors corresponded to which uses of energy. There was also a clear visual indicator added, with unselected bars fading out whenever a bar is selected.

Downloadability

Functional download buttons have been added to all of the mock-ups that are large and clear on the page. Each mock-up has a PDF and a CSV download, for an image of the graph and for the raw data behind the graph. Similarly, there is also the possibility of putting a data download button on the larger webpage, but both options might be useful in the future.

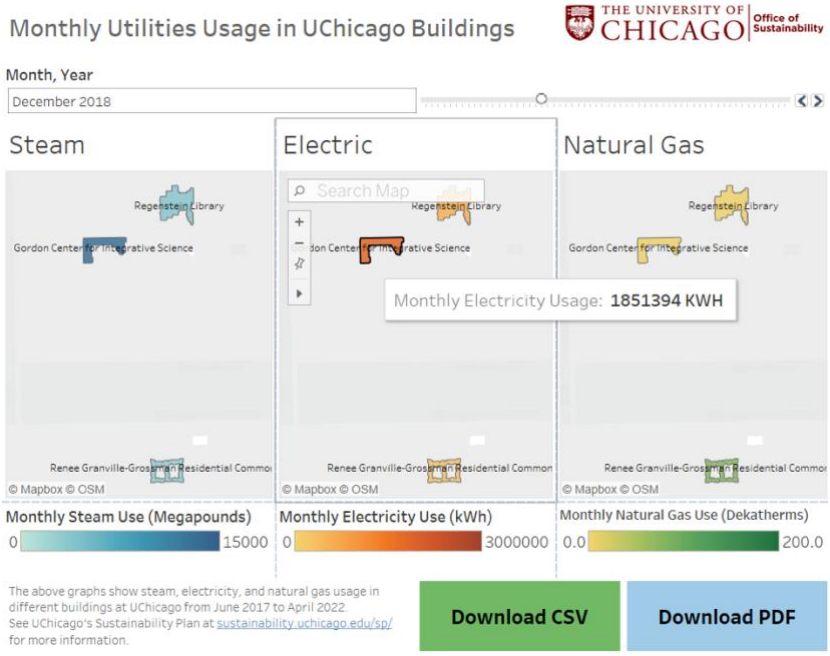


Figure 6.2.3: Tableau map of GHG operational boundary monthly utility usage for steam, electric, and natural gas usage. Only three buildings shown; final map would include all buildings.

Mapping potential

Figure 6.2.3 is a mock-up using a campus building shapefile created by University of Chicago Maps, as well as the building-level data provided by Facilities Services. This map focuses on three buildings as a smaller-scale proof of concept, but it provides a spatial perspective that the Utility Usage dashboard does not currently have.

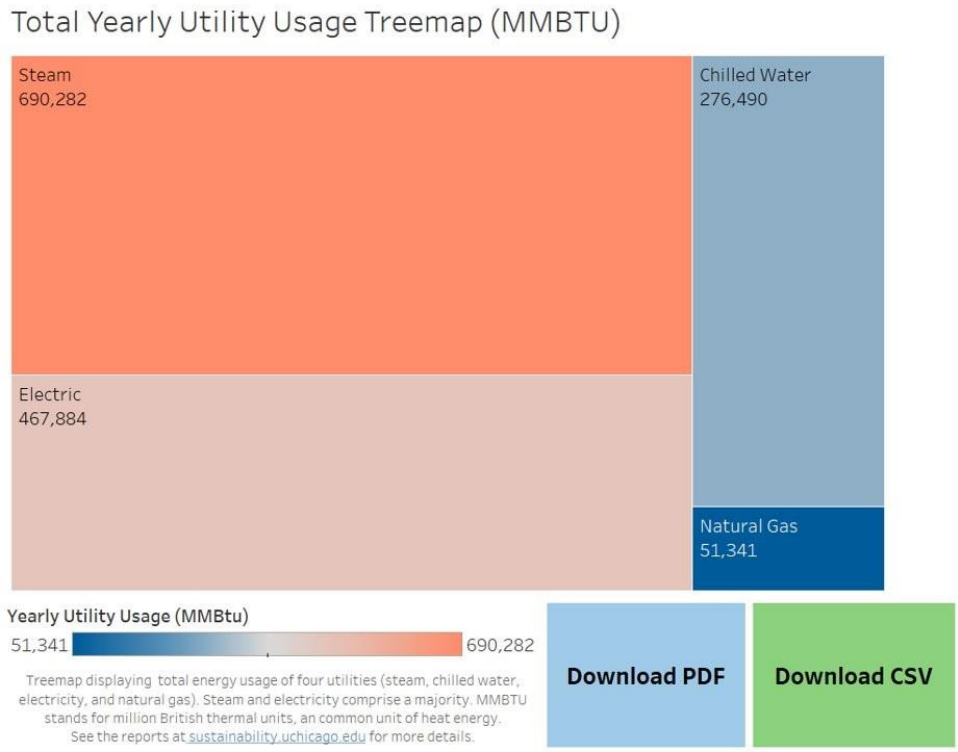


Figure 6.2.4A: Tableau tree map of total yearly utility usage for steam, electric, chilled water, and natural gas.

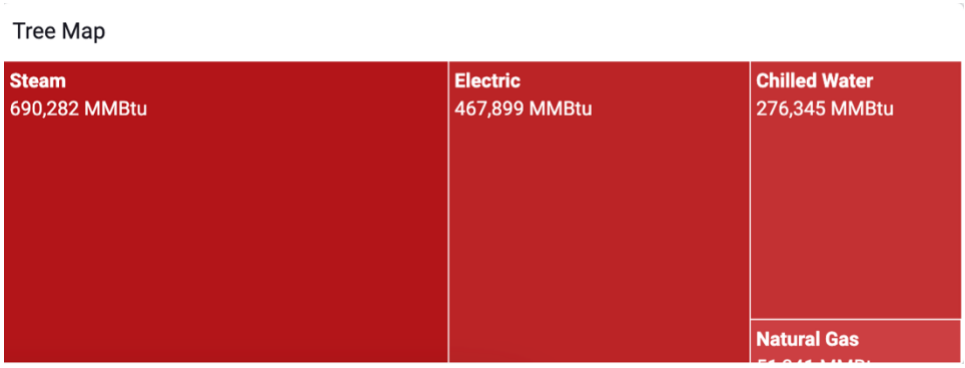


Figure 6.2.4B: Current tree map of total yearly utility usage for steam, electric, chilled water, and natural gas on the Utility Usage dashboards.

Design

Most of the proposed design changes are specific to the University's current data visualization software, and contingent on its abilities, so regarding these design suggestions, there is hope that the suggested software changes will be implemented in the near future. Specifically, for the tree map in Figure 6.2.4A, the color palette has been altered so that it is more accessible for all users.

Organization

The current Utility Usage dashboards are organized by building (laboratories, residence halls, energy projects) but could be organized differently. An alternative format is to divide the utilities by type, and have separate water, energy, and buildings dashboards. The water dashboard would contain data only on water usage, and the energy dashboard would contain data on natural gas, electricity, steam, and chilled water. Finally, the buildings dashboard would contain a shapefile with data on LEED status, utility usage, and waste output.

6.3 Office of Sustainability Website Recommendations

The Office of Sustainability website holds all links to the sustainability dashboards and reporting materials. The most important changes to the website have been determined to be improved navigation and digital accessibility, which have been implemented in the Figma mock-up (view). The improvements outlined in this section are meant to serve as a general guideline to future website improvements and are meant to be viewed alongside the above Figma mock-up.

Click this Figma mock-up (edit) link to edit the mock-up, then click the play button in the upper right-hand corner of the interface to interact with the live mock-up.

Organization and Navigation

The first recommended change to the website is organizational improvement. It is recommended that there be three tabs under the reporting section of the website: Sustainability Goals, Dashboards, and Inventory Reporting. This would improve the flow of the website and make navigation more intuitive. It also allows for future resources to be added under logical labels. Links and resources should be separated by category and placed in a central location. The Sustainability Goals tab should contain sustainability goals and GHG reduction plan links, the Dashboards tab should contain links to all dashboards, and the Inventory Reporting tab should contain links to all inventory and utilities reports.

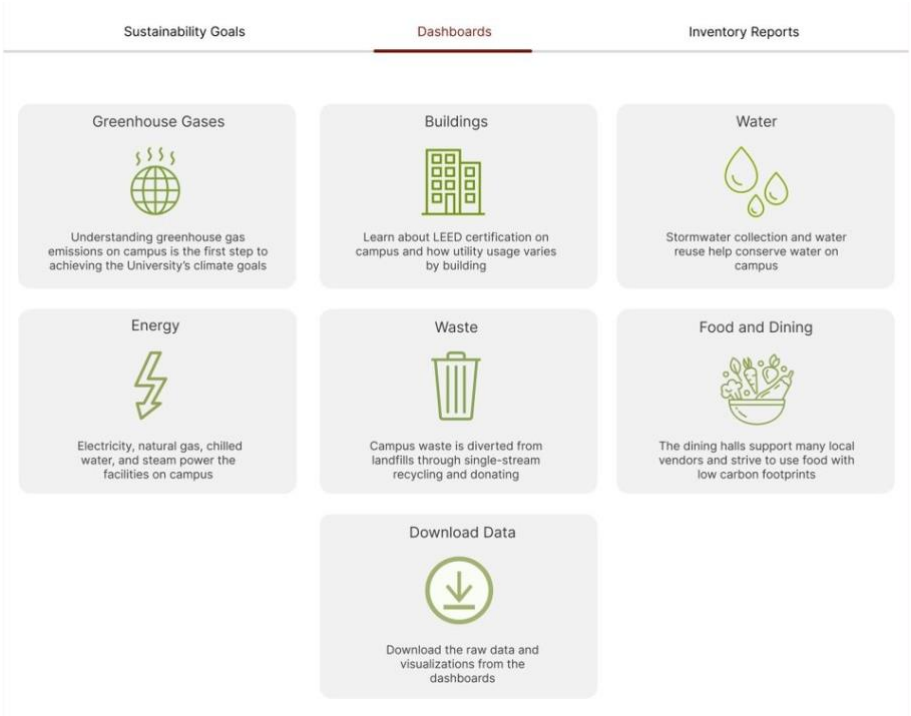


Figure 6.3.1: All dashboards are centrally located under the Dashboards tab. The greenhouse gas emissions, utilities (water, energy) all exist currently, but the buildings, waste, food and dining, and data download tabs do not exist yet.

Webpage Content

To accommodate website users who are unfamiliar with the sustainability data, the website should include summary statistics that provide a brief introduction to the data. In the mock-up, they are on the first tab of the Reporting page. When included on the live webpage, the summary statistics can be updated more regularly. Currently, they exist in the 2019 Sustainability Goals report PDF and are updated every 3 years. Another helpful feature is a summary of reporting content next to relevant links. This introduces readers to the reporting materials, and it is particularly helpful to readers unfamiliar with the website. This is modeled on the Sustainability Goals tab in the mock-up.

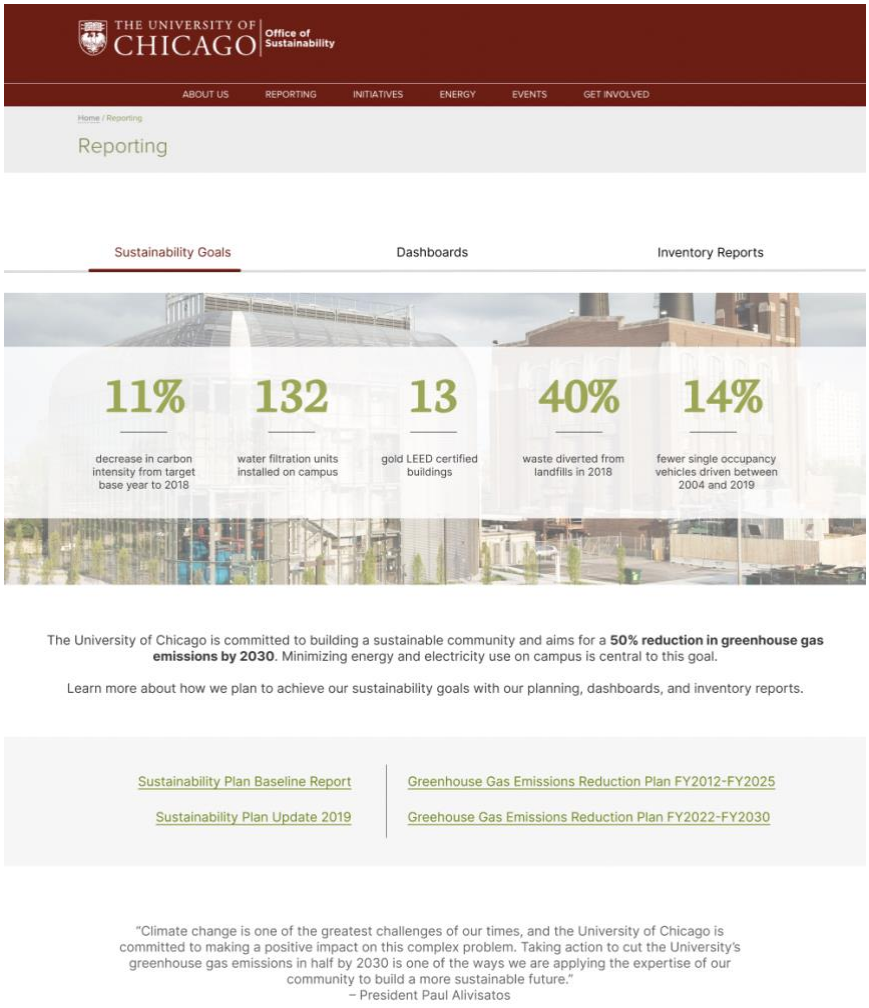


Figure 6.3.2: The first tab under the Reporting page contains all sustainability goals, greenhouse gas emissions reduction plans, and a set of summary statistics.

Digital Accessibility

Finally, there should be changes to the website to improve digital accessibility. This includes embedding alt-text in the HTML behind all images, which allows for people using screen readers to understand image content. There should also be hierarchical labeling (H1, H2, H3 headings) within the website's HTML so that people using their keyboards for website navigation would be able to select website components in order of importance. Lastly, the color palette should be accessible for colorblind users and there should be color contrast between website features.

6.4 Guidelines for Future Dashboards

Beyond improving the University of Chicago's existing dashboards, this project should continue by creating new dashboards for areas such as food waste and dining, waste diversion,

and transportation data. When building new dashboards, it is important to keep digital accessibility, usability and interactivity, and overall design in mind. The following section is a compiled list of guidelines for producing additional dashboards.

Through experimentation with the University's current software and research on other visualization software, such as Our World in Data and Datawrapper, the current software has been determined to be the most versatile. The current software used for the GHG Emissions dashboard does not require the creator of the visualization to have coding experience, and so it is easy to learn how to use. This software has a map feature that can be utilized for individual building data. This allows the dashboard creator to present the data effectively. Because of its versatility, it is recommended that future dashboards are built using the same software used for the GHG Emissions dashboard.

It is also crucial that new dashboards are "born accessible". This means that while the dashboard is being built, digital accessibility infrastructure is incorporated into the dashboard to ensure that all users, regardless of physical or cognitive disability, are able to access the same information. This infrastructure includes considerations for users who are colorblind, are only able to use their keyboard for navigation, or require a screen reader.

When thinking about color palettes and designs for dashboards, it is important to think about how to make the dashboard accessible for users who have difficulty distinguishing between colors. This includes making sure that the level of color contrast meets Web Content Accessibility Guidelines (WCAG). According to WCAG, large-scale text should have a color contrast ratio of at least 3:1 [14]. In order to check whether the color contrast of visualizations and text meets or exceeds this ratio, use the WCAG Color Contrast Checker [18]. Although improving color contrast is a large part of digital accessibility for colorblind users, secondary indicators and direct labeling also play a role. Secondary indicators, such as texture on bar graphs and differing shapes for points on a line graph, add an extra method of distinction for users who have difficulty distinguishing between colors.

When considering keyboard-only users, it is essential to ensure that each section of the dashboard is navigable using only keyboard keys. Moreover, the hierarchy that determines how the screen reader moves from one section to the next should be intuitive. It is also important to incorporate visible focus indicators to help keyboard users understand what section is selected on a page, since the mouse icon is not shown. Visible focus indicators can be in the form of a box around the selected section or highlighting it. This will allow keyboard users to see which section of the dashboard they are on so that they can toggle filters and see specific data.

For those using a screen reader, it is important to make headings more descriptive and include alternative text for each graphic. It is important to include descriptive headings, titles, and alternative text for the same reason. If a user cannot see the data visualization, screen reader-compatible titles and alternative text would give them a more comprehensive understanding of the data presented [15].

Furthermore, to improve user experience, incorporating clear explanations into data visualizations provides context to enhance user understanding. For each graphic, there should be a brief explanation of the data and links to other resources for more details. Examples of

what could be included in each explanation include overall trends of data, data collection methods, or the origin of outliers/inflection points. Examples of additional resources are the University's Sustainability Plan or the GHG emissions Inventory Report [16][30].

Another aspect of improving user experience is providing a user-friendly dashboard design. Centralizing the current dashboards on a single webpage is one way to do this. Within this webpage, each dashboard could have an image card, a brief overview of the data on the dashboard, and an image of a dashboard graph. This centralized design will make it easier to incorporate new dashboards more easily.

Lastly, it is important to ensure that the data and visualizations presented are downloadable. Having data downloadability allows users to develop their own improvements for visualizations and incorporate the accessible data into their own projects more easily. It also improves the transparency of the reporting process, holding University sources accountable for providing accurate, high-quality data. Data transparency allows for more collaboration between interested data users in a way that promotes consistent growth in data collection, visualization, and analysis. More information on data transparency can be found in Appendix B: Data Downloadability.

6.5 Future Dashboard Content Ideas

In addition to the Greenhouse Gas Emissions and Utility Usage dashboards, the University of Chicago aims to create additional sustainability dashboards. Apart from the University's existing dashboards, the most common sustainability dashboard topics among other universities are dining, waste, and transportation. Some other potential topics include sustainable purchases, stormwater, and renewable energy. A dining dashboard is currently in a preliminary exploration phase, with data being requested from relevant parties. This future dining, waste, and transportation dashboards description document outlines possible dining, waste, and transportation dashboards, both in content and structure.

7. Conclusion

7.1 Research Conclusions

The primary goal of this project was to address the question: "how can the University of Chicago's sustainability dashboards be improved to make them more digitally accessible and user-friendly?" Through ten weeks of researching digital accessibility, usability, and design best practices, the University of Chicago's sustainability dashboards and reporting were viewed through a critical lens. This highlighted these areas for improvement, guided the creation of this list of concrete recommendations, and from these recommendations, led to a collection of mock-ups to display the potential of what can be done moving forward.

From the work that has been done to produce these recommendations and mock-ups, the University, specifically the Office of Sustainability and Facilities Services, will be able to improve the sustainability dashboards, website, and reporting. Although some of the recommendations listed in this report will likely not be possible in the near future, there is hope that changes will be implemented in the mid to long-term to allow the University to present sustainability data in a way that is more user-friendly and allows for complete data transparency.

This will ultimately contribute to ensuring that all users of the University's website and dashboards have equal access to information and public-facing data.

7.2 Next Steps

The next steps outlined below serve as a starting point for the continuation of this project. This includes beginning to build out a Voices website mock-up to present to the Office of Sustainability, building out dining and food waste dashboards in partnership with the University of Chicago Dining and Chartwells, and working on getting access to more campus data to build new dashboards.

There is currently a website being built for the updated Office of Sustainability website using the Voices platform. To begin building out this website, the mock-up created this summer using Figma can be referenced in Section 6.3. This mock-up only serves as a general outline.

This project is also in the process of collaborating with the University of Chicago Dining and Chartwells to create a dining and food waste dashboard. Data from these offices will hopefully be received in the autumn quarter for future research assistants to clean and implement into new dashboards. Ideally, dashboards should be created for the University's food purchases, food emissions, and food waste/recycling.

Lastly, this project should focus on gaining access to data to build out new dashboards such as transportation data, general (non-food related) waste data, energy use and conservation data, and data about on and off-campus data centers. Transportation includes the University's shuttles, air travel, cars, buses, trains, bikes, walking, and the University owned fleet of vehicles. General waste includes waste from educational, administrative, and residential buildings. Data centers generally have very high energy usage, so gathering data on these centers to better understand how they contribute to energy usage and campus emissions would be useful in building out a new dashboard as well. Expanding the scope and breadth of data presented on the dashboards will help viewers gain a more complete understanding of the state of University sustainability.

Overall, the continuation of this project should involve progressive improvement and expansion of documents that display suggestions for the University's sustainability dashboards and website. Eventually, these suggested paths forward, along with changes to the software being used, should result in changes to the public-facing dashboards and website.

8. Appendices

8a. Condensed List of Recommendations

General Suggestions for both dashboards

1. Digital Accessibility
    a. Alternative text
    b. Digitally accessible color palettes
    c. Add raw data downloadability
    d. Make dashboard titles more descriptive
    e. Include lang attributes for each dashboard page
2. Usability

    a. Include centralized image cards for each dashboard on the sustainability website
    b. Include UChicago's sustainability goals of graphics
    c. Label graphs with units, concepts, and a link to the report
    d. Add a baseline/estimate goal line for chilled water, electricity, and steam usage
    e. Make data downloadable
3. Miscellaneous
    a. Improve title clarity
    b. Color axes to align with the graph that the axes represent
    c. Add a drop-down menu to navigate between different pages
    d. Add supplemental text/interpretive text to explain trends, outliers, etc.
    e. Compare our energy usage/emissions to other universities
    f. Compare degree days to GHG emission/ utility usage data
    g. Acknowledge shortcomings of methods for collecting data and ways to improve
    h. Centralize dashboards and include summary statistics on the home page

Suggestions for GHG Emissions dashboard

1. Separation of emissions graphs based on scope
2. Breakdown of specific contributions to emissions for each scope
3. Graphs can be filtered by scope and reporting period
4. Rename tabs to differentiate between them (or put all graphs into one dashboard)
5. Make font size consistent
6. Remove redundant graphs
7. Color-based conditional formatting and separation of data by scope on data tables
8. A drop-down menu for RP selection
9. Improve data: ink ratio
10. Embed alt-text within all graphs
11. Relabel graphs to make them easier to comprehend
12. Separate emissions sub-categories by color to eliminate need for hover-over

Suggestions for Utility Usage dashboard

1. Add a drop-down menu to filter by utility type
2. Add a map that shows energy usage by building
3. Redesign the tree map
4. Eliminate hyperlinks for buildings
5. Alter the color scheme for improved color contrast
6. Inflection point and their respective reasons labeled
7. Make it possible to access all graphs and meanings of values using the keyboard
8. Make visual focus indicators more obvious
9. Change all graph titles to descriptive H2 headings
10. Include alt text with graph trends for each graph
11. Use secondary indicators on all graphs to supplement color differences

8b. Data Downloadability

First, and most basically, the images of the graphs on the dashboards should be downloadable as PDFs or JPGs. Importantly, these images must convey vital information even without the context or interactivity provided by the website. For example, the axis labels and chart titles should be visible in the images, and there shouldn't be any absolutely essential information that is only visible when hovering over or selecting, a part of the graph. Being able to download these images makes the visualizations more easily shareable, and allows the information to reach a larger audience.

Second, and most importantly, the data behind the visualizations should be easily accessible. This data should include all information not specifically ruled as confidential to the University. This includes utility usage, greenhouse gas emissions, food and food waste, and transportation data. All such data—not just the data used to create the visualizations, but also the data that is collected and not visualized—should be downloadable. This maximizes the potential for new types of visualizations and innovative conclusions from the data. In general, this data seems to be best represented in spreadsheets (.csv files). The user should be able to upload these spreadsheets into visualization programs such as current University software or any additional programs, data processing tools like SQL, or coding interfaces like R and Python. This would mean well-titled (for the file name), well-organized, editable raw numbers. If anyone can access the data, then there will be more opportunities for collaboration between parties with different perspectives, for the discovery of new patterns, and for contributions to a sustainable future.

Third, beyond publishing the data on the Office of Sustainability and Facilities Services websites, it would be helpful to publish the data on hubs like the Office of Institutional Analysis site (data.uchicago.edu) and the University of Chicago Maps' ArcGIS site (uchicago.maps.arcgis.com/home), and the City of Chicago Open Data Portal (data.cityofchicago.org). Data on campus greenhouse gas emissions and utility usage is useful information, both for members of the University community and for people outside of it, especially given the urgency of the climate crisis. If the University of Chicago's sustainability data is more widely available to the public on a range of platforms, then its reach is broadened even further.

8c. Interactive Reporting Guidelines

In addition to improving user experience with the GHG and Utility Usage dashboards and the University's sustainability website, the structure of the sustainability reporting should also be improved to make it more interactive. According to FineReport, an interactive report allows users to "perform various types of data discovery and analysis (such as drilling down filtering, or sorting) with ease" [17]. Interactive reports are important because of their enhanced ability to engage users and increase the amount of information retained from the report. In creating an interactive report, suggestions are organized into four categories: platform, hyperlinks, visualizations, and clear sectioning.

The most recent report on the Office of Sustainability's website is a PDF. With PDFs, the structure is more rigid and does not allow for higher levels of interactivity. To improve the flexibility and interactivity of the reporting, the report should be changed from a PDF document to a more interactive webpage on the sustainability website. Changing the platform will allow for

more customization of the interactive aspects of the reporting. The PDF format is not as digitally accessible as an integrated webpage; users cannot select specific page elements, preventing those using screen readers and keyboards from interacting fully with the page.

The first interactive reporting recommendation is the ability to add hyperlinks. These would link from the table of contents to different parts of the report, as well as to additional resources to provide more context. Currently, the most recent report includes hyperlinks, so it would be helpful to model this level of interactivity on the new webpage. Altering the internal hyperlinks from the table of contents would add onto the current level of interactivity, so that when the links are copied and pasted, they go to the specific section of the report instead of downloading the entire PDF or webpage. It would also be helpful to add hyperlinks that connect the reporting to the dashboards and other parts of the reporting. Similarly, adding tooltips in the report would provide the user with specific context for key terms and concepts. Currently, the glossary of terms is at the end of the report, so having the definitions displayed in the tooltip would be helpful to the user. This would allow the user to see both the definition of the term and how it is used at the same time, eliminating the need for scrolling back and forth between sections.

The next recommendation is the ability to embed visualizations in the report. Visualizations from the dashboards can often be helpful in breaking up the text in the reporting. Currently, the reporting includes visualizations in the form of images of the graphs on the dashboard. Although this achieves the initial goal of readability, users are not able to interact with the data and access the tooltips that would be available on the dashboard. If the visualizations were embedded into the report, users would have the opportunity to view both visualizations from the dashboards and the reporting simultaneously to better understand the full picture from the information presented.

The last recommendation is clear sectioning and labeling in the report. Peer institution's sustainability reporting, such as Harvard and Stanford, influenced the addition of distinct sections in the report to improve navigability and information retention. Similar to adding the table of contents with hyperlinks to the different sections, adding distinct colors and bold headings for each section is helpful for the users to categorize the information. This allows for a clearer distinction between the information in each section, and reduces the risk of the user being overloaded by the information in the report. Ultimately, this would allow the user to retain and organize the information more easily.

8d. Digital Accessibility

Digital accessibility has been a primary consideration when making suggestions for updating existing dashboards and building out new dashboards. The University of Chicago's Center for Digital Accessibility defines digital accessibility as "the ability of a website, mobile application, electronic document or other digital content to be easily navigated and understood by a wide range of users, including users with disabilities" [5]. This means that any user, regardless of physical or cognitive disability should be able to access the same information as a person who does not have that disability. These disabilities include temporary, permanent, and situational disabilities for users.

The University currently follows the Web Content Accessibility Guidelines (WCAG) using level AA. Generally, WCAG focuses on making sure information is perceivable, operable, understandable, and robust. For information to be perceivable, the webpage must be designed so that users have access to captions and that they can see or hear all content. For information to be operable, the website must be navigable by keyboard only, give users enough time to digest the content, and not cause any seizures or physical reactions for the user. For information to be understandable and robust, it must be readable and predictable, and maximize the tools available to the user. Having predictable content means that the content only changes when prompted by the user, and navigation is consistent [14].

The dashboard suggestions primarily focus on digital accessibility for those with visual disabilities and fine-motor physical disabilities. This includes people with visual impairments or colorblindness who may have to use a screen reader, a tool that reads aloud web elements for those who cannot view their screens fully. Ensuring that online resources are accessible for users with visual impairments includes adding secondary indicators in addition to using the Coloring for Colorblindness tool and WCAG color contrast checker to make sure that the color contrast is high enough and that the color palettes used are accessible [18] [19].

Figure 8c.1: A chart from California State University, Northridge explaining good and bad color contrast in alignment with digital accessibility standards.

People with fine-motor disabilities may not be able to use their mouse or trackpad very well, so they may use alternative means of online navigation, such as a computer keyboard. To ensure that web content is keyboard-accessible, distinct page elements and visible focus indicators should be added for users who are using their keyboard to navigate the dashboards and website. A visible focus indicator is a highlight box that marks where a user has selected on the page, either with their trackpad or keyboard.

Alternative text (alt-text) should be embedded in any online image, serving as an indication for screen-readers to read aloud a visual description for those with visual impairments. A user guide to alternative text—what it is, and how to implement it in web content

with HTML—can be found on Penn State University's digital accessibility site as well as the University's Center for Digital Accessibility's presentation and Medium's article [5][15][20]. Alt-text can also be embedded in PDF documents, since Word and similar platforms have the ability to embed it in content. To create the clearest content structure for screen readers to interact with, it is suggested that webpages contain hierarchical labeling and clear headings. Within HTML code, Word documents, and most common formats, hierarchical labeling appears as "H1, H2, H3." These indicate screen readers to read the primary heading first (H1), then the secondary heading (H2), and any subtitles and body text (H3+) last.

To summarize, it is suggested that each University of Chicago online resource (website pages/materials and dashboards) is tested for screen-reader, keyboard navigation, and colorblindness compatibility. The University's Center for Digital Accessibility provides a variety of tools that can be used to check an entire webpage for digital accessibility. These tools included the chrome extensions Axe, Siteimprove Accessibility Checker, and WAVE [21][22][23].

The focus on incorporating digital accessibility ensures that the current and future dashboards contribute to a diverse and inclusive environment for all members of the University community. According to the University's Center for Digital Accessibility, 20% of people in the U.S. have a disability [5]. Currently, people heavily rely on web content to carry out every day activities. If websites did not incorporate digital accessibility when they were built, a large percentage of the U.S. population would be excluded from receiving or interacting with that content. This is why it is crucial that all digital content is "born accessible", built in a way that centers digital accessibility from the beginning, or updated to meet the most recent WCAG standards. Centering digital accessibility will not only improve the environment for the University's community, but it will also overall improve user experience overall.

8e. Dashboard References

In making the above Greenhouse Gas Emissions and Utility Usage dashboard recommendations, the sustainability dashboards of several other universities were referenced. Some of these dashboards—the ones best demonstrating descriptive captions that work well with the graphs—are included below for further reference.

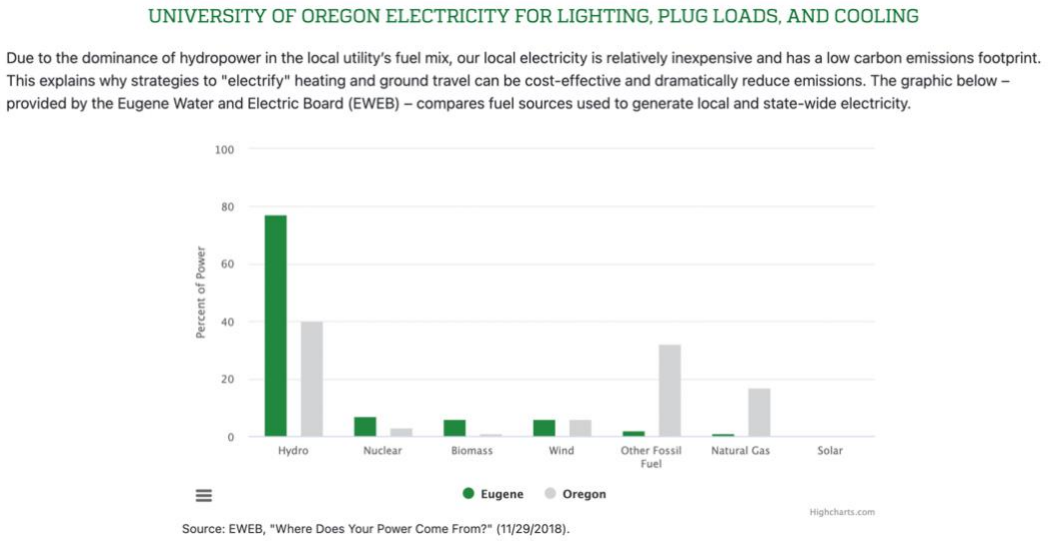


Figure 8d.1: The University of Oregon Air and Climate dashboard contains descriptions to supplement its electricity graph. It describes the influence of hydropower on its campus and the surrounding area [7].

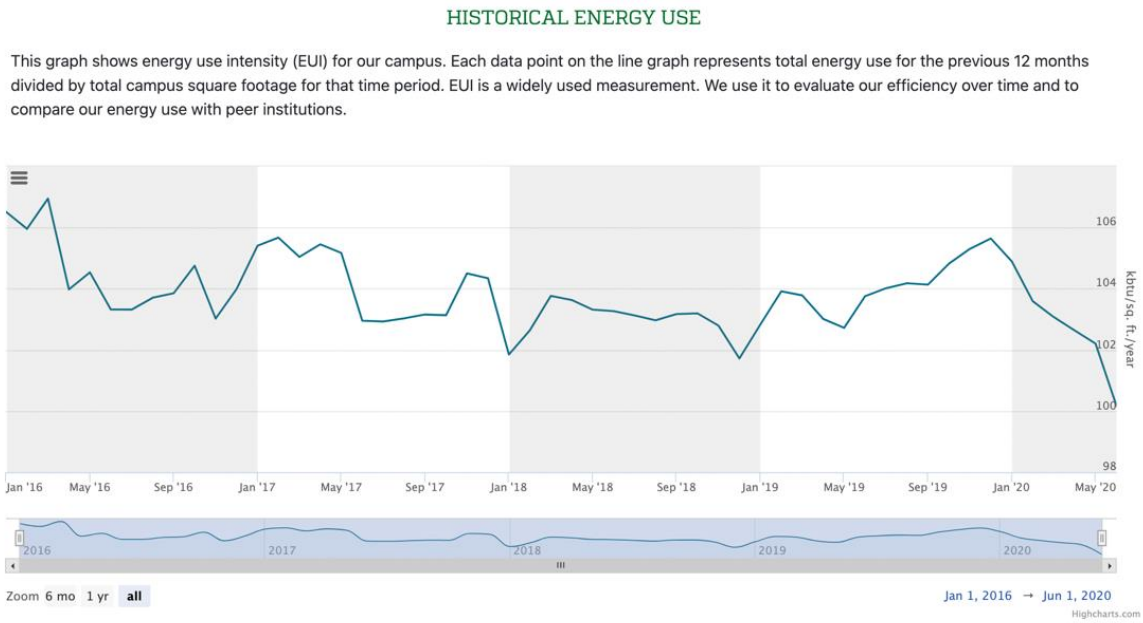


Figure 8d.2: The University of Oregon Energy dashboard contains information on the data collection and calculation methods used in the graph, which aids in its interpretation [7].

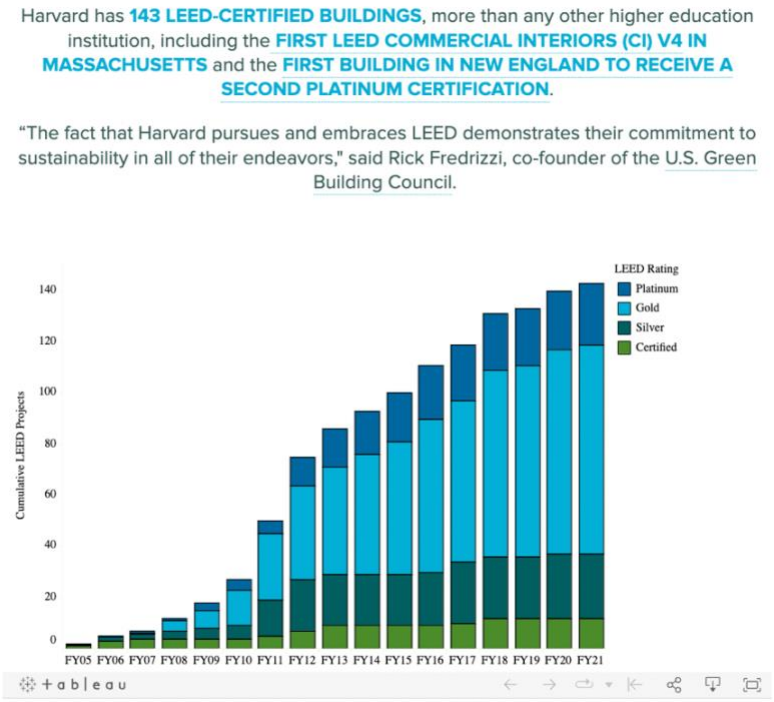


Figure 8d.3: The Harvard LEED graph is supplemented by a short description containing links to relevant articles and reporting materials. [24]

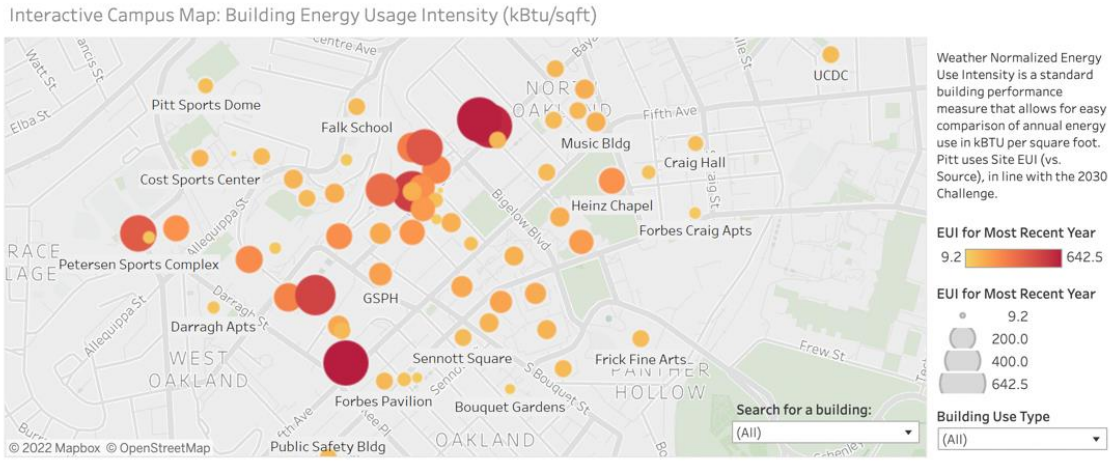


Figure 8d.4: The University of Pittsburgh Energy Use Intensity (EUI) dashboard contains a short description of what EUI represents [25].

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