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Energy Dashboards Final Report

ENV 481

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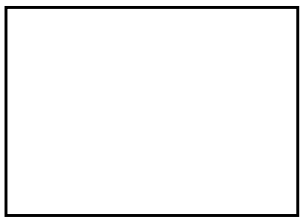


Introduction

An energy dashboard is a web-based tool that displays building energy performance in real-time. People are typically unaware of how much electricity they use, which can "impede efforts to reduce electricity consumption in the home" (Suppers & Apperley, 2014). Thus, energy dashboards are meant to raise awareness by providing individuals with energy consumption information, and in the end lead to behavioural change. The majority of our research findings however have demonstrated that although dashboards were successful in influencing building management practices, however unsuccessful in influencing building occupants' behaviours as demonstrated by a study done across Illinois college campuses by Timm and Deal (2016). The study found that since the implementation of dashboards significant energy savings had been noted (7–10% in electricity and 50% decrease in natural gas), differences in student and faculty/ staff behaviours proved insignificant (Timm and Deal, 2016). What this suggests is that the value of the dashboards are their ability to connect to external systems and initiatives (such as building management and campus sustainability groups) and generate awareness and interest for them. In order for dashboards to be most effective, they should serve as an enabler or supporter of action already happening and by creating interfaces which are useful and easy to use, there is a greater chance of increasing interest amongst students and faculty.

The focus of this study is to identify the best practices in order to increase student and faculty interaction with the energy dashboards installed, and projected to be installed, throughout the University of Toronto (U of T) St. George Campus. However, if the dashboards present information and services that are relevant to the goals and lifestyles of campus users (Hyman, 2015), it could provide beneficial behavioural changes that will hopefully increase sustainable practices throughout campus. The central research question asks how to employ dashboards in a way that is useful and usable for campus

users, and how to increase overall usage? Along with the physical dashboard, we seek to suggest methods to increase user interactions on the energy dashboard website. For both the physical and website templates, we aim to suggest a user-friendly and informative design to display building energy usage.

Methodology and Coding

Three methods were involved in the research portion of the project. As the information provided by the energy dashboards should be relevant to campus users' lifestyles and objectives (Hyman, 2015), we chose to conduct survey research to find out what the relevant information about building energy usage is most important to the dashboards' users. The survey asked participants to rate the information provided on building usage provided by the dashboards (ie, water use and greenhouse gas emissions), how they prefer to see information presented, what they found would make the dashboards appealing to use, whether or not they were interested in sustainability initiatives on campus, and if they are aware of what an energy dashboard is. Lastly, there was a section in the survey that was open for the participant's recommendations as to how to improve the awareness and usability of the dashboards.

Our survey sample was seventy-five members on campus. Though most of the participants surveyed were students, a very small portion was also comprised of faculty and staff on campus so that the sample is more representative of the whole campus. Each member of our group individually surveyed twenty people in different locations across campus in order to obtain results from students involved in different faculties, therefore making the survey random and as unbiased to scholarly background as possible.

At the beginning of the survey, we asked respondents to answer 1. If they knew what an energy dashboard is, 2. If they were aware of the energy dashboards located on campus, and 3. Whether or not they were interested in sustainability initiatives and opportunities on campus. For each section, survey respondents could answer Yes or No, and each time a respondent answered Yes, a point would be counted.

For the section regarding the energy use of buildings, we asked for respondents to rank the information (electricity use, greenhouse gas emissions, etc.,) they find most important as a 6, to the least important with a score of 1. In order to find out which categories were most favoured by survey respondents, we found the sum of the scores for each category and ranked them according to which category had the highest score.

We asked respondents to choose one of three options provided for each of the final two sections regarding how they prefer to view information, and what makes a dashboard appealing. Whichever choice the respondent found most important, they would indicate it with an **X** or a ✔, and each **X** or ✔ was coded to equal one point. From there, we added the sum of each category and ranked them according to the highest score to the lowest score to find out the preferences of campus users.

31 of 75 respondents gave suggestions in the optional open-ended section of the survey. The responses were then divided up into six categories that corresponded most with people's responses. The categories included raising awareness for the dashboards, using the dashboards for multiple purposes, making the dashboards visibly engaging, showing comparisons of metrics, and getting rid of the dashboard in favour of a website or app.

Results

Advertising the Dashboard

Once a proper website is constructed, there must be action taken in order to direct campus users towards the website and the physical dashboards. In a recent study, it was found that 91% of companies used social media as a marketing tool (Stelzner, 2009), which is why it is essential for the energy dashboard website and kiosks to be shared on social media. Mankoff et al. (2007)'s study researched into taking advantage social media, for example creating a facebook page that provide information on energy consumption, energy efficiency and energy impact on the environment which is easily seen and shared. The information is provided to motivate users to change their energy

consumption behaviour. Social media also provide a platform to compare, compete between buildings, create goals, and sharing tips and suggestions. Advertising about the dashboards through U of T social media accounts like the Environmental Student's Union (ENSU) Instagram account (@ENSU.UofT) should increase awareness and usage.

Social media pages on campus that are related to environmental practices are suggested as they are most likely attracting students more likely to make behavioural changes, as suggested by Hyman (2015). However, if the sustainability office is primarily focusing on raising the awareness of the dashboards, they can advertise on other social media accounts related to the University of Toronto. For example, the dashboard can be promoted on the OISE Instagram page (@oiseuoft) since a physical dashboard is installed in the OISE building.

It can take up to seven points of contact before a consumer buys a product, which is why email lists are also essential as a direct channel to contact consumers (Gehl, 2015). Relating this to the dashboards, there should be multiple points of contact through social media and email lists on campus in order to attract and bring users back to the dashboards. Lastly, an effective way to draw in users is by giving them an opportunity to make a change to the institution or company (Jaffrey, 2011), or in this case, affect the energy usage on campus. Once people know that their ideas can effect change, they are more motivated to participate (Jaffrey, 2011), which is why we suggest the dashboards be a platform to collect information from users as well.

Survey Results for Dashboard Content

Our survey was answered by 75 individuals on campus, 88% of which are students. Of these 75 individuals, only 25% knew what an energy dashboard is. Yet 66% of individuals are interested in sustainability initiatives and opportunities on campus, suggesting that energy dashboards could be implemented and used as a tool to spread awareness on these initiatives and opportunities.

Respondents were asked to rank which information they consider to be most important for the dashboard to display. 6 being most important and 1 being least, they were asked to rank the following:

- Greenhouse Gas Emissions (tied with Water Use)
- Water Use (tied with Greenhouse Gas Emissions)
- Electricity Use
- Improvements/Decreases in Building Efficiency
- Cost of Operating
- Heating and Cooling

After 75 surveys were completed, a points system was used to score the data to determine the average overall ranking of importance. A total of 874 points were counted, and a percentage was calculated based on the number of points each of the above received.

We found that both water use and greenhouse gas emissions scored equal ranking as most important with 167/874 points, or 19%. Electricity use followed with 16%, then improvements/decreases in building efficiency (15%), cost of operating (14%), and finally heating and cooling of buildings (12%). Based on these numbers, it can be assumed that campus users are most interested in greenhouse gas emissions and the water usage of campus buildings. If the sustainability office wanted to focus on advertising a certain statistic of energy use, it can be suggested that greenhouse gas emissions and water use rates will be of most interest to campus users. This focus on greenhouse gas emissions and water use can be on the dashboard itself, or a statistic can be used in an advertising post on social media in order to capture the interest of campus users.

Respondents were also asked how they prefer information be presented to them. 46% responded they prefer information to be presented in pictures. 39% prefer information presented in graphs, and 15% responded they prefer information to be presented in words. From this, the developers of the energy dashboard website can display data in the ways that users will find most appealing. From our findings, both pictures and graphs are the most popular ways to display information.

To conclude our survey, we asked individuals to comment on how they think dashboard usability could be improved through an optional open-ended survey. The results were then coded into six categories. The most popular category, with a 35% response rate, indicates to raise the awareness of the dashboards, as well as to educate users of their purpose. As noted earlier in the quantitative section, there is an awareness issue, as 75% of respondents did not know what an energy dashboard is. Therefore, it is essential to educate campus users on the purpose of an energy dashboard, as well as how and where to access it.

The second most important suggestion with 22% of respondent interest is to give the dashboard a multi-purpose platform. Some of the suggested technological applications include implementing games, surveys, campus news and events, maps indicating coffee shops, maps for water refill stations, and links to access the Acorn and Portal websites. Additionally, 3% of respondents suggested displaying sustainability initiatives that are available on campus. Physical suggestions included building them into or next to phone charging stations, next to water bottle refill stations, and next to hand sanitizer machines.

In order to further increase the usability of the dashboard, 22% of respondents suggested to make the dashboards more visibly engaging. Respondents suggested implementing faster loading screens, updated graphics, and less words.

The last three categories each had 3% response rates, which only accounts for one respondent. The first category was to show comparisons as to how much it would cost to power the building's electricity needs with renewable sources such as solar power, rather than the current source of electricity. Further, it was mentioned that this comparison would put the metrics into context and it would bring incentive to switch towards renewable energy sources. The second suggestion was to get rid of the physical dashboards to save energy and resources. Though it was only one person that suggested this, it should be looked into further to see whether or not campus users will use the physical dashboards. Lastly, one respondent mentioned to implement interactive puppies.

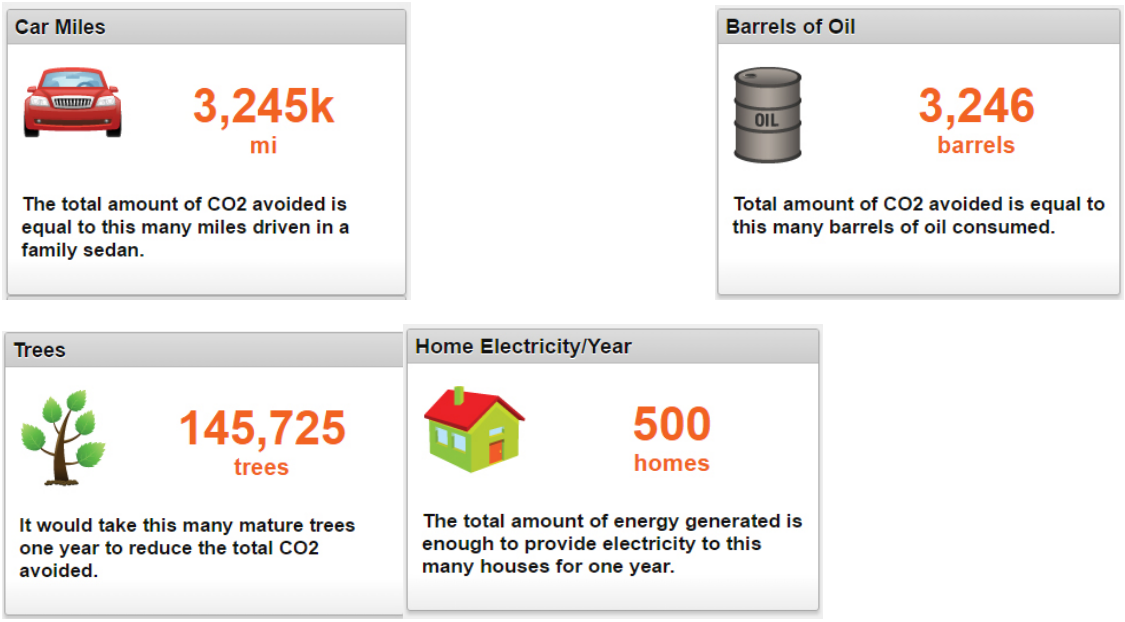
This is open to interpretation, and will likely result in no change for the dashboard; however, it was a part of the data sample and therefore should be mentioned.

Dashboard Layout

One key approach to the study of the energy dashboards concerned their physical layout, and our proposal addresses issues of metrics and graphics. We analyzed the layout of the current energy dashboard in OISE, then used energy dashboard precedents in order to inform suggestions for specific changes. We then created basic images in order to demonstrate these suggestions.

Dashboard metrics:

The energy dashboards are intended to provide information about the building's energy usage to the students and faculty using the buildings. By identifying this type of casual recipient of information, the importance of understandable metrics becomes clear. To this end we studied some best use practices put forth by the Northwest Energy Efficiency Council concerning the application of numbers in energy dashboards, which suggested limiting data points to four important digits so as to maintain simplicity, and to provide information in equivalent values (NEEC, 2016). To illustrate this point we looked at the energy dashboard put forth by Community Energy Solar, a living laboratory put together by Clarkson University in New York State, and the way in which they calculate the energy used by showing how many homes it could power in a year, and the carbon offset in barrels of oil, miles driven in a car, and trees that would have to be planted to reduce the same amount of CO2 (Community Energy Solar, 2016).



(Community Energy Solar, 2016)

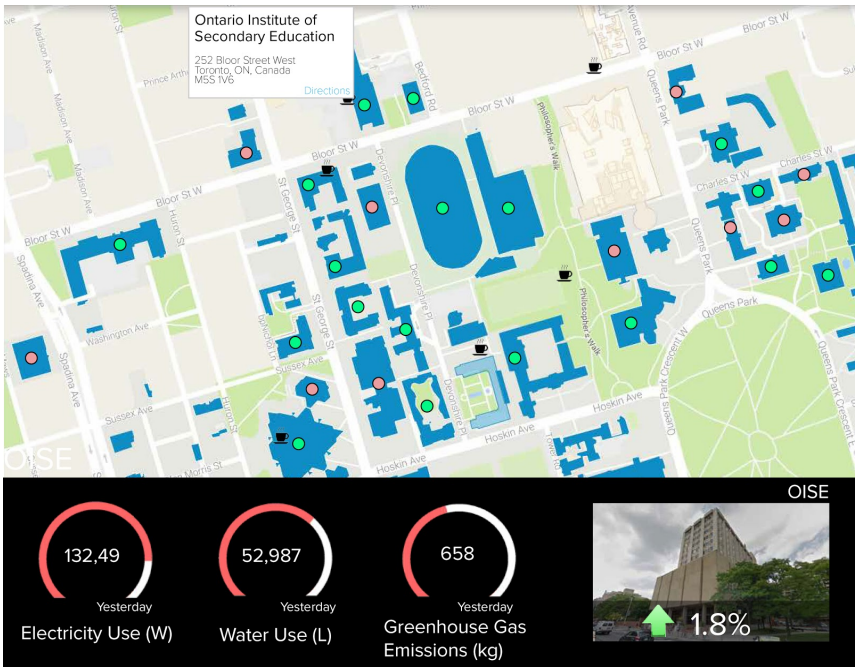
These types of metrics are easy to understand at a glance, require no deciphering of complicated numbers and units, and has the potential to be interesting to users of various backgrounds.

Dashboard Layout:

Our primary focus for the energy dashboard layout was the main display page and the page displaying the map of energy usage. Secondary pages were not addressed, and should serve as a focus of future study. According to the Northwest Energy Efficiency Council:

> "The main display should capture the attention of a person walking by and provide relevant information in an efficient manner. The main display is the most important "real estate" in the kiosk form of dashboards; as such, the graphics should be clear and concise, and highlight the most important parameters to provide a starting point for raising awareness." (Northwest Energy Efficiency Council, 2016)."

We therefore created the following images in order to create something that is eye-catching, uses minimal writing, employs simple and understandable data, and calls the user to interact with it.



The map page was created with the goal of creating an interactive interface which buildings could use to find relevant information about the building and area (such as the location of coffee shops, subway entrances, etc.) in order to create a resource that is valuable to users for alternative information, and increase dashboard general usage. What we suggest for this is to perhaps enable the existing University Campus map available at map.utoronto.ca to the energy dashboards, which has already mapped out a variety of useful information about campus. Within this image we sought to use deliberate colour schemes as opposed to the current dashboard map, limiting colours to red and green to denote either positive or negative energy savings, and incorporated an image of the building which allows for greater identification of the building. The energy data that should be included on these buildings should be prioritized according to our survey findings, which suggest that students are most interested in electricity use, water use, and greenhouse gas emissions. The metrics should be kept simple and concise, and perhaps placed into equivalent values, such as the ones employed by Clarkson University.

Because of our focus on the pages that would have the most interaction with users, we did not really analyze the organization of the dashboard, including secondary pages, which could include sustainable building design features, tips to reduce energy consumption, and a LEED education page (Northwest Energy Efficiency Council, 2016).

Physical Dashboard Location and Utility

Regarding the utility of the dashboard website, aside from providing information about building energy use, there are three services that make a website useful for its users. Firstly, there needs to be a form of communication where users of the website are able to get in touch with the producers of the website, and secondly there needs to be a way for users to produce feedback, about the information and the services provided by the website (Patsioura, Malama, & Vlachopolou, 2011). In this case, the sustainability office would be the point of contact for communication. And lastly, there needs to be a form of customer service in the sense that the website provides information to help users navigate through the information on the website (Patsioura, Malama, & Vlachopolou, 2011). There would need to be some sort of service to help students understand how to use the information provided on the website and physical dashboard. For example, this could be provided by offering ways for campus users to decrease energy use in buildings, or by providing links to sustainability initiatives available on campus.

The dashboards could also be used as a means of collecting qualitative information about buildings through the implementation of digital surveys, which also serves to increase interaction. The question can easily be changed in order to collect information that is most pertinent for the sustainability office.

Implementing simple feedback questions into the dashboard website and kiosk gives users the opportunity to make a difference to the sustainability and overall comfort and quality of the buildings on campus. Once users are able to provide feedback to the sustainability office, they are more likely to return to energy dashboard (Patsioura, Malama, & Vlachopolou, 2011). In conclusion, we highly suggest that a feedback option, is available in the dashboard.

According to Suppers & Apperley (2014), if data is large scale, such as whole building or whole campus consumption, the use-context of the visualization may be best suited in a public space where it can provide motivation and raise awareness. Individuals may not be able to know exactly how much energy they have consumed, but it encourages them to think about their usage.

Criteria for dashboard location

Energy Dashboards are slated to be installed in the ten buildings with the highest energy consumption, each of which have been listed below with the specific

recommendations for installation within these buildings. However, because the location of a dashboard in these buildings is based on their energy usage, and not on the amount of people who visit the building, some of these dashboards perhaps represents a missed opportunity. The effectiveness of these dashboards relies on people's interaction with them, therefore we would suggest buildings such as Sidney Smith and Hart House over buildings such as Ramsay Wright and the Wallberg Building.

Building Location Criteria:

- High-traffic because it means more people will be able to view the dashboard
- Near an entrance because they serve as funnels for people, so it further increases the chance that a person might view it
- Near seating, as it implies that people there have some spare time
- Near concessions as a bonus, as it serves as a further draw for people

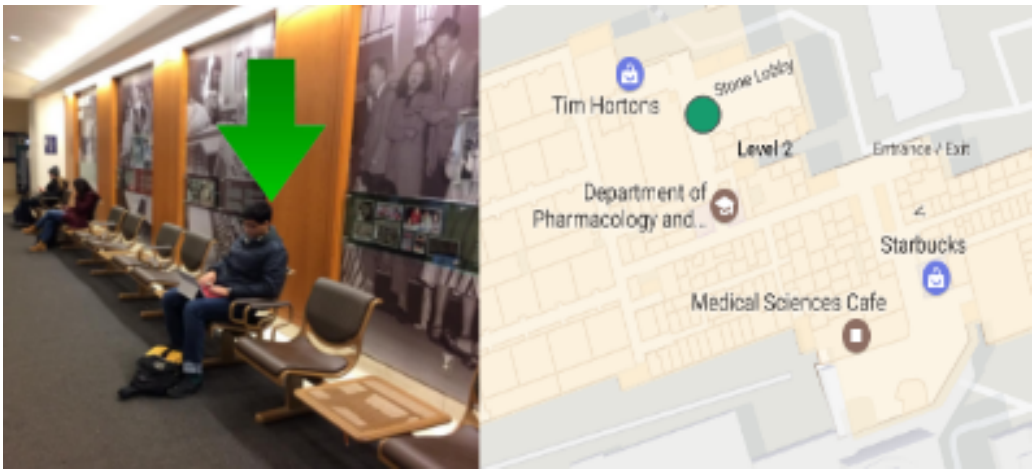
A good example of a location is in the OISE building because it is located near a doorway and a seating area with a small cafe. It is a leisurely space where students would be more inclined to learn information. An example that is not as good would be in the Exam Centre because even though it has high volumes of traffic during certain periods of the semester, it can be a stressful environment, especially for students, therefore making people less inclined to engage with the dashboard.

Locations for Dashboards

The green dot on each map indicates where the best location for the dashboard to be installed, according to the criteria mentioned above. The green arrow in the pictures indicates the exact location in the buildings.

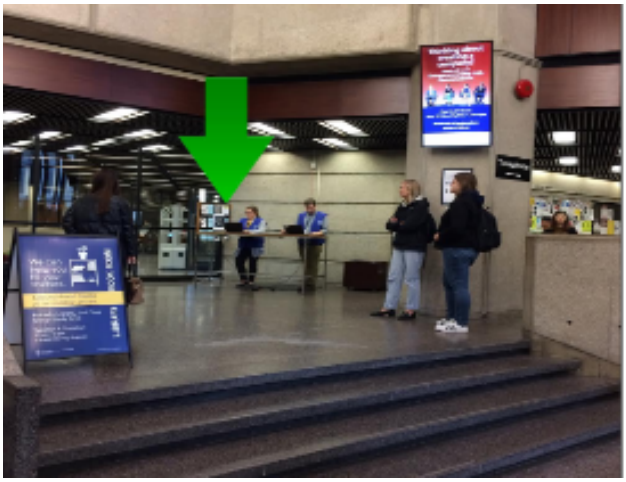
Medical Science Building

Because Med Sci is a very large building, it is important the kiosk is located in an area that sees a lot of traffic. The suggested green dot location is near one of the buildings main entrances, and is also located beside the Tim Hortons. There is a large space with plenty of seating nearby, where students go to take a break from studying, and therefore would likely have time to interact with the energy dashboard.



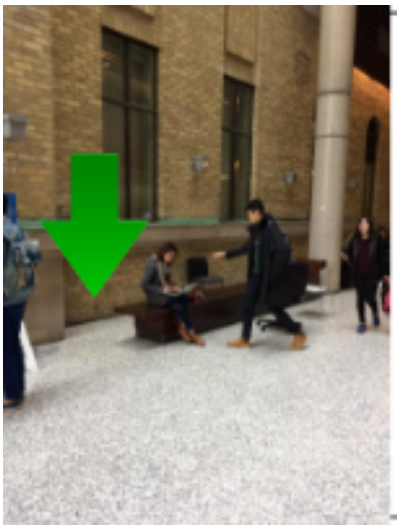
Robarts Library

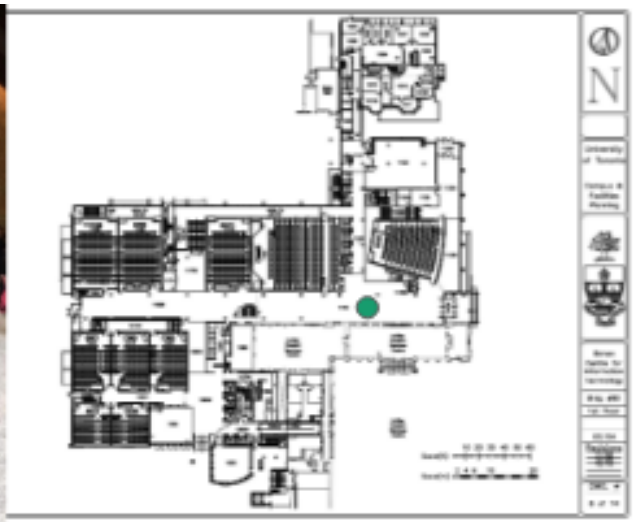
Robarts is one of the busiest multi purpose buildings on campus. The location indicated by the green dot is optimal because it is a high traffic area, located near the entrance to the building as well as the cafeteria. There are also multiple seating areas ranging from study desks to benches providing space for students to take time off from studying and relax.



Bahen Centre

Bahen is primarily filled with classroom and lecture halls, so it would be beneficial to put the dashboard kiosk where we have indicated because it is located near the main entrance of the building. This area is also arguably the most high traffic area in Bahen, and connects to the bookstore building. There are often student projects set up in this area as well, and we have observed interaction with these projects, suggesting that the kiosk would also see useage.



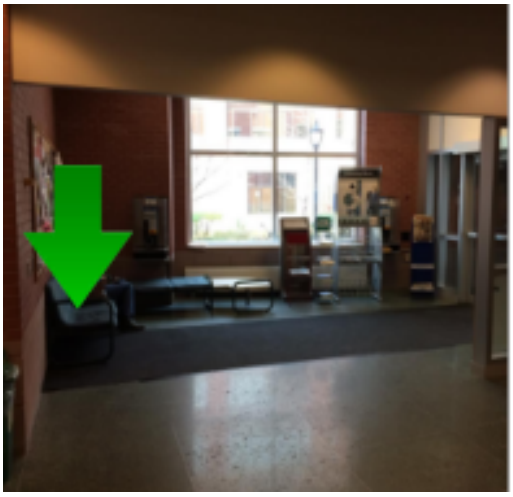


Wallberg Building

Since the Wallberg building is primarily filled with classrooms and has no designated seating areas, the best place to put a dashboard would be near the front door that exits onto College Street, as indicated by the green dot on the map. There is lots of traffic in the area suggested, however it may not be beneficial for the dashboard if the hallways are too busy with students that are passing by.

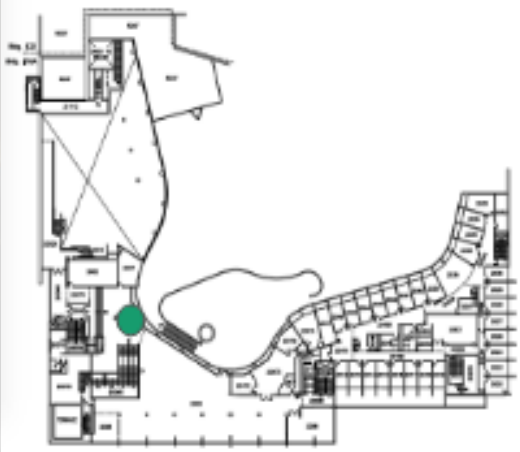
Earth Science Building

The best location to suggest would be in the front lobby of the main Earth Science building near the big round lecture hall. This is a good location due to the two doorways closeby, especially because it is one of the first things that people see as they walk in the door on the eastern side of the building. Also, this location is good because it is next to a large lecture hall, which creates a high traffic of students. It is also beneficial as it is located near two sitting areas on the first floor.



New College-Wilson Building

The best location to place an energy dashboard would be at the entrance of Wilson hall on the second floor of Wilson building. This spot connects the cafeteria, Wilson hall lounge and the main entrance of the building, thus is always very busy. New college has three buildings, Wilson Hall is the most suitable one because residence of two of the three buildings need to enter Wilson hall in order to enter the cafeteria. In addition, all of new college lecture rooms are in Wilson hall (first floor), and all major school and student union events are held in Wilson lounge.



Lash Miller

The best location to place an energy dashboard is among the benches near the main entrance, which are generally busy due to the many lecture halls. Placing the dashboard in the sitting area would be ideal, as it is also close to washrooms and near a charging station.

Ramsay Wright

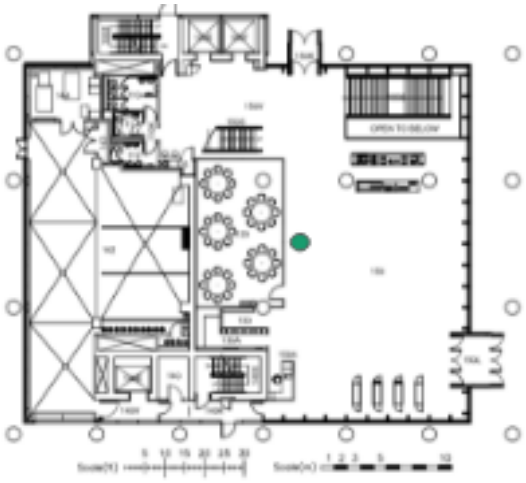
Due to the lack of concessions and a communal seating area, the best location to place an energy dashboard is near the entrance on Harbord avenue, as this serves as the primary access to the building and one of the highest traffic locations.

CCBR

The ideal location for the energy dashboard is near the East entrance, near the cafeteria. This area is part of the central circulation of the building, and therefore has plenty of traffic. Due to its location being near a cafeteria, it is a leisurely space that will make users more inclined to engage with the dashboard.

Leslie Dan Pharmacy Building

The best location for the dashboard in Leslie Dan would be in the central foyer, near the seating area as this is a popular gathering point for students. This area is also ideal because of the Second Cup which serves as a further draw for people.



Recommendations and Trade-offs for the client

Previously in the report, it was mentioned that a few of the building suggestions, such as the Wallberg Building, were not the best locations to install dashboards because they are not leisurely spaces where potential users would be interested in learning about the energy use of buildings. It was also mentioned by a survey respondent that the suggested physical energy dashboards should not be built in order to save resources and money. Though we do not recommend that you discontinue the project to build an additional ten dashboards, we suggest to perhaps look further into the effectiveness of mobile applications as an alternative to the physical dashboards. If data shows that physical dashboards are as effective as mobile applications, or if you decide to build the physical dashboards regardless, we suggest reconsidering a few buildings that are slated for the dashboard installations.

Though we did not do specific scholarly research on this issue, there was an issue mentioned in class by the recycling group that the waste and recycling receptacles were not consistent in how they looked with regards to their colour. Further, the signage pointing to each compartment (waste, paper, organics, plastics, etc.,) were not in the same order on each receptacle, which created confusion for those trying to sort their waste. From this, we recommend that all of the dashboards installed should have a consistent

design. Also, we recommend implementing signage as a way to catch the eye of people that are walking by. In conclusion, both the signage and physical dashboard should look consistent so that when users are looking for a dashboard in different buildings, they have a general idea of what to look for.

There have been studies done in the workplace on the effectiveness of online energy dashboards. A 27 week study of 80 office workers found that there were significant energy savings after the introduction of online dashboards (Yun et al., 2015). This suggests that energy dashboards could not only have effective behavioural changes in the student community, but also a significant impact on the behaviour of staff members. The study also found that when users were given access to control energy usage, for example lighting, heating or cooling, there was an even higher increase in energy efficiency, about 38% (Yun et al., 2015). Providing certain members of the community, like maintenance workers, with the ability to log into the system and control various components of buildings could be beneficial, as seen in office workplaces. To further improve energy consumption patterns at University of Toronto, we might suggest the implementation of a control center in the design of our energy dashboard.

Metrics for Assessing the Effectiveness of our Recommendations

Once the dashboards are in place, the changes that we are suggesting can be implemented incrementally, it would be beneficial to track the amount of users of the dashboards in order to see how the usership is affected. Furthermore we could track any increases in membership to any sustainability initiatives advertised by the dashboards after they are installed.

Moving Forward

Since the dashboard website is not available yet, future research could be done to measure the effectiveness of energy dashboard in two ways: its engagement and its persuasiveness, and to conclude if the dashboards can lead to behavioural change. To

assess its engagement, visitor volume of the physical kiosk and page view of the website can be recorded, as well as the question “Do you know what an energy dashboard is?” could be surveyed again after the dashboards are constructed. To analyze its persuasiveness, the question “are you interested in campus sustainability initiatives?” could be asked again and the result could be compared with our result to see if people are more interested in campus sustainability initiatives.

Since one of the largest issues with the dashboard is that nobody is aware of them, it would be wise to invest in marketing and advertising services for the dashboard. This research project majorly focused on the design, content, and utility of the dashboards, but in the future it should be researched how to create a market where campus users have a need to use the dashboards. This need would go further than to just use it as a campus map and a way to find coffee shops on campus. The need would showcase the importance of a behaviour change that would increase the sustainability of campus buildings, and the actions of the UofT campus community. In conclusion, if time and resources are going to be invested in creating an appealing and easy to use dashboard, resources should also be invested in order to efficiently raise awareness and promote usage from those that are on campus.

Conclusion

Overall, there must be a large focus on two primary issues that were discovered through the research process. Firstly, there needs to be changes in the dashboard’s layout and utility in order to make it both user-friendly and appealing in order to get users to engage with it. Followed by the remodeling of the dashboard, there should be a focus on raising the awareness of the dashboard’s existence. This advertising issue exists both for the physical dashboard and the website, and once it is implemented, further research can be constructed and compared to the results in this study in order to see if more people are aware of the dashboards. It is also very important that the dashboard be connected to sustainability initiatives on campus in order to give the dashboard users a way to engage in sustainable practices. Once these changes are implemented and some time passes in

order to raise awareness and gain a following of users, the dashboards should begin to implement a behaviour change towards more sustainable practices.

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