
TOWER HILL BOTANIC GARDENS



EXECUTIVE SUMMARY

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SUSTAINABILITY

Sustainability takes on many different meanings, but almost all of them relate back to the impact one has on the environment. Individuals have an impact on the environment with their everyday activities, but institutions pose a greater impact with their larger and more powerful acts. These institutions must pay greater attention to what they do and be aware of how they can impact the environment. One institution in particular, Tower Hill Botanic Gardens, has been wanting to work on their sustainability efforts and to provide more of an example to the public of how to be sustainable. The goal of this project was to improve Tower Hill's capability to monitor and manage their environmental impact.

In order to tell how sustainable a facility is, or, more generally, any institution, there needs to be some way, some metric, to measure certain aspects that feed into sustainability that can be compared to other, similar facilities. This method of measurement comes in the form of indicators (Bedřich, Svatava, & Tomáš, 2012). Indicators are the best approach to monitor and manage the environmental impact of an institution. These measurements provide a baseline of information that institutions can use to gauge if their environmental impact is improving or worsening over time, and if new changes to the said institution's facilities are beneficial.



SUSTAINABILITY

There's an array of approaches that institutions use to develop and identify their organization's sustainability indicators. By looking at other approaches, useful methods can be found and applied to new institutions. "In Tower Hill's case, we looked for approaches that could be applicable to a non-profit botanic gardens. We identified A ranking-based approach, which was developed for a set of museums.

The STARS system, which is used to gauge sustainability of universities nationally. The IDEA method, which used three different systems to measure sustainable aspects of farms. And footprint-based tools, which are used to itemize what aspects of an institution impact their sustainability through land use or carbon emissions and by how much.

Overall, sustainability can be broken down into a lot of different pieces, or indicators, which apply to different institutions in different circumstances. Whether it be ranked between universities, museums, farms, other institutions, or themselves, sustainability is measured in different aspects that apply to that institution. The most important aspects of each of these approaches are ideas of how to quantify a facility's sustainability efforts, the idea that we have to work with people with knowledge about the facilities to understand which aspects of sustainability we should be looking into, the importance of adapting a tool to be used with a specific facility, and a common metric to compare different types of energy and consumption data.



THE PROCESS:

Understanding Sustainability and its impact at tower Hill

The next step is to apply methods that incorporate these indicators to illustrate the institutions environmental impact. In order to relate it directly to Tower Hill, we applied methods used by similar institutions. From this, we created a plan of 3 objectives:

1. Establish indicators that are appropriate, useful, and relevant to the institution.
2. Develop a tool based on these indicators to assess current, past, and future sustainability efforts.
3. Implement and engage the staff and the public through use of the tool, and align current sustainability plans with other institutions similar to Tower Hill.



THE PROCESS:

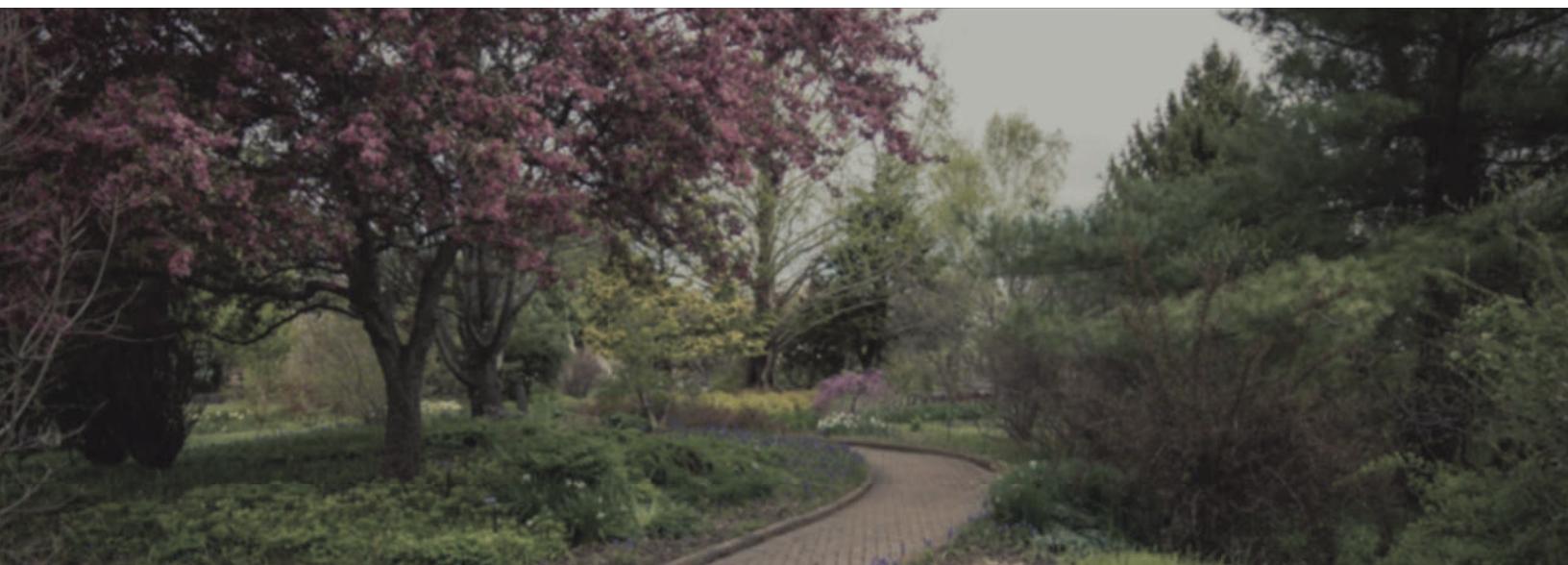
Understanding Sustainability and its impact at tower Hill

Objective 1

Within this objective, we defined what aspects of ecological sustainability we were looking at for Tower Hill's facility. In doing so, we identified what indicators drive the facility's impact on the environment. Moreover, we used a participatory process to identify indicators and eliminate indicators not relevant to the institution.

Objective 2

The purpose of the tool was to use it with the indicators identified to give us a detailed carbon footprint of the facility. When trying to monitor their facility's environmental impact, it's important to see its carbon footprint and how it has changed over the years, and the primary sources that impact the carbon footprint. The tool focused on carbon footprint in relation with time of operation and the source of the emissions.

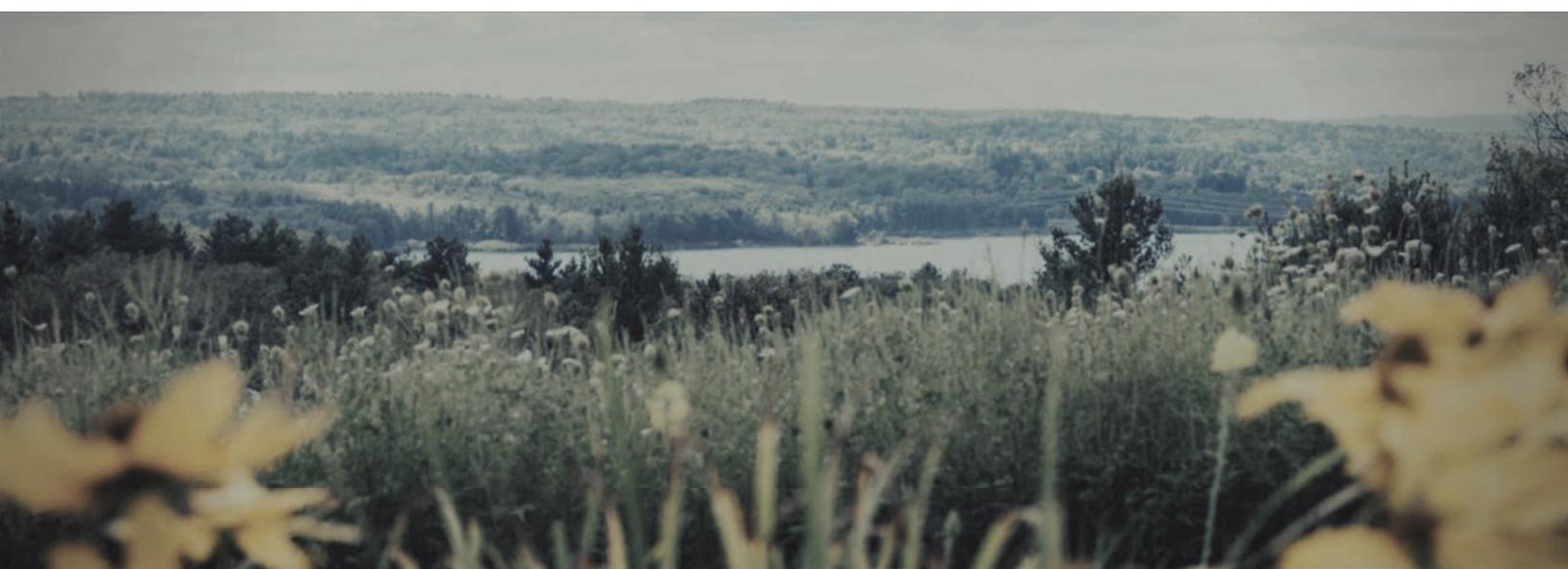


THE PROCESS:

Understanding Sustainability and its impact at tower Hill

Objective 3

Tower Hill Botanic Gardens has sustainability as one of their core values, including learning and inclusivity. In order to fulfill these core values, we helped them learn how to use the tool to monitor their carbon footprint and how to use this tool to move forward in terms of sustainability. Engaging Tower Hill was the first step as they need to fully understand what is going on in Tower Hill so they can learn the position they were in terms of sustainability and environmental impact. The second step was to reach out to other organizations and seek advice from them to see what paths Tower Hill could take now that they have the ability to monitor their environmental impact.



FINDINGS

Looking into the indicators of carbon footprint

The first thing that was done was establishing indicators that would be used to analyze and more closely look at the carbon footprint of Tower Hill. First, interviews were done with the members of the sustainability committee at Tower Hill (Sustainability Committee, February 27, 2020). After the interviews were done and the answers were collected, the data was compiled through the rankings done by the staff on the different indicators being presented to them. We thus were able to narrow down to indicators that are deemed most significant to the institution, being those relating to the carbon footprint of Tower Hill. Specifically, those incorporated fuel (oil, propane,

and diesel), water, and electricity. These were chosen over others as they were most applicable and they related directly to the carbon footprint of the institution.



FINDINGS

Looking into the indicators of carbon footprint

Finding the Appropriate Data Gathering Platform

In order to create the tool to analyze Tower Hill's carbon footprint, we looked through different software.

The two that stood out were Microsoft Excel and Tableau. Both programs are able to look at the exact same types of datasets and produce similar types of graphs, but Tableau is more freely capable of changing between different graphs without as much effort. The choice came down to a financial decision, as Tableau costs \$70/month to use (Tableau, 2020), and we ended up going with Microsoft Excel. The tool will need an input of consumption from each of the areas we decided on broken down by month, and produces a breakdown

of contributions by area for the entire year, and by season, as well as the trend over years of the carbon footprint over the whole year and by season

Baseline of Data

With data of fuel consumption gathered from Tower Hill, we were able to test the tool out and see how Tower Hill's carbon footprint has changed annually by year, annually by season, and the largest contributions from each year and season. The data we received on Tower Hill's water consumption was broken up by quarter, so we divided the amount by 3 and used the result for each of the months in that quarter



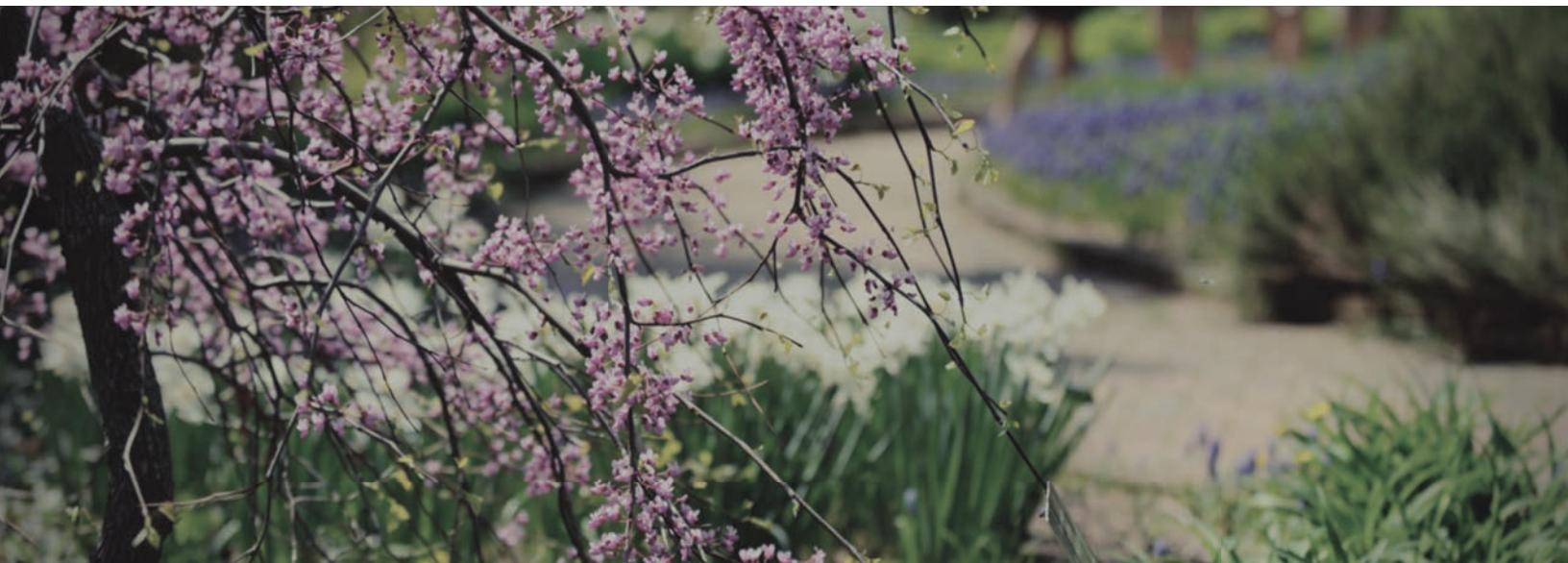
FINDINGS

Looking into the indicators of carbon footprint

Data Analysis

The largest contributor to Tower Hill's carbon footprint is the oil burnage used for heating. The second largest is the electricity usage. These two are overwhelmingly the majority of the carbon footprint of the facility, as both oil and electricity usage add up to slightly more than 85% of the overall carbon footprint. Using 2016 as the baseline, the facility's footprint has increased 12% as of 2019. The primary reason for this is the increase of oil consumption over the years. Oil consumption has increased 10.88% as of 2019. We've ruled that this is the main culprit due to the fact that oil has the highest amount of carbon production in relation to the amount

of carbon it produces. Though electricity is another larger carbon producer, its usage has actually remained steadily constant throughout the years. The usage of gasoline, propane, and diesel has gone up significantly, however, its percentage in the whole carbon footprint is so small (15% on average) that it's negligible.



FINDINGS

Looking into the indicators of carbon footprint

Advice from Similar Institutions

In order to engage Tower Hill, we needed to look to see what others have done under similar circumstances, and apply that towards the people at Tower Hill. In order to do this, we interviewed the Vice President of Operations for Mass Audubon, Bancroft (Banks) Poor. He explained that Mass Audubon started this work through measuring their carbon footprint. From the results of their carbon footprint, they started auditing and looking at recommendations that came from the audits, then started making smaller changes such as insulation, air sealing, window, door and furnace replacement, and so on, to change their carbon footprint. Before

looking into renewable sources of energy, they wanted to get consumption down as low as possible (by conserving energy and other methods). Renewables can be expensive so Poor suggested buying RECs (Renewable Energy Credits) until renewables are affordable. Composting and soils management were some of the other recommendations made to Tower Hill. Poor also suggested electric tractors and to take advantage of some of the programs at MDAR (Massachusetts Department of Agricultural Resources).



RESULTS AND RECOMMENDATIONS

Moving Towards Carbon Neutral

Assessing the carbon footprint of a facility lays the groundworks for continued management of an institution's environmental impact. Besides direct carbon emissions, indirect carbon emissions can also contribute a significant portion to an institution's carbon footprint. Other important factors such as the cost of implementing sustainable changes need to be considered when deciding how to limit an institution's carbon footprint.

Expanding the Scopes of Assessing Carbon Footprint

As mentioned in the previous chapter, indirect carbon emissions such as the

carbon emissions produced from freighting goods, commuting employees, or traveling visitors can have a significant impact on an institution's carbon footprint. Quantifying these types of indicators, however, are difficult. For that reason, we suggest that Tower Hill focuses on the direct impact that the facility has on its nearby environment. Specifically, this means for Tower Hill to focus on the carbon emissions that is produced from their fuel consumption along with electricity and water usage.



RESULTS AND RECOMMENDATIONS

Moving Towards Carbon Neutral

Implementing New Parameters

With the carbon footprint assessment tool, Tower Hill will be able to implement new parameters into the program. Parameters such as costs of energy consumption, zones of the facility that produce the most carbon emissions, and even average outside temperature can easily be added to the program. The addition of these parameters, along with others not mentioned can significantly improve Tower Hill's capability of making educated decisions on how to decrease their carbon footprint. In terms of implementing a cost benefit analysis factor to the program, however, we recognize that much of

this can be done as back hand calculations rather than formalized into the program. Therefore, we recommend that Tower Hill looks to add important parameters such as costs of energy consumption, monthly average temperature, and zones of the facility with the most carbon emissions.

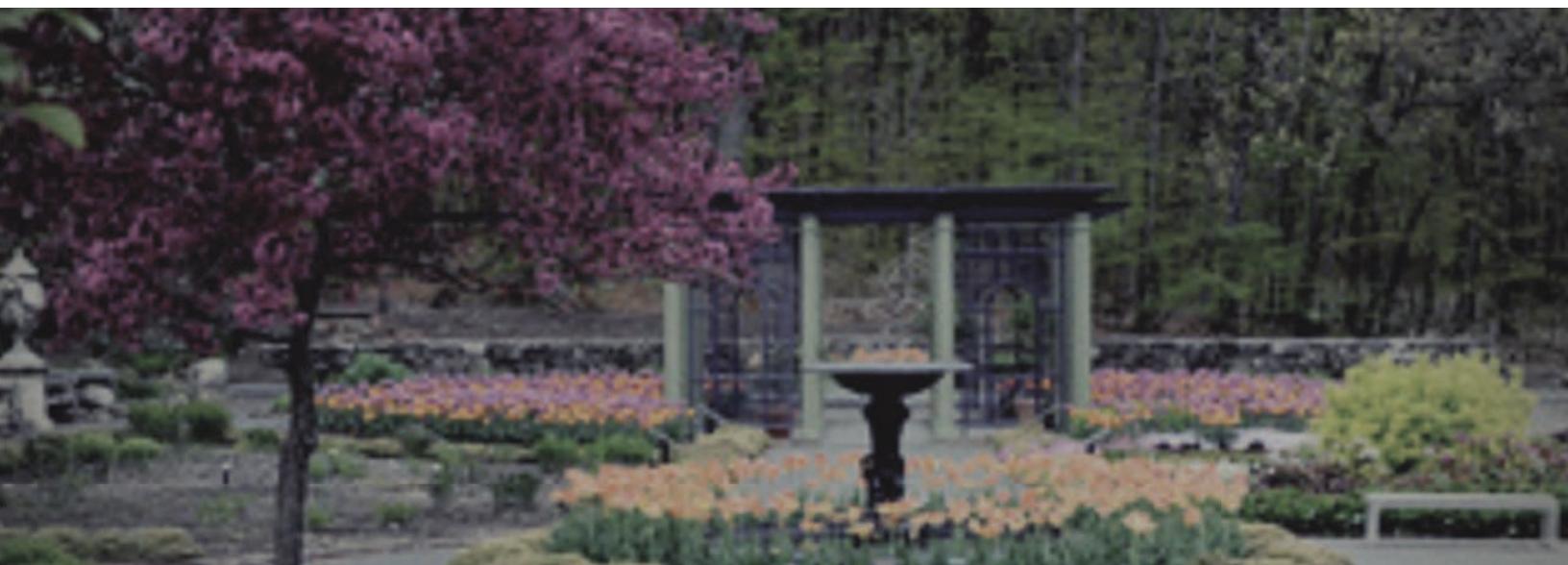


RESULTS AND RECOMMENDATIONS

Moving Towards Carbon Neutral

Continue to Monitor

Monitoring Tower Hill's carbon footprint is the first step towards a more sustainable and environmentally friendly future. This will furthermore allow Tower Hill to observe increases, decreases, or fluctuations of their carbon footprint and to pinpoint the main sources of their carbon emissions. For these reasons, we recommend that Tower Hill continue to monitor their carbon footprint and to set a goal to decrease a percentage of their carbon footprint starting from whichever year they desire. Having a goal in place will set in motion for preparation and planning for the future. This will also help keep Tower Hill accountable to themselves to make sure that measures are being taken to steadily limit their environmental impact.



RESULTS AND RECOMMENDATIONS

Moving Towards Carbon Neutral

Moving Forward

We have supported Tower Hill in creating the foundations for a sustainable future. Using this carbon footprint assessment tool, we recommend that Tower Hill research methods to conserve their energy consumption from their two main sources of carbon emissions: oil and electricity. Being that the two sources of energy make up approximately 85% of the institution's carbon footprint, we suggest implementing measures to conserve and find more efficient ways of heating, cooling, and lighting the

facility. Finding these methods can be tricky and research intensive as well as focused on costs. Within this process of finding the most beneficial methods, cost benefit analyses need to be done to see which method can limit the most carbon emission at the most sustainable costs. We further hope that Tower Hill continues to work with WPI on this path towards a more sustainable future.



RESULTS AND RECOMMENDATIONS

Moving Towards Carbon Neutral

A Model of Sustainability

Tower Hill has become a trailblazer for many institutions as they begin to change their facilities and focus to become more sustainable and environmentally friendly. By doing this, their culture of preservation and conservation of natural beauty can be spread to their employees and visitors. This focus and awareness will hopefully spread to institutions across the United States and the rest of this globe. It's up to local institutions and communities to raise environmental awareness and change the way our society views and fights climate change.

