Team 2: Leslie Science and Nature Center Energy House 2022

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Executive Summary

The Leslie Science and Nature Center (LSNC) serves a broad range of functions. From summer nature camps to wildlife exhibitions to at-home STEM support, the LSNC appeals to people of all ages and backgrounds and works to make science engaging and accessible. Their official mission is stated as such: “Leslie Science & Nature Center creates moments of discovery that inspire curiosity, exploration and respect for STEM and the natural world” (Ann Arbor Hands on Museum Leslie Science and Nature Center 2022). To uphold this mission, the Energy House with its sustainable features was built. It supports numerous programs and serves both functional and educational purposes. Consequently, it is necessary for the building to undergo renovations that bring its sustainable features up to modern standards. A “greener” DTE Energy House would demonstrate the LSNC’s commitment to sustainability in practice and better support its mission of serving the community.

We wanted to ensure that the eventual recommendations for updating the DTE Energy House served both the purpose of sustainability and fulfilled the functional needs of the LSNC. To inform our research, we spoke extensively with David Clipner, our contact at LSNC, about how the space currently serves programming functions and if the center’s needs were being fulfilled. We combed through documents about the history of the center and its various constructed components to see what the state of sustainability was in the building. Keeping in mind the importance of the DTE Energy House for programming and the history of the Leslie Science and Nature center, we conducted research online to identify sustainable building practices. Our focus was narrowed to modifications that could be done to a single building that would update the DTE Energy House to be a model of functional sustainability. By consulting both formal and informal internet sources, we were able to identify sustainable building methods that have been successful elsewhere.

Our group planned to deliver recommendations of different tiers based on budget. We will have three tiers for each section of the renovations including solar energy, waste and water, geothermal, and internal features and appliances. These tiers will also include recommendations from us based on our research and our knowledge of LNSC. These tiers also took into consideration the sustainability of certain labor and energy heavy recommendations, complimenting them with sustainable options at other price ranges. Another part of our final deliverables will be a collection of digitized Leslie Nature and Science Center documents. We hope these renovations will work as an educational tool for young people interested in sustainability as well as local homeowners learning about their own options for sustainability in their home. Compiling these resources can open avenues for funding of these recommendations from stakeholders like DTE.

Introduction & Background

Situated on land donated to the city of Ann Arbor by John Leslie, the Leslie Science and Nature Center serves as a nature preserve, wildlife conservatory, and runs nature and wildlife education programs. The LSNC has many buildings on their property, most part of Leslie's original donation. These buildings are a key part of programming, and each serve a key part of the LSNC's education and conservation efforts (David Clipner, personal communication, 2022).

The DTE energy house, previously Leslie's laboratory, is meant to be a showcase of current renewable energy and sustainable systems technology. The house was renovated in 2000 through a grant from DTE to incorporate various technologies, including solar panels, sustainable building materials, composting toilets, and much more (Kohler Architect 2015). The building is used as an educational tool to demonstrate the benefits of sustainable building technology, to show the technology in an approachable way to anyone who makes use of the building. Since the building was renovated in 2000, some of the technology in the building is outdated, along with some other issues. Due to this, the LSNC is considering renovating the building with up-to-date technology. Our project is to research current sustainable technology that could be implemented in the DTE energy, evaluate cost and feasibility, and create recommendations for a proposed renovation.

Methods

Our first step was the identification of house components that had potential for sustainable improvement. Based on an internet search for common sustainable building practices, we created our research categories: solar energy, waste and water, geothermal, and internal features and appliances. Following this, we were able to establish our scope of work and begin collecting resources from LSNC including documents and manuals for components of the Energy House as well as LSNC history. We also received some past consulting reports for the grounds, and information on the LSNC mission of community education and engagement.

From all this information, we began our research on sustainable building features and practices, keeping in mind what would best suit the needs of the LSNC. This research was conducted through internet searches and scientific databases, with each team member focusing on a specific aspect of sustainable building. We summarized this research into three tiers of potential implementation informed by price and impact. A longer form document was created for our contact at LSNC with descriptions of our findings and recommendations on which features of the DTE Energy House to update.

The scope of this project was limited to physical modifications of the building, not educational programming itself. We knew educational components would be key to the efficacy of this project, but our focus would stay on the actual updates being made rather than how they can be implemented educationally.

Results & Recommendations

Our recommendations for the updates to the DTE Energy House are formatted into tiers by category. Our structure is based on three tiers, but some may have less or more depending on what the sustainability market looks like in that area. In our higher tiers, we focused on cutting edge sustainability technology, but in lower tiers we focused on a lower price and a more holistic sustainability approach. LSNC also emphasized the importance of including our own recommendations based on the things we had researched and learned from the project.

A major part of the sustainability of a building is how well it can conserve heat, especially in areas like Michigan where winter temperatures can be quite cold. The main areas of improvement for these systems are better heating systems and better insulation. Currently, the Energy House uses a gas boiler for heating, with a radiant heat system to warm floors. The insulation is made from cellulose from recycled newspapers, and the windows are fiberglass and triple pane to trap heat in the building.

The insulation is difficult to renovate for two reasons: first, replacing insulation may be less sustainable, due to the waste produced from the construction, with not enough benefit to outweigh this process. Second, the windows and insulation do not have replacements that provide a much greater benefit than the current system, further discouraging a renovation just to replace these systems. The insulation would be replaced with another sustainably produced cellulose insulation, which is more costly to install than fiberglass insulation. Correspondence with the manufacturers of the windows indicate that the current installed technology is still high end, so maintenance would take a higher priority than replacement or upgrade. The 2015 report on the condition of the house indicated that work could be done to improve weatherstripping, as well as general maintenance on the exterior weather proofing. (Kohler Architecture, 2015)

The heating system could be replaced with a geothermal heating system, which would be more sustainable, more efficient, and longer lasting. This system would feature a high up-front cost, would require a more extensive installation, and would require an audit of the building and surrounding area to determine feasibility and cost. A geothermal system would save money on heating and cooling bills, but the high installation cost and uncertainty of the return period without an audit might be undesirable for a donor looking for a simpler investment.

The Energy House Building currently has two Clivus Model M18 composting toilets. In the past, it also housed a grey water bed which was removed due to maintenance difficulties (Kohler Architect 2015). One of the challenges posed by the composting toilets is their limited number; the LSNC conducts programming that serves large numbers of people and having only two toilets is insufficient. However, composting toilets have been shown to be more sustainable

than typical standard-flush systems (Anand and Apul 2011). They can also be paired with greywater treatment systems to effectively reduce water waste (Shillington, Cianfrani, & Hews 2019). Utilizing this system with more composting toilets may be cheaper in the long run than replacing the composting toilets with more standard flush systems, which use higher amounts of water. The composting toilets plus greywater system is certainly more sustainable, having better life cycle energy use and reducing greenhouse gas emissions (Romeiko 2019).

A less intensive but still beneficial update to the DTE Energy House would be the construction of a rain garden near the building which could help filter runoff. Placement of such a structure downhill from impervious surfaces such as sidewalks and parking lots would help reduce pollutants from ending up in groundwater / storm sewers (Trowsdale, Gabe, & Vale 2011). These types of gardens can be relatively inexpensive and have a high educational potential.

The interior of the energy house has a small kitchen as well as other features to focus on updating, like a wooden cubby section used by the summer camps and recycled carpet tiles. The appliances in the kitchen present opportunities for upgrading to more sustainable and energy efficient models, while looking at affordable Energy Star appliances can help with energy conservation and sustainability on a lower tier (Ohler 2020). A general convection top stove or just using more sustainable appliance practices can also be a part of lower recommended tiers (Zandanel 2011). The recommendations will be similar with the wooden cubbies and the recycled carpet tiles; having top tier sustainability options as well as options like up-cycling the old cubbies and supporting local flooring businesses.

As the name suggests, the Energy House's fundamental function is to model sustainable energy generation systems, specifically solar energy captured through Photovoltaic (PV) cells. However, in order to most effectively demonstrate to home owners how solar panels could function in their own homes, the existing solar panels need to be updated or replaced to reflect the modern advancements in PV cell material and integration. The House currently displays 2 different integration methods: 1) Monocrystalline embedded arrays implanted within the roofing material and 2) Thin film self-contained panels that can stand alone. While the thin film panels were developed more recently than the Monocrystalline panels, the thin film has a reputation for poor longevity leading to comparatively less efficiency (Yilmaz et al., 2015). One way to update the system is simply to add more self-contained solar panels with slightly higher efficiencies than the existing panels in order to provide the additional power necessary for programing within the house. Another option for increasing efficiency using currently available technology is Sun-Tracking Solar cells that allow the panels to adjust in accordance with the position of the sun in the sky. This would require more extensive renovation of the integration and mounting systems on the roof.

While these renovations would make improvements in energy output, it would be much more beneficial to wait a few years to make any updates because of recent significant advancements in material and structure that are anticipated to begin commercial production in the near future. The PV panels with the new and cost effective materials are anticipated to be even more affordable than panels today and the panels often pay for themselves within short time periods due to energy bill savings, subsidies, and profits from selling excess energy. In order to maximize the benefit of newer, more efficient solar panels, it is recommended that the battery storage system also be updated to save up the solar energy and to prepare for emergency situations.

Anticipated Impact

As the DTE energy house's primary function is for education, both for summer programs and general technological awareness, we hope that the impact of these proposed recommendations can serve a continued and improved educational purpose. The renovated building would continue to be used for LSNC programming and education, with updated technologies. Additionally, we would hope that the building could be used as a tool to showcase sustainable building technologies for local homeowners who could implement these systems into their own homes. This could be done at a local level by encouraging local residents to come and tour the building, or be expanded to programming for homeowners across the city. In general, we hope that the building can be used as an educational tool and resource for all ages.

Additionally, the house can continue to represent and foster collaboration between LSNC, stakeholders, and companies. The current house was funded through a grant from DTE, and helps to signify a partnership between DTE and the LSNC. As more collaborators like the Graham Sustainability Institute continue working on the project, and as more stakeholders are identified, we hope that the house can come to represent a much broader collaboration between companies, organizations, and the local community.

At a direct scale, the research that we are summarizing will be used to better communicate the needs of the building to possible donors and companies interested in collaboration. Specifically, we hope that the research summary and tiered price structure will make it easier for donors to assess investment, and make it easier for LSNC to reach out to companies and organizations to foster partnerships.

Appendix

Tiered Breakdown Document

Tier Spreadsheet

Sources

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