DOW SUSTAINABILITY FELLOWS
UNIVERSITY OF MICHIGAN

Habitat for Humanity's Carbon Footprint Mapping and Mitigation Program

Understanding Barriers and Opportunities for Implementation

Habitat for Humanity International

Carbon Footprint Mapping and Mitigation Program

Ann Arbor, Michigan, USA

2021 Dow Sustainability Fellows Team 4

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Executive Summary

The building sector is currently responsible for 39% of global greenhouse gas emissions (referred to herein as “carbon” or “carbon emissions”), with 28% attributed to building operations and 11% to “embodied carbon,” i.e., carbon emissions resulting from the production of building and construction materials (World Green Building Council, 2019). Through their newly launched Carbon Footprint Mapping and Mitigation Project (CFMMP), Habitat for Humanity International (“Habitat” or HFHI) intends to reduce the carbon emissions associated with the material and construction phases of the residences built by their affiliates in the United States.

The objectives of the Dow Fellows project were to: 1) situate the CFMMP in the context of the larger building industry and 2) understand the opportunities and barriers to implementing the CFMMP within Habitat. The fellows team conducted work in the following three phases: I) Data Collection, II) Synthesis, and III) Recommendations. The data collection phase consisted of a landscape review of existing green building standards and analysis from in-depth interviews with current Habitat personnel. The synthesis phase consisted of interview transcription, analysis and summary into emerging themes. In the recommendation phase, the fellows team integrated information from the first and second phases of work and generated recommendations for advancing the CFMMP. Over the course of the project, the fellows team developed the following deliverables for Habitat: Green Building Standards Guide (document), CFMMP Summary of Research and Recommendations (report), and Interview Results Document.

Upon review of existing green building standards, we generally found a gap in guidance explicitly related to carbon mapping and mitigation during the materials and construction phases. Many existing green building standards focus on use phase energy efficiency and some mention waste reduction during the construction phase and provide guidelines for materials selection. Following these guidelines would likely result in reduction of carbon emissions; however, the focus of the guidelines is not explicitly on carbon mapping or mitigation. These findings indicate that the CFMMP is on the forefront of advancing green building practices.

The fellows team conducted 10 one-hour interviews with affiliates and HFHI personnel. During and following the review of the interview transcripts, several themes emerged, which are summarized below.

1. **Internal operations.** Internal operations refers to projects carried out by HFHI and affiliates independently, as well as how HFHI and affiliates interact with each other.
2. **External interaction.** External interactions in the interviews and within this document include partnerships with external groups, suppliers, and contractors, as well as the influence of state and local building policies.
3. **Affiliate Diversity.** Affiliate diversity refers to the rich variety of affiliate members in regard to personal backgrounds, experiences, size, funding, and frequency of builds.
4. **Carbon mitigation.** Carbon mitigation refers to the reduction of carbon emissions associated with a given activity.
5. **Financing.** Financing refers to both inflows of money (e.g., donors and incentives) and outflows (e.g., cost of materials, time, and labor).

The fellows team compiled a set of recommendations based on the research and interviews. We considered themes from the interviews, suggestions from the interviewees, processes from current standards, and our own diverse background knowledge to form recommendations that could lead to organizational change, therefore having a large impact on carbon emissions once scaled throughout Habitat. Below is a high-level list of the seven recommendations.

1. Support affiliate interaction and knowledge share.
2. Provide dynamic incentives.
3. Analyze viability of bulk purchasing agreements.
4. Understand, advocate, and support local conditions.
5. Establish a new funding mechanism for low-carbon design.
6. Prioritize affiliate input on organization-wide initiatives.
7. Build on existing waste management strategies.

These results provide the first external evaluation of Habitat for Humanity International's pilot Carbon Footprint Mapping and Mitigation Project. A thorough assessment of existing green building standards and carbon mapping tools throughout the residential building industry identified a gap in industry standards and an opportunity for Habitat in their efforts to push sustainable building practices forward. A qualitative analysis of internal stakeholder perspectives identified barriers to project implementation, and an understanding of affiliate receptiveness towards new sustainability initiatives and the CFMMP. Together, these results will inform a path forward for Habitat in their efforts to expand and scale the CFMMP across diverse affiliate sites nationally.

Introduction

The Paris Agreement, an international treaty on climate change, aims to limit global warming to "well below" two degrees Celsius and the Intergovernmental Panel on Climate Change (IPCC) has warned that global warming must be limited to 1.5 degrees Celsius to avoid the most catastrophic impacts of climate change (IPCC, 2013; United Nations Framework Convention on Climate Change [UNFCCC], n.d.). In order to reach these ambitious targets, the entire global economy must rapidly reduce emissions of the greenhouse gases that are causing global warming ("decarbonize"). The building sector is currently responsible for 39% of global greenhouse gas emissions (referred to herein as "carbon" or "carbon emissions"), with 28% attributed to building operations and 11% to "embodied carbon," i.e., carbon emissions resulting from the production of building and construction materials (World Green Building Council, 2019).

Habitat for Humanity

Habitat for Humanity International ("Habitat" or HFHI) is an international organization that partners with local communities and homeowners to construct or renovate affordable homes with a vision of "[a] world where everyone has a decent place to live" (HFHI, n.d.[a]). Habitat works in 70 countries throughout the world and has 1,100 affiliates within the United States that work in all 50 states, DC, and Puerto Rico (HFHI, n.d.[b]). Each affiliate is an independent 501(c)(3) non-profit organization.

Project Team

The graduate student team (referred to herein as the “fellows team”) consists of Lia Delaney, Maeghen Goode, Andrew Timmins, Jesse Vega-Perkins, and Marisa Zelip.

Molly Berg, Building Science Specialist at HFHI, and Thom Phillips, Sustainable Housing Director at Habitat for Humanity Michigan, are the client representatives. The fellows team met with Molly and Thom on an approximately bi-weekly basis throughout the duration of the project.

The advisor team consists of Andy Hoffman as faculty advisor and Bo Miller as Dow consultant. The fellows team has been in communication with our advisors on an as-needed basis, particularly for feedback on major deliverables throughout the year.

Project Scope

Through their newly launched Carbon Footprint Mapping and Mitigation Project (CFMMP), Habitat intends to reduce the carbon emissions associated with the material and construction phases of the residences built by their affiliates in the United States (see Figure 1 below). As such, the fellows team considered the feasibility of CFMMP implementation in the context of these phases of the building life cycle, in which Habitat is the most directly involved. Discussion of the limitations of the life cycle scope is in the Conclusions section.

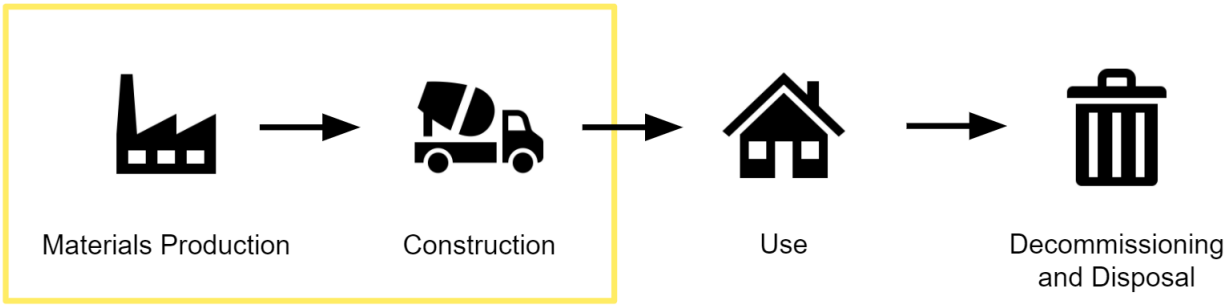

Figure 1. Current Scope of Habitat’s Carbon Footprint Mapping and Mitigation Project.

Project Objectives

The objectives of the project were to: 1) situate the CFMMP in the context of the larger building industry and 2) understand the opportunities and barriers to implementing the CFMMP within Habitat.

Over the course of the project, the fellows team developed the following deliverables for Habitat: Green Building Standards Guide (document), CFMMP Summary of Research and Recommendations (report), and Interview Results Document). These are included as Appendices to this report.

Methods

The scope of work consisted of the following three phases: I) Data Collection, II) Analysis, and III) Recommendations. The outcomes of each phase are documented in final deliverables provided to the client (see Appendices A, B, and C).

Phase I: Data Collection. The objectives of the first phase were to: 1) situate the CFMMP in the context of the larger building industry and 2) collect perspectives on CFMMP implementation. These research objectives were satisfied with a landscape review of existing green building standards and analysis from in-depth interviews with current Habitat personnel. See Table 1 for the specific tasks conducted during Phase I.

Table 1. Description of Phase I tasks.

Phase I Tasks	**Description**
Research of green building standards	A review of current green building standards within the residential building sector, with particular focus on carbon mitigation, was completed. This was presented to our client team in May 2020 and is summarized in a Green Building Standards Guide (see Appendix A).
Develop interview guide and plan	Two separate interview guides were created, with the different affiliate and corporate (i.e., HFHI) audiences in mind. The interview guides included a script for the interviewers, with several predetermined questions to guide the conversation. The list of questions is included in Appendix B. Interviews were aimed at understanding stakeholder perspectives, including their interest in sustainability and the incorporation of carbon mitigation in the HFHI mission and affiliates' building processes.
Interviews with Habitat affiliates and HFHI	15 people from affiliates in Michigan were invited to interview and 7 one-hour interviews were completed. Likewise, 6 people from HFHI were invited to interview and 3 interviews were completed. The interviews were conducted via Zoom, recorded, and then anonymized on a case-by-case basis by keeping only the audio and using a non-identifying file naming convention.

Phase II: Synthesis. The objective of the second phase was to understand the opportunities and barriers to implementing the CFMMP within Habitat. See Table 2 for a description of the specific tasks conducted during Phase II.

Table 2. Description of Phase II tasks.

Phase II Tasks	**Description**
Transcribe interviews and abstract major themes from the content	Trint, an audio transcription software, was used to transcribe the audio recordings of the interviews. The fellows team then reviewed the transcripts and edited

	them for clarity as needed. The salient portions of interviewees' responses to the questions were copied into a virtual Google Jamboard. During two team meetings, the fellows team sorted the responses into emerging themes.
Summarize emerging themes	Following two team work sessions, the emerging themes from the interviews were synthesized and summarized into a series of themes with associated barriers and opportunities.

Phase III: Recommendations. In the third phase, the fellows team integrated information from the first and second phases of work and generated recommendations for advancing the CFMMP. This phase was iterative and involved extensive discussion among the fellows team, as well as discussion with the client and advisors. See below for the specific tasks.

Phase III Tasks	**Status & Outcomes**
Develop set of draft recommendations for CFMMP implementation	Once the themes from the interviews were summarized, individual team members then proposed recommendations based on the barriers and opportunities related to each of the themes.
Discuss and finalize draft recommendations	During a team work session, team members proposed and refined their recommendations through extensive discussions. Fellows team members then refined the final draft recommendations.
Solicit feedback	The draft recommendations were sent to the client and advisors to solicit feedback on the recommendations, particularly their clarity, relevance, salience, and any other comments or critiques. The feedback was incorporated into the final recommendations.
Finalize recommendations	The fellows team incorporated feedback from the client and advisors to produce final recommendations, which are summarized in Appendix B.

Research Results

As discussed above, the objectives of the first phase were to: 1) situate the CFMMP in the context of the larger building industry and 2) collect perspectives on CFMMP implementation. These research objectives were satisfied with a landscape review of existing green building standards and analysis from in-depth interviews with current Habitat personnel.

Green Building Standards

The fellows team reviewed several existing green building standards and tools (Endeavor, Energy Star, Florida Green Home Certification, LEED Residential and Zero Carbon, Passive House, National Green building Standard, Zero Energy Ready Home) and evaluated them for their applicability to the CFMMP.

Based on this research, we found that most existing green building standards that we reviewed lack guidance explicitly related to carbon mapping and mitigation in the materials and construction phases. We identified this as a gap in current industry guidelines. While some include carbon-tracking with respect to use-phase energy and transportation (e.g. LEED Zero Carbon) or high-level waste reduction efforts (e.g. NGBS), the adopted standards did not incorporate comprehensive, construction phase carbon tracking or leverage data tracking tools which could support such an effort. The notable exception is Endeavor, which offers a construction-phase carbon calculator, but is not an adopted standard yet. Recently, cities, states, and even the federal government are moving towards more stringent energy codes, and organizations like LEED are attempting to create more robust and comprehensive carbon mitigation and mapping programs. ***These findings indicate that the CFMMP is on the forefront of advancing green building practices.***

The fellows team compiled information from each of the noted building standards as well as a handful of local jurisdictions of interest for HFHI, noting that regulations and certification improvements are continually changing so it is in HFHI's best interest to closely monitor these. See Appendix A for an in-depth overview of the standards reviewed.

Stakeholder Interviews

During and following the review of the interview transcripts, several themes emerged, which are summarized as internal operations, external interactions, organizational diversity, carbon mitigation, and financing. An overview of each theme is listed below and a comprehensive overview can be found in Appendix B.

1. **Internal operations.** Internal operations refers to projects carried out by HFHI and affiliates independently, as well as how HFHI and affiliates interact with each other. Barriers identified within internal operations include competing high-priority issues (e.g., diversity, equity, and inclusion, climate change, sustainability), operationalizing the climate position statement, accessing and sharing information and resources, and educating team members. Opportunities identified include mobilizing existing resources (e.g., "co-create" teams, understanding what's already being done, emphasizing measurement); supporting affiliates through information, funding, and leadership; and promoting resource sharing among affiliates.
2. **External interaction.** External interactions in the interviews and within this document include partnerships with external groups, suppliers, and contractors, as well as the influence of state and local building policies. The major barrier identified is the possible misalignment of Habitat's goals with the broader construction industry, such as Habitat's

prioritization of accessibility and energy efficiency. Opportunities include identifying like-minded partners and advocating for changes to local and international policy.

3. **Affiliate Diversity.** Affiliate diversity refers to the rich variety of affiliate members in regard to personal backgrounds, experiences, size, funding, and frequency of home builds. Barriers identified include differences in perspectives on climate change, limited buy-in from affiliates, recognition of affiliate diversity, creation of effective goals that can be applied across a variety of types of affiliates, and assessing the carbon baseline for a variety of affiliates. Opportunities include leveraging different perspectives on climate change to create a campaign that appeals to a diverse affiliate population, learning from and showcasing affiliates' construction experience, streamlining processes, and involving affiliates in higher level planning.
4. **Carbon mitigation.** Carbon mitigation refers to the reduction of carbon emissions associated with a given activity. Barriers included measuring and bearing costs associated with carbon mitigation, managing a variety of goals other than carbon mitigation, finding architects that align with Habitat's goals, and lack of volunteer experience. Opportunities include leveraging overlapping benefits of addressing multiple goals, developing non-financial incentives, repairing homes, and creating accessible homes.
5. **Financing.** Financing refers to both inflows of money (e.g., donors and incentives) and outflows (e.g., cost of materials, time, and labor). Barriers identified included lack of tailored incentives, overcoming single affiliate limitations, non-profit mentality that may lead to inefficiencies, loss of institutional knowledge due to turnover, and tensions between upfront costs and long-term value. Opportunities include developing external partnerships, emphasizing and expanding incentives, benchmarking cost of mitigation approaches, benefiting from external market signals such as rising material costs, and signing bulk purchase agreements.

Recommendations

The fellows team compiled a set of recommendations based on the research and interviews. We considered themes from the interviews, suggestions from the interviewees, processes from current standards, and our own diverse background knowledge to form recommendations that could lead to organizational change, therefore having a large impact on carbon emissions once scaled throughout Habitat. Below is a summary of each recommendation's goal. The comprehensive list of recommendations can be found in Appendix B.

1. **Support affiliate interaction and knowledge share.** Overcome extensive differences in size, funding, and experience amongst affiliates, bridge the gap in affiliates' access to resources, support the use of best practices, promote use of internal information during new affiliate onboarding and minimize buy-in time from affiliates' boards for large process changes.
2. **Provide dynamic incentives.** Develop incentive structures that encourage HFHI goals while accounting for the evolving experience and capabilities of affiliates after the first

iteration of a given process and promote non-reliant behavior with respect to financial rewards.

3. **Analyze viability of bulk purchasing agreements.** Leverage the aggregated buying power of many Habitat affiliates to lock in advantageous bulk purchase agreements and drive down the cost of common building materials.
4. **Understand, advocate, and support local conditions.** Become more streamlined across affiliates (i.e., similar floorplans, material usage, processes), develop positive working relationships with local governing bodies, encourage sustainable building methods and materials within Habitat and surrounding communities, prepare for upcoming changes in regional and/or federal regulation, assess the susceptibility of regulations and policies to the application of lobbying effort.
5. **Establish a new funding mechanism for low-carbon design.** Extend the work of Habitat for Humanity of Michigan to develop carbon-efficient house designs by funding a design competition or supporting a cohort of architecture and design fellows to develop Habitat-oriented housing plans for use across the United States.
6. **Prioritize affiliate input on organization-wide initiatives.** Encourage affiliates from diverse regions and backgrounds to contribute meaningful recommendations to the creation of new initiatives and standards across the organization breaking down barriers of diversity (e.g. personal backgrounds, build experience, motivations for involvement, contributions each year) and leveraging insight into how to increase the applicability of recommendations and ultimately the fidelity to new interventions.
7. **Build on existing waste management strategies.** To further encourage waste management strategies to reduce leftover materials and therefore carbon.

Conclusions

These results provide the first external evaluation of Habitat for Humanity International's pilot Carbon Footprint Mapping and Mitigation Project. A thorough assessment of existing green building standards and carbon mapping tools throughout the residential building industry identified a gap in industry standards and an opportunity for Habitat in their efforts to push sustainable building practices forward. A qualitative analysis of internal stakeholder perspectives identified barriers to project implementation, and an understanding of affiliate receptiveness towards new sustainability initiatives and the CFMMP. Together, these results will inform a path forward for Habitat in their efforts to expand and scale the CFMMP across diverse affiliate sites nationally.

Project Feedback and Impact

This project served to evaluate the CFMMP during this pilot year and to understand how the CFMMP is situated within the larger Habitat organization, as well as the general building industry. Our client Thom Phillips noted the following about the project:

> "*[These results and* recommendations*] answer several questions regarding the context of the project, both in the building industry as a whole and within the*

Habitat community. The opportunities and barriers are particularly helpful as we chart the course from here. It offers us some third party informed guidance."

- [Thom Phillips, email communication on November 29, 2021]

This project was only one component of the CFMMP's pilot year and therefore contributed to the larger effort by providing insight into the organizational feasibility of implementing a program at Habitat that aims to reduce the carbon emissions associated with the materials and construction phases of the building life cycle. Our client Molly Berg summarized the project impact in the following quote:

"Put another way, the baseline emissions measurement and key emission components only show us the influential construction factors. But the decisions that need to be made about construction factors are dependent on people factors. Without knowing what influences the people factor, we don't know how to begin talking about construction factors. The interviews provide the people factor."

- [Molly Berg, email communication on November 29, 2021]

As alluded to in Thom's quote above, by conducting interviews as a third party, the fellows team has been able to be an objective observer of comments and concerns from affiliate and HFHI personnel. The interview results have provided feedback for how to gain and sustain buy-in from the affiliates for carbon mitigation, as well as support affiliates in planning less carbon-intensive construction projects moving forward. Success in this domain will result in direct and indirect reductions in carbon emissions within vulnerable communities through carbon-conscious procurement and reduced material consumption and waste at the site level.

As discussed in Molly's quote above, another outcome of the CFMMP is that it will create a baseline for carbon emission measurements. The fellows team project has provided Habitat with a baseline gauge of affiliate and HFHI personnel's impressions and opinions. These components will allow Habitat to plan the next steps for organization-wide carbon reduction.

In addition to the contributions noted above, Molly and Thom have also indicated that they will utilize the deliverables in the future when preparing materials related to the CFMMP, including funding applications and proposals, as well as conference presentations.

Limitations

Throughout the course of the project, the fellows team noted several limitations that may have had an impact on the recommendations. Two substantial limitations include project scope and sample size. The scope of the project did not include the use phase of affordable housing, only material production and construction. Green building standards primarily focus on the energy usage of a home, however, Habitat for Humanity does not track emissions once the home is occupied. Also, the sample size used throughout this project was limited. We focused on Michigan, having worked with Habitat of Michigan and interviewed affiliates throughout the state. The challenges in Michigan may differ from states or regions. In order to compile the most

effective set of recommendations and national strategy, it will be best to replicate this work across the United States.

Next Steps

The fellows team focused on high-level, organizational barriers to implementing a new program, with less focus on the technical components of carbon mitigation. If the project continues with a new Dow Fellows team next year, the following additional steps should be considered:

1. **Review the first year of the program.** This could include internal interviews with Molly and Thom, as well as the affiliates that completed the pilot year. Materials to review include data and tools produced and used by the affiliates, as well as the life cycle assessment tools used by Thom.
2. **Support Thom's technical research.** Fellows could research particular materials, gather and suggest case studies, visit Habitat build sites, and conduct interviews within academia or industry.
3. **Facilitate the suggested list of recommendations.** The team could also help to put the suggested recommendations into motion by following and expanding upon the set of actions detailed in this document.

Acknowledgements

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Appendix A - Green Building Standard Guide

See document “Appendix A - Green Building Standard Guide.pdf”

Appendix B - Summary of Research and Recommendations

See document “Appendix B - Summary of Research and Recommendations.pdf”

Appendix C - Representative Interview Quotes

See document “Appendix C - Representative Interview Quotes.pdf”

Appendix D - Photos

See document “Appendix D - Photos.pdf”