# Gaming for Sustainability Executive Summary


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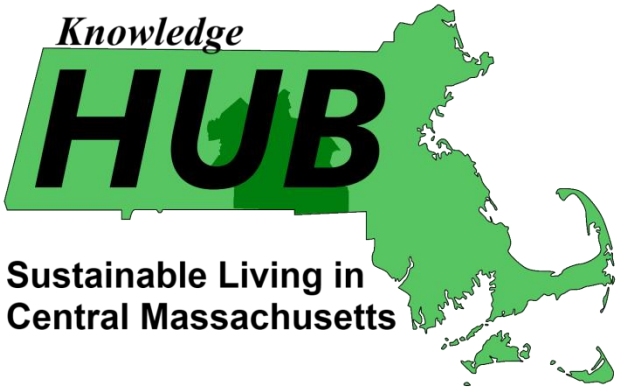


*An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science.*

*The following is an executive summary of the Gaming for Sustainability Project. The project also includes a wiki found at http://gamingforsustainability.wikidot.com/.*

## Abstract


The Gaming for Sustainability project drafted a computer game design to teach residents of Worcester sustainable behaviors in their homes. The project also developed a wiki called the Knowledge HUB as a repository of information, resources, and tools to provide an easier way for residents to learn more about sustainability. The game design and wiki have set a foundation for future developers and authors to build the game and improve the wiki.

# Contents

# Problem Statement

The people of Massachusetts need to be more sustainable. From 2004, the state population is expected to grow by 10% to roughly 7 million people by 2030 (Kenny *et al.* 2009). The increase in population also increases the resource demand – placing a greater strain on the environment. Unlike the population growth, resources such as water and fossil fuels are in limited supply. Unfortunately, people are not aware of the impact of their behaviors which will prevent them from following this lifestyle indefinitely. It has become a necessity to motivate less resource demanding, or sustainable, behaviors.

The Gaming for Sustainability group believes that an incentive to promote sustainable behavior may be found in computer gaming, specifically serious gaming, which is designed to motivate people to learn and practice new skills (Zyda 2005). The intention is that such a game would also inform and persuade players that socially, environmentally, and economically sustainable practices are feasible.

The team is trying to change the general attitude that people have towards sustainability, informing them that they can make a difference by applying the ideas taught in this project to their everyday lives.

# Goals

The Gaming for Sustainability project had three objectives: (1) to provide a repository of information, resources, and tools as an easier way for residents to learn more about sustainability, (2) to motivate residents of Worcester to practice sustainable behaviors, and (3) to set up a foundation for future developers and authors to build the game and improve the wiki respectively.

**(1) To provide a publicly accessible repository of information, resources and tools as an easier way for residents to learn more about sustainability.**

It is our understanding that there is no database that addresses sustainability in homes pertaining to the Worcester area. If people knew about sustainability in homes, people can act more efficiently to reduce their impact on the planet. The Gaming for Sustainability project developed a wiki known as the Knowledge HUB - hosted at http://gamingforsustainability.wikidot.com - which addresses the issue of sustainability in Worcester and how residents can reduce their impact on the planet.

**(2) To motivate citizens of Worcester to practice sustainable behaviors.**

We approached this objective with an assumption that residents would be motivated to act more sustainably if they see that such practices are both feasible and beneficial. To show them that sustainable practices are feasible and beneficial, we designed a computer game. Computer games were chosen as a medium because games have the ability to be persuasive (Derryberry 2007). The game we designed emulates parts of the real world to provide the player with an immersive experience. The project group intends this game design to allow the player to mirror actions in the game with actions in the real world. The Gaming for Sustainability project

drafted a serious game design document, or SGDD, which details every aspect of the game known as My Eco-Home, from the big picture to technical requirements to game features.

**(3) To set up a foundation for future developers and authors to build the game and the wiki respectively.**

Our scope goes beyond what has been developed and drafted in the project. The wiki, known as the Knowledge HUB, is designed for others outside of the Gaming for Sustainability project to expand by adding new information and updates. The serious game design document, heavily based on *Developing Serious Games* (Bergeron 2006), can also be examined to improve on features described in the document and developed to put the game design into practice.

# Project Development

Development of the Gaming for Sustainability project started with research for the wiki and for the game. Afterwards, the group compiled information into the wiki while designing the structure of the game. We wrote up the GDD-Lite and the SGDD once we had completed the wiki. While writing the SGDD, we also developed prototypes of different features of the game we were describing.

Figure 1 documents the group's path through the project. The project started with a research phase followed by a combination of design and production phases. Two main phases, one for the development of the Knowledge HUB and one for the drafting of the SGDD illustrate the group's focus throughout the project. Each box corresponds with a description in the following section which follows the flow of the figure, top to bottom, left to right.

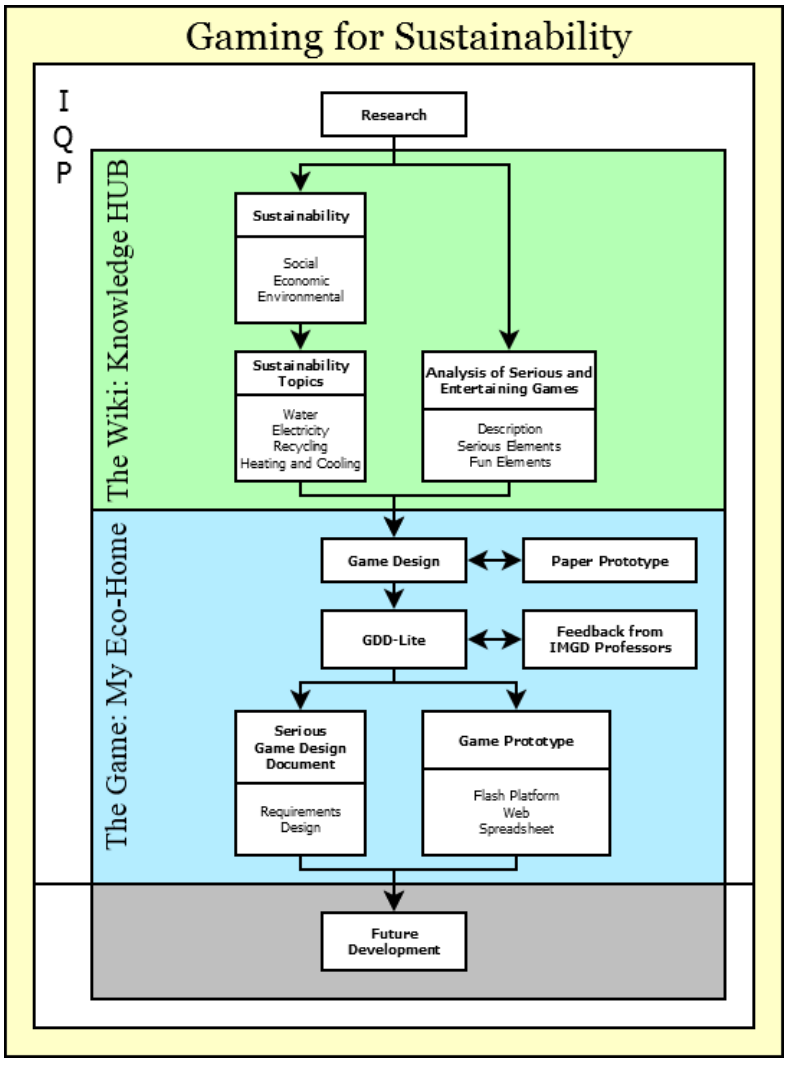


**Figure 1: Project Development Process**

# Research

The Gaming for Sustainability project researched several topics including electricity and energy consumption, water consumption, trash and recycling, and heating and cooling. The research not only included information on why the topics are important, but also how residents can reduce their consumption of electricity, water, and fuels through changes in appliances and behavior. Research sources included Worcester City Public Works, NSTAR, National Grid, EPA, EIA, USGS, local and state government data. All the information found was used not only to build the foundation of the Knowledge HUB, but it also went into the thought-processes behind the game design.

The analysis of serious games and games for entertainment also contributed to building My Eco-Home. Strengths and weaknesses of the games analyzed were used as lessons for the game design of My Eco-Home. For example, a serious game such as EnergyVille teaches about electricity production on a city-wide scale. We believe that the average person will get more information relevant to them if the game was set on a household scale. This idea manifests in My Eco-Home by keeping the player's influence within a single home so he or she can apply the information to their own lives.

# The Wiki: Knowledge HUB

The purpose of the Knowledge HUB is to house all of the relevant information pertaining to sustainability to act as a guide for our game as well as a stand-alone database that can be maintained by future groups and made available for the public.

While brainstorming on how to present our ideas to the citizens of Worcester, several important questions came about. How do we convey information about our game and sustainability to players? How do we keep the information current? Both answers came with the idea of posting our research on a wiki, as the system is publicly readable and editable without any advanced knowledge of web development. Such a wiki could stand to educate residents of Worcester, educators, and students while allowing these groups to update and maintain the information on it. The wiki also supplements the game we designed by acting as a resource of information that players can use in the game.

Two candidates were considered for hosting this wiki: Wikia and Wikidot. Wikidot proved to be preferable as Wikia has a less robust formatting language, and it posts advertisements on the wikis under their domain. Wikia also did not allow restrictions on who can edit the wiki, and since we only wanted project group members writing content at this stage of the project, Wikidot became the better choice.

## Social, Environmental, and Economic Sustainability

One of the first questions we asked ourselves was: What is sustainability? Sustainability involves meeting current needs without hindering the needs of future generations (UN General Assembly 2). We found that sustainability is a very complicated issue, but sustainability, in general, is split into three categories: social, environmental, and economic. Social sustainability addresses many social issues such as access to resources, creating a sense of community, and

physical and spiritual quality of life. Environmental sustainability aims to minimize the degeneration of the environment resulting from resource depletion. Economic sustainability relates to financial stability through the use of less finite resources, and more renewable resources while still making a profit (Greenwood 2012).

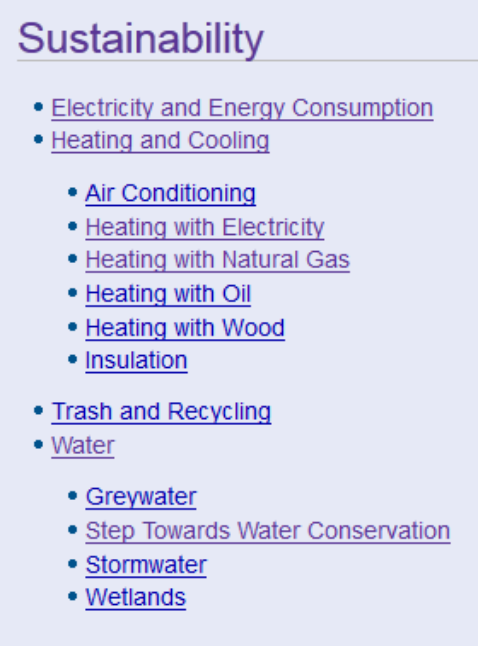


**Figure 2: Contents for the Sustainability Part of the Knowledge HUB**

## Sustainability Topics

Each topic considers the social, environmental, and economic aspects of sustainability. Topics include electricity, heating and cooling, recycling, and water. As illustrated in Figure 2, the Knowledge HUB has a section for each of the researched topics including subsections for larger topics.

## Analysis of Sustainability Topics

*Electricity* for our purposes is the supply of electric current to a house or other building for heating, lighting, or powering appliances (Google Dictionary, 2012). *Energy Consumption* is the amount of electricity being used by a household or other building for heating, lighting, or powering appliances. In Massachusetts the total energy consumption per capita is 216 million btu as of 2009, ranking it 48th in the US. The residential sector in Massachusetts used 439,501 billion btu, accounting for 2.1% of the share in the US (EIA, 2009).

*Heating* refers to the processes and equipment used in warming the air within a given space, whether it is an office, a house, or a factory. For the purposes of the Knowledge HUB, the definition of heating has been restricted to homes and residential structures. To deal with the cold winters, residents of Worcester have a variety of fuels to heat with: oil, biomass, electricity, and natural gas. Heating oil is provided by over thirty-eight local suppliers in the Worcester area ("Cost of Living" 2011). Wood also comes from either personal harvesting or local vendors (White 2011). Electricity is a joint effort between National Grid who supplies the lines and various power plants across the state, who operate on one of natural gas, oil, coal, or nuclear ("Cost of Living" 2011; "Massachusetts - U.S Energy Information Administration (EIA)." 2009). For those living in range of the pipeline, these residents also have the option of natural gas supplied by NSTAR ("Cost of Living" 2011). The specific distribution of fuels in the city is unknown, but forty-four percent of MA residents heat with natural gas, thirty-nine percent with oil, twelve percent with electricity and two percent with other sources.

*Recycling* is the process by which useful materials are sorted out of waste to be further utilized. This process helps prevent air, water, and soil from being polluted due to degradation of disposed materials. Ideally, recycling of a material would result in a new copy of the same

material with no losses coming about from the cycle. However it is generally more cost-efficient to use recycled materials in the construction of a different material ("PM's Advisor Hails Recycling." 2006). In Worcester, the Department of Public Works and Parks collects almost 1800 tons of waste every month. This is almost two-and-a-half times more than the collected recyclables in Worcester. The DPW&P divides the city into collection zones. Every day, six to eight trucks each haul out fifteen tons of waste (Trash and Recycling | City of Worcester, MA).

*Water* is a fundamental part of our lives. It entertains us with swimming pools, and water parks. It saves lives by quenching our thirsts, and puts out fires. It keeps us from getting sick and promotes good hygiene through showers and washing our hands. However, there is a limit to the amount of water we can use. Higher rates of water consumption by humans mean less water for the environment – hindering the growth of plants and animals. From 2004, the Massachusetts population is expected to grow by 10% to roughly 7 million people by 2030 ("Tomorrow & Beyond"). While the per capita use of water has remained stable at 100 gallons per day in the past two decades (Kenny *et al.* 209), the increase in water demand will put a greater strain on the local environment, increasing the risk of water shortages.

### Analysis of Serious and Entertaining Games

Serious games are designed to teach players a particular lesson (Zyda 26). For the game section of the wiki, we analyzed the serious and entertaining aspects of several games. Each entry includes a description of each game and its key serious and entertaining elements. The Knowledge HUB divides the games' characteristics into different scored categories. Each category evaluates one part, such as gameplay, graphics and social aspects. Games were rated on how they engage the player, what supplementary information the game provides, and the ease of its learning curve, among others. This way, we could determine what worked well in each and incorporate those elements into our own game. For instance, ElectroCity used clear, easy to read meters to provide to the player information about the supply of electricity throughout a city. My Eco-Home was given a similar system of meters which visualize complex information about all forms of sustainability.

## The Game: My Eco-Home

My Eco-Home (MEH) is a serious, simulation god-game[1] intended to encourage a more sustainable lifestyle for the players in their homes. MEH will simulate a person's domestic life throughout the year and illustrate the consequences of sustainable versus unsustainable actions carried out by the player. Players will also have to deal with random events in life and respond to changes in climate. My Eco-Home is a game that teaches sustainable practices by putting the player in a scenario simulating a household in Worcester, Massachusetts.

The group kept the philosophy of Learn, Plan, Act in mind while designing the game. The game itself will first teach players behaviors and ideas about domestic sustainability. Then, a

[1] A god-game is a game where the player controls the lives of multiple characters at the same time ("Definition of god-game" 2011).

separate version of the game will allow the player to plan out how to implement the behaviors and ideas learned from the game's original version. Finally, the player will apply these new ideas to his or her real life.

## Game Design

In designing the main gameplay elements of My Eco-Home, we asked ourselves the following questions: What basic functions do we need to make a game? What features do we need to convey ideas about sustainability? What in the design makes it fun to play?

To answer all these questions, we decided to implement a system of meters. There are three meters that represent the three aspects of sustainability: social, environmental, and economic. The meter system represents the win/loss conditions of the game.

Without these features in the final design, the product could turn out to be a simulation or a design tool instead of a game that challenges the player while making them want to take on the challenge by learning the sustainable solutions.

## Game Flow

My Eco-Home starts out within a house which is populated with a family of Non-Player Characters (NPCs). The player can interact with these characters, yet they are independent entities that are not directly controlled by the player. Each NPC has their own set of preset wants and needs which directly affects their health and happiness. *Wants* include consumer products and leisure activities relevant to their age. *Needs* describe what an NPC needs to survive and stay healthy.

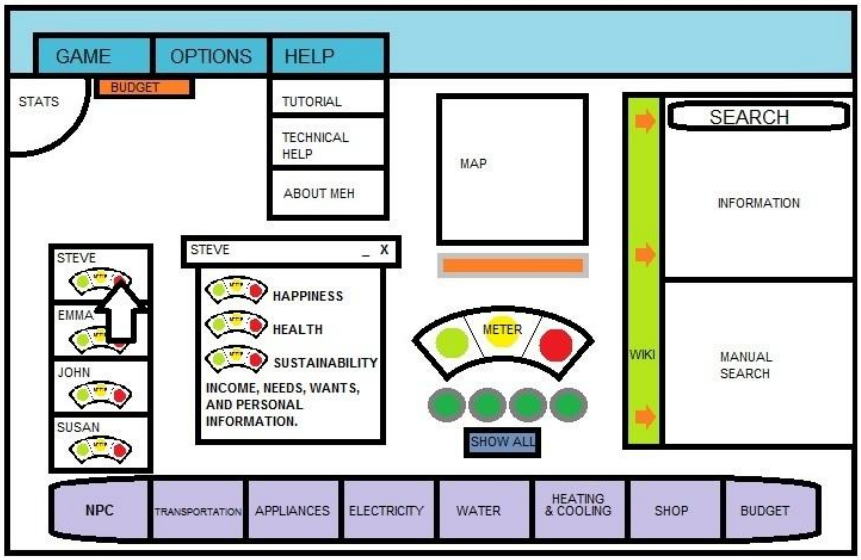


**Figure 3: Graphical User Interface for My Eco-Home**

Figure 3 shows a potential layout for the user interface for the game. The options on the bottom bar can be expanded to reveal the current status of all resources being consumed, appliances being used, and information about each NPC. The items on the bottom bar can all be described by three meters; one for each of the three categories of sustainability. The three meters will reflect the changes in available income, environmental impact, and the collective happiness of the NPC family. On the right side of the screen, a simplified version of the wiki can be accessed from a fold-out panel.

My Eco-Home starts in the spring season. Each turn signifies a month, with each level consisting of three months. Throughout each turn, NPC health and happiness are calculated based on wants and needs. Expenditures and emissions are also calculated, and the game informs the player of any random events that occur during the turn. The player keeps the remaining money from their income after the deduction of expenses from expenditures. During each turn, the player will be able to take a certain amount of actions. These actions will affect the calculations for the proceeding turn. In addition, each turn will include bill payment. Bills can be auto-budgeted, or paid on a case by case basis. Refusing to pay a bill in one month will carry it over to the next, with the addition of a late fee. If bills are ignored for too long, utilities will be cut. When the player is ready to proceed, or has run out of actions, they may choose to progress to the next turn.

The player will lose once one of the meters reaches zero. In order to win the game, the player must reach equilibrium in all meters. Once the player is satisfied with his or her progress, the player may restart the game. My Eco-Home is also designed so that each time the game is restarted it will bring a new experience to the player while providing the player with a similar learning experience.

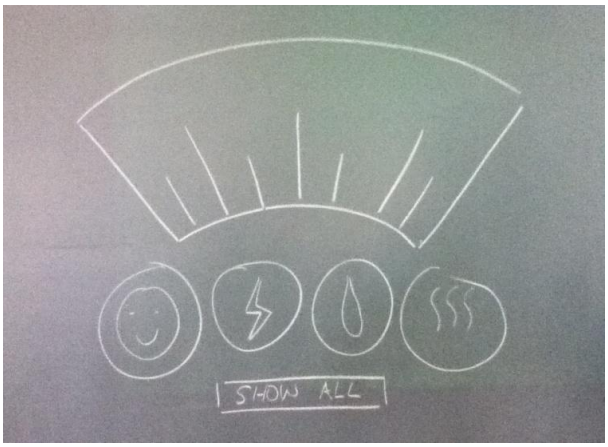


**Figure 4: Early Concepts for the Sustainability Meters on the UI**

## Paper Prototype

The group started with paper prototypes. It is common practice within the game development industry to sketch an interface on paper while a person calculates the actions of the user and provides the result, effectively acting as the computer (Snyder 2003). The group experimented with different designs until we found one that was fun and effective. This design involved a house or apartment filled with non-player characters (NPCs) that the player would teach sustainable behaviors to while buying appliances and devices for the home. Players would have to deal with seasonal changes and random events that could have positive or negative consequences. While we had originally considered quizzing the player based on the sustainability topics located on the wiki, we later decided against this, to prevent the possibility of boring the player. However, we kept an integrated wiki panel in our game's graphical user interface (GUI). The player can then read up on topics related to sustainability in-game if they so desire.

## GDD-Lite

After paper prototyping, the group began writing the GDD-Lite, a very brief summary of the core features of the game. This document outlined the larger aspects of the game with important details in place, but without the specific formatting that the final Serious Game Design Document (SGDD) would adhere to. From this, the group had a better picture of how the game should run.

## Feedback from IMGD Professors

Once we decided on a more specific direction for our game, the team decided that it would be prudent to present our ideas to Interactive Media and Game Development (IMGD) professors who provided expert feedback on our game. Their feedback proved very useful by helping us refine our ideas, and using this information along with our GDD-Lite, we drafted and revised a full SGDD.

## Serious Game Design Document

This document contains everything needed to implement My Eco-Home, from the main goals of the game to the tiniest details. According to Bryan Bergeron, writer of *Developing Serious Games*, "[t]he serious game design document serves as a communications vehicle for the development staff, as the basis for fund raising, and as a marketing and sales tool" (p. 366).

The SGDD starts out with an overview and requirements specification before delving into a section detailing the technical architecture. Some of the details under the technical architecture section extended beyond the scope of this project, so the group specified that these details were up to the development team. Some of these details include support software, marketing plan, and future updates.

Figure 5 shows the Program Evaluation and Review Technique (PERT) Chart. A PERT chart diagrams the project timeline indicating what design steps can occur in parallel or what must occur in serial ("PERT Chart" 2010). As can be seen from the PERT chart, the key aspects to the game include the user interface, graphics, characters, sounds, and programming components. The design of these aspects will be integral to the game and must be completed before moving forward with any other game components. Further aspects to the game deriving from these components include the user interface implementation, deriving from the user interface and the graphic design. With the integration of the user interface implementation and the programming for the game, controls can be developed. Beyond this point, all aspects in the game can be put together, and testing may begin. Testing may result in revisions in the game design, resulting in changes to the various components of the game. Eventually testing will be complete, and the game will be ready for release.

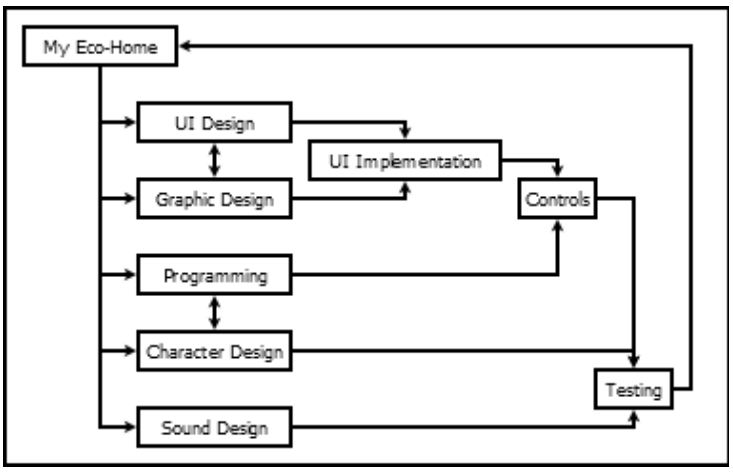


**Figure 5: Program Evaluation and Review Technique (PERT) Chart**

## Prototypes

While writing the SGDD, two prototypes were used to qualitatively judge the developmental capacities established by the game's design. Our first prototype used Adobe Flash and tested the feasibility of the game in the flash platform while also illustrating the simulation

aspect of the game. The second prototype used Javascript and web-based technologies. This prototype focused on the technical ease of expanding the game to include new features. In addition, it also made some effort to use real-world data in its calculations.

# Future Development

The team has put forth some innovative concepts with the My Eco-Home SGDD and the Knowledge HUB, but both products can serve as stepping stones to future development.

The SGDD for My Eco-Home presents some interesting ideas, but without a group to make the game, the document has limited use. The SGDD was written with the intention of another group picking up the project to develop My Eco-Home. We anticipate the group to be a Major Qualifying Project (MQP) primarily composed of Interactive Media and Game Development majors at Worcester Polytechnic Institute (WPI). Other developers may include local game designers interested in persuading the target audience to pursue sustainability. Even if the game doesn't get developed, it can still serve as a guide and inspiration to future serious games focused on sustainability.

The project group put a lot of effort into researching regional sustainability information for the Knowledge HUB wiki, and, in the process, found that good central resources for regional sustainability topics are limited. The Knowledge HUB can be repurposed into a sustainability database and research tool for Worcester and central Massachusetts. By moving the serious games information off of the wiki, it can be made into a resource focused on information about local sustainability issues, and could be maintained by a local group prepared to take on the topic. Alternatively, the wiki could be made open for anyone to edit, so anyone with an interest in the topic could contribute to the database.

The premier purpose of the Knowledge HUB is as an archive of local sustainability information, but it would also serve as a useful component of My Eco-Home. The wiki would become a combination game guide and research tool, useful both in-game and in real life. Additional information that can be added to the wiki to help supplement the game includes new gameplay features and new sustainability topics.

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