
Invasion of the Energy Monsters: A Family Board Game about Energy Consumption

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Abstract

We present Invasion of the Energy Monsters, a board game that attempts to highlight the role of family practices in household energy consumption. While household energy management activities — such as controlling heating and cooling systems — tend to be adult centric, we believe that children and adolescents have a meaningful role to play in helping their families move toward more sustainable ways of living. To that end, Energy Monsters has been designed to scaffold interactions between family members and encourage conversations about electricity consumption and waste. In this paper we provide an overview of our current design and a brief summary of results from our playtesting sessions with five families, and a description of versions that are under development.

Author Keywords

Children; environmental sustainability; board games; tractionless practices; tangible interaction; cultural forms; design; learning.

ACM Classification Keywords

H.5.2. [Information Interface And Presentation]: User Interfaces – Interaction styles;

Introduction

Efficiently managing energy use is important on both a global environmental scale [5] and on a personal economic scale. However, the knowledge and skills needed to become a responsible energy consumer seem elusive. Many adults lack an adequate mental model of domestic energy infrastructure, the basic units of consumption (e.g. kWh), and the broad ranging impact of everyday practices [2, 9, 10, 13]. This lack of awareness often leads to parents having a hands-off attitude towards devices like air-conditioning and heating systems, which in turn prompts them to actively discourage children and adolescents from participating in decisions that impact a family's energy footprint. With Energy Monsters (Figures 1 and 2) we tried to design a board game that encouraged families to playfully confront the issue of energy usage against regular household practices, and to create opportunities for informal, intergenerational learning around issues of sustainability.

Energy Monsters has gone through an iterative process in which numerous prototypes were developed and tested. We shortlisted two versions of the game for playtesting with families in their homes. Both the versions of the game incorporate traditional tangible elements such as cards, tokens, and tiles that form a game board. However, in the second design we included an iPad application as an integral feature of play. In this paper we provide an overview of both our designs and a brief summary of results from playtesting sessions of the first version of the game with five families in their homes. Our testing sessions highlight the interplay between children, adolescents, and adults, and the ways in which families drew parallels between the game and their real-world circumstances. The



Figure 1: A family playing the Energy Monsters board game.

problem this paper tries to address is not how to best provide eco-feedback to individual consumers. This has been thoroughly addressed by research communities [6, 7, 10, 11]. Rather, we are interested in how to use playful games as a way to begin to reshape, reconfigure, or give rise to practices of energy consumption involving entire families, children as well as adolescents.

Background

Energy Monsters builds upon the following areas of previous research: (1) eco-feedback technology for homes, (2) board games and play as mechanisms to encourage pro-environmental behavior, and (3) family practices and learning.

Eco-feedback technology for homes

Currently, energy consumption in homes is largely invisible; the energy distribution infrastructure hides the intermediary steps such as mining, processing, and transmission. Thus, one goal of eco-feedback technology is to help make consumption more visible in terms of scale and impact [2]. There are numerous

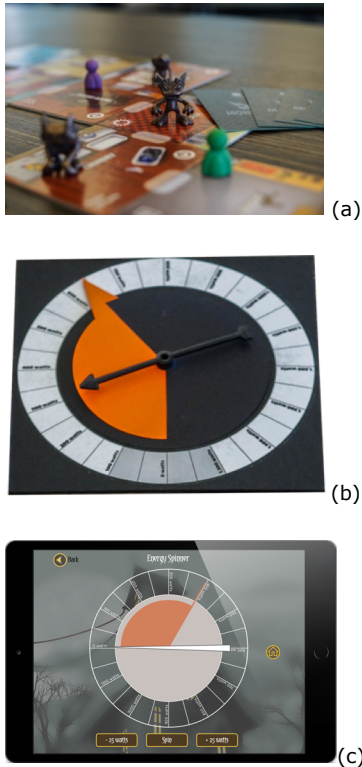


Figure 2: (a) Sample layout of room tiles, waste/monster cards fanned on the right (b) Close-up of the tangible power spinner. The orange area is variable & conveys current energy usage based on game state (c) Power spinner on an iPad app (on an alternative version of Energy Monsters) that also takes input from household infrastructure to affect game state.

examples of research in the HCI community that aims to help connect people with resource consumption. With Upstream, Kuznetsov and Paulos use a traffic-signal based metaphor to convey water consumption [11]. Gustafson and Gyllensward presented a less literal eco-feedback technology called the Power Aware Cord that gives ambient feedback by visualizing the use of energy through glowing pulses and intensity of light [7]. Froelich et al. took a broader look at water consumption by exploring eco-feedback designs based on data from fixture level sensors [6]. They emphasize the point that “eco-feedback displays do not just visualize consumption, they document household activities.”. Designing for domestic sustainability, therefore, involves not just improving the visibility of resource consumption, but also addressing social dynamics of households, and working towards a shift in social and cultural values.

More importantly for us, most eco-feedback and management technologies tend to be adult-centric (with a few notable exceptions [e.g. 3, 4, 16]). Thus children, a segment of the population that could meaningfully contribute to resource management, are potentially being excluded.

Playing to encourage pro-environmental behavior
Board games have become an increasing topic of interest for researchers in Learning Sciences and HCI. For example, Berland and Lee [1] analyzed video of college students playing the cooperative board game, Pandemic, and found evidence that players made use of sophisticated computational thinking skills in the course of game play. Nasir [14] studied children and adults from African American communities playing dominoes. Her analysis focused on the nuanced ways in which

players sought and offered help as a way to improve the game experience. These strategies became increasingly sophisticated as she moved from observing children to adults.

While not a study of board game play, Stevens, Satwicz, and McCarthy's [15] study of children playing console video games in homes is notable for what it reveals about the complex and spontaneous learning arrangements that children form during play sessions. The study also suggested a mutual interplay between “in-game” and “in-world” experiences of children as they navigate between school, homework, and play. Throughout the game design process, we were guided by the notion of intrinsic integration [8]. That is, the core mechanics of game play was tightly coupled with our intended learning outcomes.

Family Practices and Learning

There is a long history of research on the connection between family practices and children’s learning and development. A portion of this literature focuses on learning not as a formal transmission of knowledge, but as a contextualized co-construction of knowledge within apprenticeship-like relationships [12]. This often takes the form of legitimate peripheral participation in which “newcomers” learn knowledge and skills by observing and engaging with “old-timers” in a community of practice. The central idea is that learning can be understood as a process of engaging in small (but valued) acts that evolve over time. For our purposes this means that children learn, in part, by becoming more active collaborators with adults in consequential activity. With these changes come corresponding shifts in identity—how children view themselves and their role in the family. With Energy Monsters, we aim to

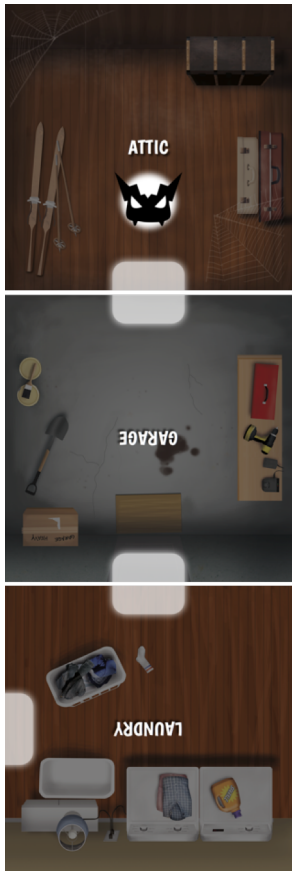


Figure 3: Close-up of connected room tiles. The attic in the top-most tile is an example of a room where an energy monster (WattWolf in this case) spawns at the beginning of the game.

encourage adults and children to collaborate and apply these principles towards household energy usage.

Design and Gameplay Overview

Energy Monsters is a family board game for 3-6 players ages 6 and up (Figure 1). The premise is that energy monsters are attacking your home and feeding off of your wasted energy. The game features a competitive style of play. Players form 2 teams, humans and energy monsters, and the humans must band together to expel the energy monsters from their home before it's too late.

In the beginning, the players build a house by arranging 15 room tiles such that all rooms are connected by doorways (Figure 3). The room tiles are double sided, with light and dark colors indicative of appliances being on or off in a particular room. The tiles are initially set with the dark side of the tile facing up to represent a room without anything being turned on. There are two decks of action cards, human and monster cards. Both teams get dealt five cards each from their respective decks. Three human tokens are placed in the dining room and three monster tokens are placed in following three *portal* rooms: the Attic, the Basement (Figure 4b), and the Back Porch. The power spinner (Figure 2b) is set to a 100 watts; this is the minimum amount used by things that are always on in a house (not necessarily the same for all houses, but is a baseline to start the game). Each team gets six hit points.

The human and monster card decks contain types of cards that are common (e.g. attack cards that can be used to reduce the opponent's hit points), as well as cards that are suitable for a particular team. For example, monsters can play the *Waste* card that allows

them to turn on devices in a particular room, while humans can play the *Switch* card to turn off devices (Figure 4 shows the attack, waste and switch cards).

Humans go first and then the monsters and humans alternate turns. On each turn, a team can do the following three actions in order:

- Draw a new card from the respective team's deck.
- Move all of the team's tokens at most 1 space through an open door to an adjacent room (doors can be locked too!).
- Play as many cards as from their hand and refill from the card pile at the end of a turn.

Play ends when all of the humans or all of the monsters are out of the game, i.e. have lost all hit points.

The Spinner

Both teams have to use a spinner when they play an attack card. The colored part of the spinner (Figure 2b) represents energy usage based on game state (sum of energy consumed by devices in each room that has been activated by the monster team).

The Monsters

Each monster in the game personifies a different form of energy waste—*Bonehead* is a mindless energy waster, always forgetting to turn off lights and appliances; *Wattwolf* loves inefficient appliances and poor insulation; and *Ampire* has a knack for things like running half empty loads of laundry or a half full dishwasher (Figure 5).

The Cards

While there are a variety of cards that are a part of the game, the primary ones are the *waste* cards for the

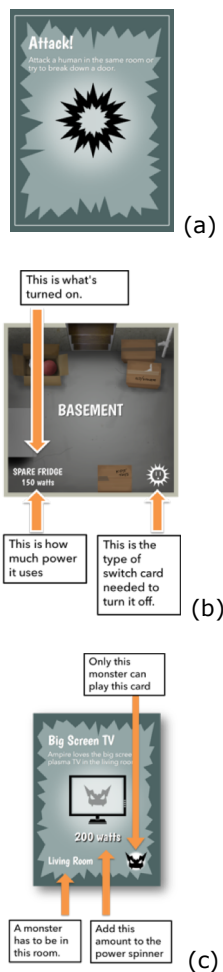


Figure 4: (a) Attack card, (b) Room tile showing required switch card & (c) Waste card that can be played by the energy monster's team

monster team, and the *switch* cards for the human team.

Monsters gain strength by wasting energy. The monster team plays the waste cards (Figure 4c) to turn on appliances and devices. Before playing a waste card, a team must move the correct monster to the room shown on the card. For example, to turn on the TV, the Ampire must be moved to the living room. After playing the card, the room tile should be flipped over to the light side and 200 watts added to the power spinner (Figure 2c).

Humans can turn things off by playing one of three switch cards (light switches, power buttons, and sockets). Room tiles show the type of switch that can be used in that room. To turn something off, the human team needs to move a token to the room and play the matching switch card. Flip the room tile back over to the dark side and reduce the power spinner by the indicated amount. Figure 2(b) shows what the values on a room tile represent if a switch card is to be used.

Learning Objectives and Initial Playtesting

Energy Monsters was designed based on the following learning objectives:

- To increase awareness of electricity consumption in homes. For example, a child may never have considered that her family's fish tank consumes electricity.
- To understand that different types of devices and appliances consume different amounts of electricity.
- To understand that many devices consume electricity even they are off or on standby (so-called vampire power).

- To become familiar with the basic unit of electricity consumption—watts(W)—even if families don't entirely understand what the unit means.

The design of Energy Monsters has gone through multiple iterations and we had also explored a collaborative version. In the collaborative version, parents and children played against the board to try and defeat the energy monsters, but in internal, as well as external playtesting, the competitive version of the game was received better by the families. Children and adults on seemed to enjoy the simple role playing built into the competitive version. More importantly, the competitive framing of the game also did not get in the way of knowledge sharing and dissemination among family members.

We are currently playtesting two versions of the game. In the first version, the game consists of only non-digital elements (i.e. traditional board game), while the second version integrates an iPad into the gameplay. In designing the second version (with the app), we were careful to balance the purely digital aspects of the app with the physical components of the board game. The iPad continues to be only one part of the game as a whole, rather than the other way around. This design decision was made in order for us to be able to integrate game play with real household infrastructure. So, for example, turning off the real table lamps can make it easier to win the game for the humans. We do this with wireless electricity meters that transmit energy consumption data to a companion iPad app (we use Apple Homekit enabled sockets that we brought along for playtesting sessions, Figure 6).

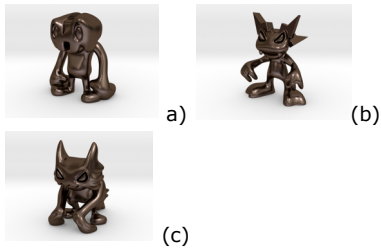


Figure 5: The 3 energy monsters (a) Bonehead, (b) Ampire & (c) WattWolf.



Figure 6: Screenshot from the iPad app where we have a mix of average energy consumption data or *actual* energy consumption data from Apple Homekit enabled sockets. This data is added to the digital Energy Spinner to affect game state.

Initial Playtesting and Findings

To evaluate our game, we have visited five families *in their homes* to conduct playtesting sessions. Participants include 7 parents and 8 children (ages 6 to 14). Each session lasted about an hour and a half. While we have seen encouraging responses – in line with our learning objectives – we are continuing to refine, playtest and compare the two versions of the game. We saw a few instances where the game helped families engage with real-world energy consumption. For example, in the following segment, a 7-year-old boy and his father used the smart socket on their TV:

Boy: I wanna do the TV.

Dad: Alright, let's do the TV <takes the socket over to the living room>

Dad: Right now it reads as 6 Watts ... now TV turns on ... it's going up. It's about a 100 Watts.

Boy: A 100 Watts now?

This exercise helped bring the relatively hidden electricity consumption of a device on stand-by come to the forefront.

Similarly, a 11-year-old girl and her father chose to use the smart socket on a table lamp:

Girl: This is the brightest lamp.

Dad: How much is it?

Girl: Only 9 watts!

The girl had assumed that a bright light consumed a lot of energy, and the subsequent conversation with her father led to discussion about why their family had

moved over to using energy-saver bulbs instead of incandescent bulbs.

Here we have only cited a couple of segments where children engaged with real-world energy consumption related concepts. However, based on this initial testing, we are optimistic that we would be able to share a conceptualization of *tractionless* family practices in the near future. Broadly speaking, our use of the word “tractionless” is meant to capture the idea that children have a difficult time getting involved (gaining traction) and in expanding their role over time as they get older. Thinking about tractionless practices may be a useful way to frame designs that target children or adolescents in sustainability activities in home.

Conclusion

In this paper we presented the design of Energy Monsters, a competitive board game. We noted that initial playtesting seems to indicate that the board game engages family members – both adults and children – to reflect upon their daily household activities and its impact on their energy footprint.

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