

# The Green Machine

## Going Green at Home

By Jeremie Jean and Aaron Marcus

Thanks to global awareness campaigns such as Al Gore's *An Inconvenient Truth*, the problem of global warming and its worrisome threat is no longer in question. However, this information, albeit frightening, does not necessarily invoke change in people's behavior and their way of life. Two vital issues need to be addressed: how to help people reduce their ecological footprint, and how to persuade and motivate them to change their behavior. Nathan Shedroff lists five approaches of sustainable design in his 2009 book *Design Is the Problem*: reduce, reuse, recycle, restore, and process. This article considers another important aspect: how to persuade people to reduce their ecological footprint. The objectives of the Green Machine, a mobile phone application that charts personal energy consumption, are to persuade and motivate people to reduce their energy consumption and change their behavior.

Our first concept focuses primarily on household energy consumption, which represents 19 percent of the U.S. total CO<sub>2</sub> emissions. However, our approach could be extended in the future to other areas, such as waste and recycling, transportation, shopping, and eating. The Green Machine is intended to build on Smart Grid technology, an important innovation that enables users to acquire instantaneous feedback about their energy consumption. Studies conducted by Sarah Darby and reported in her article *The Effectiveness of Feedback on Energy Consumption* shows that feedback has an impact on reducing household energy consumption by about 10 percent without making any important lifestyle changes. Therefore, comparing this amount to the United States Energy Information Administration data, one can readily see that we actually could save as much energy as the U.S. produces by wind and solar with simple and easy changes.

### The Green Machine: Work in Progress

We believe that simply showing data visualizations, as basic Smart Grid software will enable, is not enough to make people effectively reduce their energy consumption. We turned to persuasive techniques and the study of the behavior-change process in combination

with context of use, user-interface analysis, and information visualization in order to find ways to design a product that will make people reduce energy consumption. The result of our work, the Green Machine, is a mobile phone application based on five main functionalities:

- Providing feedback about one's energy consumption in comparison to personal goals
- Displaying a vision of the future linked to that consumption
- Enabling social interactions with social networking and energy-consumption comparisons
- Offering tips to reduce one's ecological footprint
- Providing individual or team-based competitions and games.

We have developed a prototype and are currently testing it to collect feedback about the application's usability and usefulness, as well as users' impressions about the motivational aspects of the design. User test analysis will be followed by a final redesign phase of the Green Machine application.

### Background Research

Persuasive technology, which activates an objective to motivate people to perform benefi-

cial actions, has appeared in many fields during the last decade. Persuasion is defined by Dr. B. J. Fogg, director of Stanford's Persuasive Technology Laboratories, as "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action." These persuasive applications have been developed for many different purposes, such as to encourage losing weight, quit smoking, or promoting sports and exercise. Each application bases itself on providing feedback to users about themselves and enabling analysis to increase their motivation and to change their lives through appropriate behavioral changes. These feedback-based persuasive applications have shown important beneficial results and have been applied to environmental sustainability.

Smart Grid technology makes it possible to provide this kind of instantaneous feedback about energy consumption. The challenge of designing persuasive user interfaces oriented towards the environment, however, is that most people are not intrinsically motivated to care about and change their behavior, as emphasized by Tscheligi and Reitberger in *Persuasion as an Ingredient of Societal Interfaces*. On the other hand, people with high social awareness tend to be unsatisfied with minimalist feedback, as Yun showed in *Investigating the Impact of a Minimalist In-Home Energy Consumption Display*.

Social interactions add persuasive aspects and help to increase involvement and motivation. According to Mankoff and company in *Leveraging Social Networks to Motivate Individuals to Reduce their Ecological Footprints*, leveraging social networks is a powerful tool to integrate environmental sustainability into daily activities and social context. An experiment by Cialdini and others. in *The Constructive, Destructive, and Reconstructive Power of Social Norms* emphasized the effects of neighborhood comparison in energy savings. According to the findings, people reduced their energy consumption when they found out that their neighbors had already taken steps to curb their energy use.

Competition is another way to motivate people to increase their awareness and reduce their energy consumption. For example, the "Energy Smackdown" is an internet-based challenge between individual households to reduce home energy consumption and CO<sub>2</sub> emissions.

### Analysis

The Green Machine has two persuasion objectives: *microsuasion* and *macrosuasion*, according

to Fogg's terminology. The microsuasion goal is to make people reduce their household's energy consumption and the macrosuasion goal is to change people's behavior. These objectives are intrinsically linked (as short-term and long-term objectives) although they are on two different levels. To create behavioral change through the Green Machine, we defined five key elements:

- Increase frequency use of the application
- Motivate reduced energy consumption
- Educate on how to reduce energy consumption
- Persuade users to reduce energy consumption
- Persuade users to change behavior.

Each step has requirements for the application.

Motivation is a need, want, interest, or desire that propels someone in a certain direction. From the sociobiological perspective, people in general tend to maximize reproductive success and ensure the future of descendants. We apply this

theory in the Green Machine by making people understand that every action has consequences on environmental change and the Earth's future.

We also drew on Maslow's *A Theory of Human Motivation*, which he based on his analysis of fundamental human needs. We adapted these to the Green Machine context:

- The safety and security need is met by the possibility to visualize the amount of money saved
- The belonging and love need is expressed through membership of an eco-friendly community or belonging to a particular team in the Challenges section
- The esteem need can be satisfied by social comparisons that display energy consumption and improvements
- The self-actualization need is fulfilled by being able to visualize the amount of CO<sub>2</sub> released in the atmosphere and can also be met by making donations to sustainability associations

Because setting goals helps people to learn better and improves the relevancy of feedback, the Green Machine Login page asks users how much money they want to save, or which friends' energy profiles they wish to look up.

To improve learning, the application integrates contextual tips to explain how to reduce energy consumption. It also shows tips that have been successful for other users, and other products or services they've tried.

Social interaction also has an important impact on behavior change, so the Green Machine leverages social networking and integrates features like those found in forums, Facebook or Twitter.

The Green Machine is intended to come with frequent feedback, including daily energy-consumption snapshots, a future-Earth metaphor, and social interactions, such as energy comparison, friendly challenges, or added comments. We also aimed for long-term

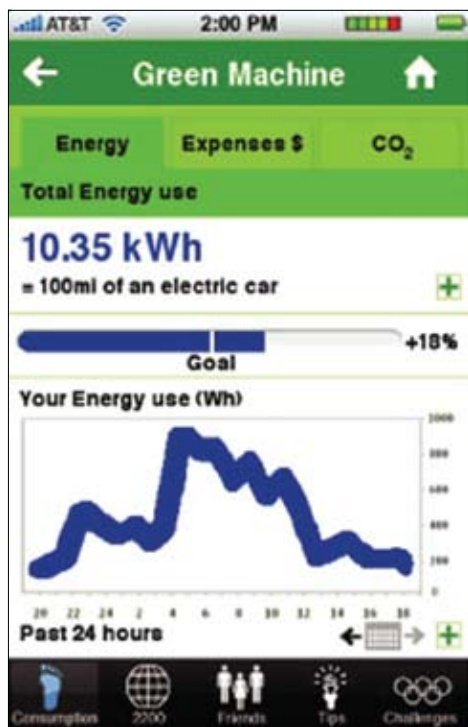
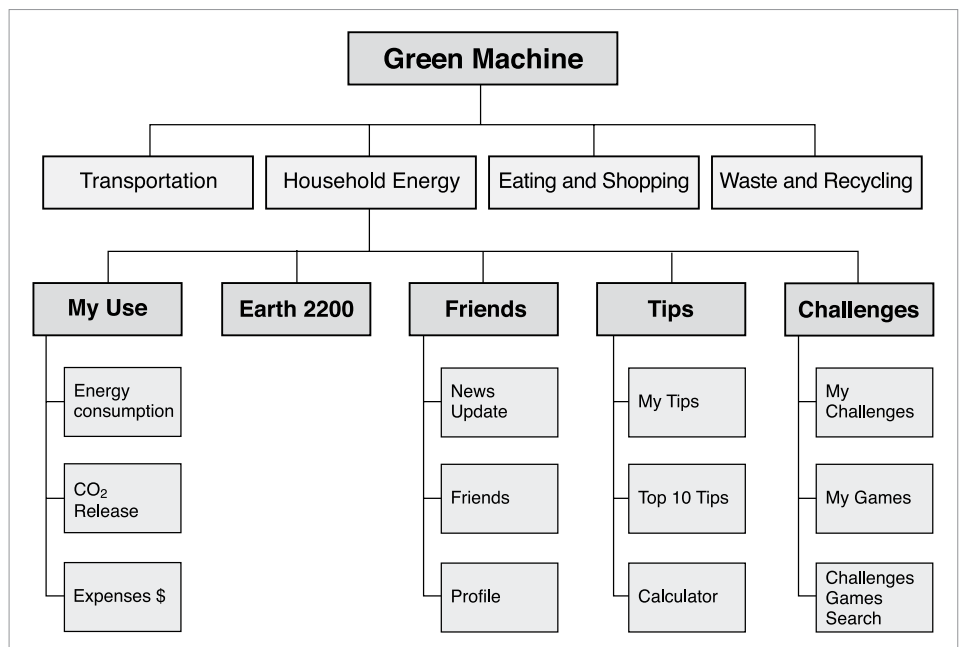
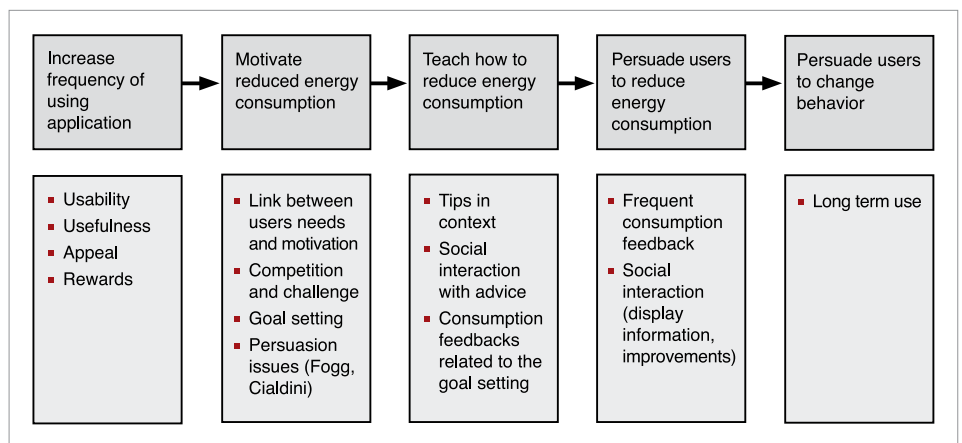


Figure 1. (Above) Machine Total Energy Use screen enables users to visualize their energy consumption in kWh (kilowatt-hour), currency, and CO<sub>2</sub> release. The screen also shows goal-setting insights and equivalent comparisons. The Calendar function and extra features will enable other types of comparisons to be made.

Figure 2. (Top right) Five-step change-behavioral process that effects the Green Machine design and catalyzes specific detailed solutions.

Figure 3. (Right) Green Machine information architecture.



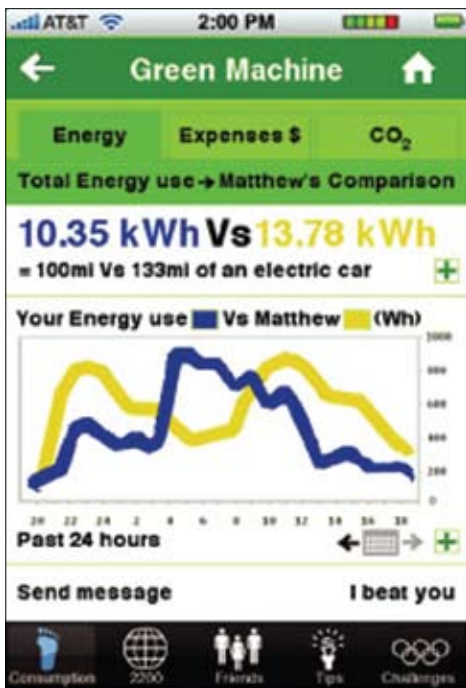


Figure 4. Green Machine Total Energy Use Vs. Friend comparison

use because, as Darby explains, it takes over three months for behavior change to become permanent.

To meet user requirements for a convenient, accessible product that matches the context of use, is suitable to other activities, is always on, and is at people's fingertips, we decided to make the Green Machine a mobile phone application. This choice makes it available on the most common and well-known electronic device in the world today.

## Design

The background research and succeeding analysis emphasized five main issues: feedback, future-Earth metaphor, social interactions, tips, and competitions/challenge.

The interaction and visual design was a particular challenge on the small screen of a mobile phone.

We decided to use a tabbed navigation so that every action can be achieved in less than four clicks. Users know exactly where they are in the application architecture thanks to the screen title information. The visual design is based on typical iPhone styles because of the product's brand image: trendy, with "early adopters" as the target market, and the application download capability. In the user interface, the small energy thermometer is always displayed at the top of the screen and shows the current household energy use.

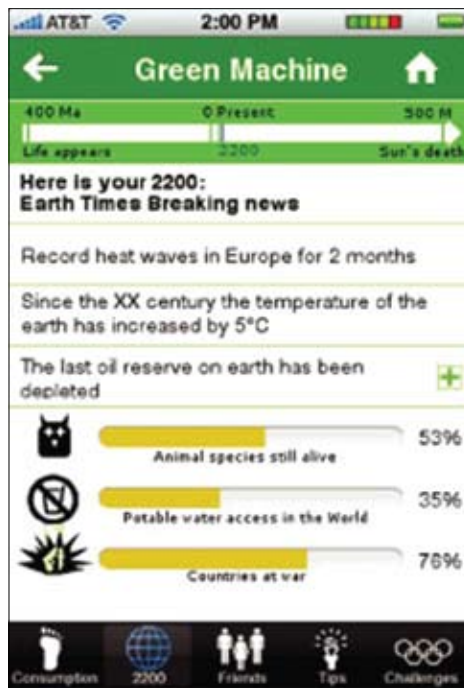


Figure 5. Green Machine Earth in 2200

The Energy tab (Total Energy Use) displays the kWh consumed, the money spent, and the amount of CO<sub>2</sub> released. Users can visualize this total energy use in different time periods such as a day, week, month, or year. This energy use is automatically compared with one's goal settings.

Social interactions are also included. Friend and celebrities comparisons enable users to select one of their friends or one of the many celebrity (for example President Barak Obama or Al Gore) using the Green Machine and compare consumption.

The Earth in 2200 screen displays breaking news according to one's energy consumption. If there is high energy consumption, the state of the Earth is shown with dire consequences, such as increased environmental refugees, outbreaks of wars, and biodiversity endangerment. For low energy consumption, we view a healthier Earth with sufficient food, water, and greater chance for peace.

A networking tab is aimed at motivation through social interactions. Users can read and visualize news from their friends with regard to how much they have consumed, what their challenge results were, which tips were helpful, what their current energy use profile is, and to which charities they have provided donations.

The Tips tab enables users to learn how to reduce their energy consumption. The data visualization for each tip maps the cost and the amount of potential reduction. This information

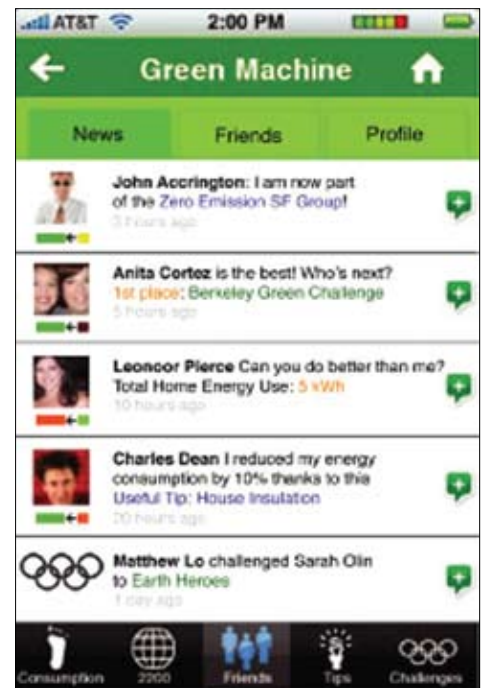


Figure 6. Green Machine friend screen

gives users a direct view of the impact of tips they choose. An individual tip also shows how many friends have used it and found it helpful, their additional comments about a particular tip, its price (if it is a physical product like a light bulb), distance to the closest store to buy it, and the overall rating given by Green Machine users.

The Challenge and Games tab has different competitions for users to reduce their energy use. Individual and team-based challenges are available to meet pro-individual and pro-social personalities. A game mode offers relevant video games to help people reduce their energy consumption.

## User Test

Our next step will be user tests of the Green Machine. The primary objective is to identify usability issues with the Green Machine application's user interface. We shall also assess whether users believe the application would make it easier for them to reduce their energy consumption and whether users believe the application could encourage them to make further reductions in their energy consumption.

These tests will gather both quantitative and qualitative results. Sessions will include free exploration to gather first impressions about the Green Machine and expectations for content and functionality. Participants will then complete a task scenario with a retrospective think-aloud.

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Finally, they will complete questionnaires, covering both their energy consumer and green profile and their evaluation of the usefulness of the Green Machine. We are particularly interested in whether or not users think that this application could motivate them to reduce their energy consumption.

### Discussion and Conclusion

The work on the Green Machine aims to incorporate persuasion and motivation for behavior change into a mobile phone application. This project shows a possible effective use of the information from Smart Grid technology in combination with mobile technology infused with persuasive design techniques and visualization.

Although previous research seems to indicate that such an application will have some impact on energy consumption, it will be interesting to gather actual user data and to study cross-cultural differences in the results of user testing as well.

Our long-term objective for the Green Machine is to create a functional working prototype so that we can test whether it actually makes people reduce their energy consumption in the long run, under real use conditions. If our theories are proven to be correct, this could have significant implications on the use of Smart Grid software, which is slated for a significant expansion over the next few years within the United States. **UX**

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### About the Authors



*Jeremie Jean has worked as an analyst/designer for Aaron Marcus and Associates, Inc., where this work was essentially completed. He has experience in usability analysis, interaction design, and user testing. He is a French graduate student from a Master's program for cognitive psychology applied to user interface design and evaluation at the University of Toulouse, France.*



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