Energy Jackets' Proposal

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4/16/15

Problem Statement.

How might we motivate homeowners to develop more energy efficient habits, through personalized feedback and education?

Problem.

Many people in developed countries use more energy than their fair share based on population size. Specifically, “Americans constitute 5% of the world's population, but consume 18% of the world's energy,” (BP,2014). Many people in these developed countries attribute this fact to the expansive business sector. According to the U.S. Energy Information Administration, however, “1.11 billion metric tons of carbon dioxide emissions were contributed annually by the residential sector in 2013,” (U.S. Energy Information Administration, 2013). These carbon dioxide emissions lead to adverse health effects for humans and animals, climate change, destruction of ecosystems, and tax dollars being put towards reducing the effects of human-caused pollution. The high and ever growing value of greenhouse emissions is caused by people’s unsustainable lifestyle and companies’ poor practices. Many researchers are searching for new alternative energy sources, but those are either currently unsustainable or nonrenewable and will become depleted. The renewable resources that researchers are currently optimizing are not yet efficient enough to replace currently used nonrenewable resources such as coal and oil, so behavior change is necessary. Companies are working toward creating more energy efficient products, but nothing is more efficient than reducing human energy consumption overall. Additionally, due to the population growth and growing reliance on energy, it has been stated that “from 2008 to 2030, world energy consumption is expected to increase by more than 55% ,” (Royston, 2009).

All of this information combined lead our team to study how we can change energy consumption habits so that they are more sustainable and less wasteful. We predicted that the reasons why people do not practice more energy efficient habits are that they are not motivated and educated on their actions’ impacts enough. We tested the first half of this hypothesis by conducting a case study on our team. We compiled a list of changes to our daily behaviors that would save energy and tried to incorporate them into our daily lives. Some of the proposed tasks included unplugging all appliances not in use, turning off lights and HVAC when leaving our dorm rooms, and taking shorter and colder showers. Based on our teams success and failure in certain tasks we looked at the motivators behind why we achieved and we failed to complete certain tasks. These reasons included apathy, forgetfulness, and inconvenience. These are the causes we will be targeting in order to solve the lack of motivation to save energy. Interviews with experts in the field supported our four reasons; for example, Dr. Ruth Kanfer, a Professor of

Psychology at Georgia Tech stated that in order for people to develop new habits, “They need to be provided with constant feedback.” Additionally, Mr. Michael Leasure, the Associate Director of the Energy Conservation Department, stated that “The population will be motivated to conserve energy once they realize the extent of the positive impact they have on the environment.” Additionally, we found that the main reason we did complete certain tasks was because of already existing habits that we were raised with as children, again reassuring the idea that developing habits is a way to solve this issue.

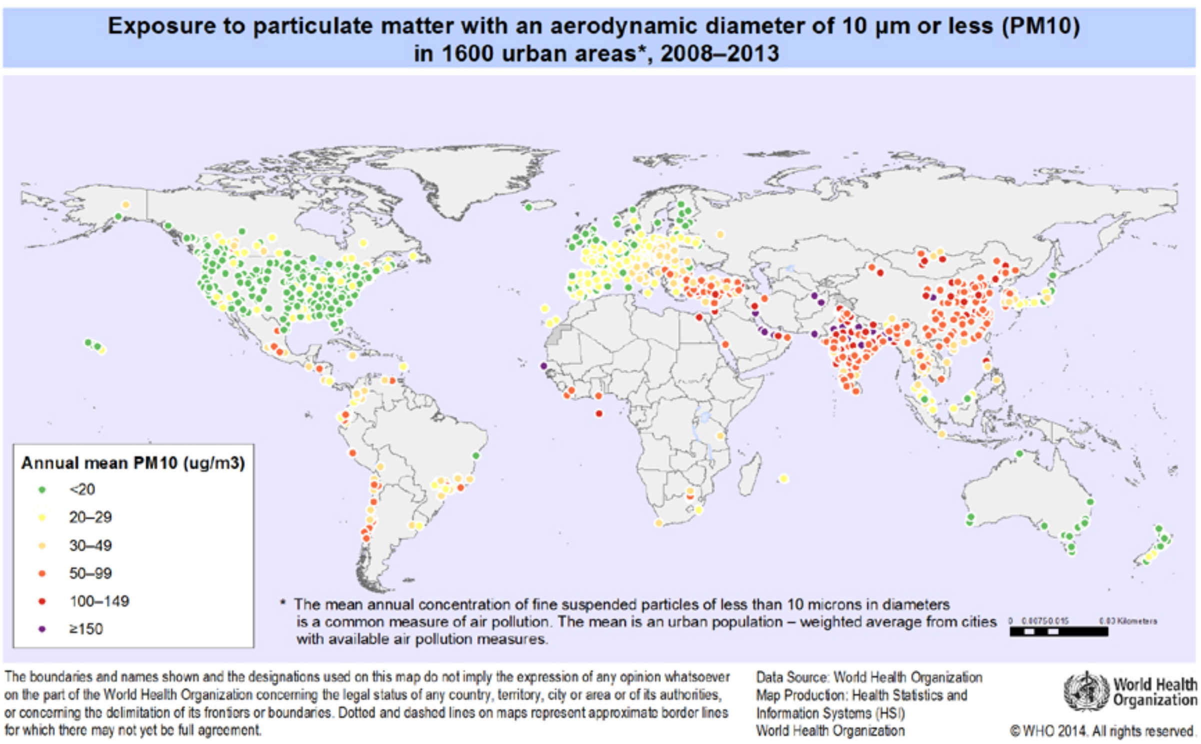
One roadblock is the difficulty of breaking habits. Even if someone is notified of their destructive habits, it is difficult to break formed habits. Based on an National Public Radio Broadcast by *New York Times* business writer Charles Duhigg, habit forming is a three-step process. The first step, the cue/trigger, tells the brain to go into an “automatic mode.” The next step is the routine, or the behaviour itself. The third step is the reward, which helps the brain remember the action in the future. When a habit is being performed, the prefrontal cortex of the brain goes into a sort of sleep, making it easier to perform the action as there is little concentration required. Punishments are used to help break habits. These can come in the form of positive punishment, such as adding something unpleasant like a bad smell associated with drinking alcohol or negative punishment, such as removing something positive, like a time-out. Our project will involve creating a method to help people break their large energy consumption habits and helping them form energy efficient habits.

Stakeholders.

The four most important stakeholders pertaining to this problem are residential energy consumers, energy providers, health organizations, and government organizations. The importance of energy usage to these stakeholders varies within groups. For example, while some residential home consumers are worried about their power bills and would therefore like to save energy, others in apartments pay a flat utility rate and do not need to worry about the amount of energy they use. As a general observation, some people do not see a significant payoff resulting from switching to more efficient and energy friendly habits or products.

Energy providers consumed with business and in general more energy usage means more money. However, hours of peak usage requires the providers to use less cost-efficient means of producing energy, so saving energy would be beneficial for them during these hours. As a result of this, some energy providers have developed incentives to save energy. For example, Georgia Power has a time of use rate plan, in which energy costs increase during peak hours.

Due to the carbon dioxide emitted and pollution caused, international health organizations are concerned about the negative effects of high energy usage. Many start campaigns to reduce energy usage and present to the United Nations to establish and execute energy caps. Local health organizations would be the most impacted, due to something known as the Jacobson Effect. Essentially, carbon dioxide emissions can cause a sort of “dome” around a local community, resulting in pollution being worse in that area (Jacobson). The best examples of this are Mexico City, Beijing, and New Delhi. The World Health Organization released a detailed study in 2014; a chart from the study is given below ("Exposure City Level 2014"). Finally, the government has created branches that are concerned with energy usage. The Environmental Protection Agency (EPA), while not directly associated with energy itself, is concerned for the negative environmental impacts of high energy usage and greenhouse emissions. The EPA also lists multiple active programs and initiatives that limit energy use and emission production (“Programs”).



Context and Existing Solutions.

Energy usage in many developed countries is still a problem because, despite all the solutions and methods that have been devised to conserve energy, people love comfort and tend to avoid even a small change that causes minimal discomfort. It is still an unsolved problem because this problem space is not a priority for many individuals, and many don’t know the negative impacts that their actions have on the environment. For most, energy is a luxury that they have worked and paid for and they do not see the adverse effects that excess energy usage causes to the world. In other words, people lack the basic motivation to save energy which is a huge factor that many existing solutions do not account for.

For example, SmartMeter technology was created to allow consumers to see how much power they are actually using in real time. By showing the power being used, energy companies hoped that consumers would become more knowledgeable of their energy usage and change their habits, therefore cutting down on their energy usage. However, even after fixing 50 million smart meters in American households, the overall energy consumption has not changed (Mooney). The problems with the SmartMeter and many others like it are that the data that is being collected isn't being coupled with the research of human behavior for habit formation. The data that is presented in these solutions are in units that normal consumers do not understand, such as kilowatt-hours. Presenting the amount of energy people are using in real time is a revolutionary idea but when the data is incomprehensible, it's useless. In addition, this information isn't located in accessible locations and people can't see how their actions will affect their energy use or the world. All of these flaws contribute to why there hasn't been a successful solution thus far.

One company, Belkin, is attempting to fix the issues stated above as well, with a home automation app and product line to help users easily monitor and control their energy usage. Users can purchase various WeMo products, such as light switches, power strips, individual outlets, and space heaters, and both turn each product on and off as well as monitor the energy usage behavior of each product. The app sends notifications showing, in real-time, how much energy users' electronics are using (Belkin). However, this app requires extensive consumer work to make their home and all appliances compatible with the app through the purchase of other Belkin appliances (cost estimate about $50 per outlet in use).

As technology advances, new companies are starting up with new innovations to analyze energy usage. One of these new companies is called Persistent Efficiency, and they created an electrical sub-meter that sticks on to individual switches on a home's circuit breaker. It wirelessly tracks electricity usage through each circuit, and does not require expert installation. Users can view the data it gathers on it's installation or export it to somewhere else. Persistent Efficiency is focused on selling these meters to companies with large buildings. Although this product is technologically innovative, it is very new and has yet to become widespread.

Related Apps.

While we found many ideas and models of apps that would encourage energy saving, all of them either did not reach the market or received very poor reviews. Furthermore, those apps that were not related to a product did not reach many downloads; only if they were paired with a company did the app receive attention. However, many of the apps showed promise through winning awards and getting praise. Ultimately, poor execution has prevented a successful implementation of an app. A few examples include:

Light Bulb Finder	Has similar goal to our app, but focuses specifically on lightbulbs. It includes carbon footprint, annual costs, and environmental facts, but has no real time data and has a very narrow scope.
Goodguide/ LabelLookup/ ClimateCount	Shows which companies are good environmentally, gives ratings based on company choices. Has small, outdated databases or faulty interface.
Leafully	Converts energy terms into simple conversions by inputting data from lighting and making the data interactive. Won an app contest, but the app itself was never released.
VELObill	Focuses on the cost of energy rather than environmental impact, but again looks at energy usage and how to save money. Again, won second place but the app was never released.
Green tip	Has tips on how to reduce waste in household. Not much different from an internet search.
Georgia Power App	Significant downloads, but not much stress on environment; mostly used as paying bill platform. Has some interesting stats on one's energy usage that could be useful.
Electricity Bill Manager	Platform that allows person to pay multiple bills online, and track overall costs of utilities. No focus on environment, but is a popular download due to its convenience.
Welectricity	Website that allows a person to create a model of their home by listing their appliances and submit their energy bill information. The website then uses this information and evaluates the user on their energy consumption and compares him to his friends through Facebook or user profiles. It provides charts and graphs similar to what we want to provide.

Proposed Work

Goal.

Our goal is to create a device which homeowners will be able to install enabling them to get live feedback on their personal energy usage in different parts of their home. This live feedback will then allow users to gain positive reinforcement and education regarding their actions which will then stimulate behavioral change and the formation of new energy efficient habits. We will be targeting the Atlanta suburbs because we have already established contacts within Georgia Power and energy professors at Georgia Tech, so geographic location is important in these initial stages. The impact our team hopes to induce is reducing the carbon emission footprint of atlanta suburbs. The use of our app in 500,000 homes will decrease the CO2 emissions of Atlanta by 4,300 metric tons a year, assuming our device and application helps reduce household energy yearly by 1%. At a minimum, our device should help all users drop to below the country's national average of 909 kWh/month, since Georgia's consumption currently exceeds that value by 100 kWh/month.

Desired Product.

Our product will be a device that will monitor energy usage in different regions of a home and relay the usage to the homeowner, providing live feedback which will be necessary to make the homeowner more aware and likely to develop new habits. The device will connect to each circuit in a home's circuit breaker and monitor the current through each circuit using an ammeter, solenoid, or other type of sensor. The hardware will consists of non-invasive ac current sensors the will be attached to the wires of the circuit breaker. Their measurements will be processed by a microprocessor (arduino) and sent via a wireless radio to a raspberry pi with storage. The raspberry pi will then perform the calculations to make the data relatable to the user and send said data to an app and computer program. Because the device will be connected to each circuit in the home, it will provide more detailed data on the homeowner's energy usage, more so than a smart meter which only gives the total energy usage of the entire house. Our device will divide the house into regions and then provide feedback making it easy for users to identify what appliances or regions of their home are most used or are using the most energy.

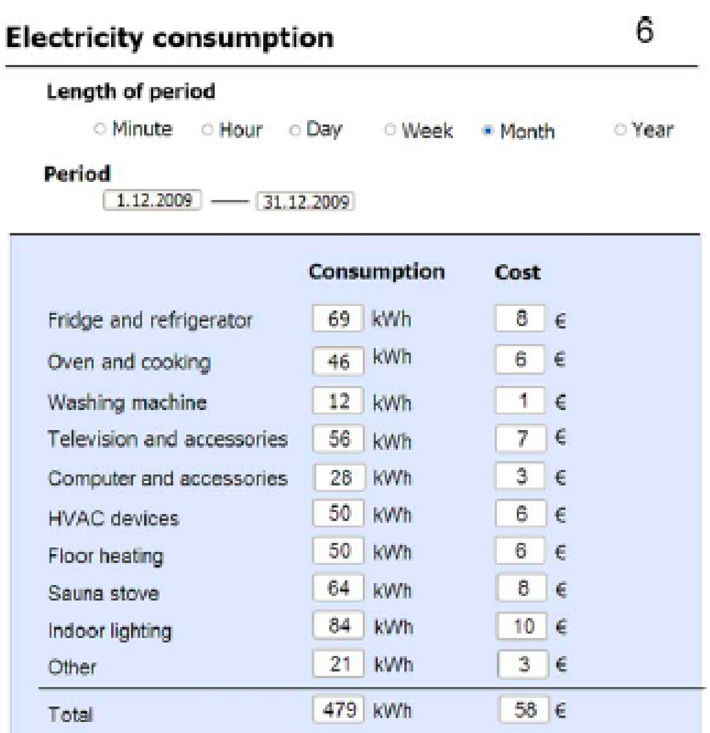
Our second product which will be worked on only after the hardware side has been completed will be a smartphone mobile application that will be paired with the hardware. The app will be used by consumers to motivate them to change their behavior and become more environmentally friendly. It will provide users with real time data of their energy usage as well as constant feedback about how they can alter their actions to reduce energy usage. The data provided will be for the house in general as well as by each circuit. This will allow us to display as close to appliance-based energy usage as possible.This app would provide users with understandable energy conversions so users can relate leaving their lights on for 10 hours to how many pounds of carbon dioxide were burned to sustain that action. Or to be even more relatable, the app would then converting that number into number of trees that would be needed to absorb all of the emitted carbon dioxide. Users will have the option to choose which combination of units they would like to see displayed. This will allow those most motivated by money to see the money saved. People who are not as motivated by the money saved can see the environmental or health benefits to the community, such as the decrease of respiratory conditions and diseases, of their reduced energy consumption. The feedback from the app will also include information on progress made on a daily, weekly, and monthly basis, in order to further encourage the newly developed energy efficient habits. In addition, our app will provide additional incentives for use, by informing them of their monetary savings and creating social motivation. Through reducing energy usage by following the advice we provide through our app, users can build a energy score which will be shared publicly. There will also be comparisons with similar houses in users' neighborhoods. This will allow users to see if they use more energy than similar houses, prompting them to find more energy efficient behaviors.Users will be able to compare their energy usage to their own energy usage in the past. This will allow users to see their improvements based on their behavioral changes.This energy score will allow users to feel competitive amongst each other and thus feel the need to save more energy. This app will therefore make users more conscious of their energy consumption behaviors and encourage them to change them.

Justification of Product Concept.

There have been many studies addressing the effect of providing feedback of energy usage on consumers. A study by Sami Karjalainen of the VIT Technical Research Centre of Finland looked at consumer preferences for feedback on electricity consumption in the residential sector. Three types of feedback were identified in article: direct, indirect, and inadvertent. Direct feedback, the most beneficial type of feedback leading to savings between five and twenty percent, includes self-meter reading, interactive feedback from a computer or mobile device, or an in-house display. Indirect feedback comes from improvements in energy bills (more frequent bills and historical and normative comparisons on bills). An example of inadvertent feedback is when a user buys a new appliance and information on its energy consumption is included on the packaging of the device. There are many different factors to make each type of feedback more effective. For example, Karjalainen suggests including a virtual reward when including a normative comparison as part of the energy usage feedback so a person does not lose motivation to conserve energy if his or her energy usage is the lowest in his or her neighborhood. Another point that we will have to consider when providing feedback is to insure that we are using specific goals. An example of this is, when providing a historical comparison, stating “my goal is to reduce electricity consumption by 10% compared to the previous month). We also have to make sure we convert any scientific units into more understandable and relatable units, such as monetary units or environmental impact. We began to do this already by evaluating how much money and trees will be saved by completing certain tasks such as unplugging a computer for 8 hours overnight or taking a ten minute shower instead of a twenty minute shower.

One effective display of energy feedback was Power Flower. This feedback display won a competition by a large energy company in Finland, Helsingin Energia (Karjalainen, S.). The design featured a flower that changed shape and color depending on energy use, with an intense color and large shape while energy consumption is low based on real time data and appearing dead if a large amount of energy is being consumed. Karjalainen stressed, however, that accurate and detailed data with specific values is required in an effective feedback display, though the design offered a easy to understand visual. The study overall found that the features most valued by consumers were: presentation of costs(over a period of time), appliance-specific breakdown, and historical comparison (with own prior consumption) (Karjalainen, S.).

The most effective Interface Design (as voted on by participants in the study) was the following display. Users found this display the most effective because it offered a breakdown of both consumption and cost on an appliance-based level as well as providing periodic increments from minutes to years.


Electricity consumption 6

Length of period

○ Minute ○ Hour ○ Day ○ Week ● Month ○ Year

Period

1.12.2009 — 31.12.2009

	Consumption	Cost
Fridge and refrigerator	69 kWh	8 €
Oven and cooking	46 kWh	6 €
Washing machine	12 kWh	1 €
Television and accessories	56 kWh	7 €
Computer and accessories	28 kWh	3 €
HVAC devices	50 kWh	6 €
Floor heating	50 kWh	6 €
Sauna stove	64 kWh	8 €
Indoor lighting	84 kWh	10 €
Other	21 kWh	3 €
Total	479 kWh	58 €

Another study looks at how peer networks affect electricity consumption. The research study, “The impact of peer network position on electricity consumption in building occupant networks utilizing energy feedback systems” by Gabriel Peschiera and John E. Taylor, looked into into the how peer networks impact consumption information. The study looked into a Watt Hall, an 88 room dormitory at Columbia University in New York City. There were 44 rooms as control with no feedback provided on their electricity consumption and 22 rooms in both Group A and Group B. The study used HOBO U30 Data loggers to monitor electric current for each room over 5-minute intervals. The subjects in Group A were given access to room-level electricity data and per capita electricity data. Subjects in Group B were given access to both room-level electricity data and peer room-level electricity data. Peer groups were determined using lists for friends to mutually sign up on. Group A saw a graph displaying their electricity usage compared to the average per capita electricity usage while Group B saw their data compared with the average electricity consumption of their peer network. Analysis of the groups showed that Group A’s electricity consumption remained constant while there was a statistically significant 8.8% decrease in electricity usage by Group B compared to the control group. Based on this study, we should utilize peer networks as part of our feedback displays to further decrease electric consumption.

A third research study conducted in Sweden by Iana Vassileva and Javier Campillo titled “Increasing energy efficiency in low-income households through targeting awareness and behavioral change” looked at the analysis between two low income neighborhoods in Sweden and the way energy consumption was displayed. While we are not planning to specifically target low-income households, some conclusions the researchers came to are applicable to our problem space. Analysis of the results of the study that participants in Group 1, who were on average older than Group 2, preferred more “old-fashioned” methods such as energy bills while Group 2 preferred in-home displays. Also, Group 1 did not put any effort into stopping standby power, such as unplugging chargers when not in use, due to inconvenience.

Objectives.

Objective 1: Develop a technology that can be easily be installed to a home circuit breaker that would record and transmit energy usage data.

Background:

It will be necessary for the product to be easily installed into a home with an existing circuit breaker so that people are more motivated to buy the product. If the product is difficult to install and requires extensive work, or the need of an electrician, then people may be discouraged from buying it. However, if we can partner with an energy company, then they can offer our product as a service to customers and can provide free installation for consumers. Or ideally, the product would be easy enough for an untrained homeowner to be able to install it. Furthermore, the product needs to be able to interface with existing circuit breakers as opposed to when circuits are being set up in the home, so our target population for the product will not be reduced to only houses that are currently being constructed or renovated. The interface should be simple and not require many changes to the existing circuit breaker so there is reduced chance of damage in installation.

Methods:

1. We will need to do consumer research regarding how much time people are willing to spend on installation and what degree of work they are comfortable with.
2. Before beginning design we will need to do research on how circuit breakers work and possible ways to interface with them in order to make an effective prototype.
3. Acquire a mentor who will oversee us while we prototype this hardware.
4. Prototype the hardware.
5. Evaluate people's response to installing the hardware themselves.
6. Redesign based on feedback and re-prototype.

Outcomes:

If the product is easy to install it will be able to reach a larger population. This objective will be measured by giving the prototype of the solution to several individuals of different backgrounds regarding circuit breakers and receiving their feedback and critiques on whether they felt comfortable installing it on their own, if the directions were clear enough, and if the installation required too much of them or required more effort than they were willing to put in. This objective will be deemed a success if 75% of the people installing it give positive feedback on the topics above. One measure of success will be if the installation period for our product is within a 10% range of the installation period found in our research for Step 1.

Anticipated Problems:

Possible barriers include little upfront knowledge in this field. Additionally, we might encounter a roadblock while optimizing the prototype, such that we can not meet the expectations we set for our product (i.e. we cannot have an easy installation). Lastly, we might not find volunteers to try our product and give us feedback used for future prototypes.

Objective 2: Develop a technology that will have a cheap total cost including the price of the product as well as the possible installation fees.

Background:

It will be necessary for the product to be cheap and cost effective for a consumer to buy, in order to motivate the purchase of this product. It will be difficult to convince users to buy a product that will simply provide information on their energy usage without allowing them to control any of their electrical outlets such as if they had a smart home. Maybe people may not initially see the benefit of installing our device, especially if it is expensive, more so than the savings it would bring to the home. Installation and the cost of the product must have a relatively quick payoff in order to appeal to the customer. This specific value will come from estimates of how much the user could save every year while using this product and becoming more aware of their energy usage. The cost of the product can not exceed the savings that it will bring the user. Therefore if the customer is saving around $100/year, they will not be willing to pay $300 or more upfront, because it will seem too expensive and too large of a cost for a service that will only be providing information. Additionally, the cost will need to be affordable for the average homeowner to buy (Johnson, Erik).

Methods (as described through an interview with energy economist Erik Johnson):

1. We will need to do customer research on how much a customer would be willing to pay for our product.
2. We will need to experiment with our prototype in households in order to see what quantity on average is saved by users
3. We will need to research what materials are needed and their costs.
4. We will need to research fabrication and installation methods and cost
5. We will need to prototype several different designs and evaluate how efficient they are with respect to how much they cost to manufacture and install.s.
6. Test prototypes and redesign and optimize them.

Outcomes:

This objective will be deemed a success if our product price is less than or equal to the price point that we calculate from researching what people are willing to pay. However, it will be essential for the product to still be effective and not have the quality of the product be compromised. The product will still need to meet all of the requirements of objective 1.

Anticipated Problems:

Homes have on average between 15 and 25 circuits depending on the size of the home. In order to provide information on each of these circuits, hardware will need to be provided that will need to connect to 15 to 25 circuits, which means the overall product will have an innately higher cost. Additionally, there will be size constraints in how the hardware connects to the circuit breaker, which will increase the cost.

Objective 3: Develop means for the technology to interface with the user to provide feedback that will be motivating enough for the user to develop more energy efficient habits.

Background:

In order effectively communicate to users their energy usage, we have two display methods. Option one is a physical display located in a central location in the house. This smart display will show the data received from the circuit breaker mounted hardware in simply quick depictions for easy viewing by the user. Option two is the app that was detailed above in the desired product section. We chose to do a complimentary app over a display, because the app will be more accessible and more detailed. A physical display will need to be simple and therefore cannot provide the level of detail that an app could. The app will be able to provide a more detailed breakdown of energy usage based on appliance/section of house, conversions, and peer, neighborhood, and historical comparisons. Additionally, in order to view the data the user would have to get up and go to that location of the house, and the user could not view their energy usage if they are out of the house.

Methods:

1. We will need to conduct research on effective graphic design and feedback methods to users.
2. We will need to learn how to develop an app to complete all of the tasks we desire of it.
3. We will need to have a beta testing phase in which we provide the app to users to get their feedback on if the data provided by the app was impactful on their day to day behavior.
4. Essentially we will need to evaluate how we are presenting the data and what data we are providing and its effectiveness.
5. Possibly contact GC'13 Fulcrum group about how they created their app and what steps they took to complete it.
6. We may also attend a hackathon in the fall to learn more about what it takes to develop on app.

Outcome:

This objective will be deemed as successful if over a period of 30 days, it helps users reduce their energy consumption by 10%.

Anticipated Problems:

Anticipated problems include lack of knowledge in programming. We may need to acquire a Computer Science major in order to help us program this sophisticated app.

Team Composition.

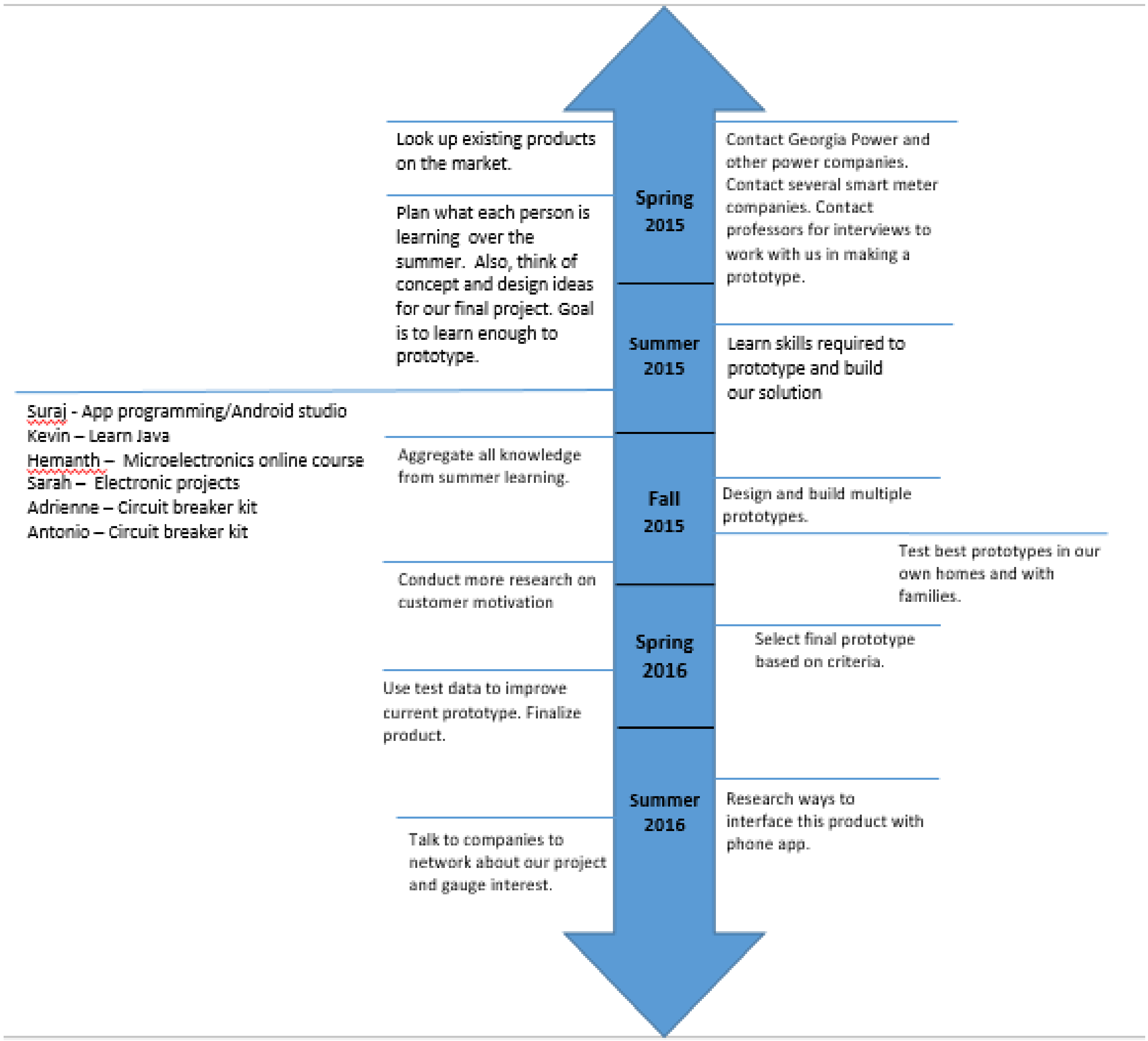
Our team has six members. We will split into 4 groups based on the necessary roles that need to be fulfilled. The teams will consist of a communications sub-team, a human preferences sub-team, a hardware design sub-team, and a software design sub-team. The communications team will be responsible for communicating with outside partners and companies to discuss what our team mission is and how that would fit with their interests. They will be in charge of finding partnerships and finding means to achieve tasks such as collaborating with other companies to share data acquired. The app portion will be very interdisciplinary and will therefore need many points of contact which our communications team will head up. As mentioned above, the app will require information on user preferences and feedback, in order to make it as effective as possible. Our human preferences team will be responsible for finding data on user interests before the app is designed as well as organizing a testing and implementation method for people to download the app once it has been created. Additionally, they will communicate what user feedback and suggested changes back to the software design team. The software design team will need to consist of one or more programmers and one or more designers who will work closely with the human preferences sub-team on improving the app and redesigning certain aspects. The team of 6 could be split up in the following ways based on intensity of jobs: 1 communication member, 1 human preferences members, 2 hardware designers, and 2 software design members. Sarah Selim will hold the communicator position, Kevin Pagan will hold the human preferences position, Suraj Greenlund and Adrienne Dooley will hold the hardware design positions, and Hemanth Koralla and Antonio Lee will hold the software design positions. These positions were allocated based upon member interest as well as skills possessed by each member. Additionally, knowledge in circuits will have to be developed if we are to pursue the circuit break path. Because the software and hardware go hand-in-hand, those designing the software must be adequately knowledgeable on how the hardware works, and they will also be tasked upon understanding the hardware and how it will interface with the software. However, the team as a whole will be working on developing the hardware, because it is such an integral part of this project. The communications team will have to be able to explain how the hardware works to potential partners, and the human preferences team will have to be able to explain the hardware to potential customers.

Skills needed to be a communication member will be good oral and written skills, as well as the ability to conduct themselves professionally with adults. They will have to communicate clearly within the team in order to convey information concisely to outside partners. A confident individual will be needed so they can effectively convince companies and partners to join our cause. The human preferences team will need to have good people skills and be a good researcher as well as experimenter. They will need to make sense of human motivators and behaviors in order to understand human preferences. The software design team will need to know how to code clearly and effectively, as well as know other graphic design software programs. The software team must also be able to interface the software with the hardware, so that the information the hardware relays is received and adequately displayed. The development of the hardware will be researched by everyone, as it is important for everyone to be able to explain and understand. In the event of a solution pivot, the communication and human preferences team will most likely still be used, however the software and hardware design team will be substituted to another new team more closely tied to the new solution space.

In order to be successful, our team will need outside points of contact and partners. Our team conducted interviews with people in both fields we are studying: psychology and energy conservation. Dr. Ruth Kanfer, a professor of psychology at Georgia Tech, has said she will work with us once we have an app fully designed, in which she can provide feedback on how it is received by a user and how effective it is. However, our work with her will not begin until we have an app designed which will be in the future. Regarding a professor on campus as a mentor, we have contacted Dr. Erik Johnson, a professor in Energy Economics, who has expressed his interest in our project. We are also speaking with Dr. Tim Lieuwen, the Executive Director of the Strategic Energy Institute, on 16 April 2015. We hope to receive recommendations for various Georgia Tech contacts from him,as well as his advice on how we should proceed with our project and any competitions he is familiar with that we could enter and benefit from.

For the intermediary steps, we have contacted Jennifer Zeller, the Regional Support Manager and Johnna Robinson, Community Development Manager at Georgia Power about the possibility of acquiring data from Georgia Power's smart meters for a testing period next semester. Both representatives put us in contact with Neil Pickard, who said Georgia Power can provide us with anonymous data from smart meters in Atlanta homes. He was also very friendly and said we can contact him if we ever need a point of contact for Georgia Power for help further with our project. Additionally, Connecticut Light & Power, a power company in Connecticut, uses neighborhood competitions to try to lower monthly energy usage, so we would like to contact them as a mentor because of our shared interest in utilizing competitive human nature. They have a Home Energy Reports program, as part of the Energize Connecticut initiative, that compares a customer's electricity usage "100 similar-sized homes in their neighborhood" ("Home Energy Reports"). Furthermore, another potential partner is a company that provides free energy audits. Because the hardware may not be simple for the average homeowner to install, we could include the installation as part of an energy audit. This might be better done with a smaller energy provider company, such as Walton EMC, with whom we are in contact with. Smaller companies are not as well funded (by grants and such), and would be more interested in saving money during peak hours and becoming more cost efficient in supplying energy. By making a home more energy efficient, the consumer would spend less and the provider would get a better use of their money.

Timeline.



Budget.

For our budget, it is difficult to place an exact cost value for our project. In addition, we may need additional money for application building software or other applicable software. In addition, once this app has been created we would require additional money for licensing to actually publish the app. Since our solution is primarily built on creating an app and changing human motivation, we don't need any equipment for our project. In addition, we are considering hiring a professional app development company to help us build our app. Since every app is different from each other, it is difficult to determine a singular cost. Once all the details of the app have been established and we begin talking with these companies a true estimate can be determined. Finally, we may attend a energy conservation conference in the near future. With airfare and conference cost, this would cost us approximately $2400.

Item	Cost	Reason
App Building Software	TBA (possible licensing/flat cost)	This will allow us to publish our app and make it available for consumers
Professional App Development Company	TBA	This will aid us in creating a professional app that will be marketable and appealing to consumers
Conferences	$2000 (airfare estimate) + $400 (conference fee) = $2400	This will help us gain a greater understanding of our problem space and see what else is being done in the solution space.
Circuit Builder Kit	30$ per kit	This will be used in order to gain a better understanding of how circuits work so that we can create hardware that utilizes circuits to maximize personalized energy consumption statistics.
Raspberry Pi	35$	This would be used in conjunction with the circuit breaker as a server

		that stores and transmits the energy usage data
Arduino DUE board	40$	Used to process the data from the sensors
RFM12B Radio and JeeNode USB	$7/ per radio and $40 for usb	Used to transmit data to the Raspberry Pi
Noninvasive AC current sensors	$12 per sensor	Used to monitor the the current in the circuit breakers
AC/AC adapter	$10 to $30	measure line voltage
Arduino MEGA Proto Shield Rev3	$4	Used as a base for everything to be connected to within the circuit breaker
USB Hub	$10-$20	Used as a hub for everything to connect to and distribute power
128GB SSD	$55-$100	Used to store data
Additional peripherals (ohm resistors, cords, etc.)	$20	Additional supplies needed in creating the hardware

Total Price - $2600-3000
Based off of http://boredomprojects.net/index.php/projects/home-energy-monitor

Expected Outcomes.

We hope to complete our hardware prototype complete by the end of spring 2016. Additionally, by that point in time we hope to have an invested partner, whether it be an individual or company, who would be willing to work with us and provide us with feedback. Corporations such as Georgia Power will be helpful to collaborate with regarding their feedback and potential interest in our project, but organizations and people affiliated with Georgia Tech, such as Strategic Energy Institute and Energy Conservation Department would be useful for day to day mentorship. For funding, we hope to compete in student group competitions as well as other scholarships provided by the school, electric companies, or government agencies for starting organizations that need funding.

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