<u>Team EcoVolt (Team #8)</u>
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How might we statement:
How might we reduce residential electrical waste in the United States?

Project Goal:
Our scope is to reduce electrical energy wasted from standby devices used in common household appliances. Our rationale is that appliances on standby mode consume an estimated 5-10% of the electrical energy used in a typical household, which, accumulates up to about 8-15 billion dollars in the United States alone [1, 2, 3, 4]. If we can successfully create a device to reduce the amount of electrical waste used by standby devices, our impact will include: helping energy consumption in homes become more efficient, allowing people to save money by wasting less energy, and creating more awareness of how much energy and money is being wasted.

Significance of The Problem:
Although reducing electrical energy waste in the United States is a very broad spectrum of possible problems with solutions, our group's focus is the energy wasted by standby devices within residential areas, ranging from entertainment appliances (televisions) to kitchen appliances (toasters). In general, appliances on standby mode account for 5-10% of total household electricity usage [1]. This translates to 542-1084 kWh per year consumed by devices on standby mode in the average US household, respectively [2]. Worth $63-125 in costs annually (at $0.1154 per kWh, the average price of electricity in the US [3]). In the entire United States, devices on standby in households use 70-140 billion kWh per year. Worth $8-15 billion in costs annually (at $0.1154 per kWh) [4]. Fossil fuels produce 67% of that electrical energy [5]. Therefore, 47-94 billion kWh per year are generated by fossil fuels, and are consumed by appliances on standby. Ultimately, over 94-188 billion lbs of CO_2 are released because of devices on standby in the US alone (given 2 lbs of CO_2 are released when producing 1 kWh of electricity [6]).

Through our research and specific solution area of standby devices, we believe we can make a significant impact for Americans financially and environmentally, while helping energy companies consume less resources to produce energy. Through preliminary research and several rounds of customer discovery, we have concluded that many Americans leave devices, such as televisions, plugged in while not in use. As shown above, these appliances while in standby consume a significant amount of electricity. One example is the digital video recorder; a recent study conducted by New York Times found out that DVR systems consume more electrical energy than a refrigerator when it is in standby mode [7]. The root of this problem stems from the lack of a way to cut off electrical power conveniently, and we believe that we can feasibly create an inexpensive device that can save Americans money over several years, while also helping the environment and sustainability of the world.

Stakeholders:

There are several stakeholders who would find themselves supportive of our idea, which include homeowners, energy producers, and energy saving organizations. Homeowners pay the bills for the extra energy that they spend on electrical appliances on standby, thus a solution to reduce waste could also reduce the cost of their electricity bill. Energy companies use valuable and limited resources to generate energy, so helping reduce the amount of energy being used by homeowners would also help energy producers waste less resources. Private and governmental energy saving organizations, such as Energy Star and EPA (Environmental Protection Agency), would be affected by any reduction in energy waste because it would help them reach their goals of using energy more efficiently with less waste. [**REF**]

External Advisors:

We have identified three possible advisers for our project who are experts in their field and guide us with their experience:

1. Miroslav Begovic, professor in School of Electrical and Computer Engineering (ECE) and chair of the Electrical Energy Technical Interest Group. Conducts research in “power systems, power electronics and controls, [and] power apparatus and photovoltaics” and is interested in “meeting the future demand for electric energy while satisfying environmental constraints.” Source: http://www.ece.gatech.edu/research/tigs/info.php?id=4.
2. Raghupathy Sivakumar, professor in ECE and of Startup Lab class, faculty in Georgia Tech Networks and Mobile Computing (GNAN) Research Group, and CTO of StarMobile, Inc. Associate at Center for Engineering and Technology Entrepreneurship, and active in Georgia Tech student startup community.
3. Tom Noonan, Georgia Tech alumnus and founder of JouleX, a software company and “leading innovator in sustainable energy management systems for enterprise customers.” Source: http://www.techoperators.com/team/tom-noonan

Our current possible advisers are all subject matter experts. If we decide to add or modify our advisers, we will look into two categories- technical experts and non-technical experts. Our technical adviser will assist us with technical aspects of creation and implementation of our solution to the problem. We can look for a technical adviser in ECE faculty, which can provide guidance, resources, and further networking; GT Strategic Energy Institute, which is already doing work in the energy sustainability area; and electrical startups in Atlanta, which can provide off-campus technical resources. Second, our non-technical adviser will assist us with customer discovery, or determining where there exists a consumer need. We can look for a customer discovery expert through Venture Lab, a startup incubator at Georgia Tech; Startup Exchange, a campus hub of students interested in entrepreneurship; Advanced Technology Development Center (ATDC), a technology startup incubator at Georgia Tech; and the Center for Engineering and Technology Entrepreneurship (CREATE), a resource for creating technologies in the ECE department.

Project Objectives:

<u>Objective 1: Research</u>
Gather enough research to determine if a need for our device exists and if our idea is feasible in terms of actually reducing the energy consumption of appliances in standby by enough to make an impact.

Significance:
By the completion of this we will know if we need to redraft our plan, or if we can continue into the design phase. Failure to complete this objective would lead to a misinterpretation of our problem space, causing us to create a device that is not useful or wanted.

Task:
Customer Discovery:
According to Dr. Raghupathy Sivakumar, customer discovery is the first step of entrepreneurship. If household residents are not very interested in lessening a small portion of their electricity bills, then nobody will use our device regardless of its design. As a result, we wouldn't be able to reach our ultimate goal of lessening energy waste. We will personally speak to homeowners about their concerns about energy usage, starting at "Do you worry about your energy usage?" then continuing to more specific questions branching off the conversation. This information will verify the problem that energy users have, if any, and will be the basis of every following objective.

Purchase tools for data collection:
The first task in this objective will be to buy tools for our own research. We will obtain a power meter in order to measure individual energy use. We will also want a product that serves a similar function to ours so we do not need to start from scratch.

Statistical data collection:
We will visit family and friends and speak to them about their interactions with their household appliances. In addition we will physically walk through households and measure the power difference between activated and standby appliances devices that homeowners have left plugged in.

Analyze data:
Analyze the feasibility of our intent, if our device reduces the electricity consumption of appliance on standby, and figure out which appliances to target. From this data we will also need to innovate for the spaces that our device will need to fit into.

Objective Complete When:
This objective is complete when we have enough data to confirm or reject our problem space, based on data collected from potential customer and appliances we test.

Anticipated Issues:
Customer discovery will reveal to us many different perspectives from household energy users and will pose challenges for us to determine which most important problem worth fixing. Also, customer discovery may not be easy, specifically walking through houses, unless it is with people who are comfortable around us, like friends and family.

Objective 2: Design
Through proper problem understanding and customer requirements obtained from Objective 1, design a solution to the problem.

Significance:
The design process would be crucial in making sure that our device is properly designed to fit our requirements and achieve our goal. If we fail to complete this objective, we will not have a design to build a prototype and test it in Objective 3 [8].

Task:
Create Product Function and Objective Tree:
For the first task, we need to create a product function and objective tree. This includes compiling and creating functions and objectives that have to be achieved by the product, including, but not limited to, purpose, features, and desired outcome.

Develop Engineering Specifications:
For every device, there are specific safety certifications that need to be met. Also, we would like to develop target design specifications and define their importance using House of Quality specifications.

Concept Generation and Evaluation:
We will be using morphological charts in order to generate concepts, and then evaluate our concepts based on specifications. We will choose our best concept from the evaluation results.

Focus Group Review:
After generating and choosing a concept design, we will review our work with potential customers in order to acquire feedback on our idea. After talking with this group, we will improve and reiterate designs if needed, creating a new concept. Once finalizing a concept that could possibly be successful, we plan to create a minimal viable product (MVP) video to test our potential success on a larger scale depending on our design.

Detail Design:

Afterwards, we will design a prototype with aid from Georgia Tech faculty members and other advisors. After completion of a prototype design, we will do a detail design analysis, such as mechanical and electrical components. After review, we will finalize components and materials needed in order to finalize design.

Objective Complete When:
This objective will be considered complete when we have completed a design, achieved target engineering specifications, and satisfied our focus group with a specific prototype design.

Anticipated Issues:
There are several anticipated issues that could arise from this step. Firstly, product specification should be well defined early, and if not, could have future issues arise, such as confusion about design and possible engineering specifications not met. Also, if we receive negative feedback from our focus group, we could have to have multiple redesigns in order to satisfy our focus group of customers.

Objective 3: Test and Build Prototype
Using designs from Objective 2, build and test prototype to ensure it achieves requirements and expectations.

Significance:
The significance of this step is to make sure that our desired prototype achieves specifications and accomplishes the purpose of reducing energy waste from standby devices. Also, we need to make sure that our device is safe for users to use. Lastly, this step is significant so that we can determine if our product is ready to market through its success.

Task:
Purchase Building Materials and Components:
In order to start the development of the prototype, we will first purchase materials and electronic components required for the design.

Build Preliminary Prototype:
We will begin our prototype design of electronic circuits on breadboard to allow rapid component change in order to expedite the process. Also, we will build basic mechanical enclosures that are needed for our product.

Preliminary Testing:
Once prototyping has begun and we have a physical design, we will test preliminary prototype to determine if design achieves target specification. We will also collect data for analysis to determine the success of our prototype. Afterwards, we will communicate with Georgia Tech faculty members in order to accommodate us and help with testing procedures, as well as

consulting safety experts to evaluate our product based on safety qualifications. Lastly, we will accumulate the data collected and improve the design.

Build Complete Prototype:
After collecting data from our prototype, we will redesign it in order to accommodate issues and develop another prototype in order to improve results.

Finalize Testing:
After testing prototypes and concluding on a finalized one, we will test this prototype according to industrial and safety standards. Also, we desire to collect performance data in order to determine the success of our product. We then wish to gather feedback and results from our focus group, which will help us determine an unbiased user response to our product. Lastly, once finished with the prototype and we are happy with our prototype, we will document our most successful design.

Objective Complete When:
Our objective will be determined as complete once we have a successful, correctly functioning device that satisfies industrial and safety standards. Upon completion, we will have well documented designs ready for production.

Anticipated Issues:
There are several issues that we anticipate will occur, such as obtaining faulty components, or unable to obtain these components at all. Also, after developing several prototypes, there is a chance that none of our prototypes perform how we expected. There could also be issues converting our design into a physical device due to a lack of building and fabrication skill among group members, although we plan on searching for help from faculty.

Budget:
Fall 2014

Items	**Amount**
Objective 1 (Research) - Total Power Meter Existing Product (In the Market)	**$130** $30 $100
Objective 2 (Design) - Total	**-**
Objective 3 (Prototyping) - Total	**-**
Miscellaneous - Total Travel (Meeting Advisors and Experts) Team Branding (T-Shirts and Stickers)	**$210** $50 $160
Semester Total	**$340**

Spring 2015

Items	Amount
Objective 1 (Research) - Total	**-**
Objective 2 (Design) - Total	**-**
Objective 3 (Prototyping) - Total Building Materials Electronics Components	**$500** $200 $300
Miscellaneous - Total Travel (Meeting Advisors and Experts)	**$200** $200
Semester Total	**$700**

Grand Total: $1040

Through the Fall 2014 we will need around $130 for material and supplies (listed on budget table), unless we get into a phase where we need materials in our actual design phase. For our research objective, most data will be collected from manufacturer details, but we will also need a power meter (at most, $30) to do our own testing to find the targets for our device. We will also want to buy a product that can do something similar to ours (at most, $100). The purpose of this will be so we can design our own product. This total will accumulate to be $130. We will also need at most $50 for travel throughout the Fall semester. If we need to travel, it will be to meet with advisors and experts. Lastly, we would like to designate a total of $160 to team shirts (based on estimates from Alison Hemmelgarn). This total comes to $340 for the semester. For Spring 2015 we are asking for $500 tentatively for material and supplies. This money will all be for designing and building our device. The electronic components of this will cost upwards of $100 dollars per iteration of design. We will also need, at most, $200 for travel throughout the Spring semester. If we need to travel, it will be to meet with advisors and experts, or to visit design labs. This total comes to $700.

The grand total for 2 semesters is $1040.

References:

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