Final Proposal

How might we reduce energy waste at the consumer level in the United States

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Problem Statement

Problem

As a team, EnerGT has chosen to address the problem space of waste energy. Currently the comprehensive "how might we…" is "how might we reduce energy waste at the consumer level in the United States?". A solution direction in this problem space would impact all people who use energy in the United States both in the residential and commercial sectors. This is a current pressing issue to which an immediate solution will be applied. The problem of waste energy is an important one to address because the more coal and natural gas that is used to produce energy, the more of a negative impact there is on the environment. This is a significant issue in the U.S. where energy is relatively inexpensive per kWh (ten cents per kWh on average in the state of Georgia) so consumers do not feel the same monetary pressure that is put on the environment for excessive energy use (EIA, 2016).

Significance

Consumer energy waste is a crucial problem for society and the planet. First, Global Warming has become one of humanity's major problems and urgent action must be taken to reduce human greenhouse gas emissions to save the planet in the future. Reducing the large amounts of energy that is being wasted by consumers will drastically reduce the amount of energy that is necessary to produce to satisfy the same demand. Second, coal and natural gas are not renewable resources, and thus the amount of these limited resources that is wasted should be reduced. In addition, there should be an increase in the efficiency of the energy system in order to be able to satisfy high and rapidly growing demand in the future. Increasing the efficiency of the system would also benefit those who have a limited supply of energy available and those who feel economic strain as it would reduce the cost of energy.

Stakeholders

Those who directly feel the daily strain of the issues of this problem space are one of two main groups of people: those who cannot afford excessive amounts of energy and those who do not have access to all the energy that they need to operate on a day to day basis. These demographics are more significantly impacted by the issue of limited energy resources and energy waste and therefore would be the most likely to believe that a solution in this problem space is important and necessary. In contrast to these lower income individuals, those with high annual salaries do not feel the same economic strain and pressures of wasting energy and high energy bills. For example, for the poorest twenty percent of Americans, 9.92% of their annual income goes to their energy bill, whereas a much smaller 1.38% is used by the wealthiest people in the nation (Citylab, 2016). For this reason, those of a higher socioeconomic status, unless they put an emphasis on the importance of the health of the environment, would be more likely to be apathetic towards a solution in this problem space because it would affect them less monetarily. In the vein of the environment, however, another group who would consider a solution in this problem space to be significant would be those who advocate for the health of the environment moving forward. Less energy being wasted would translate to less coal and natural gas being used to produce the energy while they also produce harmful pollutants at alarming rates, with carbon dioxide emissions being responsible for over 60% of the progressing greenhouse gas effect (Sciencedirect, 2016). Lastly, another important group to consider is big businesses and corporations that are trying to hold themselves to the standards of having a green building. Like the individual level of those who put emphasis on the environment, businesses that are shifting to being more environmentally friendly would find the solution in this problem space helpful in achieving their goals and at the larger scale, this solution could have a more significant impact for them economically as well.

Context and Existing Solutions

While at first glance, energy in and of itself seems like a very broad problem space full of opportunity for development and progress, the reality is that it is much more difficult to develop a novel solution in this problem space of waste energy at the consumer residential and commercial levels because so many other people are also working in this space. According to calculations done by erc-co.org, annually, all Americans totaled together, combining both household and business expenditures, spend a total of $130 billion on wasted energy (Erc-co, 2016). With a population of 318.9 million, this means that on average, the American individual spends $407.65 on the nation's wasted energy every year. While the total also considers business expenditure and not just household waste, the waste of big business directly affects the economy and therefore the individual and is therefore a crucial factor to consider. In addition to this fact, lighting in the home accounts for nine percent of energy use which is tied for second with water heating. The only home appliance above these two contributors is HVAC which accounts for 18% of energy usage in the home (EIA, 2016). In the realm of lighting, many innovative strides are being taken towards improving efficiency such as LED lights being used in the home which is astonishingly more efficient requiring only one bulb for 25,000 hours of use as opposed to the average incandescent bulb needing to be changed 21 times over to produce the same amount of energy (energy.gov, 2017). Another existing solution in this problem space that has served as a source of inspiration is a product known as Sense. Sense detects the energy usage levels in the home and reports back to the homeowner via an app in real time so that they know exactly how much energy is being used in the home while it is happening (Home Energy Monitor, 2017). To develop on Sense, power strips could be developed that can tell when something is plugged in and drawing power, but is not in use, so it will then automatically cut current to that outlet, saving energy, until the object is in use again. For example, when a charger is left plugged in after unplugging a phone, the strip will cut off current to that outlet so the adapter does not continue to draw unnecessary power.

Why is it still a problem?

Currently, consumer waste is still an issue due to how inexpensive electricity and energy is in the United States. Those who utilize energy in the United States do not realize how much energy they use nor realize how much they spend on energy until they receive a monthly billing. Furthermore, an issue appears when the consumer is informed about how cheap energy is and is told at the same time to cut back on energy use, the individual will see no benefit to themselves by limiting their energy consumption to save tens of dollars per year. Even so, consumer energy waste can still be reduced by targeting a different parallel. Current estimates from the US Department of Energy explain that 10% of a homeowner's electricity bill comes from energy not being used, vampire power (Treehugger, 2016).

Proposed Work

Goal

The focus is on saving energy in commercial buildings and households in the United States. With such a broad and numerous consumer-base, even a small impact on the individual level will have a large impact on the consumption of fossil fuels, which will impact the price of energy and minimize the detrimental effects of energy production on the environment. Eliminating vampire power from chargers, since it accounts for an average of 10% of all energy usage, could have a significant impact on the amount of fossil fuels burned, while also saving consumers an average of $165 per year. Vampire power emissions are equivalent to the total power emitted by 50 large power plants per year, making this a much larger problem than most people realize (Treehugger, 2016). By eliminating most vampire power usage, though it is impossible to eliminate it all, this

solution will save money and help the environment, reducing the greenhouse gas effect that grows rapidly worse as power plant carbon dioxide emissions contribute 60% of the pollutants causing the problem (Sciencedirect, 2016).

Objectives

Background

The objective of designing and testing a solution is important because not designing a testable solution means that the project cannot move forward. A solution should be something innovative, meaning that it is designed with new insights in mind, and testable, meaning that it works and will be comfortable and easy for consumers to use. This step is necessary because it is necessary when applying for patents, troubleshooting potential mistakes, or finding its overall impact on energy use.

Methods

First, the team must continue to research to learn more about circuits and automation. More needs to be known about how to build more efficient circuits based on what they need to accomplish for the ultimate goal, whether that is transferring the most current or potential, or a balance between the two. It will also be necessary to know how to calculate the resistance of the circuit as a whole and of the individual parts to analyze how the changes made affect the resistance so that the rest of the circuit can be adjusted to accommodate. After this, the next step will be to investigate how charger adapters know when a phone is charging or not. This technology will be used to determine when the switches should flip on and off. After enough of this research is finished, the design phase can begin. Research into cost of materials must continue to ensure no extra cost is added to the current price of a power strip, otherwise the consumer will not take interest; however, a circuit will be designed on paper first. Then, a schematic and diagram will be made in Solidworks. With the design process normally comes new insights and adjustments that will bring the team that much closer to a working prototype. Once there is a design, the prototype can be manufactured. As the prototype is built, slight adjustments may be made to the design, and tweaks in the construction methods for installing certain parts will be necessary, but in the end a prototype of the power strip will be functional for a test. Whether or not it does what it is designed to do is not part of this objective. This objective is complete when there is a testable prototype.

Outcomes

Success of this objective will be determined by building prototypes. Once they are built the team will be able to test and tweak, which would be the next phase of the design process.

Anticipated Problems

The biggest problem expected is cost. Making power strips that have this extra automation at the same price as current power strips will be a huge challenge to overcome. Likewise, it is expected that several problems will arise while constructing the prototype. It is difficult for the team to tell now exactly what problems during the building process could be encountered because the team has not yet seen or investigated the inside of these power strips, but these problems will cause changes to the design and cost of the overall product. The problems have the potential to lead into each other and spiral, which must be prevented by the team methodically and quickly.

Background

Another objective going forward is creating a solution that is significantly more cost and time effective for consumers at both the residential and commercial levels. This is an important objective to keep in consideration as the team moves forward because there must be an incentive for consumers to implement any solution to this problem space, and economic gain is one of the biggest driving factors for change in modern society. Another factor to keep in mind with this objective in addition to cost benefit is amount of effort that needs to be exerted by the consumer because ease of use is another large factor in facilitating social change. A solution in this problem

space is necessary because without it, energy will continue to be used and wasted at an alarming rate which is also significantly harming the environment. If no progress is made in this problem space, these negative impacts will go unchecked and have detrimental backlash on future generations who will feel the pressure of this problem space even more so than is felt now.

Methods

To determine the success with respect to this particular objective, the team will need to take the prototype that is produced and give it to a sample group of different socioeconomic backgrounds to best determine their level of satisfaction with ease of use and price comparison based on cost of energy used versus cost of energy saved that would have otherwise been wasted without the implementation of the solution. As was shown in the numbers earlier in this paper, energy use accounts for drastically different percentages of annual income, so therefore it is important to have multiple test groups across different socioeconomic backgrounds. This number crunching will be the most critical part of the entire experimentation because without it, the impact will just be a lot of hypotheticals based on a select population that has been observed in interviews and research.

Outcomes

Once these above-mentioned calculations have been made, the success of the prototype can be determined. Based on the results of implementing the prototype to the public, the decision could be made to either continue to produce the prototype or to try and redesign it. That is the importance of this objective to the design process and solution direction.

Anticipated Problems

One of the most major anticipated problems that will be necessary to work around with respect to this objective will be reaching a large enough population to adequately determine the success of the solution. Also, the fact that all people are different and will therefore have different opinions on standards will be a challenge in terms of this specific objective. While these challenges both deal with subjectivity issues, through intensive research, the team feels that it would be able to overcome some of the setbacks that would be potentially caused by these anticipated problems.

Project Team

The team would be composed of four members. The team members would have to combine so that the team encompasses all the required skills and attributes necessary to complete the project successfully by being able to implement an adequate solution to the problem space. Therefore, each team member would be focused in a more specific role in addition to collective task of engineering a solution. This would make the team more organized by laying out the specific task of each member. In addition, the team would become more efficient and competent by driving each member to carry out the tasks they are better at and have a deeper knowledge on them. Doing this could complicate communication and lead us to adopt a too “individualized” working style as a team, driving us to be less efficient and not coherent as a team. Therefore, constant communicating and updating each other as a team would be necessary as well as building upon each other’s suggestions in addition to performing some tasks on an individual basis. The team would carefully divide the roles and structure of the team based on the specific skills of each, while still working collectively to engineer a solution to the problem.

One of the team members would oversee the team’s organization. This includes assigning individual tasks to members, documenting all the team’s advances, staying on track for deadlines, and managing the budget/equipment. This role is crucial for the team to stay organized and focused on the problem. This important role should be held by a team member that is very organized and diligent. This team member will perform this task as an addition to contributing to the development of the solution through research, ideas, and work.

Two other team members will be the programmers. The solution requires programming the functionality of the prototypes by working with circuits. These members would have to implemtn the work and ideas of the team into the prototypes. This would require programming knowledge and experience, and thus this task would be performed by Computer Science majors. This task would involve working closely with the Electrical Engineer.

An Electrical Engineering major would lead the research and prototyping of the solution due to his or her much deeper understanding of the field. He or she would verify the proposed solutions and assist the team with technical calculations. In addition, he or she would help the team advance their research in the field to be able to develop a solution collectively. Moreover, this person would be the main person in charge of reaching out to professors with knowledge in the field to help the team expand understanding of the problem space.

Lastly, the team would seek support from three professors with strong knowledge and experience in the field to assist us with technical questions and calculations, and verify that the solutions are feasible and realistic. These individuals would be Electrical Engineering professors with research in the field. The team could potentially seek support from Dr. Divan with research on improving power grid utilization, Dr. Grijalva with research on de-centralized and autonomous power control architectures, and Dr. Verriest with research on Optimal control and control with information constraints.

Timeline

Summer 2017

- This part of solution development would encompass understanding the problem space on a much deeper level and becoming more familiar with the people who are prominent individuals in the fields that are being investigated as part of this experimentation.

Fall 2017

- During this part of the solution development process, the team would expect to do much of the background research into circuits and automation to better understand the costs, materials, and procedures necessary to prototype.

Spring 2018

- For this semester, the objective of completely designing and testing a coherent solution to the problem space would be addressed. The team would have already done a large amount of research into background and made connections with many more experts who could give us assistance if it were necessary for us.

Summer 2018

- In this semester, it is planned that the team would observe the effectiveness of the designed prototype on a larger scale rather than at just the individual level whether that be in an apartment complex or a business' building. It would be known based on the Spring semester whether the solution was effective at the individual level or not and take that feedback to implement it in the commercial sector.

Budget

Materials and Supplies

- Dry - erase markers: 2x$7.89 - To write on white boards. They are useful for fundamental design, brainstorming, and calculations.
- Pens: 2x$5.99+$3.19 - Red, Blue, and Black pens can be used for notes, and the different colors can be used to make certain things stand out.
- Normal Power Strip: 3x$15.99 - This will be used during the tests for vampire power. This will test the strip itself and the strip with different chargers plugged into it.
- Usb Power Strip: 2x$29 - Test the effect of removing phone adapters from the charging process. Test the power strips themselves for vampire power.
- Circuits textbook: $163 - It is necessary to have a reference to understand the circuits that are being built and evaluated.
- Phone adapters: 10x$1 - These are needed to take apart, test, analyze, and modify to attempt to eliminate their vampire power.
- Laptop chargers: 3x$24, 3x$24, 2x$9, 2x$23 - These are also need to take apart, test, analyze, and modify to eliminate the vampire power from these. The prices are listed in this way because they represent the prices from Mac, Lenovo, Dell, and HP.
- Tweezers: $27.89 - This is necessary to work with the tiny pieces inside the power strips.
- Screwdrivers: $6.97 - A precision screwdriver set will be useful when modifying the power strips.
- Copper Wire: $40 - This will be used when modifying the power strips to add the automated switch and test new circuits.
- Wire Cutters: $10.97 - Wires need to be cut and shaved to make them fit the switch and outlet circuit.
- Measuring Tape: $5.00 - This is necessary to measure the length of the wires and the volume of other materials so that a new shell can be designed.
- Soldering Gun: $16.97 - It would be used to connect the wires in a modified power strip.
- Safety Masks: 4x$22.60 - These are needed for protection when soldering.
- Solidworks: $1695 - CAD and other design programs are necessary to finalize the designs if a patent is applied for.

Equipment

- 3D printer: $1400 - This is needed to print a new case for the circuits that will be created.

Services

- Software Development: $200 - 5 hours of a top-rated software engineer's time so that he can connect the automated hue bridge to the ambient light sensor.

(Priced according to the Home Depot, Amazon, SolidWorks, and Office Depot)

Expected Outcomes and Future Directions

If the team is successful in its current endeavors, it can potentially save the average apartment complex in the Greater Atlanta Metropolitan area $30000 - $9000 per year if energy use is reduced by 10%. These calculations are based on the fact that average energy use for a single

person apartment for each month is 500 kWh and for two person apartments each month the number is 1500 kWh (Green, 2016). If energy consumption of large scale consumers in Atlanta is adequately improved, the project can be expanded and new found knowledge can be utilized to break into other metropolitan areas such as New York, Boston, etc. The ultimate goal would be to reach as many people as possible in the most effective way for them, so the team must create a solution that caters to people of all different socioeconomic statuses in order to ensure the greatest success.

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