Environmentally Friendly, Cost Effective, and Innovative Food Preservation During Natural Disasters and in Developing Countries

Formal Research Report

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January 2019

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Abstract

The purpose of this project is to use solar innovation to determine if a refrigeration item can provide a way to preserve food when electricity is not present. When it comes down to situations without electricity, like in other countries or during natural disasters people suffer due to a lack of resources. Food sent to these places only last for a couple of days and what spoils contributes to a vast amount of food waste. This harms the environment by producing more CO2 and causes an increase in greenhouse gases. Also, people end up starving, since they can no longer use the resources. The solar powered cooler is possible and has not been done before due to solar panels having low efficiencies and high costs. Now with new solar innovations this product is feasible. Further research needs to be done on energy storage, insulation, and other types of solar innovations that could best suit the cooler. With food wastes and natural disasters increasing, people need an environmentally friendly, cost effect, and reliable product to help easy these traumatic experiences. The solar powered cooler would provide a useful resource for millions of people.

Introduction

Product Summary Statement

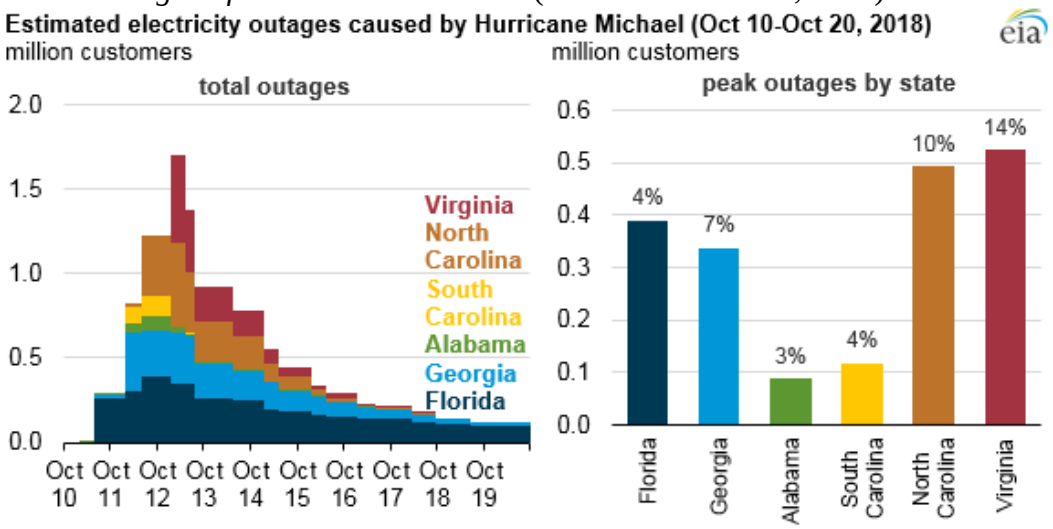
Enjoyed by the everyday adventurer, the solar powered cooler is used to keep things cool without power. It can be used in emergency situations or for protecting vaccines and medications in addition to being scalable globally in markets predominately without electricity. The cooler is both cost effective and environmentally friendly. The solar powered cooler helps the everyday adventurer, while also being applicable in emergency situations by preserving food without power, in a cost effective and environmentally friendly way.

Problem/Prevalence

Lacking refrigeration and electricity about 40% of India's produce spoils before it can be consumed (Qazi, 2017). On a global scale 16% of people live without electricity (Smith, 2017) leaving 1.3 billion without access to refrigeration (Lindeman, 2015). Those numbers do not include natural disasters and other events that cause power outages on a regular basis. For example, 90% of people were still without power in Puerto Rico, three weeks after the hurricanes hit (Glauber, 2017). Even eight months later "….14,500 people" still did not have power (Doom, 2018). Hurricane Michael left 1.7 million people without electricity as seen in figure one (Woodward & Marc, 2018). Resources sent to these places, especially Puerto Rico spoiled within days leaving people starving.

Figure One

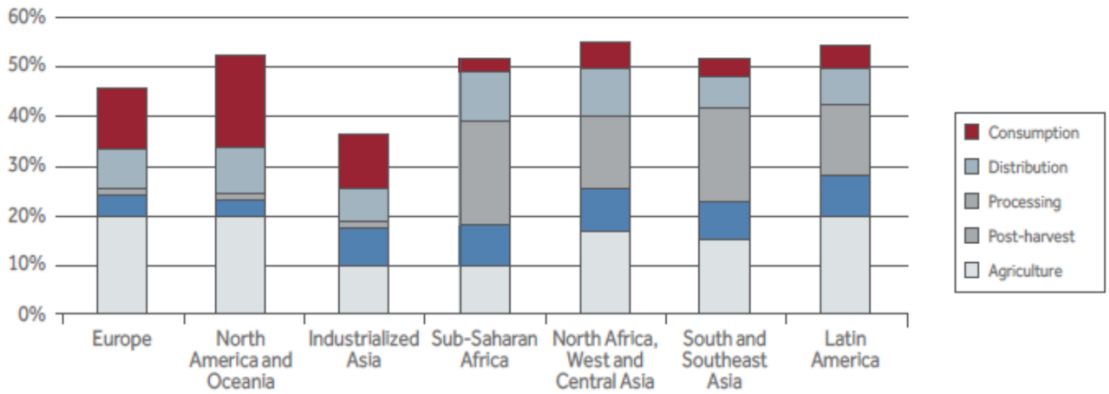
Power Outages After Hurricane Michael (Woodward & Marc, 2018)



This contributes to one-third of the entire globe's food never being consumed. Figure Two, shows in blue, how food is lost before it can even be sent to consumers. The red section is what is being consumed. This loss could have helped the 800 million "food insecure 'and' undernourished" people in the world (Dahir, 2017). It could help each child that dies "every 10 seconds" because of a lack of food (Huxta, 2018). Keeping food cool is not the only problem, medication delivery and storage is impossible in these areas and situations as well.

Figure Two

Percentages of Food Loss Over Production (Rezaei & Liu, 2017)



The problem continues to persist around the globe with food wastes reaching 1.6 billion tons. (Goldenberg, 2016; Gustavsson et al., 2011). This in turn causes “about 3.3 billion ‘tons’ of CO2” to be produced every year (Bhandari, 2018). The lack of electricity and refrigeration is not only murderous but is also affecting the entire environment.

Solution

The solution to food spoilage, loss of electricity or no electricity, and medication preservation is using new innovative solar technology to cool. Solar innovation is more efficient and cost effective than ever before. No longer is there a need for bulky, expensive solar panels. Instead, paper thin, light weight, environmentally friendly solar panels are readily available.

Having a portable cooler that sustains itself could be sent to natural disaster areas or to areas that lack electricity keeping food from spoiling. Revenue would be saved, starvation would stop, and lifesaving vaccines could be brought to areas which currently cannot sustain them, in turn saving lives. When this food is not spoiling it will overtime help the environment by not producing as much CO2.

Solar Panel Types

Several types of solar panels work with the solar powered cooler, each with different efficiency and form. The key is weight and efficiency. Some solar panels are bulky, heavy, expensive, and did not have very good efficiency. However, leaps have been made in the area of solar technology enabling extremely light weight, cost effective and efficient options for a light weight accessible iceless cooler. In any case, if the weight of the solar panel is greater than the weight of ice used in a regular cooler, then that panel will not work for this concept.

Monocrystalline

One of the most efficient of the common solar panels is the monocrystalline. This silicon-based panel, with its silicon form producing a 21.5% efficiency level, looks like it has grids (Dilthey, 2017). The problem with this type of panel is the increase in price and silicon waste compared to other types (Sendy, 2017). Having an excess of silicon during manufacturing of the panel would make the cooler less environmentally friendly. (Figure Three)

Figure Three

*Monocrystalline Solar Panel (*Sendy, 2017)

Polycrystalline

Polycrystalline is more resourceful than the other panels by reducing prices and waste during manufacturing (Dilthey, 2017). This makes it a more viable option but has a lower efficiency rating. Having levels around 16% and ending up being slight bigger than the monocrystalline makes it have some cons (Dilthey, 2017). For a product like the cooler the panel needs to be small and light weight. (Figure Four)

Figure Four

Polycrystalline Solar Panel (Sendy, 2017)

Thin Film

Lacking silicon makes thin film solar panel unique. With photovoltaic the basis of its material, these panels are flexible and have a 16% efficiency level (Dilthey, 2017). These factors make this panel very applicable for products that need to be lightweight and resist persistent damage. The flexibility allows it to go on a wide range of surfaces and makes it viable option for the cooler (Figure Five).

Figure Five

Thin Film Solar Panel (Sendy, 2017)

Energy Storage Types

Lead Acid Battery

Lead acid batteries work well for vast solar power systems. This battery type works well for powering houses even with its low depth of charge and lower lifespan (How to choose the best battery, 2019). The nice part it that it is less expensive compared to the other commonly used batteries (Peacock, n.d.).

Lithium Ion Battery

Compared to lead acid batteries, lithium ion batteries are lighter, smaller, and have both a higher depth of charge and life (How to choose the best battery, 2019). This makes them more feasible to use on a product like the solar cooler. The ideal battery needs to be as light and compact as possible, while not diminishing efficiency and storage capacity.

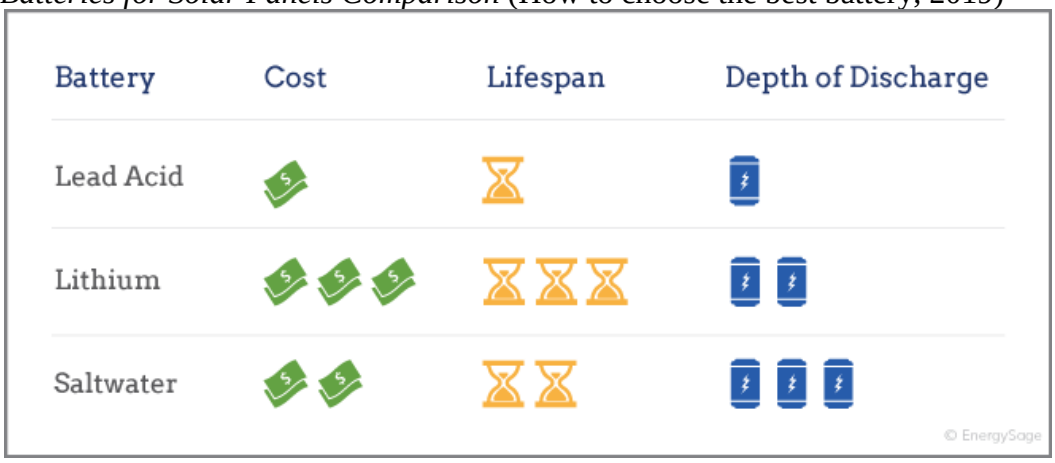
Saltwater Battery

Saltwater batteries took an interesting turn in the industry by replacing the heavy metals with saltwater electrolytes (How to choose the best battery, 2019). Also having a 100% depth of

charge make the battery last longer than other batteries (AIB saltwater battery, 2018). This innovation is cleaner for the environment and takes away the dangerous materials the other batteries contain. Figure six shows a comparison of these batteries.

Figure Six

Batteries for Solar Panels Comparison (How to choose the best battery, 2019)

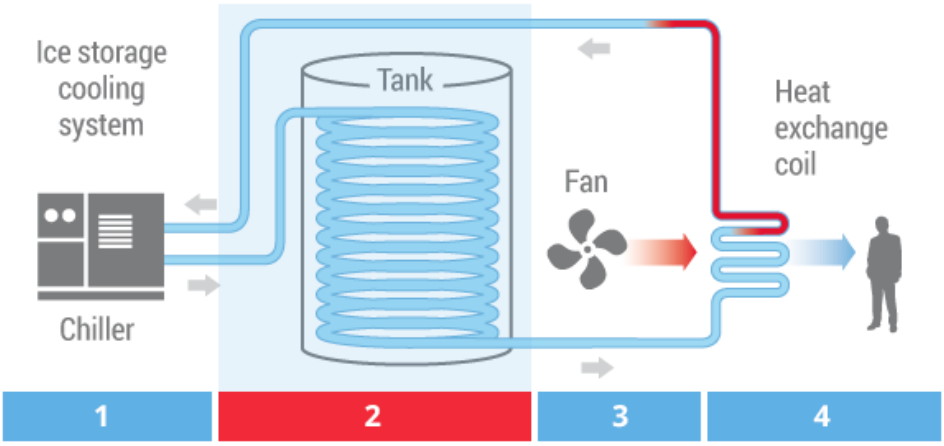


Thermal Energy Storage

Batteries are not the only type of energy storage. Thermal energy storage could also be used with the solar panels to decrease costs. A solution containing a fourth ethylene and the rest water is cooled and moved through a tank (Calmac, 2019). This cooling solution puts the needed air-conditioning in the area, that is circulated by a fan. It uses the idea of making the air-conditioning before it is needed and then using it as required. The solar power comes in to run the standard cooling equipment that is a part of the thermal energy storage. The bonus of using thermal energy instead of battery storage is that it is “one tenth the cost of battery storage” (What's new in solar energy, 2018). This along with the lowering costs of solar energy makes this product feasible. (Figure Seven)

Figure Seven

Thermal Energy Storage (Calmac, 2019)

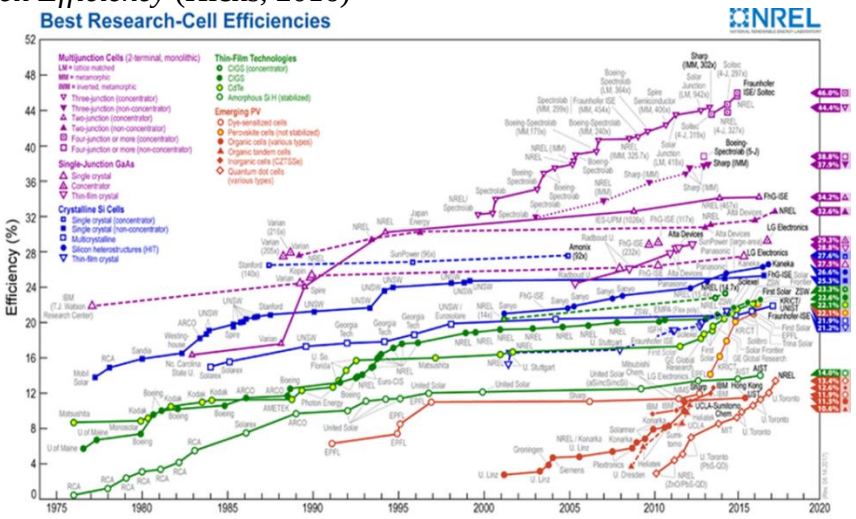


Solar Innovation

Keeping in mind the most common solar panels, there are other overall aspects to look into. Figure eight shows all the different types of solar panels and how their efficiencies are all increasing while the cost is going down. This shows promising results for the future of the solar industry and the feasibility of the solar powered cooler. Solar panels prices per watt changed from $3.25 in 2007 to $0.72 in 2014 (Solar electricity costs, n.d.). What is even more drastic is currently the prices range around $0.06 (Zipp, 2018), while in 1977 it was $76.67 per watt (Shahan, 2016). Who knows what the new innovations will bring?

Figure Eight

Solar Cell Efficiency (Hicks, 2016)



Just in 2017 two different innovations were created that change the way products can be used (Figure Nine and Ten). Instead of having pounds per square foot of a regular panel, these are ounces per square foot (Pickerel, 2016). These innovations provide a light-weight and flexible solar panel, that can collect energy on all different types of surfaces. These innovations are what makes the solar powered cooler possible.

Figure Nine

Solar Tape (infinityPV Solar Tape, 2017)

Figure Ten

Flexible Solar Panel (Charbax, 2017)

Product

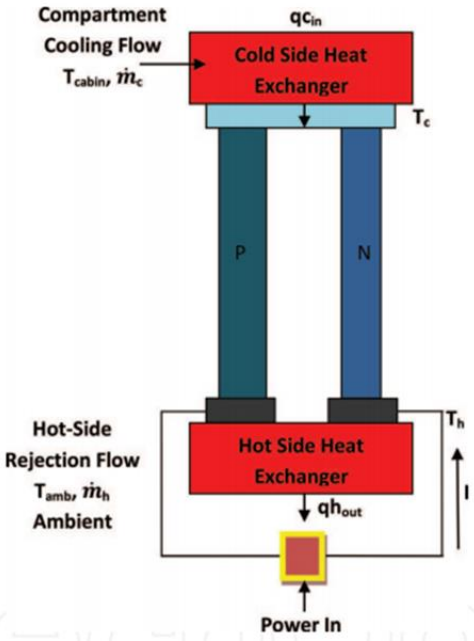
The overall concept involves a regular day cooler that uses the solar tape to power it. By purchasing a Thermoelectric Peltier Refrigeration Cooling Cooler Fan System Heatsink Kit (Figure Eleven), the cavity of the cooler is able to be cooled. Figure twelve represents the inside of the system. It works when electrons move from different energy levels by an electrical connector (Samar, 2006). This movement from the cold plate to the hot plate and vice versa creates both heating and cooling. Having the cold plate toward the cooler's cavity ends up cooling the inside. A fan helps circulation on both the cold plate side and the hot plate side. The concept also includes a battery as a backup power source.

Figure Eleven

Thermoelectric Peltier Refrigeration Cooling Cooler Fan System Heatsink Kit (Contifan, n.d.)

Figure Twelve

Thermoelectric coolers (Atta, 2018)



The concept is unique because it provides a solution to problems worldwide. It can help people in countries that do not have the same resources as we do. Its compact capabilities allow it to transport things through ruff terrain. It also can be used in regular day use, which gives the concept a wide industry.

Cost of Materials

The cost of materials has allowed with product to be feasible. Its approximately 86 dollars for this to be manufactured and that is off of retail prices, so it would be less when everything is manufactured.

$36 - Solar Tape (retail)

$20 - Cooler

$20 - Fan system (retail)

$10 – Battery (retail)

Along with that the cooler would be sold for 250 dollars. The reason why 250 dollars is plausible is because it ranges with our competitors. The closest competitor in high end coolers, Yeti, had over a $300 million increase in sales from 2015 to 2016 (Havel, 2016) and they do not have a solar cooler. They sell their coolers anywhere between 200 and sometimes over 400 dollars. This makes this product feasible in the industry.

According to Cooler Market, there are 22.1 million cooler users (Ferguson, 2015). This is kind of industry and market a product like this can compete in and it has a huge capability and scalability for the future. Along with that there's 140 million Americans already interested in outdoor activities (The outdoor recreation economy, 2012), so they'll be interested in buying a product like this.

Other Innovations

Other innovations include things such as a solar powered charger, solar powered tents, car charge stations, and a wide variety of other solar innovations (Figure Thirteen, Fourteen, & Fifteen). This just means that the industry is growing. By 2022 the global solar panel industry is supposed to hit 420 billion dollars (Sahu, 2017). Now is the time to get into the industry before it hits its peak so the product can grow with the market. This makes it the perfect time to release a concept like this. Having an eco-friendly solar cooler is just the kind of change both consumers and the environment need.

Figure Thirteen

Solar Charging (Zipp, 2013) & (Jacoby, 2016) respectively

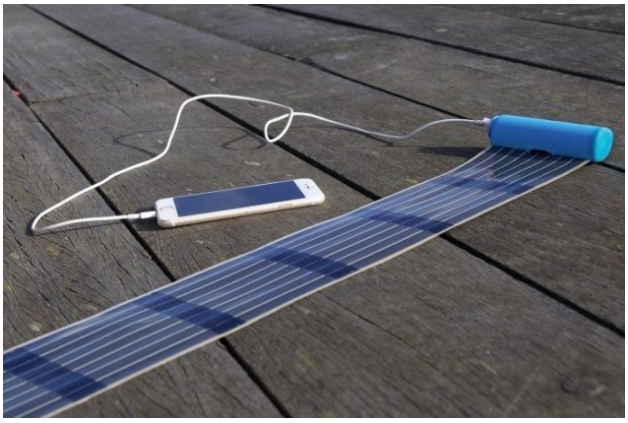


Figure Fourteen

Solar Powered Tent (Solar powered tent, n.d.)

Figure Fifteen

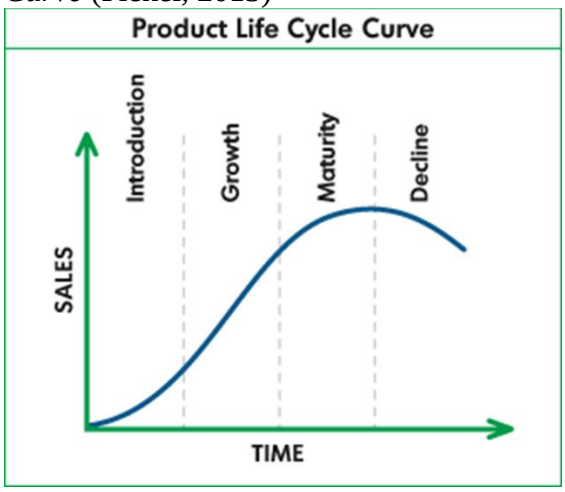
Solar Car Charging Stations (Motavalli, 2012)

Product Life Cycle

As the product is introduced to consumers it will need to adjust to the growing market and possible changes. Figure Sixteen shows the normal product life cycle. Normally products go through different stages where it could either be discontinued or grow into a new life cycle.

Figure Sixteen

Product Life Cycle Curve (Flekel, 2013)



Introduction/Market Development

During the introduction phase of our product's life cycle it could be released and sold through small businesses and through social media. This would promote awareness so people can appreciate how much it could help the globe before it really kicks off. Along with that the product could be partnered with a company, like yeti. What better way to eliminate your competitors than to be working with them? This would get it to the maturity stage faster and release the product quicker.

Maturity/Growth

During the maturity stage to increase productivity and allow consumers to truly enjoy the product, design aspects could be developed. Consumers could have the option to pick the color of the shell of the cooler. There are even new innovations that change the color of the solar panel. Also, there could be multiple sizes to pick to allow for different situation and to easily be transported to other countries and areas that could not normally be reached. These options of personalization make the product more likable and scalable.

Decline Stage

Key Risks and Unknowns

There are always risks and unknowns, but one risk to take into consideration would be the lack of sun to power the solar cell. When the sun is covered by clouds or during the night the cooler would not have a power source. To limit this, a battery system which stores energy will be key. Working with engineers would provide the perfect balance between cost and efficient storage of energy.

Another risk would be a competitor taking the concept and getting it to consumers ahead of us. It will be critical to get this to market quickly and then partner with competitors through joint ventures. Really now is the time to produce this concept and get it out, because 5 to 10 years from now the solar industry is going to be booming.

Global Trends

Along with stages of growth other aspects like global trends could be followed to increase the scalability of the product.

Technology

With the trend of technology increasing the cooler could involve aspects of smart living to adjust to the trends. A Bluetooth speaker could be added for adventures who like to listen to music on their trips. Families and others would enjoy having music at the beach or camping without having to bring a whole separate thing. Other aspects like temperature detection, phone charging, and how much energy the consumer is saving could be added to the cooler.

Pathways

Along with that selling online would open the product's market. This would appeal to a wide audience and get the cooler seen by more consumers.

Personalization

Personalization with changing the shell of the cooler and other personal touches also expands the market. Most consumers enjoy the product more when they have options to make it there's.

Location

Medications and vaccines would now be available in formidable areas. These area's market have buying power and could benefit most from solar cooling. Also, areas prone to natural disasters would benefit from the product. This is where the varying sizes could come in to play making it easier for transportation for the locations. With this technology these places that have not been easily reached can be helped and at the same time reduce global wastes.

Environment

The product perfectly fits environmental trends. It's solar cooling is environmentally friendly by using a renewable energy and reducing food waste. The cooler helps bring the globe and people together by having consumers use a product that helps the environment. The product solves global solutions and everyday solutions. Now when someone goes to the grocery store, they do not have to worry about rushing cold food home. Put the cooler in your car and go out for a movie after shopping. It does not only change refrigeration personally, but it also changes it for the world.

Consumer Research

During consumer research, consumers were able to understand the concept quickly and easily. Over 90% of costumers reacted very positive or somewhat positive as their first react to the concept. On the survey consumers were asked what they liked and what they thought could be improved about the concept. Most consumers responded with answer saying how they liked the environmental factors the cooler involves. This was surprising since most of the participants

taking the survey were around the age of eighteen, but they seem excited about the product. This means the consumer that would buy this product five to ten years for now are already excited and interested in purchasing a product like this.

Also, many like that no ice is involved. One costumer said they liked the concept because it uses what normally melts the ice packs to power the cooler. Which is a great marketing strategy. Customers will choose the concept, because it is universal and helps the environment. It can even be used in multiple activities like camping or beach days.

Direct consumer quote: “The concept of using an innovative solar powered cooler in places where sun is abundant but cool ice is not is absolutely astounding. A solar powered cooler would make things a thousand times easier after the recent hurricanes. I can also see myself bringing it to the beach to keep food cold for a longer period of time.” -anonymous

In the end the product has a wide supporting consumer base. A benefit to the product is that 76% of global consumers says costs are holding them back from leading an environmentally friendly lifestyle (Whirlpool). This 76% plus the 140 million Americans (The outdoor recreation economy, 2012), already in the outdoor industry makes the cooler have vast amount of people willing to purchase it.

Conclusion

People in areas lacking electricity suffer through starvation and agony. Due to a lack of refrigeration food wastes are increasing leaving 870 million people starving (Koba, 2013). In order to combat these issues, bring the solar powered cooler to these areas is a step in the right direction. Having an environmentally friendly, cost effective, and reliable cooler, could provide these areas and situations with a feasible solution. Before, this product was not possible do to the

low solar power efficiencies and high costs. Now with the new solar innovations a product like this is possible and viable. The technology and market are ready for this innovation

In innovation you have to disrupt the market, the solar powered cooler disrupts the cooler market with an eco-friendly product, that solves the problems of global food loss and everyday issues. More research could be done on insulation of the cooler and different battery systems to make the most efficient arrangement. This cooler could help reduce food waste, lower CO2 levels, and protect people in areas that lack the same resources as us. It could make a sense of safety a reality for millions of people.

Innovation is global and without boundaries.

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