Alternative Energy Solutions

CONOPS

Written By Team 3

Edsgn Section 001

Submitted To:

4 December 2012

Team Members:
Vivek Patel – Vdp5034@psu.edu
Zachary Solarczyk – Zts5053@psu.edu
Nathan York – Njy5022@psu.edu
Ethan Rozak – Enr5061@psu.edu
Index

1.0 Introduction
   1.1 Project Description, Use Case
      1.1.1 Background, Benchmarking with current solution
      1.1.2 Assumptions and Constraints (Use Case Considerations and Customer Needs)
   1.2 Overview of the Envisioned System
      1.2.1 Overview (Concept Generation, Benchmarking)
      1.2.2 System Scope (Target Specifications, Concept Selection)
   1.3 Document References
   1.4 Glossary

2.0 Goals, Objectives, and Rationale for the New System
   2.1 Goals and Objectives of the New System (or Capability)
   2.2 Rationale for the New System (or Capability)

3.0 Work Processes to be Automated/Supported
   3.1 Major Processes and Functions
   3.2 Process Flow

4.0 High Level Functional Requirements
   4.1 High-Level Features
   4.2 Additional Features

5.0 High Level Operational Requirements
   5.1 Non-Functional Requirements
   5.2 Deployment and Support Requirements
   5.3 System Environment

6.0 User Classes and Modes of Operation
   6.1 Classes/Categories of Users
   6.2 User Classes Mapped to Functional Features
   6.3 Sample Operational Scenarios

7.0 Impact Considerations
   7.1 Operational Organizational Impacts
   7.2 Potential Risks and Issues
1.0 Introduction

1.1 Project Description, Use Case

The main goal of the project is to design a new and innovative power charging option for a mobile device, which can harness energy from two renewable sources of energy. Although these technologies are not a distant concept today, they still can be difficult to integrate into a functional system for the intended user. For this project, the military was the audience targeted to use our product. Specifically, we aim to create a charging option for the PRC-152 radio created by Harris Communications. Considering the physical activities our audience would be doing on a daily basis, we aimed to make our product durable, easy to use, safe, and able to function in harsh conditions such as the desert heat.

1.1.1 Background, Benchmarking with current solution

For soldiers in the field, the present day’s charging option for their hand held PRC-152 radios are primarily, if not entirely based off their solar energy harvesting system. This system seems to be logical in some aspects, such as clean, renewable energy; however, by not adding in a second mechanism to charge their radios, the government is putting a cap on their charging options and in some cases, putting them in danger. For instance, if the situation occurred that the solar panels had been destroyed due to an enemy assault and the soldier’s chargers were empty due to their present 2 day recharge periods, they would be virtually isolated from outside contact and unable to pass on important information. In addition, the present charging option involves them going to their flexible solar panels and allowing their radios to charge up, which brings up the question what if it is far away from base camp and you are running low on energy for your radio. Our charging option would be virtually simple as doing what you do on a normal basis, and when the energy is needed it takes a mere slip of the hand to slide in the lithium ion batteries into your charger and you’re in the green. Additionally, concept would be light weight, environmentally friendly, safe, and easy to use.

1.1.2 Assumptions and Constraints (Use Case Considerations and Customer Needs)

In general, our proposed charging option would be based off of two constraints. Due to the fact the solar energy harvesting can have a hefty price tag on it; one must consider the renewable aspect to this
energy source and its cost saving benefits. Additionally, we created our product we went under the assumption the military has a large budget for defense; however, we still aimed to keep the price of the final product as low as possible. Additionally, we had to create a charging option that is as durable as possible and that can function under extreme heat without hindering the soldier or ruining his or her camouflage. Therefore, our final product must be able to operate on the above conditions and also be able to operate even if the soldier is unable to move.

1.2 Overview of the Envisioned System

1.2.1 Overview (Concept Generation, Benchmarking)

When we took on the mission of creating an innovative charger for our designated use case we had to consider the many available methods of producing renewable energy while keeping in mind our customer’s needs.

Generally, we looked at various sources of energy such as wind, solar, thermal, kinetic, and even fuel cell technology. When it came to wind power, the idea of creating a wind turbine and attaching to the average soldier posed many problems such as safety, visibility, and even maneuverability. Additionally, the amount of wind that is present in the harsh weathers may be too variable to consider making wind a non-ideal option.

Solar energy provides ample amounts of energy for our desired use due to the ample sunlight available in the desert regions; however rigid solar panels could pose the problem of breaking and make it hard for the soldier to move. We learned of a new innovation of flexible solar panels which could be used in the same manner; however, it would bring a hefty price tag. Additionally, this technology can also harness organic materials to make the panels which allows for different colored panels so as to keep the camouflage of the soldier a top priority.

As for thermal energy, we found an invention called “Power Felt” that is currently being researched which can produce as much as 137 Nano watts of power with a 50 kelvin thermal difference. The fabric is extremely cheap at $1000/ per kilogram of material; however, the average temperate of the desert would be nearly the same temperature of the body many the 50 kelvin difference hard to obtain making this solution out of the question.
Finally, we researched kinetic energy chargers and found many solutions involving hand cranks and continuously giving effort to actually produce the energy. Due to our desired audience, this option seemed out of place until we discovered the kinetic energy boot charger which can create energy as the soldier walks around. This charger would plainly attach to the soldiers boot and wrap around the ankle to make it very secure and not hinder the soldier in his everyday activities. The power output from this boot would be approximately 6-9 watts/leg from walking 3 mph for 85 minutes, which is ample to charge our 5 watt radio.

1.2.2 System Scope (Target Specifications, Concept Selection)

For the PRC-152 radio a minimum of 5 watts is needed for its every day operations. Therefore, we had to tailor our product to be able to cover this 5 watt minimum to meet the goals for our customers. Deciding on the use of solar energy and kinetic energy had the most practical application for our project. In addition, we had to tailor our product to be able to charge the 12 volt DC battery of the PRC-152 radio, which can be easily covered through a 5 watt solar panel that is designed to power 12 volt batteries. Therefore, by bringing together a flexible 5 watt solar panel and a kinetic energy boot charger our innovative charger begins to take shape; however we still need to consider the difficulty of running wires around a soldier to get to the radio. Wires would hinder the soldier’s maneuverability and potential pose a shocking hazard if the soldier were to be exposed to the current running through them. We solved this issue by charging lithium ion batteries that the soldier can use to insert into his charger that is the exact copy of the one the military currently uses only with the adjustment is that it has two ports for battery inserts, which is where the two lithium ion batteries come into play.

1.3 Document References


http://www.triplepundit.com/2012/05/fuel-cell-energy-pros-cons/


http://www.4lots.com/unisolar5wattflexiblesolarmodule.aspx

http://batteryuniversity.com/learn/article/lithium_based_batteries

http://batteryuniversity.com/learn/article/charging_lithium_ion_batteries


1.4 Glossary

Kinetic Energy Boot – A boot that utilizes the energy from the Achilles tendon to create electricity

![Kinetic Energy Boot](image)

2.0 Goals, Objectives, and Rationale for the New System

2.1 Goals and Objectives of the New System

In general, the final objective that our charger aims to meet is that it is safe, easy to use, economically viable, and environmentally friendly. In our overall design we are certain that the charger will not stand out by integrating the product into his every day uniform, concealing it with new technologies such as organic solar panels. Additionally, even if the soldier was to be shot through or break the product, it would pose no risk of shattering and harming the soldier due to its flexibility and the components of which the product is made out of. The economic viability is covered with the low amount of actual paneling that needs to be created and the low cost of the boot charger. Essentially, the
environmental impact of the charger would be virtually zero due to it harnessing energy from solar and kinetic motion.

2.2 Rationale for the New System (or Capability)

For success in the field of war, the paramount assumption one must make is that the enemy has perfect intelligence and cannot act without taking in consideration what advances the enemy has made. This includes a subtle undertone that can either make or break a war, information and the speed information can be processed at can win a war. As of now, if a soldier is unable to call back and report vital information of the enemy, he or she must travel back all the way to base camp and make a report, and if the soldier is wounded, this information is essentially lost and could lead to a failure of a battle. Therefore, creating a charging option for soldiers in the field is a critical concept that can prove to have some real world use. In addition, since communication is a crucial element in war having a back-up power option in a place devoid of car/ wall energy is paramount.

3.0 Work processes to be automated/ supported

Essentially, the kinetic energy boot charger harnesses the energy that the Achilles tendon exerts to create motion and converts the wasted energy into energy that can be used for other tasks. The boot works by having a rip cord attached to the heel of the soldiers boot which attaches to a ball screw with a 1mm pitch that activates a spring and turns a generator. This entire process creates power for the soldier that can be harnessed to do any task. In our case we aim to run this current directly into a lithium ion battery. Since batteries and the energy the boot produces in DC current we will not have to worry about any conversions.

Similarly, the solar panels will be placed in a location where the soldier sees fit; essentially, the panel will convert the energy of the sun into usable DC current. By running this current into a separate battery we can harness the solar power to accomplish the soldier’s needs for communications.

![Team 3 Block Diagram](image-url)
4.0 High-Level Functional Requirements

4.1 High-Level Features

For this project, we must take great care in insuring that the batteries we choose to charge will maintain a charge that is enough for the radio to make calls. Since the PRC-152 radios needs around 5 watts to make calls we have to insure that the size of the lithium ion battery can produce that amount. By examining the graph below, we can conclude that the power output a lithium ion battery for 1 cell is ~4 watts of power. By having more than one cell in our design we can overcome the shortage in watts and be able to power the radio for calls.

![Graph showing voltage and current over time](image)

4.2 Additional Features

Solar panels that are made out of organic materials will allow flexibility into the design and would be a different color, which will camouflage the system.

5.0 High-Level operational requirements

5.1 Non-functional Requirement
• The charger would provide a level of performance that would not be expected from a portable self-sustaining device because it requires such a short amount of time to charge and a small enough surface area to not be noticed.

• Our charger would also be very accessible since there are two separate chargers that would be responsible for charger the radio.

• The overall weight of the charger would be no more than 2.5 pounds on the soldier. This weight would be virtually undetectable due to the mounting locations of our product.

• For our designed system to fail, it would have to be drenched in water; however, the availability of water in the desert is limited and the chances of this are slim.

• The battery cannot be overcharged or the battery would be rendered useless.

• The battery cannot be let to undercharge for a very long period of time or it will die also.

5.2 Deployment and Support Requirements (Economics of the Charger)

Generally, the maintenance for these parts would have to be overseen by people trained to handle these systems; however, due to the simple nature of these systems, the parts can be tended to be the soldiers after some simple training and someone to overview the repair.

Essentially, the cost of the boot charger would be very minimal because that the boots would be already in the budget of the military and the combined cost of the boot and the charger would only amount to $78.00. The cost of to replace the lithium ion batteries would be no more than $100; however the chance of that these will die is very low. The cost of the charger would be essentially the same amount the military pays for their chargers today so we will not consider that as an actual cost. Finally, the solar panels would be priced around $100 to get a flexible 5 watt system. Therefore, the overall cost of our charger would amount to no more than $230 dollars for the entire kit. This figure does not include the actual price of the boot because the kinetic charger and the boot are two separate entities.

5.4 System Environment

The device would be suited to operate in the environments the soldiers would normally operate in. Generally, this device is targeted for the troops that are deployed in the current war. All of
the parts of the system are designed to be used in the field of war and able to handle the harsh conditions the soldiers must handle every day.

6.0 User Classes and Modes of Operation

6.1 Classes/Categories of Users

The main type of class that will be using this system will be the military. They require a PRC-152 radio and this system is specific to charging that type of radio for a long period of time which would be useful to the soldiers in the field. A secondary class would be researchers who would need a way of charging their equipment.

6.2 User classes mapped to functional features

The system would not vary too much between the military version and the researchers' version. The only difference would be the charger port since the devices being charged would be different.

6.3 Sample Operational Scenarios

The military would most likely use this system in a situation where they would have to send a man or men out into the field for a prolonged period of time (reconnaissance mission). During this mission the soldier would be able to constantly renew the energy of his radio allowing him to keep in contact with command.

7.0 Impact Considerations

7.1 Operational and Organizational Considerations

The major impact that this system would have is that it would allow military and research personnel to remain in the field for a longer time without their equipment running out of a charge. Additionally, the most devastating impact of this system would have to be its economic viability. For instance, the entire system that would make the average soldier a walking power station would cost around $230 dollars. Keeping in mind that this will make him a portable power station, this cost may be considered the otherwise maximum cost of the system since the scope of this project is just to enhance battery life.
7.2 Potential Risks and Issues

A potential risk of developing the envisioned system is that the boot charger could break down more easily due to the amount of stress the soldiers would put on it. The other risk is that solar panel being made of organic materials. An organic solar panel has not been attempted and therefore there is always a risk of the idea not producing viable amounts of energy.