Project Proposal

Camping Stove Thermoelectric Generator.

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Abstract

In today's every expanding world, energy consumption is the far most important issue facing humanity. We are being forced to find new reliable sources of energy, cleaner, more earth-friendly sources and ways of making energy more available to remote locations across the world. In conjunction with Engineers Without Borders, Chargers Innovations is developing a thermoelectric device that is going to change the way many people across the world are going to live. Chargers Innovations is developing a thermoelectric generating device that will be able to take any camp-stove and convert the heat off it, into usable electricity.

Thermoelectric energy generation is not a new concept; we have been harnessing the power of heat and the energy it gives off, since the dawn of mankind. This proposal has the opportunity to better many people's lives, create a clean reliable source of energy and a potentially lucrative market in today's "Go Green" culture.

Project Description

Across the planet, millions of people still use fire as their main source of energy. There are several downfalls to this, primarily it uses up natural resource, through deforestation. Also it pollutes the earth, sending out tons of greenhouse gases. It affects people's health from the smoke inhalation. Engineers Without Borders recognized this problem and began giving these people a cleaner burning camp-stove as a alternative to resource burning fires.

Chargers Innovations is proposing a thermo-generating device that can be attached to these camp-stove units. Using only the residual heat that comes off the flame while cooking, our device will be able to harness and convert this heat into usable energy. A specially fabricated aluminum cooking surface is put directly over the flame of the stove. This surface is designed to allow normal cooking application while residual heat is transferred down the side to the thermal generating device. This device, using the Seebeck effect, creates a temperature difference across it , which generates a current to flow through it. The generator composes of two HZ-2 thermal Seebeck cells, connected in series to the hot aluminum surface. Then a Peltier Junction, which is a device similar to a Seebeck cell but used for cooling down the other side of the Seebeck cell, is tightened down by another heat sink. A temperature difference of 200 °C between each side of the Seebeck cell allows the cells to generate maximum power. Ceramic disks and thermal grease are placed between each section to increase thermal contact and short circuit protection. The voltage and current that is generated is routed to a DC to DC converter which charges a nickel-metal hydride 12V battery. From here the battery is used to power a system of low-watt LED lights that gives off similar luminescence to a campfire. Also, a 12-volt power plug is available for running electronic devices.

This device will make electricity available to millions of people worldwide. It will be a clean, reliable source of light and electricity to campers or anyone using a camp stove, no matter where they are.

Background

The main concept behind thermoelectric generation is the Seebeck effect. In 1821, Thomas Johann Seebeck discovered that varying temperature across dissimilar metals, causes a magnetic flux. Resulting in a voltage, a thermoelectric magnetic field is created by this temperature difference between the two different metals or semiconductors. This causes a continuous current to flow through the conductors when they form a complete loop. The voltage created is of the order of several micro-volts per degree difference. This is why maximizing the temperature difference is very important; for that, thermal contact, heat transfer and pressurization play a critical role. There are two major applications to this effect: the Seebeck cell used for generating electricity from a temperature difference, and the more commonly known Peltier Junction which is used to create a temperature difference when electric current is applied. Figures 1 and 2 show an illustrated view of how the protons and electrons react to create current flow.

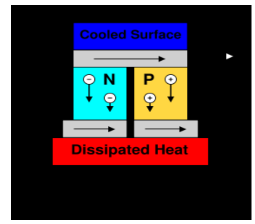


Fig. 1

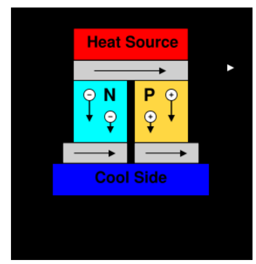


Fig. 2

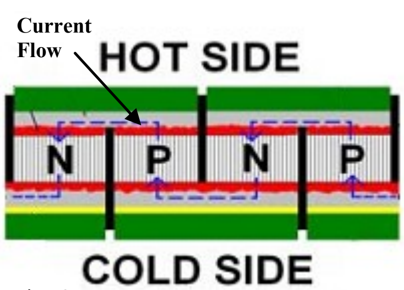
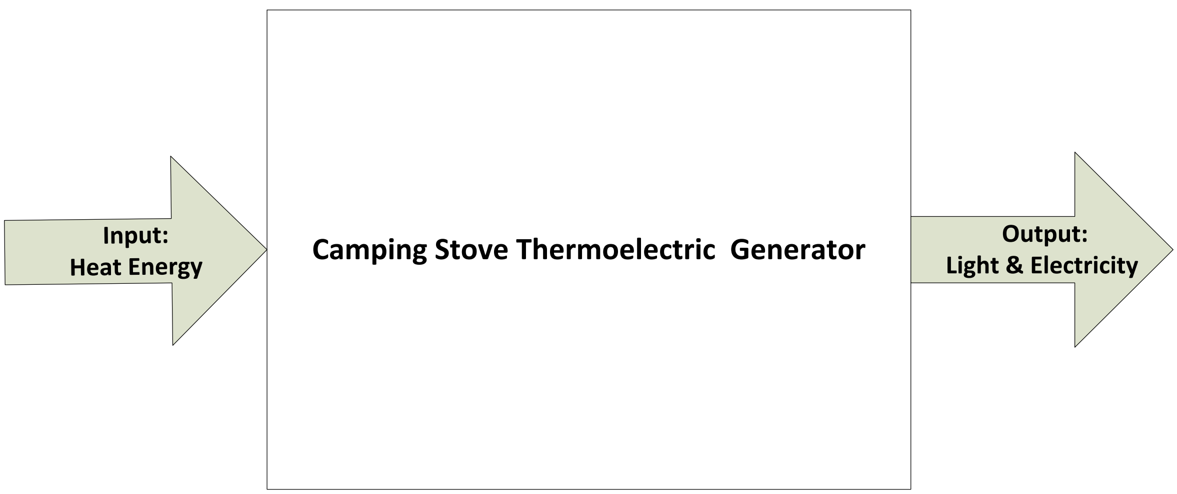


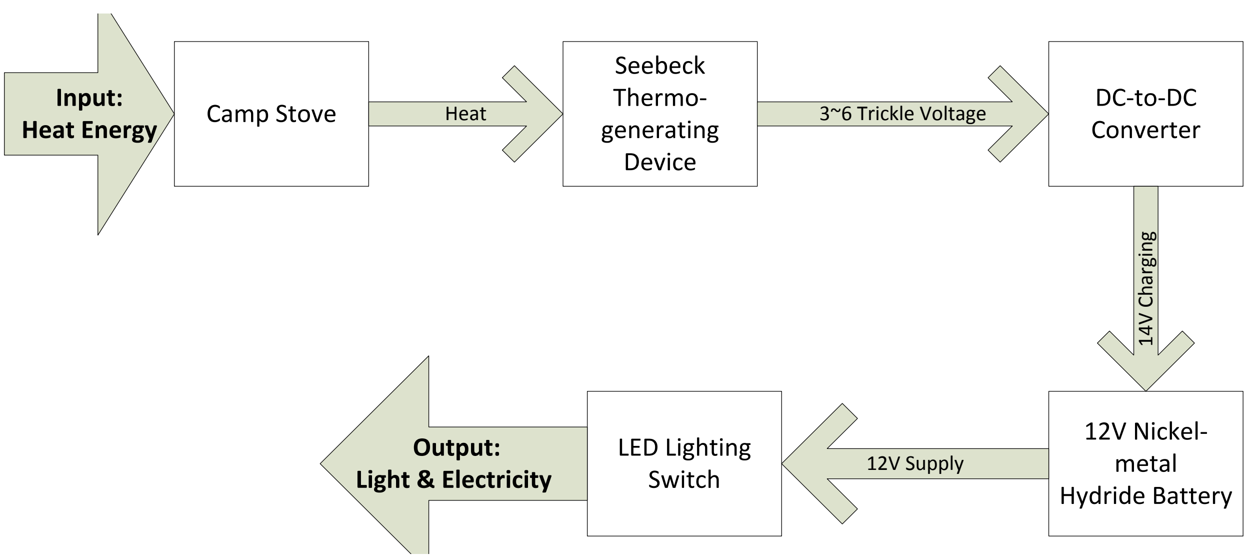
Fig. 3

The Seebeck Cells being used in this project are manufactured by Hi-Z Technologies. Their design is composed of P-N junctions lined in series and placed between two dissimilar metals. When the device is pressurized and a temperature difference is created between the two dissimilar metals, a current flow results as shown in Fig. 3. The device is coated in aluminum by an arc-sprayer, because it's thermal characteristic allows heat to be transferred easily. There are thermal generators that can range in size from 2.5 watts to 1 kilo watt. To reach the 5 watts necessary for this project, two devices rated at 2.5 watts are used.

Functional Diagram

The input is heat from a camp stove going through a Seebeck cell, to create a voltage, followed by a boost converter which is then used to charge a battery. The battery goes to a switch that can control if the LED light is on or off. After the switch, voltage goes to an LED driver chip that controls the LED, creating light.





Constraints:

Economic:

This thermo-generating device is designed in a way that can be used by developing countries, keeping in mind that the consumers have limited budget and resources. Our product must be made to be highly functional and need to be produced by countries with basic resources.

Environmental and Social Factors:

Our product needs to be durable and should be able to sustain corrosion and other natural weather factors.

S*tandards and Legislation:*

There are no standards and legislation constraints against these kinds of consumer products. Our product is small, and can be used at home or at camp-sites without interfering with homeland security or the environment. However, consumers should take precautions when using fuel sources like propane tanks and read the 'How To Use' and 'Warning' signs on the tanks before using.

Maintainability:

We designed our product to be easily maintained by using efficient components. Most of its structure is made from Aluminum, which is very durable, light weight, and most importantly, does not corrode. We also used highly efficient batteries that can last longer and sustain continuous charging and discharging.

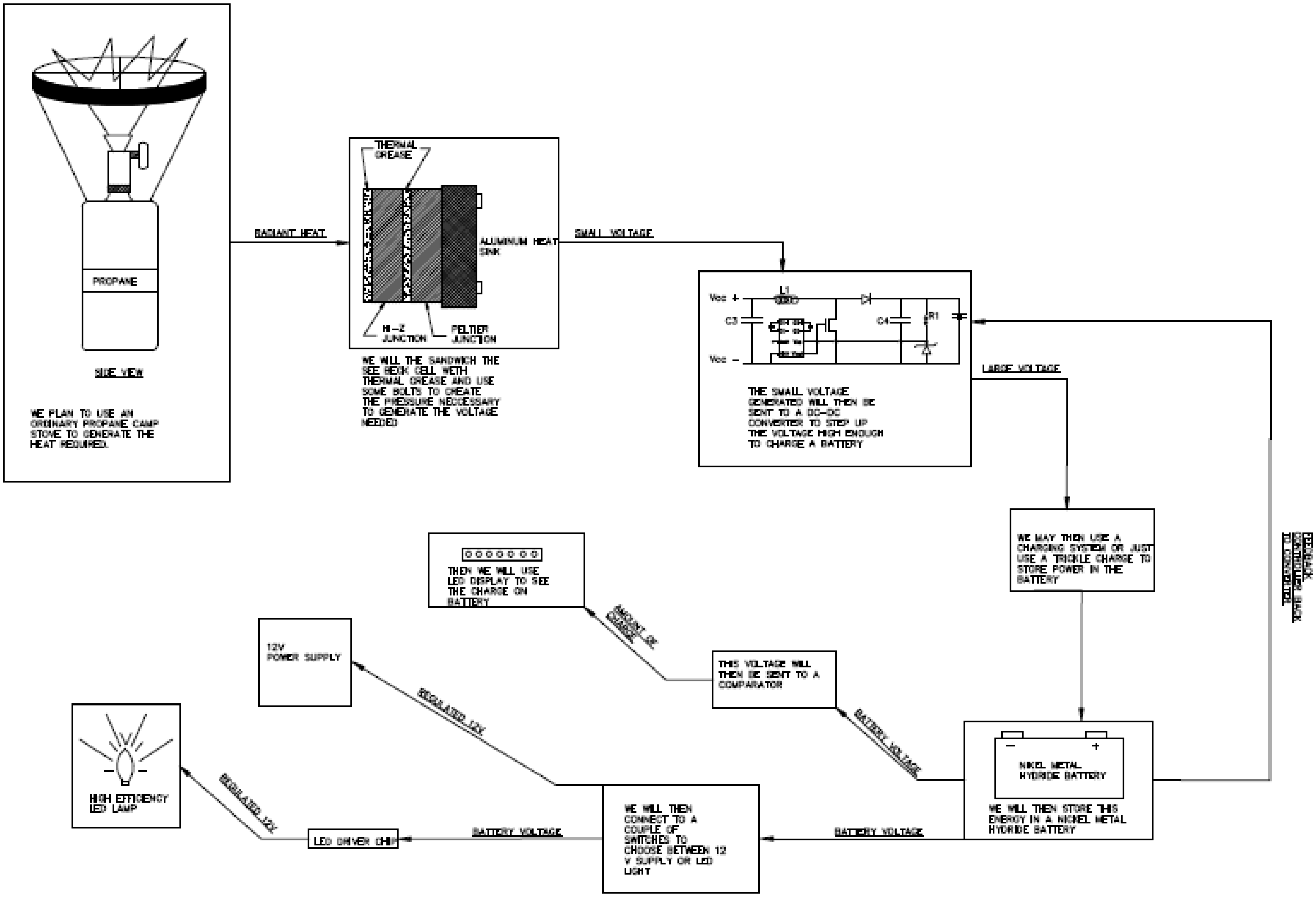
Serviceability:

Our thermo-generating device can be easily serviced by a consumer with little or no knowledge about the product, because we designed it to be less complicated and using small number of components. And parts replacement, if needed at all, should be very easy.

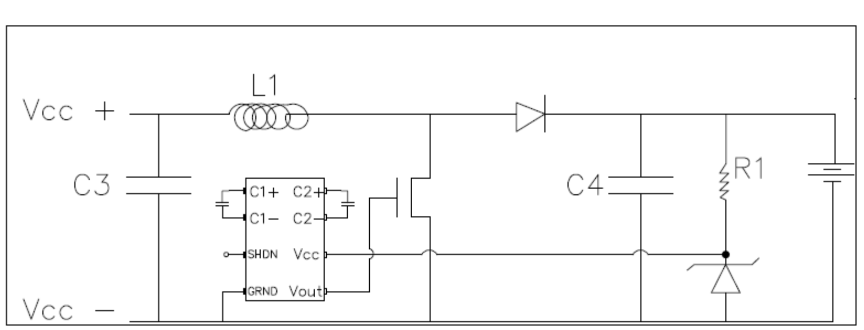
Manufacturability:

Most of the components for our thermo-generating device, except Seebeck cells, can be easily manufactured even by under-developed regions and it utilizes small number of components and electronic devices.

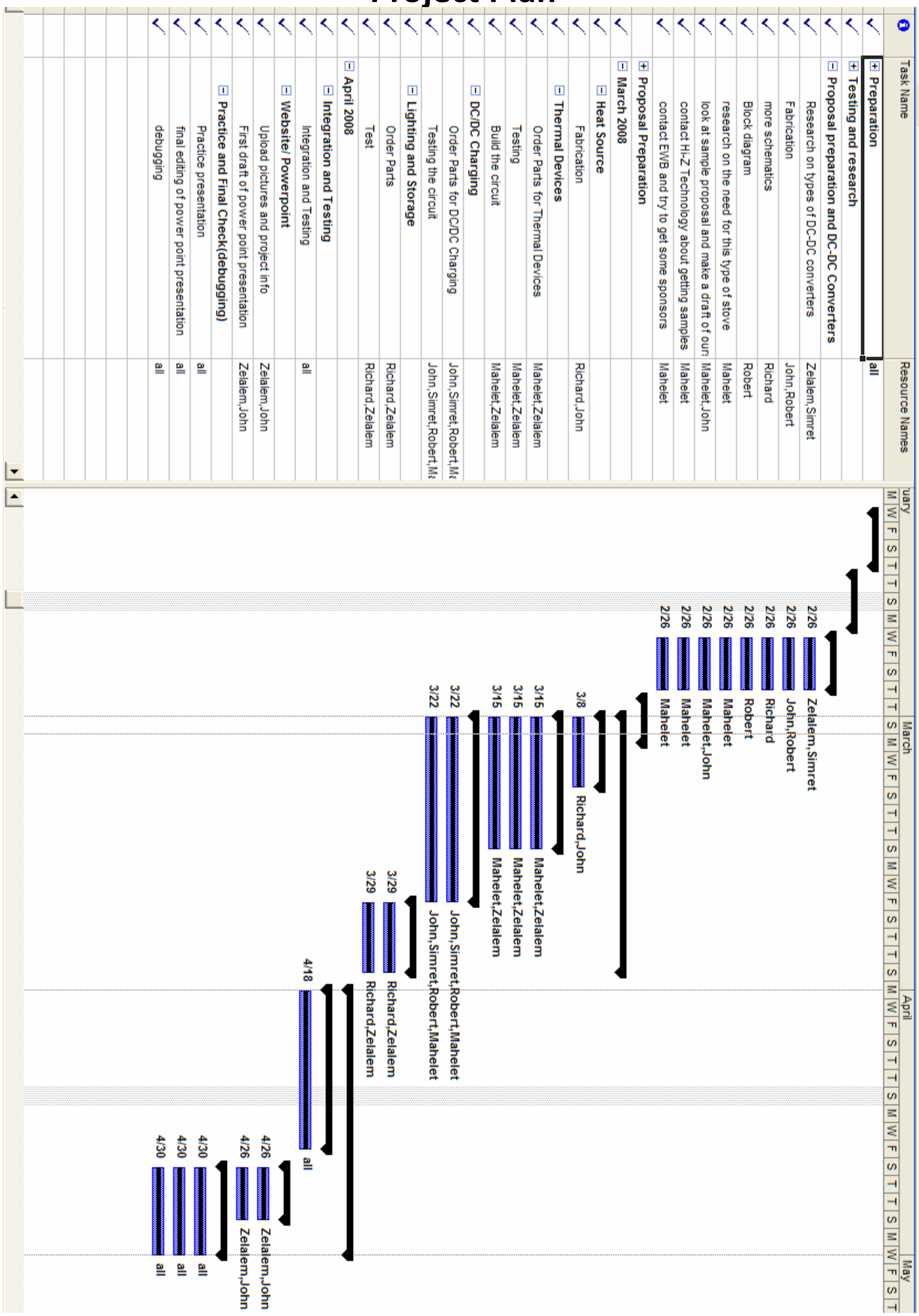
Block Diagram



Blown-Up diagram of DC-DC converter.



Project Plan



Testing

Testing will begin by seeing how much voltage and current we get off the Seebeck cells. Testing with a difference in temperatures across the Seebeck we will use two aluminum blocks with thermometers attached placed on a hot plate while the other one has an ice block to decrease the temperature of the other block. The Seebeck cell is then connected to a small load resistance so a voltage can be measured across it. The resulting current can be calculated from the voltage and resistance. These results will help in the design of the DC to DC converter.

The temperature of heat source is tested by heating an aluminum block, letting the heat source reach a leveled amount of temperature. The integrated circuit, that is the DC to DC converter, will be tested by introducing a small voltage produced by a DC power supply while the output voltage can be measured by a multi-meter. The integrated circuit that is regulating the power out can be adjusted by varying a DC power source while measuring the output voltage through a multi-meter. The final device will be tested by cooking a meal on the stove and trying to get light out of the light emitting diodes.

Cost Analysis

Budget

These are the preliminary cost estimates of our project:

***Material costs**: (5000+ quantities)*

Commercially Available Parts:

- Capacitors	$ 1.96
- Inductors	$.08
- Zener Diodes	$ 0.09
- Resistors	$ 0.05
- MOSFETS	$ 0.15
- Micro-Controllers	$ 1.46
- Bolts and Screws	$ 2.00
- Seebeck cells	$ 60.00
- Storage devices/ Batteries	$ 16.19
- LED lighting	$ 10.00
- Heat Shields	$ 5.00
- Ceramic Plates	$ 5.00
- Thermal Grease	$ 0.02

Fabricated Parts:

- Aluminum cooking surface	$ 2.00
- Heat Sinks	$ 1.00

Labor costs:

Team members - …….. hours @ $0 per hour
John - …….. hours @ $0 per hour

Total: $ 105.00

References

1. Hi-Z Technologies
http://www.hi-z.com/

2. DC-DC Converter Basics
http://www.powerdesigners.com/infoweb/design_center/articles/DC-DC/converter.shtm

3 . Kennedy, John and Tummala, Lal, "Proposal Format," San Diego State University, Fall 2008.

4. Mohan, Undeland and Robbins," Power Electronics: Converters, Applications and Design", Wiley 2003,

5. Wikipedia
http://en.wikipedia.org/wiki/Thomas_Johann_Seebeck