# Hotdog- Solar Powered Doghouse

Project Proposal

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# Introduction

## *Title*

Solar Powered Doghouse

## *Statement of Purpose*

This project was chosen keeping in mind those dog-owners who live in places with extreme climate – hot during summer and cold during the winter months. Our singular aim is to provide such dog-owners with a convenient means to house their dog, while ensuring that the dog is sheltered from inclement weather conditions. As such, there are no commercially available doghouses that provide this service while being powered by solar energy. Our group is excited about delivering a product that is safe, economically viable, and environmentally sustainable. We will focus on making the doghouse easy to use and maintain.

## *Objectives*

The goal of this project is to build a doghouse which controls its own temperature and is powered by solar energy. We will begin by developing an efficient heating mechanism which will function in extreme weather conditions and will successfully heat a doghouse with inner dimensions of 48''X24''X28''. A fan will also be included to provide relief from the heat during the summer. Next, we will design a control component which will monitor the energy harvested by the solar panels, control the charging of a battery, as well as make a decision regarding supplying power to the heating mechanism. There will also be a temperature control component which will receive feedback from temperature sensors that will serve to regulate the temperature of the dog-house, in conjunction with the power control element described above. Finally, we will install solar panels on the roof of the doghouse to provide power to the various electrical components. The result will be a fully functional doghouse which is sturdy, safe, easy to use, assemble, and maintain.

Functions:

- Designed to keep the dog warm in the winter, and cool in the summer.
- The temperature range specified by the owner is maintained.
- Sensors send feedback to microcontroller which determines whether to turn the heating on/off.
- Generates its own power via solar panels.
- Battery for storage of energy.
- Heating coil underneath the floor to provide heat, and a fan to cool the interior during summer.

Benefits:

- No extra electricity cost.
- Once temperature range is set, no need to monitor regularly.

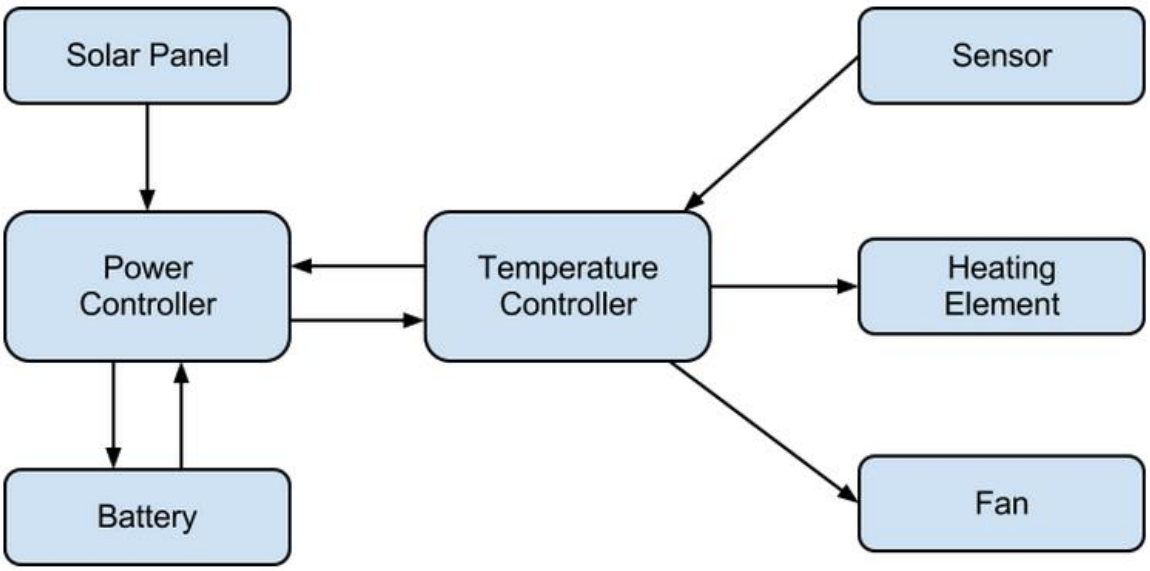
- Tiled floor is easy to clean.
- Owner can leave dogs in a convenient temperature-controlled shelter while away.
- Well insulated to minimize heat loss.
- Safe for the dog as there are no exposed electrical components

Features:

- 80 Watt solar panels on roof to generate power.
- Arduino microcontroller to monitor and control heating and battery operations.
- Thermistors to monitor range preset by the owner.
- Nichrome wire loops underneath a tiled floor serve as heating element.
- R-5 insulation in walls.
- Radiant Barrier on ceiling and below the heating element to minimize heat loss.

# Design

## *Block Diagram*




## *Block Descriptions*

Solar Panel: The solar panel will be used to collect the energy from the sun throughout the day. The power from the panel will be controlled by the power controller and used to either charge the battery or to power the heating system. The panel will most likely be one 80W panel.

Battery: The battery will be used to power the heating system when the solar panel is not able to, due to of a lack of sunlight. The battery will be charged by the solar panel when the panel is not being used to power the system. The charging and discharging of the battery will be controlled by the power controller. The battery will most likely be a 12V battery.

Power Controller: The power controller will most likely consist of an Arduino microcontroller and any other converting circuitry needed. The controller will monitor the charging of the battery by the solar panel and choose between the panel and battery, when power is needed for the heating system. When the temperature controller indicates that power is needed in the heating system, the controller will either start discharging the battery or use the power from the panel, if available.

Temperature Controller: The temperature controller will be used to control the heating system. The controller will take the temperature/mode set by the user and begin regulating the house temperature to that setting. The controller will signal to the power controller that power is needed. The system will have two different modes: heating and cooling. If the heating mode is selected, the temperature controller will use the sensor to monitor the temperature of the house. If the temperature is too low with respect to the set temperature, the power controller will start powering the heating element. If the temperature is too high with respect to the set temperature, the temperature controller will stop powering the heating element and signal to the power controller to stop providing power. The other mode available to be set by the user is the cooling mode. If the cooling mode is selected, the fan will be turned on to different speeds depending on the input from the user. At this point in time it has not been decided whether the fan will constantly be running if the input is set to cooling mode, or if the fan will also be controlled by temperature like the heating element and turn on and off.

Sensor: The sensor will be used to allow the temperature controller to monitor the temperature. The sensor will most likely be a thermistor. As of now, there will be two thermistors. One will be placed on the floor to ensure that the floor will not overheat. The other thermistor will be higher in the doghouse. This is the thermistor that will monitor the temperature of the room.

Heating Element: The heating element will consist of a nichrome wire laid into the floor. The wire will be arranged into a mat, possibly woven into a fiberglass mat to aid in distributing even heat, and laid underneath the tile floor. The tile paste will be laid directly onto the wire and the tile floor placed on top to be heated. The heating element will have a voltage applied across it by the temperature controller whenever the temperature in the house is low with respect to the temperature set by the user when the system is set to heating mode.

Fan: The fan will be installed into the back wall of the house. The fan will be a simple exhaust fan run on a dc voltage. If the system is set to cooling mode, the temperature controller will apply a voltage to the fan depending on the speed set by the user.

# Requirements and Verification

## *Requirements*

Solar Panels: This block must take energy from the sun and successfully be able to charge the battery.

Battery: The battery needs to hold a charge and power the system.

Power controller: This correctly indicates the status of the battery and monitors the power available from the solar panels.

Temperature Control: This must respond to the users input from the control box and determine to whether to supply voltage to the nichrome wire, to run the fan, or to idle.

Sensor: The resistance across the thermistor must change depending on the temperature of the thermistor.

Heating Element: This must dissipate heat depending on the signal sent by the temperature control.

Fan: When input is sent from the temperature control, the fan must turn on.

## *Verification*

Solar Panels and Battery: In order to test these blocks they must function together. Sunlight will be simulated in the lab, and will then the voltage will be measured across the battery terminals. This should be 12 V. The battery will then rest for a couple of days and then the voltage will be measured across the battery to make sure it can hold a charge. To successfully hold a charge, the battery should hold a charge for five days.

Power Controller: If a depleted battery is attached to this block, and solar panels with applied light, the power controller must start collecting power from the solar panels to charge the battery. The controller will need to keep track of whether the battery is charging or discharging at all times. A test will be also be done to check that when a simulated signal from the temperature control indicates power is needed in the system, the power controller outputs a correct voltage and correctly switches the battery from charging to discharging mode.

Temperature Control: To test fan mode the fan will be switched on and then the behavior of the fan will be monitored. If the fan goes on, it works. When the switch is flipped off, the fan should go off. To check heat mode, the switch will be set to heat mode and the temperature will be set to the desired range. The temperature will be monitored with a thermometer to make sure the temperature increases to a range of 10% of our previously set temperature. Once it reaches this point, the heating coils should turn off. Slowly the temperature will decrease until it reaches the hysteresis point. Once it reaches within 10% of this temperature, the heating coils should turn on. This process should constantly be repeating without any human interaction with the system.

Sensor: The sensors must function properly with the temperature control system. However, to check the thermistors themselves, the temperature at specific locations will be taken. The resistance across the thermistor terminals will also be measured at the same locations. By looking at the datasheet that comes with the thermistor, the temperature that corresponds to the measured resistance must correspond to the temperature measured by the thermometer. A range of 10% was determined in order for the thermistors to work successfully. More details are discussed below in the tolerance analysis.

Heating Coils: 12V will be applied to the nichrome wire. Depending on the gauge and length of the nichrome wire, the temperature should be a set value. The range of temperatures that the coil should be is 200-350 degrees Fahrenheit. (The exact temperature has yet to be determined.) The temperature of the coils will be measured with a thermometer to make sure the coils are at the temperature that was determined to be hot enough to heat the doghouse. The wire must also not break, once the voltage is applied.

Fan: A voltage will be applied to the fan terminals. The fan should turn on. When the voltage is not applied, the fan should turn off.

### *Tolerance Analysis*

One of the most integral part of the doghouse is the system that regulates the temperature. If the house becomes too hot, the heating coils need to turn off. If the house becomes too cold, there must be a voltage applied to the heating coils. Also, when set to fan mode, the fan must turn on. If this part of the dog house does not function properly, this comfortable dog house turns into just a very expensive arrangement of wood.

The thermistors must be calibrated properly with the external control. A range of 10% of the set temperature would be reasonable. This will be checked by measuring the resistance of the thermistor at various temperatures. The corresponding temperature on the data sheet should be within 10%. Seeing as this is simply the comfort level of the dog, the exact temperature is not critical. However, if the floor overheats, the thermistor will detect this and shut off. Also, if it does become extremely cold in the doghouse, the thermistor will detect this, and then the floor will start to heat. 10% is a reasonable level so that the dog remains comfortable however, safety is still under control.

## Cost and Schedule

### *Cost Analysis*

Labor Costs:

We conducted a simplified cost analysis for our project to estimate the total cost of building a solar powered dog-house. We assumed an Hourly salary of $35.00 per person, and 150 total working hours per person.

| Name | Hourly Rate | Total Hours Invested | Total Labor Cost |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Krista Giacobazzi | $35.00 | 150 | $13, 125.00 |
| Lynn Deasey | $35.00 | 150 | $13, 125.00 |
| Gurbaaz Singh Sidhu | $35.00 | 150 | $13, 125.00 |
| Total | | 450 | $39, 375.00 |

The total labor costs were calculated as shown,

Labor Costs = 35.00 * 2.5*150 = $ 13, 125.00

Components Costs:

| Component | Quantity | Cost ($) |
|---|---|---|
| Wooden Dog-house | 1 | 150.00 |
| 80 W Solar panel | 1 | 100.00 |
| 12 V battery | 1 | 40.00 |
| Arduino Microcontroller | 1 | 14.75 |
| Nichrome wire | 205 cm | 8.00 |
| Temperature sensors | 2 | 1.20 |
| Thermistor | 1 | 2.00 |
| Small Fan | 1 | 20.00 |
| Insulation | 2''X48''X8' | 24.68 |
| Radiant Barrier | 6' roll | 18.96 |
| Tiles | 8 (1 sq. foot each) | 30.00 |

Total Costs:

| Section | Total |
|---|---|
| Labor | $39, 375.00 |
| Components | $409.59 |
| **Total** | **$39784.59** |

# Schedule

| | | |
|---|---|---|
| 2/4 | Proposal | Krista- Tolerance Analysis, Verification and Requirements<br>Gurbaaz- Title Objectives, Cost<br>Lynn- Block diagram and descriptions |
| 2/11 | Design and Acquire Materials | Lynn- Design Dog House<br>Gurbaaz- Acquire materials for dog house and design heating element |

| | | |
|---|---|---|
| | | Krista-Design Floor of dog house, research thermistors |
| 2/18 | Construct physical dog house | Lynn-Build/Get dog house<br>Gurbaaz- Install fan<br>Krista-design temperature control<br>All- help with assembly |
| 2/25 Design Review | Start building components | Lynn- designing the power controller<br>Gurbaaz- Build the heated floor<br>Krista-test the temperature control<br>All- Divide up the design review |
| 3/4 | Continue designing and assembling individual components | Lynn- Program microcontroller<br>Gurbaaz-Design enclosure for battery and make connections<br>Krista- Make board on eaglecad |
| 3/11 | Finish components and begin assembly | Lynn-Assemble all power components<br>Gurbaaz- Design solar panel setup<br>Krista- Finish the temperature controller |
| 3/18 Spring Break | | |
| 3/25 Mock Up Demo | Integrate and assembling components | Everyone works together to assemble their respective parts |
| 4/1 | Integrate and assembling components | Everyone works together to assemble their respective parts |
| 4/8 | Testing/Debugging | All |
| 4/15 | Testing/Debugging | All |
| 4/22 Demo | Demo | All |
| 4/29 Presentation/Papers | Presentation | All |