



Customer Needs and Engineering Requirements for Team B12: Red Feather

By:

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Background

- Many households on the Navajo Nation and Hopi Reservation use coal and wood-fired stoves for heating
- Red Feather Development Group seeks to replace these with cleaner, more efficient, and safer solar-thermal based heating systems
- Previous capstone groups have designed solar furnaces reliant on the sun to provide daytime heating
- Our team was asked to create a thermal storage device to capture excess heat during the day and provide continuous heating at night
- Device must be made using locally available materials, and should be within the given price range of the Red Feather Development Group



Customer Needs

Table 1: Customer Needs

Question/prompt	Customer statement	Interpretation/Need
What is the main problem?	“A solution is still required to keep the home comfortable throughout the night.”	Device should provide consistent heat source to keep houses warm at night, storing heat during the day and releasing at night.
What is the scope of the project?	“Current solar furnace is Arctica solar. Run by solar panel that runs the thermostat inside and monitors the temperature. System without electricity. Runs thermostat, fan, takes care of all electrical needs.”	Device should store heat during the day and release it at night.
Where do you primarily work on homes in the reservation?	“Predominantly doing Hopi and western side of Navajo, includes major Navajo areas. Tuba City, Cameron, Leupp, Bird Springs. Currently, temperature drops into 40 degrees in the evening, 100 degrees all the way down into the 40’s and 30’s. June and July is 100-60. Gets colder as progress into fall. In the summer it is 100-50 degrees. In the fall it is 100-40 degrees. In the winter, goes down to 20’s.”	Device should be suited to functioning in Western Agency Council and Hopi Mesa regions.
How warm does the device need to keep the house?	“The design of thermal storage devices to be used in conjunction with thermal furnace solutions to keep indoor temperatures at or above 50+ deg F are the product deliverables.”	Device should maintain comfortable indoor temperature throughout night.
What is the budget?	“Comfortable with \$1200/\$1500 per unit.” [Although this is likely in tandem with Arctica Solar Air Furnace, for \$500/unit]	Device should be within purchasing capabilities of Red Feather and the relevant clients.

Customer Needs Cont.

Table 1: Customer Needs

Are there any readily available resources?	“Could ask Arctic solar if they would consider donating one [of the solar furnaces] to us to look at. Resources available would be donations.” [Needs to be easily understood by donators]	Design should be straightforward.
What are our limits to size and dimension?	“If you start drilling holes in the roof, though, you could cause enormous problems. Exterior wall mounted systems work. Even in those systems, avoid a roof-mounted system. Any attempt to mount something on the roof will present a problem.”	Device geometry should fit a variety of housing situations (no roof cave-ins).
What are the limits to the available materials?	“Device should be constructed with locally available materials”	Materials should be readily available in the region.
Will the device be reliable?	The device needs to consistently work for people in homes without maintenance.	Design a reliable design.
Will the device remain intact if dropped or damaged?	The device needs to withstand normal, everyday conditions, including different applications of force and different ranges of weather.	Create a durable and robust design.

Engineering Requirements

Table 2: Engineering Requirements

Engineering Requirement	Derived from this Customer Need	Method of measurement	Unit of Measurement
Device maintains consistent house air temperature (60deg F)	Device should maintain comfortable indoor temperature throughout night	Thermometer or Temperature Sensor for temperature of air	Fahrenheit
Device works in environments with outside temperatures ranging from 20 degrees to 60 degrees Fahrenheit.	Device should provide consistent heat source to keep houses warm at night, functioning within standard season range of Navajo Nation and Hopi Reservation temperatures.	Thermometer or Temperature sensor	Fahrenheit
Device outputs a consistent amount of heat to the house at night	Device should provide consistent heat source to keep houses warm at night AND device should store heat during the day and release it at night.	Heat equation, using mass, material qualities such as the specific heat of the medium fluid, and a measured change in temperature	BTUs

Engineering Requirements Cont.

Table 2: Engineering Requirements

Device budget is between \$800-\$1,200	Device should be within purchasing capabilities of Red Feather and the relevant clients.	Pricing	Dollars
Device has limited amount of parts.	Design should be straightforward.	Counting	Unitless
Device able to install onto a variety of homes.	Device geometry should fit a variety of housing situations (no roof cave-ins)	Device dimensions and weight	Feet, Lbs.
Materials should have minimal delivery (transit) time	Materials should be readily available in the region	Transit time of materials	Hours, Days
Device should work without interruption or maintenance.	Design a reliable design.	Amount of time device works without stopping	Hours, Days
Device should be able to withstand common displays of force without breaking.	Create a durable and robust design.	Amount of force device can withstand. Amount of water on the device, with which it still operates	Lbf, Volume of water



Let us know your questions?