Needs Identification and Problem Statement

Introduction:

This document presents the comprehensive problem statement for our prototype of the Thermal Heat Exchange Chamber (THEC) for our client. Additionally, there is an analysis of the client's needs for the design, a prioritized list of our needs as a group, and a brief benchmark of comparable products on the market. We have obtained the following information by carefully dissecting our client's statements and extracting the relevant needs communicated by them.

Problem Statement:

Our client, on behalf of their customers, needs a low-tech, zero-emission, and inexpensive heat exchange chamber. The current GCHE needs to be modified to be more compact, have a sustainable power source, and be able to achieve higher temperatures in the winter, all in the scope of an average townhouse.

Client Needs Analysis:

Customer Statement	Interpreted Needs (Key Words)
"There is no plan to change [the design]. We are working to improve its efficiency in the heating mode."	**Improve, heating mode, efficiency** - The client is happy with their design except for the heating capabilities in the winter.
In a new system, the client looks for "sustainability and cost of operation/installation."	**Sustainability, cost of operation** - The client defines the key appeals of the system as sustainability and affordability.
"On a scale of 1-10 [environmental sustainability] is a 9." The client has "no preference" on specific sustainable materials.	**Environmental sustainability, 9/10** - The client's numerical ranking of environmental sustainability highlights the importance of this feature.
"It is low-tech, has zero emissions, it is sustainable, it is inexpensive compared to other HVAC systems." "No, it is not expensive to maintain – the only moving part is the blower fan."	**Inexpensive, zero emissions, low-tech** - The client iterates the key features of the system: it should be inexpensive, easy to implement and maintain, and release zero emissions.
"There should not be any unpleasant smell from the system because it is installed air-tight and the inlet is fresh air."	**Odor, air-tight installation** - The client emphasizes a lack of odor, which should be achieved by proper installation.

Organizing and Prioritizing Needs:

	Needs	Importance
General Design Needs	The product needs to be environmentally friendly with zero emissions, as it is intended to function as a sustainable heating and cooling alternative.	5
	The power source to supply electricity to the thermostat and sump pump systems should be renewable.	5
	The product should be low-tech and inexpensive.	5
	The system should be designed to withstand 35 – 40 years of use.	3

Commented [SD1]: To answer the importance column, we will use numbers just like monsieur mentioned int the lecture
5 = Satisfying the need is critical
4 = Satisfying the need is highly desirable
3 = Satisfying the need would be nice, but is not necessary
2 = Satisfying the need is undesirable

	The system needs to be easy to maintain.	4
Technical Needs	The stabilized air entering the house should not pose any health threats to the users. All stagnant water must be collected and removed and the air must be filtered.	5
	The design needs to be compact and easily installable in an average townhouse yard. The mechanism should not span as large an area as the current GCHE does.	5
	The heating system should be able to achieve higher temperatures in the winter. The current model reaches temperatures of 15°C during winter; future models should boost it to 20°C.	4
	The air entering the building should be odorless as to not cause discomfort to users. This can be ensured with airtight pipes and proper use of sealants to close the main box.	3
	The fan system should be quiet and non-disruptive to the user.	3

User Preference Benchmarking:

By researching similar products on WaterFurnace Reviews, we discovered seven points which customers appreciated the most: low price, environmental impact, lifespan, safety, noise, performance, and maintenance. Geothermal heating typically succeeds in these fields; for example, some users commented that they were paying 40-50% less in monthly bills. This standard is one our product should meet. Additionally, many users made their purchase of a geothermal system because of its sustainable nature, a feature our product will provide. To meet this requirement, however, we will need to explore renewable power sources like solar power. Notably, the cost of our product will be significantly lower than the industry standard. The average unit is currently around $10,000 USD, and installation could be up to an additional $25,000 in some areas. Comparably, our product would have a manufacturing cost of only $100 with easy and low-cost installation, summing at a considerably low retail price. Furthermore, along with low retail prices, the product's lifetime and durability is another attractive feature to many clients; their respective systems have lifespans of around 40 years and require no maintenance. Specific features that users appreciate are the silent nature of the system as well as its safety. Because this system does not use any form of gas, there is absolutely no risk of carbon monoxide poisoning. Finally, many people mentioned that their products ensured an evenness of temperature; there were very few or no spots in their buildings where the temperature was higher or lower than the rest of the house.

Conclusion:

As of now, we have been able to empathize with the client, are familiar with their needs, and have researched general preferences of other users of the design. The client meeting and subsequent needs classification has provided us with enough information to proceed with the technical aspect of the design - namely, starting to plan our first protype. In the coming process, it is undeniable that more technical questions will arise where we require details that our client has yet to specify. We cannot explicitly define these technical ambiguities now simply because we have yet to start designing the actual product; once the design process starts, we will better understand what technical blanks must be filled to meet the client's expectations.

Citations:

WaterFurnace reviews. WaterFurnace Reviews. (n.d.). Retrieved February 2, 2022, from https://www.waterfurnace.com/residential/about-geothermal/reviews