**Evaporation Design Challenge**

# Introduction

Large areas of many developing countries have no grid energy. This is a serious challenge that threatens the continuity of vaccine cold chains. The International Energy Agency estimates that 1.3 billion people lacked access to electricity in 2010, more than one-fifth of the world’s population. Some 85 percent of those without electricity live in rural areas, mainly in sub-Saharan Africa and South Asia where there is no distribution grid for electricity. This is a serious challenge that threatens the continuity of the vaccine cold chain. Although there are alternatives to electrically powered refrigerators, they are mostly plagued by problems with gas supply interruptions, low efficiency, poor temperature control, and frequent maintenance needs. However, amongst them solar refrigeration was a promising development in the 1980’s providing an alternative to absorption technology to meet cold chain needs in remote areas. This technology is now poised to be the refrigeration method of choice for cold chains in areas with no electricity or extremely unreliable electricity and sufficient sunlight.

The Bill and Melinda Gates foundation recognizes that hundreds of thousands of lives each year could be saved by improved access to vaccines. Vaccines are cost-effective, safe, and proven to protect children from disease. Therefore, from 2012-2014, the Gates Foundation accepted nominations from around the world to identify people and organizations doing exceptional work to improve immunization rates. The Gates Vaccine Innovation Award celebrated revolutionary ways children in the poorest parts of the world are immunized. The winning innovations were recognized with a US $250,000 prize. The Gates Vaccine Innovation Award was open to individuals from any discipline. Candidates from academic institutions, governments, health care facilities, research institutions, non-profit organizations and for-profit companies were eligible for nomination.

Therefore, your challenge is to apply the concepts of thermodynamics such as extraction of work from a system and cycles (carnot, rankine etc) that can be used to solve or aid in a community in some way.

# Design Constraints

Some of the major challenges while solving the solar refrigeration problem includes:

* Designers lack data—when buyers do not provide suppliers with sufficient installation site data, including geographic location, solar radiation, and temperature to accurately design the system for optimal performance.
* Poor system sizing—when designers do not properly match the size of either the solar module and/or the battery bank with the solar radiation expected at the installation site and the power demands of the refrigerator.
* Poor installation—when installers orient and mount the solar array poorly by using inadequate structural support or not accounting for the sun path, provide insufficient protection for solar array and wiring, and/or use low-quality electrical equipment including automotive or other transportable battery types.
* Innovation and creativity – the design must apply imaginative and pioneering approaches to overcome difficult challenges to immunizing children and achieving impact. Innovation is not the same as invention. Even simple ideas applied in creative ways to overcome real-world challenges can be considered innovative.
* Scale – The design must be applied at scale or suitable to be implemented at scale within the nominee's country and around the world.

# Student Learning Outcomes

After completing this design challenge, students will be able to:

* Explain what problems are solved with the help of Thermodynamics
* Select the proper system that corresponds to any particular problem
* Define and explain the differences between different thermodynamic units
* Solve problems and apply in a real-world situation
* Collaborate in teams and pitch their ideas in formal presentations

# Project Management

You will be required to work in groups and will decide amongst yourselves who will perform each section of the lab. You are welcome to do everything together or split the different lab sections amongst the group. Keeping a courteous and respectful attitude with your collaborators and time management will be key in finishing within the time given.

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| Job title | Job Description |
| Project Manager | Responsible for submitting team deliverables, keeping the team on track and managing group progress. Everyone will pitch in with the design and aid in the brainstorming, but at some point, you will need to decide on an idea, and the project manager has final say. This reflects the real world, and sometimes ideas may be selected that are not your own. Compromise to make a better product! |
| Lead Research Scientist | Leads the team in conducting research. This person should organize documents and information gathered by the team and can assign specific research tasks to members of the team. This person should be organized and analytic. |
| Lead Market & Financial Analyst | Oversees market research on existing products. Confirms accuracy of numbers and accounts for how the team spends time. When you are working as a professional engineer, you will be responsible for justifying the time spent to your client. This person needs to be good at attention to detail and have strong ethics. |
| Lead Requirements Engineer | Responsible for keeping stakeholder requirements and customer needs in focus. This person should be able to empathize with customer experience and consider different points of view, while also considering material constraints. |
| Community coordinator | Oversees research on community engagement strategies, including understanding all relevant engineering content and developing a communication strategy aimed at broader audiences. Coordinates and advocates community interests to team members to ensure effective design. |

# Deliverables

Provide a list of deliverables and estimates for points for each deliverable. Note that you will need to make all worksheets/assignments.

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| Deliverable | Descriptions | Points |
| Deliverable 1 (completed as individuals): Short annotated bibliography | 3 cited academic sources with a paragraph for each, summarizing the contents of the paper. | Worth ~as much as a homework. Due after the cycles/reversible and irreversible processes portion of the class. |
| Deliverable 2 (completed as groups): Technical report | ~2-3 pages outlining design idea and technical specifications (cycle, isothermal/adiabatic processes, estimated efficiencies). Sources can be taken from annotated bibliography, and new sources could be added but all sources but be cited correctly. Could contain figures or graphs to illustrate design. This would be primarily focused on observing the students engineering design sense. Due ~2/3 the way through the semester. | Worth more than a HW but less than a midterm. |
| Deliverable 3 (completed as group): Final presentation | 5 Minute presentation during the last two recitations of the semester. Presentations will be over chosen application of evaporative cooling/solar refrigeration. The problem and reason for design solution must be clearly stated. Groups of 5 will create a powerpoint and present to a board of judges (Michael, Pieta, Datye, Petsev). Presentation will outline design approach, empirical evidence on the mechanisms by which the process would work (gas expansion/compression, adiabatic/isothermal processes, rankine/otto cycles, PV diagrams) | Worth ~more than HW but less than midterm. |
| Deliverable 4: Group Evaluation | Group evaluation at the end of the semester to gauge the amount of work each member contributed. | Will be used to assign +/- to the final project grades. |

# Final Presentation Guidelines

Your final presentation will include a 5-minute pitch delivered to the class accompanied by a supporting Power-point presentation. Both your pitch and Power-point document should be persuasive and include data about the problem.

See information below on how to create a pitch and the supporting document options.

## Pitch

*Your pitch should meet the following elements*

**Time:** Try to make your presentation concise and no longer than 5 minutes.

**Dress:** You may dress professionally.

**The Problem:** Concisely explain the problem and needs addressed by your design.

**Use-case:** A good pitch helps the potential investor envision how the product will be used, not just what it looks like. Sharing a (very) short story about how it will change customers’ lives for the better will help seal the deal.

**Creativity:** An idea viewed as novel will be received better than an ordinary one. Your pitch should highlight what makes your product stand out.

## Power-point Presentation

A template has been uploaded to Learn to help you get started. Feel free to add/remove anything you see fit, but each member of your group should present on at least 1 slide.

Your design schematic does **not** have to be professional (Autocad, Photoshop, etc.) but it should still be presentable. Try MS publisher, Powerpoint, or draw it by hand.

Your economic analysis does not have to be perfectly accurate, but you should be able to make some good estimations.

**Cite all references, cite all images (that aren’t your own)**

**Schedule for Evaporative Cooling Challenge CBE 302**

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| Date | Topic/ Activities | Due  \*submit on UNM Learn by 11:59 pm |
| Jan 15 | Introduction email from CATME, how we will form teams. | Sign up for CATME, check your team on UNM Learn |
| Jan 23 | Evaporative Cooling Challenge introduction |  |
| Feb 7 | Deliverable 1 | Annotated bibliography  (submit individually to UNM Learn) |
| Feb 13 | Team Rules  In Class Activity: Locate your teams, discuss team rules, meeting times, exchange contacts etc | Team Rules Document |
| Mar 14 | Deliverable 2 | Short Report (submit as a team to UNM Learn) |
| Apr 24 | Deliverable 3 | Pitch Power point Presentation (submit as a team to UNM Learn) |
| Apr 26 | Team Presentation | Present your power points as a team, dress professionally, ASK QUESTIONS |
| Apr 30 | Short Survey | Answer survey question on Google Survey |

Important Note: This schedule is tentative and subject mid-course corrections to address emergent needs. Our goal is to support and facilitate your learning.

Establishing Team Rules

*Completed as a team*

Team #

Team member names:

***Purpose:*** In your studies and in the workplace, you will be faced with team work and challenges related to working in teams. Professional engineers collaborate with each other and with non-engineers throughout their work. Research shows that team members learn from each other and that diverse teams come up with better solutions. In this class, you’ll work in a team the whole semester. This assignment will help you establish the kind of team you want to be.

How often, where, and when will your meetings be?

How will you communicate with one another? For instance, is everyone happy with just texting?

How will you share and collaborate on documents? For instance, will you use googledocs, dropbox, Office 365, email, something else?

The most common issues teams face are listed below.

* No-shows: Person X does not show up to meetings.
* Hitchhikers/coat-tail riders: Person X does not complete their work, does low quality work, or does not contribute during meetings.
* Domineering/enabling: Person X has to get a perfect score on everything and does most of the work on all assignments, making it hard for others to contribute and enabling the hitchhikers.
* Divide-and-conquer failures: Team members divide up the work, and then paste it into one document without bringing the assignment together.
* Despite having issues, team members wait until the last minute to seek help, at which point, there is little the instructors can do.

Come up with at least 5 rules for your team that you can agree on. The rules should cover the issues described above, including the consequences and what you will do if issues arise. In addition to turning in this assignment, make sure all team members have a copy of your rules!

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| *TEAM 1*  *Please evaluate the students on the following:* | *Strongly agree* | *Agree* | *Neutral* | *Disagree* | *Strongly disagree* |
| 1. The students presented confidently or worked to overcome any nervousness |  |  |  |  |  |
| 2. The students concisely explained the problem and needs addressed by their design. |  |  |  |  |  |
| 3. The pitch helps clarify how the product would be used, how it could change customers’ lives, and what makes their product better than existing products |  |  |  |  |  |
| 4. The idea presented is creative |  |  |  |  |  |
| 5. The pitch conveys the market potential of their product |  |  |  |  |  |
| Please provide any comments here: | | | | | |

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| *TEAM 2*  *Please evaluate the students on the following:* | *Strongly agree* | *Agree* | *Neutral* | *Disagree* | *Strongly disagree* |
| 1. The students presented confidently or worked to overcome any nervousness |  |  |  |  |  |
| 2. The students concisely explained the problem and needs addressed by their design. |  |  |  |  |  |
| 3. The pitch helps clarify how the product would be used, how it could change customers’ lives, and what makes their product better than existing products |  |  |  |  |  |
| 4. The idea presented is creative |  |  |  |  |  |
| 5. The pitch conveys the market potential of their product |  |  |  |  |  |
| Please provide any comments here: | | | | | |