- Teacher guidelines for case study -
Green cooling

Generic green skills

Cognitive competencies:

- Systems and risk analysis, skills to assess, interpret and understand both the need for change and the measures required
- Understanding the complexity and interconnectedness of sustainable development issues and challenges

Interpersonal competencies:

- Strategic and leadership skills to enable policymakers and business executives to set the right incentives and create conditions conducive to cleaner production, cleaner transportation, etc.

Learning objective

Students are expected to:

1. Understand how natural refrigerants help address global warming.
2. Reflect on the potentials and challenges of using natural refrigerants in addressing environmental issues relevant to cooling.
3. Suggest approaches for encouraging the use of natural refrigerants for cooling, based on the local context.

Format

Individual learning with group and class discussions and presentations

Role of teacher

Facilitator

Resources needed

A4 paper, pens, student worksheet, case study

Time required

3 hours

Assessment

The assessment will be based on:
An essay that analyzes the potentials and challenges for supermarkets/food chains in your country/region related to the use of natural refrigerants in cooling, and provide suggestions to encourage the use of natural refrigerants. The assessment of the essay is based on the clarity of students' arguments, their ability to analyze potentials and challenges related to natural refrigerant use, and their understanding about how to promote green refrigerants.

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Suggested teaching and learning sequences

Before the class:

1. Ask students to read the case study, "Green cooling" and watch the videos and articles related to natural refrigerants listed below:
   a. Naturally Cool – The history and Development of Natural Refrigerants https://www.youtube.com/watch?v=Lx5jCBQiK7k
   b. Smart Guide to Climate Change https://www.bbc.com/future/article/20201204-climate-change-how-chemicals-in-your-fridge-warm-the-planet#:~:text=These%20refrigerants%20break%20down%20ozone,to%2013%2C850%20times%20more%20potent
   c. What are Natural Refrigerants? https://www.gea.com/en/articles/natural-refrigerants/natural-refrigerants-climate-neutral.jsp
2. Consider the following questions:
   a. What is the ozone layer?
   b. What are the effects of refrigerants on the ozone layer?
   c. What are the different types of refrigerants?
   d. Compared to traditional refrigerants, how efficient are the natural ones?
   e. What are the applications of natural refrigerants?

During the class:

1. **Group discussion 1 (60 mins)**
   a. Group students into groups of 5.
   b. Facilitate the group discussion by focusing on the pre-class questions listed above. Suggest each groupmate be responsible for summarizing and presenting the ideas for at least one question, so all five questions should be covered within a group.
   c. Ask students to share their group discussion with the class (5 mins each group) and organize their findings using different graphs. Suggest students use presentation materials they prefer (PowerPoint, drawing, video, etc.).

2. **Group discussion 2 (60 mins)**
   a. Ask students to search for climate-friendly supermarkets on the global map (https://www.climatefriendlysupermarkets.org/map) and the supermarket scorecard (https://www.climatefriendlysupermarkets.org/scorecard). Ask them to identify which supermarkets have used natural refrigerants for cooling globally (e.g. Aldi).
   b. Facilitate students to explore which technologies/solutions related to using natural refrigerants these supermarkets adopted (e.g. using plug and play cabinets that use R290)?
   c. Ask students to identify what the main supermarkets/food chains are in their country, and focus the group discussion on:
   d. Analyze the potentials and challenges for these supermarket/food chains to use natural refrigerants for cooling.
   e. Suggest some approaches/rules/regulations that could encourage these supermarkets/food chains to use natural refrigerants for cooling, such as financial incentives in tax rebates and cost subsidies.

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3. **Group presentation and class discussion (60 min)**
   a. Suggest students organize their group discussion in a mind map**.**
   b. Help students to prepare a group presentation. Remind them that each groupmate should present part of it.
   c. Facilitate students' group presentation. After each group's presentation, invite students to ask questions and provide suggestions.
4. **At the end of the class, summarize the learning based on the suggested mind map.**

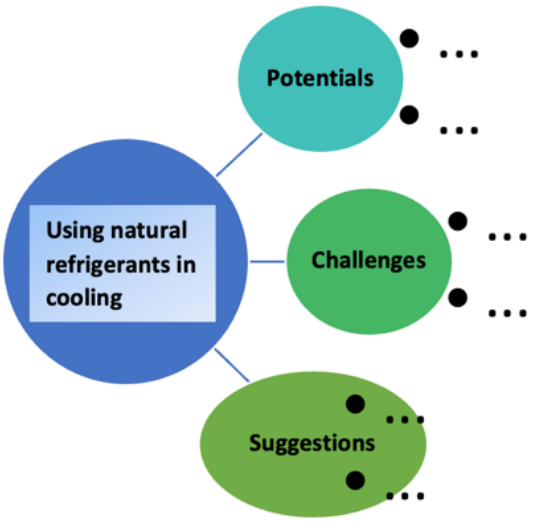

Fig. 1. Using a mind map to present your ideas

After the class:

1. Ask students to further work on the questions from group discussion 2, and do additional research if needed.
2. Ask students to submit their essay by the deadline. The essay should include the following:
   a. A clear statement of argument – why natural refrigerants are important.
   b. Analyze potentials and challenges for supermarkets/food chains when using natural refrigerants for cooling.
   c. Suggest approaches/rules/regulations that could encourage these supermarkets/food chains to use natural refrigerants for cooling, such as financial incentives in tax rebates and cost subsidies.

Encourage students to include illustrations, tables and graphs to support their arguments and suggestions. The marking criteria for the essay is included in the Appendix.

Suggested answers/examples for the activities

1. **Group discussion 1 (60 mins)**
   a. What is the ozone layer?

      The ozone layer, or ozone shield, is a region of Earth's stratosphere that absorbs most of the sun's ultraviolet radiation. It contains a high concentration of ozone in relation to other parts of the atmosphere, although it is still small compared with other gases in the stratosphere.

   b. What are the effects of refrigerants on the ozone layer?

      CFCs refrigerants break down in sunlight and then release chlorine and bromine, which destroy ozone molecules. The polar regions are more susceptible to ozone depletion because of the formation of "polar stratospheric clouds" that are caused by cold temps in these regions.

   c. What are the different types of refrigerants?

      Natural refrigerants include: ammonia, carbon dioxide, hydrocarbons, water, and air.

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d. Compared to traditional refrigerants, how efficient are the natural ones?

Hydrocarbon refrigerant blends are generally inexpensive, especially when compared to their synthetic counterparts. In addition, they're also more energy-efficient, so even thought here are initial investment costs, these can be offset later and can result in costs savings of between 17%-38% on energy consumption, providing businesses with more savings opportunities.

e. What are the applications of natural refrigerants?

Thermal storage systems

- HVAC chillers
- Process cooling
- Air conditioning
- Winter sports
- District cooling systems
- Heat pump systems
- Supermarkets

2. Online research and group discussion 2

a. Have a look at the climate-friendly supermarkets on the global map (https://www.climatefriendlysupermarkets.org/map) and the supermarket scorecard (https://www.climatefriendlysupermarkets.org/scorecard), identify which supermarkets have used natural refrigerants for cooling globally (e.g. ALDI)?

b. Explore which technologies/solutions related to using natural refrigerants have been adopted in these supermarkets (e.g. using plug and play cabinets that use R290)?

- Plug and play cabinets
- Solar powered chillers
- Walk in refrigerators
- 30ft delivery trucks
- Air-conditioners (window, split-type, and industrial/centralized)
- Refrigerators

c. Identify what are the main supermarkets/food chains in your country.

- Vegetables
- Meat and fish
- Medicine
- Processed meat
- Agriculture products
- Poultry products
- Dairy

d. Analyze the potentials and challenges for these supermarket/food chains to use natural refrigerants in cooling.

Potential

- Reduction in energy, gas, water consumption, and even CO2 production
- Reduction ozone depleting substances in the atmosphere
- Increase in workforce demand

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Challenges

- Politics – willingness of politicians to create laws and policies for local adoption
- Availability of technology and/or refrigerants in the market – some countries do not yet have the technology in their markets
- Availability of workers/trained technicians

e. Suggest some approaches/rules/regulations that could encourage these supermarket/food chains to use natural refrigerants for cooling, such as financial incentives in tax rebates and cost subsidies.

- Create extensive policies on the safe handling of natural refrigerants
- Provide incentive mechanisms for the use of natural refrigerants
- Promotion/advocacy of the technology (share success stories)

Reference:

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Nagy, B. (2020). Natural refrigerants: Supermarkets moving quickly to adopt CO2/ammonia systems - Plumbing & HVAC. Retrieved from http://plumbingandhvac.ca/natural-refrigerants-supermarkets-moving-quickly-to-adopt-co2-ammonia-systems/

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Appendix: Marking criteria for the essay

For question 1 - State a clear argument – why natural refrigerants are important.	
• Provides a thorough explanation about the importance of natural refrigerants by providing examples, explaining technical terms, and detailing its characteristics • Effectively communicates ideas, issues, and opinions in an organized, logical and coherent manner, using appropriate terminology	**4-5**
• Demonstrates basic knowledge about the topic by providing and explaining a few examples • Communicates ideas and opinions in basic form using some relevant information about the topic of discussion	**2-3**
• Makes a few relevant points about the topic of discussion • Demonstrates limited knowledge about the topic of discussion	**1**
For question 2 - Analyze potentials and challenges for supermarket/food chains when using natural refrigerants for cooling.	
• Provides a thorough explanation about the potentials and challenges with the use of natural refrigerants • Demonstrates thorough knowledge about the topic by providing examples or scenarios on the market and explains them clearly • Effectively communicates ideas, issues, and opinions in an organized, logical and coherent manner, using appropriate terminology	**4-5**
• Provides a clear explanation about the potentials and challenges on the use of natural refrigerants • Demonstrates basic knowledge about the topic through explanation and by providing a few examples • Communicates ideas and opinions in a basic manner, using some relevant information about the topic of discussion	**2-3**
• Makes a few relevant points about the topic of discussion • Provides limited knowledge about the topic of discussion	**1**
For question 3 - Suggest approaches/rules/regulations that could encourage these supermarket/food chains to use natural refrigerants for cooling, such as financial incentives in tax rebates and cost subsidies.	
• Provides suggestions about approaches, rules and regulations that could encourage consumers to utilize the technology and thoroughly explains these suggestions • Demonstrates significant knowledge about the topic by providing, and thoroughly explaining, examples	**4-5**
• Demonstrates basic knowledge about the topic by providing and clearly explaining a few examples • Identifies issues and concepts but the explanation is weak or incomplete	**2-3**
• Demonstrates limited knowledge about the topic of discussion • Provides few recommendations about policy, approaches, and/or regulations for the food cold chain sector	**1**

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