

Development of an Air Conditioning Alternative Using Thermal Energy Harvesting Technology



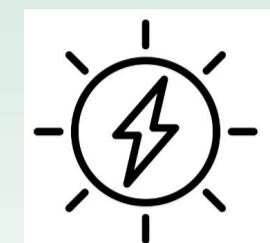
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1. Motivation



A/C Use Worsens Climate Change: Increased air conditioning usage → higher greenhouse gas emissions



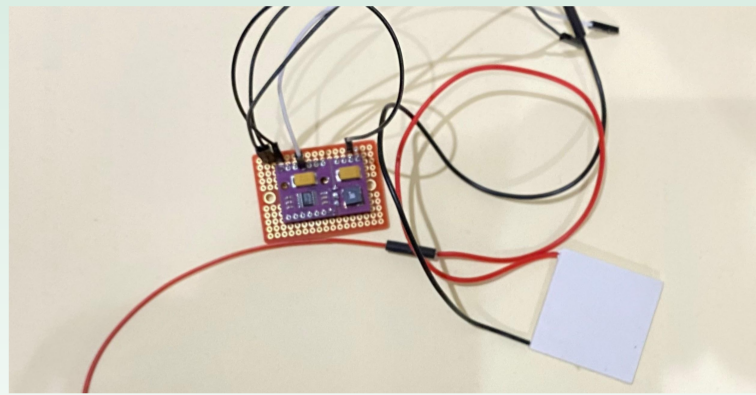
Thermoelectric Harvesting as a Solution: Converts heat into electricity for cooling; eco-friendly alternative based on the kinetic theory of gases.



Research Aims to Reduce Environmental Impact: Testing thermal energy harvesting to effectively lower kinetic energy & temperatures, rivaling traditional A/C

2. Methods

Components: LTC3108 circuit, Peltier tile, 1:20 transformer, LED/fan
LTC3108 boosts Peltier output to ~3.3V Two insulated boxes with black bases for heat absorption, equipped with hygrometers.

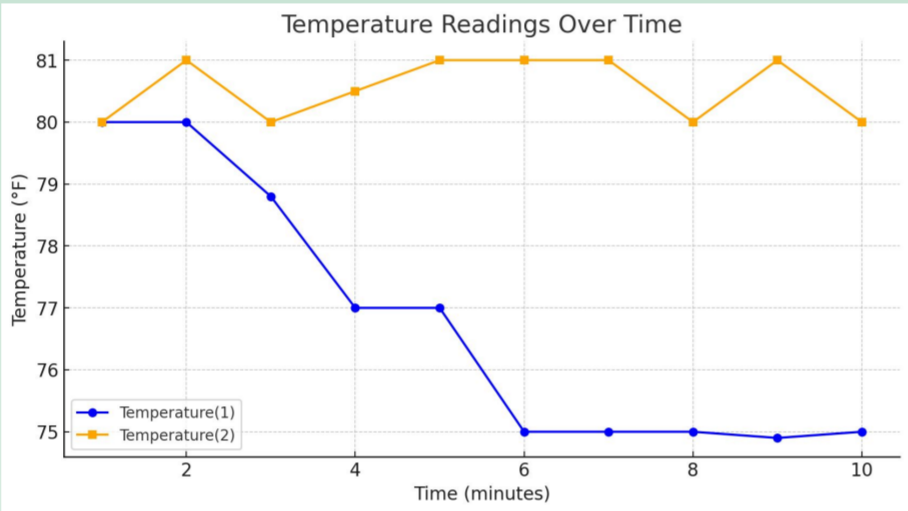
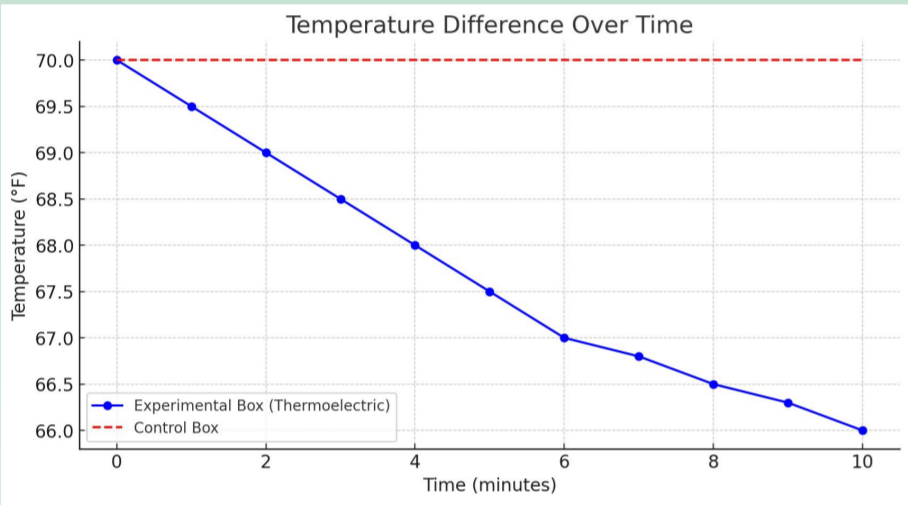


Procedure: Boxes placed in sunlight; experimental box contains thermoelectric system.

3. Results

Temperature Difference:

- Experimental box stayed 5°F cooler than control; peak 7°F difference noted at 9 minutes (excluded due to 10-minute intervals).



Temperature_Data_Over_Time		
Time (min)	Temperature(1)	Temperature(2)
1	80.0	80.0
2	80.0	81.0
3	78.8	80.0
4	77.0	80.5
5	77.0	81.0
6	75.0	81.0
7	75.0	81.0
8	75.0	80.0
9	74.9	81.0
10	75.0	80.0

Key Findings:

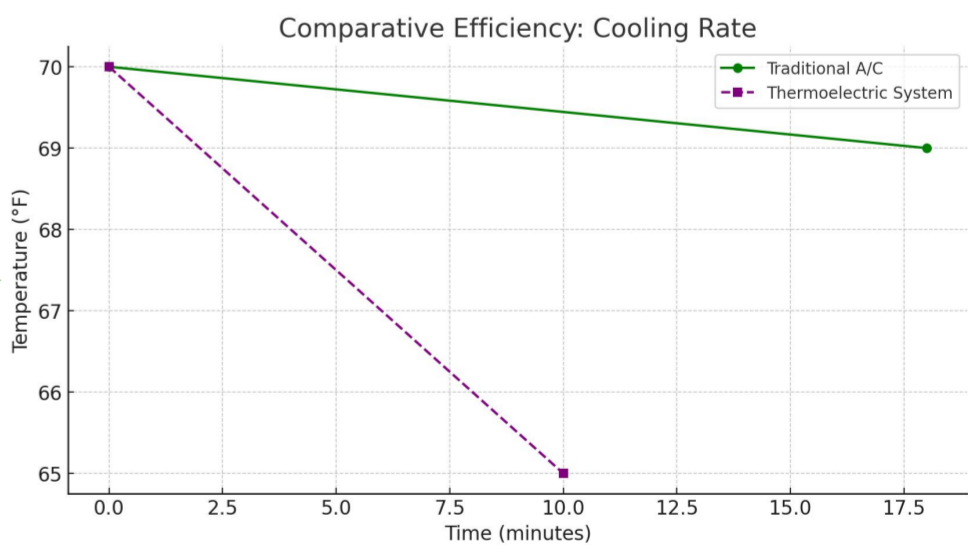
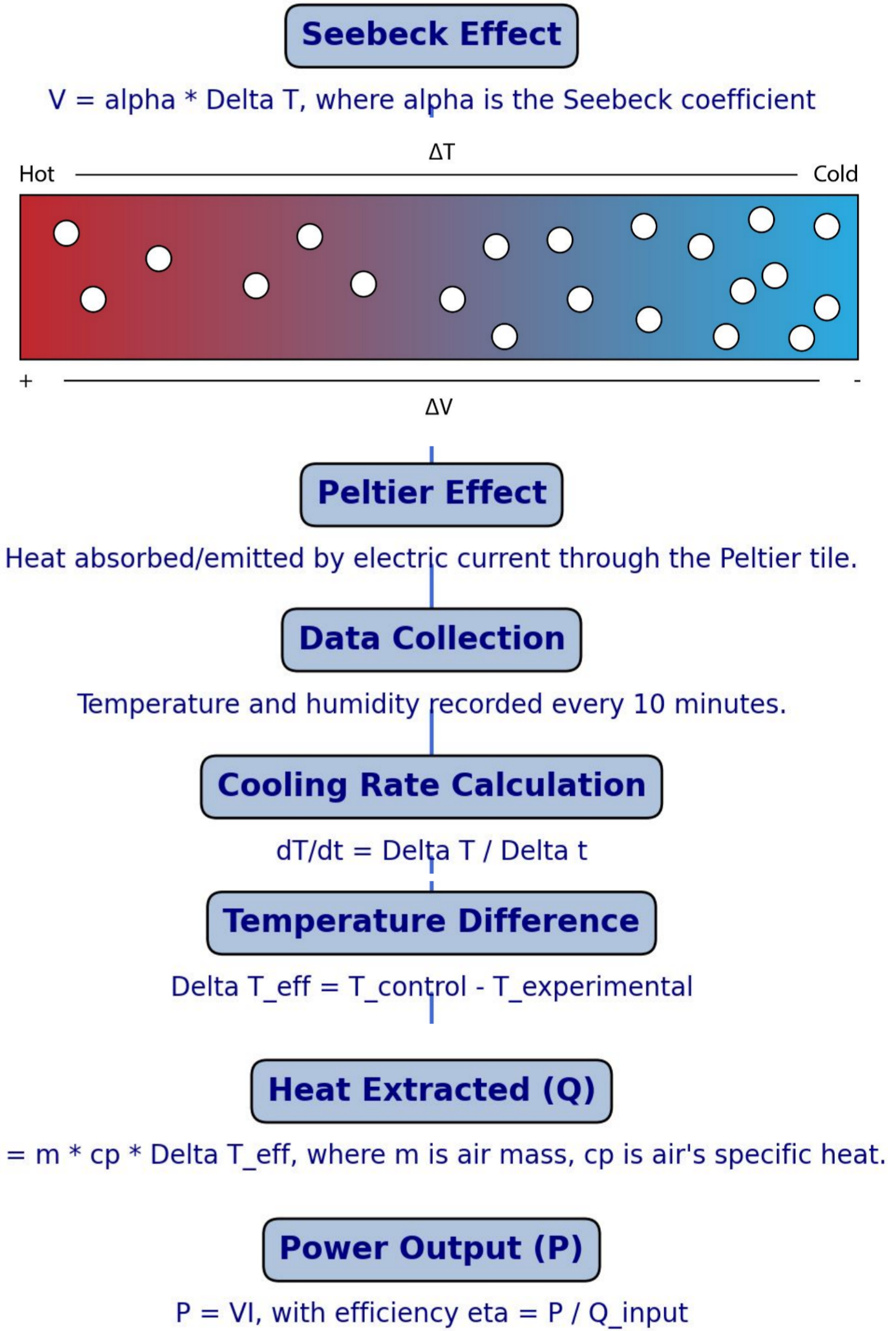
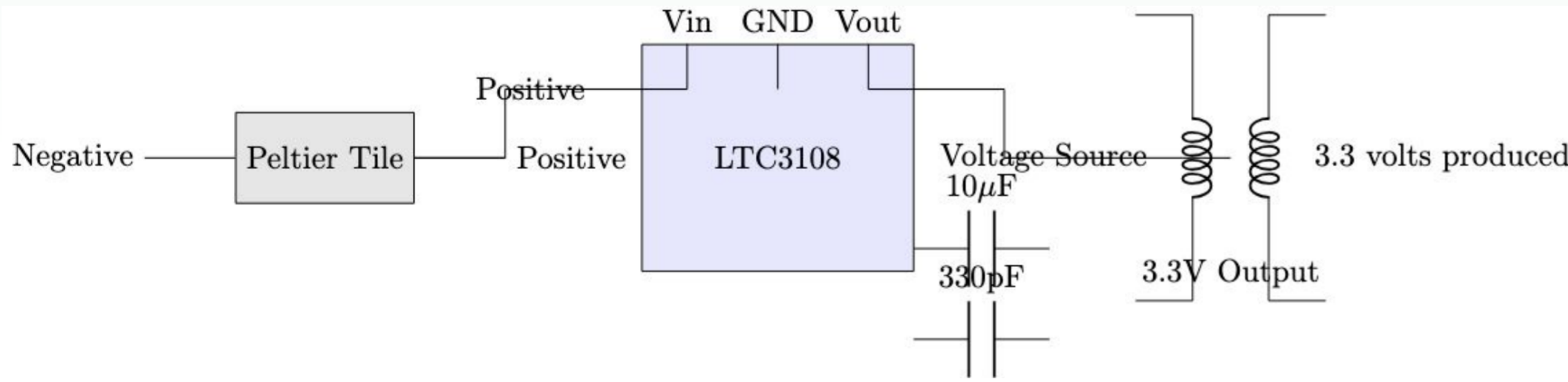
- Only the experimental box showed a temperature drop.
- Peltier tile used Seebeck effect to generate energy from temperature differences, suitable for continuous use.

Environmental Impact:

- Thermoelectric cooling is a zero-emission, sustainable alternative to A/C, lowering carbon footprint and rivaling A/C efficiency.

Comparative Efficiency:

- Thermoelectric system cooled 5°F in 10 minutes (0.5°F/min).
- Traditional A/C cools an average house by 1°F in 18 minutes and a small room in 1.4 minutes. Performance is promising for an emerging technology.



4. Discussion & Future Work

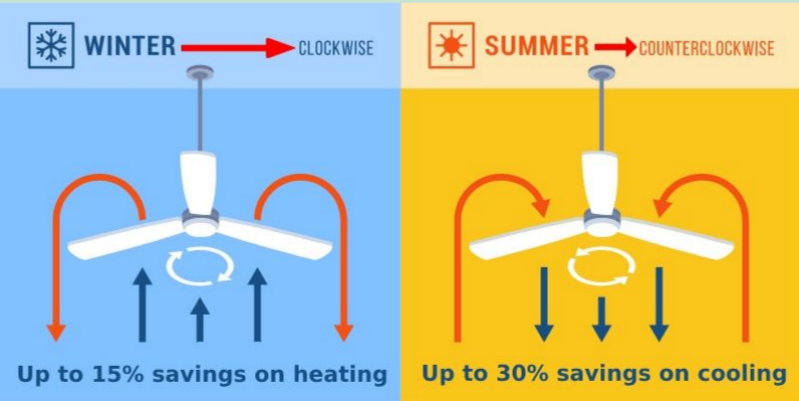
1. Improvements:

- Better insulation (e.g., styrofoam, foil)
- Voltage monitoring with a multimeter
- Scaling for larger spaces and year-round heating
- Potential A/C alternative with lower emissions

2. Sustainable Transportation: LTC3108 chip converts ambient thermal energy to electricity → carbon-free power source for EV charging(transportation sustainability)

3. Heat Wave Relief: Eco-friendly cooling

4. Impact: Thermoelectric cooling could reduce energy use and environmental impact, aiding in a carbon-neutral future.



References

- "9.15 Kinetic Theory of Gases- Molecular Speeds" Chemistry LibreTexts, 9 May 2016, chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_ChemPRIME_Moore_et_al/O993A_Gases/9.153A_Kinetic_Theory_of_Gases-_Molecular_Speeds#:~:text=The%20rms%20velocity%20is%20directly, Accessed 3 Nov. 2020.
- Davis, Lucas W., and Paul J. Gertler. "Contribution of Air Conditioning Adoption to Future Energy Use under Global Warming." *Proceedings of the National Academy of Sciences*, vol. 112, no. 19, 27 Apr. 2015, pp. 5962–5967, www.pnas.org/content/112/19/5962, https://doi.org/10.1073/pnas.1423581112.
- "Energy Emissions Soar as Europe Battles 'Life Threatening' Heatwaves." *Euronews*, 19 July 2022, www.euronews.com/green/2022/07/19/brutal-heatwaves-across-europe-create-vicious-cycle-of-more-air-con-and-higher-emissions.
- Enescu, Diana. "Thermoelectric Energy Harvesting: Basic Principles and Applications." *Green Energy Advances*, 20 Feb. 2019, www.intechopen.com/books/green-energy-advances/thermoelectric-energy-harvesting-basic-principles-and-applications, https://doi.org/10.5772/intechopen.83495, Accessed 6 Dec. 2019.
- "How Do Air Conditioners Work | How Does Central Air Work?" Carrier, www.carrier.com/residential/en/us/products/air-conditioners/how-do-air-conditioners-work/#~:text=As%20the%20liquid%20refrigerant%20inside,
- Lindsay, Rebecca, and Lukmi Dahlman. "Climate Change: Global Temperature | NOAA Climate.gov." *Climate.gov*, 15 Mar. 2021, www.climate.gov/news-features/understanding-climate/climate-change-global-temperature#~:text=According%20to%20NOAA,
- "LTC3108 Datasheet and Product Info | Analog Devices." *Analog.com*, 2013, www.analog.com/en/products/ltc3108.html.
- "News Release: Scientists Show Large Impact of Controlling Humidity on Greenhouse Gas Emissions." *Www.nrel.gov*, 14 Mar. 2022, www.nrel.gov/news/press/2022/nrel-shows-impact-of-controlling-humidity-on-greenhouse-gas-emissions.html#:~:text=The%20researchers%20calculated%20a%20conditioning,
- Nunes, Christina. "Renewable Energy, Facts and Information." *National Geographic*, 30 Jan. 2019, www.nationalgeographic.com/environment/article/renewable-energy#:~:text=in%20a%20discussion%20about%20climate,
- Sierke, Mirco, and Silke Opelkaus. "A New Way to Slow down Complex Molecules." *Physics*, vol. 14, 20 Dec. 2021, p. 180, physics.aps.org/articles/14/180, https://doi.org/10.1103/PhysRevLett.127.263002, Accessed 13 Jan. 2024.
- Snyder, G. *Thermoelectric Energy Harvesting*.
- "The Global Cooling Challenge and Air-Conditioning." *Large.stanford.edu*, large.stanford.edu/courses/2018/ph240/jacobsen2/ Accessed 13 Jan. 2024.
- Zhao, Wenjuan, et al. "A Comparative Analysis on Alternative Air-Conditioning Systems for High-Tech Cleanrooms and Their Performance in Different Climate Zones." *Energy*, vol. 261, Dec. 2022, p. 125284, https://doi.org/10.1016/j.energy.2022.125284, Accessed 6 Sept. 2022.