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***Climate Control! How Air Conditioners Can Save the World***

         There is a class of chemicals that has the potential to both dramatically combat global warming and make it several times worse. They are abundant in homes, and in some cases can make it seem like they cheat the laws of physics. They are called refrigerants, and usually include types of hydrofluorocarbons (HFCs). One of the most effective, the one that seems to be leading the charge, is R-134a also referred to as HFC-134a. As the name suggests, refrigerants are used to refrigerate. Unfortunately, nearly all refrigerants are potent greenhouse gasses – a sort of carcinogen for the atmosphere. In the case of refrigerants, most of which are several times more potent than carbon dioxide, if not handled properly, they can wreak havoc on the atmosphere. Fortunately, they have incredible redeeming qualities that are being exploited when it comes to heating and cooling. According to *Heat Pumps: The Future of Home Heating* by Technology Connections (2021), what makes refrigerants special is an “easy to manipulate boiling point” (4:23). The difference between a net positive and a net negative reaction to refrigerants is not *if* we decide to use them, but *how* we exploit their benefits and mitigate their greenhouse effect. By encouraging the transition towards heat pumps as a means of heating and cooling buildings, and by developing the necessary infrastructure to process disposed of refrigerant-using devices, we have the power of indoor and outdoor climate control in our grasp. In doing so, we will be able to increase our reliance on the high efficiency of refrigerants without increasing the amount released into the atmosphere.

         Like natural gas, refrigerants are extremely useful chemicals that must be handled with care to mitigate air pollution. Many natural gas plants are being fitted with on-site carbon sequestering systems. Unfortunately, there is currently no analogous infrastructure for managing refrigerants. According to Xiang et al., refrigerant emissions have been on the rise on a year-over-year metric. Furthermore, “recent seasonal emission patterns [show] that summertime emissions of HCFC-22 and HFC-134a are two to three times higher than wintertime emissions” (Xiang et al., 2014, p. 2). Fortunately, the emissions are manageable. For example, the authors’ research suggests several potential solutions.

Our results suggest that engineering (e.g., better temperature/vibration-resistant system sealing and new system design of more compact/efficient components) and regulatory (e.g., reinforcing system service regulations) steps to improve containment of these gases from working devices could effectively reduce their release to the atmosphere. (Xiang et al., p. 2).

If implemented, HFC emissions could be cut drastically – good news for the environment. Further, if infrastructure is put into place to properly dispose of products containing refrigerants, emissions can be cut further. Since refrigerants do not “expire” per se, they have the potential to be recycled and moved from one device to another. In short, emissions can be lowered by mitigating chemical leaks during the disposal process. In doing so, a sizable portion of greenhouse gas emissions can be cut, opening the door for an increase in refrigerant applications.

As noted previously, refrigerants are special due to their easy to manipulate boiling points. Since energy, specifically of the thermal variety, is released during evaporation through a process known as evaporative cooling, being able to change the boiling point with relative ease makes refrigerants the best option for moving heat. Evaporative cooling is exactly the process that air conditioners exploit to cool cars and buildings the world over. By managing the pressure of the refrigerant in the system, heat is moved from inside to outside with very low energy input. Enter the heat pump. Essentially a two-way air conditioning unit, heat pumps can move the heat from inside out and the heat from outside in. They are complete, all-in-one climate control units capable of both heating and cooling indoor spaces. According to *Heat Pumps: the Future of Home Heating* by Technology Connections (2021), “it is actually more energy efficient to burn natural gas at a power plant and distribute the electricity over the grid to power a heat pump to heat a home than it is to use the heat produced by the burning of natural gas to directly heat a home.” (0:57). The reason for their efficiency again comes down to the science of evaporative cooling and the economy of scale behind fossil fuel energy production. Therefore, heat pumps save consumers money, conserve energy, and more or less guarantee that heat pumps are the future of home heating.

In fact, a large-scale transition to heat pumps is already beginning to take shape. According to *Getting On Track to Net Zero: Ten Million Heat Pumps for Homes by 2030*, “heat pumps are tried and tested technology … across Scandinavia, Finland, Estonia, Switzerland, Austria, France, and Italy” (Guertler, 2020, p. 6). At this point, with the aim towards an abundance of net-zero energy buildings, investing in heat pumps is a no-brainer.

Increasing our refrigerant use alone will not put an end to climate change, however. While efficient heating and cooling is a necessary step towards solving the climate crisis, it cannot be the only thing done. Climate change is like cancer. It is responsible for an unquantifiable amount of human suffering, a solution seems impossibly far away, and it seems like every day scientists find something new that causes it. Also, like cancer, the solution is twofold – involving both proactive and reactive mitigation. Increasing power efficiency and decreasing net carbon emissions may help to reduce risk, yet a full-blown cure to this global cancer is still both warranted and necessary.

# References

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