PHONONIC

Cooling Innovation for a Warming Planet

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1.5°

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Global warming isn't slowing down

The world is at a tipping point – where it's no longer possible to ignore the dangers of rising carbon dioxide (CO_2) emissions. Countries and companies around the globe are reckoning with the fact that higher temperatures, an increasing risk of severe weather events, and rising sea levels are having an impact on our society and way of life.
To protect our safety, mitigate increasing costs and safeguard the planet, it's time to act with resolve about the dangers of global warming.

Creating the pathway to 1.5° C

Scientists estimate that limiting global warming to 1.5 degrees Celsius would reduce the odds of initiating the most dangerous and irreversible effects of climate change. The global community is realizing there are hard but necessary choices to make, to reduce the risk of both physical hazards and unwanted socioeconomic changes.

It is also clear there are real economic and employment opportunities that result from investing in climate-resilient infrastructure and the transition to a lower-carbon future. Sustainable investing assets in the U.S. have grown 42% since 2018 (McKinsey & Company, "Trends Shaping the Next Normal"; October 2020) and the growth shows no signs of slowing.

A pathway to 1.5° C requires immediate and dramatic emissions reductions over the next ten years — with shifts in food and forestry, large-scale electrification, industrial adaptation, clean-power generation, cooling and air conditioning, and strategically designed carbon management and markets.

Sustainability market pressures are heating up

Along with the efforts of governments and activists, market forces are increasingly putting pressure on organizations and corporations to reduce GhG emissions and lower their carbon footprint – and making it mandatory to build their business around sustainability.

Corporations leading the way in sustainability efforts include:

Walmart, as part of a pledge to target zero GhG emissions across its global operations, is transitioning to low-impact refrigerants for cooling and electrified equipment for heating in its stores, clubs, and data and distribution centers by 2040.

Heineken, who released a set of ambitious climate commitments that include decarbonizing their entire production process by 2030 in its mission to reach net zero by 2040.

Ahold Delhaize, who committed to reducing HFCs used in cooling – with a global target to lower the average global warming potential of refrigerants across its stores and shares their corporate average leak rate annually.

Sprouts, who committed to lowering HFC emissions from cooling by reducing leaks and piloting sustainable refrigeration technologies in stores through their participation and certification of stores in EPA's GreenChill Partnership.

Daikin, who aims to achieve carbon neutrality by 2050 by reducing greenhouse gas emissions throughout the product lifecycle and reduce the company's net CO_2 emissions by 30% or more in 2025 and 50% or more by 2030.

THE FIRESTORM OVER COOLING

Even with the growing global adoption of carbon-reducing standards and the rise in renewable energy sources, there's an equally catastrophic source of greenhouse gas emissions that's quietly creating havoc behind the scenes: refrigeration and air conditioning.

If left unchecked, over the next 20 years, the environmental damage from leaked refrigerants will have massive CO_2 ramifications: by 2045, leaked refrigerants will contribute as much to global CO_2 emissions as vehicles.[1]

[1] US EPA GhG Emissions Report, 2019

How cooling hurts the environment

The most hazardous elements in traditional refrigeration and cooling technology are refrigerants – chemical compounds used as the heat carrier within systems. Throughout the refrigeration cycle, refrigerants change from gas to liquid and back to gas again absorbing and releasing heat; this cycle creates the desired cooling effect.

Heavily regulated due to their toxicity, flammability and danger to the environment, refrigerants are also prone to leakage – up to 40% can leak out of a cooling system over the product's lifetime. This leakage can also cause compressor systems to break prematurely or require regular maintenance.

When a refrigerant is released, the gas remains trapped in the atmosphere and absorbs heat, warming the earth and acting as a CO_2 multiplier in the atmosphere. In fact, one kilogram of the highly-toxic refrigerant R410a has the same greenhouse impact as two tons of carbon dioxide, which is the equivalent of running your car for six months. That's a high price to pay for the comfort and convenience of refrigeration and AC systems.

The dangers of cooling's Global Warming Potential

When looking at the dangers of refrigerants, it's critical to understand their Global Warming Potential (GWP). The GWP of a GhG is its ability to trap extra heat in the atmosphere over time benchmarked against CO_2 – and is a useful measurement to gauge the environmental impact of specific refrigerants.

All refrigerants contribute some level of GWP, but all refrigerants are not created equal. Traditional refrigerants use toxic hydrofluorocarbons (HFCs), featuring a high GWP rating in the 1000s, as compared to just 1 for CO_2.

Freon is an example of an HFC with a high GWP that has been tagged as harmful, and is now restricted, following guidelines first set by the *Kigali Amendment of the Montreal Protocol*. More recently, the U.S. Environmental Protection Agency (EPA) stipulated the draw down in the U.S. production and importation of freon by 85% over the next 15 years – and important effort in getting us to that key global warming limit of 1.5° C.

GWP<1

Phononic's solid-state solution uses only CO_2 and water, delivering a Global Warming Potential of one or less

NATURAL REFRIGERANTS CAN BE EXPENSIVE, UNSAFE, AND ARE STILL HARMFUL TO THE ENVIRONMENT

Natural refrigerants are not the answer

In the search for sustainable refrigeration and cooling alternatives, a category of refrigerants called "natural" refrigerants is currently being marketed by its proponents as the most sustainable solution for cooling. Natural refrigerants include ammonia, carbon dioxide, hydrocarbons, isobutane and acetone.

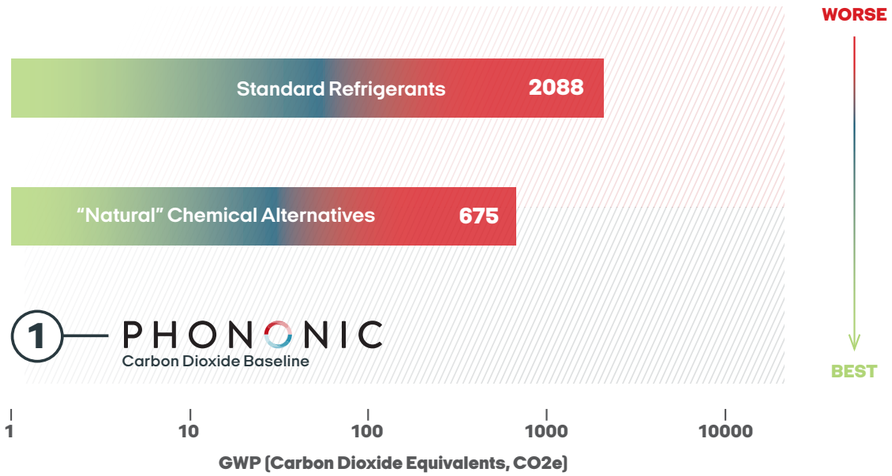
While they are more environmentally friendly than highly-damaging, toxic fluorinated refrigerants (HFCs), and have only a slightly lower GWP than traditional refrigerants, natural refrigerants pose other concerns, such as corrosion, toxicity, high pressures, flammability, and require special handling and service training. Using natural refrigerants can result in dangerous tradeoffs that are expensive, unsafe and still harmful to the environment. With that in mind, the need for dramatic innovation in this sector has never been stronger.

Meeting the climate moment with solid-state technology

The need for truly climate-friendly cooling technology has never been higher – and Phononic is ready to meet the moment through solid-state innovation, specifically designed to advance refrigeration and cooling. Built on the best practices of the semiconductor world, Phononic's solid-state thermoelectric cooling and refrigeration technology now represents a new way forward toward a cleaner, more sustainable future.

Phononic's solid-state advancements finally realize a true paradigm shift in cooling technology. In the 200 years since the thermoelectric effect was discovered, few believed commercially viable solid-state freezers, refrigerators or air conditioners using solid-state technology could compete, until now.

GLOBAL WARMING POTENTIAL OF REFRIGERANTS COMPARED TO CO_2



Phononic technology delivers a GWP of just 1 or less

Phononic's solid-state cooling, refrigeration and HVAC innovation uses just water mixed with naturally available CO_2, with a GWP of just 1, delivering the lowest GWP rating in the industry. Since its solid-state core is a fundamental departure from mechanical compressors, cooling applications are efficient, sustainable, quiet, more reliable, and more economical. Phononic's solid-state design represents an exciting new way to reduce greenhouse gas emissions, support UN climate goals, while meeting the demanding performance needs of the market.

How does solid-state cooling work?

The science behind solid-state cooling is based on established and proven thermoelectric principles. When an electric current is passed through a solid-state thermoelectric device it transfers heat from one side to the other. This is referred to as the Peltier Effect. This transfer of heat can be used to effectively heat, cool and even freeze spaces small and large for any number of market applications. With cutting edge innovation from the device to system level, Phononic has unleashed the full potential of thermoelectric principles bringing disruptive solid-state products to life.

Benefits of solid-state cooling and heating

Solid-state cooling and heating offers several advantages over the traditional methods of refrigeration, which rely on mechanical compressors and their high GWP refrigerants.

Sustainable

Using just CO_2 & water, with no toxic refrigerants that contribute to global warming.

Modular

Phononic's technology can scale from micro watts to kW levels of cooling.

Reliable

Using no moving parts, Phononic's systems and devices require limited maintenance or service.

Flexible

A unique property of thermoelectric devices is that they can be used either to heat or to cool; simply by reversing the polarity.

Solid-state innovation

The climate crisis is demanding technology innovators meet this moment. Innovation not only helps the bottom line – but also supports the health of the planet.

Phononic's solid-state technology and integrated systems design is a transformational approach to cooling and heating that is revolutionizing the way people work and communicate, how grocers merchandise and deliver food, how life-saving vaccines and drugs are protected, and how houses and buildings are cooled.

With a GWP of just 1 or less, solid-state cooling technology makes a real impact on GhG emissions and steers our global community toward the achievable goal of just 1.5° C warming. Phononic is proud to be a part of the global effort helping the world transform into a more sustainable place to live.

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About: Phononic is reimagining cooling and heating in ways never thought possible. Its breakthrough solid-state technology is transforming industries and creating new markets with innovative solutions that disrupt antiquated business models and incumbent technologies. Phononic is the critical element of innovation needed to radically change what it means to be efficient, effective and sustainable. The company has been named to the 2016, 2017 and 2019 CNBC Disruptor 50 lists, received the U.S. EPA's 2017 Emerging Tech Award, the R&D 100 Award and more.

Learn more at: **www.phononic.com**

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