Blood Management Solutions

Greening up your Laboratory

Sustainable Practices for Using Ultra-Low Freezers

No matter how big or small the research facility, there are multiple ways to achieve sustainability. With Green Lab programs gaining more awareness and acceptance across the world, research labs and institutions have been increasingly pushing researchers and scientists towards promoting sustainable initiatives especially related to ultra-low freezers, as they are one of the most energy-intensive equipment found in labs. Reducing the carbon footprint of -80°C freezers with respect to energy and other resources is a major commitment. It requires a multifold approach spanning across the procurement and day-to-day operations, as well as best practices. This paper highlights some of the best practices in using ultra-low freezers sustainably, and details about how B Medical Systems' ultra-low freezers can help you conduct energy-efficient operations and reduce CO_2 emissions, thereby driving towards the bigger goal of sustainability and green operations.

Greening up a laboratory – applying sustainable initiatives to minimize the lab's impact on the environment – is not a new concept. The effectiveness of the initiatives rely heavily on understanding the sources and practices that consume energy the most. According to a webinar organized by California Energy Commission[1], laboratories consume five times more energy than office spaces. Of that, more than one-fifth comes from plug loads, of which ULTs are the top energy consuming category. Also, their large numbers in the laboratory and research establishments represent a substantial potential for energy savings. Even though there exists a wide range of practices in achieving sustainable operations using ultra-low freezers, some of them have significant impact. They are:

1 Using energy-efficient ultra-low freezers

As ultra-low freezers are one of the most energy-intensive equipment in a laboratory, the choice of procurement of an energy-efficient model is one of the most critical aspects towards achieving sustainability. When new, these freezers consume approximately 16 to 22 kilowatt hours (kWh) per day, which is about as much energy as an average family household[2]. The high energy consumption rates also have a broader impact in terms of HVAC systems, power backup and noise levels. On average, depending on the electric power source, the ultra-low freezer and HVAC system can produce up to 100 tons of CO_2 over the freezer life[3].

Technological advances have brought a number of energy-saving alternatives that have enabled the introduction of highly energy-efficient ultra-low freezers. The two highlighted (Fig 1) categories of alternatives provide energy-efficient models, but also have constraints. For example, the insulation thickness and the relationship with performance can have an impact on the size, footprint, volume, weight and cost; while the heavy-duty operations can challenge the high energy efficiency of ultra-low freezer models equipped with variable speed compressors. Hence the decision to opt for a specific type of energy-saving alternative should also consider the performance targets of laboratory/research programs (like the freezing capacity, temperature uniformity, recovery after door opening, internal volume etc.)

As ultra-low freezers are used for storing highly valued research samples, utmost importance should also be given to the right balance between reliability, overall performance and energy efficiency of the ultra-low freezers.

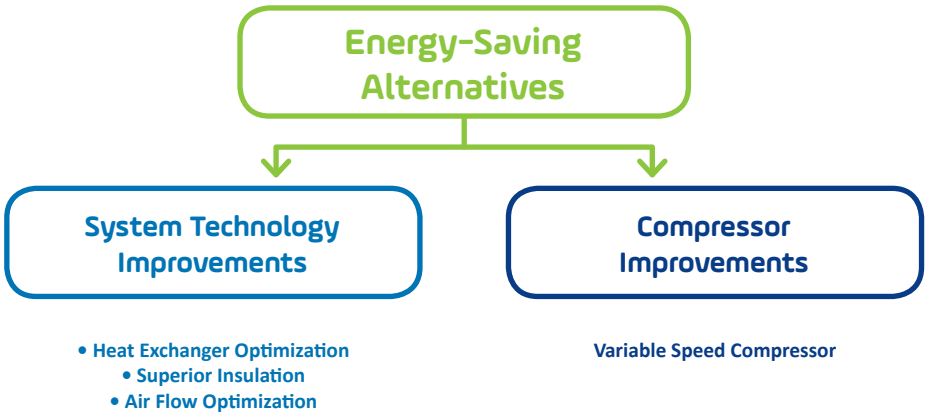


Fig 1: Energy-Saving Alternatives Followed by Ultra-Low Freezer Manufacturers

B Medical Systems' ultra-low freezers use state-of-the-art refrigeration technology, inner doors, gaskets and insulation ensuring superior energy efficiency in comparison with the traditional ultra-low freezers existing in the market. In addition, the ability to maintain uniform temperature distribution, faster pull-down and recovery, long holdover time and advanced alarm systems makes them highly reliable as well.

2 Changing the set point from -80°C to -70°C

Another way of achieving energy-efficiency - and thereby sustainability - is by changing the set point from -80°C to -70°C. Research articles have shown that a number of samples (such as proteins, bacteria and viruses) can be stored at -70°C without impacting their integrity. Espinel-Ingroff et al, proved that the long-term preservation of fungal isolates in a -70°C freezer did not have any negative impact on the viability and purity of the specimens stored[4]. Piet K Beekhof et al, concluded that -70°C is the right storage temperature to maintain the PON activity for at least one year[5]. This is further backed by the fact that labs at a number of renowned universities like CU Boulder, Dartmouth, UC Davis, etc., are switching a number of their ultra-low freezers to -70°C as a part of their sustainable drives[6]. Some case studies also demonstrated that -70°C is enough to keep samples such as antibodies and antioxidant assays stable; with even -20°C being sufficient for certain applications, such as storing extracted RNA for one month. The CDC (Center for Disease Control) also adapted the set point of 60 of their ultra-low freezers from -80°C to -70°C as part of its sustainability initiatives[7]. Adjusting the set point of an ultra-low freezer not only saves energy, but also increases the lifespan of the ULT.

B Medical Systems' ultra-low freezers are designed with a set temperature of (preset) -82°C, which can be changed from -86°C to -40°C in steps of 0.1°C. Switching the set point of B Medical Systems' ultra-low freezers from -80°C to -70°C helps in saving approximately 1.7kwh/day and switching from -80°C to -60°C helps in saving 3.5kwh/day.

3 Using natural refrigerants

Refrigerants are one of the critical components of the refrigeration system. While a lot of the newly constructed research facilities are sustainable, they often fail to be completely green when it comes to refrigerants. Even though using green gases seems to be the most logical step associated with practicing sustainability, there is a still a lot of room for improvement: a number of ultra-low freezer models in the market do not use natural refrigerants. Using natural refrigerants or green gases reduces direct emissions of F-gases, which have a negative impact on the ozone layer and the climate. They also do not produce persistent waste in the atmosphere. In addition, green refrigerants provide more cooling due to their high latent heat of evaporation resulting in improved performance, reduced power consumption and lower energy cost.

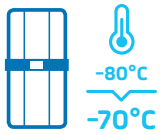
B Medical Systems ultra-low freezers' use two natural gas refrigerants. Along with R290 (Propane), R170 (Ethane) - also known for its capabilities to yield more capacity with lower wattage - has a zero Ozone Depletion Potential (ODP) and a very low Global Warming Potential (GWP), which increases the overall cooling efficiency while minimizing the environmental impact. B Medical Systems' ultra-low freezers are also compliant with the U.S. Environmental Protection Agency's Significant New Alternatives Policy (SNAP) and the European Union's F-Gas Regulation, which call for the abolishment of ozone-depleting refrigerants by 2020. The environmental impact of R170 and R290 can be found in Table 1.

	Ozone Depletion Potential (ODP)	Global Warning Potential (GWP)
R290	0	3
R170	0	6

Table 1: ODP and GWP of R290 and R170

SAMPLE SCENARIO ANALYSIS OF EMISSIONS THAT CAN BE SAVED BY USING B MEDICAL SYSTEMS' ULTRA-LOW FREEZERS[8]

Scenario: A research lab using 10 ultra-low freezers



By using B Medical Systems' ultra-low freezers in place of traditional ULT freezers and switching the set point from -80°C to -70°C

Assuming there are 10 ULT freezers, switching the set point over the lifespan of 10 years can result in

You could save
6.13 kWh/day

Saving approx.
223,765 kWh in 10 years

This means saving

From entering the atmosphere

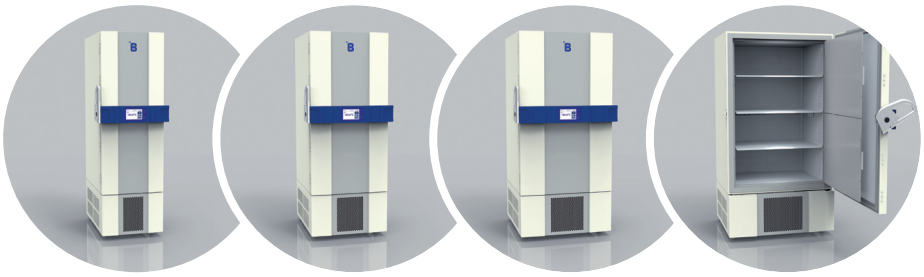
Greenhouse gas emissions from
33.6 cars

CO_2 emissions from
172,987 pounds
of coal burned

Extra tips for sustainable use of ultra-low freezers

- Defrosting freezers frequently
- Replacing old ultra-low freezers
- Efficient inventory management of samples
- Efficient sample management practices

The traditional lab operation is an energy hog. By switching towards green and sustainable initiatives, labs can help lessen the harm to the environment and lower the depletion of natural resources. However, consideration should be given to those ULTs that provide the most sustainable solution without compromising the reliability and performance of the overall system. B Medical Systems offers reliable and energy-efficient ultra-low freezers that reduce energy consumption and foster an environment of sustainability in everyday laboratory operations. Additionally, the natural refrigerants reduce environmental impact when compared to traditional ULTs. And by achieving efficiency and sustainability, B Medical Systems' ultra-low freezers also bring down the overall Total Cost of Ownership, enabling cost saving.



Ultra Low Freezers from B Medical Systems (models U401 / U501 / U701 / U901)

Want to know more about the ultra-low freezers developed by B Medical Systems?
Contact us at info@bmedicalsystems.com

Sources:

[1] https://ac-dc.power.com/green-room/

[2] University of California Davis with support from U.S. Department of Energy's Better Building Alliance (BBA) Laboratory Project Team

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[4] Long-Term Preservation of Fungal Isolates in Commercially Prepared Cryogenic Microbank Vials: A. Espinel-Ingroff, D. Montero, and E. Martin-Mazuelos: JOURNAL OF CLINICAL MICROBIOLOGY, Mar. 2004, p. 1257–1259

[5] Long term stability of paraoxonase-1 and high-density lipoprotein in human serum: Piet K Beekhof, Maryana Gorshunska and Eugène HJM Jansen. Lipids in Health and Disease 2012

[6] https://sustainable.stanford.edu

[7] http://www.i2sl.org/conference/2013/abstracts/b2_york.html

[8] Calculations based on https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

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Luxembourg, in the heart of Europe

B Medical Systems S.à r.l.

17, op der Hei
L - 9809 Hosingen, Luxembourg

Tel.: (+352) 92 07 31-1
Fax: (+352) 92 07 31-300
info@bmedicalsystems.com

www.bmedicalsystems.com

MADE IN LUXEMBOURG

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