



Conducting a Freezer Challenge to increase reliability/reduce energy

Federal Environmental Symposium

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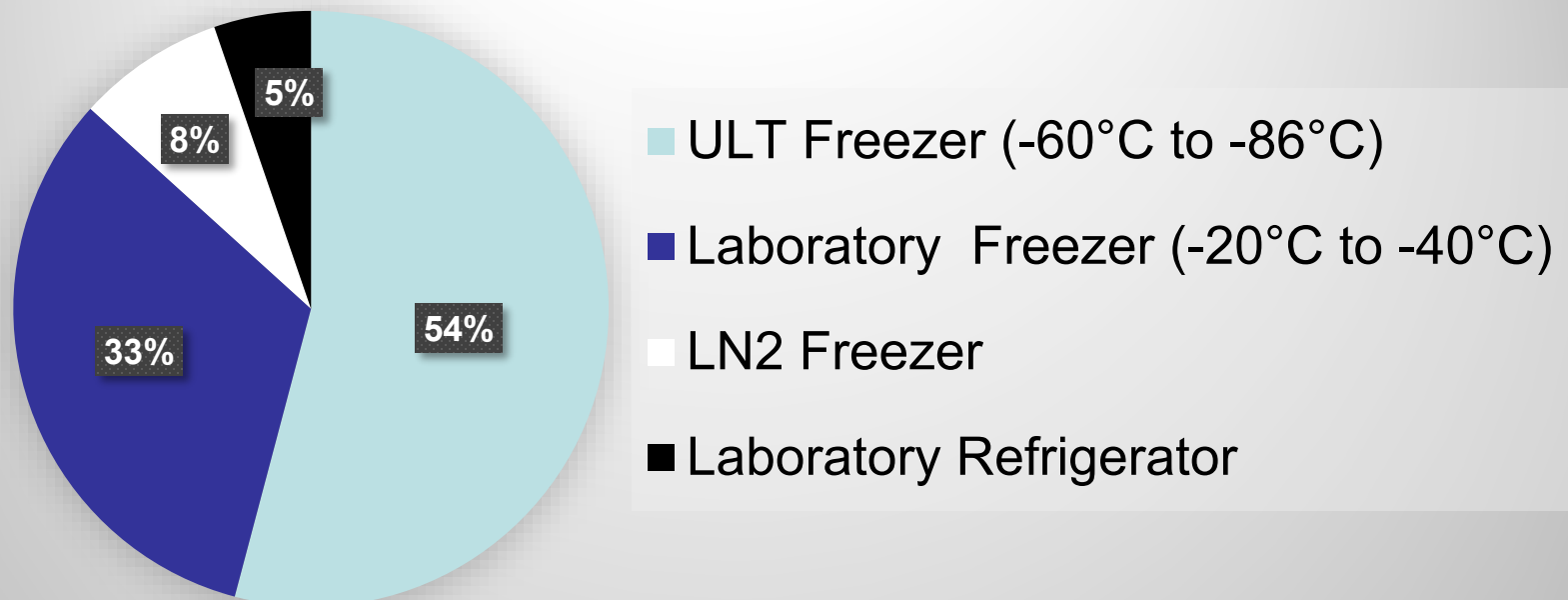
Jaroslav Sebek

NIH Sustainability Branch

Cold Storage at the NIH

- Laboratory freezers and refrigerators are essential to the NIH; providing cold storage to preserve samples, reagents, pharmaceuticals, vaccines and other materials related to research.
- The NIH has thousands of laboratory freezers and hundreds of laboratory refrigerators.

Cold Storage at the NIH





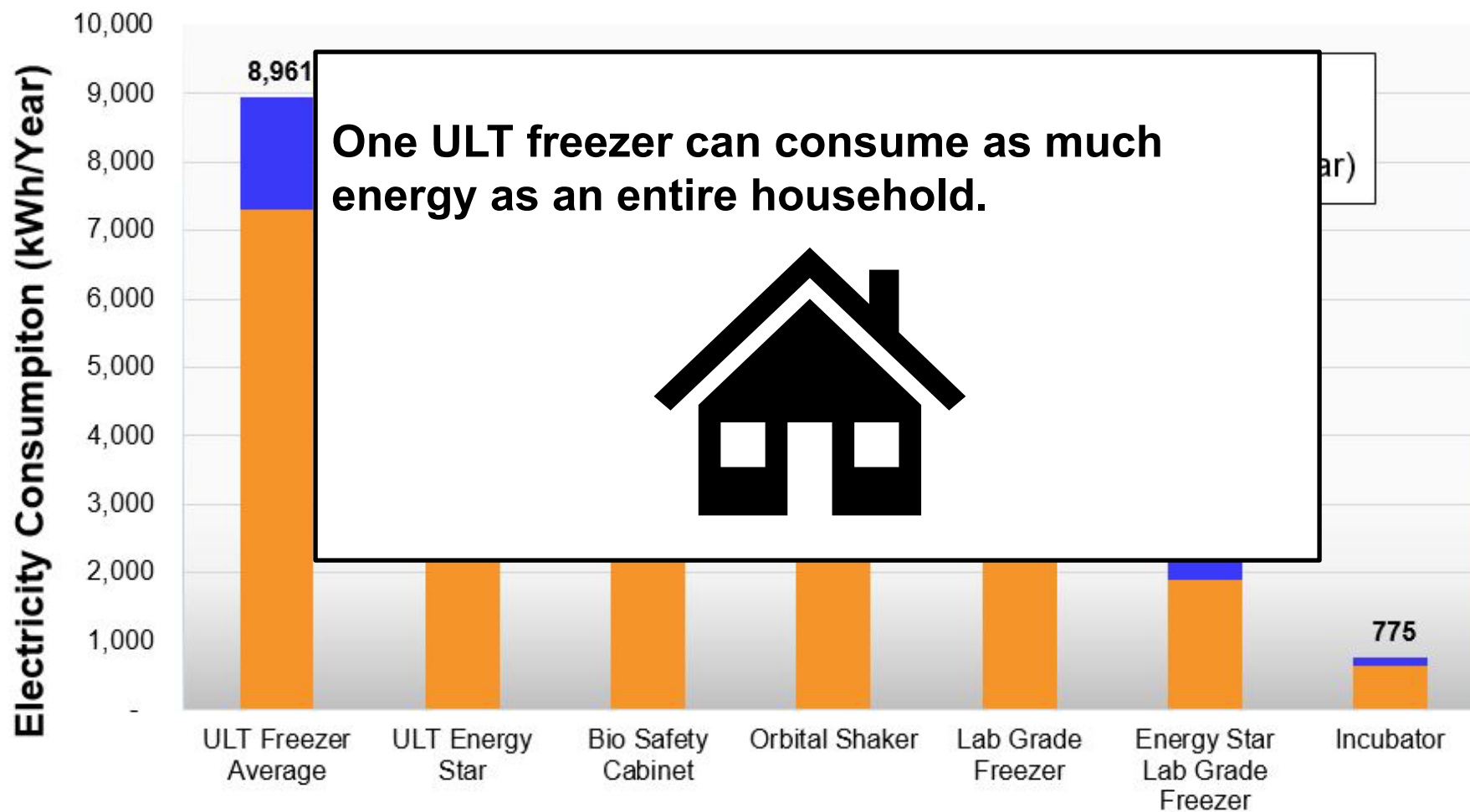
Factors Affecting the Energy Consumption of Laboratory Freezers

The NIH measured the electricity consumption of laboratory freezers in both laboratory settings and under testing conditions; emphasizing Ultra-Low Temperature (ULT) freezers.

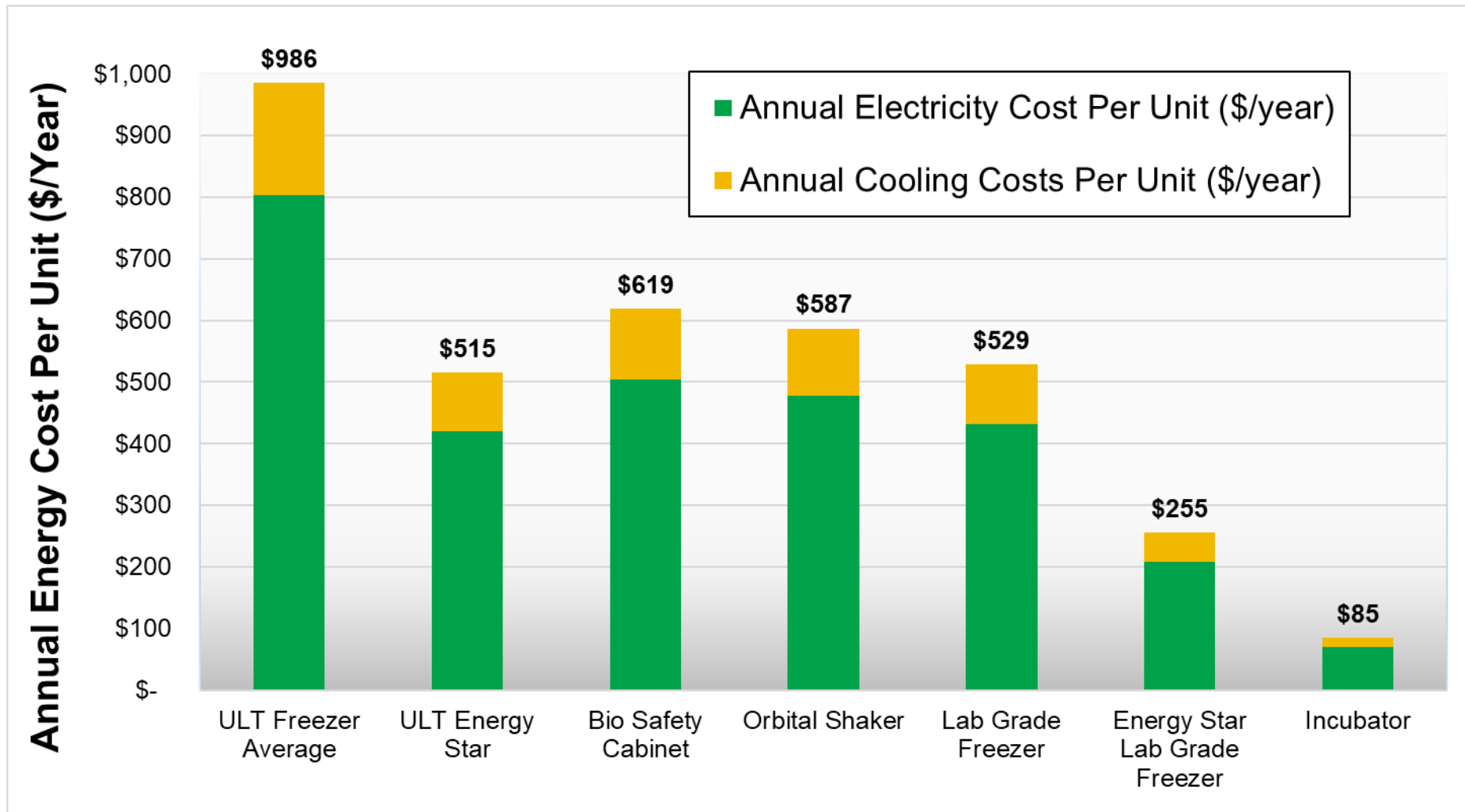
The following factors affect freezer performance and electricity consumption:

- **Baseline energy consumption**
- **Freezer temperature set point**
- **Age**
- **Ambient temperature**
- **Ventilation**
- **Dust on the filter/condenser coil**
- **Ice buildup**

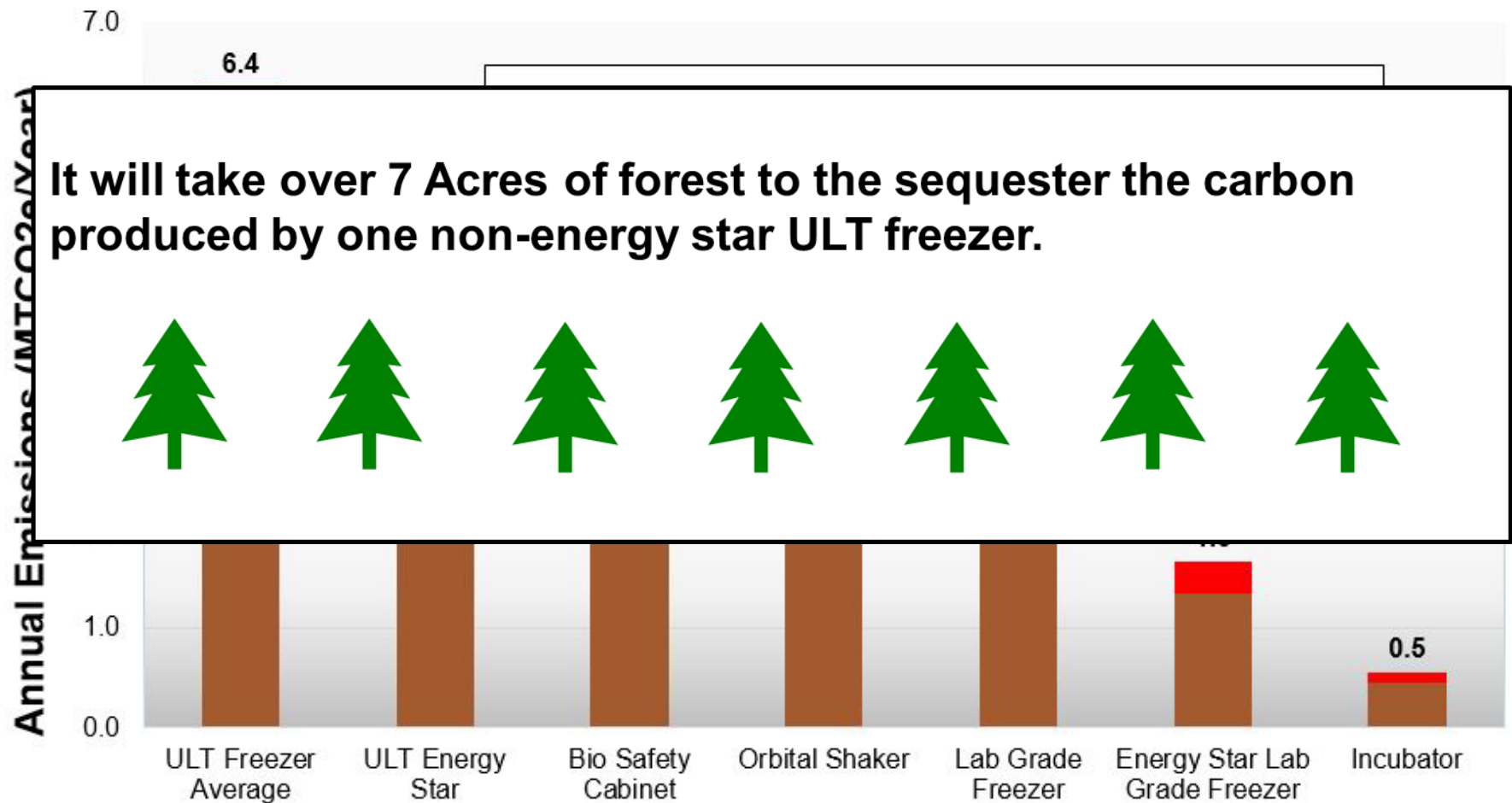
Annual Energy Consumption from Lab Equipment (kWh)/Year



Annual Energy Costs from Lab Equipment (\$/Year)



Annual Greenhouse Gas Emissions (GHG) from Lab Equipment ***Metric Tons of Carbon Dioxide Equivalent (MTCO₂e)/Year***





Efficient Freezer Management at NIH

- In July of 2016, the NIH released a freezer policy, [Manual Chapter 26101-16](#), to manage ULT freezers to increase freezer reliability and reduce energy consumption.
- Manual Chapter 26101-16 requires:
 - When purchasing a new ULT freezer, choose an Energy Star Certified model.
 - ULT freezers must have two preventative maintenances a year.
 - ULT freezers are to be located with adequate space and ventilation.
- The NIH Freezer Challenge is a voluntary program based on the International Freezer Challenge. The NIH Freezer Challenge goes beyond the requirements of Manual Chapter 26101-16 to further increase freezer reliability and decrease energy consumption.



Freezer Challenge initiatives

To participate in the freezer challenge, each lab must be meeting the requirements of the NIH Freezer Policy and complete at least one challenge initiative of their choosing.

Challenge Initiatives:

- Set Temperatures to -70 °C
- Discard Samples
- Defrost Freezers
- Share Freezer Space
- Transfer Samples to LN2
- Electronic Sample Inventory
- High Density Sample Storage
- Retire Unnecessary Freezers
- Ambient Temperature Sample Storage



Setting ULT freezer Temperature to -70°C

- Setting ULT freezers to -70°C instead of -80°C or -86 °C is one of the biggest energy saving freezer management initiatives a lab can undertake.
- Setting the temperature of ULT freezers to -70°C instead of -80°C can reduce energy consumption by 30%.
- If one (1) out of every four (4) ULT freezers at the NIH were set to -70°C. The NIH would save 2,214,090 kWh/year, \$243,550/year and 1,569 Metric Tons of Carbon Dioxide Equivalent (MTCO₂e).
- The NIH has started a database of samples that are currently being stored safely at -70°C.



Discarding Samples

- Labs are encouraged to review their sample inventory and discard samples that are no longer needed.
 - Improves freezer organization.
 - Reduces the need for additional storage space for new samples.
- To get credit for this initiative, labs are asked to keep track of how many samples of each size are being discarded and the temperature of the freezer or refrigerator they are being discarded from.



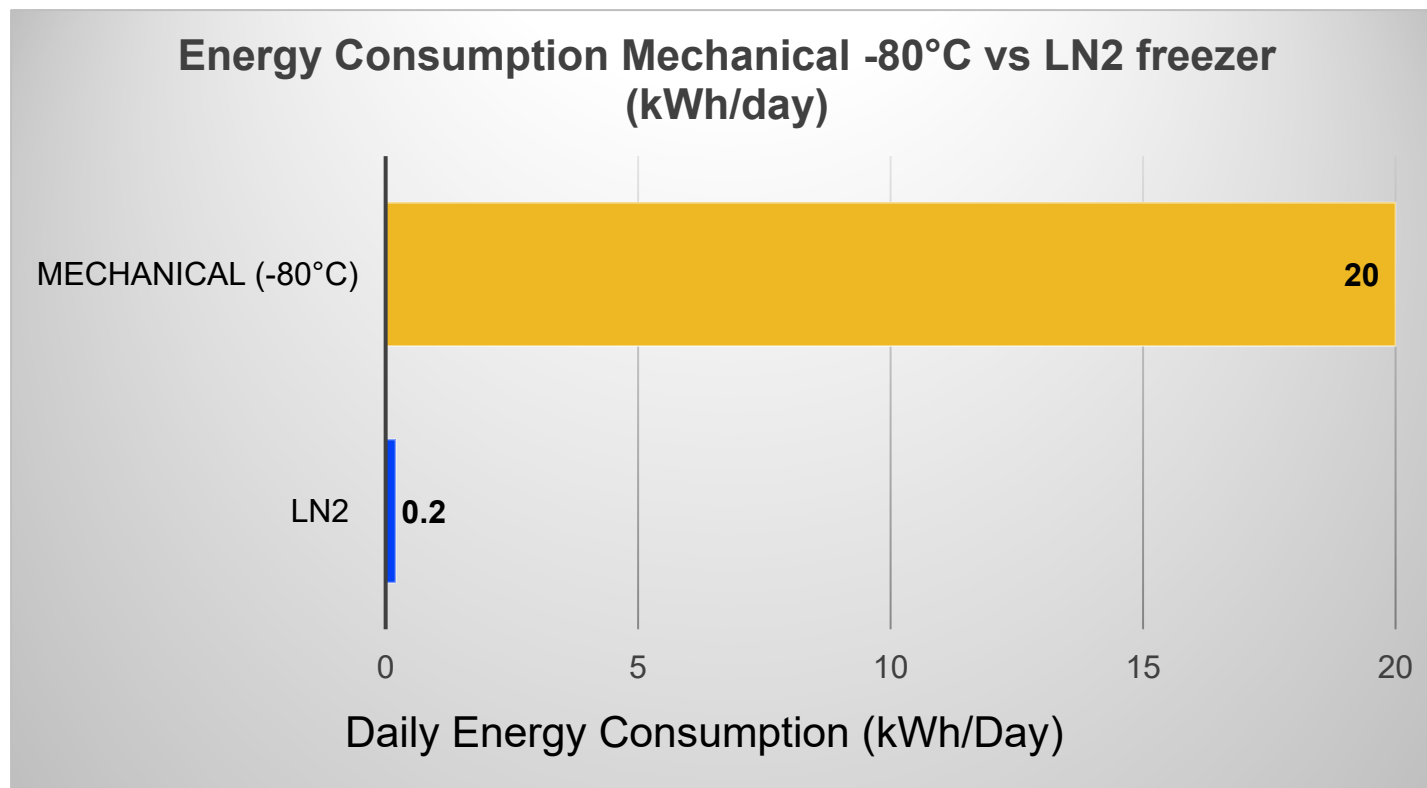


Share Freezer Space

- Many labs at the NIH that share freezers between multiple researchers within their lab.
- Not many labs at the NIH share freezers with other labs and even fewer share with other Institutes.
- Labs are encouraged to share extra freezer space with nearby labs.
- A good starting point is with emergency freezers that are only used for backup freezers in the event of a freezer failure.
- Inspections have found buildings where 10% of the ULT freezers are being run at -80°C as backup freezers.
- Sharing freezers will reduce the number of required freezers, which will:
 - Reduce energy consumption, energy costs and GHG emissions.
 - Reduce maintenance costs.
 - Increase floor space.

Transfer Samples to LN₂ Freezers

- LN₂ freezers consume less energy for mechanical ULT and are more reliable than mechanical freezers.
- Labs are encouraged to transfer long term samples to LN₂ storage.





Electronic Sample Inventory

- Maintaining an accurate electronic sample inventory enables efficient sample retrieval and sample management.
- Knowing which shelf and box a sample is stored allows researchers to retrieve samples quickly, reducing the duration of door openings.
- Door openings account for large spikes in compressor work and energy consumption.
- Electronic sample inventories also enable efficient sample management, enabling the disposal of samples and transferring to long term storage.
- Labs may choose to create a digital inventory using programs like Microsoft Excel or purchase a sample management program.
- Several companies offer software specifically designed to manage laboratory samples.



High Density Sample Storage Boxes

- Labs are encouraged to adopt high density sample storage boxes.
- 1.5 ml sample boxes are typically 9x9, 81 cell, or 10x10, 100 cell.
- Several companies offer 13x13, 169 cell, sample storage boxes for .5 ml and/or 1 ml samples.
- High density sample boxes can store 69% more samples in the same amount of space.



Retire Unnecessary Freezers

- By completing initiatives in this challenge, such as discarding samples and sharing freezer space, labs may have more freezer space than required.
- Additionally, labs that have multiple backup freezers are encouraged to evaluate how many backup freezers are required.
- If a lab determines that they have an unnecessary freezer, labs are encouraged to retire their oldest freezers or freezers that are in the worst condition.
- Retiring unnecessary freezers is one of the most effective ways to reduce energy costs, operating costs, GHG emissions and freeing up floor space which is in very high demand at the NIH.



Ambient Temperature Sample Storage

- Several companies offer Room Temperature Sample Storage (RTSS) solutions.
- DNA, RNA and some other compounds can be stored at room temperature in a dried state.
- RTSS can be used to reduce cold storage requirements.
- This can be especially beneficial during sample transportation, eliminating the constraints of using dry ice for shipping.
- Only one NIH lab has undertaken RTSS as part of the NIH Freezer Challenge.



NIH Freezer Challenge Participants (2019 – 2021)

NIH Freezer Challenge Participants by Year (2019 – 2021)					
2019		2020		2021	
IC	LAB	IC	LAB	IC	LAB
NCI	Laboratory of Human Carcinogenesis	NCI	Laboratory of Cell Biology	NCI	Laboratory of Cell Biology
NHGRI	Reproductive Cancer Genetics Section	NCI	Laboratory of Human Carcinogenesis	NCI	Molecular Oncology and Gene Transfer Section
NIA	Laboratory of Clinical Investigation Clinical Core Biorepository	NHGRI	Bell Lab	NEI	Laboratory of Immunology, Molecular immunology Section
NIDCD	Section on Sensory Cell Development and Function	NIDDK	Genetics and Metabolism Section of LDB	NHLBI	Laboratory of Myeloid Malignancies
NIDDK	Genetics and Metabolism Section of LDB			NIAID	Viral Epidemiology and Immunity Unit
NIDDK	Karen Usdin's Lab			NIDDK	Genetics and Metabolism Section of LDB
NIDDK	Liver Disease Branch			NIEHS	RTP Campus Freezer Replacement Initiative
NIEHS	MSRSG/ESCBL/DIR			NIEHS	In Vivo Neurobiology
NINDS	Viral Immunology Section at Division of Neuroimmunology and Neurovirology				Comparative Medicine Branch, Quality Assurance Lab
				NIEHS	Reproductive Medicine Group, RDBL
				NINDS	Translational Neuroradiology Section



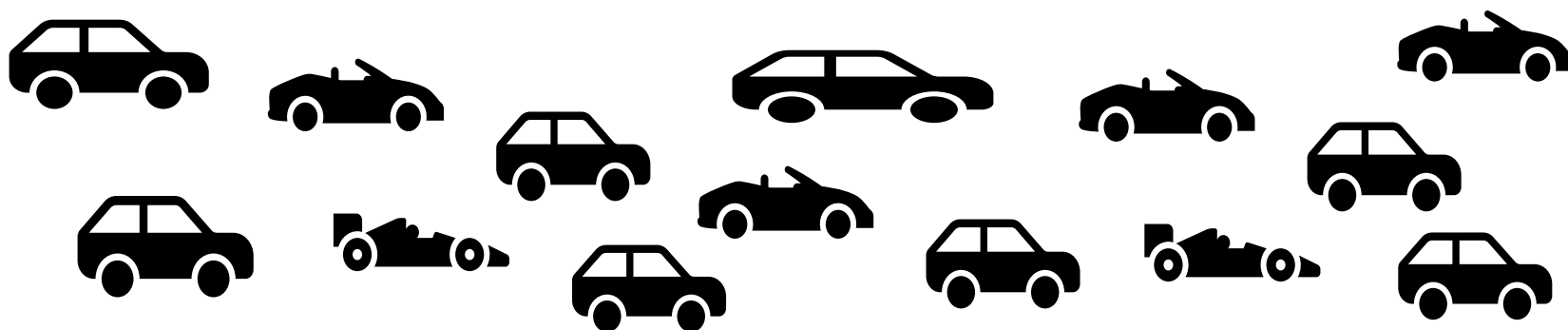
NIH Freezer Challenge Initiatives (2019 – 2021)

Freezer Challenge Initiatives by Year (2019 - 2021)			
Challenge Initiative	2019	2020	2021
Replace freezer/refrigerator with Energy Star	9	13	67
Operate ULT freezer at -70°C or warmer	18	21	17
Discard samples that are no longer needed	11,749	19,906	30,096
Conduct a complete defrost	26	28	60
Share freezer space with other researchers	34	16	45
Maintain an electronic sample inventory	107	69	137
Retire unnecessary freezers (-86°C)	3	4	7
Retire unnecessary freezers (-20°C to -40°C)	0	8	13
Retire unnecessary refrigerators (4°C)	0	11	8

NIH Freezer Challenge Savings (2019 – 2021)

- These savings were accomplished by a small number of labs, from four (4) labs in 2020 to ten (10) labs and one IC in 2021.
- Many of these initiatives are low cost or zero cost initiatives.

Reducing 261 Metric Tons of Carbon Dioxide Equivalent (MTCO₂e) is equivalent to taking 57 cars off the road.



EO 14057 Emission Reduction Requirements

- EO 14057 sets aggressive requirements for federal agencies to reduce Greenhouse Gas (GHG) emissions and combat climate change.
- Reduce Scope 1 and 2 GHG emissions by 65% by 2030 from 2008.
- Net-zero emissions building portfolio by 2045, including 50% emissions reduction by 2032.
- Reducing energy consumption and associated scope 2 GHG emissions within laboratories will help meet these requirements.



International Freezer Challenge

- My Green Lab and the International Institute for Sustainable Laboratories (I²SL) host the International Freezer Challenge annually, link below.
- Hundreds of Labs from private companies, universities, and government organizations around the world compete to achieve the largest energy reduction from the freezers in their laboratories.
- The NIH freezer challenge is based on the International Freezer Challenge.
- The NIH compiles the results from the NIH freezer challenge and submits to the International Freezer Challenge.

[**International Freezer Challenge**](#)



NIH Won the International Freezer Challenge

- The NIH won the International Freezer Challenge in 2020 and 2021 in the government organization category.
- The NIH NCI Laboratory of Cell Biology won in the International Freezer Challenge in the individual laboratory category in 2020 and 2021.
- Winners are announced on the International Freezer Challenge Page, in a Nature Article and at International Institute for Sustainable Laboratories (I₂SL) annual conference.
- 2021 Freezer Challenge Nature Article
<https://www.nature.com/articles/d42473-021-00361-7>
- 2020 Freezer Challenge Nature Article
<https://www.nature.com/articles/d42473-020-00250-5>

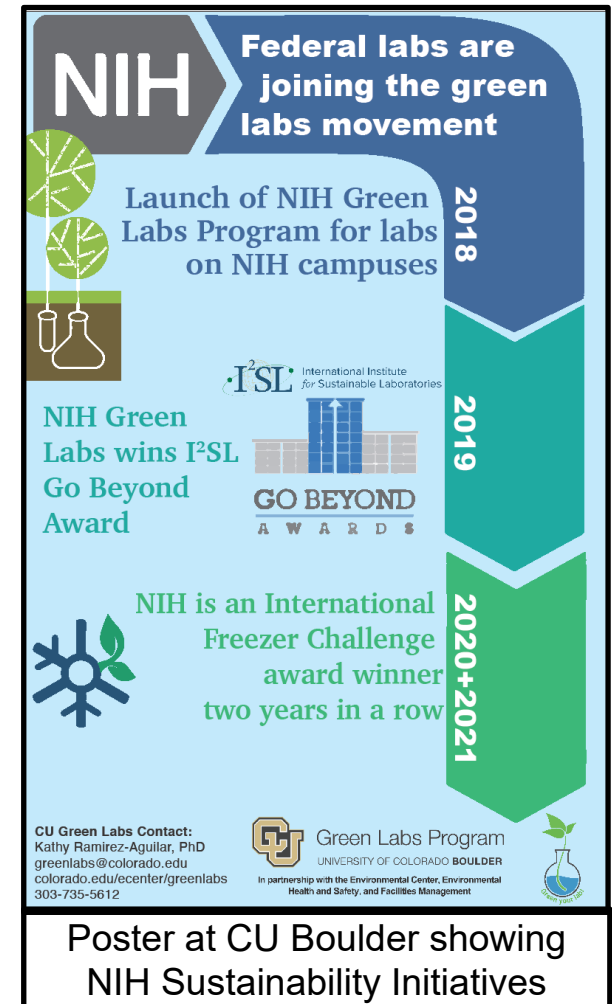
More Information about the NIH Freezer Challenge

For additional information:

- Visit the [NIH Freezer Challenge Page](#).
- Review the [NIH Freezer Challenge Guide](#).
- For NIH staff, join the NIH [Freezer Challenge MS Teams Page](#).
- Send an email to: Jaroslav Sebek sebekjd@nih.gov.
- Visit the [International Freezer Challenge Page](#).

Additional Freezer Challenge Benefits

- The freezer challenge will increase freezer reliability, reduce energy consumption and operating costs.
- Federal participation helps encourage vendors to support sponsoring sustainability initiatives, such as the International Freezer Challenge.
- This helps Universities demonstrate to their students the importance of sustainability to federal agencies and private companies.





Thank you!

Questions?