

# **FREEZER DATA: IS THERE SUCH A THING AS TOO MUCH?**

**2025 I2SL Annual Conference H2**

Ryan Weeks-Rutan, Carly Hinton, Swastik Jha | Oct 22, 2025

# LEARNING OBJECTIVES

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## LEARNING OBJECTIVE 1

- Understand how and why cold-storage units are monitored;

## LEARNING OBJECTIVE 2

- learn how monitoring data can advise on units using disproportionate amounts of energy;

## LEARNING OBJECTIVE 3

- recognize methods for addressing high-energy consumers, underutilized, and incorrectly operated cold-storage units;

## LEARNING OBJECTIVE 4

- identify opportunities to reduce their institution's energy consumption through improvement of cold-storage practices.

# OUR TEAM



**Carly Hinton**

Sustainability Manager  
BSPH Facilities Management



**Swastik Jha**

Sustainability Intern  
BSPH Facilities Management



**Ryan Weeks-Rutan**

Sr. Sustainability Specialist, Green Labs &  
Zero Waste  
JHU Office of Climate & Sustainability

# BACKGROUND

# JOHNS HOPKINS AT A GLANCE

## Johns Hopkins University (JHU)



School of Medicine



Bloomberg School of Public Health



Krieger School of Arts & Sciences,  
Whiting School of Engineering

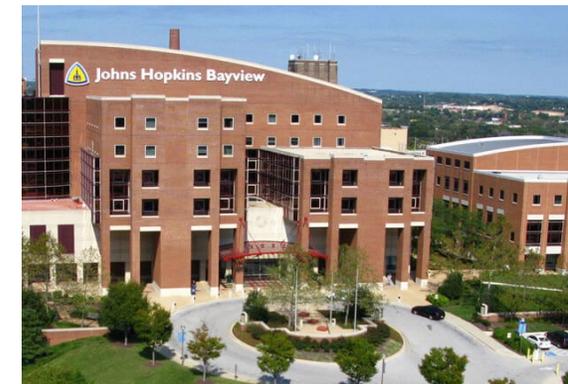


Applied Physics Lab

## Johns Hopkins Health System (JHHS)



Johns Hopkins Hospital



Johns Hopkins Bayview

# SUSTAINABILITY AT JHU

## Reducing energy consumption and cooling load from ULTs will aid our division with complying with:

- JHU Climate Action and Sustainability Plan
  - MD Building Energy Performance Standards (BEPS)
- 
- JHU has committed to achieving net zero scope 1 and 2 emissions by 2040 and enhancing sustainability through energy efficiency
  - Maryland's BEPS require buildings to meet specific energy performance targets, including reducing overall energy use intensity (EUI)
    - Social Cost of Carbon is a measure, in dollars, of the long-term damage done by a ton of carbon dioxide (CO<sub>2</sub>) emissions (US EPA)
    - BEPS defines this number as \$230 / MT CO<sub>2</sub>e

## CLIMATE ACTION

### OBJECTIVE 3.2

Accelerate decarbonization and energy efficiency in existing buildings

### KEY ACTIONS

- **Develop a prioritized action plan and continuous building commissioning program** to ambitiously reduce energy and emissions in existing buildings at each campus
- **Expand a JHU Green Labs program** to engage researchers, reduce emissions, and improve resource efficiency in laboratory spaces
- **Develop a dashboard** to track, report, and incentivize building energy and emission performance

# ULTRA LOW TEMPERATURE FREEZERS

## ULTs are one of the largest consumers of energy within the lab

- Average ULTs consume between 20-30 kWh/day set at -80C
- Energy efficient ULTs consume below 10 kWh/day set at -80C
- **Behavioral and operational improvements** include temperature tuning, inventory management, and regular maintenance that can conserve significant amounts of energy
  - Tuning to -70C can conserve up to 30%
  - Regular cleaning and deicing can prolong life by ensuring optimal conditions for use
- Every kWh of electricity consumed generates heat that puts load on our building cooling systems (typically costly to operate 100% outside air systems)

In 2022, residential customers in the United States purchased an average of:



10,791 kWh of electricity for the year.



899 kWh of electricity per month.



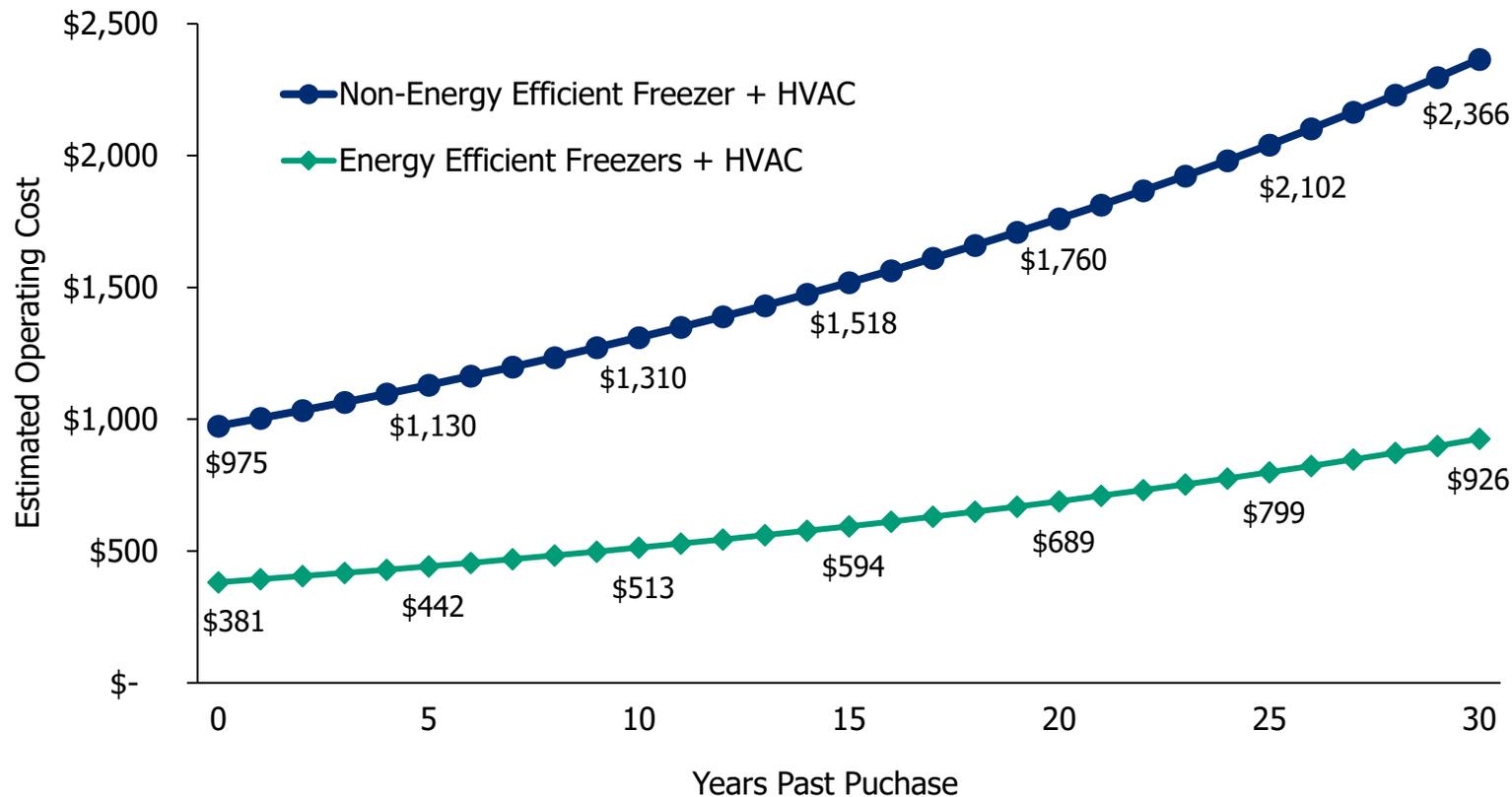
30 kWh of electricity per day.

 Constellation.

# JHU ULT FREEZER OPERATION

JHU operates nearly 1,500 ULTs Freezers, utilizing ~15 million kWh/year

Estimated Annual Operating Cost of One Aging ULT & HVAC



- Every kWh of electricity consumed generates heat that puts load on building cooling systems (estimated 29% more energy required to cool area)
- Even with proper maintenance, ULTs utilize 3% more energy each year
- Replacing inefficient ULTs-with energy efficient models can drastically lower operational costs over time

# JHU ULT FREEZER OPERATION

JHU operates nearly 1,500 ULTs Freezers, utilizing ~15 million kWh/year

Total ULTs at JHU by Division and Age

Age	SOM	BSPH	KSAS	WSE	Total by Age
0-5	431	85	19	17	558
5-10	271	51	27	8	360
10-15	186	51	10	4	251
15-20	119	11	5	1	136
20+	108	21	9	2	140
<b>Total by Division</b>	<b>1115</b>	<b>219</b>	<b>70</b>	<b>32</b>	<b>1445</b>

Inventories compiled from JHU Fixed Assets (units valued over \$5,000 at time of purchase)

ULTs purchased since FY23

Year	Total Purchased	*Energy Efficient Units	Energy Efficient (% of units)
FY23	97	48	49%
**FY24	62	37	60%

\*Energy efficient units estimated based on description provided by JHU Fixed Asset

\*\*Through April 2024

## March 2023- April 2024:

- 92 units purchased
- 37 units retired
- 55 units net gain

# UNIVERSITY STRATEGIES FOR ULT FREEZERS

- International Freezer Challenge
  - JHU has sponsored awards for an internal Freezer Challenge since 2021
  - 2025: Top Academic Institution!
- ULT Freezer Best Practices Guide
  - Promotes best practices for freezer operation and maintenance
  - List of energy-star (2025) certified ULT freezers
- Numerous biorepositories at JHU
  - Storing samples in a biorepository provides security and reduces energy consumption from freezers

## ULT FREEZERS MEETING SUSTAINABLE PROCUREMENT STANDARDS

Manufacturer	Unit Series	Energy Consumption (kWh/day/cu.ft.)	ACT Ecolabel EIF	Internal Capacity (cu. ft.)
Thermo Fisher	TSX Universal	0.24-0.31	30.0-31.0	24.1, 28.8, 33.5 (500 - 700 2" boxes)
Thermo Fisher	TSX Core	0.24-0.31	N/A	24.1, 28.8, 33.5 (500 - 700 2" boxes)
Haier	TwinCool	0.34-0.35	N/A	25.7, 29.2 (600 2" boxes)
Haier	Smart Frequency Conversion	0.29-0.34	N/A	20.4, 25.7, 29.2, 33.9 (XYZ 2" boxes)
PHCbi	VIPECO	0.29 - 0.35	N/A	18.6, 25.7, 29.8 (384 - 672 2" boxes)
PHCbi	VIPECO Smart	0.21 - 0.27	N/A	18.6, 25.7 (384 - 576 2" boxes)
PHCbi	FrostLess	0.29 - 0.33	N/A	18.5, 25.6 (352 - 528 2" boxes)
Stirling	Vault100	0.22	23	28.0 (600 2" boxes)
Stirling	SU780XLE	0.29	30.8	27.5 (600 2" boxes)

# **BSPH APPROACH TO ULT FREEZER OPERATION & MAINTENANCE**

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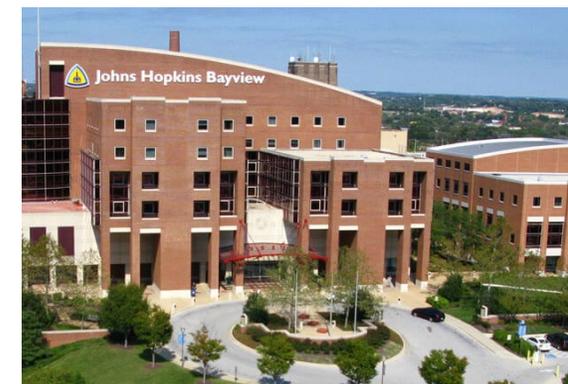


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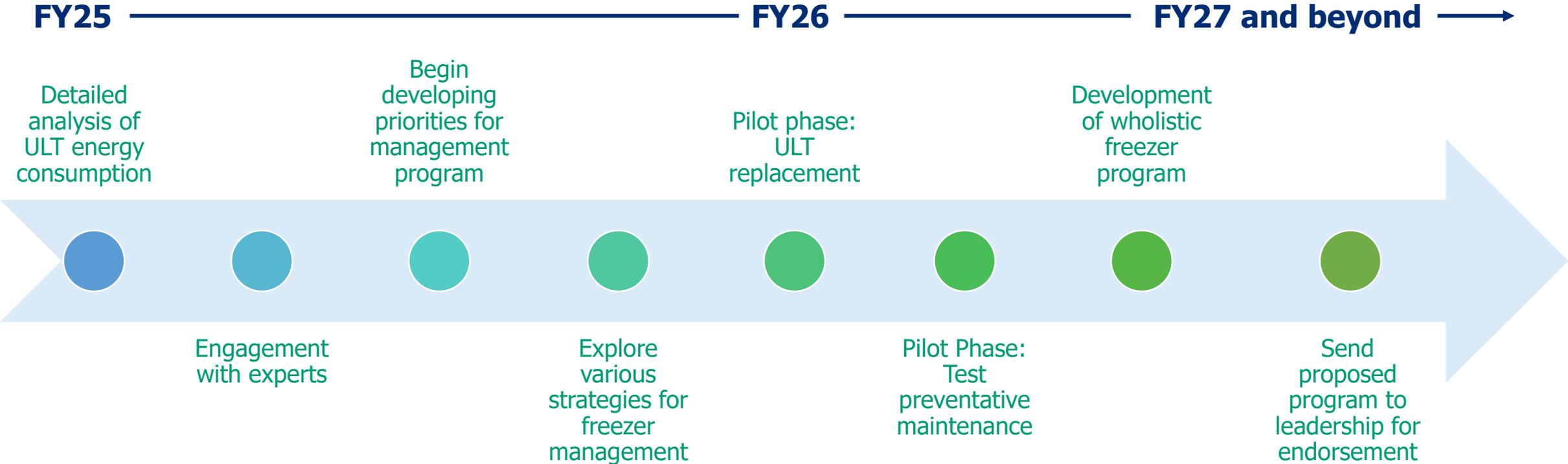
# BSPH ULT FREEZERS

## BSPH operates over 200 ULT freezers

- Nearly all freezers are monitored by the Thermo Fisher Insight System
- Average age is 8.2 years with 25% being over 12 years
- At least 23 ULTs are marked as inefficient (above 37 kWh/day) with some as high as **100 kWh/day**
- Freezers are inconsistently maintained by the lab departments which negatively impacts energy efficiency and equipment reliability



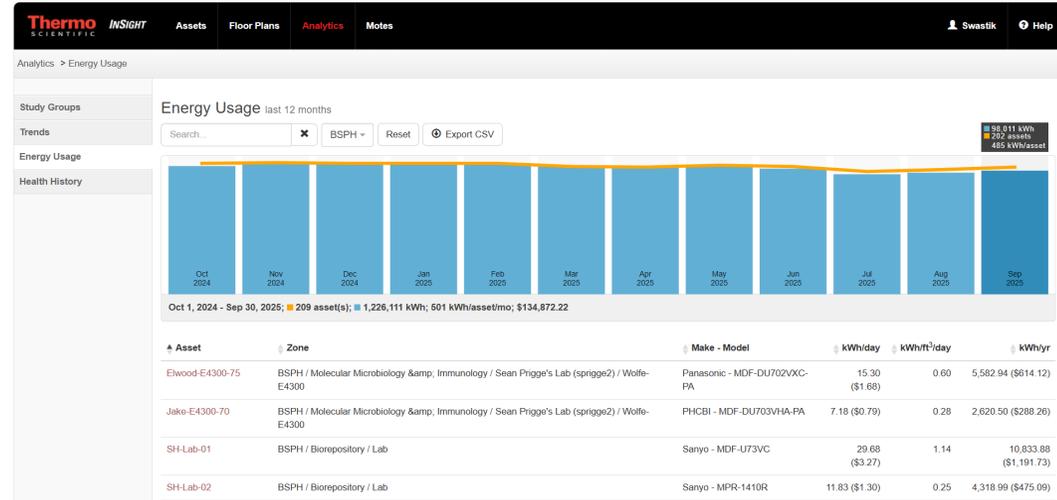
# BSPH PROGRAM DEVELOPMENT APPROACH



# ANALYSIS OF BSPH FREEZERS

## Thermo Fisher Insight

- Monitoring provides a wealth of data including **energy usage**, temperature fluctuations, **door openings**

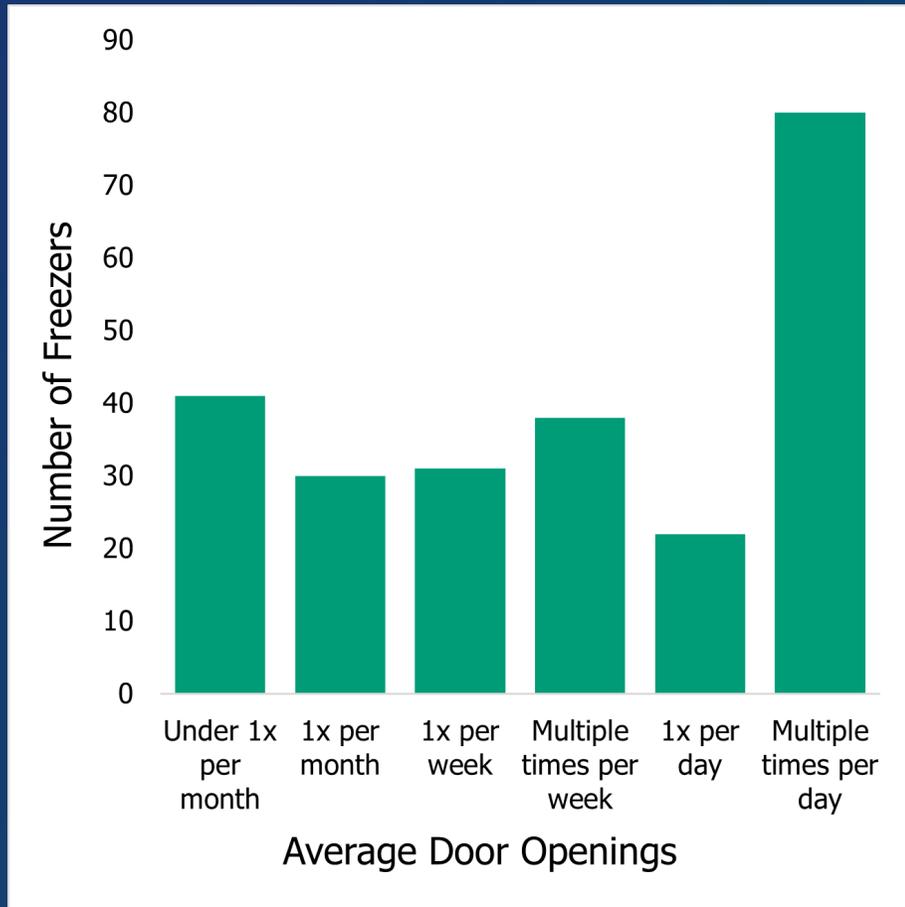


Asset	Zone	Make	Model	Capacity	Capacity Units	2024-09 kWh	2024-10 kWh	2024-11 kWh	2024-12 kWh	2025-01 kWh	2025-02 kWh	2025-03 kWh	2025-04 kWh	2025-05 kWh	2025-06 kWh	2025-07 kWh	2025-08 kWh
Wolfe-E8300B-02	BSPH / Biochemistry & Molecular Biology / Anthony Leung's Lab (aleung5) / Wolfe-E8300	Panasonic	MDF-DU702VXC-PA	25.7 cuft		346.92	357.1	338.53	351.5	303.15	340.94	343.15	356.07	329.21	342.18	341.72	341.72
Wolfe-E8300-84	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Thermo Scientific	TSU600A	28.8 cuft		916.81	902.57	952.79	958.47	877.31	990.25	984.91	735.2	783.16	867.06	910.69	910.69
Wolfe-E8300-75	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Revco	ULT1386-9-D40	13 cuft		658.14	643.1	681.33	722.54	642.94	703.85	669.74	653.18	638.48	612.19	605.27	605.27
Wolfe-E8300-17	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Thermo Sci	8960086A	28.8 cuft		249.94	241.1	257.36	265.61	236.18	257.32	246.31	259.7	254.5	270.81	268.65	268.65
Wolfe-W3707-01	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Fisher Scientific		5159	17 cuft	463.04	449.58	468.11	480.41	426.08	452.33	434.16	451.68	442.15	467.1	460.77	460.77
Wolfe-HYE8300F283	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	TRUE	GDM-47	47 cuft		244.29	241.66	272.79	304.44	263.33	271.4	247.47	225.49	221.73	207.79	198.34	198.34
Wolfe-HYE8402F202	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Fisher	13-986-122			389.13	583.62	606.56	-	-	-	-	-	-	-	-	-
Wolfe-HYFR100F774	BSPH / Biochemistry & Molecular Biology / Jiu Wang's Lab (jwang8) / Wolfe-E8300	Precision	I-36N1	79.7 cuft		74.06	41.1	41.18	40	74.54	74.19	74.41	41.69	41.57	41.44	45.11	45.11

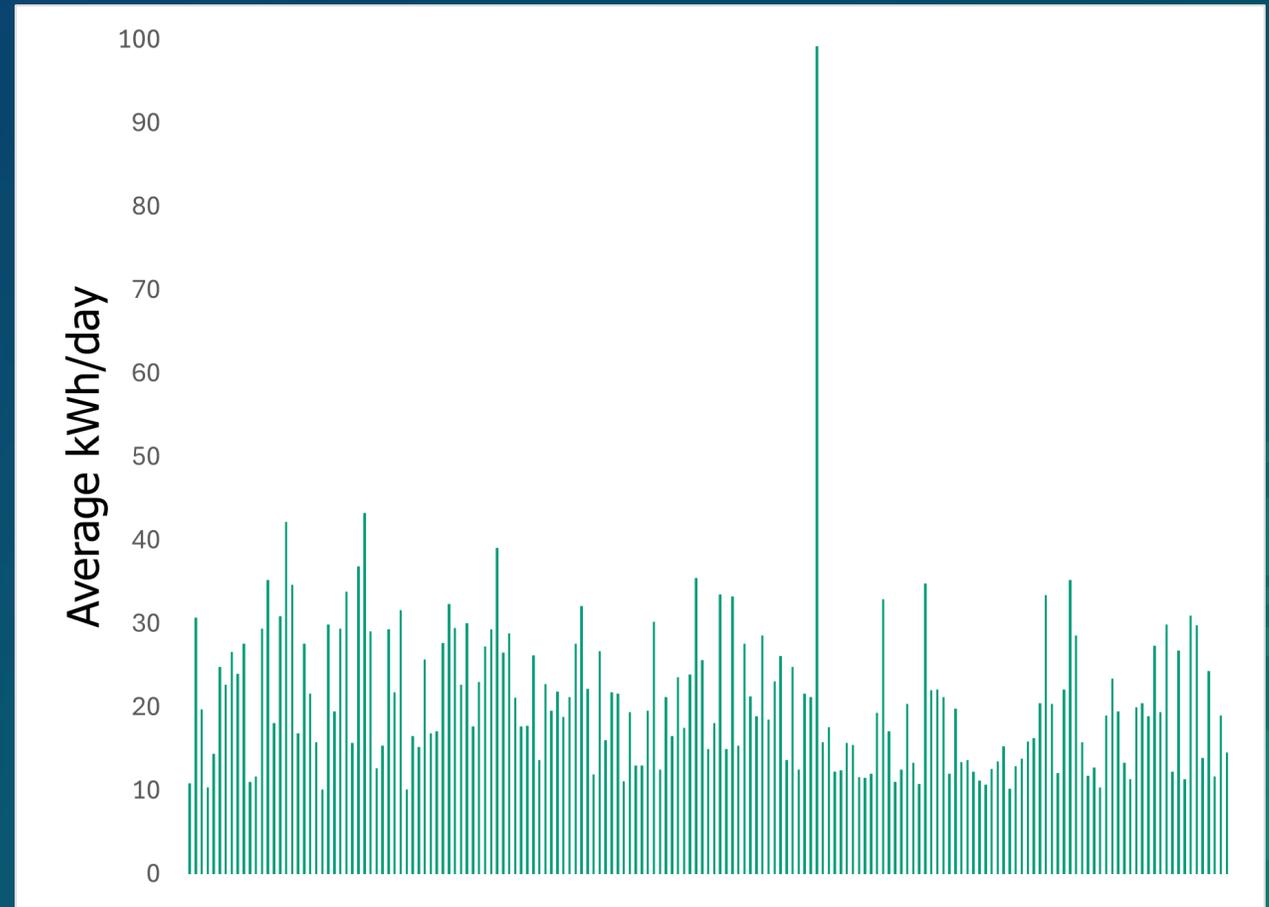
Q/Week	Asset Location	Asset Name	Asset Make - Model	Total # of Openings	Avg # of Openings/Week	2023-10-01 Door Openings	2023-10-08 Door Openings	2023-10-15 Door Openings	2023-10-22 Door Openings	2023-10-29 Door Openings	2023-11-05 Door Openings	2023-11-12 Door Openings	2023-11-19 Door Openings	2023-11-26 Door Openings	2023-12-03 Door Openings
8 <0.1/Week (~1 every 2 Months)	BSPH / Molecular Microbiology & Immunology / Fidel Zavala's Lab (fzavala1) / Wolfe-E4300	Wolfe-E4300-12	Thermo - ULT1786-6-A46	396	7.9	6	13	6	1	8	7	5	3	0	14
24 <0.2/Week (~1 every Month)	BSPH / International Health / Laura Hammit's Lab (lhammit1) / Wolfe-W5309	Wolfe-W5309-02	Thermo - 8690	436	8.7	0	0	0	1	7	0	0	7	23	16
37 <0.3/Week (~1.5 every Month)	BSPH / Environmental Health Engineering / Fenna Sille's Lab (fsille1) / Wolfe-E7300	Wolfe-E7300B-66	Stirling - SU780XLE	455	9.1	24	0	8	13	1	0	6	0	0	7
45 <0.5/Week (~2 every Month)	BSPH / Molecular Microbiology & Immunology / James Gordy's Lab (jgordy2) / Wolfe-E2300	Wolfe-E2300-Gordy-01	Fisher Scientific - IU2386A	473	9.5	0	8	1	14	5	17	19	5	12	1
54 Equipment Total	BSPH / International Health / Subhra Chakraborty's Lab (schakr11) / Wolfe-W5309	Wolfe-W5309-01	Thermo - UXF60086A63	481	9.6	39	25	15	52	46	45	5	0	6	2
242 Possible Long Term %															22.3%

# ANALYSIS OF ULT FREEZERS

## Door Openings



## Energy Use



# ENGAGEMENT WITH EXPERTS

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Stakeholders and experts were engaged to gather insights, learn best practices, and ensure alignment with institutional and industry standards

## BSPH STAKEHOLDERS

- Emergency Management
- Equipment Technicians
- Architects
- Department administrators
- Principal Investigators (professors)
- BSPH Biorepository

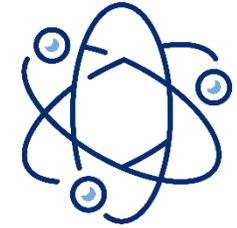
## JHU STAKEHOLDERS

- Lab procurement team
- Green Labs Specialist
- Green Labs Freezer Group leader
- JHU Health, Safety, and Environment staff
- GRCF BioBank Management

## EXTERNAL EXPERTS

- CU Boulder Shared ULT Freezer Program administrator
- Major ULT manufacturers
- ULT maintenance providers

# EMERGING PRIORITIES



## ENERGY CONSERVATION

- Biggest impact = replacing highest energy consumers
- ULT program to replace, maintain, or decommission inefficient freezers
- Utilize less energy and generate less heat

## MAINTENANCE

- Keep tight internal temperature band
- Healthy compressor cycles and reducing run hours

## RELIABILITY

- Fewer temperature alarms
- Increased lifespan

## Efficacy

- Sample safety

# STRATEGIES EXPLORED

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- **ULT rental program**

- Explored renting sample space in shared university-owned ULTs to laboratories
  - ✗ Program not a good fit due to labor requirements and existing freezer-space rental programs (biorepositories)

- **Subsidy for sample storage**

- Explored subsidizing sample storage for labs in existing Hopkins biorepositories
  - ✗ Subsidies would not have a positive return on investment
  - ✓ Sample storage will be presented to labs with freezers that are underutilized, but subsidies will not be provided

- **Subsidy for ULT replacement**

- Subsidy would provide incentive for labs to replace old, energy-intensive freezer with new, efficient freezer (full replacement cost needed due to lack of laboratory discretionary funds)
  - ✓ Pilot to replace highest consuming freezer at BSPH

- **Subsidy for ULT maintenance contract**

- Subsidy would cover annual preventative maintenance contract cost
  - ✓ Pilot for testing preventative maintenance strategies

- **BGE Custom Rebate Application**

- ✓ Working with BGE to pilot a custom rebate application for ULT freezer replacement for \$0.28 per kWh/year savings

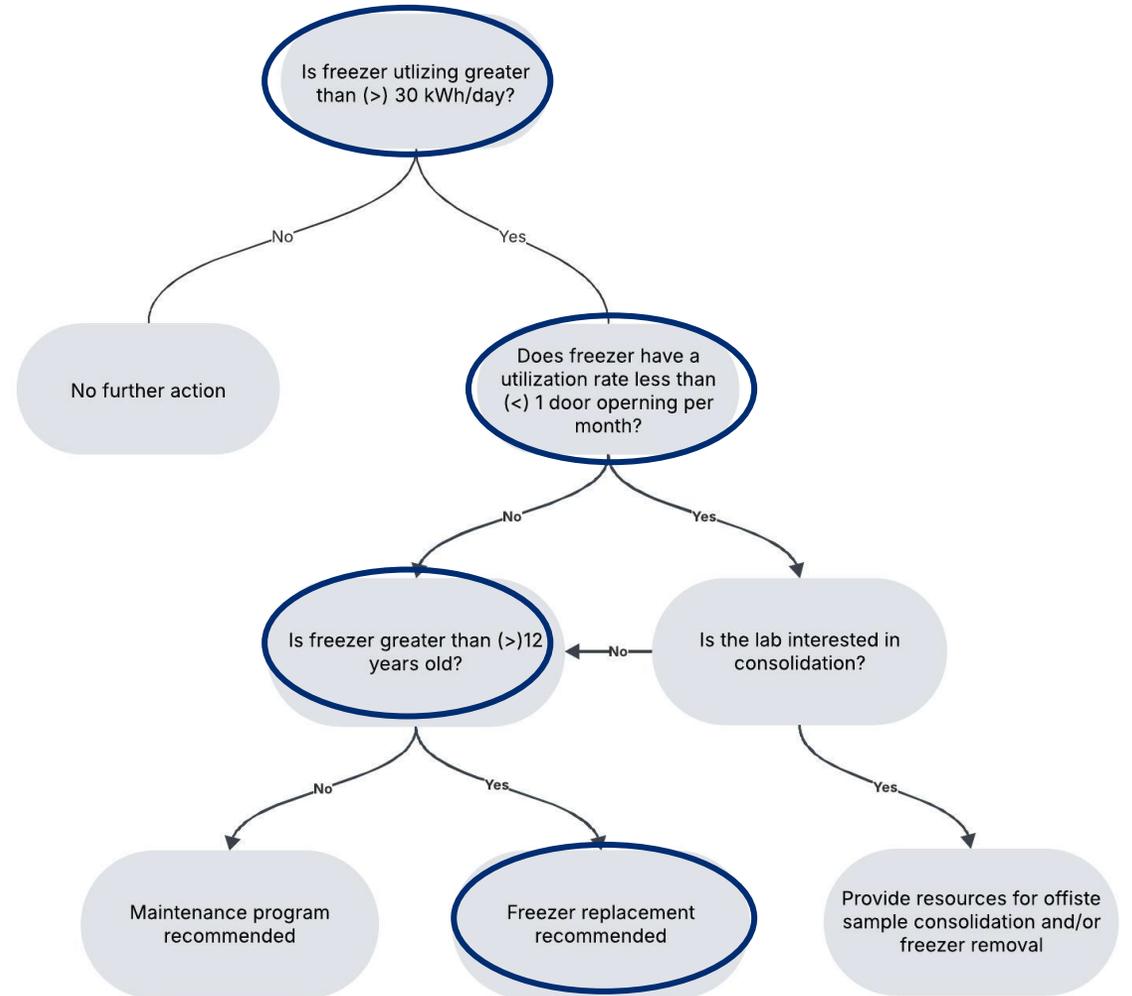
# FY25/26 PILOT PROJECTS

## GOAL: evaluate impact of recommended approaches

- Subsidy to replace with efficient units
- Testing preventative maintenance strategies

**1 FREEZER:** Provide subsidy to laboratory to replace with a more efficient unit

- Track impacts to fleet utility consumption
- Analyze return on investment
- Utilize data to establish parameters for overall program



# FY25/26 PILOT: REPLACEMENT ULT



Approx 100 kWh/day

## Estimated Savings

- 32,850 kWh/year
- 112.08 MMBtu chilled water
- 14,372 kg CO<sub>2</sub>e
- \$9,700 BGE Utility Rebate
- **≤3.1 year ROI**



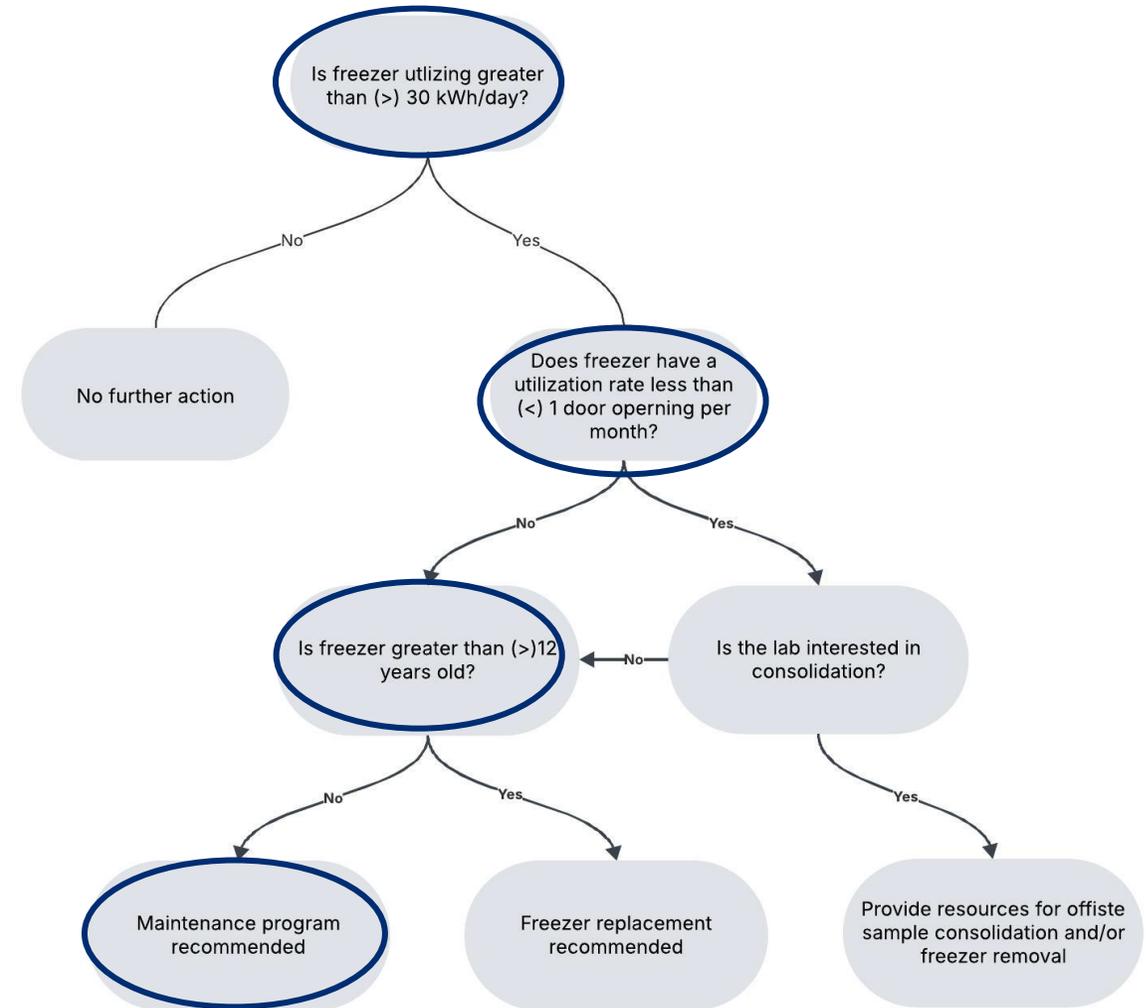
Approx 10 kWh/day

# FY25/26 PILOT: PREVENTATIVE MAINTENANCE

## Test if preventative maintenance can reduce or maintain kWh/day

- Survey current preventive maintenance efforts
- Track impact on energy consumption / performance of those ULTs

- **Group A** – Support labs in conducting manufacturer’s recommended preventive maintenance
- **Group B** – MMI ULTs with no changes to their existing program
- **Group C** – Service contract via local factory authorized service provider
- **Group D** - Control group with no new preventive maintenance support



# THANK YOU!

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## Program Expected Benefits:

By replacing inefficient freezers with energy-efficient models, performing consistent maintenance, and encouraging day-to-day maintenance and sample consolidation, this program will achieve:

- Reductions in Energy Use Intensity (EUI) and Greenhouse Gas (GHG) Emissions
- Alignment with institutional (CASP) and regulatory (BEPS) sustainability goals
- Reductions in power and cooling system demand
- Improvements in ULT reliability and operating performance
  - Reduction in sample loss
  - Reduction in freezer alarms requiring response by lab staff

## Pilot Project Outcome:

- The outcome of this pilot project will be to present findings and recommendations regarding a holistic program for future ULT renewal and maintenance.