Ultra-Low Temp Freezers

Selecting Energy Efficient Models

Key Questions to Consider:

Is the lab likely to follow a scheduled maintenance procedure (yearly defrosting, cleaning exterior coils, etc.)? – If yes, manual defrost freezers are generally more efficient than automatic. If not, automatic defrost freezers will be better than a frosted-over freezer.

If purchasing a small freezer, can the lab share with another group? – Smaller ULT freezers consume more energy per sample than larger ones. If sharing a larger freezer with another group is possible, it will maximize efficiency.

Would the lab consider running their freezer at -70°C instead of -80 or -86°C? – Many normal samples in ULT freezers can be safely stored at -70°C, but all samples are different. UCSB researchers were among the first in addition to Harvard, Dartmouth, UC Davis, and CU-Boulder to warm up to -70°C.

Summary of Desired Energy Efficiency Features/Practices:

- Manual defrost (if following a cleaning/defrosting maintenance procedure)
- Automatic defrost (if no cleaning/defrosting will be performed)
- Maximize space usage in in a large freezer (if possible)
- Maintained temperature at -70°C

Primary ULT Freezer Purchase History at UCSB, 2021-2024:

Model	Acquisition Value ($)	Lifetime	Watts	Electricity cost/year ($0.16/kWh)	Lifetime cost ($)
Thermo TSX 600 86A	14,200	10 yrs	1020	1,430	25,720
Thermo TSX 400 86A	12,300	10 yrs	1030	1,450	26,800
Eppendorf CryoCube F740	14,400	10 yrs	1440	2,018	34,580
Eppendorf CryoCube F570	14,000	10 yrs	805	1,128	25,280
Stirling SU780XLE-PWR5	15,200	10 yrs	1200	1,682	32,020
Revco RDE600	12,600	10 yrs	1,461	2,046	33,060
Average lifetime cost of ULT freezers purchased between 2021 - 2024					**25,382**

Table 1: Models listed have volumes around 20 ft3, similar to standard upright ULTs. Repeat purchases are not included.

Recommended ULT Freezer Models:

Model	Acquisition Value ($)	Lifetime	Watts	Electricity cost/year ($0.16/kWh)	Lifetime cost ($)
Stirling Ultracold	15,200	10 yrs	1200	1,682	32,020
Thermo TSX70086A	13,446	10 yrs	1,219	1,709	30,536
Average lifetime cost of energy-efficient ULT freezers					**31,278**

Notes:

Freezers marketed as having “reduced toxin levels” are no different from other freezers, as they are all legally required to be manufactured using the same low-impact chemicals.

Drosophila Incubators

Selecting Energy Efficient Models

Key Questions to Consider:

Is the incubator 115v (has a regular 3-prong plug)? – Even very large, three-door incubators are now sold as 115v. This can reduce energy usage by almost half in all models.

For large, stand-up freezer size (~20 ft^3):

Does it run using thermoelectric (Peltier) cooling? – Thermoelectric cooling is used by several brands (Thermo, Darwin Chambers) and is significantly less energy-intensive than regular compressor technology for large incubators.

For small, bench-top size:

Can these samples be moved to a larger incubator instead? – Smaller incubators and freezers use more energy per volume than larger ones.

Does it use regular compressor technology? – Compressor technology is more efficient than thermoelectric at this size.

Summary of Desired Energy Efficiency Features:

- 115V
- Thermoelectric cooling (for large units)
- Compressor technology (when small unit is absolutely required)

Recommended Models:

Darwin Chambers IN034: http://www.darwinchambers.com/wp-content/uploads/IN034_SpecSheet.pdf
ne-door thermoelectric incubator with humidity, temp, lighting control. 115v, 4.5A. 4,500 kWh/year if run 24/7 for 365 days. Other larger models available.

Thermo Fisher Peltier Incubators: https://www.thermofisher.com/order/catalog/product/3915FL
Upright, freezer-size incubators. 115v, 3A. 3,000 kWh/year. Manufacturer reported data.

Bio Safety Cabinets

Selecting Energy Efficient Models

Key Questions to Consider:

Is the BSC ducted or exhaust-to-room? – Ducted models (B1/B2) typically consume twice the energy of unducted models (A2). Our campus has very few B1/B2 models, almost all A2s.[1]

Does the BSC use DC motors? – DC Motors use up to 80% less energy than AC Motors.[2] Users will also enjoy decreased vibration and noise level.

Can users easily turn off the BSC's fluorescent lights at night? – BSC lights should not be left on when the cabinet is not in use. Consider adding an occupancy sensor.

Does the BSC offer a UV light timer (or is UV left on overnight)? – General consensus according to several peer-reviewed publications is that UV is not a very valuable feature to begin with. Chemical wipe-downs provide much more reliable decontamination without the safety risk.[3][4][5]

Does the BSC offer reduced motor speed when the sash is closed? – Most users in Bio II turn off blower entirely when not in use[6], but for lunchtimes and short breaks, reduced motor speed with a closed sash will provide measurable savings. If the cabinet is going to be left on 24/7 for some requirement of the research, this becomes an even more important feature.

Summary of Desired Energy Efficiency Features:

- Unducted (A2)
- DC Motor
- Occupancy sensor
- No UV
- Reduced motor speed functionality to be used with closed sash

Additional References:

http://www.sefalabs.com/files/public/Biological-Safety-Cabinets.pdf

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[1] Ducted models are about equivalent in energy to an unducted BSC plus a ducted fumehood. A ducted fumehood can use the energy equivalent of 3 US homes. Mills and Sartor, "Energy Use and Savings Potential for Laboratory Fume Hoods." Energy 30 (2005) 1859-1864

[2] Webber, B. A. (2008 September) University of Michigan field study of Class II biological safety cabinet energy consumption costs. American Biotechnology Laboratory; 2005; 26(9):22- 24

[3] Burgener, J. (2006) Position Paper on the Use of Ultraviolet Lights in Biological Safety Cabinets. Applied Biosafety 11(4) pp. 228-230.

[4] Meechan, P.J., and Wilson, C. (2006) Use of Ultraviolet Lights in Biological Safety Cabinets: A Contrarian View. Applied Biosafety 11(4) pp. 222-227.

[5] Turnbull, P.C.B, Reeys, A.E., Chute, M.D., and Mateczun A.J. (2008) Effectiveness of UV Exposure of Items Contaminated with Anthrax Spores in a Class 2 Biosafety Cabinet and a Biosafety Level 3 Laboratory Pass-Box. Applied Biosafety 13(3) pp. 164-168.

[6] See data on following page.

BSC Real-Time Power Data

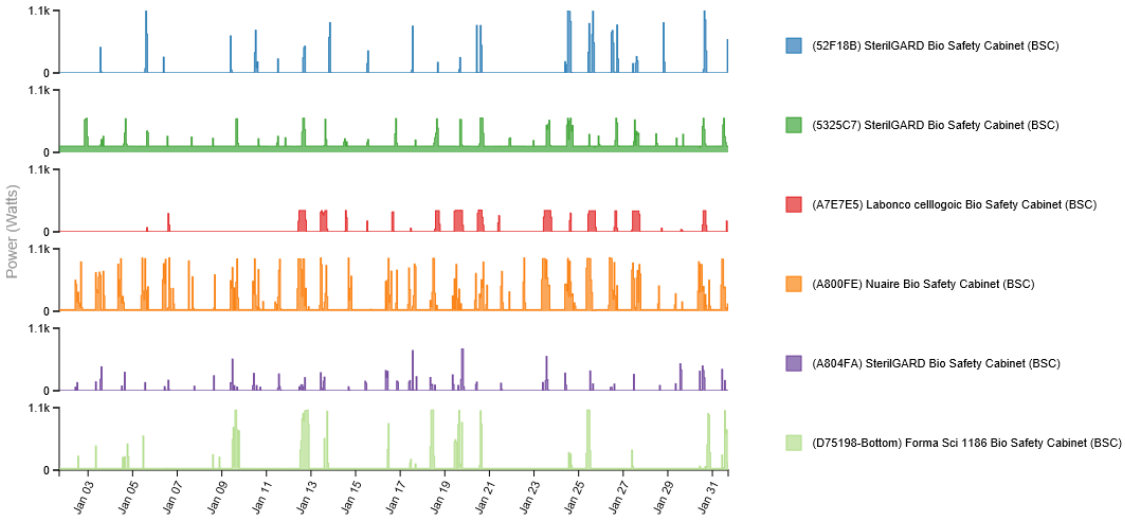

Figure 1: 30 days of use for 6 selected BSCs in Bio II building, Winter 2017.

Figure 1 shows data collected using the IBIS Networks metering system installed in UCSB's Bio II building. Four manufacturers are displayed. The two key features are the peak power when the unit is on, and any background power usage when the unit is off. This data is by no means comprehensive, but can provide some guidelines for further research.

The three SteriGARD units displayed are in the same laboratory, but there are at least two different models represented, and we see variation in consumption from all three shown units, one of which shows increased background power consumption. If purchasing SteriGARD, examine model features carefully to select for energy efficiency.

Three Labconco units were metered, all from the same laboratory. All of them showed similar power consumption trends, so only one is displayed. Typical power when on is ~370-390 W.

Two Nuaire units were metered, both in the same lab, and had comparable behavior so only one is displayed. Typical peak power is ~920-980 W.

Only 1 Forma Sci unit provided data. Peak power is 1050 W.