Green Lab Associates
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Birkbeck Research Equipment

Metering & Procurement Guide

Introduction

Laboratories are energy intensive operations which contain a variety of specialised equipment types. Many laboratories, such as those in Birkbeck, will contain common equipment types much of which is responsible for the high energy consumption of such spaces. As competition increases for funding in research, assessing common processes for efficiencies can be a method for reducing wastage and maximising output as a function of investment. Most generic research equipment will either heat or cool in some manner, and consume a combination of heat, gas, air, and water. To help users assess their laboratories, equipment types should be assessed with standardised methods to ensure comparability across institutions and even countries. This guide presents several common equipment types found in research spaces, recommends standard units for assessment of efficiency, provides tips on how to perform such assessments, and procurement considerations.

Stand-Alone Cold Storage (possesses a compressor)

Units: kWh/litre

Metering: Such equipment may be assessed via a typical plug-in or OWL power meter. As compressors will cycle, fridges and freezers should be assessed over period enduring a minimum of 12 hours, preferably 48. Ensure the unit is still running when applying and removing power meter (listen for compressors to run)! When plugging a unit back in the wall after unplugging, it is recommended to wait at least 1 minute.

Considerations: Room temperature, door openings, compromised doors seals, filter cleanliness.

Procurement Advice

- Consider long-term storage requirements. Purchasing a larger unit in advance can save further purchases. Larger units typically will utilise space and energy more efficiently.
- Spark-free is only necessary in laboratories containing combustible chemicals. Tissue-culture for e.g. may not require spark-free. Also consider internal fans, which will provide improved temperature stability.
- Manufacturer's data likely vary greatly in collection methods. Consider environmental conditions when evaluating energy performance.
- Durability > Cost. While a unit may cost more, it can save through extended lifetime and reduced energy costs.
- Ensure racking is appropriate, and items from previous units may be easily transferred.

- Ensure there is local alarming, and consider the necessity of secondary temperature probes.
- Ensure units do not automatically defrost – auto defrost cycles will vary internal temperatures and can cause sample degradation.
- Require a digital display so that temperatures may be easily viewed.
- Request ULT freezers which may perform at 13.5 watts/litre or better. Request refrigerators and freezers which perform at 2.5 watts/litre or better.

Walk-in Environmentally Controlled Rooms

Units: kWh/day to assess total cost, kWh/m^3 to assess efficiency

Methods: These rooms should **not** be assessed by anyone other than trained professionals – such rooms require power metering of what is often 3-phase power, and can be dangerous for untrained workers. Such rooms should be assessed for a minimum of 24 hours.

Considerations: Door openings, insulation and 'hot points' for cold rooms, single or 3-phase power, contained equipment which may cool or produce heat.

Procurement Advice

- Consider necessity of such rooms, and possible alternatives such as incubators or fit-for-purpose fridges, which offer improved resilience and reduced energy consumption.
- Consider emergency protocols – where do samples go during possible failures?

Incubators

Units: kWh/day to assess total cost, kWh/litre to assess efficiency

Methods: Incubators may be assessed with typical plug-in or OWL power meters. Take care not to shift or move units if samples are contained. Ensure the unit is still running when applying and removing power meter.

Considerations: Door openings, decontamination cycles (either H202 or via heat), running temperature (typically 37 °C).

Procurement Advice

- Consider long-term storage requirements. Purchasing a larger unit in advance can save further purchases. Larger units typically will utilise space and energy more efficiently.
- Consider decontamination methods. H2O2 decontamination methods exist which require less time. Heat-cycles take time and energy, though typically marginal amounts.
- Consider emergency protocols and power sources – What happens during failure?
- Ensure heat range, humidity range, and attachments (CO_2) are appropriate.
- Compare energy consumption of units.
- Compare temperature uniformity, ensure it's appropriate for your requirements.

Microbio-safety Cabinets (class II)

Units: inflow/down flow (m/s), kWh/day to assess operational cost (with lights on), kWh/m^2 to assess efficiency where m^2 indicates work surface

Methods: Inflow and down flows are measured by ventilation professionals performing regular testing. Measured inflow and down flow rates must be reported back to users either in paper form on the actual cabinet, or via a digital system. Inflow rates must be >0.4 m/s, while down flow rates must fall between 0.25 – 0.5 m/s.

To assess kWh, a typical power meter may be applied – note some cabinets will have two sets of plugs. Ensure you monitor the plug responsible for powering internal fans. Note fans and lighting will consume a steady amount of energy. This means that one can meter typical energy consumption and efficiency quickly as a live wattage reading will provide enough data to determine kWh (for e.g. if your cabinet consumes 250 watts, your cabinet will consume .25 kW/hr. Thus a cabinet in operation for 10 hours will consume 2.5kWh total. Note ducted and unducted cabinets will all consume similar energy for operating lighting and internal fans; a ducted cabinet though will also have associated costs with expulsion of conditioned air. Unducted cabinets will have lower ventilation costs, but fumigation methods must be altered.

Considerations: Operational hours, lighting source (LED or not), multiple plugs, ducting!

Procurement Advice

- Request internal LED lighting.
- Compare operational energy consumption.
- Ensure cabinet may be closed easily after use. Automated covers may initially improve ease of access, but are more likely to become faulty.
- Conduct H&S assessment of requirements – is a recirculating unit sufficient instead of requiring ducting? If the cabinet may be recirculatory, are 2 or likely only 1 Hepa filters required? Who will maintain the filters?
- Engage with local staff who have recently purchased such units. How has the servicing and customer support been? Are there engineers available during failures?
- Ensure the size of the unit is appropriate for the works to be conducted.

Ovens + Drying Cabinets

Units: kWh/day to assess total cost, kWh/litre to assess efficiency

Methods: Such equipment requires simply typical plug-in or OWL power meters. As such equipment will heat in variable cycles to assess temperature, two types of measurements should be considered. Energy required to achieve or maintain temperature can vary greatly. When metering, it should be noted what the set vs current temperature is. A cabinet with an internal temperature of 15 °C but set to 85 °C will likely consume more energy than a comparable unit with an internal and set temperature of 100 °C. Desired outcomes of metering should drive metering methods.

Considerations: Operational temperatures, level of insulation, door openings, hours of operation, supplementary sources of heat (autoclaves, wall-mounted heaters etc.)

Procurement Advice

- Ensure you differentiate Ovens from Drying cabinets. An oven typically will have notable insulation, and can operate at temperatures far higher than drying cabinets. Ovens will have better temperature uniformity, and are designed to contain samples. Drying cabinets historically have been poorly insulated, although new efficient models are available. They have reduced temperature uniformity, and are typically designed to dry glassware or consumables. Drying cabinets will consume far greater amounts of energy due to greater internal volumes and poor insulation.
- Consider having an internal fan – this will increase temperature uniformity and reduce dry times, though will increase purchase costs. Internal fans can be repaid if units are turned off after drying is complete.
- Require insulation.
- Require digital displays.
- Request fixed timers on units, particularly drying cabinets.
- Consider your requirements – can items be air dried? Could a smaller more efficient unit be utilised instead?

Water Baths + Heating Blocks

Units: kWh/day to assess total cost, kWh/litre to assess efficiency

Methods: Such units may be assessed for kWh with a typical plug-in or OWL power meter. Like with ovens and drying cabinets, set vs current temperature should be considered. Such units should be assessed in operation for several hours, though not longer than 5 hours is necessary.

Considerations: Unit size, set temperatures, operational times, whether they're operating independently or are heating materials.

Procurement Advice

- Ensure water baths have a cover.
- Consider beads instead of water. They may cost slightly more on upfront costs, but save energy as well as decontamination reagents required to keep water sterile.
- Ensure power cables are of sufficient length for your space.
- Check the size – larger units may slow warm-up times and waste energy.
- Typical water-baths are designed to heat between 5°C - 70°C. Consider your requirements.