Cupboard love gets green overtones

Fume cupboards are an essential fitting for safe research in most labs, but their use often involves high energy costs and large carbon footprints. **Susan Birks** looks at how research labs are greening their operations

Energy efficiency is a key concern of laboratories around the world, and is being driven by rising energy costs and the requirements of the latest international building standards. The EU's Directive on energy performance of buildings (2002/91/EC), rewritten and republished in 2010, has strengthened the energy performance requirements, based on the EU's aim to achieve a reduction of 20% in greenhouse gas emissions and 20% in energy savings by 2020.

In many laboratories, fume cupboards provide the infrastructure for carrying out modern scientific research in instances where sterility and safety are paramount. Regular use of fume cupboards, however, consumes considerable amounts of energy.

Some of the biggest users of fume cupboards are academic institutions. Professor Peter James of the University of Bradford and director of the S-Lab (Safe, Successful and Sustainable Laboratories) programme says that "universities and colleges spend around £150m a year on laboratory energy, of which 25-30% is associated with fume cupboards. Our audits have identified considerable opportunities to save money through more efficient use and refurbishment.

S-Lab is part of the Higher Education Environmental Performance Improvement (HEEPI) initiative and aims to create more sustainable laboratories, and to raise sustainability awareness amongst lab-using staff and students. It emphasises the synergies between safety, business success and sustainability and, although universities are its central focus, it also supports action in private and public sector labs. Regular reports and case studies on best practice in university lab design and management have been produced, and some achievements are shared here

Nottingham numerics

The University of Nottingham estimates that, if run on a 24/7 basis, each of its 642 fume cupboards would use approximately £1,650 of electricity and gas a year. This cost is mainly from the heating and cooling the large amounts of air that are pushed into the lab space to "feed" the cupboards.

Labs are typically conditioned between 18–21°C either from 8am to 6pm, or 24/7, depending on their operation. These costs can be reduced for all types of cupboard by switching them off (after safety checks) when not in use for prolonged periods (e.g. holiday periods, weekends) and, for variable air volume (VAV) models, by ensuring that sashes are closed as much as possible.

To motivate these actions, the University's Estates Department has monitored cupboard usage, by connecting the fan controls into the Building Management System (BMS). A monthly report is then produced and sent to a lab contact, such as a head of department or head technician. This details the lab's fume cupboard-related energy usage in the previous month, and the cost difference between this and running 24/7 at full power.

The reports also include a cumulative running total of savings (compared with the 24/7 situation) for the academic year. In early 2010 the scheme monitored 380 cupboards through the BMS, including 200 (out of 248) in the Chemistry department, 58 (out of 63) in the Centre for Biomolecular Sciences (CBS), and 25 (out of 39) in Pharmacy.

To raise awareness, stickers have been placed on many cupboards, showing how much money would be wasted if they were left on 24/7 throughout the year. Research students in the CBS also receive training in proper fume cupboard use at the start of their year, and this is likely to be extended to other departments.

The best results have been in Pharmacy, which has achieved energy savings of around 40% (compared with maximum use) in teaching areas, primarily because technicians have been more vigilant about shutting cupboards off at night and weekends. The university is now building on this early success through greater ▶

Esco GB kits out Edinburgh's SCRM labs with safety cabinets

Esco GB, in co-operation with one of its major distributors, has delivered and installed a range of microbiological safety cabinets and fume cupboards at The University of Edinburgh, Scottish Centre for Regenerative Medicine (SCRM).

The centre brings together world-leading stem cell research with established clinical excellence to deliver a 'bench-to-bedside' approach aimed at developing new treatments for major diseases.

Its mission is to gain fundamental understanding of stem cells, to use this knowledge to improve human health and to provide leadership in training the next generation of basic and clinical scientists in stem cell biology and regenerative medicine. It will also act as a centre for public engagement, information and as a source of advice for policy makers. These are all factors that make SCRM a high profile client for Esco GB.

The Esco scope of supply comprises 41 Labculture Plus Class II safety cabinets, four Labculture Hi-flow Class II safety cabinets fitted with Leica microscopes, six Frontier Acela 6ft ducted fume cupboards and one Frontier Radioisotope 6ft ducted fume cupboard.

Esco says the tender was won through its unbiased and fast technical guidance as well as the compatibility of the products, cost effectiveness, and an all-round willingness to understand and adapt to the customer's requirements.

● www.escogb.co.uk

◀ engagement with head technicians, school managers and safety officers. Posters are being developed to remind staff and students of fume cupboard best practice.

The exercise has also created a better understanding of fume cupboard operation, particularly the importance variable air volume (VAV) units and lowering sashes. For instance, fume cupboard sashes are designed to contain hazardous substances or events, such as explosion or fire; the lower they are, the safer the working conditions are. As VAV fume cupboards vary the amount of ventilation in accordance with sash height, the lower the sash, the lower the air movement and associated energy consumption and cost.

Shutting sashes in constant air volume (CAV) cupboards, however, makes no difference to air flow as more 'make up air' is drawn in through side or overhead vents to compensate.

At Nottingham, reducing air flow rates to fume cupboards from 0.5 to 0.4 ms^{-1}, setback laboratory night temperatures and installing separate extract systems for chemical storage ventilation have been approved by the University's Environment Committee, with the work to be completed by autumn this year. This is in conjunction with carbon saving publicity, awareness and training of staff & students. Potential savings are estimated to be £250k, 5.3mkWh energy and 1500t of CO_2 p.a.

Table 1: Example of performance data

Growth cabinet	kWh	Running cost p.a.
Cabinet 1	20.6	£549
Cabinet 2	36.4	£968
Cabinet 3	62.0	£1,814
Cabinet 4	92.9	£2,711

Energy post created at York

At the University of York, the Department of Biology is one of the UK's leading centres for life science research and teaching. It decided energy reduction would be best achieved via a dedicated Energy Manager.

Biology research and teaching at the University of York used £600,000 of electricity and £173,000 of gas in 2008/09, and accounts for approximately one third of the institution's electricity use. The Department has 600 staff and postgraduates who work in a dedicated complex of 19,360m^2 (nearly half of which is laboratories).

Dawn Cartwright, the Department of Biology's head of Infrastructure and Facilities in 2008, established a part-time Departmental Energy Manager, a unique position for a UK university laboratory. The appointee (Jo Hossell) developed the role to include benchmarking and tracking energy use; monitoring equipment; raising awareness of energy among lab users; and providing energy efficiency guidance for new purchases. Liaising closely with the University's Estates Department, the Departmental Energy Manager helped to implement large capital projects and a building metering strategy.

Practical actions taken in the Department since 2008 include:

- Voltage reduction equipment
- Inverters to enable variable control of air handling fans
- Wall insulation panels in cold spots
- 22 permanent sub-meters and additional spot metering
- Time clocks on equipment e.g. drying cabinets, screens
- Reduction of excess lighting
- More use of cheap night tariffs e.g. growth cabinets
- Development of energy efficient procurement guidance (accompanied by performance data – see Table 1).

By having a dedicated energy manager within a science department, the university estimates that there has been an 8% reduction since the post was created. In addition the department now has a better understanding of lab operation. The ability to bridge between scientists and the Estates managers enables energy improvements that would be hard to achieve by Estates-based staff alone. Jo Hossell still works for the University of York but has now moved from Biology to be a lab specialist in Estates.

As a result, annual energy usage was 3% less in the first year (2008/9) compared with the previous year, despite increased activity. An even greater reduction was expected in 2009/10. The voltage reduction equipment alone was expected to save £45,000 annually, and the fan inverters £13,700. Smaller measures also add up, such as £605 a year from two groups sharing an oven rather than having one each, or £200 plus annually from installing time clocks on equipment.

A dedicated website is updated weekly and provides feedback to researchers, technical staff and postgrads on overall lab performance, and individual corridors or blocks.

It is estimated that the cumulative savings by 2011 will cover most or all of the Departmental Energy Manager's salary, with an expectation of continuing dividends as increased awareness and information enables further efficiency improvements. This will be supported by data from a very detailed footprinting of laboratory energy consumption being conducted in collaboration with the S-Lab project.

The Department produces in excess of 5,000t of CO_2 per year, which translates into an estimated departmental carbon footprint (per staff/postgrad) of around 9t p.a. It is

estimated that more than 250t of CO_2 have been saved in the two years since the Departmental Energy Manager started.

Other benefits have included identifying under-utilised equipment and opportunities to save money through consolidation; a better working environment through improvements in room temperature control and increased job satisfaction for technicians through opportunities to 'make a difference'.

Benchmarking at Oxford

Oxford's Chemistry Research Laboratory (CRL) has a striking design, with a central atrium space encouraging interaction between its researchers. In 2009/10 it used 6,398MWh of electricity, 6,133MWh of gas, and 59,596m^3 of water, and spent £605,440 on energy. Around 25% of this is related to ventilation, especially of 332 VAV fume cupboards.

Consumption since the first year's operation in 2004/5 has changed by only +9.6% for electricity, -6.6% for gas, and +5% for water, despite a 30% increase in the number of bench scientists. The actions that have minimised usage in this period include:

- Energy efficiency induction for new lab users, focusing on the financial and safety benefits of sash closure.
- Sash closure reminders, through labelling, publicity and inspections by the Chair of the Department of Chemistry.
- Pro-active maintenance, including cleaning fume cupboard baffles and strainers in the air handling units.
- Using annual servicing (especially of air balance controls) and validation (of fume cupboard face velocity) as an opportunity for engineers to advise users on efficient fume cupboard operation (e.g. not impeding air flow through rear baffles by storing items against them).
- Daily tuning the Building Management System in response to changes in occupancy, weather and load.

Further action is planned to lower face velocities from 0.5 to 0.45m/s or lower – provided that independent testing shows this to be safe – and to establish an internal incentive scheme. This will involve a fine of £1 for open sashes when cupboards are not in use, with the annual proceeds going to the research group with the best record.

These actions have been enabled by the University's Estates function, through its devolved energy budgeting scheme; practical assistance, especially from Energy Manager Philip Pike; and delegation of daily building control to the Chemistry Department, in the form of its Buildings and Facilities manager.

If these saving strategies fail to incentivise students and staff, it may be worth considering the approach of LabRATS – a programme founded to improve lab sustainability at the University of California, in the US. Here lab users were encouraged to switch off fume cupboards with dedicated fans and close sashes of VAV cupboards when not in use with incentives such as free pizza, saving up to US$2,000 of costs p.a. **CT**

The information in this article is based on case studies from the S-Lab website (see below).

CONTACT

S-Lab
- www.goodcampus.org/s-lab

HEEPI
- www.heepi.org.uk

University of Oxford
- www.ox.ac.uk

University of York
- www.york.ac.uk/biology/energy/

University of Nottingham
- www.nottingham.ac.uk

Smithsonian builds greenest lab yet

In the US, a US$45m federal grant to the Smithsonian Institution will enable the Smithsonian Environmental Research Center (SERC) in Edgewater, MD, on the Chesapeake Bay, to build what is expected to be one of the most energy efficient labs in the US.

Creating a more sustainable laboratory, especially one with chemistry research, where fume hoods can consume up to three times as much energy as an average home, presents a challenge. The expanded and remodelled Mathias Laboratory will reduce its environmental impact on all fronts, from where it gets its power to where it gets its materials. Analysts estimate it will consume at least 37% less energy, and emit 37% less CO_2 than a similar building that meets baseline LEED certification standards.

Besides leaving a less intense carbon footprint, the new building will enhance SERC's capacity for cutting-edge environmental research. SERC scientists specialise in a multitude of disciplines, including global change, terrestrial and marine ecology, invasive species and nutrient pollution.

The groundbreaking ceremony on 6 May 2011 marked the beginning of the two-year project. Totalling 90,000ft^2, the new building will add 69,000ft^2 of labs, office and support space to 21,000ft^2 of remodelled existing space. A two-storey atrium will connect the old and new sections and create an area where researchers from the various departments can share ideas.

The project will seek gold-level LEED certification by the US Green Building Council, targeting the maximum gold score of 51 credits. In addition to its low-flow fume hoods for chemistry experiments, the new laboratory will include:

- An HVAC system supplied by a large geothermal well field (300 wells, 350ft deep) and high-efficiency enthalpy wheels that recover energy from exchanged air

Picture courtesy of EwingCole

- Roof-mounted solar panels to provide hot water
- Space for nearly 650 solar panels that will provide almost 10% of the building's electricity
- A system and plant to reclaim, treat and reuse wastewater in toilets, gardens, fire suppression and constructed wetlands
- Storm-water management with cisterns and wetlands made up of a series of pools lined with native plants to receive runoff
- Bicycle racks and priority parking for car pools and high-efficiency vehicles, along with solar panel recharging stations for electric vehicles
- Redistributed parking across the site to decrease construction of new parking areas.

The lab will also use regional materials to prevent long-distance transportation and use only certified sustainable wood.

EwingCole of Philadelphia provided the architects and engineers for the project, with Howard Skoke as principal. The general contractor is Hensel Phelps. ● www.si.edu