S-Lab Laboratory Assessment Framework

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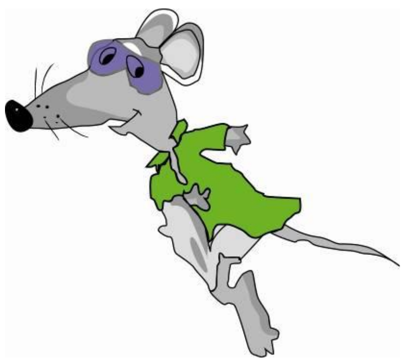
Developed by the
S-Lab (Safe, Successful and Sustainable Laboratories) initiative of
HEEPI (Higher Education for Environmental Performance Improvement)
See www.goodcampus.org

Inspired by the pioneering work of
the LabRATS (Laboratory Research and Technical Staff) programme
at the University of California, Santa Barbara
See http://sustainability.ucsb.edu/LARS

Lab-CURE:
Chemicals, Utilities, Resources and Environment in Laboratories



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Condition of Use

Organisations can freely use this document and its contents without charge, but results of the assessments must be reported back to S-Lab via Green Impact (see below) or info@heepi.org.uk so that the frameworks can be improved, and the knowledge base is developed. All information will be treated as confidential, and no individual laboratory scores will be made public.

Disclaimer

The information and guidance in this document is based on actual experience in UK and North American universities. Every effort has been made to ensure accuracy, but readers should verify all information as we cannot provide professional advice. Every laboratory is different and so it is unlikely that every sign of compliance will be applicable in all cases.

Acknowledgements

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Introduction

Laboratory operation has many significant environmental impacts ranging from energy and resource consumption to chemical and equipment use and disposal. Experience shows that many of these impacts could be reduced or avoided in cost-effective ways without compromising research, safety or teaching - indeed, they can often be enhanced. See the S-Lab section of www.goodcampus.org for many examples of this.

S-Lab has produced three related documents to support analysis of environmental impacts in laboratories, and to identify and implement improvement opportunities:

- Individual laboratory assessment framework - for individual laboratories/areas within a broader building or organisational unit (i.e. this document).
- Organisation and building assessment framework – addressing issues which are common to many individual laboratories/rooms within a building, school or department and which therefore needs to be done only once; and
- A best practice guide (in preparation) which provides a summary of resources and examples of best practice relating to each criteria.

There are many S-Lab resources (summarised in Figure 1) which can help with assessment, by:

- Providing Background – there is a wealth of resources on key lab sustainability issues such as publications, presentations from past events, and briefing papers on the S-Lab website.
- Benchmarking – S-Lab have conducted several rounds of energy benchmarking of laboratory buildings[1], and a report also provides information on typical energy consumption of lab equipment.[2]
- Highlighting Best Practice – through a growing number of S-Lab case studies, briefing papers and technical reports which will be summarised in the accompanying Best Practice Guide.
- Understanding Regulations – through the S-Lab guide to key energy and carbon regulations affecting laboratories.[3]

[1] Hopkinson L., James P., Lenegan N., McGrath T. and Tait M., 2011. Energy Consumption of University Laboratories: Detailed Results from S-Lab Audits. July 2011. Available at www.goodcampus.org

[2] Hopkinson L., and James P., 2011. Saving Money Through Sustainable Procurement of Laboratory Equipment. March 2011. Available at: www.goodcampus.org

[3] James P. and Hopkinson L., 2011. Carbon, Energy and Environmental Issues Affecting Laboratories in Higher Education - A Supplement to the HEEPI Report on General Regulations and Schemes on the Topic. July 2011. Available at www.goodcampus.org

How to Conduct a Laboratory Assessment

The assessment frameworks can be used by anyone – subject to the conditions of use that results are returned to S-Lab – but in the UK there is the option of undertaking this as part of the NUS Green Impact Scheme. This is an environmental accreditation scheme with an awards element originally designed for university departments but now being applied more broadly.[4] S-Lab recommends use of this scheme for eligible organisations if they wish to have more proactive support for the implementation of the S-Lab assessment criteria and to gain independent accreditation and recognition of their assessments.

Whether assessments are done independently, or through the Green Impact programme, they will be most effective if they involve several people to provide different perspectives. For the Organisation and Building framework, this requires a multi-functional team, ideally involving laboratory managers and technicians, academics and Estates and Procurement staff (especially when they have specialist roles related to labs), reporting into a head of department/school or other senior manager. The single laboratory/area assessment can be done exclusively by an individual such a as a technician or a graduate student (as an intern, as is the case with LabRATS, or as a course-related project) but it provides an opportunity to develop awareness and networks to support improvement, for example, by involving another technician.

The actual single laboratory/area assessment involves completing 12 tables addressing:

- Background information
- Ten key laboratory environmental issues which – when relevant to the laboratory or area being addressed - need to be addressed for effective environmental management. There are key principles associated with each issue (also summarised in Table 1). These tables contain the following information
    - 'Why are we asking? – which explains the rationale behind each individual criteria and provides further information on the issue;
    - 'Criteria' – the individual criteria themselves; and
    - Evaluation – the actions or evidence that indicates whether the lab meets a particular criteria.

If someone external to the laboratory, or parts of the area, being addressed is doing the assessment the recommended approach is to go through the criteria/evaluation on a laboratory walk around, accompanied by the lab 'owner', at a time of 'normal' conditions, and when some users will be available to answer the questions that are being asked.

[4] For more information see www.nus.org.uk/greenimpact.

Table 1: Key Laboratory Issues and Principles for Environmental Improvement

Key Laboratory Issues	Key principles	No. of criteria
1. Chemicals and Materials	1: Chemicals and materials are stored safely and used efficiently. 2: Chemicals and materials that are hazardous to humans or the environment are substituted wherever possible.	6
2. Cold Storage	1: Cold storage requirements are minimised through effective sample management and other means. 2: Cold storage devices are energy efficient and used appropriately.	6
3. Fume Cupboards and Containment	1: Fume cupboards and other containment devices are working safely and efficiently when in use. 2: Fume cupboards and other containment devices are in low or zero energy states when not in use.	6
4. Heating, Ventilation and Air Conditioning	1: Laboratory conditions are comfortable for users. 2: Air flows are minimised and appropriate to needs (where compatible with risk assessment based safety requirements).	3
5. Lighting	1: There is maximum use of natural lighting 2: Lighting is appropriate to user requirements and is always turned off or down when not required. 3: High efficiency light fixtures are used.	5
6. Management and Training	1: There is senior management support and clear responsibilities for lab environmental improvement. 2: There are cross-laboratory support activities for environmental improvement. 3. The importance of energy and environmental issues is conveyed to laboratory users	5
7. Scientific Equipment (including computing and printing)	1: Equipment is used efficiently, with high loadings and utilisation levels and turning off or powering down when not in use. 2: Energy, water and waste costs are calculated for, and a significant factor in making, equipment procurement decisions.	5
8. Waste and Recycling	1: There are effective mechanisms to achieve reuse & recycling of materials and equipment wherever possible and safe. 2: Hazardous and special waste is minimised	4
9. Water	1: Water is used efficiently and recirculated wherever possible. 2: Purified water is used appropriately and sparingly.	4
10. Innovation and Dissemination	1. Innovative actions for environmental improvement are considered and implemented. 2. Information about successful actions is disseminated to the broader laboratory community.	4

The exercise can be done at two levels. A 'broad brush' version would involve only modest follow up to deal with any remaining queries and to review and finalise a simple summary of answers and recommendations. The existence of supporting information for the evaluation criteria would be assumed on the basis of verbal assurances rather than physically checked. A more thorough version would involve checking of evidence, more probing of some key issues and more systematic consideration of improvement actions. It is the latter that would be required if taking part in the Green Impact programme. In some cases, measurement, e.g. of lighting, power consumption and/or temperature, may also be appropriate, either during the initial assessment or, more likely, as a follow up activity.

It is very important to address health and safety issues – and to do a risk assessment if necessary – before the exercise begins. As part of this, the assessor(s) should check what experiments are running, which equipment should not be touched, and whether there are any particular hazards.

Once the exercise is complete, implementation of the recommended improvement actions is obviously required. A prerequisite is the assignment of responsibility, either to individuals or project teams.

Scoring

The scoring is currently being developed, and will be guided by user feedback. If the objective is simple comparison between laboratories then a simple percentage of points obtained compared to the total available could be adequate.

Three options are available for this:

- A. Unweighted points – pass/fail (i.e. 1 point per each criteria)
- B. Unweighted points – pass/fail/working towards (i.e. 1 point for fully meeting each criteria, 0.5 points for partially meeting).
- C. Weighted points (i.e. more than 1 point for fully meeting some key criteria).

If there is a further objective of providing recognition then a Gold, Silver and Bronze classification is recommended. Again, there are three options for this:

- 1. Percentages - basing the ranking on the percentage point score (with the Gold level either being set as an absolute number, or at the level reached by the best performing laboratory).
- 2. Classifying criteria - as Bronze, Silver, and Gold ones, based primarily on their ease of achievement. This is the case with the current Green Impact model (which also has a fourth category of Working Towards to give some recognition to teams that don't complete enough criteria to gain a Bronze). However, it is possible that the lab component of Green Impact 2011-12 will adopt option 1 or 3.

- 3. Hybrid – classifying some easily achieved criteria as Bronze to give a clear target, but assigning Silver and Gold on a percentage basis. This is likely to be the approach at the University of Bristol.

The Green Impact approach for laboratories will be finalised by Autumn 2011. However it has been decided that the Bronze criteria will be:

CM5: All chemicals are stored in approved and secure locations.

CS2: All stored materials are associated with active uses, or are being kept because of specific archiving requirements.

FC3: There are effective mechanisms to encourage energy efficient use of fume cupboards.

FC5: The lab complies with COSSH regulation 9 which requires 14 monthly examinations to ensure fume cupboards are "maintained in an efficient state, in efficient working order, in good repair and in a clean condition".

HVAC1: The HVAC system is working to specification. If there is evidence that it is not, then laboratory users have made Estates aware of it. (Possible signs of not working to specification are frequent alarms on fume cupboard use; known problems with ventilation equipment; unpleasant working conditions for many users because of draughts and excessive cold or heat; fume cupboards not functioning properly and difficulty opening/closing doors because of pressure differentials).

L4: Room/corridor lighting is always turned off or down when not required, and when compatible with safety. If this is not the case, and requires Estates action, lab users have them aware of the opportunities.

MT4: All laboratory users are made aware of the energy and environmental impacts of their activities and the actions they can take to mitigate them.

SE1: Equipment that can be is generally turned off or powered down when not in use, together with related devices (e.g. AC/DC converters).

WR1: There are convenient recycling facilities for materials, packaging, and equipment within or nearby the lab and these are used in practice.

W1: In laboratories with considerable water use, there is awareness of related cost and environmental issues amongst laboratory users and policies on appropriate practices.

Please note the complexity and wide variety of laboratories means that it is difficult to have completely prescriptive criteria. S-Lab has tried to keep the individual criteria as simple and outcome-focussed as possible, however in some cases a certain amount of judgement will be required as to whether individual criteria have been met. There will need to be a point of contact within the organisation (the Green Impact lead for those involved in that scheme) to help with any difficulties.

Recommendations and Subsequent Actions

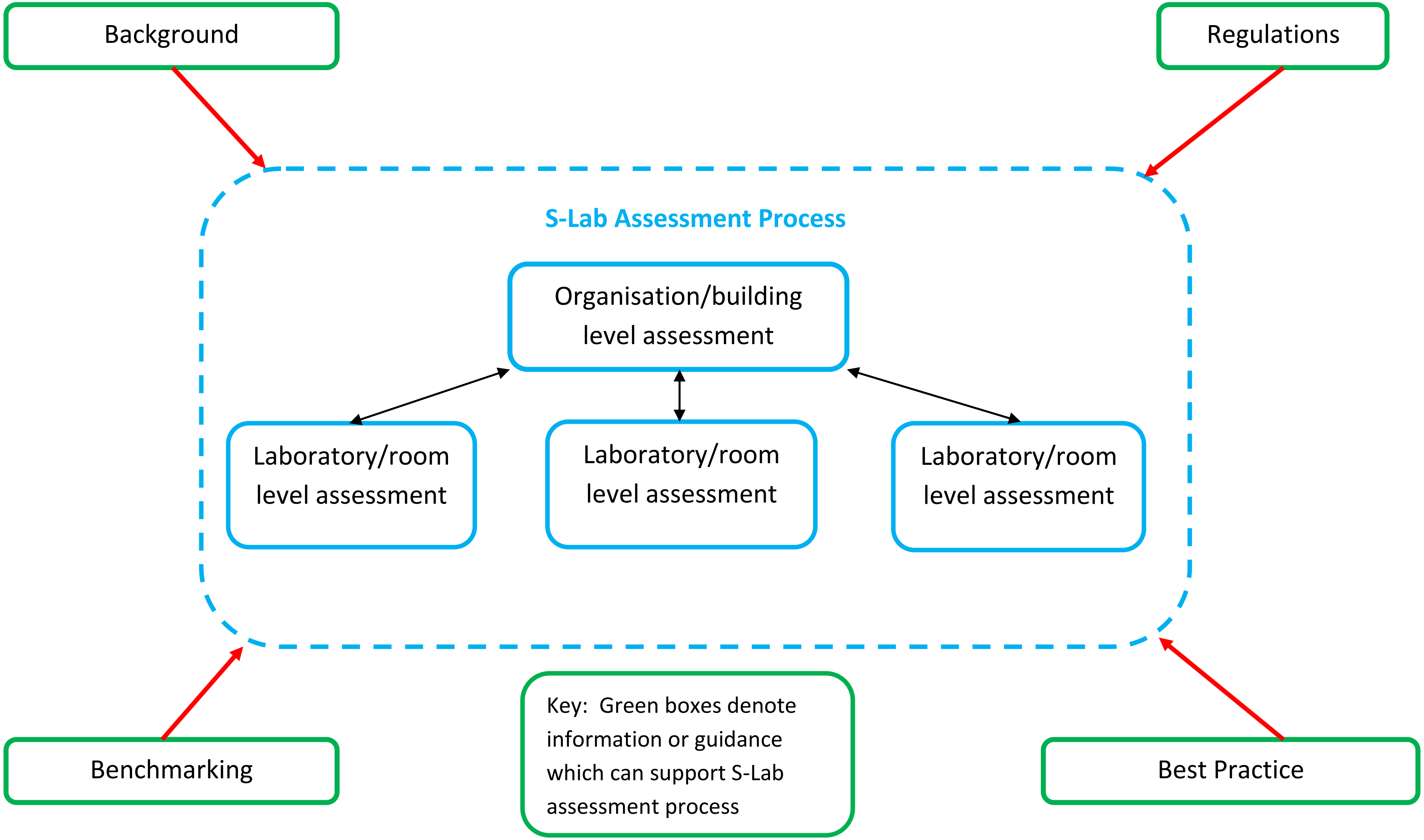
The key aim of assessment is to drive improvement in environmental performance, so it is important that opportunities for this are identified and recorded as part of the exercise. The implementation of any recommendations will generally require a risk assessment, which may need to include application of British Standard BS EN14175 for any fume cupboard actions.

Updating and Version Control

Laboratory environmental assessment and improvement is in its early stages, and lots of new experience and information is being developed. Hence, this document and its companion ones will be revised periodically. Always check www.goodcampus.org for the latest version before starting an assessment exercise. Any suggestions for improvement e.g. more clarity, further evaluation criteria, should be sent to info@heepi.org.uk

Please note these tables will also be provided in Excel format for ease of completion. Within Green Impact the tables will form part of each participant organisation's online workbook.

Figure 1: S-Lab Resources and the S-Lab Assessment Process



Lab Assessment Tables to Complete

Required Information

	Notes
Laboratory Name	
Organisational 'Home' (e.g. Department, Faculty)	
Generic Laboratory Type (e.g. Chemistry, Engineering, Life Science; Research or Teaching)	
Date of Assessment	
Name(s) of Assessors	

Optional Information (Helpful in Briefing Assessors and Assisting S-Lab Analysis of Results)

	Notes
Laboratory Size	
Laboratory Use (e.g. numbers; occupancy hours)	
Special Features (e.g. temperature, humidity, vibration requirements; especially hazardous chemicals; need to comply with DEFRA, Home Office or other guidelines))	

Issue 1: Chemicals and Materials (CM)

Principle 1: Chemicals and materials are stored safely and used efficiently.

Principle 2: Chemicals and materials that are hazardous to humans or the environment are substituted wherever possible.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	Criteria	Evaluation
Chemicals and materials usage can often be significantly reduced, with financial and health and safety as well as environmental benefits. The latter include avoided impacts from chemicals and materials production, and reduced volumes of waste. The starting point for almost all measures to achieve these is knowing exactly what is in the laboratory. Labelling is a prerequisite for this, and of course is also important for health and safety reasons	CM1. All chemical containers are labelled with details of contents, approximate quantity, ownership, and (where relevant) hazard and emergency details, in a manner which can be understood by others if the 'owners' are not available.	Personal observation – no unlabeled containers, no labels that are impossible to decipher etc. NB Chemicals may be contained in a central Chemical Store, in which case the assessment can be done once for all labs.
This is another important prerequisite for improvement actions, as well as being important for health and safety reasons.	CM2. The contents, approximate quantity held and location of all chemical containers are tracked.	Evidence of concrete measures to achieve this, e.g. database.
Many laboratories have large quantities of surplus chemicals, which often end up being disposed of as waste, at considerable cost. Often too one lab wil be ordering chemicals which are actually surplus to requirements in another. Internal exchanges can not only minimise this, but also save money on procurement and improve performance because researchers don't have to wait for chemicals to be delivered. Ordering in smaller sizes can also be beneficial by reducing health and safety risks and tying up less money in stocks.	CM3. The laboratory avoids accumulation of unwanted chemical stocks, e.g. by making surplus chemicals available to other laboratories, by ordering in appropriate sizes, by clearing out when researchers leave.	Evidence of concrete measures to achieve this, e.g. regular email requests/offers, participation in department-wide chemical management system, ordering in small sizes . Interview with lab user(s). NB Criteria not met if any chemicals or materials were sent to waste for reasons that were avoidable (e.g. not using before end of useful life) in the previous 12 months. NB Chemicals may be contained in a central Chemical Store, in which case the assessment can be done once for all labs.
Efficient use is not only important for the	CM4. Chemicals and materials are used	Interview with lab user(s).

environmental and financial performance of the laboratory, measures to achieve it can also send important messages to students and new researchers.	efficiently within laboratory demonstrations, experiments and other activities so that waste is minimised.	Evidence of action, e.g. laboratory handbook or awareness materials promoting efficient procedures, making up stock solutions for use by multiple users.
It's obviously important to avoid the potential risk of spillage or emissions of chemicals to the atmosphere.	CM5. All chemicals are stored in approved and secure locations.	Evidence of a storage policy based on health and safety assessment(s). No problems with solvent evaporation in summer. Interview with lab user(s). NB This point can't be awarded if chemicals are stored in fume cupboards or containment devices for prolonged periods (see criteria FC6)
Substitution of chemicals by less hazardous alternatives can reduce health and safety risks, environmental impacts and costs (e.g. through avoided special waste costs). Some environmentally damaging or hazardous chemicals in common use are also capable of misuse by terrorists.	CM6. There has been a systematic attempt to find alternatives to especially environmentally damaging or hazardous chemicals.	Knowledge of which chemicals are especially environmentally damaging or hazardous. Evidence of activity, e.g. changes in chemicals or procedures used. Evidence of systematic review of experiments for undergraduates and substitution of hazardous chemicals where appropriate

Issue 2: Cold Storage, i.e. fridges, freezers, nitrogen devices (CS)

Principle 1: Cold storage requirements are minimised through effective sample management and other means.

Principle 2: Cold storage devices are energy efficient and used appropriately.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	Criteria	Evaluation
Cold storage devices are highly energy intensive – they can account for up to 5% of total laboratory energy consumption, and also create indirect	CS1. All stored materials are permanently labelled with details of contents, expiry and	Personal observation.

consumption because their heat generation often requires additional cooling from ventilation air. They also take up floor space that could be used for other purposes. S-Lab research suggests that some of these impacts are unnecessary because unwanted or obsolete samples are being stored. Labelling is a prerequisite for avoiding this, and of course is also important for health and safety and regulatory compliance reasons	ownership, in a manner which can be understood by others if the 'owners' are not available.	
Ditto.	CS2. All stored materials are associated with active uses, or are being kept because of specific archiving requirements.	Evidence of a system (hand-written or digital) which tracks the location of stored materials. Evidence of a regular 'clear outs' of samples/materials which have no clear ownership or value.
Many biological samples are being stored at higher temperatures than necessary (e.g. ultracold freezers are often set to maximum settings such as -80C when -70 would be sufficient). Ambient temperature DNA storage technologies are also available.	CS3. Stored samples and materials are stored at the highest feasible temperature for effective preservation.	Evidence of written policies/guidance on storage temperatures. Interview with lab user(s). NB Check if ultracold devices are set to lowest possible temperature and, if so, whether there is a clear rationale for this.
Many cold storage devices store fewer samples than they are capable of because of awkwardly shaped containers, poor racking etc. This is not only inefficient but also threatens sample longevity because there is more ingress of warm air when doors or lids are opened.	CS4. All available space is utilised through use of appropriate racking, storage containers etc.	Evidence of use of modular or other devices to maximise space utilisation. Personal observation.
The energy consumption of cold storage devices rises if circuits or interiors are frosted, or if they are not working effectively.	CS5. There is regular (at least annual) cleaning, defrosting and (for ultracold freezers) maintenance of devices. This	Interview with lab user(s). Evidence of maintenance contracts for ultracold devices.

	includes cleaning heat exchange coils on fridges and freezers, and defrosting of any devices without auto-defrost.	
When the lifetime energy costs are taken into account, it can be very cost effective to purchase more expensive energy efficient cold storage devices. Vendors should be able to provide consumption information although it is important to check that the operating conditions this is gathered under are the same as your laboratory. Estates staff may be able to provide support for the incremental cost differences between ordinary and efficient devices.	CS6. Energy costs of new cold storage devices are quantified and incorporated into a whole life costing approach to new purchases.	Interview with lab user(s) and, possibly, procurement staff. Evidence that energy costs were considered in any purchases over the last 12 months, either directly or indirectly by purchasing from a scheme which has done this. NB If no recent purchases, treat as non applicable.

Issue 3: Fume Cupboards and Containment (FC)

Principle 1: Fume cupboards and other containment devices are working safely and efficiently when in use.

Principle 2: Fume cupboards and other containment devices are in low or zero energy states when not in use.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	**Criteria**	**Evaluation**
A fume cupboard running continuously with its sash fully open can use up to £2000 of electricity and gas a year. In the case of variable air volume (VAV) fume cupboards sash closure can reduce energy consumption by 50% or more. This can be done through automatic sash closure but the cheapest option will be through behaviour change amongst users. Sash closure in constant air volume (CAV) fume cupboards will not impact on energy use. However, it is important because a) it increases safety by protecting against explosion or outbreaks of fumes as a result of sudden air disturbance, and b) current users may use VAV fume cupboards at some point in the future so that establishing good habits is worthwhile.	FC1. Fume cupboard sashes are generally down when no one is working in them, especially at night or over weekends.	Visual inspection: are all sashes down in cupboards not being used? Evidence of automatic sash closure. Interview with lab user(s).
In many labs fume cupboards are operated 24/7 even when there are no experiments running. S-Lab materials demonstrate that actions can be taken to achieve this, such as switching all or many cupboards off overnight, weekends or during vacations (with a small number of cupboards being designated for 24/7 operation if necessary).	FC2. Fume cupboards are switched off when not in use for extended periods, where it is possible and when safe to do so (e.g. no effect on pressure requirements).	Interview with lab user(s). Evidence of capability, e.g. switches. Check with Estates.

General awareness campaigns can achieve a considerable amount with regard to sash closure and other fume cupboard efficiency measures but experience suggests that these work best when supported by enforcement measures. It also demonstrates that modest incentives can help create positive competition between labs and research groups for good performance.	FC3. There are effective mechanisms to encourage energy efficient use of fume cupboards.	Evidence of mechanisms, e.g. awareness materials such as stickers on cupboards, posters in room; training sessions for staff and students; incentive schemes; designation of an individual or individuals as responsible staff for ensuring efficient use.
Fans have to work harder when vents are partially blocked. This increases energy consumption and can also compromise safe operation of the fume cupboard.	FC4. There are no unnecessary obstacles to internal air flows within any of the fume cupboards in the lab, e.g. blocking of air vents with containers or equipment.	Visual inspection.
Maintaining fume cupboards properly ensures safe operation and optimum energy consumption. Inspection reports also enable actual face velocities (in metres per second) to be compared with design ones, and often reveal that the laboratory is not working to specification.	FC5. The lab complies with COSSH regulation 9 which requires 14 monthly examinations to ensure fume cupboards are "maintained in an efficient state, in efficient working order, in good repair and in a clean condition".	Evidence of fume cupboard testing certificates. (NB May be held by Estates).
Fume cupboards which cost up to £2000 a year to run are a very costly and energy inefficient method of storing chemicals.	FC6. Fume cupboards are not used as storage cupboards for prolonged periods (i.e. longer than the length of the set-up and conduct of an experiment).	Visual inspection confirming that ventilated storage cabinets are provided where appropriate, and actually used in practice. Interview with lab user(s).

Issue 4: Heating, Ventilation and Air Conditioning (HVAC)

Principle 1: Laboratory conditions are comfortable for users.

Principle 2: Air flows are minimised and appropriate to needs (where compatible with risk assessment based safety requirements).

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	Criteria	Evaluation
S-Lab has shown that moving and conditioning air through ventilation systems generally accounts for 40-60% of laboratory energy use. The systems are so complex, and the lab requirements they must meet are so diverse and ever changing, that they often don't work properly. This will usually be difficult to resolve, and remedial work will need to be led by Estates. However, the issue is so important that lab users need to be aware of it so that they can press for change, and be able to provide relevant information if and when action is taken.	HVAC1. The HVAC system is working to specification. If there is evidence that it is not, then laboratory users have made Estates aware of it. (Possible signs of not working to specification are frequent alarms on fume cupboard use; known problems with ventilation equipment; unpleasant working conditions for many users because of draughts and excessive cold or heat; fume cupboards not functioning properly and difficulty opening/closing doors because of pressure differentials).	Interview with lab user(s). Check with Estates. NB This criteria is present in both frameworks. It is obviously difficult for individual laboratories and their users to take action by themselves so the criteria is met if there is clear evidence that laboratory users have raised concerns with Estates, or are participating in a dialogue with them about improvement.
Ventilation is often over-specified for current needs, especially given changes in lab use. Concentrating activities which need high levels of ventilation or other special requirements (e.g. cooling of rooms with freezers in) into the smallest possible space can enable the freed up space to be ventilated at lower levels, or not at all.	HVAC2. There are no examples of large spaces being permanently ventilated or conditioned to a high specification in order to meet the needs of a small number of activities/devices, or occasional circumstances. If there are examples, then laboratory users have made Estates aware of it.	Interview with lab user(s). Personal observation (strong air flows through vents with no obvious reason when checked with users, noticeable cool air temperatures). NB This criteria is present in both frameworks, but in this one the emphasis is on areas or activties which can be influenced at the level of individual laboratories, e.g. by

		initiating discussions with Estates about changes in use.
Noise can be an indicator of inefficient operation, and is obviously disturbing to lab users, with effects on performance. Plant noise should be reported to Estates, whilst equipment noise can often be solved by moving to separate areas or as part of servicing if it is logged with the appropriate contact.	HVAC3. Equipment/plant noise does not cause significant annoyance or discomfort to users over prolonged periods. If the noise relates to plant, Estates have been made aware of it.	Interview with lab user(s). Personal observation. NB Users often become habituated to surprisingly high levels of noise so if personal observation suggests that it is unusually high or annoying, check with more than user if possible.

Issue 5: Lighting (L)

Principle 1: There is maximum use of natural lighting

Principle 2: Lighting is appropriate to user requirements and is always turned off or down when not required.

Principle 3: High efficiency light fixtures are used.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	**Criteria**	**Evaluation**
Natural light has proven benefits for health and productivity compared to artificial light, and of course uses no additional energy. However, some labs have blinds drawn and artificial lighting on for much of the year. Whilst glare is a significant issue, there are other ways of dealing with this than completely blocking daylight.	L1. There is maximum use of natural lighting.	Visual inspection: blinds are raised or curtains are open in rooms with windows and lighting can be adjusted so that it is not on in all areas of the room during bright periods. Interview with lab user(s).
Lighting can consume up to 15% of laboratory electricity. Lights are often left on (sometimes all night) when areas are not being used whilst original lighting specifications. Replacing fixtures with high efficiency ones can reduce energy consumption significantly.	L2. All luminaires are high efficiency ones, e.g. compact fluorescent lamps for task lighting, LED or T5 fluorescent lights (rather than T8 or T12s) for overhead lighting.	Confirmation by Estates for fixed lighting fixtures. Visual inspection.

LED lighting for scientific tasksis not only more energy efficient, but in many cases may be better for the science because it can be more easily tuned to specific wavelengths.	L3. The lab has examined replacement of mercury with LED low energy lighting for scientific tasks and is doing this whenever possible, e.g. in growth chambers, microscopy and plant growth rooms.	Visual inspection. Interview with lab user(s). NB LED room/corridor lighting covered by previous criteria.
Leaving lights on unnecessarily wastes considerable amounts of energy.	L4. Room/corridor lighting is always turned off or down when not required, and when compatible with safety. If this is not the case, and requires Estates action, lab users have them aware of the opportunities.	Visual inspection – lights are off when room is empty for extended period or at end of day. Evidence of action, e.g. stickers on light controls, assigned responsibility for lighting switch off.
Lighting design specifications for labs are sometimes too high for subsequent uses. The US LabRATS programme has removed many luminaires where they are not necessary. Task lighting of a small area can also be more beneficial to users, and energy efficient, than general lighting of a much larger space.	L5. Illumination is appropriate to tasks. If this is not the case, and requires Estates action, lab users have them aware of the opportunities.	Interview with lab user(s). Visual inspection, especially in corridors and little used spaces.

Issue 6: Management and Training (MT)

Principle 1: There is senior management support and clear responsibilities for laboratory environmental improvement.

Principle 2: There are cross-laboratory support activities for environmental improvement.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	Criteria	Evaluation
Many actions to improve laboratory environmental performance require approval or active support by academics, and some may also have short-term costs (recompensed by medium-long term benefits). Senior management backing is obviously important in both cases. S-Lab cases and other materials can provide useful evidence to persuade senior managers of the benefits and feasibility of taking action.	MT1. There is senior management support (e.g. Head of Department) for the lab assessment and a willingness to implement any recommendations which result from it.	Evidence of support, e.g. email, interview.
Often, things are not done because no-one takes responsibility for them. Assigning responsibilities – and ensuring that those given them can make a difference in practice – can be a powerful catalyst of improvement.	MT2. The laboratory has, or is connected to, a responsibility structure for key aspects of environmental performance, e.g. sash closure.	Evidence of structure, e.g. a 'green champion' within the lab or with responsibility for it, internal responsibilities such as monitoring recycling and sash closure.
It can be empowering to Laboratory technical staff to share experiences with peers on environmental (or sometimes other) issues , or to be aware of environmental initiatives in other labs	MT3. The laboratory participates in broader networks (within the institution or beyond it) which provide opportunities to discuss and take action on environmental issues.	Evidence of mechanisms and lab involvement (e.g. a regular technicians meeting with environmental issues on the agenda; a special lab environmental group; a general environmental champions meeting; attendance at S-Lab and other external events with an environmental focus; involvement in Green Impact training). Interview with lab user(s).
The actions of individual lab users can often make a significant contribution to environmental	MT4. All laboratory users are made aware	Interview with lab user(s).

improvement (e.g. switching off equipment, closing fume cupboard sashes, separating waste etc).	of the energy and environmental impacts of their activities and the actions they can take to mitigate them.	Evidence of induction and/or training activities on environmental issues. Evidence of awareness materials, e.g. posters.
Everyone in labs is usually short of time and has many priorities so it's easy for insights and ideas about environmental improvement to get lost, or be dealt with in *ad hoc* way, and have no follow through. Whilst no-one wants too much bureaucracy, a simple process can be helpful in overcoming this.	MT5. There is a formal improvement process in, or connected to, the laboratory which has had demonstrable impacts on issues covered in this assessment, or other issues which are clearly related to environmental performance.	Evidence of process, e.g. participation in an environmental management system such as Ecocampus; participation in a lab improvement team; implementation of relevant actions arising from health and safety audits.

Issue 7: Scientific Equipment (including personal computing and printing) (SE)

Principle 1: Equipment is used efficiently, with high loadings and utilisation levels and turning off or powering down when not in use.

Principle 2: Energy, water and waste costs are calculated for, and a significant factor in making, equipment procurement decisions.

Why are we asking? (S-Lab Best Practice guide provides further information and examples)	**Criteria**	**Evaluation**
Scientific equipment can be a significant proportion of laboratory electricity consumption – up to 30-40% or higher in some labs. Some of this equipment is left on 24/7 even when not used or needed, which wastes significant amounts of energy.	SE1. Equipment that can be is generally turned off or powered down when not in use, together with related devices (e.g. AC/DC converters).	Visual inspection – equipment (including IT) is not running unnecessarily, plugs/off switches are easily accessible, signs of awareness raising e.g. stickers/posters. Energy saving devices are being used where appropriate, e.g. automatic timers, 'slave' sockets, which switch off all connected peripherals when main equipment is used. Interview with lab user(s).
Energy, water and waste costs can make a significant contribution to the whole life costs of equipment – in some cases more than the initial purchase costs. If these costs are taken into account at procurement stage, it may be more cost effective to purchase more resource efficient but higher first cost equipment at the outset.	SE2. Energy, water and waste issues and costs (including any secondary costs such as increased room cooling) are explicitly considered when purchasing lab equipment.	Interview with lab user(s) and, possibly, procurement staff. Evidence that energy, water and waste costs were considered in any relevant purchases over the last 12 months, either directly or indirectly by purchasing from a scheme which has done this. NB If no recent purchases, treat as non applicable.
There are many examples of equipment duplication between different research groups within the same building, or in other parts of the university. Sharing equipment can save costs, space and reduce waste from ultimate disposal of the equipment.	SE3. The laboratory supports and participates in mechanisms which allow lab equipment to be shared between users in different teams/labs where appropriate.	Evidence of equipment sharing. Evidence of a digital or written system, e.g. an effective central list of shareable equipment, booking system for use of certain equipment.

		NB In some cases this will be achieved through central provision of equipment.
Regular maintenance and servicing of large equipment helps the equipment run more efficiently in terms of energy consumption.	SE4. There is regular (at least annual) checking and servicing of large equipment.	Interview with lab users and technical staff. Visual inspection.
Many items of equipment, e.g. drying ovens, some autoclaves, often have a base power consumption which means that their total consumption does not increase in line with loading. Hence, it can be more energy efficient to batch small job/loads, rather than running many times at low loadings, or to use smaller units more frequently.	SE5. Energy-intensive equipment is 'rightsized' for tasks and used with as high loadings as possible.	Interview with lab user(s). NB In some cases this will be achieved through central provision of equipment.

Issue 8: Waste and Recycling (WR)

Principle 1: There are effective mechanisms to achieve reuse/recycling of materials and equipment wherever possible and safe.

Principle 2: Hazardous and special waste is minimised

Why are we asking? (S-Lab Best Practice guide provides resources on what help is available)	**Criteria**	**Evaluation**
As well as chemical waste, labs create large amounts of solid waste, including equipment at the end of its useful life, packaging and consumables.	WR1. There are convenient recycling facilities for materials, packaging, and equipment within or nearby the lab and these are used in practice.	Visual inspection, e.g. recycling containers in accordance with organisational policies, no 'flytipping' in corridors or other common areas. Interviews with lab user(s).
If waste which is uncontaminated gets mixed in with other hazardous lab waste, it incurs costly and energy intensive waste treatment (e.g. autoclaving/incineration).	WR2. There is no mixing of contaminated with uncontaminated materials/water etc. so that the latter has to be treated as hazardous or special waste.	Identification of hazardous/special waste streams from the lab and visual inspection and interviews with lab user(s) to verify practices.
Surplus equipment takes up space and creates end of life waste. Using it elsewhere in the university or by	WR3. Measures are in place to minimise	Evidence of activity, e.g. internal alert or

other institutions can avoid these costs.	'hoarding' of unused equipment with no clear future application.	exchange system, a 'flea market' table, regular campaigns.
Much packaging and in some cases containers, can be reused or recycled by suppliers.	WR4. Procurement contracts require collection of empty bottles, packaging etc.	Documentation of contracts.

Issue 9: Water (W)

Principle 1: Water is used efficiently and recirculated wherever possible.

Principle 2: Purified water is used appropriately and sparingly.

Why are we asking? (S-Lab Best Practice guide provides resources on what help is available)	Criteria	Evaluation
Labs can consume significant amounts of water, and there is potential for wastage through leakage, oversight or choice of equipment. Often savings can be made at very little additional cost.	W1. In laboratories with considerable water use, there is awareness of related cost and environmental issues amongst laboratory users and policies on appropriate practices.	Evidence of policies and actions, e.g. stickers, training. Interviews with lab user(s).
Once-through cooling can consume significant amounts of water.	W2. Water for cooling is recirculated rather than running continuously to waste.	Visual inspection of relevant equipment such as, condensers, lasers, mass spectrometers. Rotary evaporators are used instead of aspirators Interview with lab user(s).
Water using equipment such as glass washers, sterilisers, autoclaves consume significant amounts of water. It is more efficient to make sure that the equipment is full when operated.	W3. Water-using equipment is 'rightsized' for tasks and used with as high loadings as possible.	Visual inspection of relevant equipment. Interview with lab user(s). NB In some cases this will be achieved through central provision of equipment.
Water purification is energy intensive, especially when it is done by distillation.	W4. Purified water is used only when appropriate, and produced by reverse osmosis (RO) wherever possible.	No water stills in use. Interviews with lab user(s).

Issue 10: Innovation and Dissemination (IND)

Principle: Innovative actions for environmental improvement are considered and implemented.

Principle: Information about successful actions is disseminated to the broader laboratory community.

Why are we asking? (S-Lab Best Practice guide provides resources on what help is available)	**Criteria**	**Evaluation**
The complexity and variety of labs and their users means that there will always be opportunities for innovation. This is especially true at present when concerted actions for improving laboratory environmental performance are relatively new. Some of the actions identified in this category will be incorporated into future versions of the workbook.	IND1. Innovative action(s) not recognised in previous criteria which make a real difference to the sustainability of the lab. (Up to two credits).	Interview with lab user(s). Actions not covered in previous sections, or implemented in unusual ways, which demonstrate thought and commitment and clearly produce beneficial results.
There is great potential to disseminate good practice so actions to achieve this are very desirable.	IND2. Environment-related action(s) which have been disseminated beyond the laboratory. f in a tangible way, e.g. written about in a document or a web site. had a significant influence on actions in other laboratories. (Up to two credits).	Interview with lab user(s). NB This can encompass actions which have contributed to other criteria.

Total Points

Category	Max Points in Theory	Max Points in Practice (i.e. excluding N/A)	Actual Points	Improvement Potential and Recommendations
Chemicals and Materials	6			
Cold Storage	6			
Fume Cupboards	6			
Heating, Ventilation and Air Conditioning	3			
Lighting	5			
Management and Training	5			
Scientific Equipment	5			
Waste and Recycling	4			
Water	4			
Innovation and Dissemination	4			
Total	48			