Green Labs Report

Climate & Sustainability Assembly

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4 October 2023

Table of Contents

Introduction

Climate Assemblies place people at the center of decision making on sustainability. They are a means of getting direct input from individuals and stakeholders on how to address sustainability and serve to stimulate new ideas for climate action.

As part of our Aberdeen 2040 commitment to '*encourage everyone within our community to work and live sustainably*' (commitment 16) we launched our **Climate and Sustainability Assembly** initiative in 2023. The purpose of these sessions is to regularly engage with our community over the development of key policies, initiatives and behaviors that support Aberdeen 2040 across commitment 16, commitment 17 (*'educate all our students and staff to be leaders in protecting the environment'*) and commitment 19 (*'achieve net zero carbon emissions before 2040'*). In our second assembly, held on 4 October 2023, the focus was on the exploration of sustainability issues in the context of laboratory practices across our campus.

Labs are hubs of research activity, innovation and teaching. They support and advance solutions across all of the Sustainable Development Goals, from medical advances that save lives, to addressing the climate crisis, or developing novel industrial products and applications that benefit society. They provide important spaces for learning across all branches of science and for developing the knowledge economy. As the agenda for sustainability in science advances alongside the broader societal shift to Net Zero, we recognize that labs are critical for successful research and education but also have significant impacts in terms of the emissions they generate and the materials they use. This assembly explored these impacts and co-developed options for an agenda around green labs.

Our laboratories have a variety of direct and indirect impacts on sustainability and make a significant contribution to our institutional emissions through both energy consumption and indirectly through procurement. These impacts arise from the activities conducted within laboratories, including research, experimentation, teaching, and the day-to-day management necessary to operate them. These impacts include the use of power to operate lab equipment, the use of space and storage, the generation of lab waste, and the procurement of material and equipment.

Sustainability impacts from labs include:

Energy Consumption: Laboratories often require significant energy for equipment, climate control, and lighting, with a 2022 LEAF (Laboratories Efficiency Assessment Frameowrk) report highlighting that a typical lab will consume 3-10 times more energy per m^2 than a standard office space. If the energy sources used are from fossil fuels, this contributes to our greenhouse gas emissions. This impact can be mitigated by investing in energy-efficient equipment, increasing our use of renewable energy sources, and increasing energy efficiency measures and good practice.

Supply Chains and Waste: Laboratories procure large volumes of consumable materials and generate large amounts of waste, including hazardous chemicals, biological materials, packaging and electronic waste. The embodied emissions in manufacturing and transporting lab materials is a key source of emissions captured in procurement (our lab-based emissions as a share of procurement are highlighted in Figure 1 below). Implementing positive waste management and circular economy practices can all help reduce this impact, for example by improving recycling, re-using items where possible, or using environmentally friendly alternatives from the outset.

Chemical Usage: The production, use, and disposal of chemicals in laboratories can also contribute to emissions. Some chemicals have a high carbon footprint in their production processes. Labs can adopt green chemistry practices, optimize chemical usage (including sharing), and explore alternatives to minimise enviromental impacts and save costs.

Building Design, Construction and Space: The design and construction of laboratory buildings can impact energy efficiency and environmental sustainability. Green building practices, including energy-efficient design, use of sustainable materials, and incorporating renewable ennergy sources, can help minimise the carbon footprint.

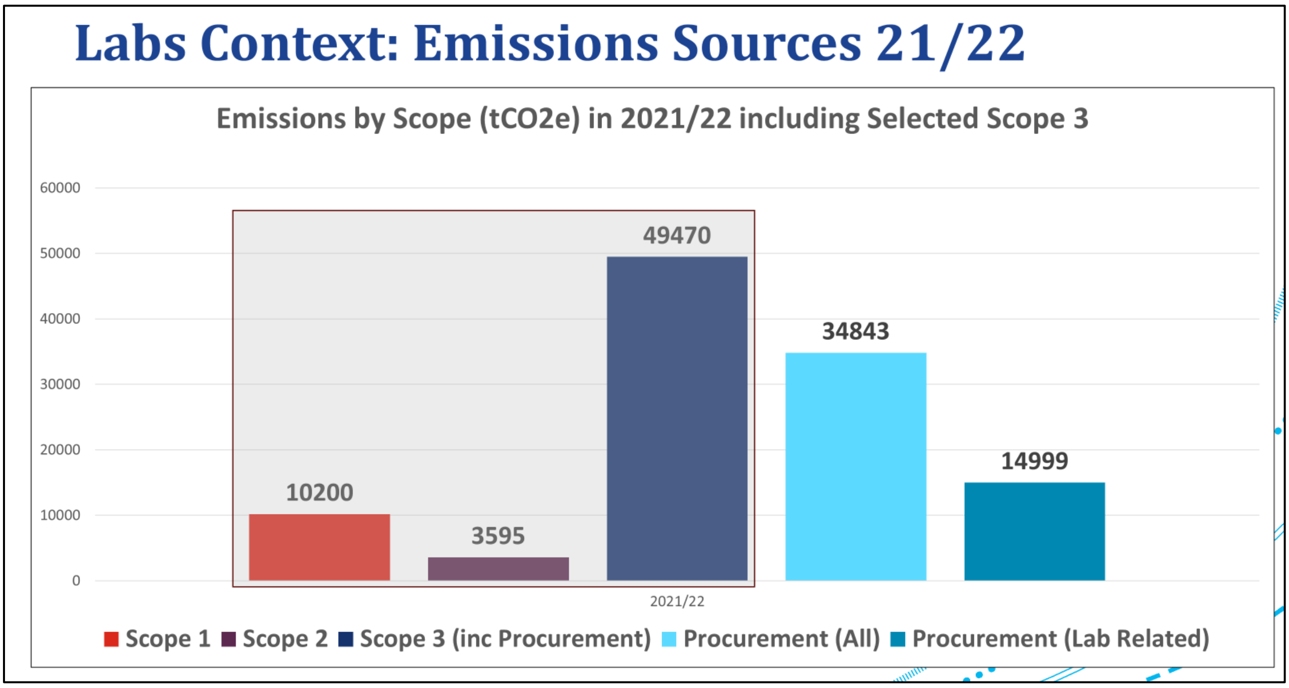


Figure 1. Shows total emissions from all University activity in 2021/22 (boxed) with Scope 3 emissions our highest source. Procurement emissons are the main source of Scope 3 at around 35k tCO2e, with lab related emissions representing almost 15k tCO2e.

Format of the Assembly

This CSA was attended by approximately 50 participants from the Schools of Biological Sciences, Geosciences, and Medicine, Medical Sciences and Nutrition, as well as colleagues from Estates and Facilities. The format of the event was designed to encourage participation and sharing of ideas on how to address sustainability in the context of laboratory use in the University.

The event was opened by expert presentations from two individuals working in the sustainable labs space. Our first presentation was delivered by Lee Hibbett (Nottingham University) on approaches to developing sustainable lab practices and the role of LEAF accreditation. The second presentation, delivered by Maggie Fostier (Manchester University), explored Manchester's use of a 6R approach in promoting lab sustainability (see appendices for copies of slides)[1].

Our deliberative sessions addressed two core questions. These were '*What are the challenges that labs must address to become sustainable?*' and *'Identify two actions that would deliver a sustainable lab? For each action identify a barrier that must be overcome to achieve that action.'* As a part of the process, we trained 9 facilitators to support these events.

The format of the event included:

[1] .ppt slides available on request.

Plenary

- Welcome & Overview: Tavis Potts (Dean for Sustainability), Fraser Lovie (Head of Sustainabiliy) & Iain McEwan (IMS)
- Guest speaker: Lee Hibbett (Nottingham University)
- Guest Speaker: Maggy Fostier (Manchester University)

Session 1

- '*What are the challenges that labs must address to become sustainable?*'
- Each person writes down 2 ideas on separate post its.
- Group discussion
- Plenary feedback & discussion

Session 2

- '*Identify two actions that would deliver a sustainable lab. For each action identify a barrier that must be overcome to achieve that action.*'
- Group discussion
- Plenary feedback & discussion

Assembly Outputs

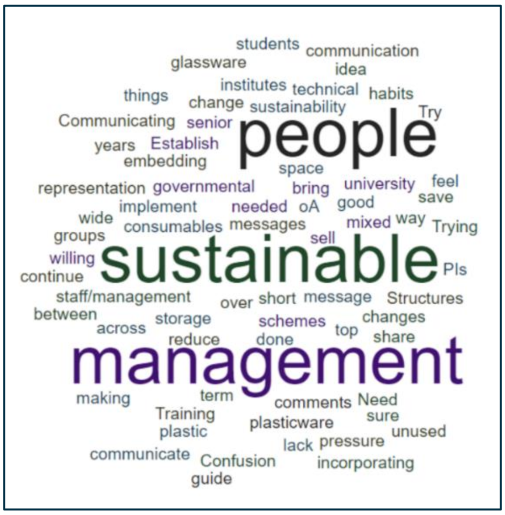
Session 1

'What are the challenges that labs must address to become sustainable?'

Facilitated groups reflected on this open-ended question with individuals across nine groups, each identifying two priority ideas for discussion. The results in this session were analysed and aggregated across all nine groups into themes that include: communication and engagement; resistance to change; protocols; resources; waste and recycling; energy use; and supply chain. The word clouds highlight recurring themes under each heading.

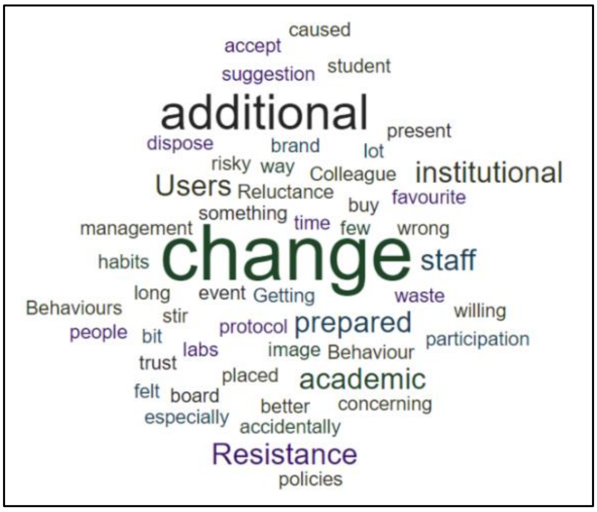
Communication & Engagement

This theme explored the importance of engagement and communication strategies for embedding sustainable lab practices across Schools regardless of whether they served a research or educational purpose. This incorporated communication between lab practitioners *within* Schools, but also communication *between* Schools to find common approaches and efficiences in practice across the University and to improve the interaction between University management, Professional Services, and lab staff. The greening of lab practices was equated with a culture change, both in terms of lab users at all levels (students, research staff and managers) and the sustainability journey of the institution as a whole.



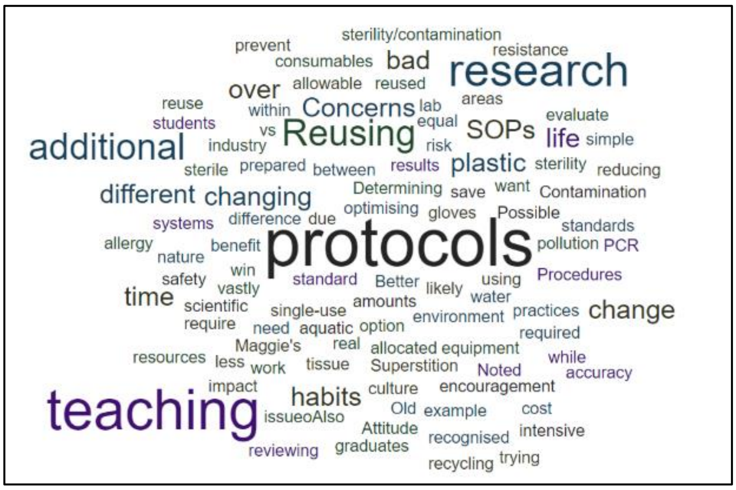
Resistance to Change

Several groups highlighted that change, or resistance to change, was a significant issue for moving forward. This included the level of 'buy-in' and subsequent pressure to act from staff and students, the level of interest from academic staff for green labs, and a fear that change in procedures may undercut the quality of the science undertaken. The reluctance to amend established protocols or to change behaviour to deal with e.g., issues around lab waste and disposal, were also cited as key challenges. Effort is required across all lab users to effectively communicate and build a constituency that embraces green labs and the practical and cost-efficiency benefits this approach may bring. This would encourage buy-in and cultivate a positive approach to change.



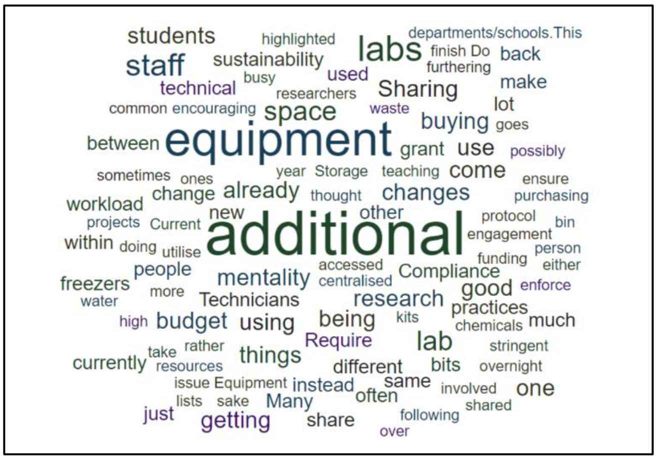
Protocols

The review and development of operational protocols that enable labs to engage with energy efficiency and waste reduction was a key point of discussion. Comments included the need for a thorough review of SOPs (Standard Operating Procedures), updating these in line with new sustainability expectations, while recognising issues around the time and staffing capacity required to do this. Groups identifed a range of tools (e.g., Manchester's [6R](6R) framework) that can support SOP reviews, but also noted that there are equal amounts of 'encouragement' and 'resistance' concerning changing procedures. It was noted that there are differences concerning the implications of changing research and teaching protocols, highlighting that while there may be more flexibility in terms of altering teaching practice, there may be some implications for sensitive research. As noted in several groups, there are evolving expectations from students that sustainability should be embedded in lab procedures.



Resources

Participants identified challenges around the resources required to support a shift to green lab parctices. These included space restrictions in labs, instances of stockpiling materials (to ensure funding is spent), and the accumulation of material stored in ultra low temperature (ULT) freezers. There was a desire to build more of a sharing culture across labs, both within and between Schools, with a need for structures to be put in place to support the sharing of lab equipment, for example via a shared equipment register, regular inter-lab communication about equipment purchases, and better information about common resources and materials. The potential role of students as advocates for driving a change in resource-use (in addition to support from technical staff and researchers) was noted, acknowledging that staff time is increasingly pressed.



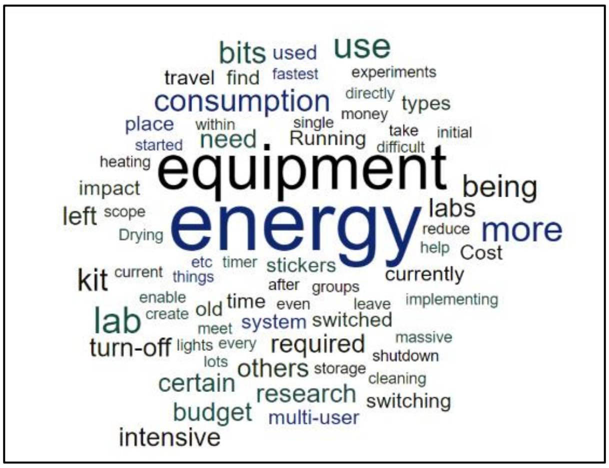
Waste and Recycling

Not surprisingly, the reduction of single-use plastic was the dominant theme that emerged when discussing waste. Participants noted the excessive use of plastics in lab processes and the need to innovate in reducing this waste stream. This included developing new procedures, advice on how to handle contaminated plastics, and waste management training for staff.

Recycling was also raised as an issue, with items like polystyrene and ice packs key issues to address. Communication within and between the labs, and across the University as a whole e.g., on our current waste procedures, was raised by participants as an area for improvement. Efforts to improve consistency in the approach to waste management, including identifying opportunities to amalgamate some smaller waste streams that cannot currently be dealt with effectively due to their low volume.

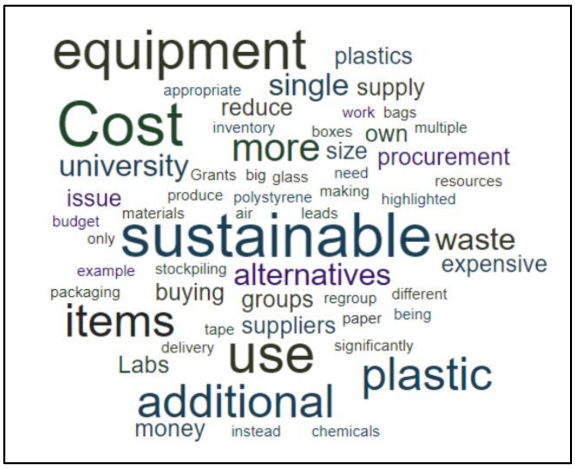
Energy Use

Participants identified energy consumption from lab equipment as a key source of emissions. It was noted that equipment is often run inefficiently (e.g., run when half-full), left on unecessarily, or not switched off after use. This could be rectified through better communication within and between labs e.g., to mitigate concerns about impacting colleagues' research by interfering with equipment while in use, or promoting the joint use of machinery. Improved data was needed to understand the current emissions profiles of different labs and their energy requirements, noting that some labs are more energy-intensive than others and may need more support. Several groups commented on the need to audit different types of lab equipment to see if they can be managed more efficiently, what the impact would be, and how to effectively communicate this within and between lab users. Options included formal audits, or the simple use of traffic light stickers (as illustrated in the Nottingham University presentation).



Supply Chain

Procurement of lab supplies was identifed as a key challenge. It was noted that universities as buying entities can have a significant influence on the products purchased and their delivery, with suggestions that this purchasing power be used to drive more sustainable alternatives. Suggestions highlighted the need to reduce plastic and polystyrene waste by regrouping orders, delivery of packages of appropriate size, and less polystyrene use in packaging where alternatives exist. The issue of improved communication and collaboration was raised again, in this instance in developing centralised sustainable procurement and inventory systems, addressing stockpiling from grants, and reducing duplication and waste. On the supply side, participants noted that often sustainable alternatives do not exist and more effort is needed to identify new suppliers and to work collectively to reduce the purchase cost of sustainable options.



Session 2

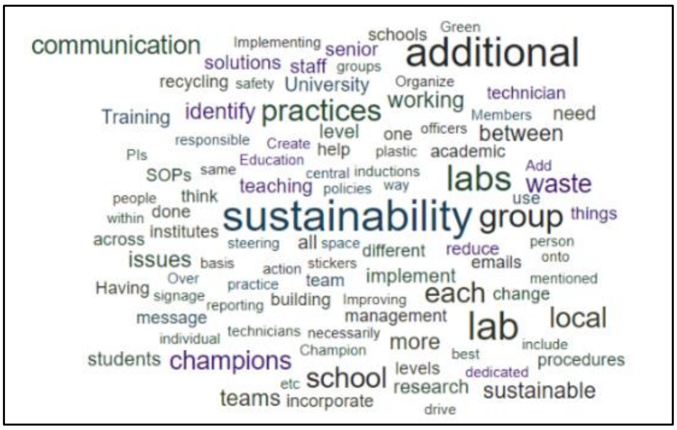
"Identify actions that would deliver a sustainable lab and the barriers to achieving them."

This session explored questions of future actions and barriers. Facilitated groups reflected on this open-ended question for 3 minutes. The results across all groups have been aggregated into themes including communication and training; equipment and sharing; procurement; and energy use. Barriers include time and capacity; financial resources; communication; and resistance to behaviour change.

Part 1: Actions

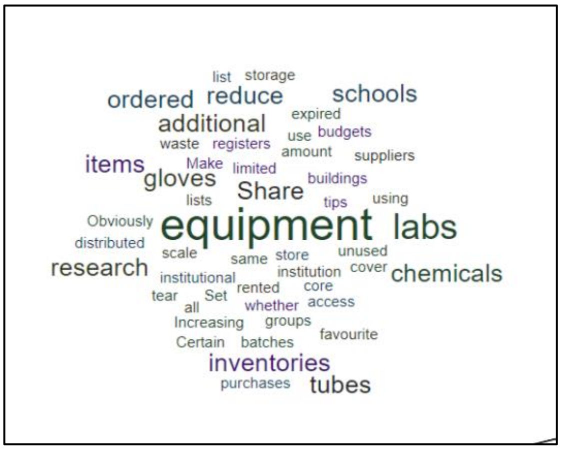
Communication and Training

Suggestions were made to improve communication and collaboration across University labs. **Sustainability champions** were noted by several groups as a way to improve communication and action. Champions would ideally be based at the lab-level to improve operations and feed into a **network of School representatives**. A recommendation was made for the creation of **School or Institute level sustainability working groups** who should collaborate and be supported by a University-wide **Green Labs MS Teams** to improve efficiencies, aid equipment sharing, and flag good practice. Training was raised as an issue, including the need to introduce sustainability as part of lab inductions. The role of central coordination and action was seen as a key enabler of change. This would include the use of central funds to facilitate changing equipment, the development of standard materials e.g., lab signage, and the development of staff training and guidance around procurement and waste practice. The role of an **external accreditation scheme**, such as the LEAF framework[2], was noted as an initiative that would support best practice and learning across all labs.



Equipment and Sharing

Solutions included setting up **centralised inventories of chemicals, assets and equipment** that would cover all Schools and would support a new sharing or 'renting' culture. This would also promote the identification and sharing of **unused or near-expired equipment to reduce waste** (e.g. in teaching labs). A more **centralised approach to purchasing at scale** could potentially reduce costs and enhance the sustainability credentials of lab products being purchased, while reducing the burden on individual labs.



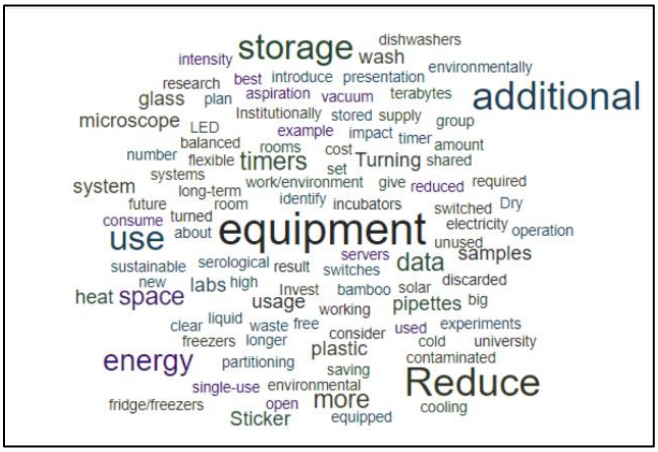
[2] https://www.ucl.ac.uk/sustainable/take-action/staff-action/leaf-laboratory-efficiency-assessment-framework

Procurement

The actions on procurement reflected the discussion in Session 1, with participants noting priority action on **developing procurement standards for wet lab equipment**, and **engaging with suppliers** over waste and single-use plastic, while also exploring alternative supplier lists. There was a suggestion that there could be a shift to animal-free alternatives for certain products with opportunities for student projects to evaluate their effectiveness.

Energy

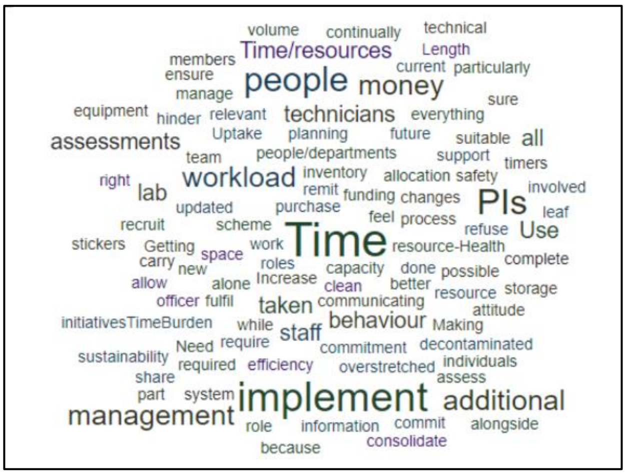
Energy was raised as a key area. Most groups identified that the **use of timers** would be appropriate for turning off equipment that is running excessively (supported by **signage** in the labs). Storge in ultra-low temperature (ULT) freezers was noted as a concern due to high energy use. While storage at -70C (or lower) is often critical for research, it was suggested that there could be a **rationalistion of storage space** and that a set of guidelines could be developed for long term storage in ULT units. Suggestions were made about more **centralised oversight of equipment purchase** to prioritise the use of efficient products (and in the context of improving shared use). The role of data centres was also raised in terms of their high energy-use and production of heat, and it was suggested the the University investigate options for **renewable energy generation**.



Part 2: Barriers

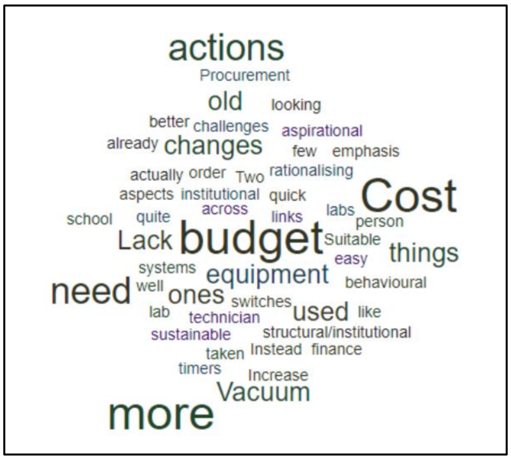
Time and Capacity

Time and capacity was consistently raised across all the groups as a limiting factor in advancing green labs. Groups highlighted that workloads, particularly amongst technicians who would need to deliver many of the measures, were very high and that there was limited capacity to take on additional responsibility and drive behaviour changes. It was noted that opportunities to train staff in new sustainability roles would be needed, with potentially new roles around sustainability coordination. While the locus of activity would be the School, there was also seen to be a need for better resourcing and coordination across Schools to make measures efficient.



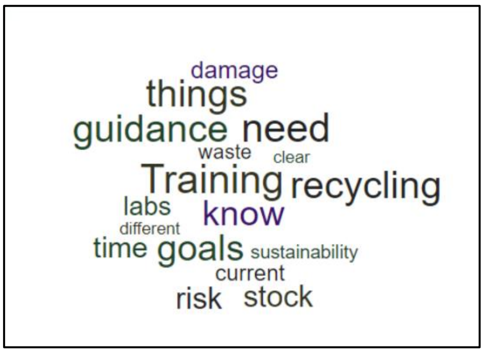
Financial Resouces

It is not surprising that funding constraints were raised as a barrer for action. Resourcing is needed for new and efficient equipment, new lab signage, investment in people, training to support behaviour change, and to address the potential cost-gap between sustainable and less-sustainable products. Some resource is also likely to be needed to progress independent accreditation of our labs via the LEAF scheme or some similar framework. Participants expressed views that there should be some central support for sustainability measures in labs (e.g., a green lab fund) that could support action within and across labs, helping deliver efficiences across our campuses. This will be particularly challenging given the current financial constraints facing the University.



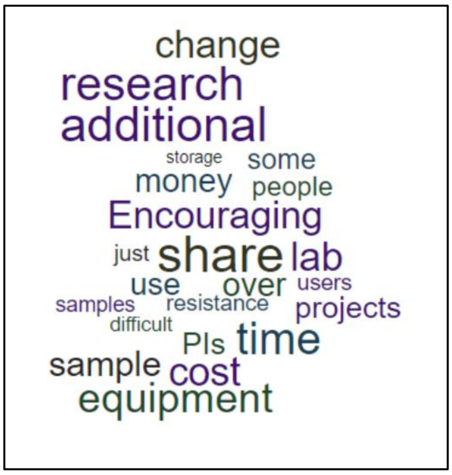
Communication

Communication barriers were seen as being numerous and multifaceted. It was noted that communications can sometimes be contradictory and that there was a need for procedures to be aligned with our 2040 sustainability goals, including staff training, inductions, and lab management. At a practical level, SOPs within labs are not routinely aligned to sustainability goals and should therefore be reviewed. Signage is inconsistent which leads to conflicting behaviours around energy-use and waste management. While respecting the heterogeneity of labs, a clear barrier is the lack of joined-up thinking, consistent communication, and a sense of shared approach across the lab estate. There is also a barrier around external communication between lab managers and external companies over procurement and what represents best practice.



Resistance to Behaviour Change.

Resistance to behaviour change was cited across all groups as a barrier. Behaviour change is a process that needs to be long term and requires buy-in at all levels, including from students, lab technicians, lab managers, PIs, and management, as well as extending to external vendors and suppliers. Participants noted a workplace culture that is 'averse to change' and not always conducive to the development of processes that encourage managers and PIs to see the 'bigger picture' and not just focus on cost. Positive behaviours underpin all elements of lab sustainability, including equipment use, waste management, procurement, freezer use, and knowledge sharing. Pro-environmental behaviours will increase over time but require pro-active interventions and support, notably across the range of integrated actions described in this report and need to be supported consistently over time.

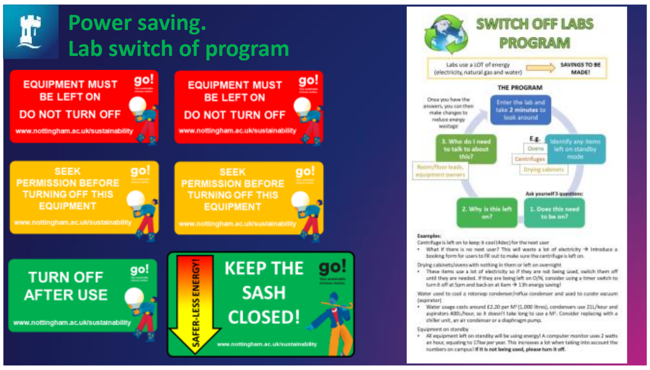


Recommendations & Next Steps

Our second Assembly has highlighted the opportunities that can address the impacts of our labs. While the emissions and waste generated from labs are a technical problem, many of the solutions in the lab environment are people centred including behaviours and culture. Action on greening our labs will require commitment at all levels – from senior management to the students who are educated in these spaces.

Recommendation 1: Lab-based Schools should initiate **green lab working groups** encompassing teaching and research. Working groups should bring together expertise and develop strategies to improve **equipment sharing**, **efficent space use** (including freezer use), **energy efficiency**, and **improved waste management** (particulalry polystyrene and single use plastic). We recommend School groups meet collectively twice per year to build solutions and to inform University-level governance via the Sustainable Development Committee. The opportunity to **establish a Green Labs MS Teams** to support information sharing should be considered immediately.

Recommendation 2: In collaboration with green lab working groups, we need to explore how University **processes can be developed** for equiment sharing, energy efficiency and guidelines for **sustainable waste management**. The opportunity should be taken to explore resource sharing between Schools and labs, supporting University-wide approaches such as consistent signage, open registers, and best pratice in efficient space and equipment use.



Example of a traffic light system (L. Hibbett, U. Nottingham)

Recommendation 3: Establish **demonstration green labs** across the University covering both research and teaching activity, including a demonstration lab in the Science Teaching Hub. Such demonstration labs could champion the development of **shared guidance** and a consistent approach to developing effective **sustainable operating procedures**. Opportunities to **review the protocols for teaching and research experiments** should be taken, adapting approaches such as the 6Rs used by Manchester to reduce waste and eliminate single-use plastics where possible.

Recommendation 4: Invest in LEAF (Laboratory Efficiency Assessment Framework) accreditation (or similar) as a tool to guide and benchmark lab performacne across all Schools. The LEAF scheme allows for consistency in reporting, benchmarking practices across labs and experience sharing. LEAF is a widely recognised, accredidated and sector-supported laboratories benchmark initialy created by UCL.

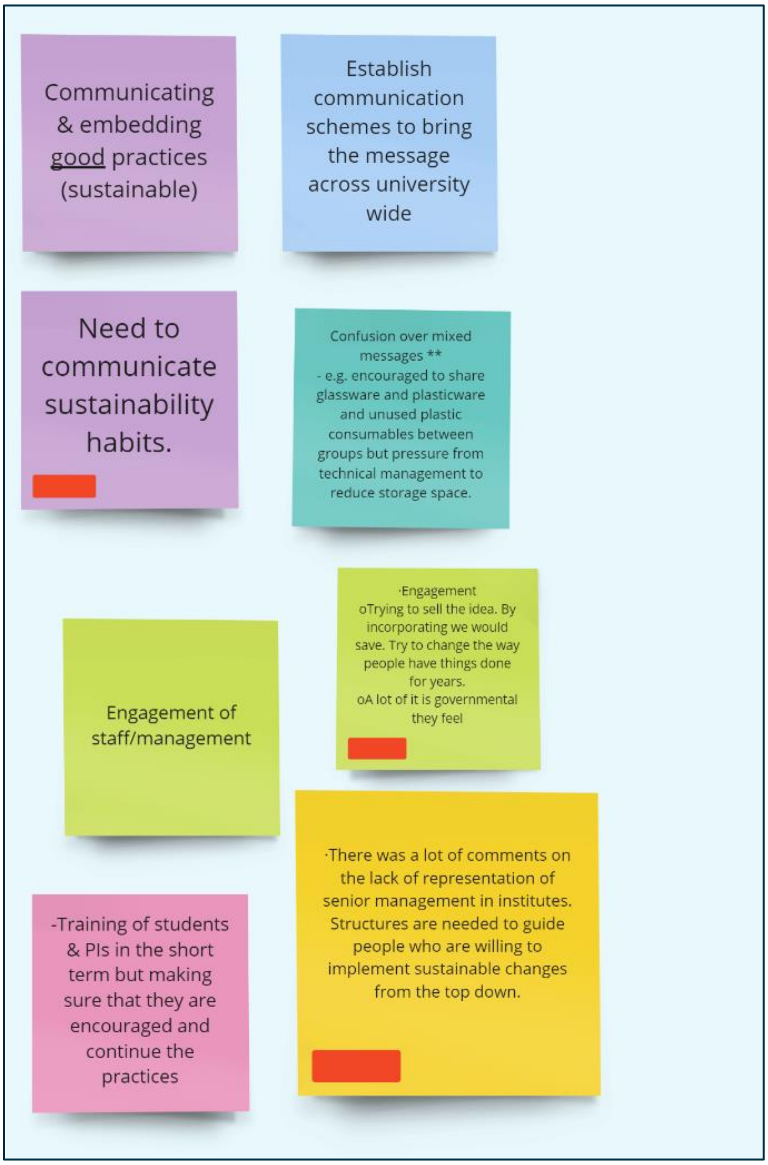
Recommendation 5: Working across our lab based Schools, Procurement, and Sustainability teams, develop appropriate **pathways and guidance for sustainable procurement** of lab materials and equipment, placing circular economy principles and sustainability at the heart of laboratory procurement University-wide.

Recommendation 6: Invest in **training and capacity building** for students, technical staff and academic staff that emphaises sustainable lab practices. Options include short upskilling courses, general sustainability awareness, recruitment training, and should reflect sustainability comptences as part of career progression and graduate training. The aim should be to build overall staff capacity, and awareness of the need to prioritise and embed sustainable behaviours.

Appendix 1

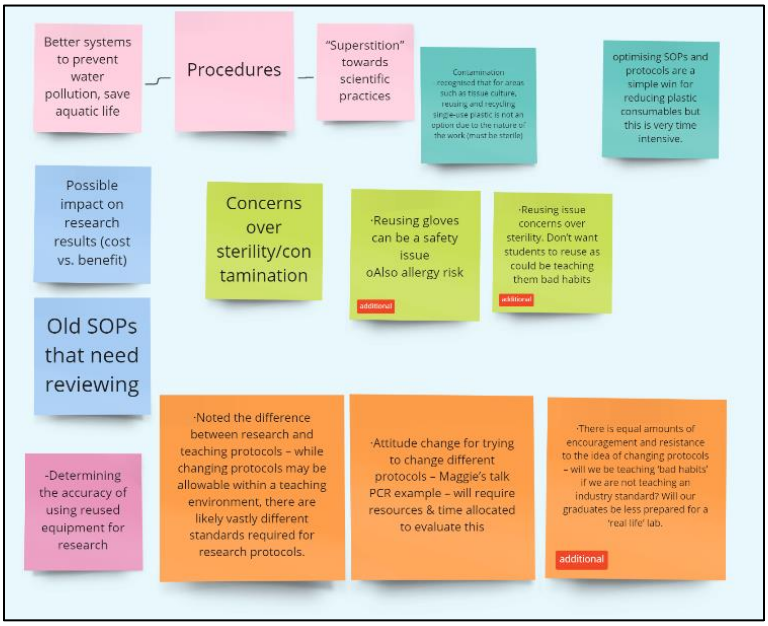
Themes from Session 1 - collated notes (Miro Boards)

Communication & Engagement



Resistance to Change

Protocols



Resources


·Sharing of equipment – different labs have different bits of kits and lists of equipment are not currently available either within or between departments/schools.This would be a very useful addition!
Sharing equipment
Each lab having own chemicals and equipment
'are the resources in or being planned in the correct place to achieve changes?'
additional
There is often a mentality of "this is mine and no one else can touch it" when it comes to lab equipment.
additional
Will likely come back to technical staff to enforce
Compliance
Space
·Challenges of staff. Not getting paid for it. If paying people to do things it is a good motivator
additional
·Also there is thought that a lot of the changes that would be made would come down to technical staff making the changes. But that's why engaging students would be so good
additional
·Technicians- Already doing the a lot of things but already technically driven. Not everything can come back to technicians. Getting students involved is good
additional
·Also compliance and engagement of staff. As well as reluctance to change protocol and concerns over sterility
additional
Technician workload is high, and it was felt that they would be the ones to enable and take on many of the suggestions when they are already busy.
additional
·Behaviour change in encouraging both research and teaching staff to utilise bits of kit that we currently have, instead of the mentality of just buying new for the sake of it. Participant mentioned that they sometimes get told to spend budget without a specific purpose – the 'use it or lose it' mentality where we are buying things just to make sure that we are not given less budget in the following year.
additional
-Understanding how to share lab equipment to reduce multiples or buying new
Students highlighted experience in other labs where equipment was shared between labs and purchasing consumables was more stringent.
additional
- inventory across school which can be accessed by everyone.
·How much space is someone using. If one person using a massive room that is an issue oEquipment not being used after research projects finish oDo try and engage some of the researchers to use same space oIntellectual property is an issue if using the same space possibly
additional
·Accumulation of stored materials in freezers (-70c).
Storage – getting people to bin old samples
Additionally, there is often a lack of communication (i.e., seeing if other labs are running a water bath overnight that you could make share instead of turning on one yourself).
additional
oCurrent grant system encourages stockpiling to ensure all funding is used. Stockpiles from labs should be centralised, rather than being controlled at a lab level. Sharing common equipment can cut down on waste from unused equipment and perishable material.
-UoA should push research grants to require sustainability targets/mandates within grant applications. Require a portion of the budget goes to furthering sustainability best practices.
additional
-Many labs use too much space in the freezers, lots of hoarding.
further strain on technician's workload to implement practices.

Energy & Emissions

Procurement & Supply Chain

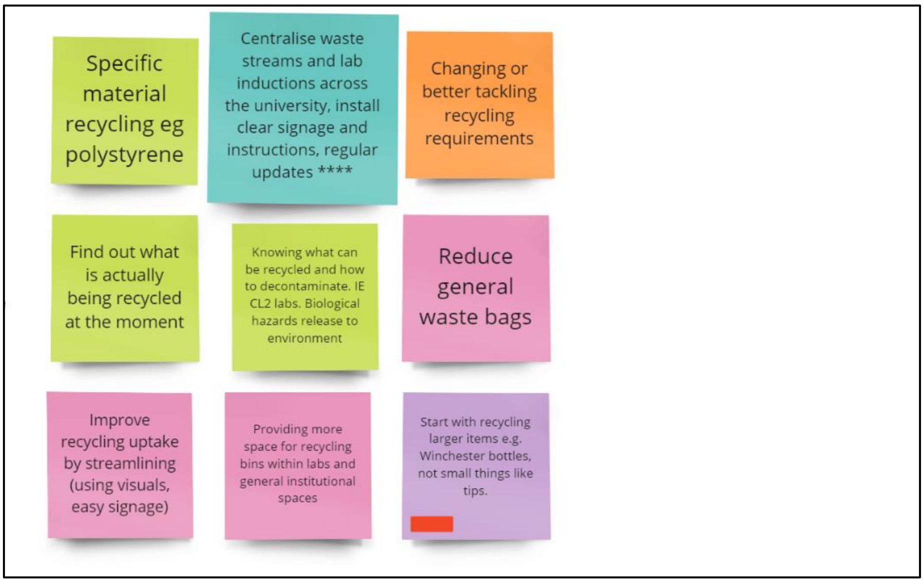
Appendix 2

Themes from Session 2 – actions (Miro Boards)

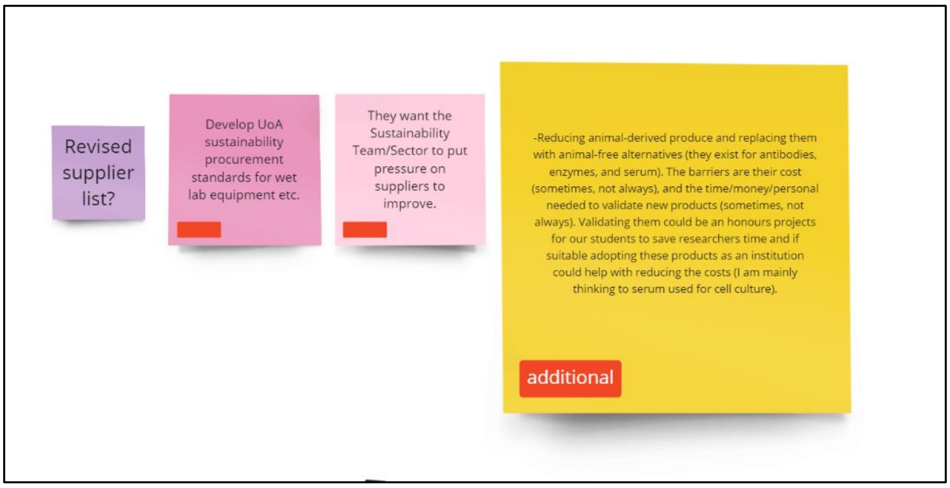
Communication and Training

Equipment Sharing

Recycling



Procurement



Energy


Timers for equipment to allow for reduced energy usage
Sticker system for turning off equipment as shown in presentation.
timer switches on e.g. heat blocks etc.
Ensure that equipment are switched off when not in use by installing timers and sticker system to identify equipment that can/shouldn't be turned off.
Turning unused equipment off
Reduce energy usage of high intensity equipment between experiments
Use of timers for equipment
Provide more storage space for labs, reduce number of samples held in long-term storage that are no longer required, free up space in incubators, cold rooms to open up room for shared equipment, glassware etc. **
Reduce group storage space in fridge/freezers and liquid nitrogen
Implement rules about -70c freezers storage so that samples are discarded after a set amount of time or when users leave the university.
Instal vacuum aspiration systems to reduce serological pipettes use and (contaminated) plastic waste.
More sustainable lab coats e.g. bamboo?
-LED microscope oGetting new microscope if very old microscope
-Reduce the use of single-use plastic and revert to glass. We are unfortunately not equipped to wash glass pipettes for example so that would trigger cost for washing equipment.
introduce flexible partitioning in very big labs and only heat used spaces
We shouldn't neglect the environmental impact of data storage. Dry research requires terabytes of data to be stored in data centres, which consume electricity for cooling and normal operation of servers.
-Do we have solar panels
Prioritising energy saving equipment
Reduce equipment in dishwashers (clear and more guidance on what to wash and when)
Purchasing of environmentally friendly equipment
Use or plan for the future working Invest in best equipment to give a balanced work/environment result
Institutionally consider the energy supply

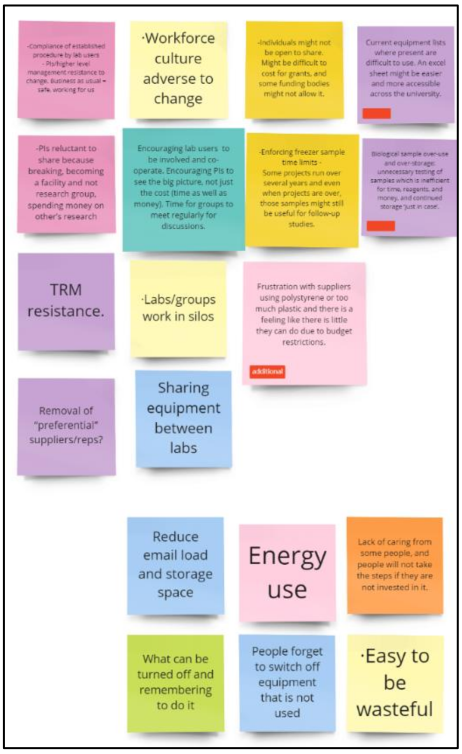
Themes from Session 2 – barriers (Miro Boards)

Time

Financial Resources

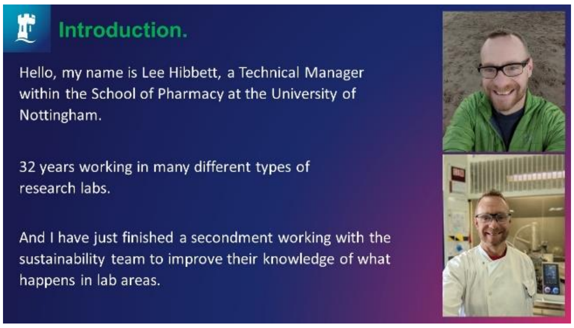
Communication

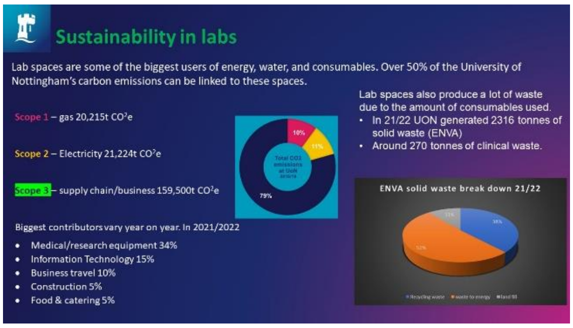
Behaviour

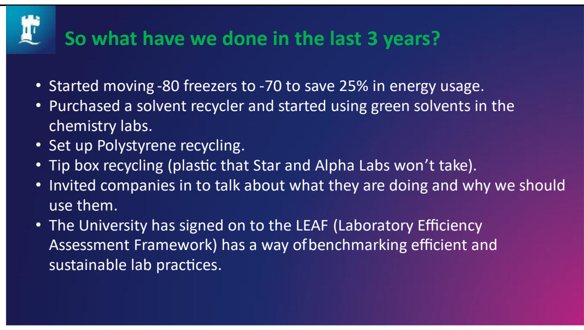


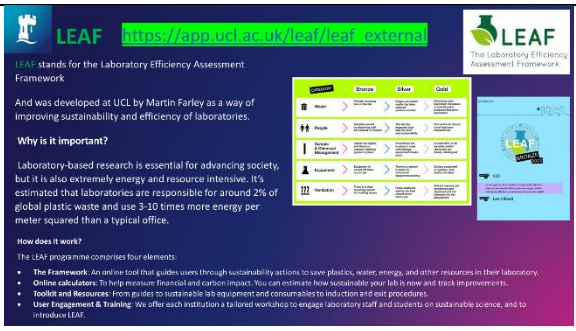
Appendix 3 Guest Presentations

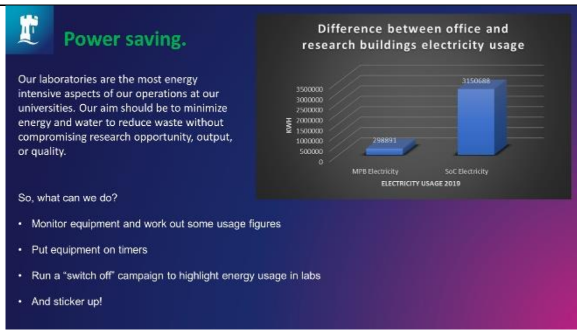
Lee Hibbett University of Nottingham.

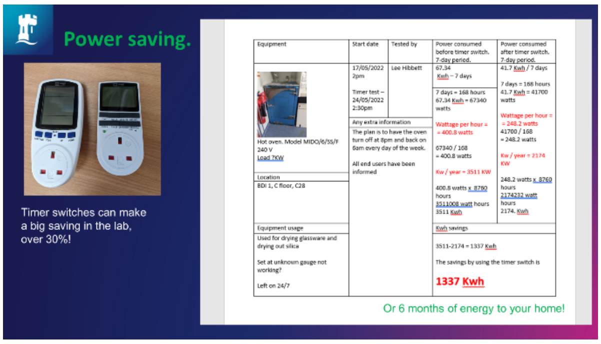


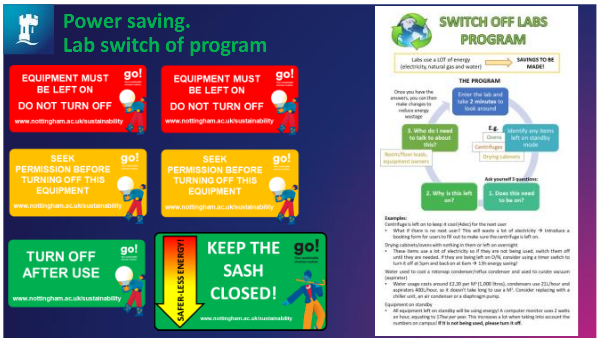


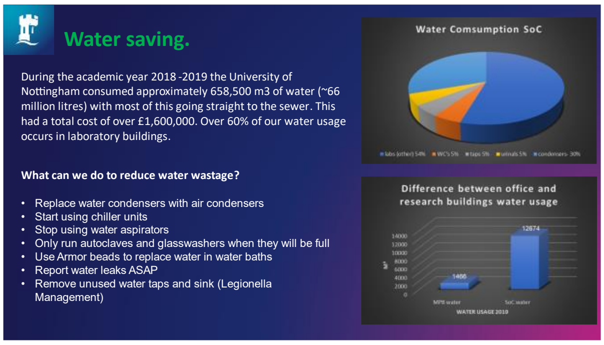


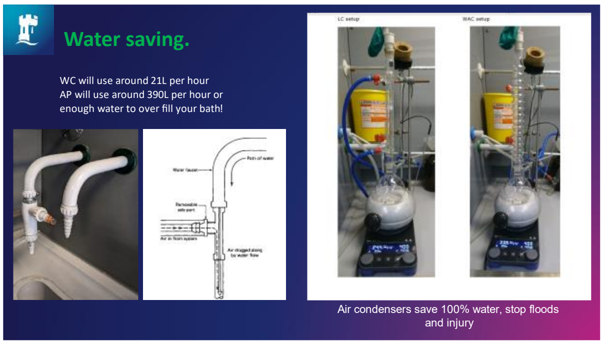




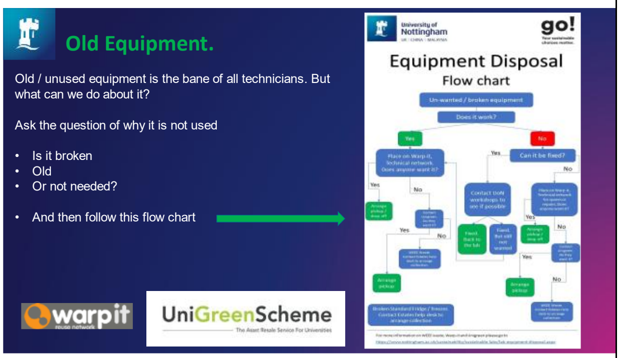

Power saving.
Timer switches can make a big saving in the lab, over 30%!
1337 Kwh
Or 6 months of energy to your home!

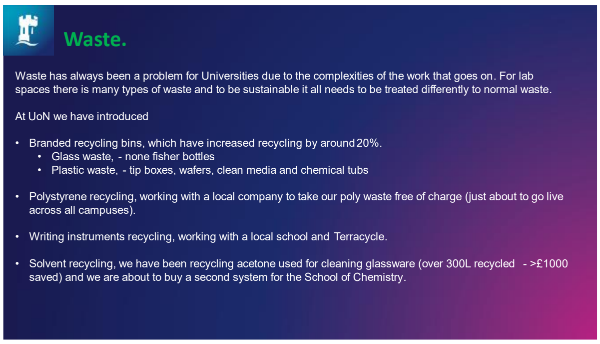

Power saving.
Lab switch of program
EQUIPMENT MUST BE LEFT ON
DO NOT TURN OFF
SEEK PERMISSION BEFORE TURNING OFF THIS EQUIPMENT
TURN OFF AFTER USE
KEEP THE SASH CLOSED!
go!
SWITCH OFF LABS PROGRAM


Water saving.
During the academic year 2018 -2019 the University of Nottingham consumed approximately 658,500 m3 of water (~66 million litres) with most of this going straight to the sewer. This had a total cost of over £1,600,000. Over 60% of our water usage occurs in laboratory buildings.
What can we do to reduce water wastage?
Replace water condensers with air condensers
Start using chiller units
Stop using water aspirators
Only run autoclaves and glasswashers when they will be full
Use Armor beads to replace water in water baths
Report water leaks ASAP
Remove unused water taps and sink (Legionella Management)
Water Consumption SoC
Difference between office and research buildings water usage


Water saving.
WC will use around 21L per hour
AP will use around 390L per hour or enough water to over fill your bath!
Air condensers save 100% water, stop floods and injury


Water saving.
Over 10 million litres of water will be saved annually!


Old Equipment.
Old / unused equipment is the bane of all technicians. But what can we do about it?
Ask the question of why it is not used
Is it broken
Old
Or not needed?
And then follow this flow chart
warpit
UniGreenScheme
Equipment Disposal
Flow chart
go!


Waste.
Waste has always been a problem for Universities due to the complexities of the work that goes on. For lab spaces there is many types of waste and to be sustainable it all needs to be treated differently to normal waste.
At UoN we have introduced
Branded recycling bins, which have increased recycling by around 20%.
Glass waste, - none fisher bottles
Plastic waste, - tip boxes, wafers, clean media and chemical tubs
Polystyrene recycling, working with a local company to take our poly waste free of charge (just about to go live across all campuses).
Writing instruments recycling, working with a local school and Terracycle.
Solvent recycling, we have been recycling acetone used for cleaning glassware (over 300L recycled - >£1000 saved) and we are about to buy a second system for the School of Chemistry.

Maggie Fostier - University of Manchester.

In our school we have >650 students per year group.

Our practical classes generate huge amount of waste with many single use items.

Our classes aim to teach techniques and an understanding of experimental science, with a chance to have a go and analyse results.

Individual results do not matter much (especially in Y1 and Y2) as we can provide model or class results to analyse and interpret.

With this in mind, we designed the 6R approach to reduce plastics

The 6R approach

The next two slides provide a slide and poster we have used to disseminate the 6R approach to colleagues.

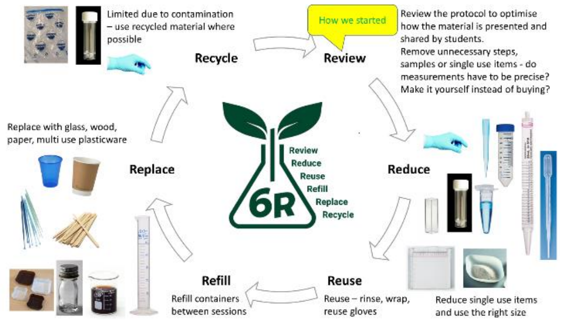
We also subscribe to the (free) UK LEAF lab accreditation programme to improve the sustainability of our research labs. As a result, we started creating green tips slides to share in lab meeting/newsletters and for our induction and training for LEAF

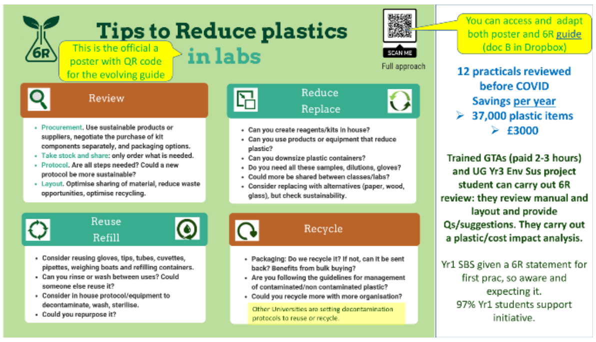
You may need to test some 6R steps.

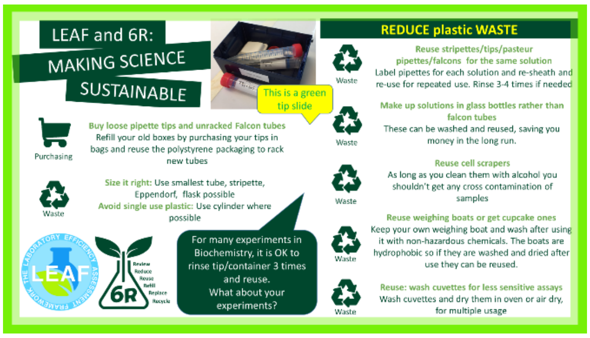
You can do so before the class or make it part of the experiment: one half of the class does this and the other this... **Students love it...**

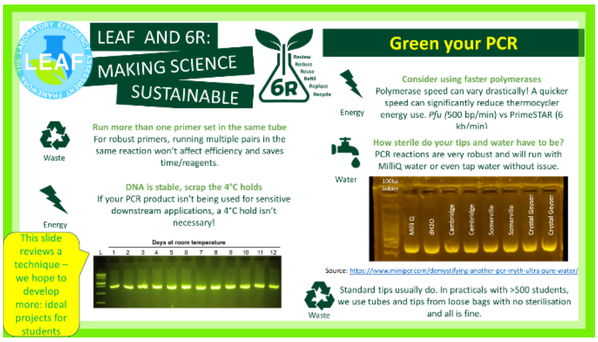
E.g. can the tip/pipette/cuvette be rinsed 3 times and reused without contamination?

E.g. what happens if I remove this 5 min incubation @95C (we also care about energy









The 6R approach

1) We provide an introductory text to students at the start of the unit – a short version is in the guide (doc B in Dropbox)

2) We provide a sustainability statement at the start of each practical reviewed (see next slides and doc B in Dropbox)

3) We use the 6R logo at key steps in the manual to explain rational or remind students not to throw something away (see doc B in Dropbox)

6R review statement to include in manual after ILOs

We have an intro to 6R at the start of the unit and then a statement for each prac reviewed

Example 1 – summary of actions preceded by sustainability ILOs

SUSTAINABILTY IN THE LAB:
This practical was designed using the 6R principles to reduce plastic and waste.

- Containers and cylinders can be washed, reused/refilled, except for microfuge tubes, PCR tubes and Universal tubes for DNA. Pipette tips were minimised, and following testing, we eliminated the plastic sterile loops to scratch the buccal cells.
- The loading buffer is within the PCR mix, saving a tip before loading.
- We are reusing the microfuge tubes for the PCR mix, gel ladder and Safeview, so do NOT throw them away.
- We are piloting the recycling of Universal tubes, so do NOT throw them away.

Happy to share this practical

Possible ILOs to include

Gain an appreciation of when a volume needs to be measured accurately or not.

Be aware of opportunities to implement 6R strategies (refine, reduce, reuse, refill, recycle, replace) for future sustainable experimental design and for personal use

Use appropriate disposal techniques and manage waste sustainably

6R review statement to include in manual after ILOs when prac has been reviewed

Example 2 with impact calculation

Sustainability in the lab:

This practical was designed with the 6R principles to reduce plastic and waste.

Review Reduce Reuse Refill Replace Recycle

For our solutions, we use glass bottles and refill/rinse them. We needed a coloured solution and chose to use a non-toxic washable paint to bypass the need for gloves.

Contamination is not an issue today, so you will reuse the same tip throughout the class, as well as a microfuge tube, and two weighing boats after rinsing them. The latter can be reused for other classes after rinsing.

This practical is provided as doc C in the dropbox

By designing this practical with the 6R principles, we estimate we save 40 pieces per person (mostly tips). With 740 students taking this class, that's 29600 items of plastics collectively for one class!!

Students need precise instructions for clearing up at the end of a class

- Adapt the slides provided to explain precisely
  - how to dispose of waste
  - how to reset room for next class or clear room if this is the end of a class.
- Add slide(s) to manual and project on screen when it is time to clear up.
- As in the lab, it is part of training and good practices to teach students
  - How to dispose of waste following health and safety rules,
  - To keep their space tidy,
  - To keep solutions/containers that can be reused.
  - To wash any items that may need washing before re -using or soaking
  - How to reset for a follow up class (best to provide a picture of what you want)
  - To clear all equipment in side baskets when class is finished.
  - To turn off all equipment after use
  - To return the ipads
  - To take their belongings home
  - To wash their hands after lab

This is important to ensure the maximum impact

We encourage staff to put prompts at the right time in manual to save Energy

Clear and reset for part 1.

Our practicals are repeated, so one class washes, clears and resets for next class

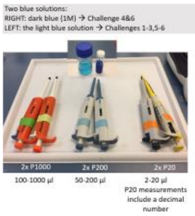
- **If group A and B:** place small equipment and solutions neatly on your bench as you found them at the start
- **If Group C:** place small equipment and solutions in the labelled side baskets
- **Make sure you leave ipad, take all your belongings and wash your hands before leaving.**

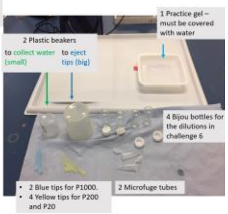
Clinical waste bin	Bench sink	Normal waste bin	6R	Paper bin	Plastic
Gloves Blue roll from bench Tips Microfuge tubes	Water from rinsing SDS-PAGE gel and tank	Blue roll from hand wash Gum Food Empty cup	Collate at end of bench: - PCR master mix tube - Universal tube for DNA after rinsing once Put on side bench any clear plastic packaging	**Outside lab** Paper ONLY	**Outside lab** Bottles ONLY
In the lab				Outside the lab	

Ensure all is ready for the next class.

Empty bijou bottles **only in sink**
Use large beaker as washing bowl for bijou bottle, tips and microfuge tubes. Tap dry on blue roll
Reset work station as below.

Reducing water use matters too





- Dispose of excess blue roll in yellow bag
- Leave goggles on work station
- Leave ipad on bench
- Take your labcoat home

GTAs or project students are well placed to review pracs

1) GTAs demonstrating for a prac & trained in 6R are ideal to review a practical. We pay them 2-3 hours to do so (see method slide 15, rationale slide 16, a practical review example in doc E and summary in slide 17, and more examples in doc F)

2) GTAs can test some steps if you need

3) We now pay two GTAs to cast our SDS-PAGE gels for our classes. This is 3 times cheaper and uses 16 times less plastic (see slide 18 and 19).

Process for a GTA to review a practical

BEFORE class:
- GTA receives training in 6R or demonstrates for a 6R reviewed practical so enough familiarity.
- GTA liaises with academic in charge to agree on observation time and to acquire manual. NB: Best if GTA is actually allocated to the practical.

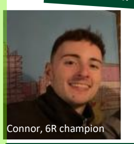
DURING CLASS.
- On top of their normal duties to deliver the class, GTA reviews a practical with 6R guide

The GTA
- Takes pics of layout,
- Observes how students carry out steps of protocol and interact with material
- Jots down notes when they spot excess plastic seems to be used
- Discuss ideas/suggestions to reduce plastics with students, other GTA, academic and**teaching lab tech staff**
- Consider reusing as much as possible within class and possibly from/with otherpracticals (discuss with teaching tech staff)
- Consider the need for sterility and accuracy when it comes to measure volumes.

AFTER CLASS:
- Write a commentary on the manual with proposed reductions and calculate possible impact.
- The academic is presented with the report containing proposals/queries and makes the final decisions for next year. This can be further discussed with the 6R GTA, tech staff in MUL (who will be very knowledgeable on 6R) or Maggy.

LEAF and 6R: MAKING SCIENCE SUSTAINABLE

Review Reduce Reuse Refill Replace Recycle



GTAs are good reviewers

You see in practice when instructions are misunderstood, how students interact with the material, how waste could be avoided by sharing more or a better layout.

Thinking outside the box

Do you know of another practical which uses similar techniques?
Could reagents/consumables be shared or recycled between different labs?
Query that needs to be sterile or not? Why don't you try and see what happens?

TOP TIPS FOR 6R CHAMPIONs

Measuring – size and accuracy matters

Does the measurement has to be accurate?
Can you pour ~ 3ml in cuvette instead of measuring it?
Could a cylinder be used instead of single use plastics?
Are you using the right size? e.g. measure 2 ml with a P1000 rather than a stripette.

Easy changes

Reuse tips! If the same reagent is needed throughout the practical, save the tip (rest it on labelled blue roll) and use it again later.
You could also rinse between uses, esp a 5ml tip. Rinsing 3 times works well in practicals.

Reuse gloves! Unless handling toxic or dangerous chemicals, the same pair of gloves can be reused throughout the whole practical day, or when students come back from toilet or lunch. Here is a video to show how.

What is done with leftover reagents? Can the amount provided be reduced or can the leftovers be used elsewhere?

LEAF and 6R:
MAKING SCIENCE
SUSTAINABLE

TOP TIPS FOR 6R CHAMPIONs

Example savings – BIOL21041

	Proposed change	Current use	Proposed Use	5 year material savings	5 year cost savings
Gloves	Promote reuse of gloves throughout the day	996	332	3320 gloves	£160
6 cm agar plates	Keep only a few spare dishes for the entire lab group, rather than giving each group spare dishes	420	336 6R Review of a practical	420 dishes	£63
Microscope slides	Encourage cleaning and re-use of microscope slides between samples	252	168	420 slides	£12.50
1.5 mL Eppendorf tubes	Share Neurospora strains between groups	462	294	840 tubes	£6.75

Reasons to use homecast SDS-PAGE gels
3x cheaper, 16x less plastic than precast

Comparison for 20 gels	Pre-cast	Home-cast
Acrylamide %	Set % - good choice	Up to you
Cost	£260 (no spare) (1)	£87 (4 spares) [GTA for 3 hours] (2)
Plastic waste	80 items (4 per gel)	5 items for 24 gels (6R applied)

- 2MUL has 43 gel casting set ups, 80 plain glass plates with 1 mm bonded spacers and notched glass plates, and ~ 110 plastic combs
- We trained a team of 3 GTA who cast gels routinely in their lab – ready to work with 2MUL staff
- We optimised protocol: Classic recipe (can adapt) + dye in stacking for well visualisation
- We tested handcast vs pre-cast in 3 settings and vs fast cast in one setting → comparable or better. We also tested 30% APS, but no difference, so **we are sticking to HANDCAST 10% APS as in original recipe + blue stained stacking**
- 12 wells of 60 ul but kit makes difficult reaching well 1 and 12, so consider 10 wells.
- Gels lasts up to a week in cold room.
- Hand cast gels have been running faster than pre-cast in trials, so good if a group is behind.
- Short videos to train GTAs to remove comb, straighten wells if needed and release gel for staining

We have at least of 6 practicals using 300 precast SDS PAGE in SBS

Precast	Home cast
£4,275 (1)	£962
1080 plastic	65 plastic

Handcast SDS-PAGE protocol

6R protocol for 24 gels

Click in Normal View to open and can download

Should use cylinder for large volume but in own lab could also label stripettes to reuse.