UNIVERSITY OF LIVERPOOL

SUSTAINABLE LABORATORIES GUIDANCE

Contents

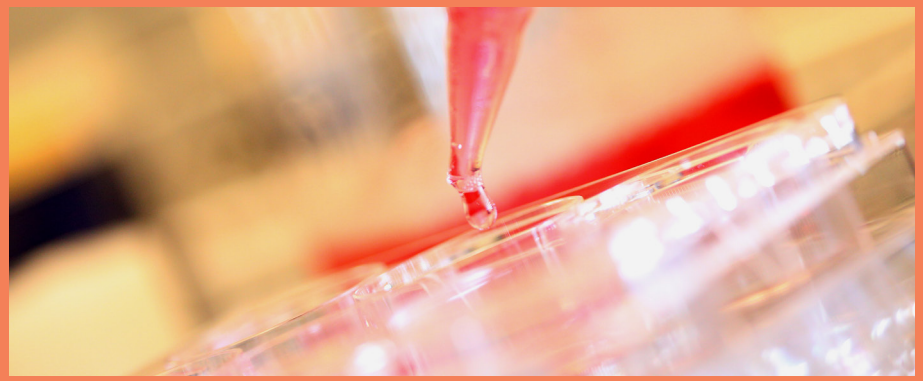
Introduction

This guide is designed to help laboratory users integrate more sustainable practices into their daily work. It offers practical advice on minimizing waste, conserving energy and water, and managing chemicals responsibly – all while maintaining high health and safety standards.

This guide also explores options for waste reduction and recycling, sustainable procurement, and environmentally conscious experimental design.

We recognise that every laboratory is different, so some actions may not be applicable in all cases. For more detailed information on any of the topics below visit the **LEAF (Laboratory Efficiency Assessment Framework) webpages,** where the resources section offers further guidance on these topics and more.

If you would like to discuss sustainability improvements in your laboratory, please **contact** the Laboratory Sustainability Officer.



Health and safety

When enhancing procedures and protocols related to sustainability management, the safety of individuals and the environment – both within and beyond the university – must remain the top priority.

Always evaluate safety considerations before finalising any decisions regarding sustainable practices. In most cases, sustainable solutions align with safety objectives however if there are concerns about potential trade-offs or risks, consult your local Health and Safety Advisor.

Vision and Aims

Vision

This guide supports the ambitions set out in the Sustainability Strategy, Climate Plan and the University's strategic framework, Liverpool 2031. Our vision is to create a more sustainable future for laboratories and for the wider University by reducing environmental impact and embedding a culture of responsibility and continuous improvement.

By minimising waste, energy and water use, and by adopting more efficient practices, laboratories can contribute to the University's sustainability goals. These actions not only support the environment but also improve efficiency and help reduce costs.

Aims

The aim of this guide is to support more sustainable laboratory practices by providing practical information on how to minimise the use of resources such as consumables, energy, and water.

This guide offers guidance on sustainable chemical management, reducing and efficiently handling waste, and procuring laboratory consumables responsibly. Additionally, it highlights potential cost-saving opportunities, supports adherence to the environmental policies of grant funders, and contributes to protecting the environment. These efforts also align with our commitment to continuous improvement under our ISO 14001 environmental management accreditation.

LEAF

LEAF is a green initiative developed by UCL used to improve the sustainability and efficiency of laboratories, technical workspaces, workshops, studios and galleries.

LEAF is a program that evaluates the sustainability of laboratories and helps them reduce their carbon footprint. By providing laboratories with guidance and resources, LEAF helps increase efficiency in 10 areas': waste, people, purchasing, equipment, IT, sample and chemical management, research quality, teaching, ventilation and water. Participating laboratories are awarded either a bronze, silver, or gold award depending on how many sustainable actions they take.

Why join LEAF?

Becoming accredited by the Laboratory Efficiency Assessment Framework (LEAF) helps optimise the sustainable impact of your laboratory and supports the University's Sustainability Strategy.

Laboratory-based research is essential for advancing society but is also extremely energy and resource-intensive. Improving the sustainability of laboratories is crucial for minimising their environmental impact and ensuring the responsible use of resources for future generations. See **here** for more information on LEAF at the University.

"It's estimated that laboratories are responsible for around 2% of global plastic waste and use 3-10 times more energy per meter squared than a typical office."

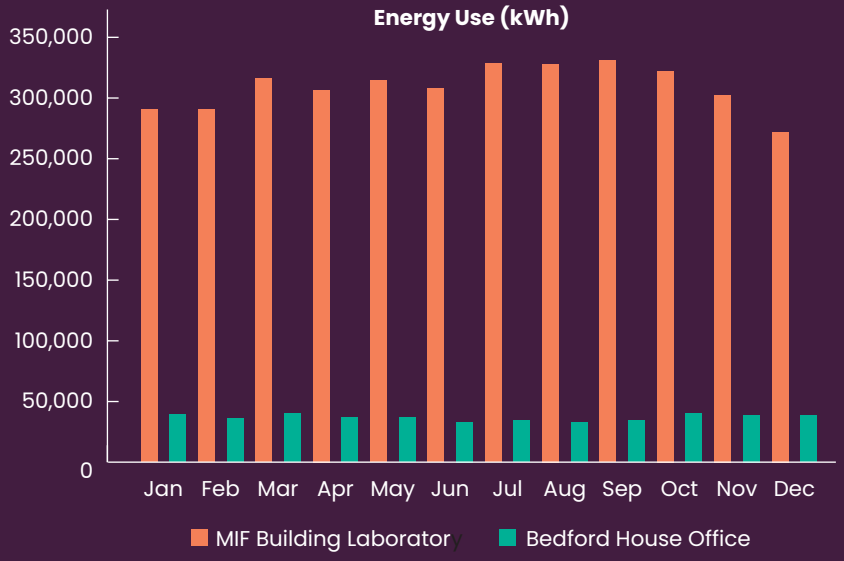
UCL LEAF website

Energy

40% of global CO2 emissions come from generating electricity and since laboratories consume 3-10 times more energy than a typical office building, they are one of the most energy intensive industries.

The graph below compares the energy usage between an office building – Bedford house and a laboratory building – the Materials Innovation Factory, for the calendar year 2024.

This difference in energy consumption highlights the importance of reducing energy use in our laboratories. Below is information on some of the most energy-intensive equipment, along with tips on how to operate them more efficiently.



Fume hoods

Air circulation is a major contributor to the high energy consumption in laboratories. This includes equipment such as fume hoods, laminar flow cabinets, biosafety cabinets, and general air conditioning systems.

Fume hoods can consume as much energy as 2–3 average UK households per year when in continuous operation. It is therefore important to understand how they work and explore ways to **reduce their energy use**.

Types of fume hood ventilation systems

There are two main types of fume hood ventilation systems:

- **Constant Air Volume (CAV):** These systems operate at a fixed fan speed, providing a consistent volume of airflow regardless of sash height.
- **Variable Air Volume (VAV):** These systems adjust the airflow based on the sash position. When the sash is raised, airflow increases; when lowered, it decreases.

For safety and energy efficiency:

- Raise the sash only when actively working in the hood.
- Lower the sash when not in use to reduce energy consumption and protect lab personnel.

VAV fume hoods consume less energy because energy use is directly related to the volume of air being exhausted, lowering the sash on a VAV fume hood can result in significant energy savings.

Good

Bad

Fume hood best practice

Before starting work	Check there is a test sticker fixed to the cabinet and confirm that it has been annually serviced. Ensure the fume hood is operational and there is airflow – use a piece of tissue to check for air movement. **Check no alarms are sounding, the airflow is between 0.3 and 0.8m/sec and the indicator light is green.** Report any issues to PCS immediately.
Keep the sash at the appropriate height during work	The **appropriate sash height is ≤ 0.5m**. the sash is designed to protect the user therefore must be kept as low as possible. **Never open the sash above the safety catch and never position your head inside the fume cupboard.**
Shut the sash when not in use	This will protect against any accidents in the hood and reduce the energy consumption of a VAV fume hood.
Do not use for excess storage of chemicals or equipment	Storing excess items under the fume hood can block the air flow resulting in less effective protection and increase energy consumption. Only bring in items you require and remove all items after use. If required use a dedicated vented storage area for chemicals.
Move arms in and out of the fume hood slowly and avoid unnecessary movement in front of the hood	Poor operator movements may lead to turbulence and may result in unsafe containment aswell as increase energy consumption.
Work at least 15cm inside the hood.	Contaminants released close to the sash are at an increased risk of being released from the fume hood.
Make sure items are placed at least 20cm behind the sash, 10cm from the sides and nothing is blocking the back	Placing items close to the edges of the fume cupboard can disturb the air flow resulting in less effective protection and increase energy consumption.
Maintain appropriate face velocity (as checked by an anemometer)	Check manufacturers guidance but face **velocity should be between 0.3 and 0.5 m/sec** report to PCS if this falls out of this range.

All these measures can help reduce energy consumption by 30–50% without compromising health and safety.

Cold storage

Fridges and freezers are among the highest energy consumers in laboratories. In addition to their direct energy use, they generate significant heat, placing extra demand on HVAC systems and indirectly increasing overall energy consumption.

Ultra-low temperature (ULT) freezers, typically set between -80°C and -70°C, are especially energy-intensive. A single ULT freezer can consume as much energy as an average UK household over the course of a year. With over 400 ULT freezers in use across our campus, this represents a substantial portion of our laboratory energy use.

As ULT freezers age, their energy efficiency declines. In fact, each year of a ULT freezer's life results in an estimated **3% increase in energy consumption**.

Below is a comparison between an older model currently in use on campus and a newer, more efficient model available on the market.

Model	Annual energy consumption (kWh)	Annual carbon emissions (kgCO2e)	Annual cost (£)
Old	10,862	2,249	1,629
New	1,825	378	456

Cold storage best practice

Many cold storage units across campus may be consuming more energy than necessary due to poor management and maintenance. Implementing best practices can:

- Reduce carbon emissions
- Extend the lifespan of equipment
- Better protect stored samples

The following outlines practical steps that can be applied to all cold storage units to improve efficiency and sustainability:

Inventories	Place a sample inventory sheet/map on the outside of the unit. This helps identify where samples are kept, and how long they have been stored for. Knowing sample locations reduces the amount of time where the unit door is open and reduce the amount of warm air entering the freezer.
Positioning	Position cold storage units away from heat sources and in well-ventilated rooms that are between 20-25°C. Do not push units against walls, leave a gap for vents to properly draw/expel air. Do not sore any items on top of cold storage units.
Sample storage	Clearly label all samples with the type, name, date, owner and expiry. Store samples in labelled boxes and use racking for ULT freezers to allow quick retrieval. Review stored samples regularly and dispose of unneeded or unlabelled items. Ensure samples are stored at the appropriate temperature i.e. do not store at -80°C if -20°C is adequate. -20°C freezers consume up to 80% less energy than a ULT freezer.
Doors	Open and close doors as quickly as possible and avoid leaving the door open for extended periods of time to reduce the amount of warm air entering the unit.
Empty space (ULT only)	Avoid leaving large empty spaces in freezers, as this can increase energy consumption, use empty polystyrene boxes to fill gaps.
Temperature	Consider turning up your ULT from -80°C to -70°C, this can reduce energy consumption by up to 30%. There is a growing body of **evidence** to show that -70°C is safe for most samples. For -20°C freezers consider adjusting to -15°C and change fridge settings from 4°C to 7°C if possible.
Temperature monitoring	All ULT freezers should be connected to a temperature monitoring system, –20°C freezers and fridges can also be added where feasible.
Maintenance	Carry out regular maintenance: check and clean filters to prevent them from becoming blocked, check doors and seals for damage and report any issues immediately. Remove ice build-up regularly and fully defrost annually. During the annual defrost check inventories and dispose of any unwanted and unlabelled samples.
Faults	Report faults immediately. Consider placing an emergency contact number on each unit for quick response.

Good

Bad

Purchasing

Before purchasing a new cold storage unit, we recommend considering the following:

- Check for availability: Are there any spare or underutilised units already available within the University?
- Assess your actual needs: Do you require a new unit, or could space be freed up by clearing out old or unwanted samples? For ULT freezers, would additional racking provide the storage you need?
- Replacing an older unit: Ensure that any new model you consider is energy-efficient and more efficient than the unit you're replacing.
- Buying a new unit (not replacing): Select a unit that is appropriately sized for your needs—avoid purchasing a larger unit than necessary. Also, confirm that the model is energy efficient.

Further guidance

For more information on managing and maintaining ULT freezers, please refer to the University's **Ultra-Low Temperature Freezer Guidance**. This document also includes a maintenance checklist that should be followed for all ULT freezers.

Other laboratory equipment

Many smaller laboratory devices are also significant energy consumers. For example:

- A **heat block** set at 95°C can use as much energy as **1.5x -20°C freezers**
- A **10–12L water bath** maintained at 37°C can use as much energy as **1x -20°C freezers**
- A PCR machine, dependant on the cycle can use as much energy as **4x -20°C freezers per run.** Holding at 4°C overnight can add **3x more -20°C freezers** to this.

Being aware of the energy impact of everyday equipment can help reduce overall lab energy consumption.

Equipment best practice

Measure Heat-Up and Cool-Down Times for equipment	Record how long equipment takes to heat up or cool down (e.g., time for a heat block to reach 95°C or a centrifuge to cool to 4°C). This helps reduce idle running times. **Label** equipment with this information for user reference.
Turn off equipment when not in use	Switching off equipment reduces energy consumption directly and indirectly (by lowering laboratory temperature and easing HVAC load). It also reduces wear and tear on equipment.
Avoid standby mode	Equipment in standby still uses energy. Switch off equipment fully, when possible, rather than leaving them on standby or using screen savers.
PCR hold times and temperature	Always move samples to the fridge after the run and time runs to avoid having to hold temperature overnight. Holding at 4°C overnight can use the same energy as 3x -20°C freezers.. Holding at 10°C after a run rather than 4°C can use almost 50% less energy.
Sticker up	Place stickers (available from the Laboratory Sustainability Officer) to indicate which equipment can be switched off and which must remain on.
Booking sheets	Use booking sheets for equipment like safety cabinets, fume hoods, PCR machines, centrifuges, and heat blocks. This helps schedule use including heat-up and cool-down times and allows users to switch off equipment when not needed. Check booking sheets regularly and switch off equipment if no one is scheduled to use it after you.
Maintenance	Keep equipment well-maintained to ensure it runs efficiently and consumes less energy.
Batch loads	For equipment that supports batching, run only full loads and set scheduled run times. Communicate with lab users to coordinate batching.
Share equipment	Sharing equipment within and between labs saves money, reduces space needs and prevents excess WEEE waste. Check local inventories before purchasing.
UV decontamination	Limit UV lamp uses to required sterilisation time – generally 20–30 minutes in PCR and biosafety cabinets.
Switch to LED lighting	Replace fluorescent lights with LED alternatives, especially in microscopy. LEDs consume less energy and have a longer life span.
Right size your equipment	When buying new equipment, select sizes that match your actual needs to avoid unnecessary energy consumption.
Computer Use	Turn off monitors at the end of the day – leaving one monitor on overnight can waste enough energy to print 500 pages or microwave 6 dinners. Activate sleep mode - Laptops use between 15-60 watts when in use but only 2 when in sleep mode. Avoid screen savers – these prevent to monitor going into sleep mode and waste energy.

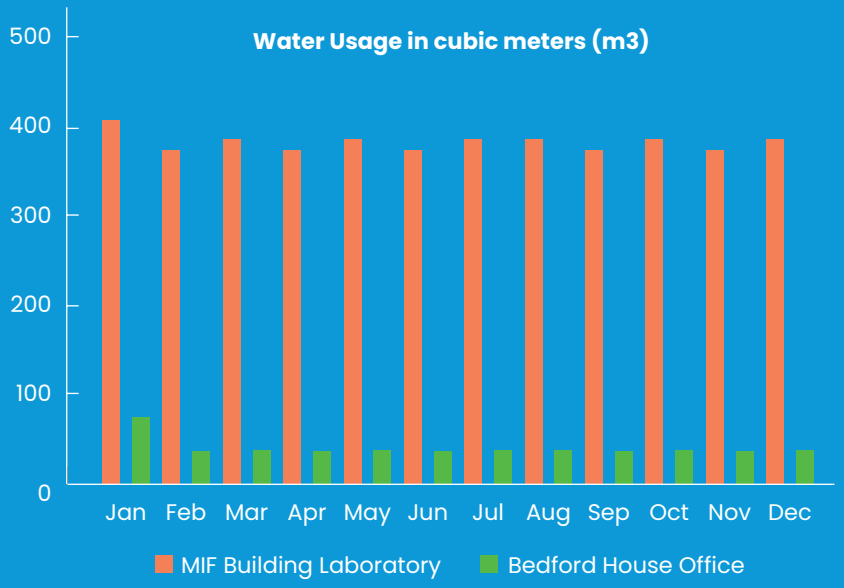
Water

Laboratories use at least 5x more water than a standard office building.

The below graph compares the water usage between an office building – Bedford house and a laboratory building – the Materials Innovation Factory, for the calendar year 2024.

With water considered as a finite resource we must manage our global water supplies **more efficiently**.

Some of the items of equipment we use in the laboratory are extremely water intensive and we need to look at ways we can reduce this water consumption. As well as equipment we also need to think about the amount and type of water we use in the laboratory.



The following is some information on the most water intensive pieces of equipment and water intensive operations in the laboratory and tips on how we can reduce the water usage.

Autoclaves

Autoclaves use high temperatures and pressure, combined with steam, to sterilise equipment, reagents, and hazardous waste. While essential in laboratories, they are also highly energy- and water-intensive.

A typical steam-jacketed autoclave can use up to **230 litres of water per cycle**, with older models (10+ years) potentially consuming even more. In addition to high water use, autoclaves also draw a significant amount of energy during operation. Putting autoclaves in standby mode, using autoclaves with automatic standby mode, or powering autoclaves off, when possible, can help save energy and water, always consult the operating manual before proceeding.

For more details on autoclave types and their water/energy usage, see this **report** by My Green Lab.

Autoclave best practice

Consolidate loads	Only run the autoclave when you have a full load, schedule times for running clean or dirty loads to allow items to build up.
Does it need to be autoclaved?	Evaluate whether items really need to be autoclaved – only sterilise what is required.
Choose the right model	When purchasing a new autoclave, consider energy efficiency and water consumption. Select the smallest model that meets your needs for greater efficiency.
Consider a bench top model	For small volumes, bench-top autoclaves can be more efficient, using less water and energy than larger units. Always consult with your health and safety teams before using a bench top model to make sure it meets the required COSHH regulations.

Single-pass cooling

Single-pass cooling uses a continuous flow of water to cool equipment or reactions, after which the water is discharged down the drain.

- Water condensers can use up to **2 litres per minute**. When used for several hours or overnight, this results in a large volume of wasted water and increases the risk of laboratory flooding.
  - **Alternative:** Replace with **air condensers**, which use specially designed glass to promote condensation using ambient air—no water is required.
- Use **chiller units** instead of tap water cooling. Chillers provide stable temperature, pressure, and flow while using significantly less water (approx. **21 litres per hour**). They offer a cost-effective, environmentally friendly solution.

Glasswashers

Glasswashers are used to clean glassware of chemicals and other contaminants. While they typically use potable water, many also include a final rinse using deionised (DI) or reverse osmosis (RO) water.

- Water consumption varies based on size and rinse settings, typically ranging from **170–340 litres per load**.
- To reduce waste:
  - Only run glasswashers when fully loaded.
  - Avoid washing unnecessary items.
  - Where appropriate, reuse glassware multiple times for the same substance instead of washing after each use.

Water baths

Water baths require regular maintenance to prevent contamination and bacterial growth, which often involves water changes and the use of additives.

- **Efficiency tips:**
  - Always keep water baths **covered** to reduce heat loss and evaporation.
  - Where suitable, **replace water baths with heat blocks**, which consume less energy and eliminate the need for water and chemicals.
- **Alternative solution:** Use **Lab Armor beads**:
  - Suitable for non-circulating and non-shaking water baths.
  - Can also be frozen and used in place of ice in buckets.

Ice

Use **only the necessary amount of ice**—avoid overfilling buckets unless essential. If **Lab Armor beads** are available, freeze and use them as a sustainable alternative to ice.

Cooling blocks for tubes (e.g., PCR cooling blocks) are a better option:

- Stored at -20°C.
- Maintain 0–4°C for up to 3 hours.
- Change colour when temperature rises above 7°C.

Maintenance

Report leaking taps immediately, a dripping tap can waste up to **1,460 litres of water per year**.

For **Legionella management**, University of Liverpool **policy** requires all "infrequently used" outlets (i.e. unused for 7 days or more) to be **flushed for 3 minutes every 7 days**. If any outlets are no longer in use, consider having them removed or isolated.

Water purity

Laboratories use water at different purity levels, each suited to specific experimental needs. It's crucial to:

- Use the **appropriate level of water purity** to prevent contamination and avoid unnecessary repeats.
- **Avoid using ultra-pure water where it's not required**—it can take **up to 5 litres of tap water** to produce **1 litre of ultra-pure water**, resulting in **4 litres of waste**.

Type 1 or **ultrapure water** is the purest form of water, It has extremely low levels of Ions, organics and biological contaminants. Type 1 water Is used for the most critical applications Including:

- Cell and Tissue Culture
- Liquid Chromatography, including High Performance Liquid Chromatography (HPLC)
- Gas Chromatography
- Inductively Coupled Plasma
- Mass Spectrometry (ICP-MS)
- Molecular Biology
- Polymerase Chain Reaction
- (PCR)

Type 2 or **deionised water** is more economical and uses a different grade of ion-exchange resin. While it still maintains a high purity level it Is used for applications that don't require the highest level of purity. Type 2 water can be used in the following applications:

- General Lab Practices
  - Buffer preparation
  - Media preparation
  - Sample dilution
  - General chemistry
- Feed water for clinical analysers
- Microbiological Analysis and preparation
- Electrochemlstry
- FAAS
- General

Type 3 or **RO water** is produced through the purification technology reverse osmosis, It Is the most economical method of removing up to 99% of contaminants In potable water. Type 3 has the lowest purity level and can be used for the following applications:

- Cleaning glassware
- Water baths
- Autoclave feed

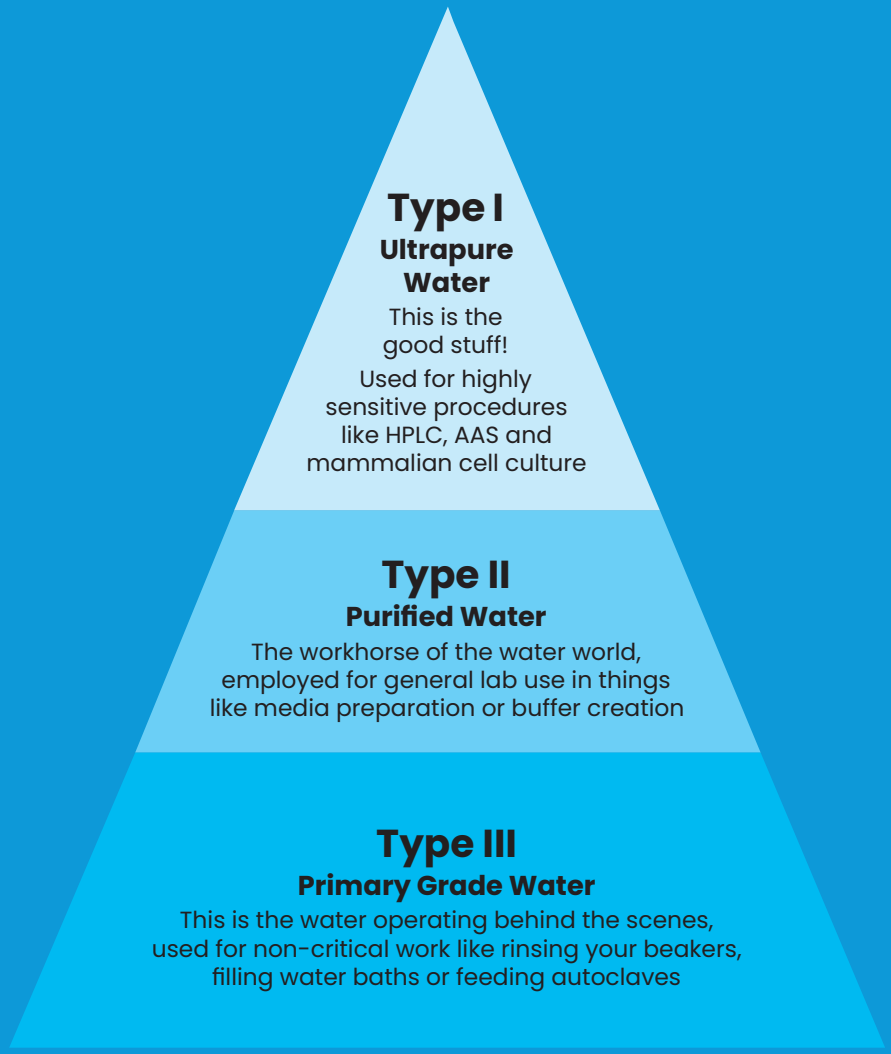


Diagram showing the different types of water used in the lab, ultrapure water, pure water and primary grade water. *©ELGA LJbWater 2014*

Chemical Management

Chemical management can cost up to £1 for every £1 spent on the chemical itself and the way we use and manage our chemicals can have a huge environmental impact. The following offers advice on how we can manage our chemicals in a more sustainable way.

Preparing

Plan experiments in advance and prepare only the quantities needed. This reduces chemical handling, waste, and disposal costs. It is better to prevent waste than to treat or clean up waste after it has been created.

Conduct reactions at the **smallest possible scale** ("right-sizing") and analyse results before scaling up.

Record detailed information on reaction conditions, procedures, and data to enhance reproducibility. Share **negative results** to avoid unnecessary repetition.

Check for **less hazardous alternatives** and substitute where possible. Practice **greener solvent selection** by choosing solvents with lower toxicity and environmental impact. Use solvent selection guides such as:

- **Curr Green Chemistry Organic Resource Guide – Beyond Benign**
- **CHEM21 Solvent Selection Guide – ACS GCI Pharmaceutical Roundtable**
- **Greener Solvents – Merck**
- **Royal Society of Chemistry**

There is no universal solvent selection method; use these resources to choose the best solvents for your specific methods.

Labelling

How chemicals are labelled with vary greatly depending on the type of laboratory you work in, always follow your group's guidelines for chemical and sample labelling.

Clear and consistent labelling is essential for safety, proper storage (preventing degradation), disposal, sharing, data management, and reproducibility.

Unidentifiable chemicals must be disposed of as **unknown waste**, which can cost up to **five times more** than disposal of known chemicals.

Management, storage and procurement

Maintain an up-to-date inventory of all chemicals in your lab to promote sharing and avoid over-purchasing.

Before purchasing, check if the chemical is already available within the lab, building, or department. If the chemical is not available, then purchase the **smallest volume** necessary for your needs.

Store chemicals in appropriate locations; consult your local health and safety advisor if unsure. Replace damaged containers and storage units immediately and use secondary containment where possible.

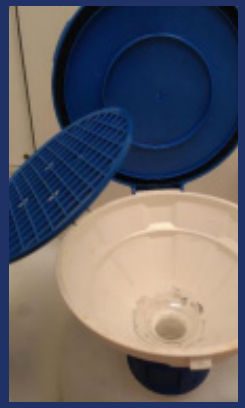
Waste and disposal

Ensure **proper separation of waste streams** and have clear guidance, such as waste SOPs or charts.

Keep waste containers closed when not adding waste to prevent solvent evaporation or use funnels designed to minimize evaporation.

NEVER DISPOSE OF HAZARDOUS CHEMICALS DOWN THE SINK. Disposal must comply with the Water Industry Act 1991, Environmental Protection Act 1990, Environmental Damage Regulations 2015, and Hazardous Waste Regulations 2005. Proper disposal protects both the University's drainage infrastructure and the wider environment. More information can be found on the University Safety Advisors Office intranet pages and the LEAF webpages.

If you are in any doubt whether a solution can be put down the sink, contact the Departmental H&S Advisor.



Hints and tips

For vacuum pumps used overnight, improve sustainability of cold traps by avoiding pure liquid nitrogen. Use frozen isopropanol instead, which is effective without condensing oxygen. Frozen acetone is less environmentally friendly and has poorer freezing properties.

Enhance HPLC purification by using columns with smaller inner diameters to reduce solvent use and waste. Consider greener solvents like ethyl acetate/ethanol mixtures or heptane.

Reuse cartridges for automated flash chromatography systems up to **5 times** (reverse phase cartridges up to **100 times**) as recommended by suppliers.

Green Chemistry

Green Chemistry is an approach to chemistry that aims to maximise efficiency and minimise hazardous effects on human health and the environment. You can optimise synthesis by applying these principles.

The **12 principles of green chemistry** are a framework for evaluating and minimizing the impacts of a product or process. Some of the principles also incorporate tools for calculating efficiency or minimizing waste.

It is vital to embed green chemistry principles into lab practice and education. This **guide** aims to support labs in adopting sustainable chemistry methods effectively.

It is important to recognise that green chemistry principles are not just for chemistry laboratories, they can be embedded into biology and medical laboratories aswell. Please follow available guides for more information.

Consumables

Laboratory plastics account for approximately 2% of the total global plastic waste produced each year. A 2015 *Nature* article estimated that academic research laboratories generate around 5.5 million tonnes of plastic waste annually.

Studies have shown that **reusing glassware and plasticware** significantly reduces both **CO_2 emissions** and **costs**, compared to relying on single-use plastics.

Below are some practical examples of how you can reduce consumable use in your laboratory.

Consumable use best practice:

Refuse	• Research products before ordering and refuse unsustainable products. • Reduce deliveries and packaging waste by sharing resources and only purchasing what you need, consolidate orders with other lab users.
Reduce	• Optimise experimental design to minimise consumable use, plan ahead and select the smallest vessel suitable for your needs (e.g. 1.5ml, 2ml, 5ml, 15ml, 25ml or 50ml tubes) • Use tip refill systems or even bagged tips, this can reduce the amount of plastic coming into the lab by up to 63%. • When running a PCR think if a plate is required, if you are not running a full plate then use strips instead. • Although safety in the lab is paramount, not all lab operations require the use of gloves. Think about if gloves can be reused or if they are necessary for your task.
Reuse	• Reuse plastics where possible (e.g. reservoirs, serological pipettes and even tissue culture flasks can be reused when growing up cells). • Reuse packaging within the lab or send back to suppliers if possible. • Use a box for centrifuge counterbalance weights to avoid preparing new ones each time. • Wash and reuse empty glass chemical containers for waste collection.
Repurpose	• Repurpose empty plastic containers, such as media bottles for waste tips, tip boxes for sample storage, and the wafers of some sizes of tips are great for holding PCR tubes.
Recycle	• Recycle what you can in the laboratory, not all waste produced in labs is hazardous. • Take advantage of supplier take-back and recycling schemes.
Replace	• Replace plastics with alternatives like glass, paper, or wood. • Use glass bottles to make up solutions instead of plastic tubes. Glass bottles can also be autoclaved before use if a sterile container is required, if the autoclave is being used for a run fill any space with glass bottles. Remember autoclaving is very energy intensive so only run the autoclave when it is full. • Switch plastic loops/spreaders to reusable metal or wooden toothpicks for picking colonies. • Replace plastic serological pipettes with glass or use a measuring cylinder. • Use paper cases or glass dishes as weigh boats or weigh directly into container. • Replace plastic disposafe jars with bio-bins which are made of 96% paper, these are available in various sizes. • Consider using animal-free alternatives (e.g., FBS and antibodies) in place of animal products.

Waste and Recycling

Waste hierarchy

Prevent
Top priority is placed on preventing waste. Avoid unnecessary consumption and purchases.

Reduce
Can unnecessary packaging be reduced. Reduction can be as simple as switching to more resource-efficient alternatives.

Reuse
Reusing products and materials before it becomes waste. Can materials or items be re-used elsewhere.

Recycle
Can the materials be recycled, either in whole or in part to turn the waste into a new product.

Recover
Where further recycling is not possible, materials, chemicals or energy could be extracted from waste through processes such as anaerobic digestion or incineration with energy recovery.

Dispose
In certain scenarios, materials that cannot be reused, recycled or recovered for energy will be landfilled or incinerated (without energy recovery).

Reuse and resale

The University offers several options for the redistribution, reuse and resale of surplus or unwanted laboratory equipment, furniture and consumables.

For all data-bearing assets issued by ITS follow the **IT Services Disposal Guidance** for secure data destruction before being redistributed, resold or recycled.

For more information on any of these services visit the **Circular Economy intranet pages** or **contact** the Circular Economy Manager.

Recycling

Once reuse, resale, and take-back options have been explored, recycling or disposal of unwanted and non-functional lab equipment can be arranged:

- Submit a request via the Property and Campus Services Hub to arrange collection by the Heavy Gang.
- Collected equipment is recycled through the University's waste contractor.

For laboratory consumables, if reuse or resale isn't possible, they should be recycled wherever feasible.

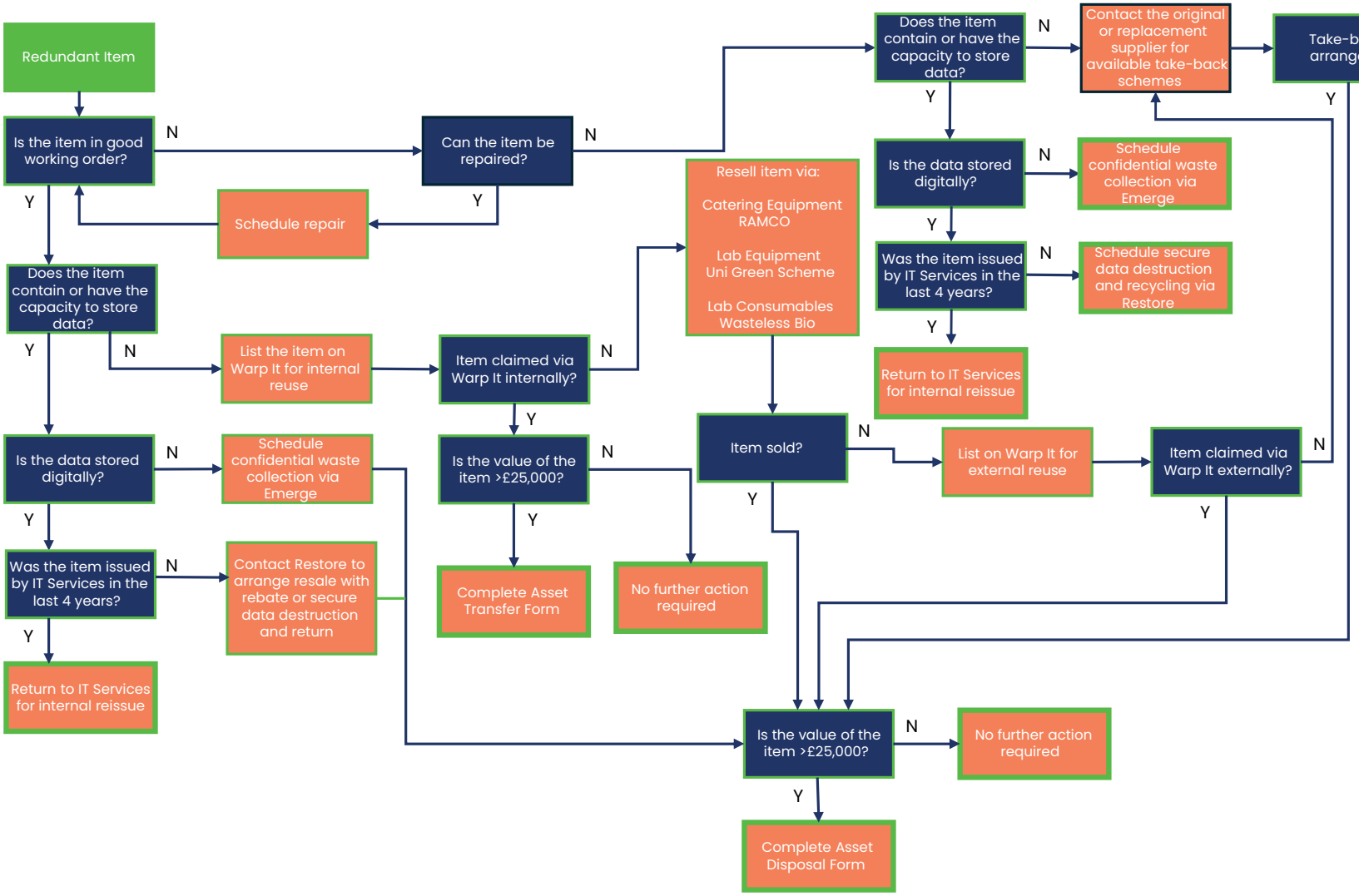
For more information on these processes and recycling options available at the University please visit the **Waste and Recycling intranet pages**.

Many laboratory waste types are recyclable and some suppliers offer take back schemes, please see **here** for more information. Additional schemes may be available—speak to your supplier for more details.

Important: For all recycling schemes, please notify us of any collections so we can document them for **legal compliance**.

Other common laboratory items that are not collected by suppliers can also be recycled, please see **here** for more information or **contact** the laboratory sustainability officer.

Circular solutions for surplus items



Procurement

Laboratory suppliers now offer a wide range of sustainable options, so it's important to do your research before procuring goods. Reach out to the suppliers to gain insight into what they are doing to improve sustainability – both in their products and on their company practices. Some useful information can be found here.

Equipment

Before purchasing equipment for your laboratory, check if it is already available for use or redistribution within the University.

The **Liverpool Asset Management System (LAMS)** is the University's centralized register for equipment. It allows laboratories to manage equipment throughout its lifecycle—from planning and purchase to use and eventual disposal. More information can be found **here**. Access LAMS **here** to list the assets within your laboratory area and to check if the item you need is already available on campus.

Using the University's **reuse** platforms you can check if an item has been listed for redistribution. If another laboratory no longer needs a piece of equipment, it can be transferred to your laboratory instead of purchasing new.

If the equipment is not available on these platforms, consider the environmental impact of your purchase:

- Check the energy rating of the equipment.
- Look for eco-friendly and energy-efficient models.
- If possible, ask the vendor for a **Life Cycle Assessment (LCA)** to understand the full environmental cost of the equipment.

Pre-installation assessment

Prior to purchasing any large items of equipment that may require hard-wiring or changes to the fabric of the building, please contact PCS to check if installation will be possible.

Equipment maintenance and repair

When procuring equipment, it is advisable to check the warranty agreements and take out the necessary maintenance and repair contracts once the warranty expires. Make sure all laboratory users are aware of all warranty and maintenance contract details and know who to contact in case of a breakdown.

Please ensure **repair** of existing equipment is explored prior to purchasing new. Some **organisations** may be approached for the purchase of second-hand spare parts, especially in the case of discontinued models.

Consumables

When purchasing consumables, making informed and sustainable decisions is essential. Many suppliers now offer eco-friendly alternatives to commonly used lab items. Check if the items you need are already available from another lab on the university reuse platform.

Tips for Sustainable Consumable Management:

- **Maintain inventories** of consumables and track stock levels to avoid over-ordering.
- **Set up a centralised ordering system**, such as a shared spreadsheet, to prevent duplicated orders.
- **Consolidate orders** with others in your lab, department, or building to reduce the number of deliveries to campus.
- **Order only what you need**—special deals like "buy one get one free" may lead to unnecessary waste if surplus items go unused.
- **Order chemicals in appropriate quantities** to minimise hazardous waste.

Consider using the **ACT label database** (Accountability, Consistency, and Transparency). This independent system provides environmental impact ratings—covering manufacturing, energy and water use, packaging, and end-of-life disposal—allowing you to compare products across companies.

Exit checklist

Use an **exit checklist** when a staff member or student leaves the laboratory. This ensures that their consumables, samples, and equipment can be redistributed among other laboratory members or correctly disposed of, helping to:

- Prevent unnecessary purchases,
- Reduce waste from expired items,
- Free up storage space in fridges and freezers,
- Avoid long-term storage of unneeded samples.

An example of an exit checklist can be found **here**.

Resource Use

Effective resource management is essential for maintaining an efficient, sustainable, and well-organised laboratory environment. The following guidelines outline practical steps to optimise the use of samples, reagents, equipment, and shared facilities, helping reduce waste, minimise costs, and support collaborative working across research groups.

- Be aware of the recommended storage conditions for samples and reagents. Do not store items in an ultra-low temperature (ULT) freezer if they can be safely stored at –20°C or in a fridge, or at room temperature if stable.
- Ensure all samples, chemicals, and reagents are **clearly labelled** to avoid confusion and misuse.
- Maintain a **database** of storage locations for samples, chemicals, and reagents. This helps save time when locating items and reduces the risk of duplicate purchases. Where possible, share your inventory list with other labs to encourage resource sharing.
- **Regularly dispose of** outdated or unnecessary samples, chemicals, and reagents to optimise the use of fridges, freezers, and general lab space.
- **Share equipment** whenever possible and make full use of the **Liverpool Shared Research Facilities (LIV-SRF)**. These facilities offer flexible access to world-class equipment, resources, and expertise to support your research. More information on LIV-SRF can be found **here**.
- Before placing an order check local inventories to see if the item is already available within the institution.

Tips for Sustainable Experimental Design

Optimise experimental planning

Plan and optimise your experiments in advance to reduce the use of consumables and reagents, and to minimise waste. This can be achieved by:

- Conducting a feasibility study
- Reviewing past research
- Using appropriate controls
- Considering multiplexing where possible

Thoughtful planning can improve efficiency and sustainability across your workflow.

Check if samples required have been gathered by a previous study or are stored in the University Biobanks rather than gathering novel samples.

Optimise resource use

Reducing plastic waste does not necessarily require changing experimental steps but can often be achieved simply by altering the handling of single-use consumables.

Examples include:

- Using appropriately sized containers to match your experimental needs, don't use a 50 ml Falcon tube if 15 ml will suffice.
- Avoid using a full PCR plate if fewer samples are required—use strips or tubes instead.
- Only prepare the volume of chemical solution needed; for instance, don't make up 1 L if you only need 100 ml.
- Preparing master mixes and optimizing pipetting orders can enable reusing of pipette tips, reducing the amount used.

Small adjustments like these can significantly reduce waste and costs.

Use greener solvents

Refer to the **Chemical Management** section for guidance on using greener solvents and incorporating the **12 Principles of Green Chemistry**. Adopting these practices can reduce environmental impact, enhance lab safety, and generate cost savings.

Microscale experiments

Microscale experiments use smaller quantities of reagents and generate less waste compared to conventional approaches. Benefits include:

- Reduced chemical consumption
- Improved safety
- Lower costs
- Greater efficiency in resource use

Equipment

Use lab equipment efficiently and only for the necessary duration:

- Determine and record heat-up and cool-down times and include this in protocols.
- Make sure all equipment is being used optimally, consider temperatures used and duration of use.
- Schedule experiments so that equipment is used within optimal time frames and avoid leaving equipment (e.g. PCR machines) on overnight unless absolutely required

Proper management of equipment helps reduce energy consumption and wear and tear.

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