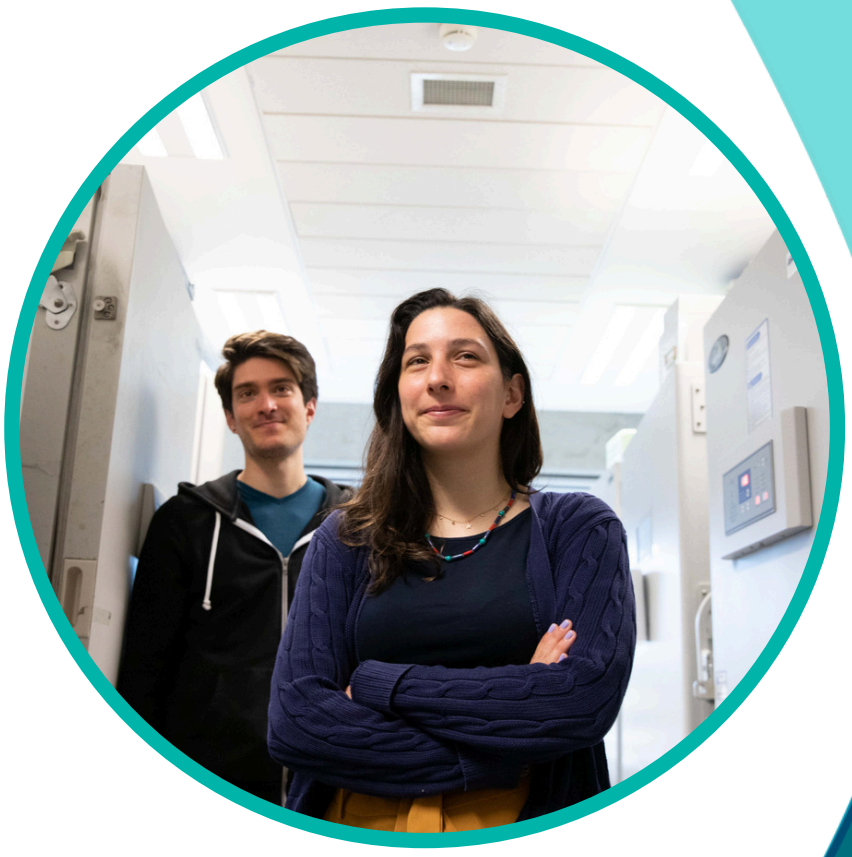
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

GREEN LABS GUIDE



TRINITY SUSTAINABILITY

tcd.ie/sustainability | **greenlabs@tcd.ie**

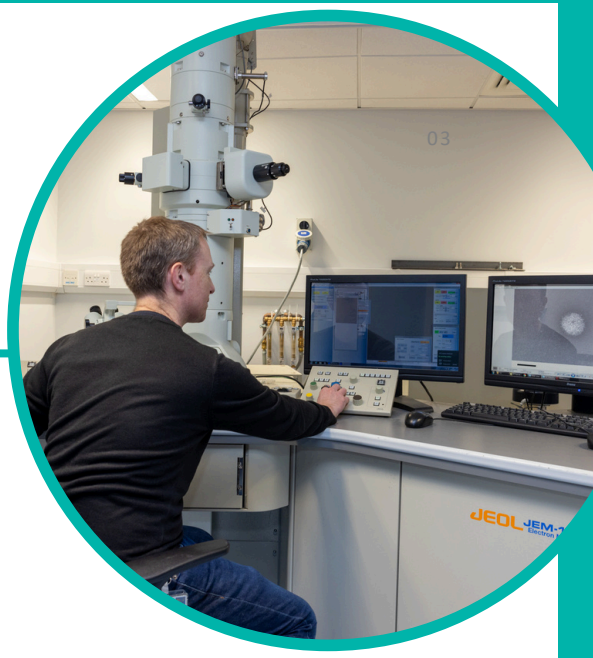
Sustainable Research

Why aim for greener labs?

In today's scientific landscape, the urgency for sustainability in laboratory practices has become increasingly clear. Laboratories across diverse fields—biology, chemistry, physics, medicine, engineering, and more—are resource-intensive, with high energy demands, substantial waste production, and significant consumption of water and other materials. For example, laboratories consume 5–10 times more energy per square meter than office buildings, with ventilation and specialized equipment like fume hoods and ultra-low temperature freezers driving these figures. Similarly, lab water usage exceeds that of standard office spaces, with autoclaves and cooling systems as major contributors. Waste, including chemicals, single-use plastics, and electronic equipment, further compounds these challenges, underscoring the environmental footprint of research spaces.

This guidebook is designed to empower laboratory professionals to make meaningful changes in their practices. It provides actionable strategies for improving energy efficiency, optimizing water use, managing waste responsibly, enhancing digital sustainability, and adopting sustainable procurement methods. By focusing on these areas, researchers can significantly reduce their environmental impact while achieving substantial savings for their labs, all without compromising the quality and rigor of their work.

Energy

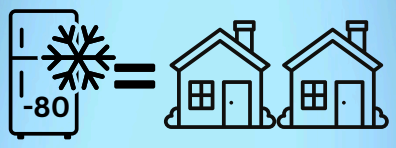


Fume Hoods

- Keep the sash as low as possible during operation.
- Use sash ruler stickers for guidance.
- Close the sash completely when not in use; this saves energy and enhances safety.
- Report malfunctions in automated systems immediately to facilities management.
- Avoid using fume hoods as storage areas where possible.

One fume hood uses 3.4 times more electricity than an average Irish household.

Freezers and cold storage



One ULT Freezer uses twice as much electricity as an averageIrish household.

- Implement a cleaning and defrost roster.
- Defrost annually.
- Optimize storage space.
- Share freezer space before purchasing new ones.
- Set up searchable sample inventories.
- Choose energy-efficient commercial grade models when buying new freezers.
- Regularly update inventory lists & conduct annual cleanouts.
- Consider raising ultra-low temperature freezers from -80°C to -70°C.
- Increase standard freezer temperatures (from -25°C to -15°C) when possible.
- Maintain freezers: check door seals, vacuum condenser coils, ensure proper air flow.
- Use freezer packs or boxes to maintain temperature in partially full freezers.
- Evaluate if samples can be stored at alternative temperatures.
- Open and close freezer doors quickly (under 30-45 seconds) to reduce frost buildup.

General Appliance Efficiency

- Turn off equipment when not in use, especially those with heating functions.
- Use "Switch Off & Save" and "Warm Up Time" stickers.
- Use appropriately sized appliances.
- Measure energy use of lab equipment to monitor efficiency.
- Include energy efficiency in selection criteria for new equipment.
- Investigate and potentially replace high energy-consuming equipment.

HVAC and Lighting

- Keep doors and windows closed.
- Remove space heaters; address underlying issues causing their need.
- Switch off lighting when natural light is sufficient.
- Use reminder prompts for turning off lights.
- Keep thermostats unobstructed.

Computers and Printers

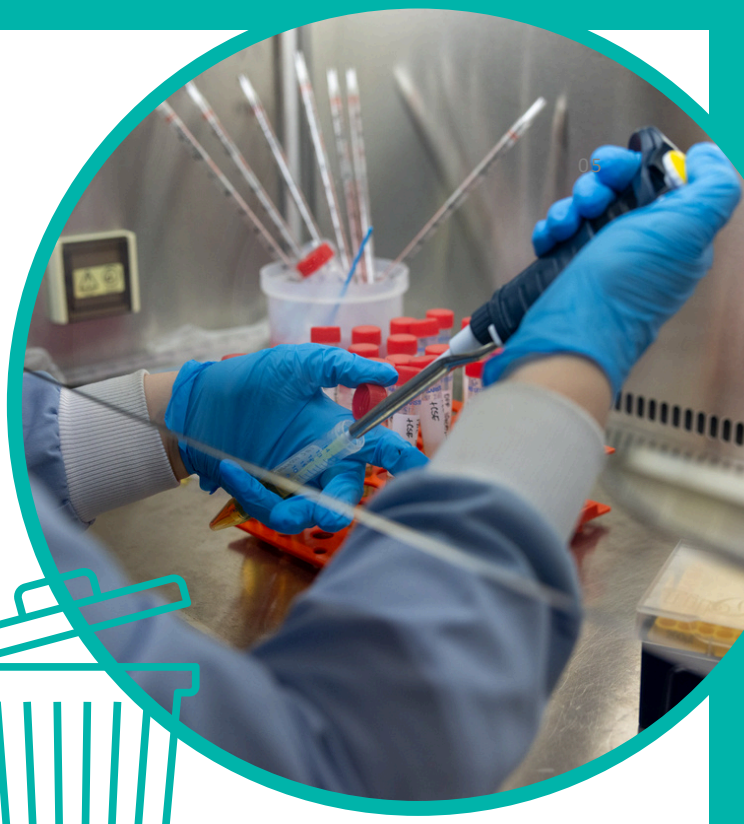
- Put PCs in sleep mode or switch off when not in use.
- Share printers when possible.
- Set default print to black and white and double-sided printing.
- Reduce printing; use chlorine-free recycled paper.
- Recycle ink and toner cartridges.

Additional practices

- Use a traffic light system for equipment shutdown guidance.
- Evaluate rarely used equipment for sharing, decommissioning, or recycling.
- Use covers for water baths to maintain temperature.
- Operate ovens and other heating devices only when needed.

Waste

Trinity College generates 2,000 tonnes of general waste and 50 tonnes of hazardous waste every year.



Reduce

- Opt for smaller storage containers and pipette tips when possible.
- Purchase in bulk to minimize packaging waste. If storage space is available.
- Use inventory management tools to share resources between labs.
- Buy refill pipette tips instead of new boxes.
- Apply Green Chemistry principles to minimize hazardous waste. See page 7.

Reuse

- Switch to glassware instead of single-use plastics where feasible.
- Reuse items like weighing boats when contamination is not a concern.
- Implement refillable systems for pipette filter tips.

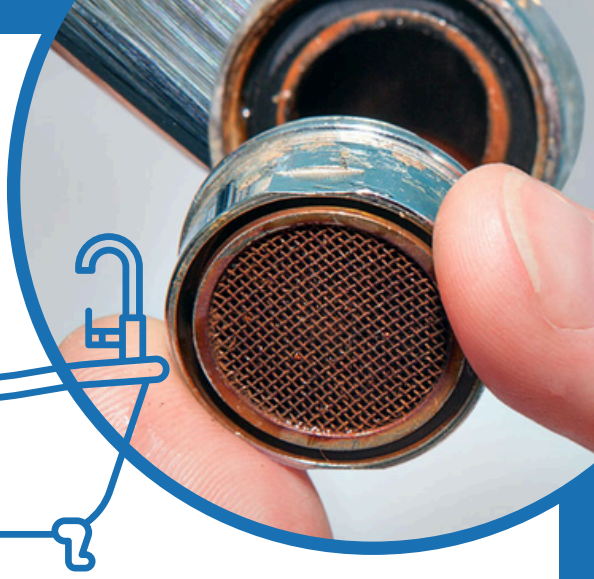
Recycle

- Participate in take-back programmes offered by suppliers for items like Styrofoam boxes and pipette tip boxes, provided they are not contaminated.
- Ensure all recyclable lab plastics are clean, dry, and loose and not contaminated.
- Participate in electronic waste recycling programs.

Rethink

- Exchange ideas with other research groups.
- Invest in or advocate for shared facilities for equipment to avoid redundancy.
- Choose experiments that have minimal waste output without compromising research integrity.

Water



Did you know that an autoclave uses **227 litres** per cycle? Older models can use up to 341 liters per cycle. Enough to fill a bathtub!

It takes **3 liters** of water to make 1 liter of deionized (DI) water.

Leak management

Report leaks immediately to Estates & Facilities. Small leaks can waste significant amounts of water daily.

Water purity

Use appropriate water purity for each experiment.
Higher purity water (e.g., deionized) requires more resources to produce.
Use the lowest grade water suitable for the task.

Equipment upgrades

Replace water-intensive machines with more sustainable models:
Water baths → bead baths or heat blocks.
Single-pass cooling systems → air condensers or recirculating systems.
For sustainable cooling in laboratories, consider using high-efficiency air condensers, such as the CondenSyn or Findenser.

Tap usage

Turn off taps when not in use.
Install water aerators to reduce flow (from 15 liters/minute to <7 liters/minute).
Use cold water instead of hot water when possible, as heating water consumes additional energy.

Autoclave Usage

Run autoclaves only when full, but avoid overfilling them, as this can prevent proper decontamination or sterilization.
Share loads with nearby labs.
Consider upgrading to water-saving models.
Ensure the autoclave is inspected and maintained by a qualified contractor.

Lab Ware Washing

Fill sink rather than using running water.
Run dishwashers only when full.
Reduce rinse cycles when possible.
Reuse glassware when possible to minimize washing.

Green Chemistry

University Chemical Safety Workshop

University Biological Safety Workshop

Liquid Nitrogen training

University Radiation Safety Workshop

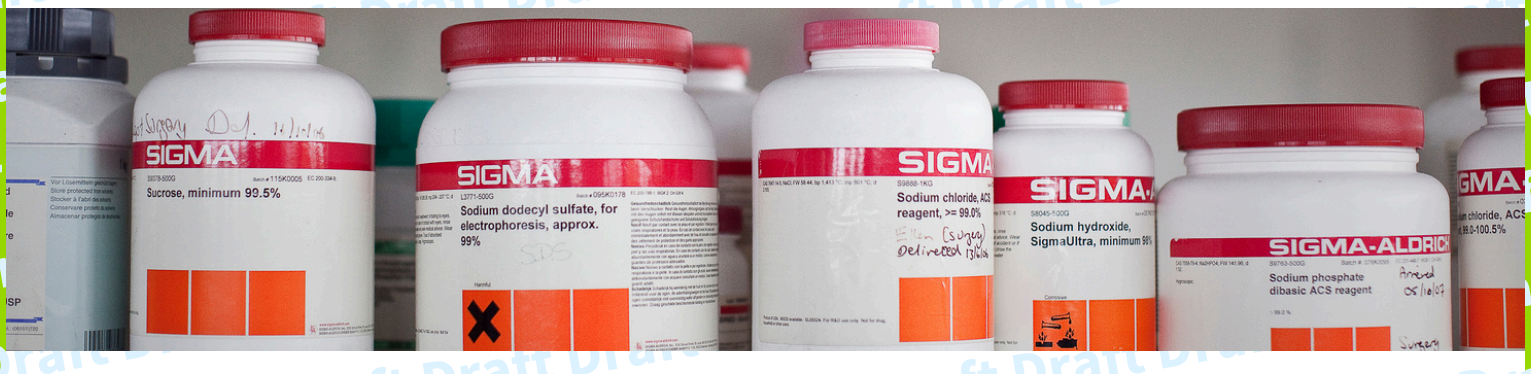
beyondbenign
green chemistry education

For more info click on the image bellow

labcup
www.labcup.net

Some ways to minimize environmental impact:

- Always seek less toxic alternatives in reagents and equipment.
- Use shared chemical databases to reduce unnecessary purchases.
- Explore the 12 principles of Green Chemistry (next page) and apply them where possible.
- Learn more about Hazardous Waste.
- Remove any mercury thermometers in your lab, and dispose of them properly through HMF. You can use LabCup to mark items for disposal. You can find more information on that here.
- For duplicate chemicals, use the one with the closest expiration date first.
- Buy only the quantity of chemicals you need to avoid excess waste.
- Avoid halogenated reagents, which harm the ozone and contaminate water supplies.
- Replace ethidium bromide with safer alternatives—it's a mutagen with potential health risks.
- Opt for catalytic rather than stoichiometric reagents when feasible.



Twelve principles of Green Chemistry_

1 Prevention

It's better to prevent waste than to treat or clean it up later. Green Chemistry aims to design processes that minimize the production of waste from the start, rather than finding ways to manage it afterward.

2 Atom Economy

This principle focuses on maximizing the amount of raw materials incorporated into the final product. By designing reactions that use resources efficiently, we reduce waste and make processes more sustainable.

3 Less Hazardous Chemical Synthesis

Green Chemistry encourages using safer chemicals that are less harmful to human health and the environment, reducing risks associated with handling and disposal.

4 Designing Safer Chemicals

Chemicals should be designed to achieve their intended function while minimizing toxicity. This means making substances that are effective yet safer for both users and the environment.

5 Safer Solvents and Auxiliaries

Whenever possible, reduce or eliminate the use of solvents or auxiliary chemicals, as they often contribute to waste and hazards. When needed, choose the least toxic and most sustainable options.

6 Design for Energy Efficiency

Energy demands have environmental impacts. Processes should be designed to minimize energy consumption, using ambient temperature and pressure when possible to reduce the carbon footprint.

7 Use renewable Feedstocks

Green Chemistry promotes the use of renewable resources, like plant-based materials, over nonrenewable resources like petroleum, reducing dependence on finite resources.

8 Reduce Derivatives

Minimizing the use of unnecessary modifications, such as temporary derivatives, reduces waste and conserves resources, making processes simpler and more efficient.

9 Catalysis

Using catalytic reactions, rather than stoichiometric ones, allows for more efficient reactions that require smaller amounts of chemicals, thereby reducing waste and energy use.

10 Design for Degradation

Chemicals should be designed to break down into harmless substances after use, preventing long-term environmental accumulation and pollution.

11 Real-Time Analysis for Pollution prevention

Integrating real-time monitoring during chemical processes helps detect and control pollutants before they are created, minimizing waste and risks.

12 Inherently safer Chemistry for accident prevention

Choosing safer chemicals and processes reduces the potential for chemical accidents, like explosions, fires, and releases of toxic substances, enhancing lab and workplace safety.

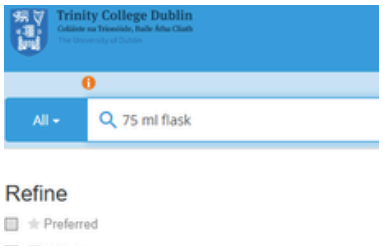
Green Procurement

When working to reduce your research's environmental footprint, it's equally important to monitor what comes into the lab as well as how waste leaves it. The entire life cycle of equipment and consumables should be considered, including the materials used in production, sustainability efforts in manufacturing, transportation, usage, and especially the end-of-life disposal.

Use the core Facilities

- Hazardous Materials Facility offers a wide range of supplies.
- To find out more contact them at HAZMAT@tcd.ie
- Collection points in **TBSI** and **East End 4/5**

LEARN MORE



Collaboration and Resource Sharing

- Consolidate orders with neighboring labs when possible.
- Donating functional equipment to other labs or institutes for continued use.
- Partner with equipment repair services.

Inventory Management and Equipment Efficiency

- Maintain an up-to-date inventory of chemicals and equipment using LabCup.
- Prioritize energy-efficient and water-efficient models.
- Right-size purchases to minimize waste.

epeat TM

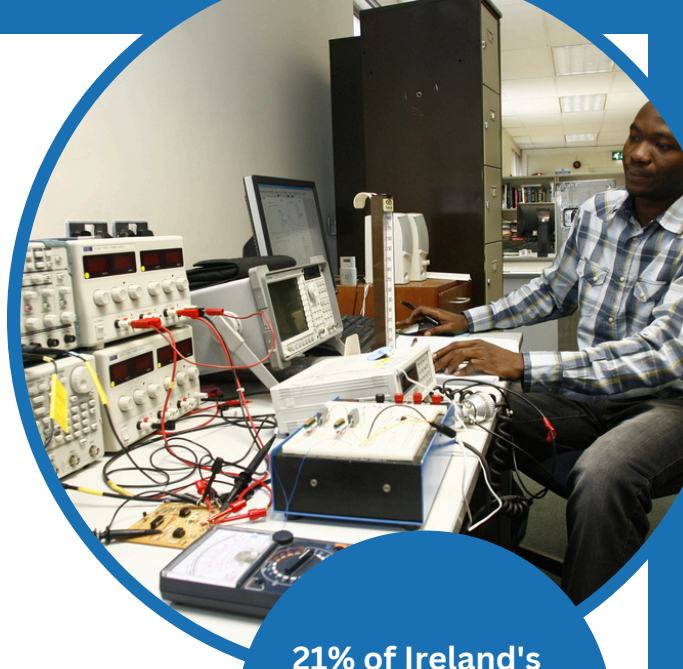
ACT. The Environmental Impact Factor Label

Sustainable Purchasing Practices

- Designate a single employee to handle orders.
- Purchase only the minimum amounts required for experiments.
- Look for products with reduced packaging and take-back programs.
- Use My Green Lab's ACT Label to compare products' environmental impact.
- Look for Energy Rating and EPEAT Registry certifications.
- Choose long-life products that can be repaired, reused, and recycled

Dry labs

Dry labs, which focus on computational and data-driven experiments, also have a significant environmental impact that needs to be addressed for sustainable scientific practices.



21% of Ireland's electricity was used by data centers in 2023

Identify the hardware used in the dry lab	• Inventory all lab hardware • Measure energy consumption during simulations and idle times • Evaluate computational resource efficiency, noting older hardware's lower efficiency
Inventory of all large datasets	• Implement appropriate backup workflows for all large datasets • For easily regenerated data, store only regeneration information • Evaluate alternative storage locations for improved efficiency • Delete unnecessary data past mandated storage periods • Avoid storing reproducible interim results
Reduce energy consumption of your devices	• Turn off hardware when not in use • Set up automatic shutdowns for unused devices overnight • Implement power-saving modes • Use reminder stickers for turning off lights and devices
Management	• Improve training and policies on energy use, hardware renewal, and data storage • Review power management settings • Deduplicate large datasets to reduce storage and energy needs • Use checkpointing to minimize repeated simulations • Apply open science principles where possible

Resources

Energy	• Changing Behavior Through Design: A Lab Fume Hood Closure Experiment • VALIDATING COST AND ENERGY SAVINGS FROM HARVARD'S SHUT THE SASH PROGRAM • Efficient ULT freezer storage • Stability of Genomic DNA at various storage conditions • Ultra Low Freezer Management Guide • Ultra-Low Freezer Maintenance Quick Reference Guide • My Green Lab freezer challenge • Cold storage audit template • Sustainable European Laboratories Network • Using Outlet Timers on Lab Equipment Reduces Energy Consumption • Stickers and Posters
Waste	• How To Reduce Waste in the Laboratory • Re-use of labware reduces CO2 equivalent footprint and running costs in laboratories • A case report: insights into reducing plastic waste in a microbiology laboratory • Plastic waste training video – Sustainable European Laboratories Network • Reducing single-use laboratory plastics • Biomedical waste management: Incineration vs. environmental safety • Stickers and Posters
Water	• Top 9 Actions to Take in the Lab to Improve Water Efficiency • Stickers
Procurement	• Saving Money Through Sustainable Procurement of Laboratory Equipment • Sustainable Laboratory Equipment Metering, Procurement, and Operations Guide • Green Lab Consumables Guide • LEAN – Sustainable procrement Procurement Links
Green Chemistry	• 12 Principles of Green Chemistry • Approaches to Incorporating Green Chemistry and Safety into Laboratory Culture • Green Chemistry journal • Green Chemistry Education
Dry Labs	• The Carbon Footprint of Bioinformatics • PRACTICAL GUIDE TO SUSTAINABLE RESEARCH DATA • Green Algorithms: Quantifying the Carbon Footprint of Computation • Digital Cleanup Day
Full guides	• A guidebook for sustainability in laboratories • The relevance of sustainable laboratory practices