Trinity College Dublin
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The University of Dublin

Trinity Green Labs Guide.

Trinity College Dublin Sustainability Guide for Researchers

Contents

This guide is a PhD student led initiative, co-authored by:

Martha Gulman PhD student School of Chemistry
Camilla Roselli PhD Student, School of Genetics and Institute of Neuroscience (TCIN)
Michele Hallahan Sustainability Advisor, Trinity College Dublin.

Why go 'Green' in your laboratory?

The clock is ticking, climate change is already underway and accelerating in impact, and our responsibility both as scientists, and citizens is to do all we can to prevent the global temperature rising by +1.5 °Celsius. Almost everything we do as humans impacts the Earth negatively, causing pollution, consuming resources and pushing more carbon dioxide into the atmosphere.

If the Earth's temperature increases by 1.5°C, the planet will experience even more extreme heat waves, fires, droughts and limited water availability, a 2019 NASA report on global climate change warns. Under the Paris Agreement, 189 countries have pledged to work together to keep Earth's temperature below a rise of two degrees Celsius (3.6°F) — and if possible, below 1.5°C. Clearly a global effort is needed, and this Trinity Green Labs initiative is part of that global ongoing effort.

To date, there have been 8.2 billion tons of plastic produced worldwide, of which only 9% has ever been recycled. Our world's reliance on single use plastic combined with today's throwaway mentality is simply not a desirable or sustainable way to continue to live and work.

Worldwide, labs consume ten times more energy than offices, four times more water than offices, and produce 5.5 tons of plastic waste annually (an equivalent to 2% global plastic production).

An average Irish person produces 61kg of plastic annually compared to an average bench scientist who typically produces over 1000 kg of plastic waste each year.

These staggering statistics are a direct result of old habits and poor management of resources. Diverting just 2% of lab plastic from landfill would save 100 million metric tons of CO_2 being released into the atmosphere annually.

Operating a sustainable lab will also reduce its operational costs in the long run, which benefits not only the environment but also the research budget. Therefore, it is in everybody's interest to place sustainability at the forefront when operating a research lab.

In this guide, we offer simple, cheap (sometimes free!) ways to reduce costs in your lab, as well as improving the efficiency of running the lab.

Operation of a 'Green' Lab

In order to operate a 'green' lab, a few easy steps are necessary which are outlined below. Labs are busy and complex environments, and no two labs are the same. Role delegation is often key for the successful operation of a lab, and assigning a Green Lab or Sustainability Coordinator will ensure that the advice in this guide is integrated into everyday lab operations.

Try taking this **quick quiz** to see how sustainable your lab is at the moment.

1. Water Management

Less than 1% of the Earth's water is freshwater (the remainder is saline, such as oceans, seas, brine aquifers). Less than 40% of that is unpolluted. Minimising water consumption ensures that there is more clean fresh water available to all species on the planet. Access to water has serious repercussions for biodiversity globally. Conscious water consumption helps to redress our imbalanced global water usage. The water services industry is the fourth most energy intensive sector in the EU. Labs contain a myriad of water-driven equipment, from condensers, to pumps, to autoclaves. Reducing your lab's water consumption not only saves the precious resource of fresh water but also reduces carbon footprint from electricity needed to pump water throughout the water infrastructure.

Here are some tips on how to reduce water use and save our university money.

1.1 Tap Water

Always turn off the tap when not in use. Install an aerator in the tap if possible – this is a very cheap device that simply screws onto the end of your tap (faucet) and aerates the water flow in order to reduce water waste.

Total Cost of Water

Not all water costs are the same! As an example, domestic hot water costs more than five times that of cold water. The added cost comes from the energy required to heat the water. Other specialist water used in laboratories can be very expensive. Examples include de-ionised water and ultra high purity water. The manufacture of these waters requires high pressure pumps and filters **which add to the energy consumption**, consumables and often a wastewater stream. The more valuable the water the more benefit will be gained by keeping consumption as low as possible. Best practice is to know which level of water purity is needed for the work, to minimise the cost and environmental impact.

1.2 Machine Replacement

Various machines in labs are water-driven. When one of these machines breaks / is no longer repairable, it should be replaced with a more sustainable model:

- Water-vacuum aspirators can be replaced with membrane/diaphragm/oil-free pumps;

- Single pass cooling for distillations or other procedures can be replaced with a high efficiency air condenser, recirculating water bath, or even an aquarium pump placed in a bucket of iced water.

1.3 Autoclave

Run autoclaves at full capacity and set them to stand-by mode or turn them off when not in use to reduce their water and energy consumption. See more information here. Medical-grade steam-jacketed autoclaves can be replaced with more efficient research-grade units or install water saving devices on autoclaves.

1.4 Glass Washers

Similar to autoclaves, glass washers should be run at full capacity. When not in use they should be turned off. Some glass washers have an eco programme that will be suitable for some applications.

2. Energy

In 2018, Trinity spent €6.3 million on electricity and gas. Through collaborative effort and conscientious work, this staggering figure can be reduced.

2.1 Switch off

Switch off any equipment when not in use, particularly equipment with a heating or cooling function as those have the greatest energy demand. Using outlet timers for equipment can save 10% of energy annually and is an excellent way to ensure the equipment is ready for use, but does not stay on 24 hours a day. Science published an excellent article about how to make lab equipment more efficient.

2.2 Colour Code

To communicate the various energy needs of equipment with your lab mates, your lab can adopt a colour coded sticker system:

Green sticker: for machines which can be turned off immediately after use
Yellow sticker: for machines which need to be turned off at the end of the day
Red sticker: for machines which can never be turned off

Consider having a system for the "last person out" to look at equipment or processes that can be turned off at the end of the day. By the nature of laboratory work it may not always be clear who will be finishing last. So, some system to identify last person out could help with turning off equipment at the end of the working day.

2.3 Shut the Sash

Chemistry labs' ventilation costs can account for **over 60% of the overall energy** consumption in a lab. Closing the fume hood sash will reduce the electricity bill for your lab, as well as ensure safety, where the sash level has an actual impact on fan speed (check your fume hood). Not every fume hood is required to operate at the same flow rate, with lower flow rates needed at night-time. Installation of sensor-controlled demand-based ventilation with varied flow rates will allow for substantial electricity savings.

In some instances, fume hoods can be fully turned off if not in use. This saves the electrical energy for the exhaust fan and the thermal energy to heat the air. It may be possible to consolidate some activities within a smaller number of fume hoods allowing some to be turned off and then used when peak demand occurs. Specialist equipment used in the fume hood should be turned off when not in use. Equipment such as plate heaters, shakers or agitators should be switched off when not in use.

Easy task: To remind your lab mates you could print a small poster to remind people to "shut the sash".

2.4 Share equipment

Sharing equipment such as large freezers, cold rooms and autoclaves saves on energy consumption, water usage, and costs for labs.

2.5 -70 °C is the new -80 °C

Keeping freezers at -70 degrees rather than -80 degrees saves up to 30% plug-load energy. Making sure that fridges and freezers are organised, defrosting regularly, keeping the coils free of dust, and freeing up space by disposing of old samples will ensure that they are operating as efficiently as possible. Consider if you can consolidate material within a smaller number of -80 freezers? Any surplus units could be cleaned out and left fully dry with the door slightly ajar ready for re-use when and if demand requires. Your lab can also participate in the international "Freezer challenge"!

If any -80 freezers are dated (i.e. very old) it may be worth considering replacement with new high efficiency freezers that will consume less electricity. It is essential that any old units are disposed of appropriately as they contain CFCs (ozone-depleting chlorofluorocarbons) and many materials that can be safely re-cycled. When purchasing a new unit, ensure that your supplier will take back the old one (they are obliged to, under EU Waste Electronics [WEEE] regulations).

2.6 Replace Fluorescent Lights with LED

LED light sources can easily replace inefficient fluorescent light sources, reducing the energy suck by 50-75%. LEDs still provide the desired wavelength and intensity, whilst having a longer lifespan than fluorescent bulbs. This is particularly important for operational growth cabinets used for biological experiments.

2.7 Computers

Turn off your computer when you leave the office. If your computer requires time in the morning to turn it on you could get a plug-in timer switch to turn on the computer before you arrive in the morning. Note: this may require edits to BIOS* settings on some computers – check with ITServices.

*[BIOS is the "boot" software of a PC and controls the most basic functions prior to the Operating System (OS) booting. It can usually be accessed with an 'F' key upon start-up (F10, F12 and F2 are common)].
During the day have the power-save modes of your computer turned on. This can set the computer to step into a sleep mode, which can be "woken up" quickly. Screen savers do not save energy as they generally keep the CPU operating.

Ensure any local and networked printers have their sleep modes turned on and set to default to double sided printing in black and white.

Some laboratory equipment has dedicated PC's or controllers that interface with the equipment. Where possible this electronic equipment should be turned off. It may be necessary to talk to the specialist supplier to confirm what can be turned off or possibly put into a "hibernate" mode when equipment is not in active use.

2.8 Send Less Emails

Each email sent emits 4g of CO_2 to the atmosphere and if the email includes an attachment it emits another 50g of CO_2 or more.

Sending less emails and unsubscribing from unwanted mailing lists could save >16 tonnes CO_2/year/ lab member (i.e. as much as you – as an individual – produce in one year). Additionally you can select 'upload to OneDrive' when sending large attachments, which minimises the carbon footprint of your email.

2.9 Building Management

At building level you can ask the director or manager of your building to be part of the International Institute for Sustainable Laboratories (I2SL) to learn and discuss how to make a building more energy efficient. Find your Premises Manager here.

3. Waste

3.1 Reduce, Reuse, Recycle

Reducing your purchases is the best way to eliminate waste. Simply don't buy it in the first place, where possible. Do other labs have an excess of what you might need?

You can ask for supplies which might not be in use/ might be excess to someone else's needs on our Reuse/ Repurpose Yammer group.

Secondly, reuse what you can. Opting for glassware (such as test tubes and pipettes) reduces plastic waste and saves money. Reuse pipette tips, syringe plungers and other items where possible. Can you reuse an item if only using water (for example), or use one item multiple times within one hour/day before discarding?

Buying from companies with **take back programs** is a great initiative for waste management, however Ireland is a small market when compared to the UK or the US and take back programs are not as widely available, but by making the request, we can influence suppliers. With each lab member generating on average 1,000kg of plastic waste each year, this is one battle worth fighting!

For purchases of plastic containers of ethanol, methanol and IMS from Trinity College Hazardous Materials Facility (HMF), **always return the plastic container to HMF** who refill and reuse these containers. As much as 94% of items which end up in the rubbish bin at Trinity can be recycled. Check the plastics you use – ALL hard plastics can be recycled. When recycling chemical plastic containers, be sure to rinse thoroughly and remove hazard stickers where possible, or print and place a 'Thoroughly Rinsed' sticker over the label before recycling.

Always triple rinse and vent containers before placing into recycling bins. If unable to remove labels then these should be defaced or crossed out with permanent marker. (This gives the waste workers in recycling plants confidence that they are not handling toxic chemicals).

Some containers can be **reused**, e.g. silica tubs can be refilled with waste silica and taken for disposal with HMF.

By being more mindful while carrying out everyday tasks, reusing, and recycling what you can saves money in the lab as well as reducing our burden on the environment.

3.2 Plastic in the Lab:

Plastic found in the lab can be divided into four categories; Polyethylene or PE (autoclavable and non-autoclavable) and Polypropylene or PP (autoclavable and non-autoclavable). All four are highly recyclable, and can be placed in the recycling bins. Be CERTAIN that they are rinsed/ uncontaminated before recycling. Common sources of polyethylene include needle caps, syringe plungers, falcon tube lids, cell culture flask lids, and pipette tip racks. Pipette tip boxes are already collected in TBSI for recycling.

Common sources of polypropylene include Eppendorf tubes, pipette tips, falcon tube bodies, and syringe barrels.

Generally the best practice is trying to replace these single use plastic items with reusable glassware, which can be washed and reused.

3.3 Plastic Gloves

Plastic gloves should be worn ONLY where needed, and can be carefully reused where possible, in order to minimise wastefulness and excess cost to the lab.

3.4 Waste Disposal

Trinity is in contract with Stericycle (SRCL) to remove all hazardous and clinical waste. Waste solvent is either blended into fuel for industrial use or back into clean solvent for resale. (This conversion occurs in Athlone).

PLEASE NOTE that when PPE is contaminated with hazardous materials that it must be disposed of as hazardous waste through HMF. HMF provide advice on this and can assess lab waste streams and help to optimise, FREE OF CHARGE.

4. Green Chemistry

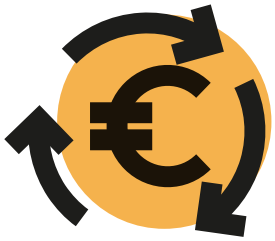
Green chemistry is not a sub-discipline of chemistry, but applies to all areas of chemistry, science, and beyond. Incorporating green chemistry and safety into everyday lab culture is of vital importance, as outlined here.

When designing novel protocols and synthetic methods, it is important to incorporate green chemistry into the initial planning. Quite often teaching protocols are outdated, employing toxic solvents and reagents even though a less toxic option might be available. It is important to analyse each protocol, to ensure you are only using toxic substances if it is absolutely necessary to do so. A metric based on the 12 Principles of Green Chemistry which allows the researcher to compare greener alternatives systematically can be found here.

DOZN2.0 is a novel virtual resource set up by Millipore Sigma which scores reactions and chemicals according to their environmental and health impact, offering alternative solutions to toxic chemicals and energy demanding protocols. DOZN2.0 does not save any of the reactions entered on its website, thus securing the integrity of your research. It can also be used on teaching, undergraduate, and postgraduate level.

Search the EU database here for chemical toxicity.

Alternatively, the US EPA (United States Environmental Protection Agency) chemical substances inventory provides a comprehensive guide for environmental toxicity reports for chemicals used in the lab and is updated regularly.



5. Sustainable Purchasing and Management of Substances Inventory

5.1 Substances/ Chemical Inventory

Keeping an organised inventory on LabCup is mandatory at Trinity, and this platform helps to reduce unnecessary buying as well as offering labs the option of obtaining excess chemicals from other Trinity Labs. Buying wisely and in small amounts will ensure that no chemicals become forgotten and/or unsafe with time.

5.2 Sustainable Purchasing

Sustainable procurement (purchasing) incorporates environmental concerns, human health, and social equity. Trinity has a Sustainable Procurement Policy and guidelines for staff which can be found here. Section 3, Labs and Research, covers procurement for labs.

Before buying a new piece of equipment, consider checking to see if another lab might have spare or disused equipment on Trinity's Yammer Reuse/ Repurpose Group. Precious budget can be saved by doing so, for free.

When making a purchase, email the supplier to ask if they employ reusable packaging, and if not, is the packaging at least recyclable or can it be made recyclable? Are there take back programs for their packaging, and are there discounts for returning customers who avail of the take back programs?

When buying a new piece of equipment, ask the supplier if there is a more energy efficient or water efficient product available. Can the product be configured for energy efficiency modes or automatic "sleep modes" that will reduce energy consumption?

Swap to a supplier who has a clear commitment to sustainability/ environmental criteria incorporated into their business practices. You can find out more about approved suppliers here. While these actions may appear small, collective effort will result in a positive impact for the planet.

5.3 ACT Label

My Green Lab have developed an ACT label which has been adopted by many chemical suppliers. It is an environmental impact factor label which incorporates manufacturing impact of the product and its packaging, user impact in energy and water consumption, and the products' end of life status. It is a versatile tool which allows you to compare the environmental impacts of different products, with the lowest score being the most environmentally preferable.

Labconscious and GPE Scientific are a great source for sustainable lab purchasing for chemicals and equipment, as well as offering a how-to guide for sustainable labs.

6. Green Lab Certification

My Green Lab is a not for profit organisation which is educating and supporting the redesign of todays' lab work to be less polluting.

It does so through a certification process based on three overall aims:

- 70% Water reduction
- 30% Energy reduction
- 10% Waste diversion from incineration*

*Landfill is no longer available in Dublin – all rubbish is incinerated, which causes air pollution and renders those materials forever lost.

The "My Green Lab Certification" is a self-assessment of 14 topics related to energy, water, waste, chemistry/materials, and engagement. Carrying out this assessment in your lab will give you a direct marker for how sustainable your lab is, and how it can improve, to do better. Trinity College Dublin has become an institutional member of the My Green Lab project, which allows all laboratories in Trinity to start the Green Lab Certification programme at a reduced cost.

The lab investment to complete this certification is:

- Registration & feedback report $175/lab
- Feedback report & presentation $350/lab

'Lab' can be either a single lab or a group of labs which work in close contact.

The green lab certification programme consists of 5 steps:

01

Baseline Assessment

An online survey is provided by the My Green Lab Team (MGL Team) and is completed by all the lab members. The responses are analyzed by the MGL Team and a report with recommendations on which steps the lab could take to adopt sustainability best practices is furnished.

02

Implement Changes

Using the recommendations as guidelines, labs are encouraged to take some time (usually ~6 months) to make improvements in their laboratory practices to reduce consumption and pollution.

03

Certification

Members of the lab re-take the online survey and the MGL team provides the lab with their overall score and certification level. MGL team will also give the lab additional recommendations for further improvements to make before they seek re-certification.

04

Implement Additional Changes

After the initial certification, MGL encourages labs to take 1-2 years to maintain the best practices they have adopted and work on further improvements.

05

Re-Certification

When labs are ready for re-certification, lab members retake the self-assessment to see what best practices they are still implementing and where they might make future changes.

If you have further questions about the My Green Lab Certification you can contact the MGL team directly (info@mygreenlab.org) or Trinity Green Lab Team.

7. Conclusions

There isn't a single way to make your lab less resource-intense, this is a constant exercise each scientist has to do on a day-to-day basis. Single decisions matter but don't worry if you can't apply all these changes in one fell swoop, as they say: "Rome wasn't built in one day". Let's keep up the good work and good luck!

Contact:
tcdgreenlabs@gmail.com
@TCDgreenlabs

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