
Dublin City University Green Lab Guide (2023)

DCU Sustainability Office
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Contents

1. Introduction	3
2. Water	4
3. Energy	5
4. Waste.....	6
5. Sustainable Purchasing	7
Decision Tree – Sustainable Purchasing	9
6. Carbon Emissions.....	11
7. Plastic	13
8. Travel.....	14
Decision Tree - Travel.....	15
9. Green Chemistry.....	16
10. Sources	16

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1. Introduction

Among the scientific community and beyond, climate change has been recognized as an existential threat for decades. Scientists have known since 1896 that burning fossil fuels would result in increasing global temperatures due to the greenhouse effect¹. Despite many warnings limited action has been undertaken to address the challenges. Significant damage to the environment has already occurred and the effects of climate change and other forms of pollution are already being felt across the globe, with impacts concentrated in lower income areas, particularly in the global south, and disproportionately affecting women and girls due to ingrained inequality².

Laboratories have a significant negative environmental impact³. They consume large quantities of direct energy, both thermal and electrical, running low temperature freezers, fume hoods, autoclaves, and other equipment. Many labs use chemicals like mercury and ethidium bromide that can be harmful and consume a huge quantity of single-use plastics and often waste a lot of water. Since lab work cannot be done remotely, there are also significant transport emissions associated with getting everyone to and from the lab.

While some laboratory operations/activities are essential for conducting experiments others are done for convenience. With increasing national and international emission reduction targets action is required on all fronts now to mitigate the impacts and adapt processes and procedures to ensure these mandatory targets are met.

We must change what can be changed immediately. More than that, we must re-evaluate our conceptions of what changes are 'realistic'. Realistically, if we don't radically overhaul the way we do things, hundreds of millions of lives could be lost. This is the harsh truth of environmental degradation.

This Green Lab Guide builds on work done by many other people in other universities including in particular Trinity College Dublin who produced the first version of the Green Lab Guide. We have also drawn on best practice resources developed in other institutions such as the Tyndall Centre for Climate Change Research (<https://tyndall.ac.uk/>). However, the challenges and the required actions are ever evolving, and we have only limited resources and so you might well have identified better 'best practice' and if so we would be very grateful if you could email your suggestions to sustainability@dcu.ie and we will aim to include these in our next edition.

The actions in this guide range from technological fixes to changes of behaviour and practices. How best to implement these changes will vary from lab to lab and person to person. Some of these changes require labs to work together, so it will be important to establish a unified action from an institutional level. Initial steps could also include a sustainability lecture as part of lab orientation to set the expectation for both students and staff. The DCU Sustainability Office would be happy to facilitate this give reasonable notice.

Some of these changes are small and others are large, but all are worthwhile. This is not someone else's problem – it is our problem as part of our class, our university and our society.

*"In short, our world needs climate action on all fronts
- everything, everywhere, all at once"*

UN Secretary General Antonio Guterres

2. Water

While our planet's surface area is more than 70% water, less than 1% of that is freshwater.

- **Install Aerators on Taps:**
Aerators are inexpensive devices that screw onto the end of taps and add air to the water to reduce water wastage.
- **Use Recirculating Water Systems:**
Closed loop systems are much more efficient when it comes to water usage. That is because you don't have to keep topping up the water periodically. No lab equipment should be connected to the mains water supply, as this can cause wastage.
- **Replace Old Machines with More Sustainable Models:**
Equipment which requires water for its operation should be replaced with more sustainable models where possible. For example, water vacuum aspirators can be replaced with membrane/oil-free/diaphragm pumps.
- **Turn Off Taps When Not in Use:**
This is a no-brainer, but it is still important to mention. There are few better ways to waste water than to literally flush it straight down the drain!
- **Use Low-Grade and Cold Water Where Possible:**
Deionized water needs to be processed using high pressure and filters, so it requires more energy and water to produce. Domestic hot water costs much more than cold water and has a much higher environmental impact.
- **Only Run When Full:**
Machines like autoclaves and dishwashers should only be run when at full capacity to minimize water and energy wastage.
- **Report leaks ASAP:**
Leaks can cause a lot of water loss. The sooner a leaky tap is reported, the sooner it can be fixed. That means less water going down the drain.
- **Establish Efficient Lab Procedures:**
Collect water purification cartridges for recycling through takeback program (If applicable). Use waterless baths like Armor bead baths. These are metallic beads which can be heated and cooled, then reused.
- **Measure Before You Pour:**
Use graduated cylinders to measure out the exact amount of water needed to dilute chemicals.
- **Use Water Timers:**
Water timers can be installed to minimize water usage by measuring the volume of water in containers and limiting it to a pre-set quantity.

3. Energy

Energy production has contributed around 72% of all greenhouse gas emissions to date.

- **Shut Fume Hood Sash:**

Leaving a fume hood open can use the same amount of energy as 3.5 homes! The reason fume hoods are so energy intensive is that they suck in the air from the lab and vent it outdoors, meaning that the air conditioning or heating needs to work much harder to keep the lab comfortable. Make sure that the fume hood sash is only ever open when the fume hood is in use.

- **Reduce Freezer Temperature:**

In modern labs, many samples are kept at -80°C. However, many samples do just fine at higher temperatures! The Universities of Boulder and California have developed [a database](#) of common biological samples which can be stored at -70°C. Increasing the temperature by just 10°C can reduce energy usage by about 30%!

- **Slay Your Vampires:**

Vampire power refers to the electricity which is used by electronics when they are in standby mode. A good indicator of whether something is an energy vampire is whether it has some form of light or display which stays on when not in use. If you do not need a device to be on, it should be switched off at the wall!

- **Monitor Energy Usage:**

This should be done to see where energy is being wasted, lost or at least where it could be conserved. Knowing which equipment uses the most energy is incredibly useful when trying to reduce electricity consumption.

- **Share freezers with other labs and keep them full:**

It is better to have one full freezer than to have two half-empty ones. Running half as many freezers uses half the electricity and emits half the carbon!

- **Only Run Equipment When Full:**

Just like with the freezers, it is important to make sure you only run the autoclave or dishwasher when you have enough to fill it. A smaller load means you will be running it more frequently.

- **Send Fewer Emails:**

Each email emits 4g of CO₂ and emails with attachments can emit up to 50g⁹¹! Try adding an email signature that lets people know that you don't send 'thank you' emails to reduce your environmental impact!

- **Only Use Lights When Needed:**

Make the most of the natural lighting during the day. Not only does this save energy, but natural light is also better for our health! Make sure to turn off all the lights before you leave the lab. If you are having trouble remembering to do this, you can install timers to make the lights turn off automatically. Dimmer switches can also help to reduce energy use, since you can adjust the brightness to suit your needs.

- **Repair Broken Equipment:**

Rather than replacing broken equipment, efforts should be made to identify and fix the problem, since the manufacture of new equipment can have a large environmental impact, known as the 'embodied' or 'embedded' emissions.

4. Waste

Humanity produces approximately 13 tonnes of hazardous waste every second!

- **Redesign Experiments:**

Try replacing experiments which use heavy metals or other hazardous materials with safer alternatives. Redesigning experiments can also significantly reduce plastic waste!

- **Use Chemicals on a First in/First out Basis:**

This means that you use the oldest chemicals first to reduce or eliminate chemical waste. Consider using an inventory management system like [Quartzly](#) to keep track of which chemicals came in most recently, and when they will expire.

- **Reduce the Scale of Experiments:**

If you can reduce the size of experiments without compromising research, this helps to reduce energy and chemical use. It will also save you time!

- **Substitute Hazardous Materials:**

Often, it is possible to replace dangerous chemicals with safer alternatives. [Here is a guide](#) for how to assess whether a substitute is safer for the environment or for human health.

- **Purchase a solvent recycler:**

These devices use fractional distillation to recover spent solvents like alcohol or acetone so they can be used again.

- **Borrow from Other Labs:**

If you need a small amount of something, see if another lab has some to spare rather than buying unnecessarily from a retailer. This will save on packaging waste and delivery emissions.

- **Unsubscribe From Junk Mailing:**

This reduces the level of wastepaper to deal with. Unsubscribing from email newsletters also helps to reduce your carbon footprint.

- **Know Your Stocks:**

Maintain a chemical and equipment inventory across all labs and audit it annually to avoid over-buying. Quartzly can also be used for this purpose!

- **Practice Green Printing:**

Set double sided printing as the default and reduce margins to get the most out of each page. This will reduce paper and electricity waste at the same time!

- **Do Not Mix Chemical Waste with General Waste:**

Not only will this contaminate the general waste, it also creates the risk of hazardous chemicals finding their way into the environment, where they can harm wildlife and enter the drinking supply.

- **Have a Paper Recycling Bin:**

Putting a wastepaper basket beside printers and photocopier is a great way to reduce paper waste. This seems very basic, but many labs don't have this facility!

5. Sustainable Purchasing

To be sustainable, you need to buy sustainably. We vote with our wallets!

- **Think before you buy:**

The vast majority of the environmental impact of a product or service is imposed pre-procurement i.e. the ghg emissions of a product start with raw material extraction, manufacturing, packaging, transport to the university etc – the disposal via appropriate waste route typically contributes less the 1% of the overall impact. It is therefore extremely important to 'Think Sustainability' before you raise that PO. Do you really need it or could you borrow from another group – maybe not so useful for consumable materials but for those consider how you can reduce your use.

- **Buy in Bulk Where Possible:**

This reduces the number of delivery trips that need to be made which, in turn, reduces the carbon footprint. Be careful, however, not to buy more than you need just to reduce transport emissions! Consider consolidating orders of commonly used consumables with other groups or schools.

- **Know Your Vendor:**

Shop around to see if other lab suppliers place a greater emphasis on sustainability. Do they sell recycled or compostable materials? Do they dedicate space on their website to sustainability concerns?

- **Know Your Product:**

Purchase paper and plastic that is at least partly made from recycled material. In the case of paper, also look for the Forestry Stewardship Council symbol: This means that the wood used to make the paper was sustainably sourced!

- **Use Refillable Consumables:**

Try buying refills for your pipette tips instead of buying a new box each time. The same goes for tubes! Refilling the racks during a lab meeting means you won't have to waste any time when you should be experimenting. Plus, it gives you something to do with your hands!

- **Buy From Campus Storerooms:**

Avoid purchasing from retailers but if you need to remember to make sure to consolidate orders with others to save on packaging waste and shipping emissions.

- **Talk to Your Vendor:**

When you are contacting your vendor to purchase equipment or consumables, ask them about the environmental impact of the products. If they can see that their customers are concerned about things like packaging and renewable energy, they will make more of an effort to address these problems.

- **Use the ACT Label:**

'My Green Lab' has developed a label for the environmental impact of lab equipment, consumables, and chemicals. Similar to a nutrition label on food, this can tell you all you need to know about the impact of a product. You can find more information on ACT Labels [here](#).

- **Buy De-icing Kits:**

These are often overlooked during purchasing but having de-icing kits around the lab will go a long way towards reducing your footprint. Freezers get less and less efficient over time, and de-icing can help you get more bang for your buck when it comes to energy usage.

- **Downsize If you Can:**

Are you regularly using plates or tubes that only get half-filled? By purchasing the next size down, you reduce plastic waste and create extra space in your freezers! Aside from anything else, it's cheaper!

- **Purchase Green Cleaning Supplies:**

This means fewer harsh chemicals. It also means that you should purchase, for example, a mop instead of paper towels. The more you can reuse your cleaning equipment, the better the environmental impact over its lifetime.

Decision Tree – Sustainable Purchasing

students in the University of Exeter in the 'Be the change' Society.
 (<https://www.exeter.ac.uk/about/sustainability/yourfootprint/whatyoubuy/>)

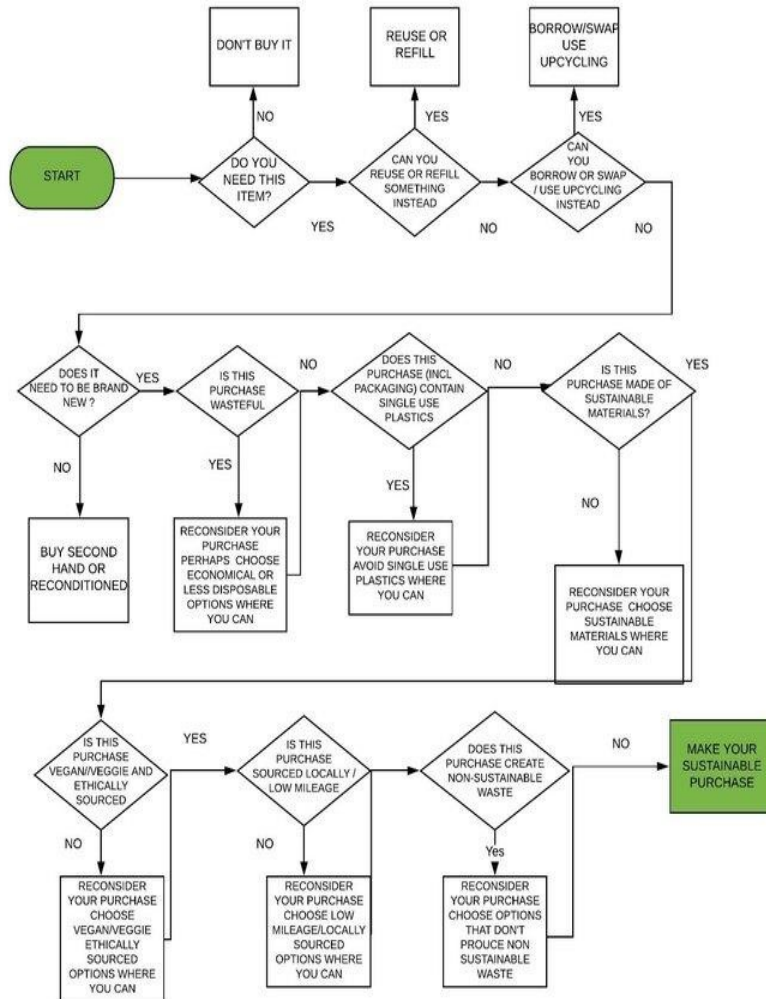


Figure Caption: Approximately 61% of our footprint at the University is classified as procurement aka 'what we buy', highlighting the magnitude of our buying habits – both as an institution and individuals! This decision tree was developed by

6. Carbon Emissions

Each of the last four decades has been successively hotter than any decade that preceded it since 1850⁶

- **Know What Matters Most:**

It is sometimes difficult to know which actions you can take to help in the fight against climate change. Knowing how much carbon different activities emit is a great way of focusing in. Did you know, for example, that taking one single transatlantic flight cancels out the carbon savings from 10 years of recycling?

- **Carbon is Everywhere:**

It is important to remember that we emit carbon all day every day. Any time you use electricity, buy a product, travel, or even breathe, you are releasing carbon dioxide. No one expects you to stop breathing. It is a matter of working out where the carbon can be avoided and where it is necessary.

- **Systemic Change is Required:**

Often, too much emphasis is placed on individual actions. Climate change affects every sector of society, so overarching policies and government initiatives are required in order to make the changes we need. There is not much you can do, for example, about the speed at which renewable energy infrastructure is being built.

- **Know Your Energy Provider:**

Reducing electricity use is a great way to reduce carbon emissions. However, reducing the proportion of energy you are buying that comes from fossil fuels is also very effective! By switching to a provider with higher levels of renewables, you can increase demand for renewable energy and reduce demand for fossil fuel energy.

- **Know Your Heating:**

There are plenty of sustainable ways to heat a building, from thermal solar panels to ground source heat pumps. The more renewable option is also often the cheaper option in the long run, and heating is no exception. Talk to your building management team about switching to a more sustainable heating system.

- **Educate Yourself:**

There are countless resources out there that you can use to educate yourself about climate change.

- Try some short courses on [Linked Learning](#) - you have access thru' your DCU account. There are lots of course so do a search on what you want to know more about like - climate change, sustainability, carbon footprints.....
- There are also course on Circular Economy, Renewable Heat, Energy use in Labs... available from the [Sustainable Energy Authority of Ireland](#) under their [SEAI Energy Academy](#).

There are also lots of **podcasts** available - just make sure you wear your critical thinking hat!

- [Climate Alarm Clock](#)
- [The Great Simplification](#)
- [5deg of change](#)

Here are some accessible books we recommend to get started:

This Changes Everything – Naomi Klein
The Uninhabitable Earth – David Wallace Wells
There is No Planet B – Mike Berners-Lee
How Bad are Bananas? – Mike Berners-Lee

Losing Earth – Nathaniel Rich
Doughnut Economics – Kate Raworth

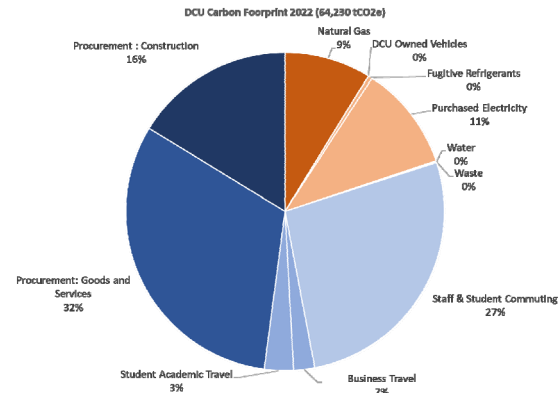


Figure Caption: DCU Carbon Footprint from 2022.

7. Plastic

*At least 12.5 million tonnes of plastic waste
Enter our oceans each year!*



- **Consider Plastic Use When Designing Experiments:**
The best way to reduce plastic waste is to not create it in the first place. The most effective time to reduce use is in the design phase before you have committed to doing things in a particular way.
- **Triple-rinse and Vent Containers Before Recycling:**
Recycling centers cannot accept dirty items and will reject them. What's more, dirty items can contaminate clean ones and undo someone else's good work!
- **Reuse Nitrile Gloves Where Possible:**
In certain circumstances, they can be removed and worn again once or twice. Try to identify the areas where contamination is not so important, and reuse gloves for those activities. Be careful not to do this when working with hazardous biological or chemical agents, or when there is a risk of cross-contamination.
- **Look Into Take-Back Schemes:**
When you are buying a product, ask if the vendor has their own recycling program. Take advantage of it if they do! Several suppliers will also take the packaging from your orders back from you! You may have to work this out with the delivery company, but the more people ask the more likely they are to do it.
- **Use Glass Where Possible:**
Glass can be reused over and over again. Eventually, when it is time to get rid of it, glass can be recycled without losing any of its quality. While glass production can be environmentally damaging, this reuse and recycling aspect makes it more sustainable overall.
- **Use a Master Mix:**
When pipetting (PCR), preparing a master mix reduces the number of tubes and pipette tips used. It also reduces the risk of contamination and saves time!
- **Repurpose:**
Ask yourself whether any leftover plastic containers could be used for another purpose. For example, you could take home a plastic bottle and use it as a vase for flowers or a bird feeder!
- **Separate Packaging:**
The moment you remove the packaging from your consumables or chemicals, put the packaging straight into the recycling bin. This will prevent the plastic from being contaminated during the experiment.
- **Downsize Your Containers:**
If you are consistently only filling your test tubes halfway, you should consider purchasing a smaller size. This will reduce the amount of plastic being produced, as well as the amount that ends up in the incinerator or landfill.
- **Use Bioplastics When Reduction is Impossible:**
Bioplastics are any plastics that are either bio-based, compostable or biodegradable. Make sure if you are using a compostable plastic that it goes into the correct waste stream, since many bioplastics will not break down naturally in the environment.
- **Consider Using Metal Weigh Boats:**
If this is not possible due to reactivity, look into glass or paper weight boats and only use plastic as a last resort.

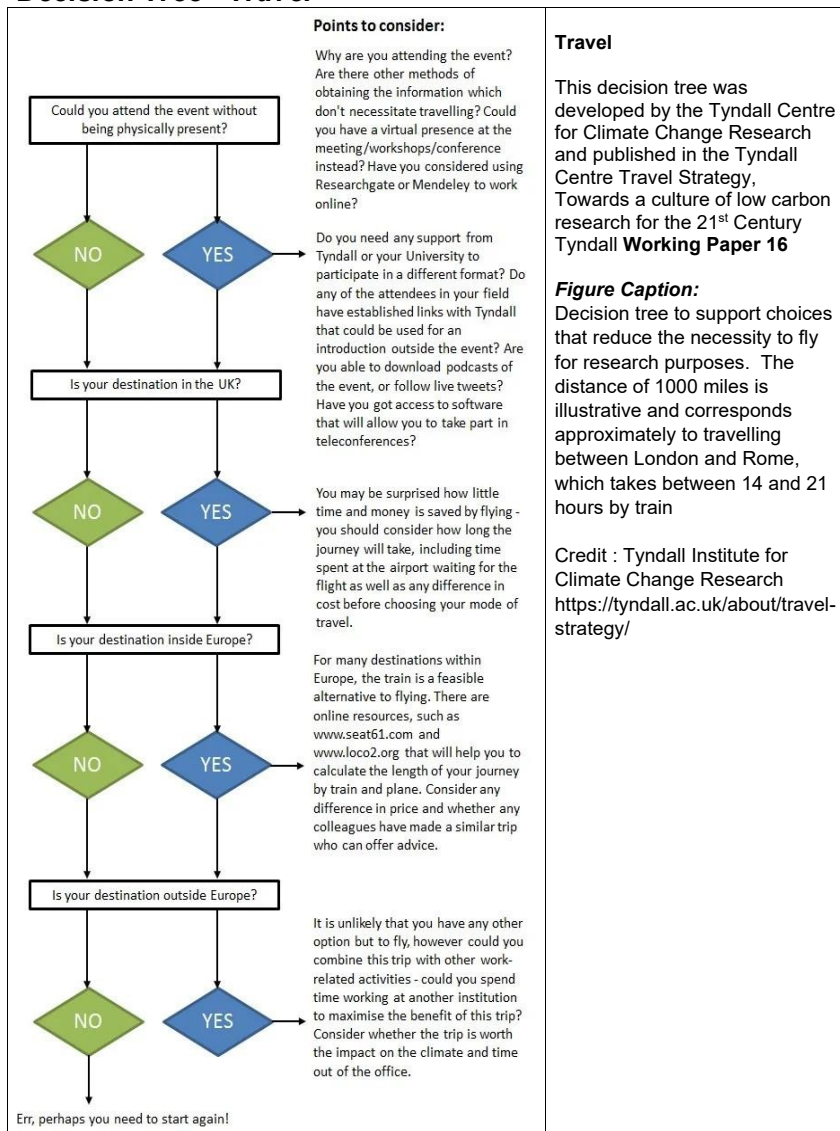
8. Travel

*Just 1% of the world's population are
responsible for over half of all aviation
emissions!*



- **Avoid Flying:**
Flying is by far the most carbon-intensive way to get from A to B. One return transatlantic flight emits the same amount of carbon as would be saved by doing 20 years of recycling⁸! Virtual conferencing is becoming more popular!
- **Work Remotely When Possible:**
The Covid-19 pandemic made it clear that working from home is not an outlandish idea! While many lab activities must be done in person, try to limit the number of days you come in as much as possible. Staying home 1 day per week reduces your transport emissions by 20%!
- **Use Public Transport:**
Travelling by bus, train or tram emits significantly less carbon per passenger than cars. While there is work to be done, these services are gradually improving in Ireland. Try leaving the car at home one or two days per week if you can!
- **Active Travel is Best:**
While public transport is better than private cars, active travel like walking and cycling is much better again. These transport options use some of the cleanest fuel around; whatever you had for breakfast!
- **Use Electric Bikes and Scooters:**
One thing to remember about transport emissions is that the lighter the vehicle, the less energy required to move it. That is why driving an SUV is much higher carbon than an electric scooter! Plus, electric motors do not spew out pollutants into the air the same way internal combustion engines do!
- **Order Materials Locally:**
Transport emissions are not limited to the ones from getting you from A to B. There are also transport emissions associated with transporting goods! If you buy your lab consumables and other materials from local suppliers, you cut down the distance those supplies must travel before arriving at your lab.
- **Advocate for Greater Public and Active Transport Infrastructure:**
Government (or university) policy can have a huge effect on how easy it is for people to make green choices when it comes to their travel. Signing petitions or attending protests is a great way to push these bodies to improve infrastructure and make green travel easier and cheaper!

Decision Tree - Travel



9. Green Chemistry

The weight of materials required to make a computer chip is 630 times more than the weight of the chip itself!



Sigma Aldrich Green Chemistry Chemical Substitution Tool:

<https://www.sigmaaldrich.com/IE/en/services/software-and-digital-platforms/dozn-tool>

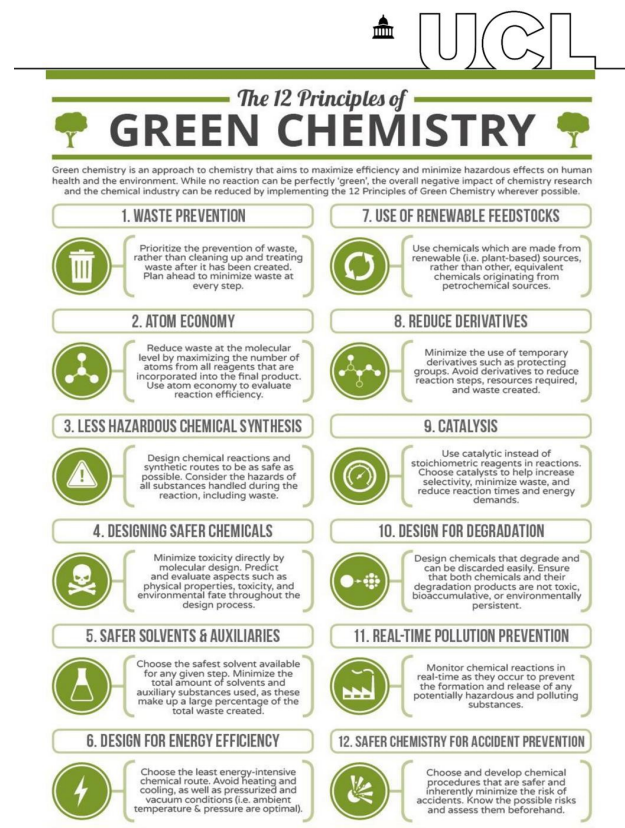


Image Credit: [Laboratory Efficiency Assessment Framework LEAF](#) University College London

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