bist Sustainability Handbook

bist SCIENTIFIC COMMUNITY

CRG · IBEC · ICFO · ICIQ · ICN2 · IFAE · IRB BARCELONA

bist Sustainability Handbook

Version 1.0 (2023)

This handbook was created by the members of the BIST Sustainability Working Group, Marcos Francisco Pérez, Andre Faure and Donate Weghorn (CRG), Xavier Blanch (ICIQ), José Pérez and Marta Duran (ICN2), Anna Vilches (IRB Barcelona), Clara Vilches (ICFO), Isabel Oliveira and Teresa Sanchis (IBEC), Vanessa Acín (IFAE), and Àlex González (BIST core team), and edited by the BIST Communications Commission.

Illustrations and design by: Marina Juanet.

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INTRODUCTION

The science is clear –across all sectors of society we have to shrink our environmental impact, and do it soon.

We, members of the BIST Community, believe that scientists and scientific institutions should step up and lead the way; and that's why we're joining the fight.

Science is essential for forging a sustainable future, but right now it also uses a lot of energy and creates a lot of waste. Between all of us, simple steps can slash our environmental impact. In this handbook, we try to give you the minimum information you need to maximally reduce your environmental footprint in the lab.

As well as minimising our environmental impact, in a different way we should aim to maximise it. We need everyone to join the fight. Changing the behaviour of a few individuals is not enough; we need cultural change to shift lab practices towards sustainability. If you are motivated to action by the crisis of sustainability, become an active agent catalysing change in your group and the institute at large. This guide also provides some tips on how to have difficult conversations with labmates to steer them in the right direction.

HOW TO READ THIS GUIDE

The guide aims to provide information to help BIST Community members reduce their environmental impact.

We begin with an overview of why sustainability is so important at this stage in history.

Next, we consider the relative impact of sustainability actions, highlighting the importance of prioritising those with the largest effects.

We then provide specific information on how we can reduce our impact.

What follows is divided into 4 sections: Travel, Energy, Waste and Outside the Lab. At the start of each section we provide quick tips on the most impactful changes 'at a glance'.

Within each section is more information on various ways of reducing our environmental impact. You will find concrete steps you can take outlined in bullet points. Icons at the top of each section indicate whether the advice applies to experimental scientists ( ), computational scientists ( ) and/or administrative staff ( ).

Lastly, we consider the important skill of how to steer our groups and institutions in a gentle and inclusive way towards sustainability.

We provide concise information to empower BIST Community members with all the information that they really need. However, we provide links in the digital handbook for those who wish to have more information, discussion and references about the points raised.

WHAT IS THE ECOSOCIAL CRISIS?

We are currently witnessing an unprecedented rise in the Earth's average temperature, which is due to rising levels of greenhouse gases in the atmosphere, most importantly CO_2 [1].

Atmospheric CO_2 has been rising since the beginning of the industrial revolution (~1830s) and is primarily caused by the burning of fossil fuels [2] (oil, gas and coal) for, among others, transportation, food production, massive consumption and temperature regulation (heating and air-conditioning).

The consequences of this temperature increase are not limited to gradually rising sea levels and declining polar bear numbers - they are of truly massive proportions [3] including:

- More severe and more frequent floods, storms, droughts and wildfires
- Displacement of people from their homes, with at least 500 million climate crisis refugees expected in the coming decades
- Declining agricultural yields in food crops, consequent food shortages
- Shortages of drinking water
- Desertification of residential and agricultural land
- Destruction of animal habitats and decline in biodiversity, increasing the likelihood/frequency of pandemics

Importantly, climate change is already severely impacting **human health** [4] and environmental pressures on populations coupled with resource shortages are expected to increase the likelihood of future **violent conflicts** [3].

The rise in Earth's average temperature is not the only problem we face. Humans are also producing enormous amounts of **waste**, particularly non-biodegradable plastic waste. This is destroying human and other animals' habitats and their health [5]. We are monopolising the Earth's fresh water supply. Through urbanisation, deforestation and pollution we are destroying the biodiversity which sustains the function of Earth's ecosystems.

WHY CARE ABOUT SUSTAINABILITY?

In 1987, the United Nations Brundtland Commission defined **sustainability** as: "*meeting the needs of the present without compromising the ability of future generations to meet their own needs.*" [6]

We are all citizens that care deeply about the societies we live in. Whether or not we have children, we want the best for future generations. The ecological crisis puts their lives and livelihoods in jeopardy. As citizens we are called upon to take action, both individually and collectively.

More broadly, the climate crisis complicates, and is complicated by, many other global issues. For example, while richer nations bear most responsibility for historical greenhouse gas emissions, it is the poorest countries that stand to suffer the most and can do least about climate change. As such, it is most fair that richer nations lead the way towards sustainability.

Another major problem is the reliance of our current economic model on continued exponential growth, at a time when humanity's use of both natural resources and fossil fuels are already far above sustainable limits. As a society we need new ways of viewing nature as more than resources to be exploited.

This handbook focuses on measures that we can adopt in our workplaces; however, as the co-chair of IPCC Working Group II stated:

"*[We need] unprecedented transitions in all aspects of society, including energy, land and ecosystems, urban and infrastructure as well as industry [to ...] ultimately sustain all life on Earth.*" [7]

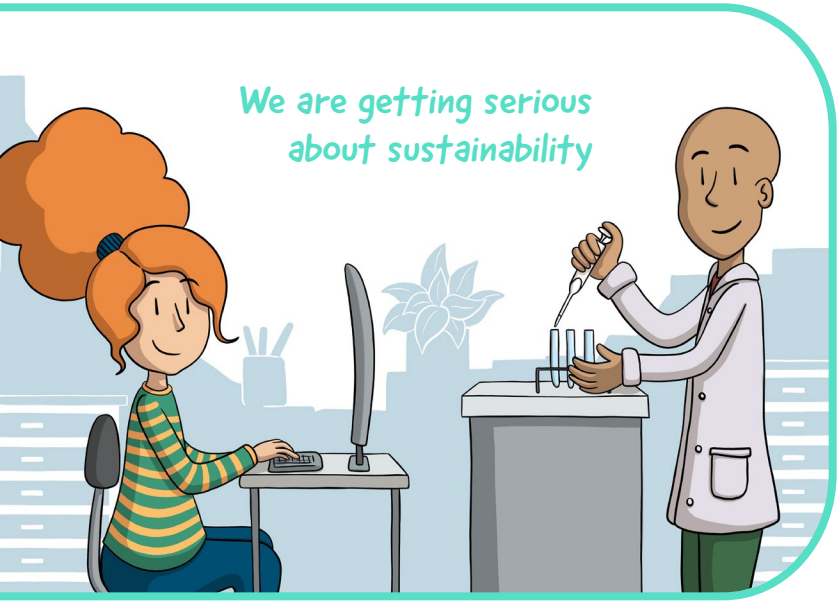
WHAT CAN SCIENTISTS DO?

Scientists have a special responsibility when it comes to sustainability.

Firstly, scientists have a valuable ability to understand scientific data and are privileged to be trusted by others. Scientists are therefore well-placed to clearly communicate the seriousness of the climate crisis (to friends, family and more widely in society).

Secondly, the research we conduct - biotechnological, ecological, chemical and physical - has the potential to reduce the impact of and improve the health of societies and ecosystems when applied in the real world.

Thirdly, the way we conduct our research has a huge impact. For example, scientists generate 2% of plastic waste globally [8] and have 5-10 times the carbon footprint of the average individual [9]. Moreover, modern data science requires energy- and material-intensive computing resources.



We believe that scientists can and should lead the way in this societal transition. In this spirit we can all endeavour to transform the impact of our work.

INCONVENIENT TRUTHS

1. Rich industrialised countries are overwhelmingly responsible for global historical fossil fuel emissions [10].

2. **Individual behaviour change** is required but will be insufficient to stave off the worst of the climate crisis. See this toolkit [11] for a deeper discussion.

3. For this reason, **system change** (economies and societies) is crucially important in developed nations in order to achieve a just transition to a sustainable, carbon-neutral world [12].

4. Despite impressive advances in green energy technologies, the growing economy still consumes a greater quantity of resources and fossil fuels every year [13].

5. Therefore, fundamentally different economic models that ensure human thriving **without the growth imperative** are needed most urgently in developed nations if we are to meet our stated climate goals [14]. A majority of Spaniards [15] are supportive of this.

SUMMARY

The graphic below provides a summary of the relative impacts of emissions reduction measures that can be adopted in BIST Community labs and offices as well as outside the lab.

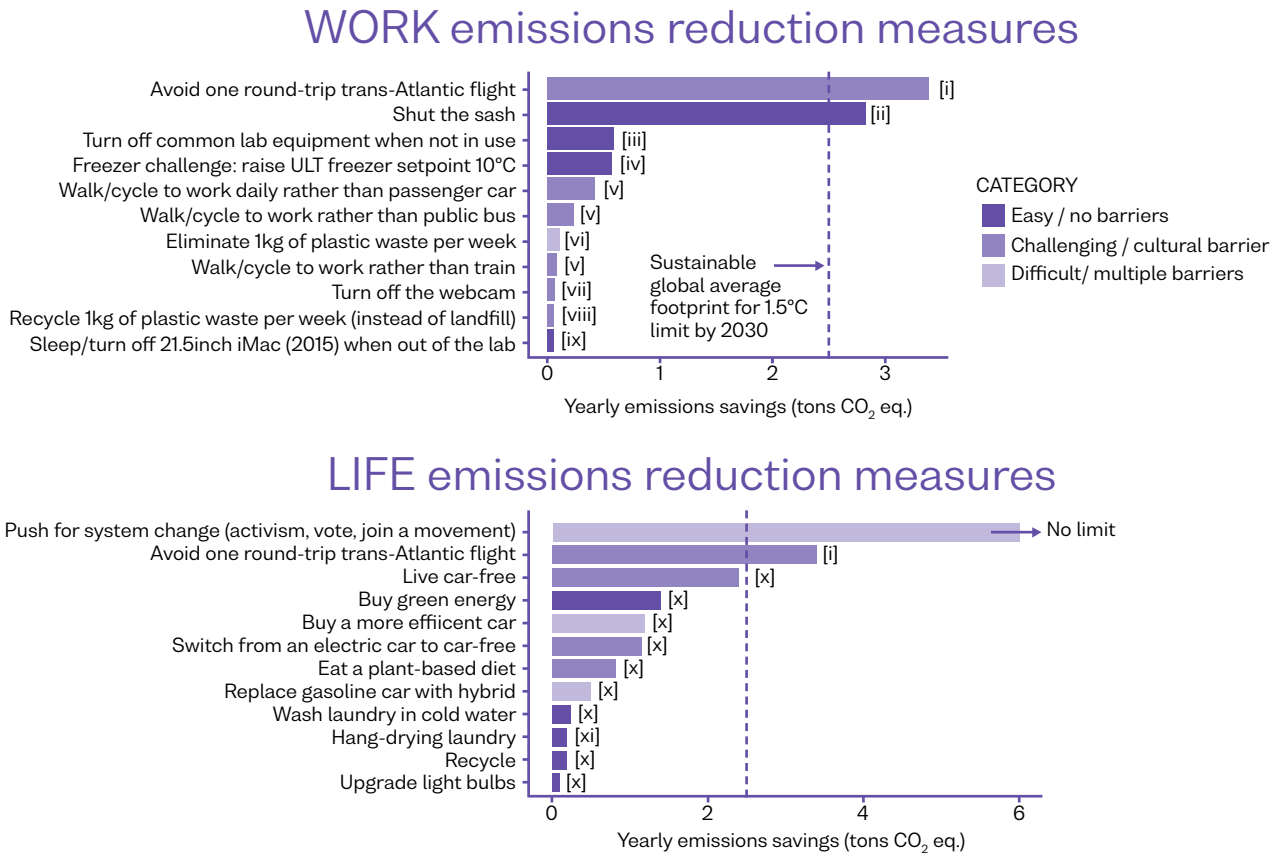


Figure 1. Estimated yearly emissions savings (tons CO_2 equivalents) for typical BIST workplace and high-income lifestyle measures ordered by impact. Measures are coloured according to a subjective qualitative scale ('Category') indicating the ease with which they can be adopted (see legend).

[i] Return-flight London-New York per passenger: www.atmosfair.de
[ii] Per hood*: https://sustainable.harvard.edu/wp-content/uploads/2023/09/FumeHoodWhitePaper-1.pdf
[iii] Per lab*: https://www.mygreenlab.org/turn-off-equipment.html
[iv] 6kWh/day saving per ULT freezer at -70°C vs. -80°C setpoint*: https://www.etcc-ca.com/reports/ultra-low-temperature-freezers-opening-door-energy-savings-laboratories
[v] Return 5km journey per day for 45 weeks: https://ourworldindata.org/travel-carbon-footprint
[vi] 1kg plastic production (2.6 kg CO_2 eq.) per week for 45 weeks: https://woodly.com/carbon_neutrality/what-is-the-carbon-footprint-of-plastic/
[vii] 10h of Zoom per week for 45 weeks*: https://www.resilience.org/stories/2021-01-16/turn-off-that-camera-during-virtual-meetings-environmental-study-says/
[viii] 1kg plastic recycling per week for 45 weeks (instead of landfill): http://www.stopwaste.co
[ix] Compared to idle (display on) 16h per workday and 24h on weekends*: https://www.apple.com/environment/pdf/products/desktops/21_5inch_iMac_PER_Oct2015.pdf
[x] https://iopscience.iop.org/article/10.1088/1748-9326/aa7541

*Electricity savings to emissions conversion factor: 0.265 kg CO_2 eq. per kWh

It's clear that different measures can have wildly differing impacts, with a handful of measures having outsized CO_2 reduction potential. For more information about these and other impacts and actions see this app: https://www.earthhero.org/ [16].

Eliminating (or reducing) **air travel** is one of the most important ways to reduce emissions in both one's work and personal lives.

In the lab, the highest impact measures are:

1. **Shutting the sash** in labs with a fume hood
2. Raising **freezer temperature** setpoint
3. **Turning off equipment** when not in use

For more information, guidelines and action plans to monitor and improve sustainable practices in the lab, assessment methodologies like My Green Lab (https://www.mygreenlab.org/ [17]) or LEAF (https://www.ucl.ac.uk/sustainable/leaf-laboratory-efficiency-assessment-framework [18]) may also be consulted.

The enormous challenge of sustainability may seem overwhelming at first, but the good news is that prioritising just a few measures goes a long way towards reducing the climate impact of our day-to-day activities.

On the other hand, despite the historical focus on the reduction and recycling of plastics, the relative emissions component of these measures is perhaps surprisingly small. However, it is important to point out that climate change is just one of nine planetary boundaries [19] affected by human actions and plastic pollution has a shocking impact on marine biodiversity.

TRAVEL

AT A GLANCE

- AIR TRAVEL - REDUCE, REUSE AND STAY GROUNDED

- COMMUTE WELL FOR A PLEASANT CITY

AIR TRAVEL: REDUCE, REUSE AND STAY GROUNDED

Emissions from aviation are huge and reflect global inequality: frequent flyers (1% of the world's population) cause 50% of commercial aviation emissions. Just one return transatlantic flight (3.4 tons CO_2 equivalents) puts you outside the yearly sustainable budget for 1.5°C limit by 2030 [20].

Researchers have an outsized travel footprint, sometimes taking multiple long-haul flights every year [21]. Conference attendance accounts for 35% of a researcher's carbon footprint [22]. Connections and collaborations are essential to modern science and we feel that international travel and conferences are indispensable for our academic success —although a recent study [23] disputes this. Many trips are avoidable, and the impact for many more can be lessened with some planning [24].

What can I do?

- **Reduce**. Try to take fewer trips, and fly economy if you do fly. During the Covid-19 pandemic, online meetings, seminars and even conferences became the norm. To connect with collaborators on a human level, try drinks or even a pizza over Zoom —you don't need to fly to establish that connection.

- **Reuse**. If you will travel, consider doing more with less. Sometimes conferences are planned at a similar time to allow researchers to attend both in a single trip. Maybe while you are there you can arrange to give a talk at a nearby institute. Further, if you have flown abroad, why not stay awhile and make it a holiday, if possible? You might save a couple of flights later in the year.

- **Stay grounded (try not to fly)**. Flying is far and away the most destructive [25] means of travelling. Especially for trips below 1000 km, non-aviation options are possible, comfortable and practical. For example, London or Heidelberg can be easily reached by train in a day from Barcelona. Within Europe, night trains can reduce perceived travel times. Use websites such as raileurope.com to identify routes and set alerts for cheap tickets or ask your institute's travel agency.

COMMUTE WELL FOR A PLEASANT CITY

Cars are a particularly inefficient form of transport: a typical European car is parked 92% of the time, spends 20% of its driving time looking for parking and has 5 seats to move just 1.5 people on average. 86% of the energy in its fuel never reaches the wheels, and most of what gets there is used to move the weight of the car, not people [26].

Traffic and congestion make for a dangerous, noisy and polluted city. For example, air pollution alone kills more than 350 people per year in Barcelona [27]. Do what you can to make the city more pleasant for everyone.

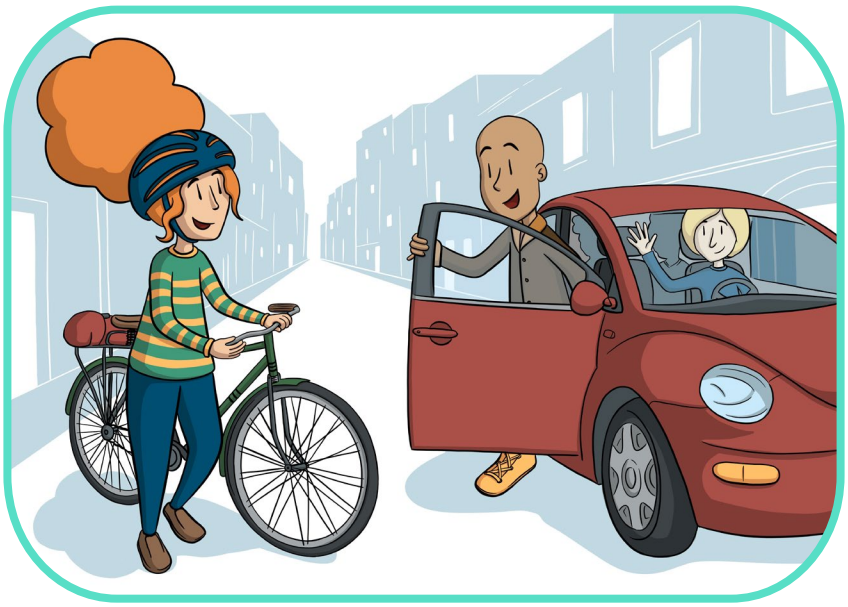
What can I do?

- **Walk or cycle to work.** Walking and cycling keep the air clean and boost your health. They also help you to know your surroundings.

- **Use public transport.** Using public transport is preferable to using a motor vehicle. You can always use public transport for part of your journey, with the rest on foot or a fold-up bike.

- **Share lifts with colleagues.** If cycling or public transport are impractical for you, see if anyone else working on your site lives in your area and if you can share lifts to reduce traffic. Find out if your institute, parc or campus runs a carpooling scheme (e.g. IRB/IBEC).

- **Beware of electric scooter ride-sharing.** As they have no exhaust emissions, these scooters appear eco-friendly and are often marketed as such. However, a US study found that one service, Bird (which has operated in Barcelona and Tarragona), had upstream and downstream impacts that altogether made overall **CO_2 emissions for electric scooters worse than a moped** [28].



CYCLING TO WORK

There are many factors which make cycling an ideal way to get around the BIST Community Centres:

1. First of all, the **weather**. With ample sunshine, infrequent rain and balmy winters, you can comfortably cycle year-round.

2. There are plenty of **safe bike lanes** around the BIST Community Centres and the network is expanding. Check the links to find bike lanes maps around Barcelona [29], Castelldefels [30] Cerdanyola [31], and Tarragona [32]. Further, if there is no cycle lane, it is permitted to cycle on pavements wider than 5m under most circumstances.

3. Your research centre might not be that far with a bike. For example, Barcelona is **medium-sized**, which puts most of the city within 30 minutes cycling from the centre, and Tarragona's city centre is compact, making it the ideal size for cycling or walking around. Most of the city is within 15 minutes cycling from the centre.

4. Barcelona has a **public bicycle sharing network**, Bicing [33], which allows users to take bikes, from more than 400 stations around the city. An electric bike sharing system Ambici [34], also reaches other towns in the metropolitan area, such as Castelledefels. Also the UAB Campus has a bike renting service, the BiciUAB [35]. Users must register to use these services.

ENERGY

AT A GLANCE

- SHUT THE SASH ON THE FUME HOOD

- TURN OFF EQUIPMENT


- -70°C IS THE NEW -80°C

SHUT THE SASH ON THE FUME HOOD

Along with Ultra Low Temperature freezers, one of the most energy-hungry machines in many labs is the fume hood [36]. If the hood is left open wide, the energy use is equivalent to a whopping 10 households. By keeping the sash shut whenever we are not using it, the airflow is greatly reduced, and so is the energy usage - not only by the hood itself but also to maintain the ambient temperature in the lab.

What can I do?

- **Shut the sash!** Keep the sash as low as possible at all times.
- **Make sure your lab mates shut the sash.** If someone in your lab is regularly leaving the sash open, they are probably unaware of the energy they are wasting. Find out who it is and politely educate them.

N.B. SAFETY FIRST!

The hood exists to protect lab workers from noxious fumes. Don't be tempted to turn off the hood entirely unless you are absolutely sure that it contains nothing that can jeopardize the health of you or your colleagues. If in any doubt, just shut the sash.

SWITCH OFF EQUIPMENT WHEN NOT IN USE

Heated or refrigerated equipment —such as incubators, centrifuges or PCR machines— are some of the most energy-intensive machines we run in the lab. Turning these machines off when not in use —or changing their set-point temperature when they are— can save a lot of energy.

Similarly, many **computers and lights** are left on overnight unnecessarily.

During the COVID-19 pandemic, Zoom and Teams became the standard forums for lab meetings, seminars and conferences. This trend also promises to reduce travel for collaborations and conferences in the future. Nonetheless, the environmental impact of web streaming is significant. **Turning off the webcam can reduce energy use by a stunning 96%** [37,38].

What can I do?

- **Turn equipment off after use.** Make sure you don't leave energy hungry machines on when you are finished using them. Turning them off is usually as simple as a flick of a switch.

- **Regularly check equipment in your lab.** When people are busy, they may forget to turn off equipment - and if no one is vigilant, that incubator might be running empty at 37°C for a month before someone notices. Keep your eyes open and periodically check equipment in your lab - shut down whatever is not needed.

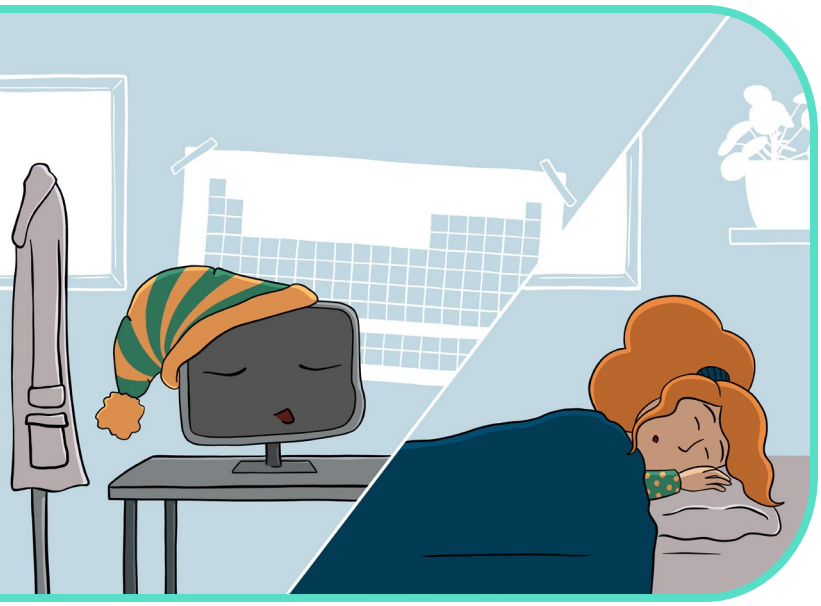
- **Don't leave PCR samples at 4°C.** PCR machines are inefficient refrigerators —at 4°C they use as much electricity as a typical -20°C freezer. When your PCR

run finishes, set the rest temperature to room temperature. If your reactions really need to be chilled (and they probably don't [39]), ask someone to take your reactions and place them in the fridge.

- **Turn off your computer when you leave.** If you can turn the computer off, that's best. Failing that, put the computer to sleep or turn off the screen when not in use.

- **Establish Wake-on-LAN to remotely access sleeping computers.** Wake-on-LAN [40] allows for remote activation of a sleeping computer connected to the ethernet. Wake-on-lan requires 0.5W to run, sleep mode consumes 3-10W and leaving your computer on consumes 60-300W.

- **Turn the lights off when you leave.** If you are the last one out of the lab, take responsibility and turn off all the lights that remain on. Talk to your lab mates, and try working with natural light only - you might prefer it.



- **Turn off the webcam.** Sometimes, to see each other over a video call is exactly what is needed. Other times —for example, when watching someone else giving a presentation or seminar— your video stream is just uselessly burning carbon. Try to keep it switched off whenever you can.

AVOID THE TRAGEDY OF THE COMMONS

Common equipment is often neglected because no-one feels responsible for it. We tend to leave it in the state that we found it, even if that means leaving an empty incubator at 37°C.

What can I do?

- **Turn common equipment off.** The default option should be to turn unused equipment off, even if we found it on before.

- **Check the booking calendars.** If in doubt, check for other users after you. If someone will use it soon after you, they might want you to leave it on (you can always email to ask). If the equipment will go unused for several hours, turn it off.

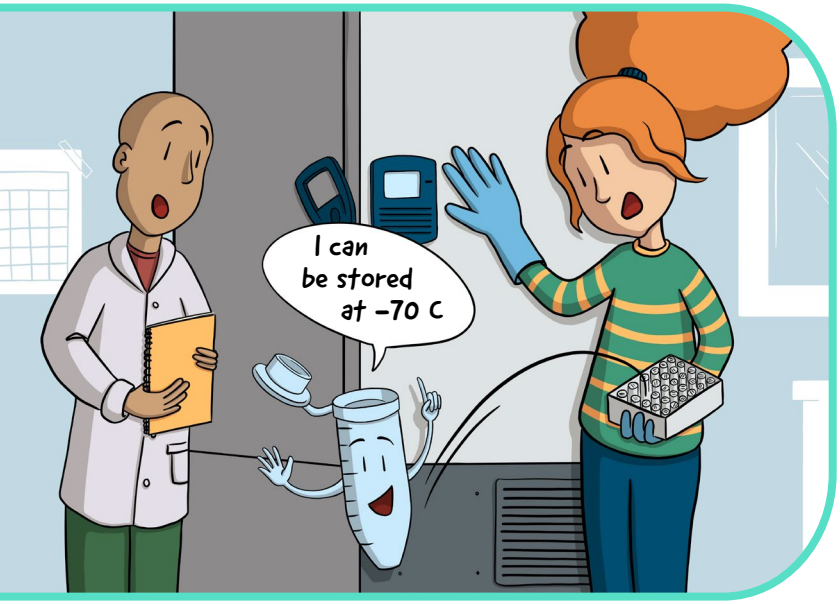
ULTRA LOW TEMPERATURE FREEZERS - WARM THEM UP AND USE THEM RIGHT

Each -80°C freezer uses as much energy as 1.7 households. Raising temperatures to -70°C instead saves up to 40% of this energy. Meanwhile, reagents, cells and samples are preserved just as well as at -80°C [41].

One valid concern is that in the case of a freezer failure there will be less time to react before temperatures are dangerously high. While true, the difference between -80°C and -70°C is small and most freezers are protected by an alarm system that provides early warning of freezer failure.

What can I do?

- **After agreeing with the rest of your group's members, set your lab's freezers to -70°C.** This is likely to be the single largest energy saving step we can take in the lab, and it comes with essentially no cost in time, effort or sample integrity.

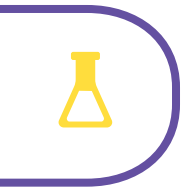


- **Keep the freezer door closed.** While you are looking for a sample, remove the box and close the door. The longer the door is open, the more the freezer warms and the more energy it uses.
- **Keep your samples organized.** If you know exactly where to find what you are looking

for, you can be in and out of the freezer with surgical precision. This helps to keep temperatures and energy costs low.

- **Keep samples at -20°C instead.** Many samples, such as DNA, are preserved indefinitely at -20°C and do not need to be kept in a ULT freezer [41]. Fewer samples means fewer fridges means less energy.

REMEMBER TO TURN OFF THE GAS



Chemists at BIST Community centres consume large amounts of N_2 and Ar, feeding hundreds of fume hoods and gas regulators. Often, these valuable resources are taken for granted by researchers. However consumption could total more than 400 m^3 of liquid N_2 and Ar every year, at high financial and environmental cost.

What can I do?

- **Remember to close the valves tightly after use.** Make sure you close the CUT valves instead of the reducer valves to make sure the gas is closed.

- **Check all valves are closed before leaving the lab.** An almost imperceptible leak in just 2-3% of the ICIQ's many gas regulators would represent an annual waste exceeding 5000 m^3 of gas.

- **Check the gas lines periodically in order to detect possible leaks**. You can also invest in monitoring systems to control the gas consumption.

WASTE

AT A GLANCE

- DON'T DISPOSE OF NON-HAZARDOUS WASTE IN HAZARD BINS

- REDUCE, REUSE, RECYCLE - FOR LAB PLASTICS TOO

- USE LESS PAPER


MINIMIZE HAZARDOUS WASTE DISPOSAL

Hazardous waste bins are subject to management and disposal protocols that are costly for the institute and the environment. For example, black and yellow biohazard bins are made of heavy duty plastic and are autoclaved, using a lot of energy and water, prior to disposal at landfill.

What can you do?

- **Dispose of waste correctly.** Remember: hazardous waste bins are not for general waste. Plastic packaging and disposable plastic equipment such as tubes that have only been used for nontoxic reagents such as buffers or sterile growth medium should not go into hazardous waste bins, and can often be recycled.

- **Familiarise yourself with your institute's guidelines for waste management.** By separating waste and throwing only contaminated materials into the specialised bins, you are helping reduce the cost and complexity of hazardous waste management and allowing paper and plastic to be recycled.

- **Gently remind your lab mates** when you see them filling hazardous waste bins with nontoxic solid waste.

MINIMIZE PLASTIC WASTE IN THE LAB

The old environmental adage —reduce, reuse, recycle— applies perfectly to lab plastic.

Shockingly, labs produce an estimated 2% of all plastic waste globally [42]. If you make an effort to reuse plastic bags at home, take some time to reconsider your lab practices; the impact is likely far greater.

What can I do?

- **Reduce.** Consider using reusable glassware instead of single-use plastics. For instance, if you grow bacterial cultures in plastic tubes, consider using a glass flask instead. Likewise, for many purposes glass test tubes are an alternative to single-use plastic tubes.

- **Reuse.** You reuse plastic at home; why not in the lab? If you regularly use tubes for nontoxic reagents and they don't need to be sterile, you can wash and reuse plastic tubes time and time again. Likewise, consider whether you really need to use a new pipette tip for each well of an

electrophoresis gel or whether you can reuse a single tip if cross-contamination is not an issue (for instance, for genotyping).

- **Recycle.** As well as plastic packaging, plastic lab tubes and plastic pipette tip boxes, can often be recycled. If it's nontoxic and nothing has been growing in it, rinse and recycle it.

MAKE GOOD USE OF PAPER


We can read on our screens, but sometimes we like to hold a paper in our hands, to make notes and to engage more with the text. If that sounds like you, no problem; but take a moment to do it the right way.

What can I do?

- **Read on screen.** Obviously, the best thing is to not print a document in the first place. We like to take notes, but many software packages like Mendeley, Zotero or Papers allow you to do this too; and you don't lose them at the bottom of a paper pile.

- **Print double sided and multiple pages per sheet.** This reduces the paper you need for an article by 75%. Ask your IT department to configure double-sided printing by default.

- **Don't throw away usable paper.** Use the white side of unwanted printed pages as scrap paper for e.g. note-taking.

- **Take care not to print unnecessary pages.** Do you need to print the list of 178 references, or the

supplementary information? Take a moment to check you print only the pages you need.

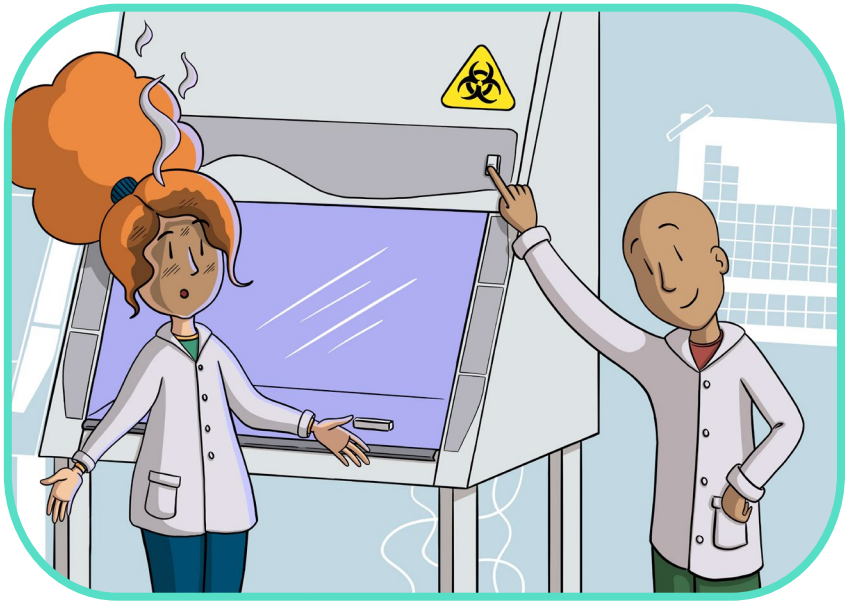
- **Use an electronic lab book.** Electronic lab books save paper and improve the security and accessibility of your information.

ULTRAVIOLET/FLUORESCENT BULBS IN MICROSCOPES AND HOODS

We use ultraviolet (UV) fluorescent bulbs for sterilisation of microbiology hoods, and fluorescent bulbs in microscopy. However, both represent a significant stream of toxic waste at the end of their lives.

What can I do?

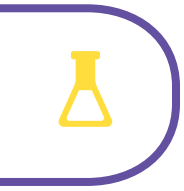
- **Don't UV sterilise the hood.** The CDC and NIH agree that UV sterilisation of biological safety cabinets is "not recommended... nor necessary" [43]. Furthermore, UV lights are a health hazard for workers. Sterilising with 70% ethanol is quicker, more robust, more environmentally friendly and safer.



- **Replace fluorescent bulbs for microscopy with LEDs.** Fluorescent bulbs often contain mercury, which is acutely toxic. LEDs are safer, last longer, use less energy and produce a more stable illumination than fluorescent bulbs.

- **Take care of your bulbs.** If you do use fluorescent bulbs for microscopy, make your bulbs go further. Fluorescent bulbs have a limited lifetime. Turn the light off when you don't need it, it will last longer.

KNOW YOUR PURIFIED WATER



Water can be pure —or ultrapure, like that produced by Milli-Q machines. Ultrapure water has dissolved gases removed— but of course, once exposed to air they rapidly diffuse back in. For that brief period of ultra-purity —as little as 20 minutes— the Milli-Q machine uses much more water and energy than needed for regular pure or deionised water. Milli-Q water should only be used for highly sensitive applications, e.g. performing analytical chemistry. For most purposes, such as making growth medium, buffers or reagents, deionised water will suffice.

What can I do?

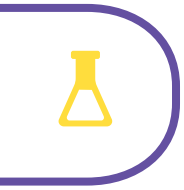
- **Use deionised water taps if you want clean water.** Typically every lab has a deionised water tap. If what you need is clean water with minerals removed, but it does not need to be sterile, use these.

- **Use autoclaved water if you want sterility.** If your institute has a kitchen, they may offer autoclaved purified water (and if they don't, ask them for it!). This is clean, demineralised and sterile, and good enough for most applications.

- **Reduce single-pass cooling.** Many experimental set-ups, especially related with chemical synthesis,require water for cooling (e.g. rotary evaporators, condensers...). Instead of running water down the sink, install a recirculating loop through a cold-water bath as an alternative.

- **Use autoclaves efficiently.** Wait until an autoclave is fully loaded before starting it. Don't run an autoclave to sterilise a single item.

SHARING (EQUIPMENT AND CONSUMABLES) IS CARING



Many labs have a diverse chemical inventory but use none or only a few grams of each reagent in a given year. This leads to waste of expired and unused reagents. Reagent sharing between labs can reduce this waste. Likewise, if you need to use equipment only rarely, check if other labs are willing to let you use theirs.

What can I do?

- **Borrow what you need.** If you just need a little of a reagent, see if you can borrow before you buy. Your institute may have a scientific requests email list where you can ask people in other labs if they have what you need (and if it doesn't, ask IT to set it up!).

- **Share chemical inventories with other labs.** If there's another lab or labs that use similar basic reagents as you, you could set up a combined chemical stock, or at least share inventories using a single software tool so you can borrow and don't need to duplicate.

- **Encourage reagent 'freecycling'.** If there is something you don't need anymore, give it to other labs for free. Consider establishing a 'freecycling' area where other labs can also leave unwanted equipment or consumables.

OUTSIDE THE LAB

AT A GLANCE

- PUSH FOR SYSTEM CHANGE

- BUY GREEN ENERGY

- EAT FOR THE HEALTH OF ALL

- RECONNECT TO NATURE

- INSPIRE THE NEXT GENERATION

PUSH FOR SYSTEM CHANGE

Collective action (working together with others) is by far the single most effective way to have a positive impact in the fight for a sustainable future. From an economic perspective, individual actions, while crucial [11], have incremental and limited effects on the demand side, whereas collective action targets the supply side –fossil fuels and associated industries– with much greater potential for far-reaching consequences. Societal changes achieved in this way are potentially enormous with no theoretical upper limit on their positive impacts (see Figure 1).

What can I do?

- **Find your niche.** There is no one-size-fits-all when it comes to what type of collective action is right for you. This will depend on your values, skills and motivations. Try using this app [16], taking this quiz [44] or reading this toolkit [45] for inspiration.

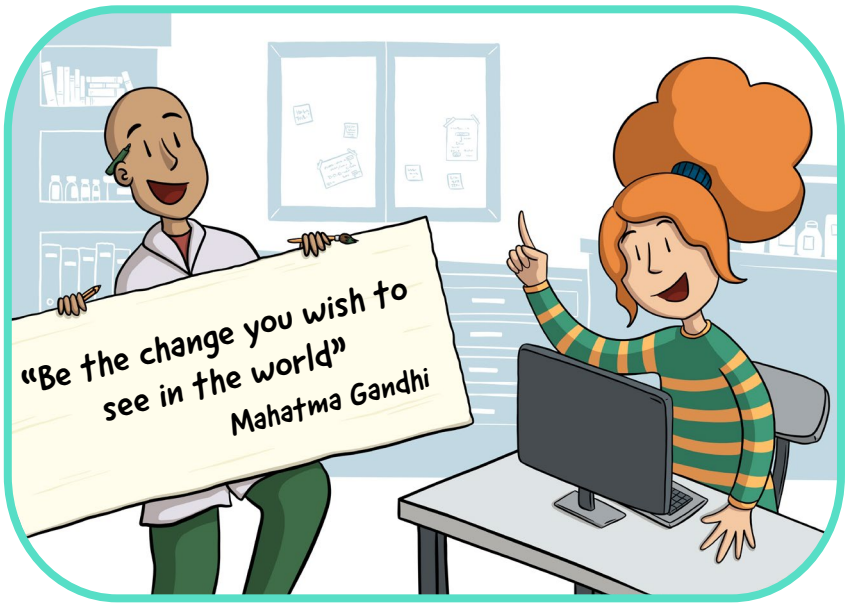
- **Start small.** Effective action can be as simple as talking about the ecological crisis with friends, family and colleagues. As scientists we have implicit authority and legitimacy when it comes to winning people over to our point of view.

- **Vote.** Every election and referendum is an opportunity: both to support better leaders who are serious about climate action but also to shift the conversation towards the greatest challenge in history. Exercise your democratic rights and perhaps even run yourself! For example, Barcelona has a public platform [46] for participation and voting in budget decisions and municipal projects, many of which are related to climate resilience and sustainability.

- **Join a local group.** With local grassroots groups you can spend time and share ideas with like-minded people. Get involved with groups in your BIST Community centre, such as the PRBB sustainability group [47] (where the CRG is located). Or simply celebrate the joy of urban pedal-power with Critical Mass [48], which meets monthly in Barcelona [49].

- **Join (or donate to) a global movement.** Global environmental and climate organisations include 350.org [50] with global success in fossil fuel divestment, Extinction Rebellion [51] and Scientist Rebellion [52] which focus on nonviolent civil disobedience to compel meaningful government action and the youth-led Fridays For Future [53] movement of school strikes started by Greta Thunberg, which has inspired the formation of Scientists For Future [54].

- **Protest.** Using your own voice and presence in public is a powerful way to advocate for societal change. Look out for actions initiated in your area by the organisations above. Protesting can also help to relieve some of the cognitive dissonance associated with living a relatively normal life during a planetary crisis situation.



BUY GREEN ENERGY

Switching your home energy provider is one of the simplest ways to reduce your carbon footprint.

In Spain the energy system is divided into distributors and suppliers. Distributors control the energy infrastructure in your local area, whereas suppliers buy energy from generating companies, pay to use distribution infrastructure and handle customer contracts and billing.

Although customers cannot choose their distributor, freedom to choose from a number of 100% "green" suppliers means that customers can ensure that their money contributes to increased renewable energy generation on the supply side.

What can I do?

- **Switch energy supplier.** In Spain, this is typically as straightforward as making a quick phone call to a 100% green supplier and they will take care of the rest. Although bills tend to be slightly higher with green suppliers, remember that the true cost of fossil energy is externalised in the form of emissions and consequent future losses from climate breakdown.

EAT FOR THE HEALTH OF ALL

Diets high in sugar and animal products and low in fibre have produced a burgeoning obesity epidemic in recent decades [55]. Meanwhile, scientists warn that rapid dietary changes are required [56] to mitigate climate change [57] and avoid catastrophic environmental degradation.

What can I do?

- **Follow the Planetary Health Diet.** In 2019, a multidisciplinary team of researchers writing in the Lancet warned that "the data [on food system impacts] are both sufficient and strong enough to warrant immediate action". Their solution was the Planetary Health Diet [58], aiming to provide a balanced and nutritious diet to a growing population without contributing to further climate change or environmental degradation. The researchers recommend a diet rich in fresh fruits and vegetables, nuts, seeds and whole grains, while limiting animal products to sustainable levels.

- **Don't strive for purity.** You don't need to eliminate all animal products from your diet. If you reduce your intake by two-thirds, that's twice as impactful as eliminating what's left over. Try swapping high impact foods like beef for lower impact alternatives like chicken. Enjoy your food - striving for moral purity tends to lead to disillusionment and alienation.

- **Take it slow.** Just as you don't need to eliminate animal products, you don't need to make changes overnight. Fundamental habits like eating take time to change and going too fast is a surefire recipe for failure. Just try to move along a positive trajectory, at your own speed.

- **Minimise food waste.** About 30% of food that is produced is wasted. Buy only what you need, eat what needs eating and take advantage of apps like Too Good To Go which connect you with restaurants and shops with unsold food that would otherwise be thrown away.

RECONNECT TO NATURE AROUND YOUR WORKPLACE

The great biologist E. O. Wilson proposed that humans have an innate need to connect to nature [59]. Indeed, evidence abounds that reconnecting to nature is good for our physical and mental health - and that is good for our work. Meanwhile, studies have shown that an individual's connection to nature is a powerful determinant of pro-environmental behaviour. Cultivating this connection is a powerful step for your own health and that of our planet.

What can I do?

- **Go forest bathing.** In Japan, the health benefits of shinrin-yoku —'forest bathing' [60]— are well documented. Discover the forests close to your workplace, and other magnificent natural spaces in Catalonia within easy reach of public transport - try senderismeentren.cat for inspiration.

- **Walk near water.** Researchers at the Barcelona Biomedical Research Park (PRBB) have reported that regular walks in 'blue space', such as the beach or lakes, improved mood and well-being. There are many options close to the BIST Community Centres to do it.

- **Enjoy urban flora and fauna.** You don't have to head out of the city to reconnect. From boars to bats, herons to hoopoes and ravens to robins, a wide array of species makes its home in greater Barcelona (and some even within the grounds of BIST Community research centres).

INSPIRE THE NEXT GENERATION

An increasingly urban youth are growing up without direct experience of nature. Researchers call this 'the extinction of experience' [61], and it comes at a time when society urgently needs future generations to take up the mantle of environmental protection. Further, young people's physical and mental health suffer as a result of 'nature deficit disorder' [62].

What can I do?

- **Tell young people about your science.** At many outreach events, such as Open Days and high school visits, scientists have the opportunity to directly engage with local kids. Tell them about what you do, emphasise the magic and wonder of your work and let the experience rekindle your love of life and your own research.

- **Take your young relatives into nature.** Whether your own children or beloved nephews, nieces or cousins, share your enthusiasm for living things with an impressionable audience.

LEADERSHIP FOR SUSTAINABILITY

As much as we all need to change our behaviour, to do so in isolation is but a drop in the ocean. What we need is culture change, in wider society and also in high impact sectors such as scientific research. This is where the environmentally conscious researcher can lead the way and help catalyse wider change within their group and institute.

That said, when advocating for any type of change our suggestions run the risk of alienating others with different responsibilities, values and/or priorities. Ultimately people must make their own decisions freely.

Here is some advice that may help in becoming an effective and sensitive leader for sustainability:

- **Be frank.** Lead conversations with data (where available) and honestly engage with the pros and cons of the changes you encourage.

- **Be a team player.** Encourage group decisions with participation and suggestions from others.

- **Be a role model.** Striving to improve your own practices –being open about your efforts– will do most to inspire change in others.

- **Join with others.** Try to join forces with like-minded people at your institute, for example to organise a network of lab eco-representatives.

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