Sustainability in the wet lab

BIOMEDICAL CENTER MUNICH
BIOMEDIZINISCHES CENTRUM MÜNCHEN

The BMC with its 450 employees consumes on average 6.3 Mio kWh per year whereas an average 3-person household in Germany consumes on average 3500 kWh per year. In other words, we (450 employees) consume as much energy as ~1800 households per year!

Small individual changes amplify and make enormous impact on our energy consumption!

grINIM

GREEN Lab @ BMC

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Sustainable Actions:

Chemical and biological safety hoods

One biological safety cabinet consumes as much energy as three average German households. Please switch off biological safety cabinets and close fume hood sash whenever it is not in use. In addition to saving energy and costs, this also prolongs the lifetime of the device.

Bacteria shakers

We propose to turn off the bacteria shaker by default as it is not frequently in use. Each bacteria shaker consumes 5.28 kWh per day to maintain device at 37°C; however, it only takes 21 minutes to warm up the shaker to 37°C after switching it on, so we could avoid this unnecessary consumption by switching them off by default.

Bench-top devices

In the lab, we often keep our devices on "stand-by" (e.g. centrifuges, shakers, stirrers, cell counters, heaters… etc.). However, these devices do still consume energy because the display and set temperature are maintained.

These are some measures of devices in our lab:

In use: 6,4 W
Idling: 5.0 W

In use: 37,4 W
Idling: 5,7 W

In use = Idling = 10,4 W

In use = Idling

In use: 919,5 W
Idling: 7,9 W

In use: 423.4 W
Idling: 6,7 W

W ("Watt") is the measure of the "rate of energy consumed" = 1 Joule per second.
Wh ("Watthour") is an unit of energy = 1W over 1 hour = 3600 Joules.

Some devices consume as much energy as if they were in use, since the function is maintained when idling; for instance, the heater expends energy to keep the device at a set temperature whether the samples are in there or not. Please be aware of the time it takes for heaters to warm up to the set temperature and avoid keeping the heater on for long periods of time. An average heater takes approximately 5-10 minutes to reach 37°C and approximately 15-20 minutes to reach 95°C.

What you can do:

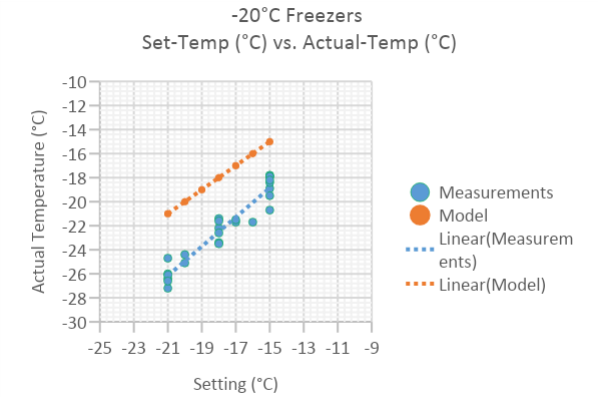
1. Simply close the centrifuge lids between uses to keep the device at the set temperature and avoid additional cooling.
2. Don't forget to stop the stirrer when the buffers are well mixed.
3. If possible, please share the devices.
4. This also applies to the computers and the room lights. Please remember to turn off all devices and lights at the end of the day. During breaks, it is also possible to set it in "energy saving mode" or "hibernate".

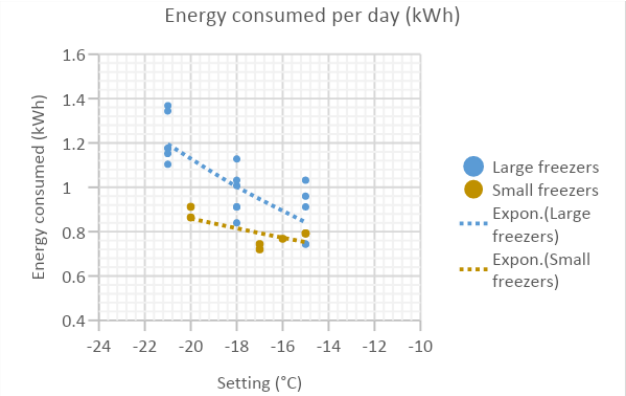
Each individual device may not consume a lot of energy alone, but it adds up over time and in mass.

Freezers

-20°C Freezers:

We have observed that our -20°C freezers are usually colder than its settings. For instance, a setting of -21°C resulted in an actual temperature of around -26°C on average (n=7). As cooling down the freezers colder than -20°C may not be favourable for all the samples and also causes the freezers to consume more energy, it makes sense to turn up all the -20°C freezer up to a setting that would result in an actual temperature of -20°C inside the freezer; typically around the setting of -18°C. The modification should be confirmed with a thermometer.





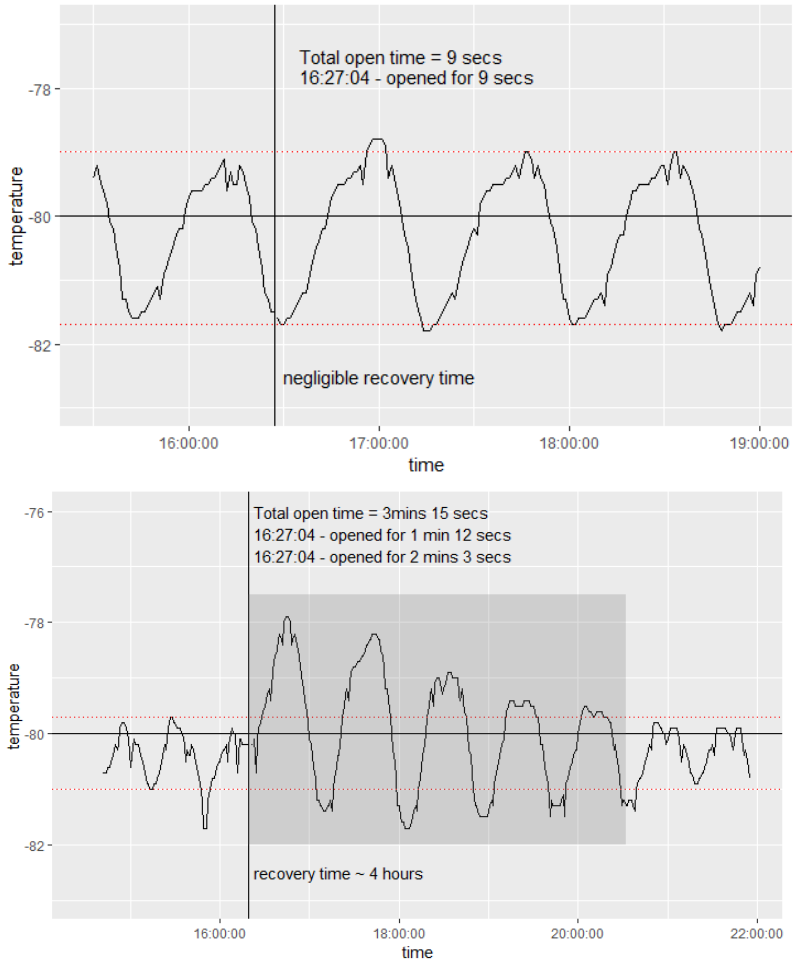
Ultra-low freezers (-70°C ~ -80°C):

Ultra-low freezers (-80°C freezers) are energy-demanding devices that consume 28-35 kWh per day each (equivalent to three 3-person households in Germany). While their function in the laboratory setting cannot be replaced, there are some actions we could take to reduce its energy consumption and prolong its lifetime:

1. **Reduce the freezer's open-time.** Keep the freezers organized so it takes less time to look for samples while keeping the freezer doors open. The longer we open the freezers, the more the freezers warm up, hence, more energy is needed to cool it down to the set temperature. Currently, our freezers are being opened for as much as 3 minutes. If the freezer was opened multiple times in a short time frame, the warming effect is accumulative.

2. **Regularly defrost the freezers twice a year** and remove ice buildup.

3. **Regularly vacuum the condenser filter** and coils to ensure efficient cooling.



In these graphs, the red lines indicate the maximum and minimum average natural temperature fluctuations of a freezer. When the freezer was opened for only 9 seconds, the freezer swiftly recovered within its normal temperature range. However, the same freezer took approximately 4 hours to stabilize within the normal temperature range after being opened for 3 minutes and 15 seconds.

To reduce opening time:

- Keep your freezers organized.
- Reduce opening time of freezers' doors.
- When searching for samples in a box, take the box out and close the freezer door. Use dry ice when necessary.
- If you need to search for a box, take the rack out and close the freezer door. Use dry ice when necessary.

Water

Water is a scarce resource: more than 2 billion people worldwide have insufficient access to clean water.

Climate change is coming: the past 3 years have seen extreme droughts all over Germany.

A lab like ours consumes 5x more water than an office workplace. **Therefore, being aware and decreasing our water consumption will have a big impact on our water footprint.**

We would like to propose 3 simple actions to help reduce our water footprint.

1. Use less purified water (where possible).

With purified water, 1L does not always equal 1L. In fact, 5L of tap water is used to produce 1L of ultrapure water (Milli-Q water) by reverse osmosis. 3L is necessary to produce 1L of deionized water. Only with tap water, what you see is what you get. Therefore, re-think which grade of purity is really necessary for your purpose. For example, many buffers may be good enough with deionized instead of ultrapure water. For rinsing and cleaning, use tap water, not deionized water.

2. Run the autoclave less often.

One autoclave run uses approximately 270 liters of water. In an autoclave, water is not only used to create hot steam, but also to cool this steam down after the autoclaving process to prevent heat damage to drain pipes. To save water, run the autoclave only when it is full. Also, re-think which materials really need to be autoclaved. For example, Eppis and pipette tips usually arrive PCR clean and can be used straight from the bag without further autoclaving for many experimental purposes.

3. Report dripping taps, eye showers, etc.

A dripping tap can easily cost you 2L of water per day. Therefore, report any dripping as soon as you notice it, so that the tap, eye shower etc. can be repaired as soon as possible.

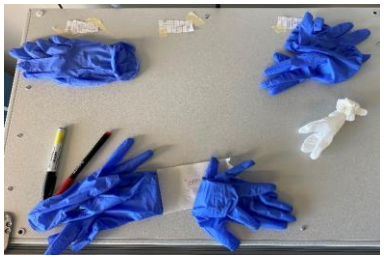
Replace, reduce, re-use

Labs produce incredible amounts of waste, of which a large percentage is non-hazardous. A study of the University of Exeter has estimated that a scientist produces over 1000 Kg of plastic waste per year. As a comparison, the plastic waste per person/year in Europe is 174 kg. Following a similar trend, labs also consume large amounts of energy, in which lab equipment constantly connected to the power supply account for 25% of it. By using our resources responsibly we can make a big impact on our waste reduction.

We would like to encourage you to decrease the amount of consumables and equipment usage.

For example:


Serological pipettes: it is possible to reuse serological pipettes by keeping it either on the pipette boy or in the bottle.



Gloves: leave your gloves at a designated area to avoid confusion with other gloves.

Centrifugation bottles: use large centrifugation bottles instead of multiple falcons.

Share reagents and equipment!

To share BMC-wide, ask a postdoc to write to the postdoc network to ask for samples or exchange materials.

Make inventory lists, organize your supplies, check and share with members of other groups.

Recyclable plastic

Worldwide, around 300 million tons of plastic are produced per year, of which 5.5 million tons of plastics are produced by laboratories. While there are current efforts to recycle our enormous amount of plastic wastes, the recycled plastic granules are hardly used for the production of new laboratory plasticwares due to the low purity of the recycled material. In order to address this issue, Panbiotech, a local biotech company, is in collaboration with a local recycler to recycle PET plastic bottles separately. This way, the recycled PET granules can achieve high PET purity and be used again for production of PET bottles.

To participate in the program: https://recycling.pan-biotech.de/recyceling/

1. Rinsing your empty PET bottles with tap water and

2. Separating the lid to let the bottles dry in our collection boxes

All PET bottles has the recycling triangle sign with 01 inside.

In addition, Pan biotech is also collected hard-shell cooling packs to be directly reused. Please also place the hard-shell cooling packs that you no longer need in our PET collection box for pick-up.

These are some examples of PET bottles:

Proper waste disposal:

Why waste separation?

1. To enable recycling, which is the best available option for any waste that cannot be prevented or further reduced (see April 2021 SAM: use less ≠ useless)
2. Containment of hazardous agents

What happens to well separated waste?

a. Recycling
   - organic waste -> soil
   - paper, glass, styrofoam and aluminum -> new paper, glass, styrofoam and aluminum
   - some plastics (details below) -> new plastics

b. Energy recovery (i.e. waste is burned to produce energy)
   - residual waste, autoclaved waste and animal bedding
   - some plastics (details below)

- To enable recycling, put everything in the correct bin. Recyclable materials in residual waste are lost for recycling. Recycling waste containing too much wrongly sorted waste will be forwarded to energy recovery, meaning that the complete bag is lost for recycling.
- Don't carelessly use recyclable materials. Recycling is an energy intensive process, meaning that also recyclable waste should be prevented and reduced where possible.

The problem with plastic recycling:

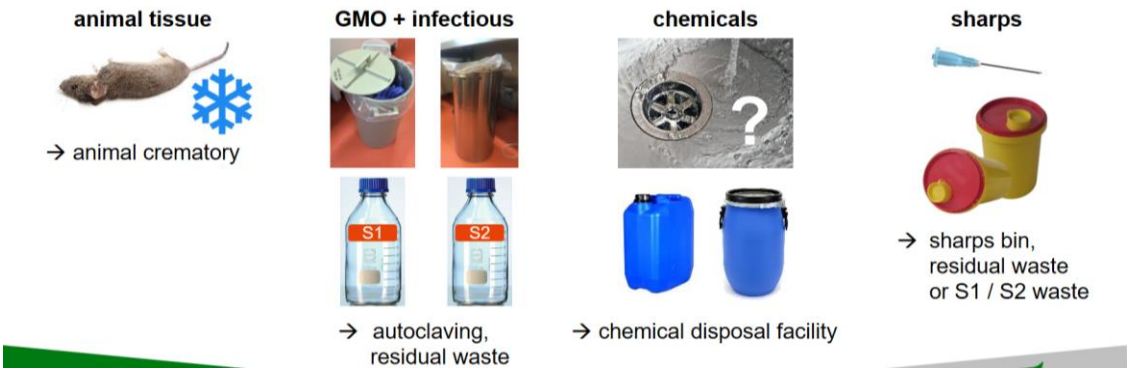
- Plastic is a collective term for many different resins such as polyethylene, polypropylene, etc.
- In theory, closed loop recycling (e.g. PET to PET recycling) is possible, but rarely economical.
- In Germany, more than half of the plastic waste is therefore burned for energy recovery, the rest is downcycled into low quality mixed-resin plastics.
- We have established a sustainable closed loop recycling option for PET bottles. Please put them in the PET collection bins in the cell culture rooms.

How to separate waste correctly:

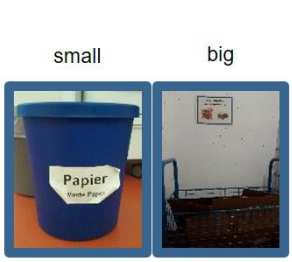
Don’t simply choose the bin that is nearest to you or trash everything as residual waste. Instead, consider two things:

1. Is the waste harmful?
2. What material is it made of?

- <u>Harmful waste:</u>
  - Animal tissue is collected in the designated freezer drawers and forwarded to the animal crematory
  - GMO and infectious waste is collected separately, autoclaved, then considered residual waste
  - Toxic chemicals are collected in designated containers, then forwarded to the chemical disposal facility
  - Sharps are collected in yellow hard-plastic bins, which go into residual waste (or S1 / S2 if applicable) once full and safely closed



- <u>Non-harmful waste:</u>
  - Paper & cardboard
    - small pieces -> blue paper waste bins in the docu zones
    - big pieces -> big trolley in the disposal room
  - Plastics
    -  -> PET collection boxes in the cell culture rooms
    - Styrofoam boxes and pieces -> bag/bin in the disposal room
    - Other clean plastics (mostly packaging, no used falcons or similar) -> yellow plastic bins
    - Contaminated plastics & gloves -> residual waste!
  - Aluminum
    - Very clean aluminum foil -> put in the scullery aluminum bin for re-use
    - Other -> aluminum bin in the disposal room
  - Glass
    - Separate bins for “normal” and “laboratory” glass in the disposal room
  - Organic
    - Small bin in the kitchen. It is not only for ground coffee.
  - Residual
    - Everything that belongs in no other bin
    - Gloves are residual waste! (unless S1/S2)



paper / cardboard

plastics

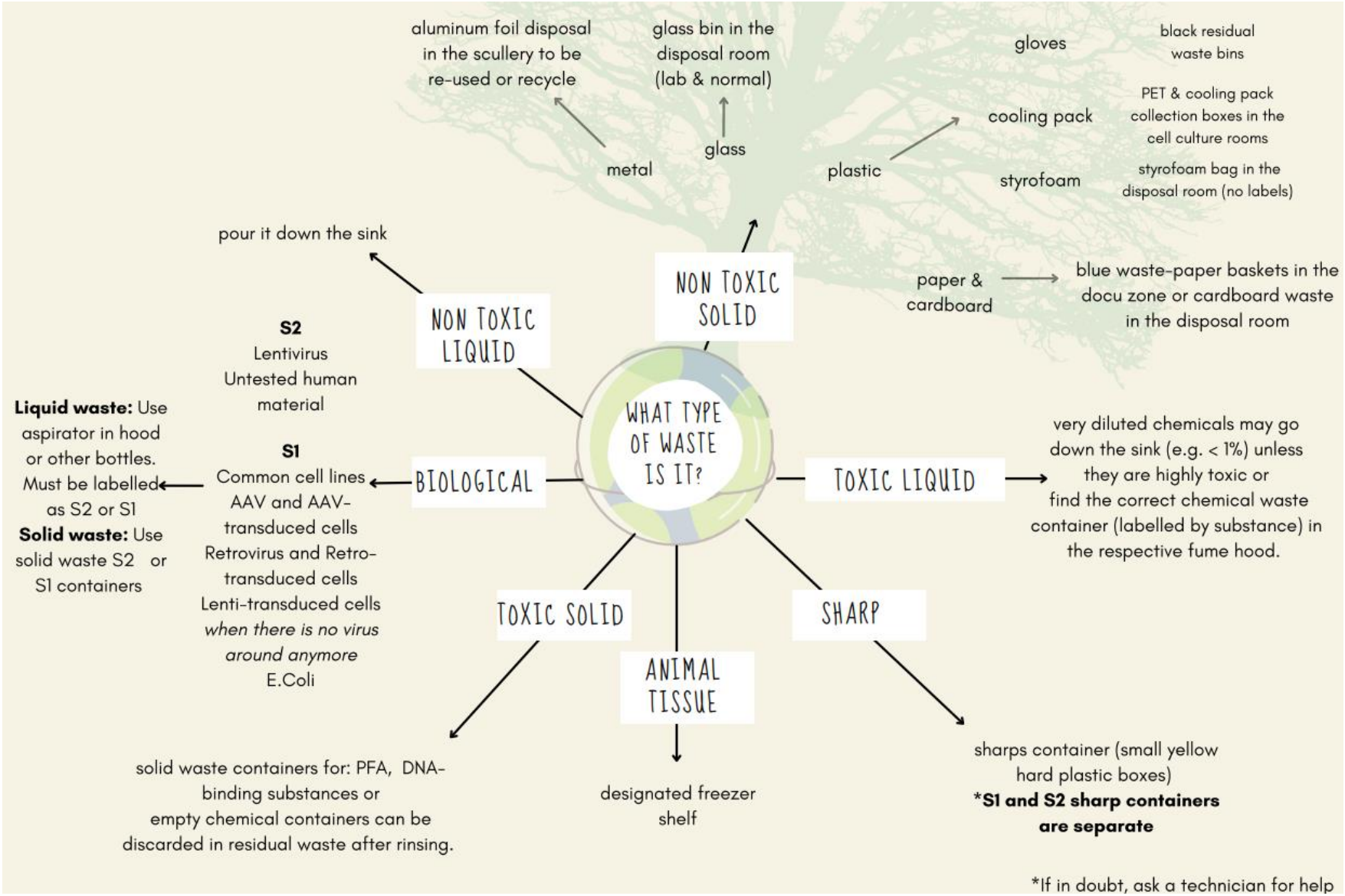
aluminum



organic


glass


residual


WHAT TYPE OF WASTE IS IT?
NON TOXIC SOLID
aluminum foil disposal in the scullery to be re-used or recycle
glass bin in the disposal room (lab & normal)
metal
glass
plastic
gloves
black residual waste bins
cooling pack
PET & cooling pack collection boxes in the cell culture rooms
styrofoam
styrofoam bag in the disposal room (no labels)
paper & cardboard
blue waste-paper baskets in the docu zone or cardboard waste in the disposal room
NON TOXIC LIQUID
pour it down the sink
BIOLOGICAL
S2
Lentivirus
Untested human material
S1
Common cell lines
AAV and AAV-transduced cells
Retrovirus and Retro-transduced cells
Lenti-transduced cells
when there is no virus around anymore
E.Coli
Liquid waste: Use aspirator in hood or other bottles. Must be labelled as S2 or S1
Solid waste: Use solid waste S2 or S1 containers
TOXIC LIQUID
very diluted chemicals may go down the sink (e.g. < 1%) unless they are highly toxic or find the correct chemical waste container (labelled by substance) in the respective fume hood.
TOXIC SOLID
solid waste containers for: PFA, DNA-binding substances or empty chemical containers can be discarded in residual waste after rinsing.
ANIMAL TISSUE
designated freezer shelf
SHARP
sharps container (small yellow hard plastic boxes)
*S1 and S2 sharp containers are separate
*If in doubt, ask a technician for help

How to start a green initiative in your department:

Whom you should get to know or get on board?

- group and/or institute leader
- people in charge of ordering (e.g. technicians, central ordering department)
- facility management
- university contact for waste, sustainability, etc.
- other green lab initiatives in your building or around

How to organize the team?

- get an e-mail address
- use a shared google drive or similar tools to organize shared documents
- regular meetings and actions are helpful to keep momentum

Means to raise awareness:

- stickers, posters etc. around your lab
- presentations at lab/institute/other meetings (try to be regular)
- lab/institute website
- social media

Additional resources:

www.mygreenlab.org

www.labconscious.com

www.sels-network.org

www.ucl.ac.uk/sustainable/make-your-lab-sustainable-leaf

www.lean-science.org

www.greenlabsaustria.at

www.nachhaltigkeitsnetzwerk.mpg.de

www.greenlabs-nl.eu

www.green.harvard.edu/sites/green.harvard.edu/files/GreenLabsGuide.pdf

www.neuroimmunology-munich.de/sustainability

Podcast: “The Caring Scientist: Mission Sustainable”