



Resource efficiency in laboratory operations

A handout by the Heine-Center for Sustainable Development
and Heinrich Heine University Düsseldorf

Legal notes

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Introduction

A significant proportion of the research and teaching in the Medical Faculty and the Faculty of Mathematics and Natural Sciences at Heinrich Heine University (HHU) takes place in laboratories. Laboratory work consumes vast amounts of energy and water, while also generating significant waste and greenhouse gas emissions. For example, a laboratory building needs three to five times as much energy and water as an office building.¹ In its University Development Plan 20.26, HHU has committed to fulfilling its social responsibility, also with a view to sustainability in a local, regional and global context, and encourages sustainable development in research, teaching and all university operations.² This also includes work in laboratories. In addition to technical measures like those already being implemented by the HHU Facility Management Division such as reducing air renewal in the ventilation systems during restricted operation mode, energy and resource consumption in research activities can also be significantly reduced via a few simple changes in behaviour – without compromising the quality of research results or safe work in the laboratories. Closing fume hoods, switching equipment/devices off when not in use or optimising use of fridges/freezers – these measures require minimal effort, but can have a significant impact if everyone implements them.

This handout aims to provide inspiration and orientation. It was formulated together with the academic facilities of the Faculty of Mathematics and Natural Sciences and the Occupational and Environmental Safety Unit at HHU. Some of the measures listed below

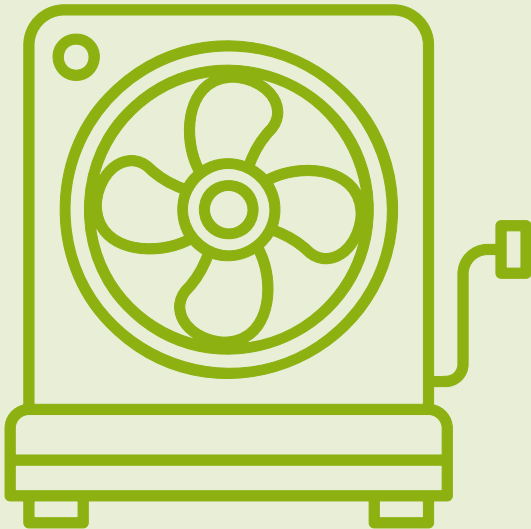
can be applied on a broad basis, while others may only be relevant for certain laboratories. The stated tips should be understood as an invitation to reflect on your own laboratory operations with a view to making them more eco-friendly and conserving resources.

If you have any feedback on this guide or further suggestions that could benefit all laboratory users, you are welcome to contact the team from the Heine-Center for Sustainable Development at environment@hhu.de. You can also contact this address to order e.g. labels and a poster in A3 format, which summarises the key tips in brief.

¹ Hermuth-Kleinschmidt, K. (7 October 2020): How can laboratory processes be made resource-efficient and sustainable? LABO. <https://www.labo.de/qualitaets-tipp/laborprozesse-ressourcen-effizient-und-nachhaltig-gestalten.htm> (accessed on 2 November 2023, German only).

² Heinrich Heine University Düsseldorf (2022): Creating knowledge. Sharing knowledge. Strategic alignment of Heinrich Heine University Düsseldorf – extract from the University Development Plan 2022 – 2026. Heinrich Heine University Düsseldorf, Division 2 – University Development. https://www.hhu.de/fileadmin/redaktion/Oeffentliche_Medien/Presse/Presse-meldungen/Dokumente_ab_2021/HEP_20-26ok_Auszug.pdf (German only).

Fume hoods and ventilation systems



Fume hoods and ventilation systems

The need for good air extraction while maintaining constant laboratory conditions requires a vast amount of electricity and heat as the inlet/extractor fans operate continuously and the inlet air also needs to be pre-heated. One fume hood uses up to 3.5 times as much energy as an average single-family home.³ In addition to optimised regulation of the technical systems by the HHU Facility Management Division, you – as users – can also save a significant amount of energy with one simple hand movement: Always shut the sash when you are not actually working with your hands in the hood. Shutting the fume hood manually eliminates the waiting time before any automatic closure. Please also shut the movable baffles at the side completely when not in use. The air volume flow drawn through the fume hood can be reduced by half when the



TIPS

Front sashes and side baffles of fume hoods should be kept shut when not in use.

Attach “Shut the sash” labels as a reminder to users.

Keep fume hoods tidy and do not use them to store chemicals or laboratory equipment.

Arrange for the Facility Management Division to reduce the air renewal in the ventilation systems in unused rooms.

front sash is pulled down from its maximum working height to the fully closed position.⁴ This results in significant energy savings. You can attach labels to fume hoods to remind people to “shut the sash”. You can order these labels from the Heine-Center for Sustainable Development.

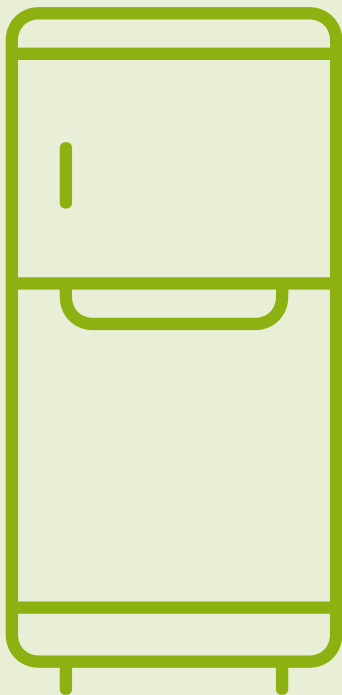
And here’s another tip: Fume hoods work most energy-efficiently and safely when the airflow in the hood is not impaired unnecessarily, so hoods should be kept tidy and not used to store chemicals or laboratory equipment unless they are required for a test set-up.

Reducing the volume of air in the ventilation systems in unused zones or rooms is also recommended. If special changes should be made to the ventilation settings, they can – following consultation with the Occupational and Environmental Safety Unit – be modified in the central control system by the Facility Management Division.

³ Mills, E. & Sartor, D. (2005): Energy use and savings potential for laboratory fume hoods. *Energy*, 30(10), 1859 – 1864. <https://doi.org/10.1016/j.energy.2004.11.008>.

⁴ Technical University of Darmstadt (28 March 2023): Sustainability in laboratories: fume hoods. https://www.intern.tu-darmstadt.de/informationsportal/themenwelten/news_details_de_en_402112.en.jsp (accessed on 31 October 2023).

Fridges and freezers



Fridges and freezers

Fume hoods and freezers are often the most energy-intensive components of a laboratory. While some of this energy consumption is unavoidable, there are good practices that show how the energy consumption of fridges and freezers can be reduced. A few questions can provide guidance here: Are all the devices really being used or can the number be reduced? Is the space being utilised to optimum effect? And can old samples or samples that are no longer needed be disposed of? This includes samples that are unusable for research purposes – for example, samples without additional data, of unknown quality or origin. Do samples have to be cooled or can they also be stored at room temperature?⁵

Raising the temperature of fridges and freezers significantly reduces energy requirements, as electricity consumption increases exponentially at colder temperatures. Each working group should therefore review whether the cooling temperatures for less sensitive samples can be raised. Practical laboratory experience gained at other universities has shown that it is possible e.g. to store less sensitive samples at -70°C instead of -80°C.⁶

⁵ Jensen, G. (2009). Cf. Room Temperature Biological Sample Storage. Stanford University Pilot. https://sustainable.stanford.edu/sites/g/files/sbiybj267o1/files/media/file/stanford_room_temp_pilot_may09.pdf

⁶ Berlin Technical University (29 March 2023): First green laboratory at Berlin Technical University. <https://www.tu.berlin/ueber-die-tu-berlin/profil/pressemitteilungen-nachrichten/erstes-gruenes-labor-an-der-tu-berlin> (accessed on 7 November 2023, German only).



TIPS

Review cooling temperatures for samples and raise temperatures where possible.

Old samples and samples that are no longer needed should be disposed of. This also optimises the utilisation of space, allowing the number of fridges/freezers to be reduced.

A classification system can help locate samples quickly.

Remove any ice that has built up and check seals regularly.

Remove any ice that has built up on a regular basis as this also saves energy. In addition, it helps to check and clean seals and filters frequently. Keeping sample storage facilities tidy can also help as leaving the door open for longer periods while looking for samples allows warmth in. A classification system can help locate samples quickly.

Other laboratory devices





Other laboratory devices

In consultation with others in your laboratory, define which devices can be switched off when not in use and identify/label devices, which must always remain switched on. It is usually expedient to switch off devices such as centrifuges, hot plates, PCR machines, autoclaves, etc. when you have finished your work or when no-one else needs to use them directly after you. If you set e.g. a sterile workbench to standby mode when not in use and switch it off entirely if it is not going to be used for several hours, you can reduce its electricity requirements by around a third.⁷ Attach corresponding labels to devices. You can also order these labels from the Heine-Center for Sustainable Development via: environment@hhu.de.

Is it perhaps possible to use a device that belongs to a neighbouring working group or can you use the research infrastructure of the core facilities, which are available to all researchers at HHU? An overview of the core facilities and technology platforms can be found at: <https://www.math-nat-fak.hhu.de/en/research/translate-to-english-geraetezentren-und-technologieplattformen>.



TIPS

Determine which laboratory devices need to remain switched on and which can be switched off after use. Then label the devices accordingly.

Share devices as far as possible.

Take energy efficiency and longevity into account when procuring new devices. Inquire about manufacturer maintenance and repair packages.

When procuring new devices, you should select the most energy-efficient models possible. The Energy Star and the energy efficiency class provide good guide values here. Longevity should also be taken into account when procuring new devices. Inquire about manufacturer maintenance and repair packages.

⁷ Berlin Technical University (29 March 2023): First green laboratory at Berlin Technical University. <https://www.tu.berlin/ueber-die-tu-berlin/profil/pressemitteilungen-nachrichten/erstes-gruenes-labor-an-der-tu-berlin> (accessed on 7 November 2023, German only).

Material usage and waste



Material usage and waste

While changes in laboratory practices must always be considered carefully to ensure that safety and quality are not compromised, there are also things you can do here to make processes more sustainable.

For example, you can reconsider the scaling of experiments and field trials. Perhaps smaller-scale experiments that use less energy and fewer materials can be carried out instead, thereby reducing the amount of samples and reagents used.

Clever coordination of chemical storage and orders helps reduce wastage, as does sharing/passing materials on to other research groups. Cooperation between different working groups, as is currently being implemented in the Department of Chemistry, optimises the use of chemicals. This eliminates duplicate orders and chemicals that are rarely used in one department can be made available to other researchers before their expiry date is reached. The central chemicals storeroom at the Faculty of Mathematics and Natural Sciences (ZCL) also has an automated system for the redistillation of solvents and solvent mixtures. This is available to users who have received corresponding briefing and will enable significant material and energy savings to be achieved. You should also keep an eye on expiry dates and only order new materials when the existing ones have been used up or will be used up in the near future. It is easy to maintain an overview if you keep inventory records and it is helpful to add “storage life” information to the register of hazardous substances.

Is it possible to reduce single-use items or use recycled material in items? For example, some tubes and pipette tips made from fossil-based plastics can be replaced with versions made from bio-based plastics. Incidentally: Procurement law supports such approaches by enabling social and environmental aspects to be taken into account in each phase of a procurement process.



TIPS

Consider the scaling of experiments and field trials.

Keep inventory records of consumables, optimise material orders and share consumables with other working groups.

Note expiry dates in the register of hazardous substances.

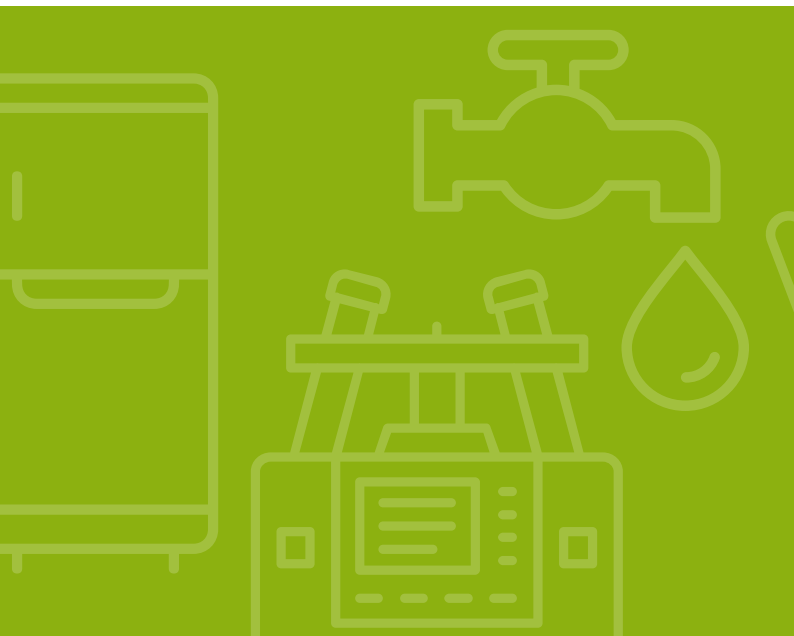
Review whether single-use items can be replaced with more sustainable alternatives (ensure safety and quality are maintained).

Further information

- **McGill University Sustainable Labs Guide**
www.mcgill.ca/sustainability/engage/sustainable-labs/sustainable-labs-guide
- **Harvard University Sustainable Labs programme**
www.sustainable.harvard.edu/schools-units/sustainable-labs
- **My Green Lab**
www.mygreenlab.org
- **Laboratory Efficiency Assessment Framework (LEAF)**
www.ucl.ac.uk/sustainable/take-action/staff-action/leaf-laboratory-efficiency-assessment-framework
- **The Freezer Challenge**
www.freezerchallenge.org
- **German Research Foundation – DFG Sustainability Guide for Research Processes**
www.dfg.de/en/principles-dfg-funding/developments-within-the-research-system/sustainability-guide-for-research-processes

PLEASE NOTE

All the materials mentioned in this guide can be found on the homepage of the Heine-Center for Sustainable Development at:
www.hcsd.hhu.de/en/energy/laboratory



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