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ILLUSTRATIONS BY CLAIRE WELSH/*NATURE*

SUSTAINABILITY

Recycling's liquid assets

Going green doesn't just help the planet — it also puts more money in your pocket for research.

BY ELIE DOLGIN

The freezers were stuffed and their racks encrusted in ice, with a thin blanket of snow covering all the sample boxes inside. Such was the state of the cold-storage system in Hopi Hoekstra's laboratory a decade after the evolutionary biologist and her team started studying the genetics and behaviour of deer mice there.

Kyle Turner, manager of the lab at Harvard University in Cambridge, Massachusetts, was about to spend more than US$10,000 on a new ultra-low-temperature (ULT) freezer. Then he heard about a competition called the North American Laboratory Freezer Challenge, which had been launched in January 2017 by two US non-profit organizations — My Green Lab, in Los Gatos, California, and the International Institute for Sustainable Laboratories (I2SL), in Annandale, Virginia.

The challenge, which is now international (go.nature.com/2dyh8xi), urges labs to reduce energy consumption and improve equipment life through various measures. Some of those include defrosting freezers, to eliminate crusty ice and provide more space for samples, and raising the temperature set-point on ULT freezers from −80 °C to −70 °C, to cut electricity demands.

The Hoekstra lab won first place in the individual-laboratory category for an academic institution. Lab members also freed so much space in their two existing ULT freezers that, despite accumulating new research materials, they haven't yet needed to buy a third.

The energy savings helped to cut Harvard's electricity bill by around $2,500 a year, according to My Green Lab, and slashed annual greenhouse-gas emissions by the equivalent of 4.1 tonnes of carbon dioxide — roughly what would be saved by taking three cars off the road. It also meant that Hoekstra's lab could spend the funds earmarked for a new freezer on other science-related expenses instead.

Hoekstra likens it to "a free $10,000 grant" — and is using the money to send some trainees to this August's Joint Congress on Evolutionary Biology in Montpellier, France. The funds will also help to support a high-throughput gene-expression analysis of brain cells from two related species of deer mouse.

Campus sustainability initiatives are usually framed as ways for scientists to shrink their carbon footprints and bring down energy costs (see *Nature* **546**, 565–567; 2017). But the Hoekstra lab's experience shows that there are other reasons to pool surplus reagents, share equipment or keep better tabs on lab chemicals to avoid duplicate purchasing. "These exercises are about helping science as much as they are about helping the planet," says Peter James, director of S-Lab, a UK initiative based in London that promotes sustainable lab practices. "They free up resources that can be applied for scientific purposes."

BOUNTY HUNTERS

One increasingly popular way to cut lab waste and operational costs is through exchange programmes for surplus resources. At ▶

the University of Michigan, Ann Arbor, for example, more than 230 research and teaching laboratories now routinely share leftover chemicals, equipment and materials through a campus-wide recycling and reuse initiative.

"Before this programme, these were thrown in the trash or disposed of as hazardous waste for a price," says Sudhakar Reddy, who coordinated the university's sustainability efforts until his retirement last December. Now, he estimates, more than one-third of all unexpired and unused lab resources get passed on to other researchers, who leap on the surplus bounty — saving themselves a combined total of more than $250,000 a year.

One new recruit, pulmonary-health researcher Benjamin Singer, freely acquired two high-end microscopes — valued at more than $6,000 apiece — which he now uses to study donated human-brain specimens for molecular signs of injury after a critical illness. A second researcher, cell biologist Anthony Vecchiarelli, saved more than $10,000 while kitting out his lab with free peristaltic pumps, circulating water baths, slide warmers and consumables. "I check the website almost weekly for goodies," says Vecchiarelli. "It is a valuable resource for a new investigator."

Not all academics have such a website at their fingertips, however. Garry Cooper didn't when he was a postdoc studying neurophysiology at the Northwestern University Feinberg School of Medicine in Chicago, Illinois. And it was while he was helping to clean out a lab freezer one day in 2015 that he realized there was a need for such a platform: he'd been handing a PhD student some expensive reagents, but still throwing away bagfuls of antibodies, a common, yet pricey, research tool for identifying proteins.

He decided to create a company to reduce wasteful spending and promote trading among colleagues. He envisaged it as a kind of eBay, Craigslist and Ask.com rolled into one, providing lab scientists with a valuable service at a time when research funding is increasingly hard to come by (see 'Too much of a good thing'). He called the start-up Rheaply, a portmanteau of 'research' and 'cheaply'.

After developing a web-based platform, Cooper and his company launched a pilot programme at Northwestern's medical school last year. In its first 6 months, around 300 researchers — close to one-third of all lab scientists on the medical campus — created Rheaply accounts. According to Cooper, who remains a visiting scholar at Northwestern, those users collectively posted around 200 items, ranging from pipettes and glassware to chemicals and biological probes; at least 55 items were passed on, saving labs across the campus more than $25,000 and keeping those resources out of landfills.

Khalid Alam is one Rheaply user. Just last month, he got hold of an $800 vacuum pump for his postdoctoral research into RNA engineering — although in general, he says, "there's not a tonne of stuff on there". That's one of the main problems with any environmentally minded programme aimed at scientists, says Michael Blayney, executive director of the Office for Research Safety at Northwestern. "The challenge is: how do you encourage and motivate people to interact with it?"

TOO MUCH OF A GOOD THING

Why lab stock lies idle

Before launching Rheaply, an online platform where scientists can buy, sell, trade or donate surplus labware and supplies, Garry Cooper surveyed 120 academic researchers at Northwestern University in Chicago, Illinois, to learn more about why reagents and equipment go unused, and whether scientists would be willing to donate surplus supplies. Most respondents said they had extra lab provisions that they would gladly give to colleagues. Here's a summary of Cooper's findings:

Top reasons for reagents and equipment going unused or remaining in surplus

- Initial/pilot experiments failed (71.6%)
- Initial experimental needs changed (63.6%)
- Original purchaser leaves lab (56.8%)
- Starting quantity too large (54.5%)
- Items stored in secluded areas (18.2%)
- Double ordering (15.9%)

Types of reagents and equipment that go unused or remain in surplus

- Chemicals (80.2%)
- Antibodies/biologics (38.4%)
- Kit reagents (37.2%)
- Glassware (27.9%)
- Imaging dyes/agents (25.6%)
- Tools (16.3%)
- Tissue/cell-culture items (15.1%)
- Tubing (12.8%)
- Microscopy equipment/accessories (10.5%)
- Computer software (8.1%)

TANGIBLE BENEFITS

Amorette Getty is involved in a number of waste-reduction initiatives. One is at the University of California, Santa Barbara, where she co-directs a programme called LabRATS (short for Laboratory Resources, Advocates and Teamwork for Sustainability) that encourages shared use of surplus chemicals and instrumentation. She says that scientists are most likely to pitch in for those efforts that offer them personal, tangible benefits — although these needn't be directly monetary. "Any time I can connect the things I'm trying to do to increase safety and research efficiency, or get better storage to protect samples — that's when I have my greatest successes," she says.

That same ethos underpins moves by three institutes at the University of Aberdeen, UK, to centrally manage ULT freezers and raise the operating temperature to –70 °C. The initiative, says Peter McCafferey, a brain researcher who previously led the university's Freezer Protocol Group, is as much about research resilience and reliable sample preservation as it is about energy efficiency. "We have all the freezers together, which makes it easier to keep an eye on," he explains.

But Cooper reckoned that people would need more motivation before adopting such practices. To help Rheaply catch on, he devised a point-based system that rewards online engagement and activity. So far, Cooper has convinced a handful of large academic and private clients to sign up, and he hopes to close deals soon with several prominent universities and government research agencies, including the US National Institutes of Health.

Expanding that idea of collective action offers additional opportunities for cutting costs. Most universities already have core facilities for specialized equipment, technologies and services, but a few are now taking this centralized approach further in how they set up their labs.

Take cell-culture work, for example. This line of research requires fairly basic equipment — laminar-flow hood, incubator, cell counter, microscope, centrifuge, cryostorage tanks — all of which is priced within the budget of a typical lab. According to a survey of biosafety officers at member institutions of the Association of American Universities, 86% of cell-culture spaces remain private, used only by individual labs.

But at the University of Colorado Boulder, the Biochemistry Cell Culture Facility is shared by 70 users from 16 labs, all of whom chip in to pay the salary of a single facility manager. A case study of the collaborative research space, published earlier this year, compared the facility's approach with a hypothetical situation in which all the labs worked on cell culture independently (see go.nature.com/2fwzjhm). The study found that centralizing media preparation and other tasks, instead of getting graduate students and postdocs in each group to perform these jobs, saved each lab more than nine hours a week.

Other savings, achieved through bulk purchasing and the use of recycled ethanol, for example, helped the biochemistry department and individual labs to collectively cut their expenses by around $195,000 per year, the analysis showed. Their efforts saved the university a further $71,000 each year by reducing energy bills and lowering the costs of ventilation and lab maintenance. "There's so

much cost avoidance," says Kathy Ramirez-Aguilar, programme manager of the university's Green Labs Program, who conducted the study with her deputy, Christina Greever.

Robert Kuchta, an enzymologist who uses the facility, points to a less obvious, environmental benefit of the sharing system. "It dramatically reduces liquid-nitrogen usage," he says. That's because containers used to store liquid nitrogen are typically cylindrical, and many small cylinders, of the type that might be used by individual labs, have a larger collective surface area — and thus a higher rate of nitrogen evaporation — than does a single, large cryopreservation tank of the same volume that can store samples in one place.

Even without access to a joint facility, individual labs can still realize some of these gains by taking advantage of laboratory-management software. An automated inventory system can free money that would otherwise be spent on paying someone to keep tabs on the thousands of reagents commonly used by large chemistry labs. And it can save researchers from making wasteful purchases because they can't find existing stock on the shelves.

"You find ways to pack the same waste together — and it's quite often the same price, because you're disposing of one package."

What's more, just as members of the University of Colorado's shared facility can pool their hazardous junk for disposal — reducing the number of times sterilized autoclaves are inefficiently run half-empty, and getting a better deal from waste-disposal companies — so, too, can individual labs that share a common chemical-tracking system.

"You find ways to pack the same waste together — and it's quite often the same price, because you're disposing of one package," says Marcus Phelan, a chief technical officer and dangerous-goods safety adviser at Trinity College Dublin, where chemistry labs all use a cloud-based inventory system called LabCup.

A NEW LIGHT DAWNS

As well as benefiting from campus-wide initiatives, scientists can take individual action that will simultaneously save money, the environment and the integrity of their research.

For example, labs with fluorescent microscopes can replace mercury lamps with light-emitting diodes (LEDs), which are less toxic and more energy-efficient. According to Allison Paradise, executive director of My Green Lab, LEDs are better for science because they provide a more consistent light source than do mercury lamps, which degrade over time and make it hard to quantitatively compare images from different time points in an experiment. Buoyed by the success of the freezer challenge, Paradise says that she is in discussions with sponsors to set up a similar initiative, this time aimed at eliminating mercury from microscope lamps. If she's successful, that effort will launch later this year.

Ultimately, it might take a greater attention to sustainability and efficiency across the entire research enterprise for the biggest benefits to accrue, both financially and environmentally — in which case, scientists and funding agencies must band together to make that goal a priority.

Individual labs might not have to pay the energy bills out of their own research grants, but facilities fees are part of the funding infrastructure, through what's often referred to as 'indirect costs'. Bringing those costs down could make more funds available for salaries, travel, equipment and other expenses that more directly support scientists and their research projects.

So far, there's little incentive for individual scientists to do their part. However, with many funding agencies emphasizing the need to justify the broader impacts of proposed research, Ramirez-Aguilar argues that implementing energy-efficient and environmentally sustainable lab practices can be a smart way for researchers to make their grants stand out. It might seem a small detail, but having such procedures in place could make all the difference to the success of your application. "If it makes your proposal look better," she says, "you're more likely to get funding." ■

Elie Dolgin *is a science writer in Somerville, Massachusetts.*

TRADE TALK
River reader

Formerly an Arctic hydrologist at the University of Alaska Fairbanks, Jessie Cherry is now a senior hydrologist with the US Alaska-Pacific River Forecast Center in Anchorage, where she predicts river levels and flow. Shortlisted twice for NASA's astronaut programme, she is also a commercial bush pilot with two single-engine planes.

Why did you leave academia?
I loved Earth science and being outside. But I spent most of my time finding funding for my research programme and staff. And as the chief scientist of the Geographic Information Network of Alaska, I had to raise another US$2 million a year. I was also unhappy with the shift towards projects with multiple principal investigators.

Why did you get a pilot's licence?
Planes are the main form of transport in Alaska, so a licence is handy. From the air, I've photographed methane bubbles frozen in lakes, and ice build-up under bridges.

What made you a good candidate for NASA's astronaut programme?
I applied because the independence required to live and work in the Arctic — like doing my own plumbing and electrical work — made me highly qualified. As a commercial pilot, I'm familiar with aviation and aircraft systems, and I can make quick judgement calls about safety and risk.

Describe your job.
We forecast river levels and flows — floods in particular — for public safety. I compare measured river observations against forecast data, check the weather across Alaska and forecast how precipitation will affect river flows. And I get to do side projects, such as studies of glacial outburst floods.

Why did you join the forecast centre?
In academia, I was so overwhelmed with grant writing that I couldn't keep up with my field. Now I can become an expert in Arctic hydrology and examine the relationship between river flows and snowmelt, for example. Plus I enjoy the 40-hour working week. ■

INTERVIEW BY SARAH BOON

This interview has been edited for length and clarity.