

Green Labs – Lab Energy 2019

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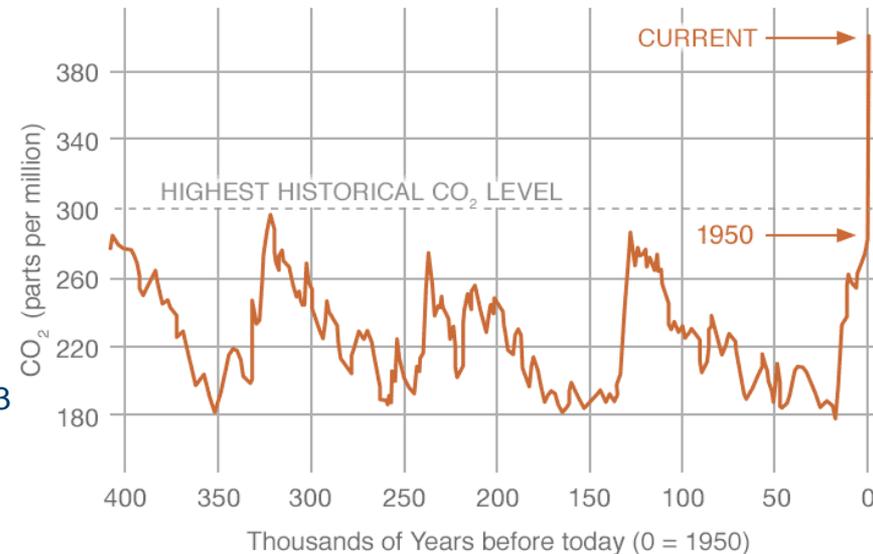
Friday 8th February – 17 Mill Lane (Central Cambridge)

Monday 11th February – Clinical School (Addenbrooke's Site)

Environment & Energy

Some of the challenges

- Wavers of slowing funds (increases in spending marked with decrease of overall GDP and slight decrease in RCUK spend)¹ Brexit, etc.
- Concerns over our methods – reproducibility is notably low²
- Plenty of PhDs, albeit rate is slowing³
- Lots to study – Cardiovascular disease, cancer, industry, and more
- Climate Change⁴



¹UK office for national statistics: UK government expenditure on science, engineering and technology: 2015

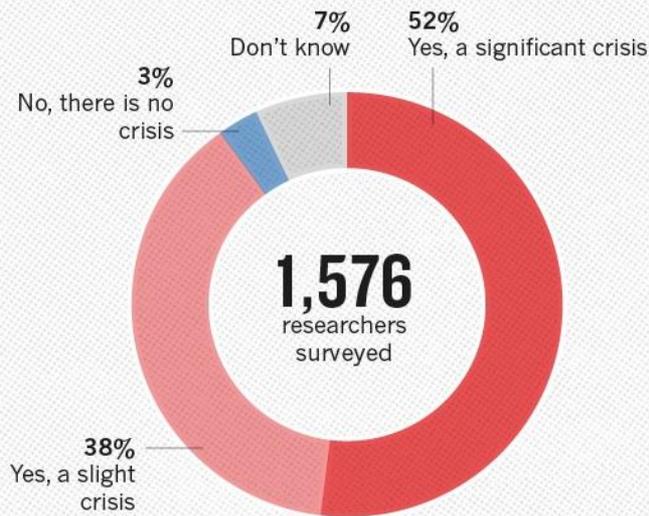
²<http://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970>

³ <http://www.hefce.ac.uk/analysis/HEinEngland/subjects/stem/>

⁴ <http://climate.nasa.gov/vital-signs/carbon-dioxide/>

Challenges to reproducibility

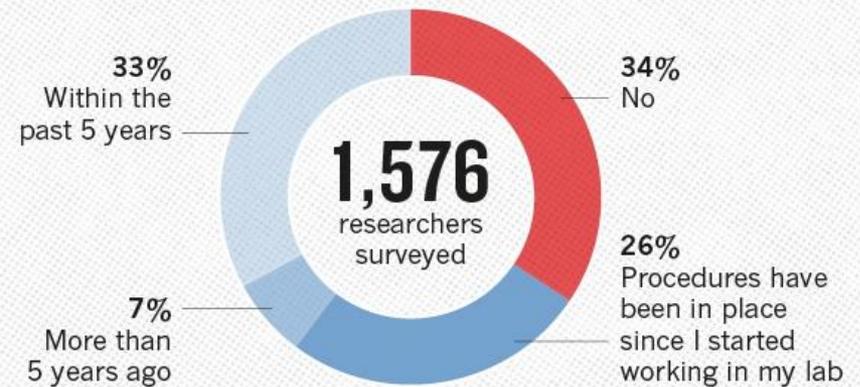
IS THERE A REPRODUCIBILITY CRISIS?



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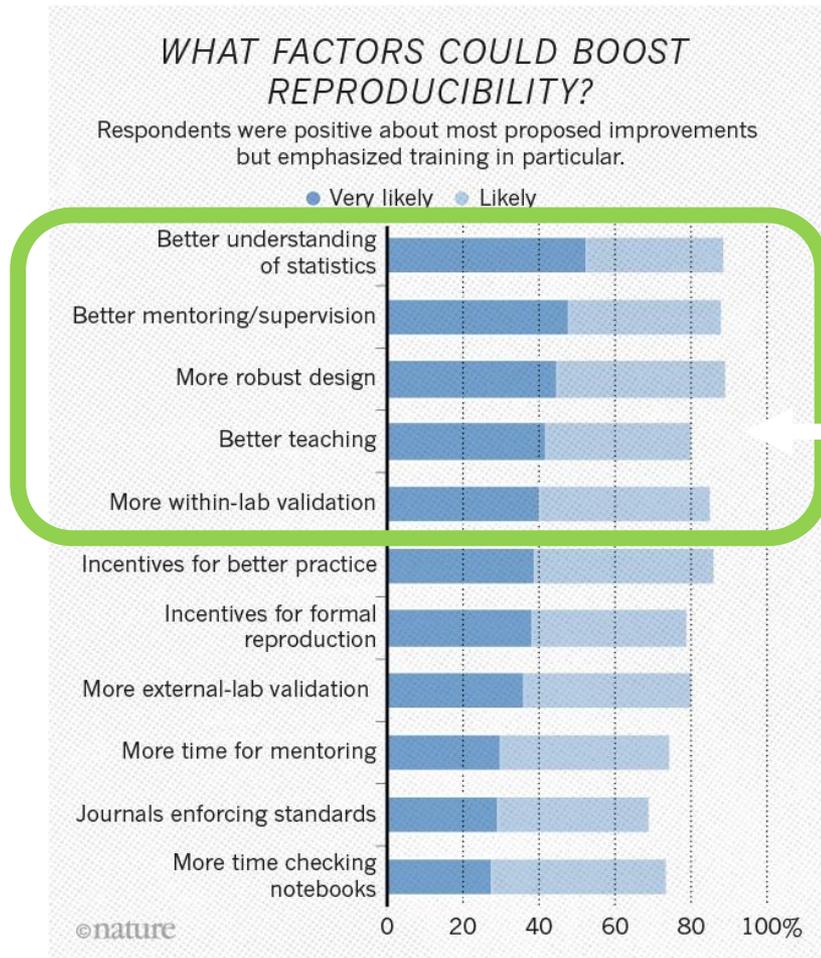
HAVE YOU ESTABLISHED PROCEDURES FOR REPRODUCIBILITY?

Among the most popular strategies was having different lab members redo experiments.



©nature

Challenges to reproducibility



Improving reproducibility starts with good laboratory management & procedures.

We can look at *how* we conduct the research

Integration efficiency and sustainability are possible ways to mitigate some of the growing challenges.

Quick Quiz - Answers

1. Lab plastics are estimated to contribute **...1.8%..** to the total global plastic waste in 2014^[1].
2. What piece of standard lab equipment consumes the most energy?
Fume cupboards
3. A typical new ULT freezer (Cambridge has 700+) will consume as much electricity in a year as: **an average UK household**
4. University of Cambridge spent **~£19 million** on energy last year.

^[1] <http://www.nature.com/nature/journal/v528/n7583/full/528479c.html?foxtrotcallback=true>

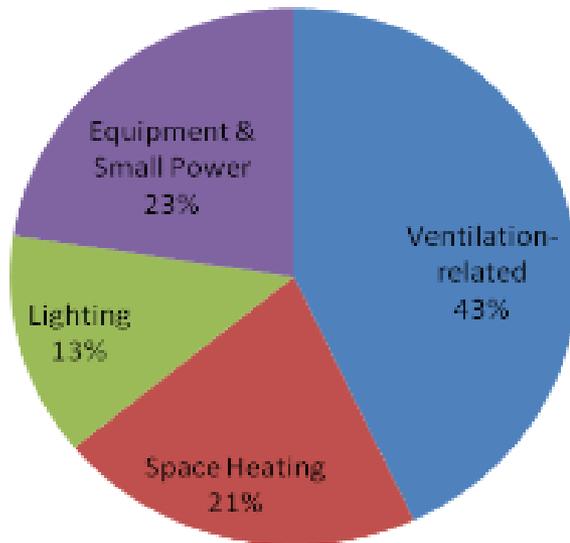
Why Research Laboratories?

- Research spaces consume 3-10 times more energy per square meter than academic spaces
- A typical research institution will have 60-65% of its electricity consumed by research spaces. Construction costs can exceed £2000+/m²
- Oxford – 72% of electricity goes to laboratories buildings
- Often unaddressed due to specified nature of research – though some processes are common enough. Not just about energy

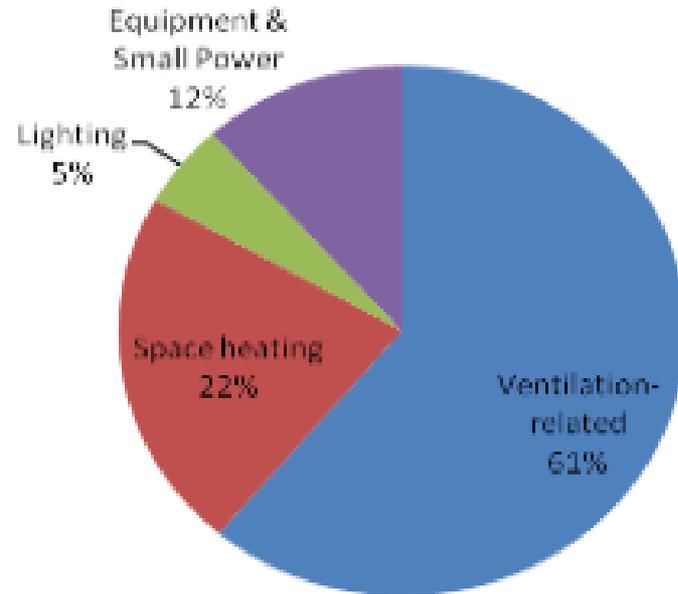


Big energy consumers in the lab

York - Life Sciences
Department



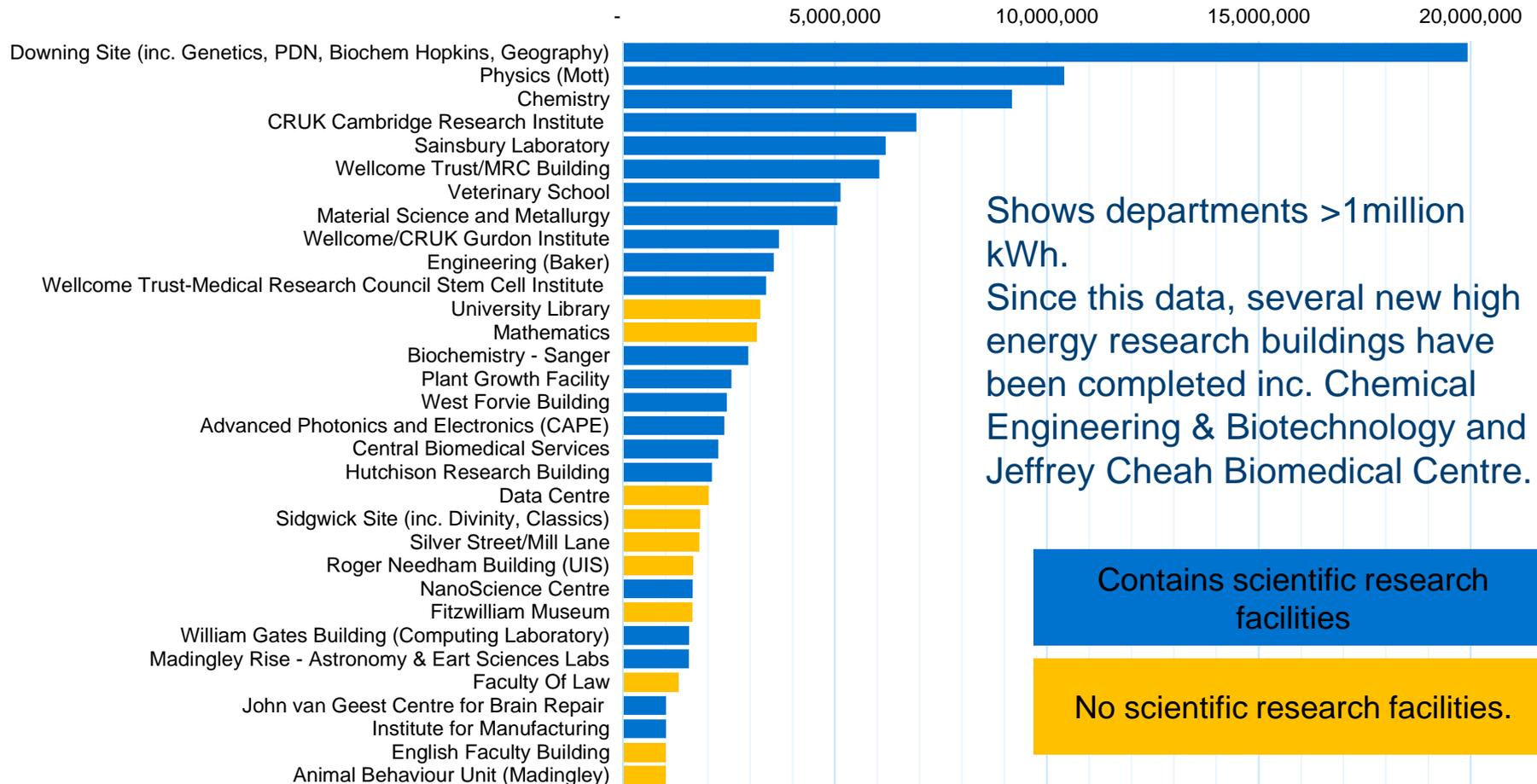
Manchester – Chemistry
Department



Life Sciences typical has more cold storage, Chemistry typically has more fume cupboards.

How bad are labs?

2014-15 Electricity by Department as metering allows (kWh)



Shows departments >1 million kWh.
 Since this data, several new high energy research buildings have been completed inc. Chemical Engineering & Biotechnology and Jeffrey Cheah Biomedical Centre.

Contains scientific research facilities

No scientific research facilities.

Making energy use tangible

For now, departments do not see their energy bills, though the Electricity Devolution Programme is on its way.

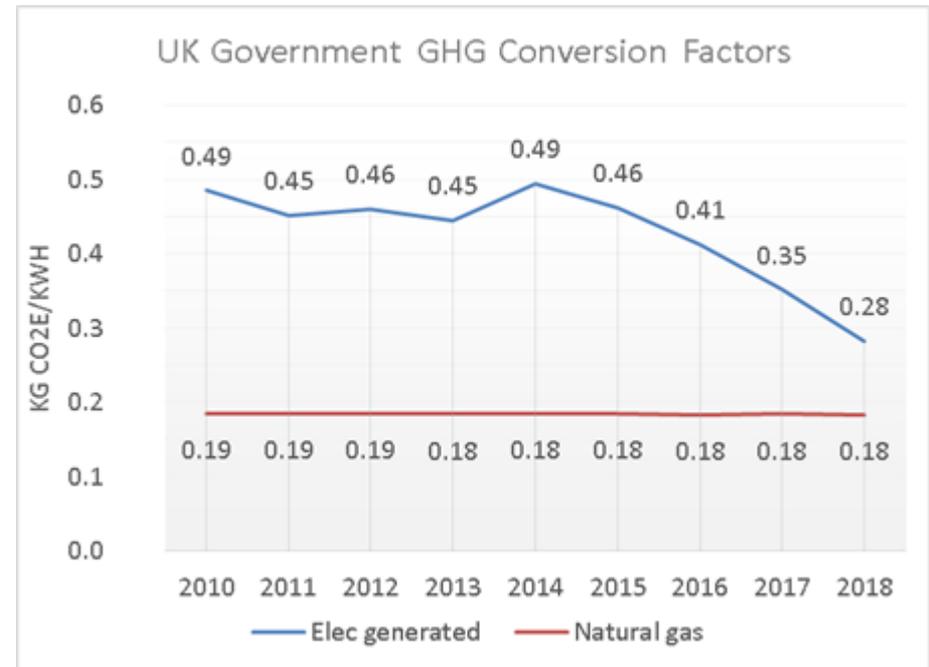
Even then, how can we make electricity usage tangible?

Convert to carbon emissions...
kg CO₂e/kWh

The grid is de-carbonising quickly.

For 2018/19, grid electricity has the carbon cost of:

1kWh = 0.28307 kg CO₂e



Making energy use tangible

3-5kg



10-30kg



80-100kg



200-300kg



400-600kg



1,500-2,300kg

Which Equipment is worst?

Permanently on (or for days at a time)

	Carbon Cost (kg CO ₂ e/yr)
Ultra-Low Temperature Freezers	620 - 3,100 kg
Drying Cabinets	520 - 3,820 kg
Cryostat	1,550 - 2,480 kg
Oven (various temps, sizes)	70 - 720 kg
Biomedical Freezers	
- Upright	70 - 350 kg
- Underbench	30 - 130 kg
Incubator	40 - 330 kg
CO₂ Incubator	260 - 330 kg
Fridges	
- Upright	80 kg
- Underbench	17 kg

Which Equipment is worst?

Equipment that runs in cycles

	Typical Usage	Annual Carbon Cost (kg CO ₂ e/yr) 3 runs a day, 5 days a week
Autoclaves (large internal steam source)	8 - 18 kWh/run	1,760 - 4,000 kg
Autoclaves (benchtop)	0.4 kWh/run	90 kg
Centrifuges (large benchtop)	2 kWh/run	440 kg
Mini-centrifuges (pre-cool + 15min spin)	0.2 kWh/run	44 kg
PCR machines	0.15 - 0.3 kWh/run	33 - 66 kg

Which Equipment is worst?

Equipment easily switched off when not in use

	Usage	Annual Carbon Cost (kg CO ₂ e/yr)	
		4hrs a day, 5 days a week	Permanently on
Safety Cabinets	50 - 400 W (Old up to 2,000 W)	15 - 120 kg 590 kg	120 - 1,000 kg 5,000 kg
Flow Hood	335 W	100 kg	830 kg
Hotplate with Stirrer at 120°C	74 - 160 W	22 - 47 kg	180 - 400 kg
Water baths at 37°C	50 W 12 W (avg with metal beads)	15 kg 3.5 kg	120 kg 30 kg
Balances	5 W	1.5 kg	12 kg
Spectrophotometer	5 W	1.5 kg	12 kg

What can you do?

General

- Connect sustainability to your passion/motivation at work
- Switch off labels (request from E&E)
- Good housekeeping: filters, de-icing, leaks, seals
- Timers, booking systems and out-of-hours permits – enforceable?
- Allocate space, limit opening times
- Temp hold at end of cycle (PCR)
- Which ancillaries do you need, e.g. UV lamps on MSCs?
- Understand heat-up, cool-down times and factor that in, e.g. microscope lights
- Equipment feng-shui
- Only run when full (autoclaves, glasswashers)
- Request a Green Labs survey



What can you do?

Ventilation

Plug-in lab equipment is only part of the story. Your lab is provided with energy-hungry ventilation, heating, cooling and lighting

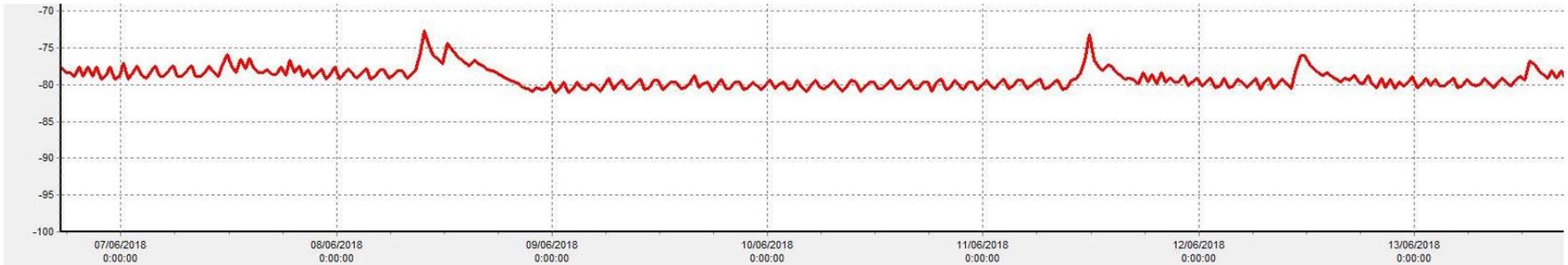
As lab users you may have less control over these but there are still improvements to be made:

- 1. Choose the correct units – recirculating are more energy efficient than ducted.
- 2. Set them up efficiently - correct flow rates
- 3. Close the sashes (saves 50% energy), turn them off (depending)
- 4. Report issues, consider long-term uses



What can you do?

Cold Storage



- Interrogate your monitoring system and tune temperature accurately. Don't rely on display temperature. CIMR's Eltek Britannia system shows door openings and recovery time.(above).
- Minimise door openings (ULT Freezer at Dept. of Medicine used 6.8 kWh/day when kept closed but went up to 13.6 kWh/day with lengthy openings)
- Use freezer maps – know where your stuff is.
- Racked units are far more resilient to door openings - 6°C colder after door opened for 60 seconds (Green Light Labs - University of Oxford Oct 2018)
- Improve airflow around the back and top of units, allowing waste heat to escape. Grouping and applying air-con can be worth it.

What can you do?

Cold Storage

	Daily Usage	Annual Electricity Cost	Reduction from Average Old ULT Freezer
Old ULT Freezer at -80 (> 10 years)	10-30 kWh/day	£438 - £1,314	
New ULT Freezer at -80°C	8-11 kWh/day	£350 - £480	-55%
New ULT Freezer at -70°C	6-8 kWh/day	£260 - £350	-67%

Data collected from University of Cambridge's Equipment Replacement Programme: 2015-2019 [1]

What can you do?

Cold Storage

Set Temperature

- Raise the set temperature where feasible, e.g. -80°C to -70°C .
Set -80°C by exception.
MRC-Epidemiology sets -70°C for non-DNA, like urine, plasma, serum, -80°C for tissues and if already mid-study)
- An underbench freezer set at -26°C as opposed to -20°C will use 33% more electricity (Green Light Labs, University of Warwick Aug 2018)
- Buy quality fridges/freezers that you can accurately set the temperature of. Add to a temperature monitoring system.

People

- Actions need people!
- Create an induction that goes beyond using equipment
- Get approval for an exit-policy: This benefits all!
 - Improves sample tracking
 - Reduces liability
 - Reduces need for freezers etc.
 - Reduces need for new chemicals at times
- Run an engagement programme
- Use a framework, like Green Impact – Labs or LEAF...



Laboratory Efficiency Assessment Framework

- Contains progressive, set criteria in Bronze, Silver, Gold awards levels
- Criteria exclude Health & Safety and Estates & Facilities, but include Research Quality
- Includes a means to estimate impact of actions
- Generates comparable results, baseline
- Intended to be a free tool.

Want to learn more?

- Cambridge is in the pilot study. Ask E&E to try yourself, or get a survey done using it!
- Further background information

<http://www.ses.ac.uk/2018/12/13/cell-secrets-2/>

http://www.sustainabilityexchange.ac.uk/leaf_a_new_approach_to_achieving_laboratory_sus

Conclusion, Outcomes

- Try LEAF!
- Request Information. The E&E team are here for you!
- Get a Green Labs Survey
- Borrow a logger
- Share what works (and what doesn't)



THE CAMBRIDGE *green*
CHALLENGE
• GREEN LABS •

Thank you for coming

Feedback appreciated!

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