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# Transforming to Zero

Changing Behaviours to Decarbonise Laboratories

White Paper | June 2024

3PM | GXN

## Mission Statement Decarbonising Labs

Public and private laboratories are setting targets for decarbonising operations, improving energy efficiency, and reducing waste. The most ambitious of these net zero targets are due as early as 2030.

They have good reason to do so. Improving the operation of laboratories can play a crucial role in society's efforts to mitigate and adapt to climate change as globally, the healthcare sector alone is responsible for 4–5%<sup>1 2</sup> of global greenhouse gas emissions and 2% of all plastic waste.<sup>3 4</sup>

With this white paper, we aim to deliver practical guidance on how to decarbonise laboratories, and to reduce energy and waste. The paper seeks to do so with a particular focus on the behaviour of scientists, technicians, specialists, and executive teams working in and around labs.

While there exists some guidance on how improvements to technical equipment can drive down energy demand and emissions, there is little research into how day-to-day behaviours in labs might hinder or advance sustainability efforts.

Technological fixes and better design will get us some of the way towards decarbonisation of laboratories in the near and medium term, but everyday use of buildings and equipment is a key lever for change right now. Consequently, we focus on how to implement and support sustainable behaviours, while also addressing the technical aspects of design and operations that can support these.

The white paper will offer insights into the challenges and practical approaches to delivering sustainable change for three key areas:

***(1) how to drive through organisational change by aligning visions, people, and initiatives in labs;***

***(2) how to improve operations of lab buildings to better support sustainable behaviours;***

***(3) what to consider during design and construction to create better lab buildings.***

***Each section is tailored to address the unique needs and perspectives of different stakeholders within the science ecosystem involved in laboratory environments.***

Developed by 3PM and GXN with the support of Oxford Properties, this white paper is based on in-depth research with a range of members of the science community. The research team has visited six laboratories and interviewed more than 50 scientists, lab managers, executives, and sustainability experts.

Public and private laboratories have already set ambitious net zero targets – now, they require practical tools to accelerate action and meet their goals. With this white paper we hope to do our part in delivering some of this.

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## Partner Statement **Oxford Properties**

Laboratories play a crucial role in delivering breakthrough research and innovation, life-saving therapies, and new technologies crucial for meeting our pressing environmental challenges. And yet laboratories also present unique challenges of their own when it comes to decarbonisation and the environment. Today, leading research and innovation institutions are looking at sustainability in a holistic manner, introducing strategies to enhance social benefits for employees and local communities while minimising environmental impact and improving governance and reporting.

The most forward-thinking organisations have already set bold targets across these aspects with the most ambitious net zero targets due as early as 2030. Now they require tangible advice on how to get there. This is why we are delighted to sponsor this research initiative with 3PM and GXN. The importance of initiatives like these, that can help the full research and innovation ecosystem gain a holistic understanding of the nature of challenges and opportunities, should be clear to anyone working in and around laboratories and the timing could not be more pertinent.

Oxford Properties has a proven track record in transformational, world-class developments. Its life sciences portfolio encompasses over 7 million sq. ft of completed properties and development projects including R&D labs and GMP facilities. We take pride in creating smart, sustainable, and healthy communities that are futureproofed, flexible, and put people first.

The life sciences sector, due to the operational complexity and often energy intensive processes of its assets, is one of the most challenging asset classes to decarbonise. In the UK, where the life sciences market is nascent and quickly expanding, we have a unique opportunity to approach the development of speculative life sciences assets in a more sustainable way. However, for true success, we recognised the need for a pathway to collaborate with our tenants to drive meaningful change. Our partnership with 3PM and GXN on the development of this white paper has provided us with a unique opportunity to develop a roadmap towards achieving this goal.

Sharing lessons learned on tackling this complex challenge is a vital first step in fostering further collaboration and innovation across all stakeholders within the industry. Significant change will take time, we remain focused on making progressive improvements across all aspects of our operations to improve the carbon efficiency of our life sciences assets.

Importantly, now that we've laid out this plan, we must act on it. This white paper represents a significant step towards the decarbonisation of labs, and we're proud to be part of this journey. We hope that our involvement will inspire the sector towards a more sustainable and resilient future.

# Project Team

## Who We Are

### 3PM

**3PM** are independent, creative Project, Programme, and Portfolio Managers, blending personable professionalism with dynamic expertise. Specialising in science & technology projects and strategic advisory, they combine their innovative mindset to challenge the standard approach and promote a sustainable future for the industry.

[3pm.uk.com](http://3pm.uk.com)

### GXN

**GXN** is an independent design-driven research studio that pioneers strategic sustainability within the construction industry. Their work has a twofold remit: to connect the dots between a healthy planet and human well-being. Founded by 3XN in 2007, they are currently represented in Copenhagen and London. The studio leverages experience from over 16 years of collaborative design research with leading companies and research environments to advance frameworks for generous and innovative behavioural and circular design.

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# Project Stakeholders

## Who We've Engaged With

To understand how to **support decarbonisation pathways for labs**, we have engaged the science community, visited six laboratories, and interviewed more than 50 researchers, lab managers, science leaders, and sustainability experts.

### Research partners

The findings in this white paper stem from more than 50 workshops, lab visits and semi-structured interviews carried out during 2022, 2023, and 2024. We have engaged all levels and a full cross-section of the science ecosystem to understand how low carbon goals are implemented across UK laboratories.

### Empirical grounding: interviews and lab visits

We have interviewed researchers, lab managers, and science leaders at key UK laboratories. To ensure a broad empirical grounding of insights we have engaged with major life sciences research institutes (The Pirbright Institute, Institute of Cancer Research, Norwich Bioscience Institute and The Francis Crick Institute), pharmaceutical companies (GSK), commercial science businesses (ADC Therapeutics, Multus, RFC Power and Domainex), research universities (Imperial College, University College London and University of Cambridge), sustainability experts (UCL LEAF), government funders (Innovate UK and BBSRC), and laboratory investors and asset owners (Oxford Properties and British Land). We have enhanced interview findings and themes with visits and observations at six laboratories, namely, Pirbright's BBSRC National Virology Centre: The Plowright Building and BBSRC National Vaccinology Centre: The Jenner Building; ICR's Centre for Cancer Drug Discovery and Chester Beatty Labs; ADC Therapeutics' facilities and RFC Power's lab, both at Imperial College's White City Campus. We have also gathered specialist engineering advice from Arup and Cryoserve.

### Reviews and expert input

We have supplemented empirical research insights with desktop reviews of relevant research, policies, and guidance documents – including reviews of ESG reports, sustainability policies, standard operating procedures, and other training materials from several science institutions. We have also engaged with Leesman to obtain quantitative data from the Lab Module to evaluate correlations with our qualitative data.

The findings and recommendations in the white paper have been developed and reviewed by subject matter experts from 3PM and GXN who share practical insights on science operations, equipment and sustainability, and behaviour and architectural design.

The following individuals participated in interviews and workshops for this white paper:



#### ADC Therapeutics

Lisa Skelton, Paul Hogg, Ian Kirby, Pedro Alves, Ben Leatherdale, Francesca Zammarchi



#### ARUP

Tim Fry



#### The Biotechnology and Biological Sciences Research Council (BBSRC)

Joan Shadwell



#### British Land

Gareth Roberts, Matthew Webster, Kath Ames, Luke Kelly,



#### University of Cambridge

Marita Walsh



#### Cryoserve

Matt Gibbons



#### Domainex

David Cronk



#### The Francis Crick Institute

Emma Nye



#### GSK

Duncan Parsley



#### Imperial College London

Paul Foley, Peter Beard, Claire Goode



#### Innovate UK

John Topliss



#### The Institute of Cancer Research (ICR)

Simon Francis, Lisa O'Fee, Richard Woods



#### Leesman

Mike Walsh, Peggie Rothe



#### Multus

Reka Tron



#### Norwich Bioscience Institute

Andrew Peck, Steven Guy



#### Norwich Research Park

Nick Goodwin, Jonathan Barnard, Matthew Poll



#### Oxford Properties

Emma Downey, Hala El Akl, Pierre-Etienne Accarier, Antara Woodring



#### The Pirbright Institute

David Shadwell, Ben Williams, Anthony Clarke, Nicole Doyle, Michael Boylan, Emily Kinsella, Miriam Windsor, Olga Kotik, Jim Chadwick, Ryan Waters, Jason Tearle



#### RFC Power

Tim Von Werne



#### University College London (UCL)

Jason Millichamp, Ben Stubbs, Andrea Hodgetts, Professor Rebecca Shipley



#### Watts Sustainability

Peter Watts

# Executive Summary

## Organisational Change



Leaders must integrate **sustainability into the scientific mission** and embed environmental considerations into research planning and execution processes to ensure that scientific advancements do not come at the cost of environmental degradation.

There is little existing knowledge on how the outsized environmental footprint of laboratories impacts the motivations and well-being of the people working in research and innovation. Our qualitative research with more than 50 respondents indicates that environmental concerns and even climate anxiety are becoming a topic of concern for scientists – especially the younger generation.

From our interviews we can see a pattern of engagement and frustration around the climate agenda: engagement comes from a sense of urgency and importance, frustration arising when perceived values of the workplace do not align with private concerns about the environment. We have seen examples of this concern and frustration leading to disengagement and even some cases of scientists quitting their jobs. However, we have also talked to many engaged scientists and have seen real ingenuity and pride in driving through change; indicating that decarbonising labs represents an opportunity to attract and retain science workers by helping them act on what matters to them. The outsized impacts of labs represent an opportunity for lab workers to make a difference through their professional work. For example, it has been estimated that every laboratory researcher produces nearly 15 times the amount of plastic waste that the average individual produces.<sup>5</sup>

We identify a series of recurring barriers these engaged scientists run up against, namely: a lack of dedicated time to drive through change as initiatives happen on top of existing workload; a perceived

lack of interest and backing from coworkers and the broader organisation; a lack of specialist knowledge to evaluate decisions based on environmental impacts; and a lack of organisational backing and pathways to scale solutions from pilots to business-as-usual.

Bold and visible leadership is, therefore, essential for the transformation. However, leaders must recognise that even small institutions are not monolithic entities but contain a mix of organisations, practices, and people. They must institute a diverse range of formal and informal initiatives to bring people along with the transition.

Climate leaders must find ways of bringing together their organisations' scientific, economic, and environmental goals. By acknowledging their impact on the environment and taking specific steps to mitigate it, leaders demonstrate their commitment to the wider organisation. This requires turning high-level goals and pledges into tangible actions. Climate leadership must provide clear and proactive steps towards decarbonisation and sustainability to be efficient. Climate leadership must be embedded at several organisational levels and entails a deep sense of responsibility towards the environment, employees, clients, and wider stakeholders. Executive teams and lead scientists in laboratories are crucial – without their active and ongoing buy-in and support, the rest of the organisation will find it hard to scale up change.

## Challenges

### **Disparity of personal and professional values:**

Laboratory professionals often face a conflict between their personal environmental values and the environmental impact of their work, which can lead to frustration and disengagement.

### **Limited visibility and backing from leadership:**

A lack of visible leadership around climate agendas can frustrate engaged scientists and means that individual feel less of a licence or imperative to act.

### **Inadequate knowledge and training:**

Many lab professionals are not adequately trained in sustainability principles or how to apply them in a lab setting and lacking skills to evaluate climate impacts of initiatives.

### **Limited impact of climate task forces:**

Insufficient funding, limited leadership support, and inadequate pathways to influence decision-making all hamper the efficiency of climate task forces.

### **Resistance to change in established procedures:**

Laboratories often have long-standing procedures and norms that are resistant to change. This can be a significant barrier to integrating sustainable practices.

## Opportunities

### **Bridging personal and professional values:**

Encouraging practices that resonate with lab workers' personal environmental ethics can significantly boost their engagement and help attract and retain researchers.

### **Effective communication and leadership:**

Leaders must clearly articulate the vision and rationale for sustainability initiatives, providing guidance and support throughout the process.

### **Appointing dedicated climate champions:**

Individuals who possess expertise in both laboratory operations and environmental sustainability can effectively bridge the gap between standard lab practices and sustainable alternatives.

### **Integrating sustainability into training materials:**

Embedding sustainability principles into the training and induction for lab personnel can make environmental considerations a foundational aspect of lab work from the outset.

### **Experimenting-then-scale Initiatives:**

Successfully implementing small-scale sustainability projects can lead to immediate benefits, evidence for the viability of approaches, and pave the way for broader environmental initiatives.

# Executive Summary

## Improving Operations



Addressing the environmental challenges in laboratory operations requires **optimising energy use** in building, implementing **effective waste management**, and driving **greater transparency** within the supply chain.

Lab buildings are substantial consumers of energy, between 3-10 times as much as a typical office building,<sup>6</sup> primarily due to systems designed to maintain optimal air quality and temperature. Addressing this requires a collaborative approach among building owners, occupants, scientists, and regulatory authorities in order to implement energy-efficient technologies and practices. This means upgrading HVAC systems, improving insulation, and utilising smart building technologies to monitor and optimise energy use. Standard Operating Procedures (SOPs) must align with regulatory requirements to minimise environmental impacts.

Energy-intensive lab equipment like centrifuges, autoclaves, and refrigeration also significantly contribute to labs' environmental footprint. Often, there is a lack of understanding about these devices' impact on greenhouse gas emissions. Optimising equipment usage and exploring alternatives with lower energy consumption is necessary. Promoting awareness among lab personnel about the environmental impact of their equipment and encouraging practices like metering, switching off, and sharing equipment can help. Training programmes can educate scientists and technicians on the benefits of energy-efficient equipment and practices.

Upgrading essential lab equipment to more sustainable options presents financial, technical, and regulatory challenges. Financial constraints limit the ability to invest in newer, more efficient equipment. Technically, new equipment must meet scientific research demands while being energy efficient.

Regulatory challenges involve navigating compliance requirements while implementing new technologies. Overcoming these hurdles requires thorough research into alternative equipment that meets both scientific and environmental standards. Emphasising the reuse of typically discarded equipment is also crucial.

Laboratories generate significant waste, including single-use plastics, hazardous chemicals, and non-recyclable materials, posing environmental and logistical challenges. Effective waste management and reduction strategies are imperative. Laboratories must focus on recycling and proper disposal methods, including waste segregation at the source, using biodegradable or recyclable materials where possible, and ensuring safe disposal of hazardous waste. Specialist waste contractors can provide expertise in managing and reducing waste, helping laboratories minimise their environmental impact.

Lack of transparency in supply chains regarding environmental impacts hinders sustainable practices. Many laboratory products, including chemicals, reagents, and equipment, have complex supply chains with significant environmental footprints. Organisations must demand greater transparency and sustainability from suppliers. By holding suppliers accountable, laboratories can make informed decisions supporting sustainability goals. Engaging suppliers in initiatives like reducing packaging waste or sourcing materials responsibly can further enhance laboratories' environmental performance.

## Challenges

### **Complex regulatory constraints:**

Navigating the regulatory context governing standard operating procedures (SOPs) is challenging to ensure compliance with environmental regulations whilst targeting sustainability goals.

### **High energy demand from building operations:**

Reducing building systems' energy use requires close collaboration amongst all stakeholders to implement efficient technologies and practices, whilst ensuring regulatory compliance.

### **High energy demand from equipment:**

The inefficient use of energy-intensive equipment in labs requires focus to optimise usage and explore alternatives with lower energy consumption. Despite the significant environmental impact of lab equipment misuse, many scientists remain unaware of its adverse effects on the climate.

## Opportunities

### **Optimise building energy use:**

Focus on major energy-consuming lab equipment and collaborate with stakeholders to implement energy-efficient technologies and align SOPs with regulations.

### **Promote equipment transparency:**

Educate lab users on environmental impacts and provide equipment footprint insights to encourage sustainable, eco-friendly decisions.

### **Facilitate equipment upgrades:**

Overcome barriers to upgrading lab equipment by researching sustainable alternatives, promoting reuse, and ensuring new equipment meets standards.

### **Difficulty in equipment change:**

Essential lab equipment presents challenges in upgrading to more sustainable options due to financial, technical, or regulatory constraints.

### **Waste and contamination concerns:**

The generation of large amounts of waste, including single use plastics, hazardous chemicals and non-recyclable materials in labs poses environmental and logistical challenges.

### **Lack of supply chain transparency:**

A lack of transparency in lab product supply chains regarding environmental impacts of equipment and products hampers efforts to adopt more sustainable practices.

### **Streamline lab storage and right-size equipment:**

Enhance lab storage to improve efficiency, reduce consumption, and match equipment size to needs, avoiding unnecessary energy use.

### **Implement effective waste management:**

Develop waste management strategies focusing on recycling and collaborate with specialists to handle single-use plastics, hazardous chemicals sustainably.

### **Enhance supply chain transparency:**

Demand greater transparency and sustainability from suppliers regarding the environmental impacts of their products, so lab users can make informed, environmentally responsible decisions.

# Executive Summary

## Better Buildings



Adopting a **balanced approach** to product and market fit, alongside adaptability and low carbon design choices, allow teams to create lab buildings that meet the needs of occupiers without sacrificing long term sustainability.

The influx of investment in laboratory facilities across the UK presents a unique opportunity to advance sustainability, as laboratory investments contribute to both innovation and potential sustainability challenges. With the UK science sector growing, the demand for laboratory space across the country exceeds available supply. Laboratory vacancy rates are just 1% in Cambridge and London, and 7% in Oxford.<sup>7</sup> Across these areas, projects to construct 11.6m sq feet of labs are in the pipeline so getting the business case right is essential to ensure the long-term viability of new laboratory buildings.

A deep understanding of the science the occupier will undertake is paramount, as it informs investment and design decisions tailored to the specific needs and operations of various scientific disciplines. Location remains important, developing an ecosystem around laboratory developments is vital to foster collaboration, innovation, and sustainability within the scientific community.

Adaptability and flexibility are key considerations when constructing and refurbishing labs, but they must be balanced with the risk of over-designing, which can lead to wasteful outcomes.

The recent concept of providing lab-enabled spaces is potentially wasteful if these spaces turn out to be used for more typical office purposes. Considering the divergent needs of the different branches of science occupiers, the decision of whether to design a building with lab-enabled capabilities has become a perplexing challenge - there are complex

trade-offs between embodied and operational carbon, market dynamics, and the changing nature of laboratory spaces due to advances in technology and innovation in research.

Designers must prioritise decisions that balance flexibility and resource efficiency to minimise carbon emissions throughout the facility's lifecycle. Design teams should prioritise durability, longevity, and energy efficiency in building systems and invest in high-quality, low-maintenance infrastructure designed to withstand evolving needs and technical advancements. We identify a number of features of good structural "bones" for lab design, including: adequate floor-to-floor heights; grid sizes that work for lab functionality; adequate space for back-of-house functions and logistics; efficient and futureproof zoning; robust floor build-ups for vibration requirements; and futureproof servicing.

Building less and repurposing existing structures not only minimises the embodied carbon footprint of construction but must also promote long-term sustainability and energy efficiency. When undertaking significant redevelopment, a key goal should be to maximise the future asset lifespan to ensure that large expenditures of capital and carbon pay offs by minimising needs for future interventions. To do this efficiently, developers and their consultants must define the appropriate extent of redevelopment, along with cost estimates and the embodied carbon spent, against trade-offs in future assets and operational energy reductions.

## Challenges

### **Market immaturity, and uncertainty about product:**

With the market for fully fitted and lab enabled space evolving fast, developers lack clear knowledge about market and product fit, leading to challenges with overdesign.

### **Energy efficiency in high-performance labs**

Designing energy-efficient laboratories is challenging due to the complex and energy-intensive nature of lab activities, and the specific requirements of different types of lab occupiers.

### **The trade-off between adaptability and carbon**

Deciding whether to design a building with lab-enabled capabilities brings trade-offs between embodied and operational carbon cost on one side and long-term asset viability on the other.

## Opportunities

### **Ensuring commercial viability in lab design**

Having the right location, links to research clusters, attractive low carbon design choices and the right mix of amenities can ensure long-term asset viability.

### **Adaptive and flexible lab design**

Implementing flexible and adaptive design in laboratories can further enable long-term asset viability by allowing buildings to meet the changing needs of science occupiers.

### **Optimising structure and layout for efficiency and flexibility**

Getting the 'bones' right includes considerations of lab layouts and zoning, load-bearing capacities, vibration requirements, variable air changes, and efficient logistics.

### **Complexity repurposing existing assets for labs**

Transforming existing commercial buildings into laboratories brings numerous technical and design complexities that must be solved within the constraints of the building structure.

### **Balancing carbon and operational efficiency in refurbishments**

Achieving a balance between reducing the carbon footprint in the refurbishment process and ensuring operational energy efficiency in labs is challenging.

### **Integrating sustainable building materials**

The need for durability, safety, and specific technical functionalities can limit the use of ecofriendly materials, making it difficult to align lab construction with decarbonisation goals.

### **Prioritising the reuse of existing structures**

Successful transformation requires careful decision-making to maximise reuse of existing structures, and implementing structural upgrades, functional zoning, and flexible servicing.

### **Cost-benefit analysis for sustainable refurbishments**

Refurbishments should consider the environmental impact of building services and materials, the energy efficiency of design choices, and the long-term operational costs.

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Andrew Alliance

Waters  
MAKING WHAT'S POSSIBLE™

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# 01. The Carbon Challenge

## 01. The Carbon Challenge

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# Introduction

## Why Transform to Zero?

Society, funders and public and private organisations have already set ambitious **net zero targets** – now they require practical tools **to accelerate action and meet their goals.**

### **What does Transforming to Zero entail?**

The United Kingdom was amongst the first countries to enshrine into law a requirement to achieve net zero by 2050,<sup>1</sup> including a 78% reduction of Green House Gas (GHG) emissions by 2035.<sup>2</sup>

Laboratories play a crucial role in implementing viable net zero pathways. The healthcare sector alone is responsible for some 5% of global GHG emissions,<sup>3,4</sup> with lab buildings consuming between 3-10 times as much energy as comparable office buildings.<sup>5,6</sup> Compare this to aviation, which accounts for 2.4% of global emissions,<sup>7</sup> and it becomes evident that decarbonising laboratories is important for keeping global warming well below 2.0°C as enshrined in the Paris Agreement.<sup>8</sup>

In line with this urgent need, public and private laboratories are setting targets for decarbonising operations, improving energy efficiency, and reducing waste – with the most ambitious of these net zero targets due as early as 2030 (see p. 44).

### **Mind your behaviour**

With this report, we aim to deliver practical carbon reduction guidance, and seek to do so with a particular focus on the behaviour of lab technicians, lab managers, support staff and executives in laboratories, as well as professional teams developing laboratories.

Consequently, we focus on implementing and supporting sustainable behaviours in laboratories. We discuss improving the operation of existing laboratories, paying particular attention to motivating

and engaging employees. We also discuss how to lead and drive change, as well as reconsidering equipment, procurement, and logistics to minimise environmental footprints and reduce waste.

Given the large amount of investment into new laboratories – whether retrofitting or new build – we also discuss how to improve laboratory design and logistics, and how to drive through environmental performance in the briefing and design stages while considering both environmental and behavioural factors.

### **This chapter describes the carbon challenge**

The remainder of Chapter One sets out the context for Transforming to Zero. We define key terms connected to the decarbonisation agenda, and discuss the biggest drivers for change in UK labs, as well as the goals and pledges of some of the key science organisations in the country.



**We all believe in net zero**, we all have this ambition to get there, but then there is a **massive unknown** about what that actually is.

Engineering Manager



# Introduction

## Definitions

As more organisations are publishing climate commitments, the need for clarity on terminology grows. Understanding what we talk about, **when we talk about 'transforming to zero'**, is a prerequisite for evaluating plans and actions in the laboratory.

### Definition of a 'Net Zero Laboratory'

As defined by the Oxford Net Zero initiative, Net Zero: "refers to a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere."<sup>9</sup> Under this definition, net zero is the state at which global warming stops.

A 'Net Zero Carbon' Laboratory is one where the sum of all greenhouse gas (GHG) emissions, both operational and embodied, over the laboratory's lifecycle are minimised as far as possible, and with residual emissions offset through high integrity carbon credits to equal 'net' zero.<sup>10</sup>

Most credits today are associated with emission reductions or avoided emissions. These can play a key role in the short and medium term to accelerate the transition to a low-carbon future, but are coming under scrutiny for failing to live up to their promises. In addition, the scope for further emission reductions will decrease as we approach net zero target date. Organisations must shift towards carbon removal credits, which remove carbon from the atmosphere to achieve net zero. Those targeting net zero with the use of credits will need to increase the proportion that comes from carbon removal, rather than from emission reductions, aiming to reach 100% carbon removal credits by the global net zero date (2050).<sup>11</sup>

### Operational Carbon: Energy, Water, Equipment

Operational carbon describes emissions of GHG during the in-use operation of a building. Emissions arise from energy-consuming activities such as heating, cooling, ventilation, and specialist equipment. Indeed, lab buildings are substantial consumers of energy, between 3-10 times as much as a typical office building.<sup>12</sup>

Decarbonising laboratories requires a combination of energy demand reductions from buildings, and decarbonisation of the electrical grid through increased renewable supply. Recent experience indicates a rapid decarbonisation of the UK's national grid, which will result in buildings that produce less carbon emissions in operation over time. However, due to laboratories' outsized energy needs, and minimising energy demand remains a key priority.

### Embodied Carbon: Products and Materials

Embodied carbon describes the GHG emissions associated with the manufacture of materials and products that themselves emit carbon, either as part of chemical reactions or from relying on high temperature processes that require significant energy.

Cement, for example, requires the burning of raw materials such as limestone, clay, and sand at temperatures exceeding 1,400 °C, leading to emissions of large amounts of CO<sub>2</sub>.

As the energy demand of our buildings reduces, and the grid decarbonises, a significant portion of the carbon emissions over a building's lifetime will be due to its embodied carbon. Addressing the embodied carbon of buildings through better utilisation, building transformation and life extension, and better design and material choices will be key to meeting future sustainability requirements.

### Whole Life Carbon: Complete Carbon Lifecycle

Whole life carbon refers to the total amount of GHG associated with a product, service, or building throughout its entire lifecycle, including extraction of raw materials, manufacturing, transportation, use, and disposal. Whole Life Carbon therefore includes both operational and embodied emissions

# Lab Impacts

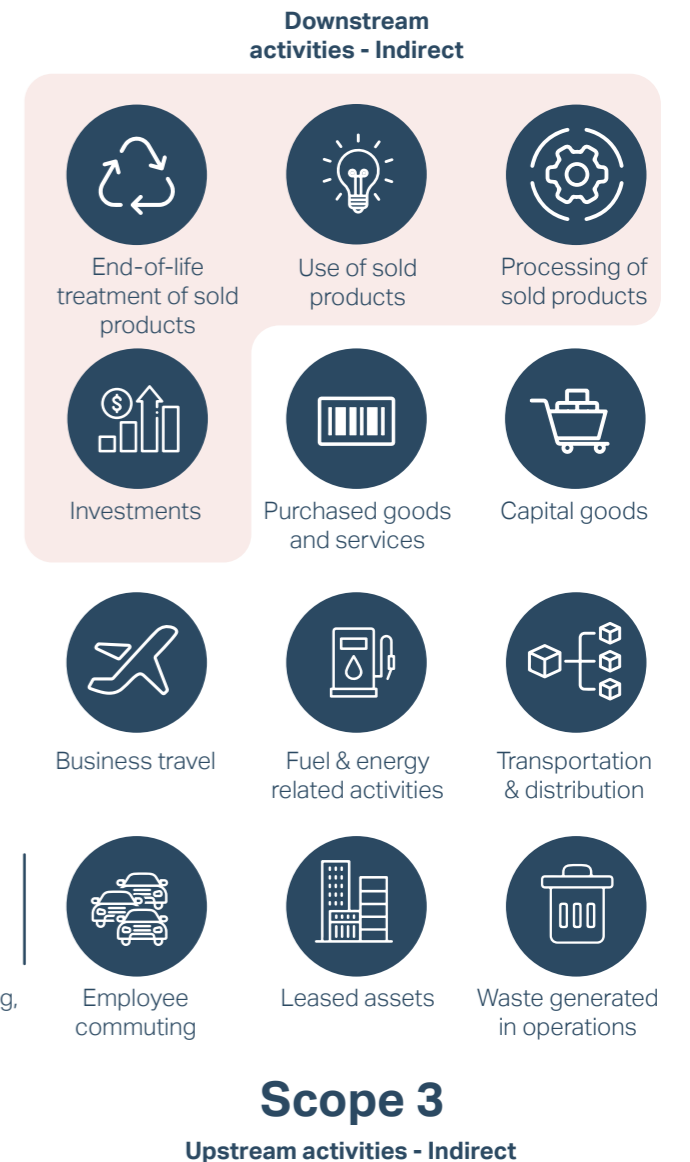
## Laboratory Emission Scopes

Reducing GHG requires an **understanding of where they occur**. The Greenhouse Gas Protocol accounting standard defines three sources - Scopes 1, 2 and 3 - to categorise the emissions an organisation emits throughout its operations and value chain.

The carbon impact of indirect emissions in a company's value chain (Scope 3) is generally higher than emissions captured in Scope 1 and 2. A recent report by My Green Lab evaluating a dataset of 373 reports from Biotech and Pharma companies found that Scope 3 emissions are about 4.5 times higher than Scope 1 and 2 combined.<sup>13</sup> However, as tracking Scope 3 emissions is notoriously difficult, the real ratio might well be higher. My Green Lab highlights AstraZeneca as a company where a targeted effort to do more accurate reporting has revealed Scope 3 to be more than 19-fold that of Scopes 1 and 2. Similarly, a McKinsey analysis of 75 medtech companies' emissions profiles found that more than 90% of a typical company's emissions falls under Scope 3, with purchased goods and services accounting for 45% of the total, while the use of sold products downstream accounts for 28%.<sup>14</sup>

It is important to note that Scope 3 emissions are sometimes overlooked in laboratories' ESG efforts as they occur outside the direct control of organisations. They should not be. A key challenge for the sector will be to develop successful Scope 3 emission reduction strategies, including improvements to procurement and use of products in the lab, as well as better end-of-life strategies. This necessitates a focus on supplier selection (including distributor, and waste management), interrogating operating models and capabilities, updating product specifications, and developing partnerships and collaboration in the value chain. Companies must address Scope 3 emissions in their ESG efforts to ensure a sustainable future.

Scope 1 emissions are direct emissions from sources owned or controlled by an organisation. For science labs, this includes emissions from combustion in boilers and furnaces, as well as vehicles, and fugitive emissions such as leaks of gases from lab equipment. For example, Danish company Novo Nordisk has, amongst other initiatives, taken steps to reduce emissions from its car fleet, with the aim of having 100% electric or plug-in hybrid cars by 2030.<sup>15</sup> Transitioning to electric or more fuel-efficient vehicles is a common strategy for reducing Scope 1 emissions in transportation.



Scope 2 emissions are indirect emissions from the use of purchased energy. In the context of science labs, this would typically involve emissions related to electricity, heating, or cooling that are purchased to operate the lab facilities. Switching to cleaner energy sources is a significant move towards reducing Scope 2 emissions.

Many labs are taking steps towards renewable energy. For example, GSK aims to use 100% renewable electricity (imported and generated) by 2030.<sup>16</sup>

Scope 3 emissions encompass all other indirect emissions that occur up and down in an organisation's value chain, for example, the buying, use and disposal of plastic products from suppliers.

Scope 3 emissions are difficult to control but highly significant for labs. For example, in 2020, AstraZeneca's Scope 3 emissions made up more than 95% of their total corporate output, and they have set a target to reduce these by 50% by 2030 and 90% by 2045.<sup>17</sup> To achieve this goal, they are using suppliers signed up with the Science-Based Targets Initiative and are seeking to develop more environmentally friendly products.

# Lab Impacts

## How UK Labs Contribute to the Climate Issue

### Global



The building sector is responsible for approximately **39% of global greenhouse gas (GHG) emissions**<sup>18</sup>

Of those total emissions, **building operations** are responsible for **27%**<sup>19</sup>

**2%**

of world plastic waste comes from labs<sup>20</sup>

**5%**

of global greenhouse gas emissions is from the healthcare sector alone<sup>21 22</sup>

**3-10x**

Labs consume **3-10 times more energy** per square meter than other academic spaces<sup>23</sup>



**406m**

The **UK's total territorial greenhouse gas emissions** were approximately **406 million metric tons of carbon dioxide equivalent (CO<sub>2</sub>e)** per year.<sup>24</sup>

It's no secret laboratories are GHG emission-intensive buildings. Most are required to operate 24/7 and cater for complex environmental requirements for the manufacture and storage of chemicals, biological containment, or close temperature control for micro-, nano- and sub-atomic scale work. Chemical labs are the worst offenders, consuming three to four times as much energy per square metre as an office building. Meanwhile, life science labs with their energy-hungry equipment (bio containment, big freezers, environmental growth chambers, incubators, ovens etc.) also have an outsize carbon footprint.

# Lab Impacts

## We Cannot Rely on Offsetting

Carbon offsets are increasingly scrutinised for perpetuating greenwashing as our over-reliance and their questionable efficacies mask the urgent need for direct emission reductions and **more transparent environmental practices.**

Carbon offsets are a form of trade in which companies or individuals compensate for their carbon emissions by buying carbon credits to fund projects designed to make equivalent reductions of CO<sub>2</sub> in another location. One credit represents one ton of CO<sub>2</sub>, and the most widely used credits typically revolve around renewable energy, energy efficiency, or reforestation efforts.<sup>25</sup>

Under the United Nations Framework Convention on Climate Change (UNFCCC), the UN have established carbon markets such as the Clean Development Mechanism (CDM), which seeks to commit participants to meet binding targets set by governments. In addition, private companies also choose to buy offsets on the Voluntary Carbon Market (VCM) to help meet the goals of climate neutrality.

The VCM has grown significantly in recent years and was estimated to be worth \$2 billion in 2022.<sup>26</sup> It has been predicted that the carbon credits market could be worth upward of \$50 billion in 2030, reflecting a growing awareness of the need to address climate change and the increasing demand from companies seeking to improve their environmental credentials.<sup>27</sup>

However, the legitimacy and effectiveness of carbon offsets are under scrutiny. A 2023 report by The Guardian and researchers from Corporate Accountability revealed that the majority of offset projects that have sold the most carbon credits in the VCM were 'likely junk', casting serious doubt on the overall integrity of the market.<sup>28</sup>

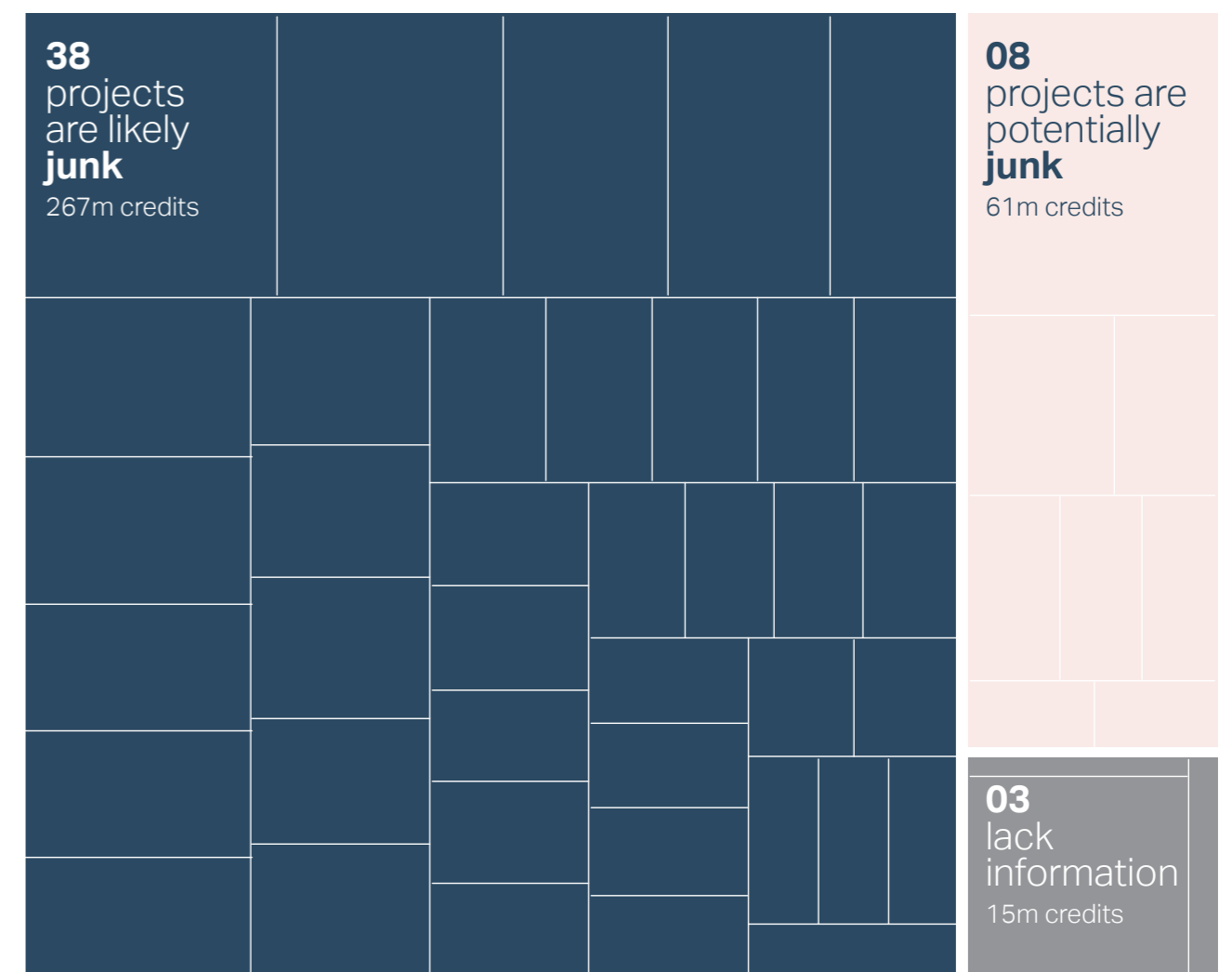
Three main issues drive this: additionality, inflated baselines, and second-order effects. Additionality concerns whether the carbon-saving activities would have occurred without the funding from carbon credits, while inflated baselines refer to the exaggeration of emissions levels in the absence of the project to make the offsets seem more effective. Lastly, some projects can lead to external damage, such as displacing indigenous peoples or causing unintended environmental harm. The critical question that emerges is how efficient offsets are in causing CO<sub>2</sub> reductions.

In a 2023 review of more than 2,000 offset projects, including evidence from 51 additional studies, researchers from ETH Zurich concluded that 88% of credit volume in the VCM does not constitute real emission reductions. This offset achievement gap corresponds to almost twice the annual German CO<sub>2</sub> emissions.<sup>29</sup>

In 2024, members of the European Parliament adopted a new law banning greenwashing and misleading product information, including 'claims that a product has a neutral, reduced or positive impact on the environment because the producer is offsetting emissions'.<sup>30</sup> When ratified, member states have two years to enshrine this law into national regulation, spelling an end to what has traditionally been accepted as 'net zero' claims for most industries.

### 50 carbon offset projects which have sold/retired the most credits

A 2023 report by The Guardian and researchers from Corporate Accountability investigated the 50 largest offset projects in the Voluntary Carbon Market, representing 343m retired credits, nearly one-third of the entire market. The study revealed that a large part of these were 'likely junk' or 'potential junk' due to challenges with additionality, exaggerated claims, inflated baselines, and lack of documentation amongst other things.<sup>31</sup>



Guardian/Corporate Accountability analysis using raw data from AlliedOffsets database.

# Drivers of Change

## Legislation, Policy, and Guidance

The UK was the first country to set **legally binding national carbon targets** and has committed to bring all GHG emissions to Net Zero by 2050. To follow through on this commitment, additional legislation and policies are being implemented.

The UK's commitment to achieving net-zero carbon emissions in buildings consists of a framework of legislation and policies, aligning with international agreements, and the employment of strategic directives to combat climate change.

At the heart of the UK's climate action is the Climate Change Act of 2008, providing the legislative backbone for carbon reduction efforts. This legislation was subsequently augmented to align with the Paris Agreement, the international accord that sets out global efforts to limit global warming to below 2 degrees Celsius. The UK's 2019 Net Zero Target for 2050,<sup>32</sup> enshrined in law, builds upon these commitments, emphasising the urgency and gravity of transitioning to a net-zero carbon future.

### Taxonomy and financial disclosure

The European Union Taxonomy further complements the UK's domestic efforts, providing a classification system that identifies environmentally sustainable economic activities.<sup>33</sup> As the UK transitions post-Brexit, aligning with EU standards remains crucial for harmonising sustainability goals. The UK Green Taxonomy, closely related to the EU Taxonomy, classifies investments based on their environmental impact, guiding financial institutions and investors towards green and sustainable projects.<sup>34</sup>

In parallel, the UK Green Finance Strategy is aligned with the EU Task Force on Climate-Related Financial Disclosures and seeks to amplify these efforts by incentivising investments in sustainable building practices.<sup>35</sup> By aligning financial incentives with

eco-friendly initiatives, this strategy encourages the adoption of energy-efficient technologies, retrofitting projects, and the integration of renewable energy sources.

### Measuring progress

The independent Climate Change Committee (CCC) was set up to scrutinise the UK Government's policy progress towards net zero through annual reports. In 2023, the CCC highlighted that there had been limited progress in the sectors of industry and buildings, and that the rate of emissions reduction needs to accelerate two or three times the current rate.<sup>36</sup> This will likely put more legislative and policy pressure on laboratories in the future as UK CO<sub>2</sub> emission targets come due, further highlighting the need for implementing coherent emission reduction strategies - and the risks of failing to do so.



2008

## Climate Change Act 2008

The Climate Change Act **2008** refers to a government commitment to ensure the UK reduces its greenhouse gas emissions by 80% from **1990** levels by **2050**.<sup>37</sup>



2016

## The Paris Agreement

The Paris Agreement, implemented in **2016**, is an international treaty requiring economic and social transformation, based on the best available science. The Paris Agreement works on a five-year cycles of review, with the key CO<sub>2</sub> targets in **2030** and **2050**.<sup>38</sup>



2019

## The 'Net Zero Target'

UK becomes first major economy to pass net zero emissions law. New target will require the UK to bring all greenhouse gas emissions to net zero by **2050**.<sup>39</sup>



2021

## The EU Taxonomy

Introduced in **2021**, the EU Taxonomy promotes sustainable finance and represents an important step towards managing sustainable investment. The Taxonomy aligns with the EU's CO<sub>2</sub> targets for **2030** and **2050**.<sup>40</sup>



2023 Updated

## Green Finance Strategy

Ensures that the information exists to enable every financial decision to factor in climate change and the environment.<sup>41</sup>



...

## UK Green Taxonomy

The UK Green Taxonomy will be a framework for disclosing sustainability - it will clearly set out criteria which specific economic activities must meet in order to be considered environmentally sustainable.<sup>42</sup>

# Drivers of Change

## Science Funding

United Kingdom Research and Innovation (**UKRI**) plays **a crucial role in funding** science. Researchers seeking funding are required to adhere to specific standards, which are expected to increasingly incorporate decarbonisation.

UKRI is a non-departmental public body sponsored by the Department for Science, Innovation and Technology (DSIT), that directs funding to research and innovation. The organisation brings together the seven disciplinary research councils, which are responsible for supporting research and knowledge exchange at higher education institutions in England, as well as the UK's innovation agency, Innovate UK. Providing investment and support for researchers and businesses, UKRI helps researchers develop new skills, enabling collaboration and engagement across and beyond communities. It is responsible for promoting and managing large programme grants, some of which are available for universities, start-ups, spinouts and businesses as part of their Catapult programme.

As an entity responsible for addressing national and global challenges, UKRI holds a significant responsibility in the building of a green future for the UK and achieving national Net Zero targets. UKRI has established cross-organisational working groups that address sustainability and carbon reduction. Within UKRI, the Natural Environmental Research Council (NERC) is leading the Net Zero and Green Future initiatives on behalf of all the UKRI councils.

UKRI's environmental sustainability strategy aims to embed environmental sustainability into all investment decisions by 2025. This strategy is seen as a significant step toward achieving sustainability goals and guiding funding decisions and is outlined in the UKRI Environmental Sustainability Plan, which will: *“ensure that environmental sustainability is factored into how we make investment decisions,*

*including through the UKRI funding service and how we operate as an organisation.”<sup>43</sup>*

### **Funding Feasibilities and Energy Efficiency**

In our interviews with BBSRC and Innovate UK, we found a current emphasis within the Research Councils on the importance of feasibility studies to initiate carbon reduction and green sustainability projects, predominantly driven by energy use.

Within the current funding cycle, research councils have been provided with yearly funding to identify energy-saving opportunities and to support smaller sustainability initiatives and projects. These grants are meant to cover a range of sustainability-focused projects, with funding ranging from £5,000 to £50,000. Innovate UK is implementing a new requirement for grant applicants, as part of their commitment to achieving net zero emissions. In the past, operational carbon costs were not factored into funding applications, however, Innovate UK is now asking for whole-life carbon assessments for facility and equipment development. This initiative is being driven by individuals while specific requirements and objectives are being developed by the organisation.

At this stage, the integration of sustainability criteria into business cases for UKRI funding is an evolving process and will soon be made a priority. The implementation of these initiatives is critical for UKRI to drive down carbon emissions from within their funding envelope. There is progress within the organisation, however the pace of application will need to increase in order to achieve their ambitious carbon reduction targets.



“I think everybody is pretty acutely aware that we've got to **develop better and smarter buildings** – be more efficient with the resources that we use.”

Capital Portfolio Executive



## Case Study:

# Greener Research Together: the UK's Concordat for the Environmental Sustainability of Research and Innovation Practice

The UK research and innovation (R&I) sector have co-developed a **voluntary environmental sustainability concordat**. Signatories agree to work individually and collectively to ensure the future design and practice of UK research and innovation is environmentally sustainable.

Over the course of this research, several of our collaborators have been engaged to develop a cross-sector agreement to drive sustainable practices in R&I. Enter the Concordat for the Environmental Sustainability of Research and Innovation Practice, a collaborative effort to green the UK's R&I landscape, and a step that directly aligns with our research findings on the need for guidance, sharing of knowledge and alignment of goals.

### A Shared Vision for Change

Launched in May 2024, the concordat is a voluntary agreement between universities, research institutes, and funders, reflecting a shared ambition to ensure cutting-edge research continues, but in a way that minimises environmental impact. The concordat acknowledges the environmental cost of research activities. From energy-intensive lab equipment to travel for conferences, R&I can contribute to greenhouse gas emissions, resource depletion, and pollution. By signing the concordat, organisations commit to taking action to reduce these impacts.

### Why is the Concordat Important?

The concordat's significance lies in its potential to drive systemic change, directly addressing the need we have identified for guidance and alignment:

- **Collective Action and Alignment:** By uniting signatories under a common framework, the concordat will foster collaboration and knowledge sharing. This will accelerate the identification and implementation of best practices for sustainable research, ensuring everyone is working towards the same goals.

- **Promoting Long-Term Thinking:** The concordat encourages signatories to consider environmental implications throughout the research lifecycle, from project design to data analysis and dissemination. This shift towards a more holistic approach, guided by concordat principles, will lead to environmental gains.
- **Aligning with National Goals:** The concordat directly supports the UK's net zero ambitions. By greening its own practices, the R&I sector sets an example for other industries and demonstrates its commitment to environmental responsibility.
- **Unlocking New Opportunities:** A focus on sustainability, encouraged by the concordat, can lead to innovation in research methods and technologies. This, in turn, can lead to the development of new solutions for environmental challenges, creating a positive feedback loop.

### The Road Ahead

The concordat is a significant step forward, but it's only the beginning. Challenges remain:

- **Implementation:** Translating the concordat's principles into actionable steps requires strong leadership, clear strategies, and adequate resources within research institutions.
- **Monitoring Progress:** Mechanisms need to be established to track progress and identify areas where further action is needed. Sharing best practices and success stories will be crucial for motivating continued commitment.
- **Inclusivity:** The concordat needs to consider the diverse nature of R&I activities, ensuring its

principles are applicable to different research disciplines and scales.

### Joining the Effort

The concordat offers two ways for organisations to participate:

- **Signatories:** By signing the concordat, organisations make a formal commitment to its principles. Signatories agree to develop and implement an action plan that outlines specific measures to reduce their environmental footprint. They also agree to participate in progress reviews and share best practices with other signatories.
- **Supporters:** Organisations that are not yet ready to become signatories can still express their support for the concordat's goals. Supporters can do this by publicly endorsing the document and promoting its principles within their organizations.

### Becoming a Signatory

Signatories will need to adhere to the following principles:

- **Leadership and System Change:** This emphasises the need for visible and credible leadership at all levels, from individual researchers to research institutions and funders. Signatories should work to embed sustainability considerations throughout their R&I activities and advocate for systemic change in the sector.
- **Sustainable Infrastructure:** This focuses on minimising the environmental impact of research facilities and infrastructure. Signatories

might commit to actions like improving energy efficiency in labs, using sustainable building materials, and adopting responsible waste management practices.

- **Sustainable Procurement:** Signatories should consider the environmental impact of their purchasing decisions. This could involve prioritising sustainable products and services, reducing unnecessary procurement, and implementing ethical sourcing practices.
- **Emissions from Business and Academic Travel:** Signatories might explore ways to reduce travel needs (e.g., virtual conferencing), choose more sustainable travel options (e.g., public transport), and offset unavoidable emissions.
- **Collaborations and Partnerships:** Signatories are encouraged to work with other institutions, industry partners, and research funders to share best practices and develop joint solutions.
- **Environmental Impact and Reporting Data:** Monitoring and reporting on environmental impacts are crucial for measuring progress. Signatories might commit to collecting and sharing relevant data on their environmental footprint, allowing for a transparent evaluation of their sustainability efforts.

**To learn more and sign up visit: <https://wellcome.org/what-we-do/our-work/environmental-sustainability-concordat>**

# Drivers of Change

## Laboratory Development

In recent years, the UK has witnessed a notable surge in the demand for laboratory facilities across various science sectors. The dilemma emerges in **balancing the imperative for scientific progress with environmental change.**

In life sciences, pharmaceuticals, and biotechnology, the UK has emerged as a hub for innovation. The prominence of leading research universities, including the University College London, the University of Cambridge, and Imperial College London, alongside numerous biotech startups and pharmaceutical giants, has fuelled breakthroughs in drug development, genomics, and medical research on a national scale. This ecosystem has attracted significant investments from both public and private sectors, positioning the UK as a frontrunner in global scientific research. A total of £192.5 million of life sciences real estate transacted across the Golden Triangle in Q1 2024 - this was over double Q4 2023 and represented the highest quarterly figure since Q1 2023.<sup>44</sup>

With the UK science sector growing, the demand for laboratory space across the country exceeds available supply. A 2023 report by British Land and Savills found that Laboratory vacancy rates are just 1% in Cambridge and London, and 7% in Oxford.<sup>45</sup> Across these areas, projects to construct 11.6m sq feet of labs are waiting for a planning decision or are in the pipeline. Developers and investors are seizing on the opportunity to help de-risking portfolio strategy away from over-reliance on office space.

### Building green

Government initiatives, driven by the levelling up agenda, seek to upgrade and expand laboratory facilities nationwide. Measures such as the Industrial Strategy and the Life Sciences Sector Deal are responses to the increasing demand, although

challenges persist in correlating these developments with tangible decarbonisation incentives.

The influx of investment in laboratory facilities across the UK presents a unique opportunity to advance sustainability, as laboratory investments contribute to both innovation and potential sustainability challenges. Questions arise about aligning state-of-the-art facilities with broader climate goals, necessitating strategic integration of decarbonisation incentives within ongoing laboratory infrastructure investments.

Addressing this, there is a need for strategic integration of decarbonisation incentives within the ongoing investments in laboratory infrastructure. Government policies and industry stakeholders must collaborate to ensure that the expansion and enhancement of laboratory facilities not only meet the growing demand for scientific advancements but also align with sustainable practices. This entails exploring avenues for positive environmental impact, such as adopting green building standards and technologies, and acknowledging the climate-negative aspects that may be associated with certain lab practices. The surge in funding should be strategically harnessed to integrate cutting-edge technologies and practices that prioritise environmental stewardship. By seizing this opportunity, the UK can not only maintain its position as a global scientific leader but also lead the way in fostering a more sustainable and resilient scientific infrastructure that aligns with broader climate objectives.

# < 1%

The vacancy rates for available fitted laboratory space are below 1% in both Cambridge and London.

# < 7%

The vacancy rates for available fitted laboratory space are below 7% in Oxford.

# 1.39 mil sq ft

Take-up for science-related real estate across the 'golden triangle' of London, Oxford and Cambridge totalled 1.39 million sq ft in 2022.

# 2.8 mil sq ft

Lab space currently under construction across the golden triangle.

To Read More: [https://www.savills.co.uk/research\\_articles/229130/340692-0/spotlight--life-sciences---trends-and-outlook-2023](https://www.savills.co.uk/research_articles/229130/340692-0/spotlight--life-sciences---trends-and-outlook-2023)

# Drivers of Change

## ESG Investment

As Environmental, Social, and Governance (ESG) considerations **gain prominence in investment decisions**, incorporating these principles into laboratory facilities becomes imperative.

ESG is a measured assessment of sustainability using established benchmarks and metrics. Its main purpose is to provide stakeholders and investors with a framework to assess an organisation's impact on the environment, on society and how it manages its corporate governance practices.

ESG investing refers to how financial companies rate these aspects for potential investments - and the field is growing fast. At the end of 2023, the value of sustainable investment globally stood at \$30.3 trillion, according to the Global Sustainable Investment Alliance (GSIA), with non-US markets – Canada, Europe, Japan, Australia and New Zealand – seeing a 20% increase in sustainable assets under management since 2020.<sup>46</sup>

As the industry matures, tighter definitions of what counts as sustainable investment have been implemented to combat greenwashing and requirements for data coverage and quality have increased. Initiatives like the EU Taxonomy and EU Corporate Sustainability Reporting Directive (CSRD) have streamlined rules concerning the social and environmental information that companies have to disclose.

ESG relates directly to an organisation's business model and risk management as initiatives to meet requirements become active and evolving strategies for minimising negative operational impacts. Organisations have to identify what data is needed to meet business strategy, stakeholder and regulatory needs.

ESG, then, is about more than reporting and requires embedding data literacy and transparency into all aspects of an organisation's decision-making. For the science organisations interviewed in this report, a key focus is on how to move from high-level ESG targets, including net zero pledges, to efficient organisational strategies that can drive through change. This is leading to changing behaviours across all aspects of laboratory investment, development, and operation.

However, meeting ESG requirements and translating high level goals to impactful actions remains tricky for most organisations. But if done right ESG-focused investments and initiatives can drive a dual impact—supporting scientific progress while adhering to sustainability goals. Striking this balance will be crucial for the UK to continue its trajectory as a global scientific powerhouse with a responsible and climate-conscious approach.



If sustainability and ESG initiatives are not aligned with the business plan of an asset **they remain theoretical.**

Global Sustainability Executive



## Case Study:

### Oxford Properties: data driven decisions, from principles to practice

To accelerate sustainability commitments, Oxford Properties is embedding data governance and transparency throughout their investments and operations. The result is empowering asset managers with data-driven decision-making – and is bringing sustainability and asset teams closer together.

#### Meeting needs for data coverage and quality

Global investor, asset manager and developer Oxford Properties is committed to strengthening economies and communities through real estate to fulfil the OMERS pension promise. As Vice President of Sustainable Investing and Operations at Oxford Properties, Hala El Akl is the global lead of Oxford's sustainability programme. Over the past few years, she has been spearheading efforts in three areas: integrating sustainable investing, decarbonizing the global portfolio, and solidifying Oxford's sustainability data foundation.

The needs around sustainability data have evolved quickly, Hala explains. As ESG regulation and frameworks have matured, requirements around public disclosure in real estate have become more streamlined. As a result, metrics and methodologies are converging. In turn, this alignment has resulted in increasing demands for – and improvements to – data coverage and quality.

But this is about more than data and reporting, Hala emphasises: *“Our approach has been about integrating sustainability into everything we do, making it part of the everyday workflow for our asset managers, and empowering them to scale operational efficiencies and maximise environmental and financial impact.”*

Owned by Canadian pension fund OMERS, Oxford Properties is committed to meeting their duties to pension plan members by accelerating environmental sustainability initiatives, integrating



Oxford Properties, 2023 Global Sustainability Report

social value through operations and development, and securing transparency in governance. Access to finance is also vitally dependent on sound environmental practices, as banks have progressively incorporated sustainability provisions in their conditions. Increasingly, Hala explains, tenants are asking for information about how the buildings and spaces they rent can enable them to meet their own corporate commitments.

#### Building the foundation for data literacy within the organisation

Meeting these requirements has required restructuring workflows at Oxford, Hala says, explaining that organisations must recognise that this requires embedding data transparency and literacy within the organisation, securing ownership

## Case Study:

Oxford Properties: data driven decisions, from principles to practice



Victoria House, Oxford Properties and Pioneer Group

within asset management teams, and linking sustainability to core business objectives through data-driven decision-making.

Hala's team have spent the last few years building the structural foundation for environmental data management through investment in a new data platform and workflow, as well as onboarding key people on its use.

This structural foundation also extends to ensuring that asset data for the last three years is available within the platform, through automated processes and establishing workflows for asset managers to review the output and interrogating anomalies and outliers.

### Embedding sustainability in asset management and investment lifecycles

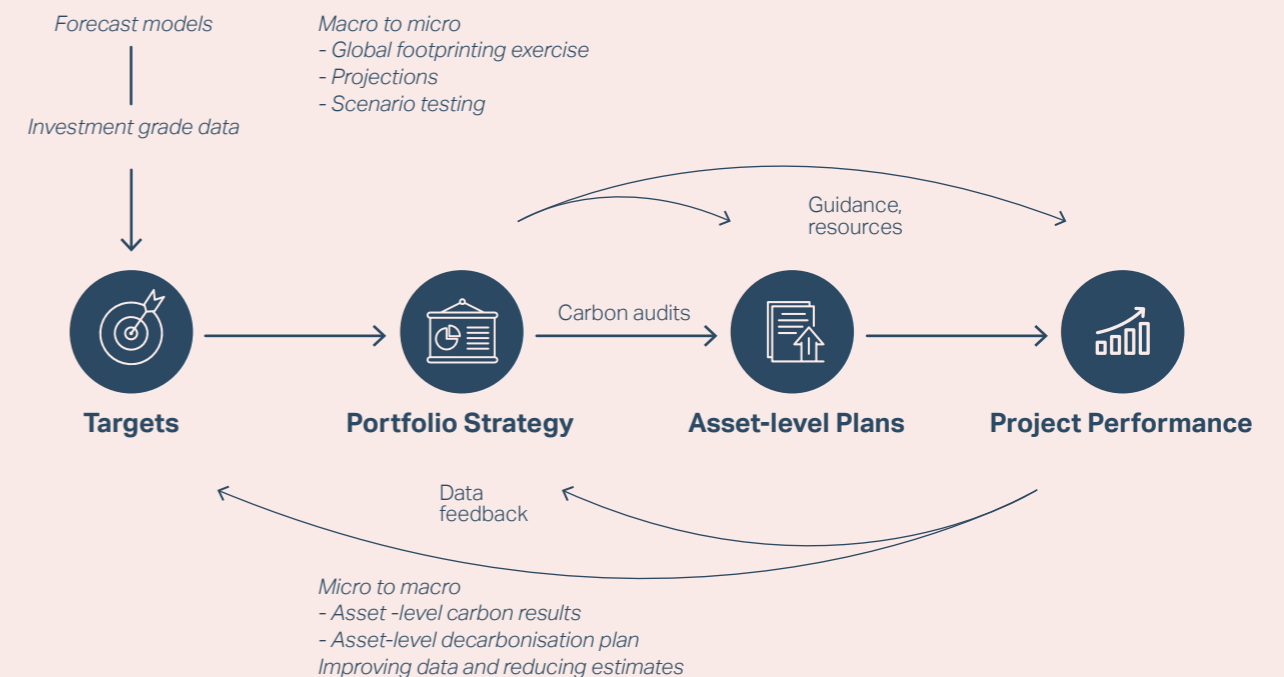
Actively engaging asset managers in platform maintenance means that data that might have been siloed or disaggregated is now readily available

and embedded into asset management decision-making. "Our programme seeks to empower asset managers by creating new feedback loops, allowing them to understand the sustainability performance of their asset and link this understanding to business decision-making." Hala explains, continuing: "If sustainability initiatives are not aligned with the business plan of an asset they remain theoretical. It's been key for us to align work of asset teams to the sustainability objectives of the organisation."

Critically, managing environmental data in this way supports accuracy and precision when it comes to actioning decarbonisation across the portfolio in order to meet Oxford's 2050 net zero target.

Asset managers are ultimately key players when it comes to meeting these performance objectives, particularly as sustainability needs and expectations continue to evolve. With their ongoing work at Oxford Properties, Hala's team seeks to empower the asset teams to meet these evolving needs and their goals.

### Oxford Properties' 'Five-step approach to decarbonisation'



#### Model/forecast carbon emissions data

"We are modelling and forecasting carbon emissions data for our portfolio to inform asset-level decarbonisation plans for acquisitions, new developments and existing buildings. This will inform how our carbon emissions could trend down over time across markets and sectors."

#### Acquire investment grade energy and carbon emissions data

"We are actively working to improve our data quality and coverage to understand the footprint and energy ecosystem of each building. We have introduced a common ESG data platform and integrated data-sharing clauses into green lease agreements with our customers."

#### Develop a portfolio-level decarbonisation strategy

"We have begun leveraging the outputs from our carbon emissions models to identify areas of focus for our portfolio-level decarbonisation strategy. This will inform a macro approach to portfolio-level carbon emissions monitoring."

#### Perform asset-level carbon audits and design asset-level decarbonisation plans

"We have begun conducting asset level carbon audits to inform our overall strategy and ensure asset-level decarbonisation plans are rooted in the individual reduction potential of each property. We will leverage the data insights to prioritise opportunities for the greatest impact."

#### Implement asset-level decarbonisation projects

"Our property teams will implement the asset-level decarbonisation plans and report on asset energy and carbon emissions data and progress toward asset carbon reduction targets."

# Pathways

## How Organisations have Responded to the Challenge

In response to evolving legislation, funding and investment landscapes, organisations seek to publicly document a shift towards 'net zero.' **Finding robust tracking mechanisms** and KPIs to ensure follow-through remains tricky but several UK organisations are proposing tangible ways forward.



**University of Cambridge Goals<sup>47</sup>**



**Imperial College London Goals<sup>48</sup>**



**GSK's Goals<sup>49</sup>**



**The Institute of Cancer Research's Goals<sup>50</sup>**



**The Pirbright Institute's Goals<sup>51</sup>**

	University of Cambridge Goals <sup>47</sup>	Imperial College London Goals <sup>48</sup>	GSK's Goals <sup>49</sup>	The Institute of Cancer Research's Goals <sup>50</sup>	The Pirbright Institute's Goals <sup>51</sup>
<b>Overall Emission Reduction Goals and Net Zero Targets</b>	Reduce total scope 1 and 2 carbon emissions to absolute zero by <b>2048</b> .	To be a sustainable and net-zero carbon institution by <b>2040</b> .	80% absolute reduction in greenhouse gas emissions by <b>2030</b> .  By <b>2045</b> , reduce carbon emissions by at least 90%.	Reduce carbon footprint by 50% by <b>2030</b> and net zero by <b>2040</b> .  Reduce our carbon emissions from buildings by 42% by <b>2030</b> and 90% by <b>2040</b> .	Achieve net zero for carbon emissions by <b>2040</b> .  <i>The Pirbright Institute's net zero targets align to the UKRI Environmental Sustainability Strategy.</i>
<b>Energy</b>	Reduce energy-related emissions to absolute zero, for scope 1 and 2 emissions, by <b>2048</b> .	To achieve carbon neutrality for Scope 1 and 2 emissions by <b>2040</b> .	100% imported renewable electricity by <b>2025</b> . 100% renewable electricity (imported and generated) by <b>2030</b> .	By <b>2030</b> , ensure universal access to affordable, reliable, and modern energy services.	
<b>Travel, Transport, and Waste</b>	Reduce corporate travel emissions by 25 percent by <b>2024/2025</b> .  Recycle 80% of materials in <b>2023</b> .	Reduction in carbon emissions from air travel by 25% by <b>2026</b> against the baseline year 2017–18.	Zero operational waste including eliminating single-use plastics by <b>2030</b> .	Reduce waste by 4.2% per year until <b>2024-25</b> and to recycling at least 50% of site waste by the end of <b>2025</b> .  Reduce the carbon intensity of commuting by 4.2% per year.	
<b>Scope 1, 2, 3</b>	Developing science-based targets for Scope 3 emissions, addressing emissions from purchased products, travel, transport, and waste. These targets are under review.	Reduce total Scope 1 and 2 carbon emissions from energy consumption by 15% by <b>2025–26</b> .  Achieving carbon neutrality for Scope 1 and 2 emissions by <b>2040</b> .  Increase procurement of sustainable supplies and services.	Net zero greenhouse gas emissions across our full value chain by <b>2045</b> . 90% absolute reduction in emissions from a 2020 baseline, across all scopes and all residual emissions neutralised.  10% waste reduction from our supply chain by <b>2030</b> .	Expect that 100% of their suppliers will be aligned with their Net Zero target by <b>2030</b> .	

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# 02. Organisational Change

## 02. Organisational Change

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# Introduction

## *The Organisational Challenge*

The climate impact of labs is becoming a hot topic amongst scientists – **especially younger researchers**. Addressing their concerns can be key to making changes in the lab while enhancing employee engagement and retention.

### **Scientists care about the environment**

In all labs we visited during our research, we met with people who were worried about global warming and climate change. These people came from all levels of their organisations but shared a sense of urgency around the climate challenge along with a keen awareness of the outsize environmental impact of laboratories.

Motivations for caring about the environmental impacts of their work varied. One lab scientist offered a lifelong commitment to the environmental cause instilled by a parent, another professed a love of nature borne from outdoor hobbies, others again described receiving a “wakeup call” when having kids and thinking about the world they would inherit. Many simply agreed that the environmental challenge was important and tackling it in line with the values that had made them become scientists in the first place. As one science lead told us: *“It is the right thing to do. Our scientific purpose is to help combat human diseases through research. If we don’t try and reduce our environmental impact in our research then we are contributing to the climate crisis and adverse impacts to those around us.”*

### **Challenge and opportunity**

There is little existing knowledge on how the outsized environmental footprint of laboratories impacts the motivations and well-being of the people working in science. Our qualitative research with more than 50 respondents indicates that environmental concerns and even climate anxiety is becoming a topic of concern for scientists – especially younger scientists.

From our interviews we can see a pattern of both engagement and frustration around the climate agenda – engagement coming from a sense of urgency and importance, frustration arising when perceived values of the workplace do not align with private concerns about the environment.

Through our research, we have seen examples of this concern and frustration leading to disengagement and even some cases of scientists quitting their jobs. However, we have also talked to many engaged scientists and seen real ingenuity and pride in driving through change – indicating that decarbonising labs is not only ‘the right thing to do’ but also represents an opportunity to engage science workers by helping them act on what matters to them.

### **Leveraging organisational diversity**

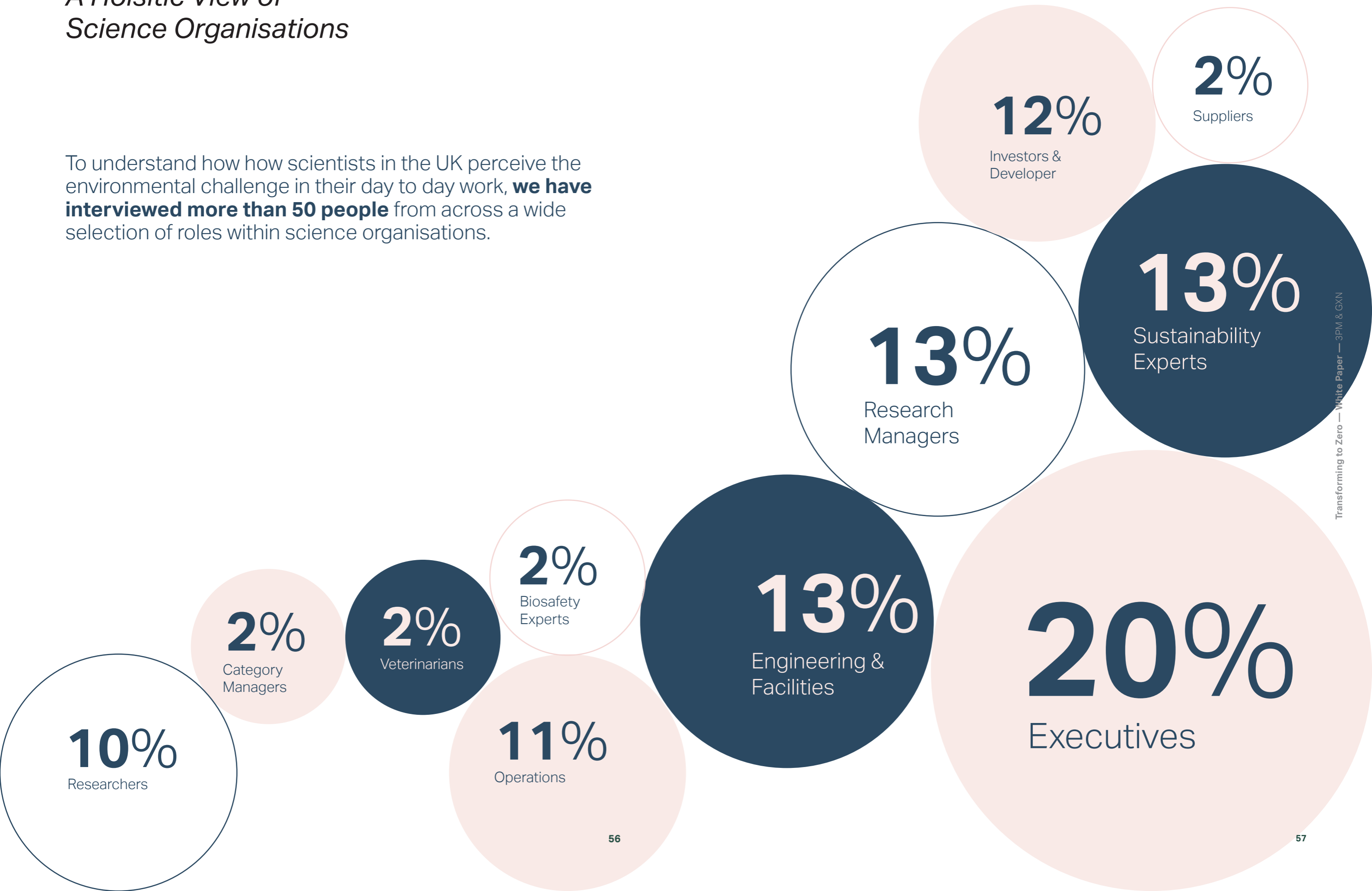
Bold and visible leadership is essential - but leaders must recognise that even small institutions are not monolithic entities but contain a mix of organisations, practices and people. In this diverse landscape, a top-down approach cannot stand alone. As one scientist explained to us, they were longing for more backing from the institute’s leadership, whom they respected highly, but in the same sentence, they emphasised the collaborative approach to sustainability they were taking in their lab and how proud they were to be working together in this more egalitarian setting. A multipronged organisational approach should recognise this multiplicity, enabling teams to assemble a portfolio of approaches with multiple points of entry, where each participant can contribute in ways matching their opportunities and wishes.



## Introduction

### *A Holsitic View of Science Organisations*

To understand how how scientists in the UK perceive the environmental challenge in their day to day work, **we have interviewed more than 50 people** from across a wide selection of roles within science organisations.



# Climate Engagement

## Growing Amongst Lab Workers

Addressing the concerns of climate conscious scientists can be key to making changes in the lab while **enhancing employee engagement and retention.**

### Greta Goes to the Lab

While we found engagement around climate issues across all professional levels and age groups in our interviews, there was broad agreement that this was particularly strong amongst younger scientists. This may not be surprising. Climate change is a major concern for younger employees across sectors – and science does not appear to be any different.

Consider, for example, the student campaign group People and Planet's University League, which ranks universities according to climate and ethical performance in a yearly updated table that awards ambitious moves and reveals laggards.<sup>1</sup> A similar concern was borne out from our research, where predominantly younger people felt the biggest alarm about global warming and climate change.

### From climate concerns to climate anxiety

Our research indicates that climate concerns and anxiety are growing amongst lab workers. If unchecked, these concerns can become driving factors for dissatisfaction and disengagement. For many of the lab workers we spoke to, it was becoming a challenge to reconcile their private concerns about the climate with the demands of their professional work in the lab.

Especially younger people professed a growing unease going about their day-to-day work with an acute awareness of the devastating effects of climate change and environmental degradation resulting from this very work. As one postdoc told us: *"you look at how much plastic we go through, and then at the same time your parents are doing the*

*whole reusing of plastic bottles thing, and you just have to hang your head in shame."*

In one case, this constant misalignment of private lives and professional concerns had led to an early career scientist being diagnosed with climate anxiety, and seeking clinical treatment for their condition. Climate anxiety goes beyond the worry about the environment that many share to become a deep distress about climate change and its impacts. This can manifest as intrusive thoughts, feelings of distress and symptoms such as heart racing and shortness of breath.<sup>2,3</sup> For the person in question, this experience had them questioning how they could find ways of getting more involved in day-to-day activities to improve environmental performance and help reduce this anxiety:



I've been diagnosed with **climate anxiety** since 2018. So I've had to do CBT therapy and take medication and stuff like that. I mean, the more that you can get involved in things that would help.

Postdoc Researcher



### Generational attitudes quantified

Quantitative research from Deloitte<sup>4</sup> confirms that concerns about climate change have a major impact on younger people's decision-making, including career and workplace choices.

Young people are taking action on climate change, with seven in 10 respondents saying they actively try to minimise their impact on the environment. Financial concerns may put a dampener on these efforts; more than half of respondents think it will become harder or impossible to pay more for sustainable products and services if the economic situation stays the same or worsens.<sup>5</sup> With this in mind, being able to effect change through ones work could take on importance.

In fact, younger people are demanding greater climate action from their employers, the research concludes, and believe some have failed to prioritise sustainability strategies even as the effects of climate have become more obvious. They see a critical role for employers to lead the way within their field and for them to provide the necessary skills training to prepare the workforce for the transition to a low carbon economy.

# 20%

of **Gen Zs** express climate change as their top societal concern.

# 21%

of **Millennials** express climate change as their top societal concern.

# 34%

of **Millennials** are willing to turn down employers that do not align with their values.

# 39%

of **Gen Zs** are willing to turn down employers that do not align with their values.

Deloitte, (2023). The Deloitte Global 2023 Gen Z and Millennial Survey. Deloitte.

# Climate Engagement

## Bridging Professional and Personal Values

It can be challenging for scientists practicing climate-friendly habits at home to witness how laboratory work results in **substantial energy consumption, carbon emissions, and waste production.**

### **Labs are naturally energy-intensive**

A single ultra-low temperature (ULT) freezer uses roughly three times as much energy as one family home.<sup>6</sup> Fume hoods, ubiquitous in labs, are also heavy hitters. The energy consumed by a single fume hood in a year can be 1 to 3.5 times that of the average residential home.<sup>7</sup> In addition, it is estimated that laboratories generate 2% of all plastic waste worldwide,<sup>8</sup> which did not seem to come as a surprise to any of the scientists we interviewed:



We use a humongous amount of plastic **but when I go home, I go to great lengths to recycle every single big bit of waste** that I come across...

PHD Student



Laboratories throng with energy-hungry equipment, elaborate experimental processes, single use plastics, and noxious chemicals and gasses. Work at the lab bench is understandably regulated by strict health and safety guidelines and well-defined standard operating procedures. However, these rarely include a perspective on sustainability and the environment.

### **Outsize impacts may be an outsize opportunity**

It is no wonder, then, that scientists profess to be confounded by the gap between their private concerns about the climate and day-to-day work in the lab. However, for people working in and around labs, making a meaningful change in the way they carry out this work may be where their actions can have the biggest impact towards reducing climate change. It has been estimated that scientists' actions in the lab can have up to 125 times higher impact on the environment than actions at home.<sup>9</sup>

For example, changing the setpoint of an ULT freezer from -80 to -70 °C can save an average of 1 tonne of CO<sub>2</sub> per year,<sup>10</sup> equivalent to going vegetarian for 138 meals or skipping a flight from Paris to New York. Considering the number of freezers and other energy hungry kit in labs, even a few choice decisions and actions can have large effects beyond the reach of any individual in their private lives.

### **It remains tricky to do something about it**

The most environmentally engaged scientists we spoke to were keenly aware of this potential and actively seeking to find ways to improve their organisations' climate footprint. However, our respondents often professed frustration with the rate of change and the perceived lack of backing and engagement from the wider organisation. As one scientist told us: *"We try to identify small steps that we can easily change in-house, making a difference and raising interest among our colleagues - which I think is the most challenging thing to start with. Once all of us are engaged, then it becomes easier."*

From our interviews, we can identify a pattern in the key barriers these engaged scientists run up against, namely:

- 1. lack of dedicated time to drive through change as initiatives happen on top of existing workload;**
- 2. perceived lack of interest and backing from co-workers and the wider organisation;**
- 3. lack of specialist knowledge to evaluate decisions based on environmental impacts;**
- 4. lack of organisational pathways to scale solutions from pilots to business-as-usual.**

### **From concern to disengagement**

Climate concerns and climate anxiety can worsen wellbeing at work. If these feelings are in part caused by the workplace itself, they can also lead to disillusionment and disengagement in the workplace. Global research firm Gallup defines employee engagement as the involvement and enthusiasm of employees in their workplace.<sup>11</sup> The way a company or organisation treats its employees, and the way employees treat each other, can have positive or negative effects on their engagement and actions. In our research, science researchers expressing frustration with the climate actions of their organisations shared a feeling of isolation around their concerns and ideas. Not being able to recognise a sense of shared purpose or commitment from leadership and a perceived lack of support in implementing ideas means that people see little opportunity for change around a subject that matters deeply to them. This is a clear driver of workplace disengagement.



## Case Study:

### Building a Culture of Sustainability, Emma Nye, The Francis Crick Institute

The role of the leader is pivotal in **driving positive environmental change** in research settings, supporting researchers in implementing ideas, and acting as a backstop when others are too busy for taking on key tasks.

Emma Nye is the Head of Experimental Histopathology at The Francis Crick Institute, where she leads the research and operations of a histology-based lab where tissue processing, microscopy, and other histological procedures are conducted. Emma's story exemplifies the transformative power of leadership in promoting sustainability in her team. Through her dedication, vision, and collaborative approach, she has not only initiated meaningful change within her own lab, but also inspires a broader culture of sustainability within the Institute and wider scientific community.

#### Engaging the Team

Emma's leadership style focuses on fostering collaboration and empowering her team members. Despite having limited resources and navigating some resistance to change, through open discussions and idea-sharing sessions, she encourages her team to contribute suggestions and initiatives for sustainable research practices. This inclusive approach not only generates innovative ideas, but also instils a sense of ownership among her team members, Emma explains: *"We talk about sustainability, we share ideas. We are all very proactive about doing these things, allowing me to push people on whether they have done their actions, asking for follow ups in lab meetings, and so on."*

Emma showcases ideas in presentations and talks, and invites speakers and experts to share insights and collaborate on sustainability initiatives.

#### Initiating Change

Personally passionate about mitigating the effects of research practices, Emma has taken proactive steps to integrate it into all aspects of her lab's culture. Inductions and weekly lab team meetings have a dedicated section on sustainability, making it an integral part of regular discussions: *"It's something we talk about every week. And so therefore it's just what we do, it's on our minds and people come up with ideas."* By consistently highlighting sustainability issues and encouraging participation at all levels, Emma has ensured that her team remains engaged and proactively pursue energy and waste reduction measures. Emma's efforts have led to her lab receiving accolades such as the Green Impact Gold Award and LEAF certification.

**"We worked out that each cassette weighs 2.4 grams, the average plastic container was 10 out of the different sizes that we measured. And we have 13,000 samples processed in one year. So that would have been 130 kilograms of plastic saved."**

Emma Nye, The Francis Crick Institute

“

We do a lab induction for every new person. And in that induction we have a section on sustainability. We talk about all the initiatives. **We talk about the reason we're doing it** and trying to get people on board and ask them for feedback to make it even easier. Like what could make this easier for you.

Emma Nye, The Francis Crick Institute

#### Institutional Advocacy

Emma actively advocates for sustainability initiatives at the institutional level within the Crick. She collaborates with the sustainability task force along with volunteers from various other teams who are committed to driving systemic change beyond the confines of their own lab. The task force facilitates cross-departmental collaboration and knowledge-sharing, fostering discussions and sharing of insights from each lab's sustainability initiatives.

#### Consumables Usage

Emma's team is always looking for ways to reduce their single-use plastics and optimising consumables usage. One notable initiative involves transitioning from opt-in to opt-out practices for the use of

plastic tissue processing cassettes, effectively streamlining the workflow and reducing unnecessary plastic consumption. By automatically printing FFPE processing cassettes and encouraging direct sample collection into cassettes, the team have successfully eliminated the need for intermediary plastic tubes, significantly reducing plastic waste generation in their lab. The team manages a shared server where everyone can save documentation about products they consider unsustainable, enabling the team to go back to suppliers and ask whether they have more fitting products or smarter packaging.

#### Energy Reduction Measures

Under Emma's guidance, the Histopathology lab has implemented various energy-saving practices, such as end-of-day and holiday shutdown routines and optimising equipment settings to promote responsible resource usage. The team were quick to reduce the set points of ultra-low temperature freezers and have also compacted samples to reduce the total number of freezers required in the lab. With conscientious management of lab equipment, including desktop computers, cryostats, and microscopes, they encourage staff to switch off or reduce energy consumption on equipment when not in use. By implementing automated shutdown systems where feasible, Emma's team has effectively reduced standby power consumption, leading to tangible energy savings. They conduct energy audits to identify areas for improvement and invest in energy-efficient appliances and lighting fixtures where possible.

# Climate Engagement

## Touchpoints for Change

Culture and values are built through day-to-day practice. If scientists do not meet climate values in their work at the lab bench, they **may question whether the organisation is doing anything meaningful to change.**

### **An education in what matters most**

Finding ways to bridge the gap between high-level climate pledges and day-to-day operations in the lab was a challenge in most of the organisations we talked to. Addressing this challenge will be important to secure employee motivation and engagement around plans for transforming to zero.

When young scientists enter labs as part of their research or early career development, they receive an induction on how to do things in ways particular to the organisation and research group they join:



... it's almost like a **micro apprenticeship**, that you're working in their ways. And they'll show you their ways of doing something and then you emulate it.

PhD Researcher



Participating in supervised daily activities helps new employees gain knowledge of how to set up research and experiments, as well as lab-specific ways of dealing with equipment, consumables and handling of waste, amongst many other things. This is not just a practical induction, but also an education

in which values are important in the lab – they might not be stated explicitly but will be imparted through the multitude of contextual and social cues people meet in this process.

### **Seniors teach norms**

To drive through successful environmental and behavioural change, organisations must implement practices that can help deliver on the expectations employees have of them. By considering the touchpoints where new and existing employees are presented with knowledge about how to do things in the lab, we can identify prominent points for introducing climate-conscious values and behaviour.

These touchpoints include training exercises and standard operating procedures, already codified attempts to capture workplace culture that can allow for additional focus on environment and climate conscious actions. They also include how lab managers communicate about the priorities and work in individual labs, and how technical lab managers inform the use and setup of equipment.

According to Gallup's findings on workplace engagement, managers and team leaders account for 70% of the variance in team engagement.<sup>12</sup> Considering the many explicit and implicit cues they impart as part of induction and day-to-day work, research leads and lab managers hold one of the most immediate opportunities to effect change and improve employee engagement around decarbonisation agendas. But they require help and backing from leadership to do so efficiently.

## Actions Inside the Lab

### Informing Lab Managers

Lab managers set tasks and projects for new scientists and are vital in setting the climate transformation agenda:

- **Provide with knowledge and training on how to support new scientists with sustainable practices**
- **Support to become climate leads, acknowledging the importance and balance between science goals and carbon goals**

### Informing Technical Lab Managers

Technical managers teach how to use lab equipment properly. They can help impart an understanding of impacts of each machine and their best usage:

- **Provide with knowledge about impact and optimised use of lab equipment so new scientists receive the same knowledge**
- **Support in engaging and challenging scientists to update high impact research practices**

### Early Induction & Ongoing Training

Often on or before a new scientist's first day, there is a training process, and a first impression of a company's carbon mindset and approach:

- **As a first and lasting impression, emphasise in all induction processes the importance placed on sustainable practices**
- **Reiterate the importance of climate conscious practices in all ongoing training**

### Standard Operating Procedures Changes

SOPs outline the practices within the lab and are often outlined to scientists on day one by the most experienced scientist:

- **Curate a considered SOP introduction and include climate conscious advice in these**
- **Identify big impact, low risk changes within the SOPs and do the experiments needed to validate that changes won't adversely impact the science.**

# How to Lead Organisational Strategies

Leaders play a critical role in formulating and implementing plans to decarbonise laboratories and have the power to **inspire their wider organisations.**

Across all our interviews, climate leadership was a recurring theme. This highlights the critical role of leaders in the transition towards decarbonisation of laboratories. Becoming a climate leader in the laboratory is not just a moral imperative, but a strategic move that positions laboratories to thrive in an increasingly sustainability-conscious world.

To be efficient, climate leadership must show tangible and proactive steps towards decarbonisation and sustainability. The executive teams and lead scientists in laboratories are crucial – without their active and ongoing buy-in and support, the rest of the organisation will find it hard to scale up change. However, climate leadership can (and should) happen at all levels in an organisation and entails a deep sense of responsibility towards the environment, employees, clients, and wider stakeholders. Informed by this sense of responsibility, the climate leaders will seek to find ways of improving the environmental performance.

Climate leaders must find ways of bringing together scientific, economic, and environmental goals of their organisations. By acknowledging their impact on the environment and taking specific steps to mitigate it, leaders demonstrate their commitment to the wider organisation. This requires turning high levels goals and pledges into tangible actions.

Effective sustainability reporting enables leaders to assess and manage these risks strategically. By prioritising and reporting on these issues, leaders can not only fulfil their ethical responsibilities,

but also unlock numerous benefits for their organisations and the world at large.

In the remainder of this chapter, we outline six interconnected steps climate leaders can take in seeking to drive through sustainable change in their organisations.

In an increasingly climate-conscious world, the organisations that successfully embrace climate change action and sustainability will gain a competitive advantage by demonstrating leadership. As we have seen from our interviews this is also crucial for attracting and retaining the best scientific talent, as particularly younger scientists are looking actively for organisations that align with their values and show leadership in transforming to zero.



## 01. Set out and Connect People with a Vision

Outlining a company-wide vision should encompass the strategies, actions, and communication required to empower lab leaders and their teams with a sense of purpose and the license to act on their values.



## 02. Appoint Dedicated Climate Champion(s)

A leader with extensive knowledge of both laboratory practices and a deep understanding of carbon-related issues can bridge the gap between science and sustainability.



## 03. Align with Recognised Programmes

Recognised standards and programmes targeting decarbonisation of laboratories can provide climate leaders with crucial guidance on which initiatives and activities to undertake to enable buy-in and change.



## 04. Set up Efficient Climate Task Forces

Climate task forces with adequate mandate and backing from senior leadership can identify viable actions and strategies and spearhead change. Funding and executive representation is key to this.



## 05. Experiment then Scale

Successful climate leaders identify and scale tested carbon initiatives. They commit to proven initiatives and attract further financial support to ensure the widespread adoption of sustainable practices.



## 06. Keep the Conversation Going

Keeping climate concerns top of mind and celebrating carbon milestones is essential to acknowledge progress, boost motivation, and inspire continued efforts in the fight against climate change.

# How to Lead

## 01. Set out and Connect People with the Vision

A **clearly defined vision** must lay out the aspiration to achieve net zero carbon emissions as well as specific milestones, strategies, and actions required to get there.

### **Climate leadership from the top is crucial**

Becoming a climate leader is a strategic move that can position laboratories to thrive in a climate-conscious world. Driving through decarbonisation ambitions requires significant organisational changes. Executive teams, lab leaders and managers must be at the forefront of these changes, setting out a direction and guiding their teams through the process. This was recognised by all the scientists we spoke to. Many emphasised the respect they had for their seniors, often leading scientists in their fields, but as one science lead also said when describing a lack of climate leadership: *"I felt like I was banging my head on a brick wall you know, we have no support."*

### **Provide people with a vision, lead from the front**

Executive teams and lab leaders must not only articulate clear climate visions but should communicate these visions effectively throughout their organisation. By defining and owning the vision, leaders can inspire employees, provide engaged scientists with the licence to pursue change, push supply chains, and engage stakeholders. Setting out a climate vision for laboratories involves defining tangible and meaningful actions, which includes:

1. identifying how decarbonisation efforts align with the laboratory's targeted scientific, commercial, and cultural outcomes;
2. specifying behaviours that need to change or be embraced, clarifying who within the laboratory must undertake these changes;
3. recognising the prevailing conditions that require modification throughout this transformative process and keeping focus on the transition.

### **Enable a collaborative approach**

Lab leaders can collaborate with sustainability experts, supply chains, and stakeholders to develop sustainability strategies that align with their institution's broader scientific and environmental goals. This might involve reevaluating research methodologies to prioritise sustainability, investing in energy-efficient equipment, and implementing green procurement practices. By doing so, they play a crucial role in re-orienting the company's vision towards a more climate-conscious and sustainable future. Collaboration also entails creating the conditions and support within an organisation for the more engaged employees to take on responsibility for implementing change where they can.

### **A compass not a map**

Successful climate change mitigation in laboratories hinges upon proactive leadership, where lab leaders and managers act as pioneers of change. However, while top-down directives can be effective to some extent, true sustainability transformation comes from aligning lab workers within the organisation with the vision of a low-carbon future.

This shift underscores the necessity for laboratory leaders and managers to pave the way with a carbon vision that serves as the guiding 'compass' heading rather than a rigid 'map' that in worst cases can inhibit individual ingenuity. As the landscape around transforming to zero is growing more acute and more unpredictable, a clearly defined and well-communicated compass heading enables decentralised action at all levels in an organisation.

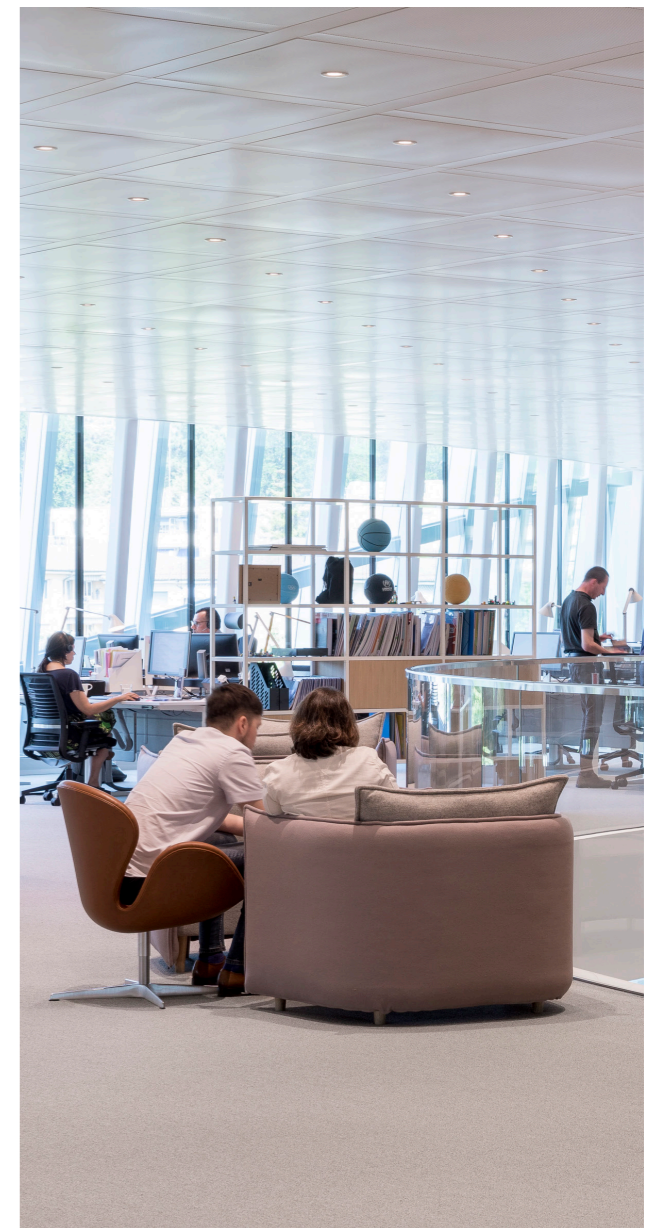
By fostering a culture that encourages innovation and experimentation to reduce carbon footprints, executives and lab leaders can set the stage for the organisation to achieve its net zero ambitions while employees thrive. To do so, lab leaders must lead by example and ensure that climate goals are not just written statements but are actively integrated into the daily operations and communications of the laboratory. In doing so, they lay the foundation for a sustainable and environmentally responsible future, ensuring that their laboratories are not just places of scientific discovery but also hubs of climate action and responsibility.

“

**It needs to come from the top down,** not necessarily the ideas of the initiative, but at least a strategy. 'This is what it is. These are our targets.' This would allow us to come up with ideas on how to get there.

”

Lab Manager



# How to Lead

## 02. Appoint Dedicated Climate Champion(s)

A climate champion with practical knowledge of lab practices and a **deep understanding** of carbon-related issues can **build momentum** around strategies while helping teams evaluate ideas and scale solutions.

### **Bridging science and sustainability**

Appointing a dedicated climate champion with expertise across laboratories and sustainability can be a highly effective way to drive meaningful change in climate initiatives within laboratories.

Most of the scientists we interviewed, told us in various ways that it is necessary to have someone with responsibility and mandate to pursue change. The nature of scientific research, requirements to lab work, and wider institutional and organisational concerns means that change can be difficult. As one climate-conscious scientist told us: *“There’s no fast track and unless you are very persistent, like a number of people are getting to be here now, you probably would have given up on the first hurdle.”*

Prerequisite for a good climate champion or team is the knowledge, ability, and backing to successfully navigate the worlds of both science and science organisations.

### **The champions are there but require support**

In the labs we visited we saw varying degrees of formalisation of this role, but even in labs where the role was not officially enshrined, some form of climate champions had stepped in to try to steward decarbonisation efforts.

However, due to the challenges outlined above, the more formal the role and clear the backing from the executive leadership team, the more these people were able to achieve transformation at scale (see p. 76-77).

### **Driving through change requires dedicated time**

A climate champion can serve as a central point of authority and responsibility for the organisation, driving forward initiatives while evaluating proposed climate actions for impact and feasibility.

This requires time set aside for doing so. A person – or small dedicated team – with time set aside to develop practical input to transition strategies will be able to seize on opportunities for sustainability improvements, such as optimising energy use, reducing waste, and adopting greener technologies.

In addition, a climate champion can develop and implement strategies to track the organisation’s carbon footprint, incorporating best practices to ensure greater transparency. If allowed the time, this champion can also stay informed of emerging carbon regulations and incentives, ensuring that the organisation remains compliant and seizes opportunities for cost savings and reputation enhancement.

By serving as a one-stop shop for knowledge around the transition they can share knowledge to support active and engaged researchers in implementing their ideas. Combining expertise in lab practices and carbon management, this champion can guide the organisation towards a more sustainable, environmentally responsible future. Their leadership can break down silos, secure funding, and drive the cultural shift needed to instil real change in addressing climate-related challenges.



“

Someone actually has to have the seniority to say, **this will be implemented from now on**, because I send the emails, you know, inviting people to join the initiative but it is not enough.

Research scientist

”

# How to Lead

## 03. Align with Recognised Programmes

Understanding where to start and how to prioritise efforts can be a challenge. A number of initiatives are seeking to address that with **standardised decarbonisation and sustainability schemes for labs.**

### Where to start

Many of the people we spoke to professed to be confounded at times by the size and unwieldiness of the decarbonisation challenge. Understanding where to start, how to identify key impact areas, and how to evaluate the relative merits of different initiatives can all seem like insurmountable tasks at times. As one early-stage researcher who had volunteered to take on sustainability responsibilities told us: *"I've been looking at sustainability, but I can't find any documentation. I'm just one person and I'm finding it really difficult to do anything or come with any ideas because of the way things run. I'm a bit lost."* When we returned to do follow up interviews, this person had quit their job.

### Tapping into existing knowledge

It should be clear that organisational backing and support is crucial for sustainability champions and task forces to be able to do their job in a meaningful way. But practical knowledge and support on how to drive through initiatives is also an important prerequisite for success.

One way to deal with this, while also ensuring that efforts align with best practices, is to align with recognised standards and programmes for how to consider decarbonisation of laboratories. Rather than starting from scratch these programmes have already collected overviews of best practices and step by step approaches to implementing them in individual labs.

### Third party verification

By providing standardised frameworks for initiatives and offering guidance on their implementation, these programmes can help establish confidence for climate champions and task forces worrying about whether they are doing the right thing. These programmes can provide third party verification of efforts, and a recognised standard to display adherence to. This supports impactful communication about the organisations progress and commitments, and as discussed can also support attracting and retaining highly qualified research talent, who are increasingly seeking out organisations that share their values.



We kind of got stuck in this **perception loop** where whenever we come up with something, they'll say 'oh well the institute's reputation is at stake' - surely our **green reputation** is just as important.

Technical manager



## Case Study: Sustainability Programmes for Labs



**The Science-Based Targets Initiative (SBTi)** provides organisations and companies with a defined path to reduce emissions in line with the Paris Agreement goals. When a company submits a target, the SBTi Target Validation Team assesses it to ensure that it conforms with SBTi Criteria and is aligned with climate science. If the target is in conformance, it is validated and marked on their Target Dashboard as 'Targets set'. Following approval, companies are required to disclose emissions annually and monitor progress on reaching their target.



**My Green Lab** is a non-profit organisation committed to promoting sustainability in science with a focus on reducing environmental impacts of laboratories and research facilities. My Green Lab advocates for sustainable practices through certification programs, partnerships, and education. They offer a My Green Lab Certification scheme providing science teams with support and actionable ways to make change. To date, My Green Lab has supported over 2,000 labs in a range of sectors.



**The ACT Environmental Impact Factor Label**, developed by My Green Lab, ACT is designed to help scientists and procurement specialists make informed, sustainable choices by offering third-party verified data on product impacts through Accountability, Consistency, and Transparency (ACT), also known as the Environmental Impact Factor (EIF) criteria. ACT-labelled products undergo rigorous audits, promoting continuous improvement and sustainability in the life sciences industry.



**The Laboratory Efficiency Assessment Framework (LEAF)** developed by University College London, LEAF contains actions which lab users can take to save plastics, water, energy, and other resources. By taking part in the programme, laboratories will reduce their carbon emissions and create an environment that supports research quality. Laboratories are awarded either a Bronze, Silver or Gold level depending on their sustainability actions. Laboratories may estimate the impact of their actions in both carbon and financial terms, using LEAF's inbuilt calculators.



**Green Impact** is an award-winning sustainability program operated by Students Organising for Sustainability (SOS-UK). It is designed to foster environmentally and socially sustainable practices within organisations through employee engagement and structured action. This program helps visualise and implement sustainable practices by providing a bespoke online toolkit tailored to the specific needs and context of each participating organisation.

# How to Lead

## 04. Set up Efficient Climate Task Forces

Many science organisations are establishing dedicated climate task forces. Getting the setup of these task forces right is key to **avoiding them being merely talking shops.**

### Task forces with teeth

In our research, we have seen how volunteer climate task forces within scientific organisations encounter challenges that can hinder their ability to bring about substantial change: *"We got a [task force] but the emphasis is on us to create the ideas, it is not driven by anybody, sometimes we meet and there are no suggestions, it reports formally to no one... it places the emphasis on those ten people in that room to come up with a strategy for the whole organisation. We are all volunteers!"*

### Access to decision-makers

We have already touched on the need for dedicated climate champions to steer these task forces. Another key factor contributing to their failure is blocked pathways to decision-makers vested with the authority to institute change. Even when task forces have well-defined goals and a clear vision for addressing climate-related issues, the inability to reach decision-makers can obstruct progress. Without the engagement and support of key decision-makers, the task force may face insurmountable barriers, impeding the implementation of meaningful changes and undermining the effectiveness of their endeavours. Time seen as wasted without result can significantly impact willingness to volunteer time and lead to lack of belief in the organisation's vision and goals.

### Access to funding

Another primary impediment is the issue of insufficient funding for sustainable initiatives, constraining the group's capacity to execute ideas and initiatives that are raised within the

forum. While financial priorities for science and its supporting infrastructure will always be a pervasive challenge, having funding earmarked specifically for sustainable projects can provide the task force with the necessary resources to implement eco-friendly practices and contribute to long-term environmental solutions. A clear allocation of funds for sustainability not only addresses the financial hurdle but also signifies organisational commitment to environmentally-conscious efforts. Giving a route for ideas to become a reality provides great encouragement to those willing to give up their time to contribute and donate to these volunteer climate task forces.

### When it works

We have seen task forces with representation from senior leaders and access to earmarked funding drive through significant changes. Providing the most engaged employees with the support and means to spearhead decarbonisation and sustainability efforts should be a priority for any organisation wishing to transform to zero.



**We like to make a lot of noise, And if we're not getting heard, we have routes to bypass if we need to.**



Research lead

## Case Study:

### Initiatives & Programs that Make Change Actionable: ActNow

#### Engaging Researchers to ActNow

Lisa O'Fee, Sustainability Advisor at The Institute of Cancer Research (ICR), spearheads ActNow, the ICR's sustainability working group which provides an opportunity for all staff and students to play a part in driving sustainability. ActNow aims to drive the implementation of sustainability projects across the ICR including in laboratories, offices, ancillary areas. To do so, Lisa explains, the group acts as a consultative forum and responds to requests for support on new sustainability initiatives proposed by the ICR's Sustainability Advisory Group (SAG) and groups within the Estates and Facilities directorate. ActNow also seeks to encourage local managers and colleagues to implement/adopt sustainability measures including new ways of working and fostering a sustainability culture in their approach to scientific research. As well as communicating sustainability projects and initiatives to the ICR community in media formats that suit everyone.

**ActNow - 'provides an opportunity for all staff and students to play a part in driving sustainability at the ICR'**

## ActNow.

**ActNow the Institute of Cancer Research's sustainability working group aims to:**



Drive the implementation of sustainability projects across the ICR including in laboratories, offices, ancillary areas



Act as a consultative forum and respond to requests for support on new sustainability initiatives proposed by Sustainability Advisory group (SAG) and groups within the Estates and Facilities directorate



Encourage local managers and colleagues to implement/adopt sustainability measures & new ways of working and foster a sustainability culture in our approach to scientific research



Communicate sustainability projects and initiatives to the ICR community in media formats that suit everyone

# Case Study:

## Portrait of a Sustainability Leader: Lisa O'Fee, Institute of Cancer Research

Plain, efficient and targeted sustainability initiatives do not happen on their own. They require leadership and coordination. The value of having a central coordinator with deep knowledge of both science workflows and sustainability should not be underestimated.

### Leading Sustainable Science with Grassroots Insight

Lisa O'Fee has been working at the Institute of Cancer Research (ICR) for over 10 years, as Senior Scientific Officer within the Division of Cancer Therapeutics. Whilst in this role, she spearheaded many sustainable initiatives within the lab, including coordinating the "Freezer Challenge" across the ICR.

In 2023, Lisa says, she decided to dedicate her time fully to sustainability by completing an MSc in Sustainable Development at the University of Surrey and transitioning to a new role as Sustainability Advisor across the ICR. The founder and co-chair of ActNow, the ICR's sustainability working group, Lisa has been an integral part of the team that put together the ICR's sustainability action plan, 'Sustainable Discoveries'.

### My Green Lab Accreditations

In her new role, Lisa has spearheaded My Green Lab accreditations for scientists in the Centre for Cancer Drug Discovery to prove ICR's commitment to sustainability to all ICR stakeholders, including research partners and funders. Lisa explains that her team chose My Green Lab due to its alignment with drug discovery protocols in cancer therapeutics, providing structure in line with industry standards. My Green Lab requires a 50% participation rate amongst scientists in labs, and Lisa emphasises that the ICR's lab technicians and managers played a pivotal role in the certification process, with 97% of her colleagues in the Centre participating in the programme.

### Stakeholder Involvement in Improving Strategies

Lisa emphasises the importance of involving all stakeholders in the ICR's sustainability journey, including research teams, engineering, project and design teams, as well as health and safety teams. Integration of sustainable initiatives into funding partnerships for drug discovery and research collaborations with pharmaceutical companies is an ongoing strategy.

Initiatives for continuous improvement include waste audits, training sessions including modules on green chemistry; the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.

### Energy-Saving Strategies

Lisa's team constantly develop and review energy-saving strategies within their labs, focusing on understanding and reducing energy consumption of equipment, implementing air and power monitoring systems, and optimising equipment setpoints. Only 20% of ULT freezers at the ICR Sutton site are now set at -80°C, following a comprehensive process to reduce setpoints, whilst also rationalising storage density and logistics of samples.

### Sample Management

Proper inventory management, training on use and storage, and sustainability in research practices are important at ICR. Teams are made aware of the environmental impact of storing biological samples at different temperatures and the need for sustainable waste management solutions. FreezerPro software, a web-based sample management inventory system, is used to support the research teams with efficient inventory tracking, robust reporting capabilities, live and intelligent search capabilities, and audit trails to ensure data integrity. The ICR's "One Waste" initiative promotes recycling and reducing waste in the lab.

### Consolidation and Sharing

Lisa's teams endeavour to share resources and consolidate suppliers in order to reduce storage and waste. Grant restrictions on sharing of consumables can be a challenge, but can be overcome with a positive mindset to sharing and efficiency between teams.

### Sustainable Procurement

Sustainable procurement is one of the four pillars of Sustainable Discoveries, the ICR's action plan for how they will respond to the climate crisis and other sustainability challenges. The plan reflects how they integrate sustainability principles into their research and teaching practices. Procurement is an important factor of the plan as approximately 90% of the ICR's climate footprint is from Scope 3 emissions and, therefore, directly related to procurement. Lisa and colleagues promote sustainable procurement practices and training programmes, creating educational materials on sustainable practices for scientists, aiming to foster environmentally friendly choices in consumables and equipment.

In addition, the ICR are part of the Responsible Procurement Group (RPG), a collaboration of The Alliance for Sustainability Leadership in Education (EAUC) and HEPA (the network for procurement professionals in the HE sector) which was relaunched in May 2023. The purpose of the RPG is to identify, share and promote best practice on Responsible Procurement throughout the sector and to stimulate the development of resources, principles and guidance to support members on Responsible Procurement. Prioritisation of products with the ACT Environmental Impact Factor Label, shows researchers third-party verified information about the environmental impact of laboratory products.

### The Institute of Cancer Research's GHG Emissions

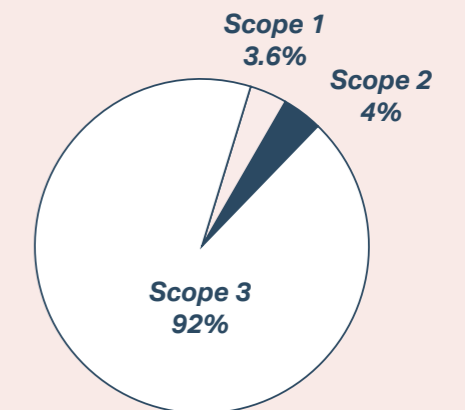
Total Academic Year 2021/22

**68,033 tCO<sub>2</sub>**

vs

Total Academic Year 2020/21

**69,865 tCO<sub>2</sub>**



#### Scope 1 - Directly controlled GHG emissions 3.6%

Gas consumption, fuel used in ICR owned vehicles, fuel for back-up electrical generators, refrigerant

#### Scope 2 - Indirect GHG emissions from purchased electricity 4.3%

Grid electricity

#### Scope 3 - Value Chain GHG emissions 92.1%

Purchased goods and services (97%), waste generated in operations, transmission and distribution losses from electricity, business travel employee commuting, water supply



Average UK resident  
= 11.7 tCO<sub>2</sub>e per year



Average ICR staff/student  
= 61.8 tCO<sub>2</sub>e per year

# How to Lead

## 05. Experiment then Scale

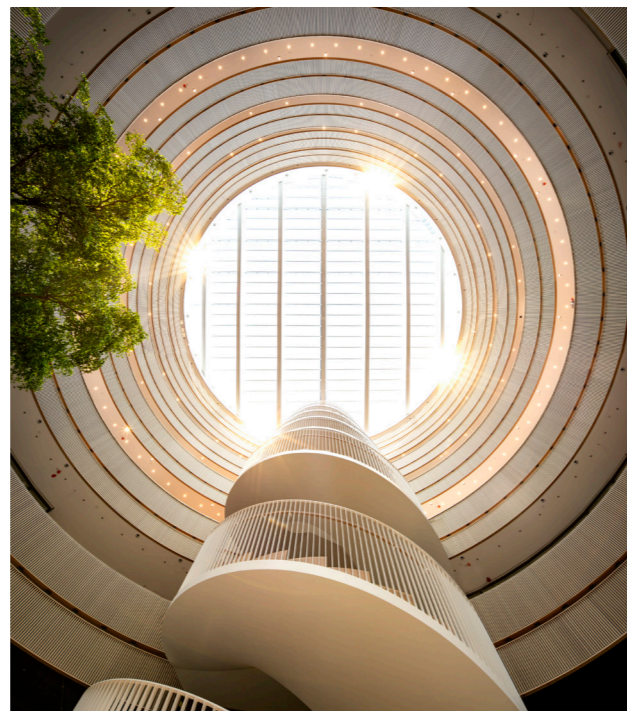
When first embarking on the journey to reduce carbon emissions in laboratories, it can be helpful to prioritise safe-to-fail changes and experiments. Once documented, these **can form the basis to roll them out at scale.**

### Experiment then scale

It can be hard to know where to start when seeking to implement activities to decarbonise laboratories. The challenge relates to the lack of overview over high impact equipment and processes described in these pages, but as many scientists also told us the challenge is further compounded by the in-built scepticism of science practices, where tinkering with proven experimental setups and health and safety guidelines is disapproved of.

We were often met with stories about this resistance to change, usually linked to comments about, 'it's the science above all', but also met scientists that were actively asking to be challenged by team members with better sustainability information. The scientists with results to show all told us stories of being willing to test ideas at smaller scale and through these tests produce the evidence required to convince sceptical colleagues.

By focusing on immediate, achievable actions and ensuring that these initiatives are within a manageable scope, laboratories can demonstrate tangible progress towards their carbon reduction goals, inspiring confidence and momentum for more ambitious sustainability efforts. This approach not only accelerates the laboratory's journey towards transforming to zero but also cultivates a culture of continuous improvement and adaptability, setting the stage for broader and more transformative changes over time.



Forskaren, 3XN/GXN



Once they've actually tried this and it worked for them they are happy to use it but it is getting them to try... **some of them are more receptive to change than others.**

Stores Manager



### How to Experiment then Scale

#### Identify Low Risk Changes

Identify small-scale, low-risk changes that can reduce carbon emissions in your laboratory. You might not have a full overview of where the biggest impact lies, but you will know what you can change while avoiding disruptions to essential operations - start there.

#### Build a Tracker of Opportunities

Assessments utilising existing frameworks such as those provided by My Green Lab or the Laboratory Efficiency Framework (LEAF) can help you identify further areas where sustainable adjustments can lead to reductions while maintaining safety and affordability.

#### Set Clear Objectives

Set objectives and test your ideas, measure reduction in energy demand/waste/carbon emissions as a result of the changes. Clear objectives help in tracking progress and enables evaluation of initiatives to better understand whether they function as planned.

#### Build Evidence for Viability

Determine what additional research and compliance would be required to implement initiatives at scale. Consider how it would be possible to trial initiatives at one or more labs to build knowledge and confidence before taking the next step.

#### Recognise Boundaries

Acknowledge when attempting to make a change may be too difficult, risky, or cost-prohibitive. Some changes require buy-in and change at the larger organisational level and can be introduced at relevant levels to help build the institutional backing for change.

#### Provide Access to Funds

Access to dedicated and diverse climate funds can enable both experiments and scaled roll out of initiatives. Employees should understand the availability of funding mechanisms. Smaller budget allocations should be simple to access while larger initiatives can be supported by a dedicated sustainability fund, supported by contributions from cost savings generated through energy-efficient measures.

## How to Lead

### 06. Keep the Conversation Going

When embarking on the journey to reduce carbon emissions in laboratories, it's important to maintain momentum by **celebrating sustainability milestones and wins.**

#### **Ongoing communication is key**

Many of the most engaged scientists we spoke to felt isolated in their concern about the environment. While some acknowledged a shift in their organisations towards more climate-conscious communication, few felt that the subject was adequately addressed in internal communications.

This matters, building the organisational impetus for change requires an ongoing reiteration of goals, focus, and commitment from leaders in order to back up people driving through initiatives and inspire engagement more broadly.

Not talking about this, is a missed opportunity, as one sustainability lead told us: *"The moment they walk in the door they should see that they are in a place that encourages this. There is nothing like that at the moment."*

#### **Diverse entry points to the Conversation**

We all respond differently to different types of messaging and have different concerns when going about our day-to-day work. Top-down messaging can empower people to seek change where they can, while more informal communication enables ongoing discussion and sharing of ideas. By diversifying communication around transformation efforts, more people can become involved.

This goes for content and format as well, as one science lead told us: *"Sometimes it's not just about carbon. Recently we held an event for World Environment Day focused on plastic pollution."*

*We showed a David Attenborough video in the lecture theatres, and there was a real appetite for biodiversity and making an impact into that."*

In general, broader sustainability discussions with external speakers seem to be well received as it allows people to situate their process of change within a wider framework, as one scientist explained: *"we do have sustainability talks with external speakers here as well, which have been the most well attended talks that we have had recently."*

#### **Celebrate wins**

Celebrating wins small and large, keeping track of milestones and giving engaged individuals the opportunity to shine is a great way to show continued focus while also showcasing tangible progress and creating a positive story around efforts. This approach not only accelerates the laboratory's journey towards net zero emissions but also cultivates a culture of continuous improvement and adaptability, setting the stage for broader and more transformative changes over time.



On Scope 1 and 2 emissions we're more than hitting our target at the moment. **We've got staff satisfaction... jump 20% this year,** which I think is great!

Science Lead



# Case Study:

## Understanding Day-to-day Lab Usage — Satisfaction with Leesman Lab Module

Organisational change should start with **understanding the needs and experiences of people** in the lab. Survey tools like Leesman’s Lab Module offer a comprehensive way for leaders to stay up to date and make informed decisions.

### A wide-ranging database and resource

The Leesman Index, spearheaded by Leesman, the global independent workplace experience assessor, is a pioneering tool in measuring and benchmarking workplace effectiveness and employee satisfaction.

Unlike traditional metrics focusing on quantitative measures like square footage or cost per square foot, the Leesman Index delves deeper, examining the qualitative aspects of the workplace experience.

### Making informed decisions

By surveying employees and gathering feedback on various aspects of the workplace environment, such as comfort, functionality, and amenities, the Leesman Workplace Experience Assessment provides organisations with valuable insights into what truly drives productivity and engagement. It identifies areas for improvement allowing companies to tailor their workplace strategies to better meet the needs and preferences of their workforce.

In 2020, Leesman added a lab module to their survey platform and have collected responses from more than 6,000 individuals working in labs. The lab module provides functionalities for science organisations to gauge and optimise their workplace experience, covering three additional question blocks that can be added to the wider workplace survey: lab activities, lab physical features, and lab service features.

For activities respondents are asked to indicate which activities within the lab are important to them, such as preparing samples, documenting

experiment results, or receiving training, as well as rating how well these activities are supported. For physical features and service features, including elements like lab workbenches, comfort in lab, and lab supplies and consumables, respondents likewise select the ones that are important as well as rate their satisfaction with these features.

### Applying Leesman learnings

The Leesman lab module empowers companies to delve deep into the intricacies of their workspace performance. Understanding how well key activities are supported and how satisfied lab employees are with the lab features can enable science organisations to identify strengths, weaknesses, and areas for improvement, which can be starting points for driving through organisational change and supporting decarbonisation efforts.

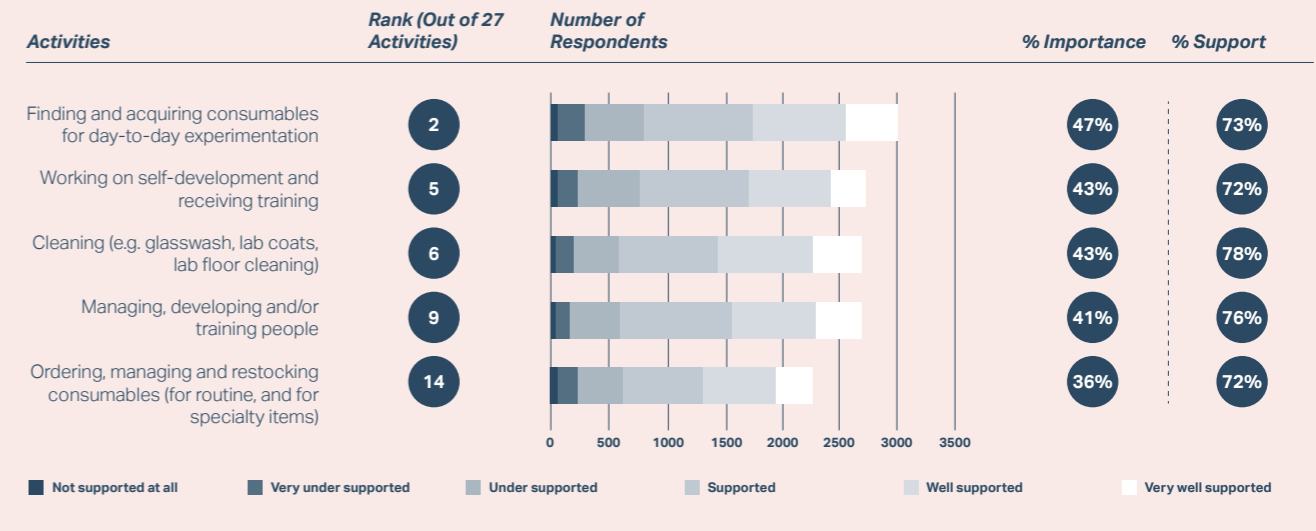
With a keen focus on user experience and productivity, the Leesman Lab Module equips organisations with actionable insights to refine their workplace strategies, foster employee engagement, and drive overall performance. By prioritising employee well-being and satisfaction, companies can foster a more positive and productive work culture, ultimately driving better business outcomes. As the importance of employee experience continues to gain recognition, the Leesman Index remains a vital tool for organisations striving to create dynamic and thriving work environments.

Thank you to the Leesman team, specifically Peggie Rothe, Mike Walsh, and Kamrul Shikdar for their support and collaboration.

## Leesman Lab Module

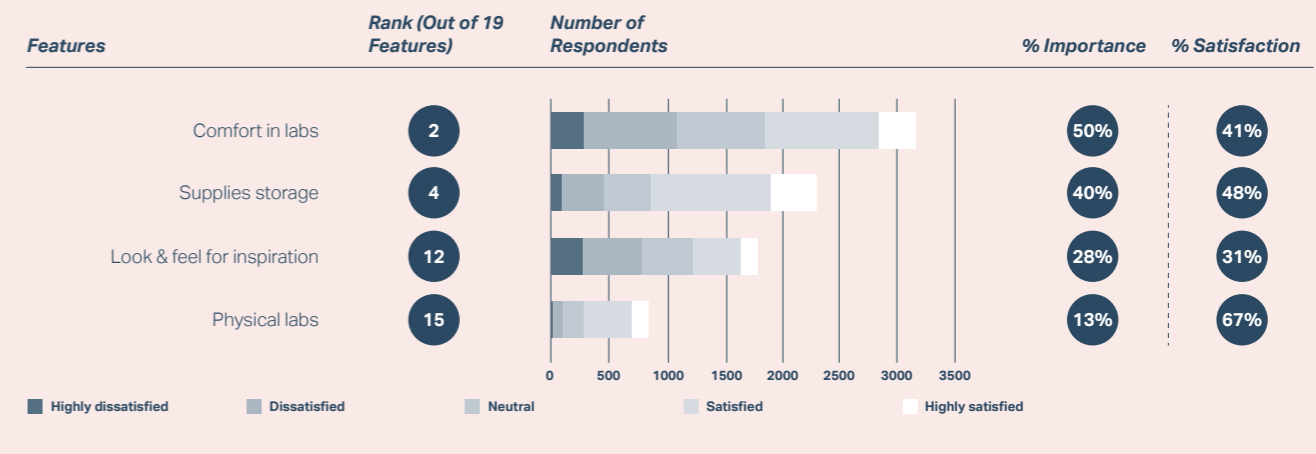
### Lab activities – Importance and support

Q — Which of the following activities are important for the work that you do in your lab environment?



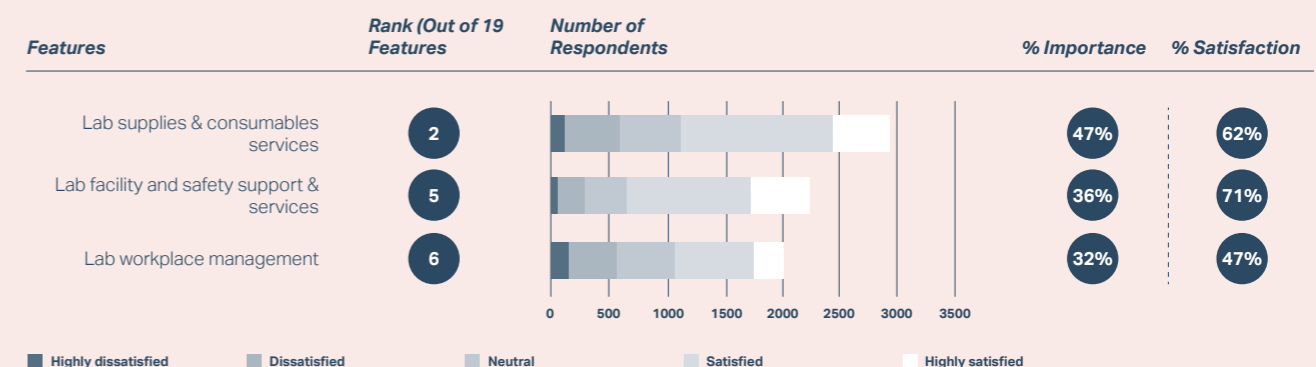
### Physical lab features – Importance and satisfaction

Q — Which of the following Physical lab features are important in creating an optimal lab environment for you?



### Lab service features – Importance and satisfaction

Q — Which of the following lab service features are important in creating an optimal lab environment for you?



# Organisational Change Summary

## Main Challenges

The main challenge for companies is **implementing and scaling sustainable practices** amidst organisational constraints and the struggle to align deeply rooted scientific procedures with evolving environmental responsibilities.

### **Disparity of personal and professional values:**

Laboratory professionals often face a conflict between their personal environmental values and the environmental impact of their work. Many feel a sense of responsibility to address climate change personally, but struggle to reconcile this with the high carbon footprint of laboratory practices. Encouraging a more sustainable work environment aligns personal and professional values, fostering a more motivated and engaged workforce.

### **Limited visibility and backing from leadership:**

Climate leadership is a recurring theme, highlighting the critical role of leaders in the transition towards decarbonisation of laboratories. Lack of visible leadership around climate agendas can frustrate engaged scientists and means that individual feels less of a licence, or imperative, to act. On the other hand, organisations with full support from senior leadership and dedicated leaders within labs have shown large gains in a relative short amount of time.

### **Inadequate knowledge and training:**

A major barrier to implementing sustainable practices in laboratories is the lack of specialised knowledge and training among lab personnel. Many are not adequately trained in sustainability principles or how to apply them in a lab setting. This results in missed opportunities for reducing carbon footprints through simple changes in everyday practices. The transition requires support from personnel versed in both science practices and sustainability strategy.

### **Limited impact of climate task forces:**

Climate task forces within labs often face challenges in driving significant change. These include insufficient funding, limited support from leadership, and inadequate pathways to influence decision-making. While these groups are often passionate and committed, their impact is constrained by these limitations. To be effective, climate task forces need clear mandates, access to resources, and direct lines of communication with organisational leaders.

### **Resistance to change in established procedures:**

Laboratories often have long-standing procedures and norms that are resistant to change. This can be a significant barrier to integrating sustainable practices. Changing these established norms requires not only new policies and standard operating procedures but also a shift in lab culture. This involves building evidence for the safety and viability of initiatives ensuring that these are practical and do not compromise integrity of scientific work.



# Organisational Change Summary

## *Main Opportunities*

Create a lab environment where sustainable practices are ingrained throughout leadership, training, and are all underpinned by a **strong alignment between personal values and professional actions.**

### ***Bridging personal and professional values:***

Encouraging practices that resonate with lab workers' personal environmental ethics can significantly boost their engagement and job satisfaction. This approach involves integrating sustainability into everyday lab operations, making it a part of the professional identity of lab workers. Getting this right could be key to attracting and retaining younger researchers and employees.

### ***Effective communication and leadership:***

Effective communication and strong leadership are essential in aligning a lab's team towards sustainability goals. Leaders must clearly articulate the vision and rationale for sustainability initiatives, providing guidance and support throughout the process. Transparent communication helps in building a shared understanding of the importance of these goals, motivating staff, and fostering a collaborative effort towards achieving the lab's decarbonisation objectives.

### ***Appointing dedicated climate champions:***

The role of climate champions is crucial in advancing sustainability initiatives within laboratory settings. Individuals who possess expertise in both laboratory operations and environmental sustainability, can effectively bridge the gap between standard lab practices and sustainable alternatives. They serve as key drivers for change, helping to implement climate initiatives, educate colleagues, and foster a culture of sustainability throughout the organisation.

### ***Integrating sustainability into training materials:***

Embedding sustainability principles into the training and induction processes for lab personnel can help make environmental considerations a foundational aspect of lab work from the outset. By doing so, new employees are equipped with the knowledge and mindset needed to engage in sustainable practices, helping to cultivate a lab culture that prioritises environmental responsibility from the very beginning.

### ***Experiment-then-scale Initiatives:***

Successfully implementing small-scale sustainability projects can lead to immediate benefits, evidence for viability of approaches, and pave the way for broader environmental initiatives. These experiments allow organisations to test and refine sustainable practices in a controlled, low-risk environment. Successful initiatives can demonstrate the feasibility and benefits of sustainable practices, serving as a catalyst for larger-scale adoption and encouraging a more proactive approach to environmental stewardship.



# Roadmap for Change

## Change Management



### Leadership



### Organisation



### Tracking



### Communication

Goals

**Establish a holistic, clear, and shared vision for decarbonisation** that links sustainability aims to core organisational priorities and goals

**Develop an organisational structure** capable of identifying challenges, opportunities, and follow through change

**Set up sustainability benchmarks and KPIs**, including current baselines to enable efficient tracking of performance

**Keep the conversation going** by embedding climate consciousness in all relevant internal and external communication

**Establish multiple organisational practices** to engage and empower the widest array of people to do their part

**Develop the infrastructure and expertise to regularly track and report on KPIs and evaluate efficiency of initiatives**

**Publish, share, and debate sustainability vision** continuously to ensure broad understanding and buy-in in organisation

Activities

**Review policy and funding landscape** to understand external drivers for decarbonisation and how they impact core organisational priorities and goals

**Set up stakeholder engagement workshops** broadly in the organisation to help define vision and goals with broad appeal and backing

**Define environmental benchmarks and KPIs** for the organisation at large and break down targets for individual functions

**Set up dedicated meetings** for discussing sustainability visions, strategies, and progress at regular intervals

**Understand current baselines** by metering energy, water, and waste data - not only at an overall organisational level, but a thorough understanding of the shortcomings and opportunities within the multiple scales of an organisation

**Identify barriers to change within the organisation and develop strategies for dealing with them**

**Consider programmes like Science Based Targets Initiative** to provide clear pathways, guidance, and peer review of approach

**Include sustainability progress and reporting** as an item in all relevant organisational briefings and meetings, such as monthly reports, town halls, etc.

**Develop a vision and a roadmap for decarbonisation**, including clear goals and KPIs, linked to organisations research and cultural aims

**Identify, hire, or partner with climate champions(s)** that understand how to bridge scientific and environmental needs

**Set up organisational data infrastructure and management processes** to allow timely and accurate reporting on KPIs

**Set up initiatives for more informal sustainability meetings** allowing people to build relationships and share what works

**Undertake scoping and goal setting exercise** to set realistic targets and timelines

**Set up climate task forces with teeth** and direct representation from leadership, finance, technical science, and human resource functions

**Consider utilising lab specific programmes and certifications like MyGreenLab or LEAF** to streamline activities and earn labels

**Celebrate milestones, initiatives, and people who are making a difference in the organisation**

**Identify and prioritise high impact initiatives and develop business case** and plans of action for implementation

**Develop training materials** to bring people along with the decarbonisation roadmap, clarify aims, and empower people to meet requirements

**Consider external review of tracking methodologies**, tracking data and relevant calculations to ensure compliance

**Run environmentally-focused talks** with a mix of internal and external speakers to link initiatives to the wider societal transition

**Ensure visible leadership around vision and strategies** to emphasise importance and give licence to decentralised change

Output

**Policy and funding landscape report** including identified initiatives that the organisation will align to

**Organisational chart** for linking sustainability teams and functions outlining roles, responsibilities and organisational reporting paths

**KPI progress tracker** - can be solved using bespoke software or spreadsheets depending on complexity

**Internal communications plan and calendar for sustainability-focused initiatives and materials**

**Published sustainability vision** with overall goals, key strategies, importance for organisation and key commitments

**Updated Standard Operating Procedures (SOPs)** reflecting environmental concerns and safe proven behaviours in the lab

**Yearly sustainability and ESG report collecting reporting materials and results**

**Working paper** on high impact sustainability initiatives and pathways for implementation

**Updated training materials**, incorporating sustainability into relevant existing inductions and targeted new materials

**Third party reviewers reports of tracking and benchmark materials**

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# 03. Improving Operations

## 03. Improving Operations

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# Introduction

## The Operational Challenge

The challenge of **reducing energy use and waste** in labs is multifaceted and requires collaboration among scientists, building owners, tenants, and regulatory authorities to implement efficient technologies and practices.

One of the key challenges in reducing GHG emissions and waste in labs is the lack of transparency regarding actual environmental impacts, and what to do with the waste. Where the occupier does not own the building, misalignment of priorities may further complicate the issue, as control over building and operational drivers may not reside within a single organisation.

### Right-sizing MEP

Right-sizing mechanical, electrical, and plumbing (MEP) components such as chillers, boilers, and electrical distribution systems is crucial for optimal energy efficiency and reduced carbon emissions. Selecting scalable MEP solutions that can adapt to changing lab needs over time helps prevent the installation of unnecessarily large systems, thus reducing the carbon footprint associated with construction and equipment manufacturing.

### Get smart

To address energy consumption, labs can implement advanced control systems and sensors to ensure that equipment operates only when and where it is needed, thereby reducing unnecessary energy use. Even sub-metering of all services will provide better data on energy use than what was available in many of the labs we visited. Incorporating energy recovery technologies within HVAC systems can capture and reuse waste heat, further improving energy efficiency and reducing carbon emissions.

Humidity control, which can be a high-energy demand, should be installed as needed and when

the laboratory space is fitted-out, rather than as a base provision. Relative humidity control is typically required only for specific functions, assays, or runs in laboratories.

### Can I turn it off?

Despite the significant environmental impact of lab equipment misuse, many scientists remain unaware of the specifics of its adverse effects on the climate. This lack of awareness highlights the urgent need for increased education and action to mitigate these impacts. Understanding, metering, and sharing of equipment, as well as guidance on what can be turned off and when, can translate into significant gains for the organisation.

### Rules are rules

Labs must also navigate the regulatory context governing Standard Operating Procedures (SOPs) to ensure compliance with environmental regulations whilst targeting sustainability goals. Regulatory frameworks are complex and vary by the research being undertaken, but generally include standards for waste management, energy efficiency, and environmental protection.

Ensuring that SOPs align with regulatory requirements is essential for labs seeking to minimise their environmental impact. This may involve implementing protocols for proper disposal of hazardous waste, reducing energy consumption through efficient equipment use, and adhering to emissions standards.

Regulatory compliance often requires regular monitoring and reporting of lab activities, including waste generation, energy usage, and emissions. Labs may need to invest in monitoring technologies and personnel training to meet these requirements.

Furthermore, regulatory frameworks may evolve over time, requiring labs to stay informed about changes in environmental legislation and adjust their SOPs accordingly. Engaging with regulatory agencies and industry associations will help labs stay up-to-date on emerging regulations and best practices.

“

... You're talking about behaviours, but trying to get people to **turn off stuff** in a lab that they're not actually using is almost **impossible**.

”

Lab Manager

### Principle Science H&S guidance and Legislation

- Health & Safety at work act 1974
- HSE/Approved code of Dangerous Pathogens - Management of microbiological lab March 2009
- COSHH - Control of substances hazardous to health regulations 2002
- European Directive (Directive 2000/54/EC) protection of workers
- HSE Guidance on Genetically Modified Organisms (GMO)
- Management of H&S at Work Regulations (MHSWR) 1999
- HSE Guidance - So far as reasonably practicable (SFAIRP)
- Biological Safety Advisors Regulations (BSA)
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR 2013)
- National Counter Terrorism Security Office (NaCTSO)
- Part 7 Anti-Terrorism, Crime and Security Act 2001
- BS- EN 12469 MBSC performance criteria
- Health Technical Memorandum (HTM) 07-01- Waste Pressure System Safety Regulations 2000 8(1) - Autoclaves and pressure systems
- Healthcare Technical Memorandum (HTM) 02 Medical Gases

# Operational Energy

## Building Systems

HVAC systems, designed to maintain optimal air quality and temperature, often involve large air changes to ensure a safe and controlled environment, and are **by far the biggest energy consumer in a laboratory building.**

### **Understanding building-related energy usage**

A typical research institution will have 60-65% of its electricity consumed by research spaces.<sup>1</sup> The largest quantity of this comes from building related energy usage such as ventilation and heating, though energy hungry equipment also take up a significant proportion.

In 2011, a study on energy consumption of university laboratories carried out detailed audits of energy use at three life science laboratories at the Universities of Edinburgh, Liverpool, and York, and two chemistry laboratories at the Universities of Cambridge and Manchester.<sup>2</sup> Key findings were:

- Ventilation-related energy (all the energy used to move, cool and heat air) comprised around 60% of total energy in chemistry labs and 45% in life science labs.
- Equipment/small power comprised around 25% in life science labs and 15% in chemistry labs.
- Space heating accounted for around 20% in both types of lab.
- Lighting comprised around 10% for life science labs and 5% for chemistry.

### **Bringing down air changes**

The operation of lab building systems requires large volumes of air movement to ensure a safe and controlled environment within lab spaces. These frequent air changes are essential for preventing the buildup of contaminants and maintaining the integrity of experiments, but they also contribute significantly to energy consumption.

The challenge lies in finding a balance between meeting the rigorous safety and environmental requirements of laboratory settings while minimising energy usage. Lab ventilation systems must adhere to strict regulations and standards to ensure the safety of personnel and the integrity of experiments. As a result, there is often limited flexibility in adjusting ventilation rates to reduce energy consumption without compromising safety and research outcomes.

### **Day and night**

The 24/7 operational nature of many laboratories further complicates energy-saving efforts. Unlike office buildings or residential spaces where occupancy fluctuates throughout the day and systems can be set accordingly, laboratories often require continuous ventilation and conditioning of air, leading to constant energy demands. This presents a significant challenge in implementing energy-efficient strategies such as setback modes or scheduling ventilation during off-peak hours.

### **Challenge the norm**

Despite these challenges, there is a growing recognition of the importance of sustainable practices in lab design and operation. Engineers and facility managers are exploring innovative solutions to improve the energy efficiency of building systems in labs. This includes the integration of advanced HVAC technologies, such as demand-controlled ventilation and energy recovery systems, to optimise energy usage while maintaining safety standards.



### **Engage the people**

Researchers and lab personnel should be educated about the environmental impact of their work, promoting a mindset that values efficiency and conservation. Collaborative efforts between research institutions, equipment manufacturers, and environmental experts will promote the development of eco-friendly alternatives and best practices for laboratory operations.

By fostering a culture of energy conservation and providing training on best practices, labs can further reduce their environmental footprint without compromising research integrity.

## Case Study:

### Reducing Ventilation Volumes: A Strategy for Energy Efficiency in Lab Infrastructure - Tim Fry, Director and Science Leder UKIMEA

As energy costs rise, laboratory engineering teams are increasingly adopting strategies to reduce ventilation volumes in their existing facilities, to save energy without compromising safety and user comfort. We talked to Tim Fry, Director and Science Leder UKIMEA at ARUP, to shed light on the process and benefits of several initiatives they are leading for their clients including The Francis Crick Institute.

The initiative to reduce air changes in high containment labs was prompted by the need to optimise energy usage, without compromising biosafety standards. Several of our research collaborators have faced challenges in implementing similar changes due to user resistance and regulatory hurdles. However, Tim's team successfully navigated these obstacles, achieving significant energy savings for Crick without compromising safety.

Initially commissioned with air change rates higher than regulations require, the labs underwent adjustments to bring them closer to regulations while optimising energy efficiency. Through detailed planning and gradual adjustments, ventilation volumes were reduced from as high as 27 air changes per hour in some spaces, to a more efficient 15 changes, resulting in substantial energy savings. This process involved careful monitoring of each change and consultation with lab users to ensure minimal disruption and address any concerns if they arose. The changes were implemented in stages, with sufficient time allowed to ensure that conditions were still maintained at each stage, prior to making the next reduction. The revised air volumes are still compliant with the regulations, so no regulatory approval process was required.

The initiative was supported by a financial model prepared by Arup demonstrating the potential energy savings, which proved the case for the

project and was realised in practice. By presenting changes in a manner understandable to users and aligning them with scientific needs, Tim's team provided this information to the Crick, for them to engage and align stakeholders of the initiative.

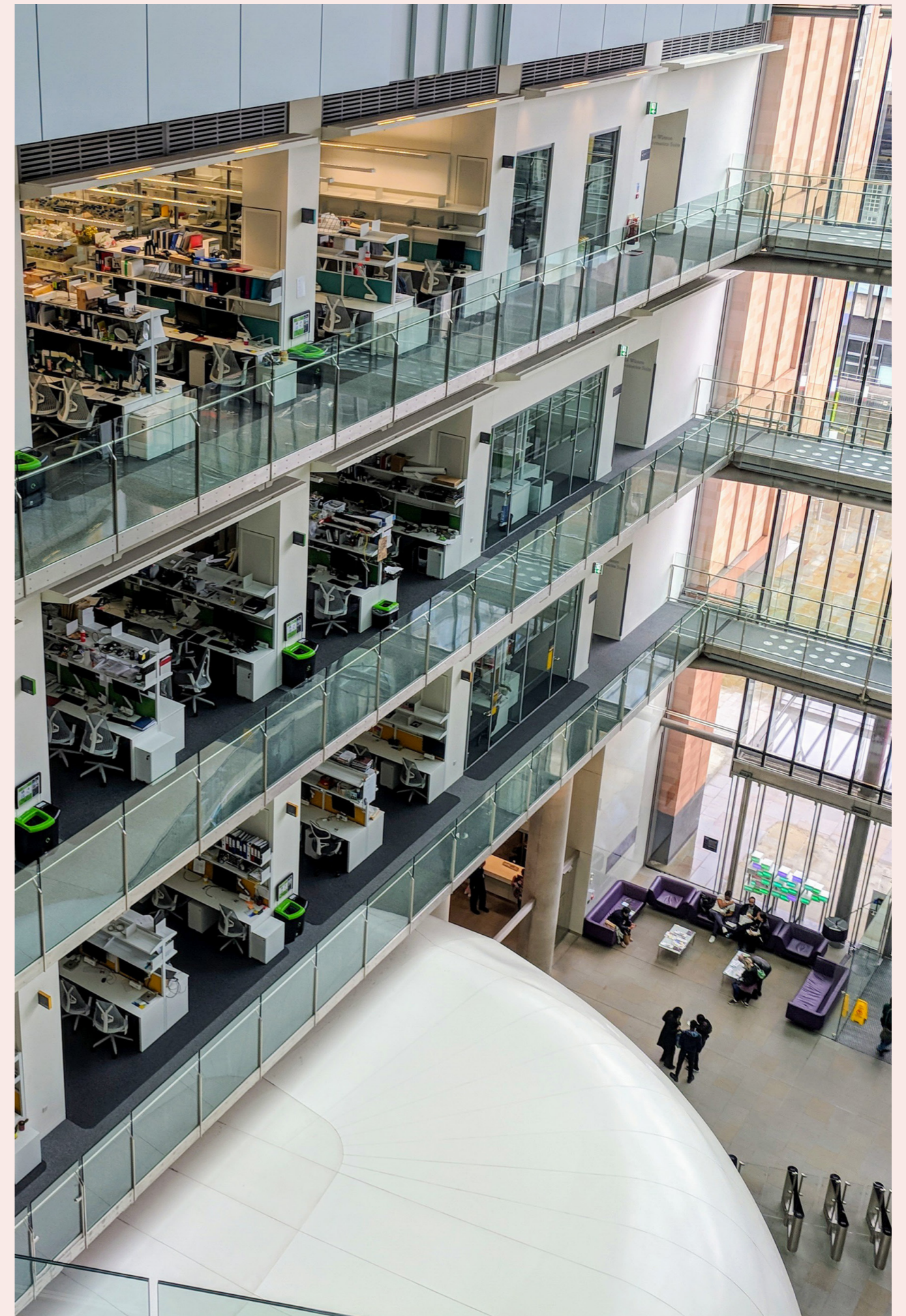
Negotiating with users played a pivotal role in the success of these initiatives, with effective communication and collaboration between facility managers and lab occupants being key. It is critical that engineering teams engage users in the decision-making process, ensuring that changes align with their work requirements and safety concerns.

“

It was driven by the energy. That's why we built the financial model, for assessment of the energy use and to prove, if we drop it by this much, you're going to see that this will **generate this much energy reduction** and therefore just saved this much cash.

Tim Fry, Director and Science Leder UKIMEA

”



The Francis Crick Institute, HOK with PLP Architecture

# Operational Energy

## Energy Intensive Equipment

Despite their indispensable roles in various scientific processes, energy-intensive equipment and instruments often come with **a significant contribution to greenhouse gas emissions.**

Inside the lab, the extensive use of specialised equipment presents a formidable challenge in the context of energy use.

### Energy hungry equipment

Fume hoods and safety cabinets, crucial for protecting researchers from hazardous materials, typically require constant airflow and ventilation, leading to high energy consumption. Centrifuges, employed for separating particles in biological samples, require high rotational speeds necessitating substantial energy input. The constant need for controlled temperature and humidity levels in incubators significantly adds to the energy demand in laboratories, while washing machines used for cleaning glassware and instruments contribute to water and energy consumption. Analytical instruments, ranging from mass spectrometers to chromatographs, are fundamental for detailed analysis in various scientific disciplines. However, these instruments often require complex cooling systems and high-power consumption, significantly impacting the environmental footprint of laboratories.

### Highly powered

Specialist equipment such as autoclaves, which are commonly used for sterilising equipment and materials, rely on high temperatures and pressure. The energy-intensive nature of this process, often powered by electricity or natural gas, results in substantial energy demands and emissions. Similarly, reactors utilised for chemical synthesis and analysis often demand significant amounts of

energy, contributing to the overall carbon footprint of laboratory operations.

In high-containment labs, cage washes, essential for housing and maintaining the health of animals, involve significant water and energy consumption. Pass-through hatches, designed for secure transfer of materials, operate on differential pressure and can impact the lab's energy efficiency.

### Adding up the bill

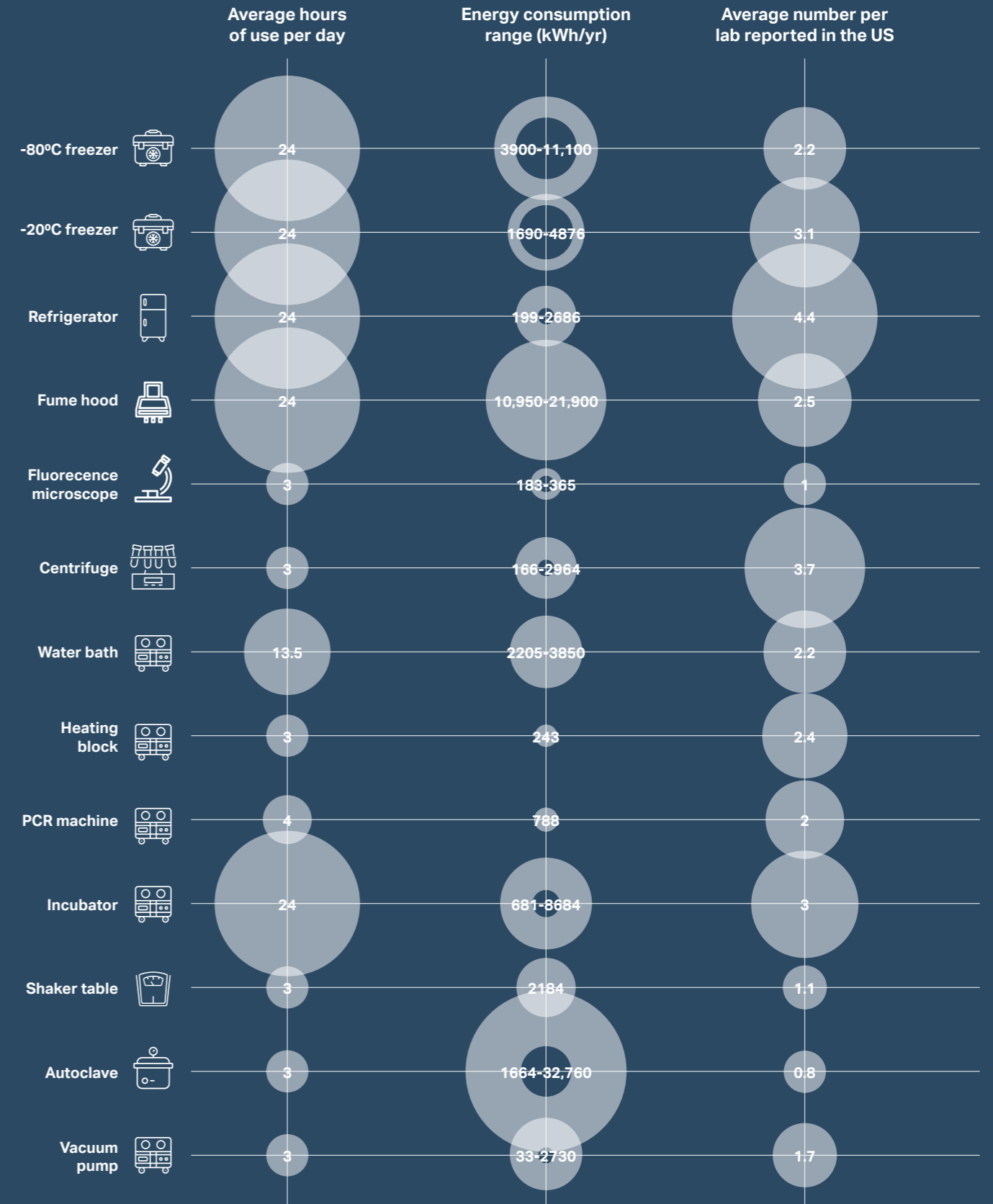
It is difficult to find a comprehensive overview of impacts of the most energy-hungry lab equipment.

The table on the right outlines energy intensive equipment that is often found inside labs based on an American survey from 2015 by I2SL, S-Labs, Caltech, and the University of British Columbia.<sup>3</sup> While the numbers may vary, the relative impacts can serve as a guide to tallying up equipment in the lab and understanding where to focus efforts to minimise energy use.

Getting from energy use to GHG emissions depends on the energy mix provided to the lab, the UK **Government's conversion factors for company reporting of greenhouse gas emissions in 2023 was:**

$$1\text{kWh} = 0.207074 \text{ kgCO}_2\text{e}^4$$

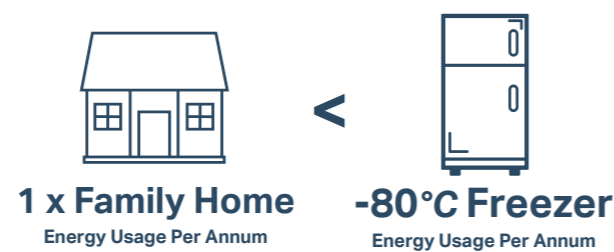
Estimated Energy Consumption Ranges for Laboratory Equipment, Emerging Technologies Program<sup>5</sup>



# Operational Energy Ultra-low Temperature (ULT) Freezers

ULT lab freezers typically operate at  $-80^{\circ}\text{C}$ . They can consume between **16 to 22 KWh of energy every day**. In comparison, the average UK household consumes between 8 to 10 KWh daily.<sup>6</sup>

A common issue in laboratory settings is the continuous operation of freezers, incubators, and fridges, often containing an inefficiently-stored number of samples. This results in a significant energy expenditure that could be reduced through consolidation. Optimising storage and organisation methods (while maintaining the same sample preservation standards) can limit the number of active units required, and can potentially cut down resource consumption significantly.

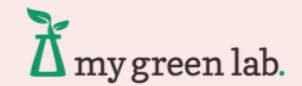


One  $-80^{\circ}\text{C}$  Freezer can use up to three times as much energy annually (kWh/Yr) as one family home.<sup>7</sup>

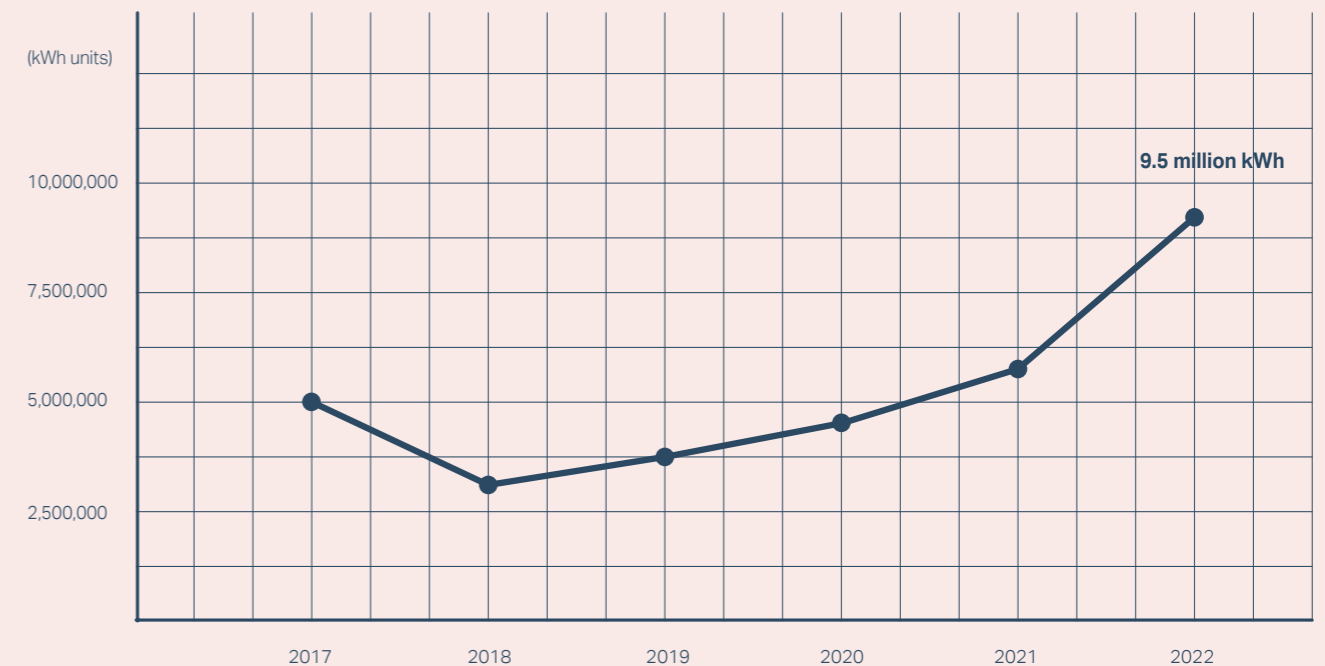
The logistics involved in throwing away samples or transferring samples from one freezer to another can be a formidable task. However, efficient management and consolidation efforts can streamline these operations and lead to more sustainable storage and equipment usage. Often, samples are stored at ultra-low temperatures ( $-80^{\circ}\text{C}$ ) for long-term preservation, but the question arises as to whether slightly higher temperatures, such as  $-70^{\circ}\text{C}$  (see p.76), might still adequately preserve samples without adverse effects.<sup>7</sup> In several of the labs we visited, freezer set points have been reduced following an extensive process of proving the validity and efficacy of the reduced temperature for samples stored, requiring some time and effort away from science by those passionate about the cause. Such considerations can be part of a broader strategy to reduce energy consumption while maintaining research integrity, demonstrating how a combination of thoughtful planning, logistics, and scientific evaluation can contribute to more sustainable laboratory practices.



## Case Study: The 'Freezer Challenge' freezerchallenge.org



24 Million kWh of Energy Saved Through the Freezer Challenge Between 2017 and 2022



The "Freezer Challenge" is an initiative aimed at promoting sustainability within research labs and scientific facilities, particularly in the context of freezer usage. It encourages labs to create an inventory of the contents of their freezers, cataloguing what samples are stored, their locations within the freezer, and their status (e.g., active research, obsolete, etc.). This mapping helps labs understand what they have and how it's being used.

Labs are encouraged to identify and dispose of obsolete samples that are no longer needed for research. This not only helps free up valuable freezer space but also reduces energy consumption because freezers don't need to work as hard to maintain temperature with fewer items inside. The challenge focuses on optimising energy usage by consolidating the contents of multiple freezers if a lab has more than one. This can help reduce the number of freezers in operation and, consequently, lower energy consumption.

Furthermore, the challenge aims to improve storage and research operations. This could involve reorganising how samples are stored for

better accessibility and efficiency. By optimising storage and research workflows, labs can reduce energy waste and enhance their overall operations. The challenge encourages scientists to share equipment, minimising the need for multiple labs to have their own equipment. This leads to reduced energy consumption and cost savings, contributing to a more sustainable and efficient research environment. The Freezer Challenge's overall goal is to raise awareness about the environmental impact of lab practices, particularly regarding freezer usage, and to incentivise positive changes that lead to reduced energy waste, lower costs, and improved operational efficiency within scientific research facilities.

The 2023 Freezer Challenge achieved significant results. The challenge involved nearly 2,000 laboratories across the world, with over 26,000 participating cold storage units and 170 organisations committed to sustainability. This large-scale participation led to a remarkable saving of approximately 20.7 million kWh of energy, which translates to about 14,663 metric tons of carbon dioxide equivalent.

## Case Study:

# Navigating the Path to Sustainability in High-Containment Labs at The Pirbright Institute

Driving **sustainability in high containment environments** presents challenges due to the high energy demand of high volume building systems, energy-hungry equipment, strict regulation, and maintaining optimal conditions for research activities that must adhere to stringent safety measures.

### **Leadership from the top**

As a BBSRC-funded institute, Pirbright aligns with the government's NetZero 2030 vision, however, it is up to each of the Research Councils' institutes how they achieve these targets. It is fundamental that leadership provides the vision and inspiration to their teams to strive for more sustainable lab practices - this often relies on the personal views of senior leaders and lab managers with a passion for sustainability.

### **On the ground in Pirbright**

The Pirbright Institute is a world-leading centre of excellence in research and surveillance of virus diseases of farm animals and viruses that spread from animals to humans. They receive strategic funding from the BBSRC, and work to enhance capability to contain, control and eliminate these economically and medically important diseases through highly innovative fundamental and applied bioscience.

We visited Pirbright's The Plowright Building, a 14,000 m<sup>2</sup> Category 4 bio-containment facility that accommodates 160 staff, including 125 scientists, and is essential to the Institute's scientific programmes for the purposes of in vitro research into viral diseases.

Meeting lab technicians and managers, as well as Miriam Windsor, Head of Research Services, Dr Jason Tearle, Biorisk Technical Lead, and Ryan Waters, Pirbright's named Veterinary Surgeon and Training & Competency Officer, we explored their

journey in striving towards the government-funded institute's NetZero 2030 goals while balancing biosafety, scientific integrity, and operational efficiency.

### **Nudging good behaviours**

Overcoming resistance to sustainable initiatives practices among lab personnel, including researchers, technicians, and support staff, can be a hurdle for those driving more sustainable research habits, Miriam explains.

Encouraging behavioural changes, such as turning off equipment when not in use and adhering to waste management protocols, requires effective communication, training, and incentives.

Miriam stresses that addressing the perception that sustainability initiatives may compromise research outcomes or operational efficiency necessitates clear demonstration of the benefits and long-term impact on both environmental and scientific objectives.

### **A high-energy environment**

One of Pirbright's biggest challenges relates to energy consumption, Miriam explains; *"due to the unique requirements of high-containment labs, we require high air volumes and 100% fresh airflow."* Maintaining optimal conditions within high-containment labs, including temperature, humidity, and air quality, demands significant energy consumption.

This constraint presents a trade-off between

maintaining the strict safety measures required for working with hazardous pathogens, and the targeting of energy efficiency and reduction.

The team at Pirbright have been implementing energy-saving initiatives, such as night setback of ventilation systems, reducing ultra-low temperature (ULT) freezer set points, and the metering and controlling of specialist equipment use. This has required careful planning and consideration of research requirements and impact on biosafety standards. However, such changes require dedicated resources and time for thorough review and implementation.

### **Regulations rule**

The intersection of regulatory compliance and sustainability goals presents another challenge. While existing regulations prioritise safety and containment, there is a growing recognition of the need for regulatory frameworks to evolve to address sustainability concerns. Government agencies and regulators are under increasing pressure to update policies and standards to incorporate environmental considerations into lab operations. Modifying established procedures within this stringent framework requires evidence-based changes and a delicate balance between safety and environmental considerations.

Adhering to regulatory standards and guidelines for biosafety and biosecurity while implementing sustainability measures requires careful alignment and coordination, Jason explains. With over three

decades of experience in biosafety, Jason sheds light on the hurdles of implementing changes within established regulatory procedures, emphasising the need for extensive validation to ensure safety and compliance, which can slow down the adoption of sustainable practices: *"I've not seen any significant change in policy that regulates high containment in the years I've been working on it."*

### **Quiet at night?**

When The Plowright Building was first built, it was designed with a setback mode to save energy of building ventilation systems at night, however this has not been prioritised until rising energy costs recently became a concern.

Jason acknowledges the potential benefits of reducing air change rates during periods of low occupancy to save energy but emphasises the importance of maintaining containment standards: *"It's important to find this balance because we do have a commitment to be continually available. We have certain obligations to adhere to."*

Balance is required between energy efficiency with safety requirements, however, setback mode could be beneficial if implemented effectively and aligned with scientific needs. Jason also emphasises the necessity of presenting changes in a manner that is understandable and acceptable to users, considering their work requirements and safety concerns: *"It has to be presented in a manner that acknowledges that this is going to mean changes to the way people work, but there are benefits. It's*

## Case Study: Navigating the Path to Sustainability in High-Containment Labs at The Pirbright Institute

just got to be framed in a way that takes account of people's needs. From experience many years ago as a PhD student, I know that there have been times when I had to come in every four hours if I was doing certain things, so this got me to understanding that it has to fit the science hasn't it?"

Allocation of resource and funding for these initiatives remains a challenge with current funding models and the fact that science outcomes must always remain the highest priority.

### **What to do with waste**

High containment labs use significant volumes of plastic in their research and generate large amounts of offensive waste. Much of this is unavoidable in such an environment where anything perishable that passes the biocontainment barrier must be autoclaved or incinerated.

Challenging behaviours remains the key strategy for Pirbright to minimise waste. Streamlining the suppliers of plastic research utensils like pipette tips and reducing single use 96 well plates used in experiments.

Lab users are challenged to reduce the cardboard taken across the containment barrier as it must then be destroyed, however this requires more extensive and efficient storage solutions.

Incineration is a high-carbon method of disposal, and Pirbright make efforts to streamline this and include off-site methods where possible.

### **Getting to know the supply chain**

Procurement and supply chain management present hurdles due to the need for specialised equipment and consumables that meet stringent containment and safety requirements. Limited availability of options for eco-friendly alternatives for essential lab equipment complicates efforts to reduce energy consumption and minimise environmental impact.

Often scientists have differing preferences and favourite consumables items, Miriam notes addressing this as a challenge; "procurement don't really get involved in that, whatever the scientists want, is all of their individual preferences."

### **Strategic Partnerships**

The Pirbright team collaborate with suppliers, industry experts, and regulatory agencies to identify sustainable solutions and innovative technologies tailored to the unique needs of high-containment labs.

By leveraging partnerships with academic and research institutions, they share best practices, lessons learned, and success stories in integrating sustainability into their lab operations.

### **Education and Training**

The Pirbright leadership provides comprehensive training programs and educational resources to raise awareness about sustainability, safety, and regulatory compliance among lab personnel. Researchers and staff are empowered to make informed decisions by highlighting the environmental and cost-saving



The Plowright Medical Centre, HDR Architecture

benefits of adopting sustainable practices in their daily workflows.

### **Data-Driven Decision Making**

Pirbright is exploring advanced monitoring and analytics tools to track energy consumption, waste generation, and resource utilisation within the lab. Leveraging data insights to identify areas for improvement can optimise processes and allow for measuring the effectiveness of sustainability initiatives over time. Efforts are made to share energy data with staff to give context and share improvements.

### **Always improving and innovating**

A culture of continuous improvement and innovation is fostered by encouraging experimentation with new technologies, processes, and workflows. Cross-functional teams and a volunteer Environment Forum provide staff with a means to raise sustainability initiatives and foster collaboration across departments and disciplines. Forum volunteers have been recognised and invited to become part of the Energy and Environment team, where they can now have greater influence. Pirbright are working to ensure that initiatives conceived in this forum have routes and funding to support implementation.

# Operational Energy

## *Better Use Of Equipment*

**Correct utilisation** of lab equipment helps reduce unnecessary energy consumption and resource waste, thereby contributing to a more sustainable and climate-friendly laboratory environment.

Ensuring optimal equipment utilisation involves actively managing the use of equipment in labs to minimise energy demand and emissions.

Through equipment monitoring systems for common specialist equipment like autoclaves, lab managers can track the frequency and duration of autoclave usage. By analysing this data, researchers can identify opportunities to streamline sterilisation processes, avoiding unnecessary energy consumption during idle times and reducing emissions associated with prolonged operation.

By implementing a centralised booking system for equipment, researchers can reserve time slots for using lab machines, ensuring they are fully utilised without unnecessary idle time. This not only optimises energy usage but also promotes resource efficiency by maximising the capacity of use cycle.

The integration of metering systems and sharing of Building Management System (BMS) data can further enhance efficiency. By connecting equipment monitoring systems to BMS platforms, lab managers can gain insights into energy usage patterns and identify areas for usage improvement. This integrated approach allows for real-time monitoring of energy consumption and facilitates data-driven decision-making to optimise equipment usage and minimise environmental impact.

When it comes to older equipment, scientists may be reluctant to replace them with newer, more energy-efficient models due to attachment or familiarity.

However, by promoting the benefits of newer technologies and providing incentives for upgrading, lab managers can encourage the adoption of energy-efficient technologies. Equipment usage monitoring can highlight the energy consumption of older devices, raising awareness among scientists and prompting them to consider sustainability factors when selecting equipment.

Proactive maintenance and repair schedules can help extend the lifespan of equipment, reducing the need for frequent replacements and minimising environmental impact.



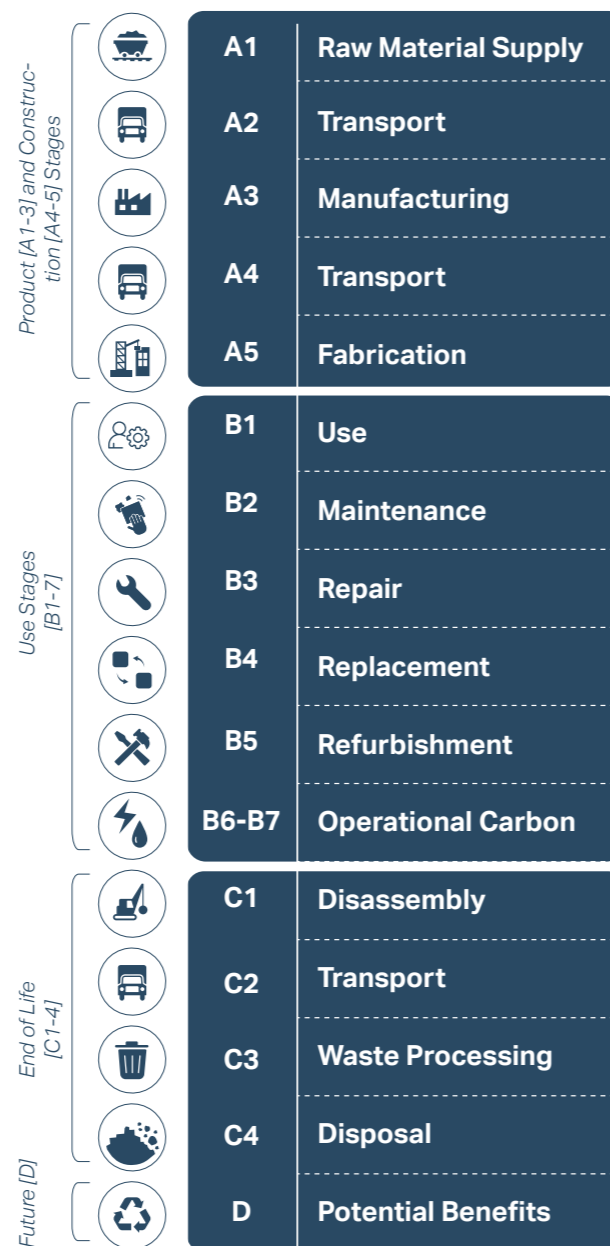
# Operational Energy

## LCA of Lab Processes

Understanding the environmental impacts of laboratory protocols is a key challenge in research and innovation. **Life Cycle Assessment (LCA) can empower researchers** to make more informed decisions.

LCA is a systematic methodology used to evaluate the environmental impact of a product, process, or service throughout its entire life cycle, from raw material extraction and production (Stage A) through use (Stage B), to disposal (Stage C), or recycling (Stage D). LCA quantifies the environmental effects in various categories, such as energy consumption, greenhouse gas emissions, resource depletion, and pollution, allowing for informed decisions to minimise environmental burdens and promote sustainability.

LCAs are often used to make informed decisions in sustainable production or design, helping to reduce the environmental footprint of products and projects and identifying opportunities for resource optimisation. The same methodology is amenable to analysis of common lab processes, such as biochemical assays, image analysis, proteomics, and gene expression profiling, to assess their environmental impact and provide ultimate transparency between lab users and product manufacturers.



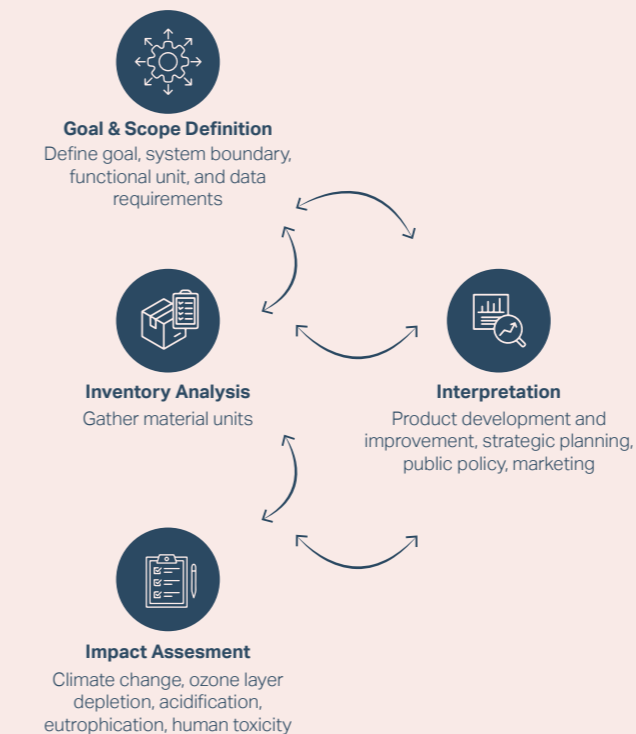
# Case Study:

## Life Cycle Assessments for Common Lab Processes

In a collaboration between The Institute of Cancer Research (ICR) and The University of Surrey, Lisa O'Fee and Professor Richard Murphy are in the process of developing and implementing LCA for laboratory processes.

**Defining processes and boundaries for analysis**  
During her part-time Masters of Science (MSc) in Sustainable Development at the University of Surrey Centre for Environment and Sustainability, Lisa O'Fee recognised the power of lifecycle assessment for laboratory practices: *"To identify environmental hotspots and look for ways to reduce these without compromising on data quality. What actually has the most significant impact? Single-use plastics, energy consumption or the resulting waste?"*

When coming up with ideas for how to improve environmental performance at the ICR, she saw



an opportunity for testing the methodology on common lab processes. Using an LCA framework carried out according to ISO14040, Lisa has been collecting detailed data on materials, equipment, and energy consumption. "You have to kind of go back to basics and look at every single thing you're using," she explains forwarding the example of cell viability assays. For these, she catalogued every piece of equipment and consumable used, monitored energy and water usage, weighed up components, and went to manufacturers to ask for information about raw materials and scope 1, 2 and 3 emissions.

### Aims for Calculating the Life Cycle Assessment (LCA) of research laboratory protocols:

**Quantify the environmental footprint** (carbon footprint and additional environmental impact indicators), of current laboratory protocols in use at ICR and wider bioscience sector and the adaptation/re-design of these for lower environmental impact

**Disseminate all learnings** including; datasets, results, environmental and economic costs & benefits to the bio- and medical-research communities and the LCA practitioner community

### The core sustainability tool will provide:

**Granular, detailed environmental impact data/evidence** on these protocols in formats that have real meaning for the science teams

**Prospective, forward-looking analysis** of environmental gains that can be reached by improvement/adaptations to the protocols

## Case Study:

# Life Cycle Assessments for Common Lab Processes

### Computing and reporting on high impact areas

All results were initially collected in a large spreadsheet, then inventory data is fed into the SimaPro LCA Software which integrates with the ecoinvent Life Cycle Inventory database to calculate results across 15 environmental impact categories. "Obviously, most people look at carbon, but there's also eco toxicity, eutrophication, acidification, and so on," Lisa explains, continuing: "What you tend to do is look at the 15 and narrow down the ones that have the most significant impact. Then you report on those five or six, but you have the data for all of them."

Lisa tends to focus on carbon because there is a public awareness of climate change, and a reporting requirement for carbon emissions, but biodiversity loss goes hand and hand with this, therefore, it is important to examine all environmental impact categories.

### Transparency allows for sharing and comparing

This is a laborious process, but one carried out under the ISO 14040:2006 Standard for LCA to enable use and comparison in the wider science world. By clearly defining a system boundary and functional unit, the data can be applied to any science lab: *"It allows someone else to compare the data on how they use this assay, for example looking at the number of assays they use to support a drug discovery program for a year comparing that to how many we use."*

Lisa stresses the significance of all stakeholders to be transparent with their own processes and product's environmental impacts. It is critical to also ensure that the limitations and assumptions in individual LCAs are clearly communicated as transparency aids in the broader application and improvement of lab practices.

### Life Cycle Assessment of a Cell Viability Assay Example

#### Full Scope of 'Bench to Result' - Cradle to Grave



#### Seed Cells - Mammalian Cells

- Source – ATCC, Thermofisher
- Propagation – Incubator, centrifuge, MSC, culture media, plastic labware
- Quality assurance – Mycoplasma testing, STR profiling
- Storage ULT/Liquid nitrogen



#### Add Therapeutic - Test Agent

- Synthesis
- Liquid nitrogen / -70°C
- Disposal
- Equipment & Consumables



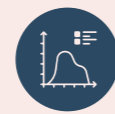
#### Incubate at 370°C/5%RH

- Hardware
- Servicing
- Carbon dioxide
- Energy



#### Detection Reagent

- Manufacture
- Storage
- Dispensing hardware & consumables
- Pipette calibration



#### Output - Analysis & Reporting

- Hardware – servicing/training
- Software
- Data analysis
- Data storage

#### General

- PPE
- Waste
- Deliveries
- Infrastructure not included

### Creating a template for other institutions to follow

Overall, Lisa O'Fee and Professor Richard Murphy's MRC-funded environmental sustainability project aims to reduce the environmental impact of scientific research by applying LCA to laboratory settings. This novel application of the assessment method represents a significant step in integrating environmental considerations and transparency into lab practices.

Specifically, the project will highlight the impact of various laboratory plastics used at the Institute of Cancer Research (ICR), such as polystyrene and polypropylene items, detailing their consumption and giving suggestions for their reduction. This inventory not only raises awareness internally but also among suppliers and manufacturers, prompting them to consider more sustainable practices.

By having a lab-based insight, it has been possible for Lisa to suggest realistic opportunities to reduce environmental impacts, whether you work at a routine testing laboratory or in a FTSE 100 pharmaceutical company.

Ultimately, this project represents a proactive approach to embedding sustainability in medical and bioscience research, offering a template for other institutions to follow. It demonstrates a commitment to continuous improvement and engagement with both internal stakeholders and the wider community to enhance the sustainability of critical research processes.



I can see in the near future there's either an in-house or external role for doing **a lot more lifecycle assessment.**

Lisa O'Fee, ICR



# Lab Consumables

## Lab Waste

Laboratories generate a **significant amount of waste**, including single-use plastics, hazardous chemicals, and non-recyclable materials, which poses substantial environmental and logistical challenges

### Science-first mentality - environment takes a back seat

Scientists are sometimes too busy and focused on a project goal to go out of their way to make change

### Limited knowledge of, or control with, product supply chain

Most product and supplier lists in labs have little transparency around environmental impacts

### Scientists have to follow SOPs

Scientists are told to follow specific protocols, with good reason, but these tend to go unquestioned as they are passed down the chain, making scientists hesitant to make changes

### Scientists often have a preferred/favourite item

Scientists tend to favour specific products they are familiar with, resulting in labs having to accommodate wide diversity in procurement and waste handling

### Unnecessary contamination and waste

Laboratories produce an unnecessary amount of waste, which protocols and spatial logistics interfering with reuse and disposal

### Wrong amount or product ordered, old samples kept

We have seen a tendency to stockpile products and old samples, which either takes up large amounts of storage or are thrown away unused

## The Chain of Misuse



# 67x

Labs are estimated to trash 5.5 million tons of plastic waste in a single year; that is the weight of 67 cruise liners.<sup>8</sup>

# 2%

2% of the world's plastic waste comes from labs.<sup>9</sup>

# 15x

A laboratory researcher produces nearly 15 times the amount of plastic waste as the average individual.<sup>10</sup>

# 55%

The emissions produced by the biotech and pharmaceutical industry are 55% higher than the automotive industry when measured by carbon emission for revenue.<sup>11</sup>

“

When I did my PhD ten years ago I think we were probably closer to net zero because we used a lot of glass, **now it is all plastic, plastic, plastic.**

Research Lead

”

# Lab Consumables

## *Reduce, Reuse, Recycle*

Moving from a linear economy to a **circular economy** where feasible can enable continuous reuse, refurbishment, and recycling of lab equipment and products to minimise waste and resource depletion.

At its most basic, the circular economy seeks to a) eliminate waste and b) circulate products and materials at their highest value to minimise adverse environmental impacts. While several definitions and principles co-exist, three overarching strategies can be considered for bringing circularity to the lab.<sup>12</sup>

### **Reduce**

Reducing consumables use and waste is paramount in the laboratory. By carefully optimising the usage of materials and equipment, lab facilities can significantly reduce their waste and carbon footprint. Implementing responsible procurement practices can reduce operational costs while contributing to more sustainable laboratory processes.

### **Reuse**

Laboratory equipment and materials can often have long lifespans and can be refurbished, repurposed, or shared among researchers to extend their usefulness. By promoting reuse of products and sharing of equipment between research teams, lab facilities can minimise waste and maximise the utility of equipment while improving collaboration.

### **Recycle**

Recycling should be incorporated into lab practices to ensure the responsible disposal of waste materials. Recycling reduces the environmental impact of waste disposal while minimising the need for extraction and manufacture of virgin materials. Proper waste segregation and recycling programs within lab facilities can lead to a significant reduction in waste incineration and landfill, promoting a more sustainable laboratory environment.

**Most Preferable**



**Reduce**

**Reuse**

**Recycle**

**Landfill/  
Incineration**

**Less Preferable**



# Lab Consumables

## Reducing Lab Waste

Tackling lab waste must rely on strategies to reduce the **5.5 million tonnes** of annual plastic waste generated by life science, including reduced packaging, optimised experiments, and embracing resource-sharing models.

### Smarter procurement

Minimising the amount of materials and packaging going into labs is a great place to start. Several of the scientists we spoke to had identified products with inefficient packaging and were going back to suppliers looking for alternatives, including using cardboard boxes rather than polystyrene, and minimising plastic packaging for individual items. Scientists looking to reduce their overall plastic consumption can also pick vendors that minimise waste such as 2Bscientific<sup>13</sup>, a large carbon neutral UK supplier

### Better planning of experiments

Ultimately, every scientist has the responsibility to plan experiments to optimise material use. Even though initial purchase costs might be higher, glassware is cheaper in the long run. For example, 30ml autoclavable glass tubes are about 10 times the price of a single plastic falcon, meaning they save money from the 11th use onwards.<sup>14</sup> Reusable glass bottles and pipettes are other alternatives to single-use plastics. Another approach to reducing plastics is to pool resources. For example, scientists can reduce the number of reagent bottles used by buying chemicals in bulk and sharing amongst labs.

### Creating a waste reduction plan

Establishing a waste reduction plan can start from observations in the lab. By going through premises, scientists can identify practices to eliminate waste, this involves observing waste and material flows, behaviour of personnel around waste management, the location of collection bins and disposal fees for

waste tonnages. Scientists in individual labs can help identify wasteful practice. Once an overview has been created, the largest volumes of waste can be assessed for easy wins while more challenging fractions can be identified and a waste reduction plan developed.

### Make it Visible: Lab Waste Day

The third Tuesday in September has been designated #LabWasteDay. Scientists shared pictures with all the plastic waste they have generated during one day of lab work and extrapolate to get an estimate of yearly impacts. On average, scientists produced 300–400g plastic waste in one day, which equates to 70–100kg per year. Collections are shared under the hashtag on twitter and social media along with ideas for how waste can be reduced.

“If the scientists say ‘our work is such that we must use a million tips’ then we have to supply a million tips, **it doesn’t matter if it is single use.**”

Head of Research



## Case Study: #LabWasteDay



# Lab Consumables

## Reusing Lab Products

**A common unknown** throughout labs is whether certain **equipment and consumables can be reused**. Scientists will not risk derailing their experiments, but evidence for safe reuse can help challenge preconceived ideas.

### Reuse of lab consumables

Some lab products such as glassware can be reused if washed and possibly sterilised. Specialist suppliers also allow for reuse of plastic products. The company Grenova provides instruments for washing plastic pipette tips or multi-well plates. The company provides use cases and validation case studies for mass spectrometry, molecular, biochemical, and immuno-based assays.

Plastic materials used in tissue culture, once deemed non-recyclable due to contamination concerns, can now be recycled after implementing safety measures. These materials undergo thorough disinfection with 70% ethanol, followed by rinsing, drying, and eventual recycling as part of mixed dry recycling processes.

### Reuse of lab equipment

Laboratory instruments - such as Mass Spectrometers and Atomic Spectroscopy equipment - contain precious metals, silicone chips, and other finite resources, and creating new instruments require large amounts of plastics, electronics, and energy input required in manufacturing.

In collaboration with My Green Lab, Agilent provides a Certified Pre-Owned Instruments programme,<sup>15</sup> which seeks to give analytical instruments a second life. Once laboratories no longer need equipment, they can return the used instrument to Agilent through a Trade-in and Buyback program and receive credit in exchange for the instrument's residual value.

Agilent engineers perform an inspection, cleaning, and decontamination process to clean and replace parts that have been in contact with lab samples. The instrument will then go through further parts replacement and a series of tests allowing it to pass original specification requirements. This enables Agilent to provide high quality certified pre-owned instruments complete with new covers, consumables, and required firmware and software, for resale.

On a peer to peer basis, The Warp it Reuse Network, allows organisations to find, give away, or loan laboratory equipment, office furniture and other unused resources.

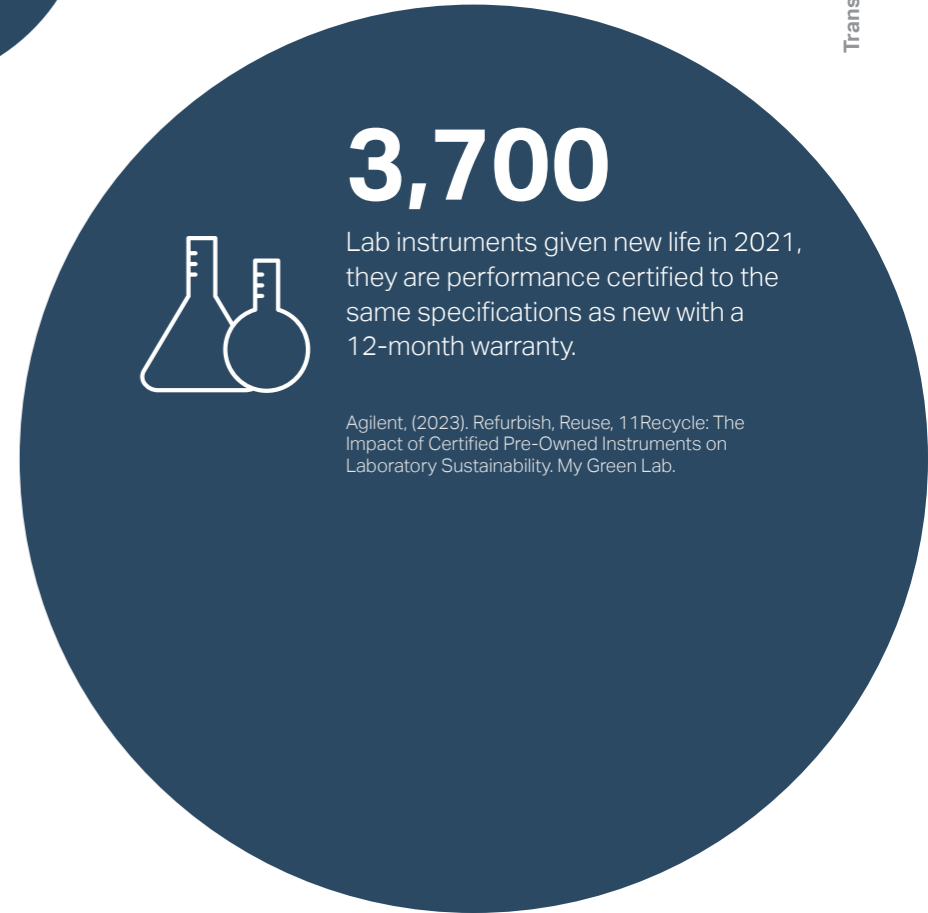


Agilent is the first sponsor of the My Green Lab certification program and the Environmental+Energy Leader Award 2022 winner.



# 2,300

Instruments kept out of landfills in 2021 by trading in old and used instruments.



# 3,700

Lab instruments given new life in 2021, they are performance certified to the same specifications as new with a 12-month warranty.

Agilent, (2023). Refurbish, Reuse, 11Recycle: The Impact of Certified Pre-Owned Instruments on Laboratory Sustainability. My Green Lab.

# Lab Consumables

## Making Recycling Convenient

Most scientists use a large amount of single-use plastic in their experiments, **enabling recycling of this waste stream** is a core challenge in the laboratory setting.

### Contamination remains a hurdle

Currently, less than 1% of single use plastics from labs, including pipette tips, test tubes, petri dishes and multi-well plates, are being recycled.<sup>16</sup> Several of the research facilities we engaged with had little organised infrastructure in place to sustainably deal with this waste stream and scientists complain that waste management companies often show little interest in recycling lab waste.

Chemical or biological contamination introduces understandable challenges in recycling lab plastics. Lab waste often must be washed with chemicals or autoclaved before being sent to landfill or specialist handling companies that will incinerate it. Many local facilities or recycling contractors are hesitant to take materials from labs for general recycling because of concerns about contamination. Worrying about contamination also prevents scientists from recycling plastics in the lab. The University of Edinburgh recently surveyed scientists and found that while 75% reported recycling some types of plastic, many said that they were “not allowed” to recycle anything from the lab in general recycling.<sup>17</sup>

One science lead had decided to take matters into their own hands: “We have a lot of plastic here that is not contaminated but they wouldn’t recycle them. So I’ve been taking them home and take them to Marks and Spencer or Sainsbury’s myself. These are massive bags that I cycle up there to deposit.”

### Enabling take back and sorting

Most recycling of lab plastic waste at scale relies on take-back schemes with individual suppliers. However, many suppliers will not take back materials from other suppliers, which is a challenge compounded by the large variety of products preferred by scientists in the same labs. Laboratories have little space for multiple segregated waste streams and meeting several supplier requirements means taking up a lot of additional space and effort.

Ensuring that people understand how to segregate and recycle items remains a challenge, even when separate bins have been provided for the purpose. Organisations are finding ways to address this through a combination of formal launches of waste initiatives, training and information campaigns, and more informal knowledge-sharing activities, such as Friday sessions with beer and pizza hosted by individual sections or labs. One draw of this approach, explained a lab manager, was that it satisfied people’s curiosity to see each other’s labs while creating a space for sharing of initiatives and results amongst scientists.

“If we find you put things in our recycling that’s wrong, we’ll kind of give you **one strike and then you’re out.**”

Science lead



## Case Study:

### LabCycle: circular economy for lab plastics

UK start-up LabCycle have opened the country’s first facility that can recycle single use plastics from Containment Level 1 and 2 laboratories.

In 2023, LabCycle, a UK start-up co-founded by a University of Bath graduate, launched the country’s first pilot plant capable of recycling up to 60% of lab plastic waste. The aim is to establish the first high-grade recycled lab plastic supply chain, ensuring that lab plastic waste can be recycled at scale rather than be incinerated or go into landfill.

### Fully circular solution

LabCycle targets single-use plastic waste from containment level 1 and 2 laboratories. After decontamination, the plastic is turned into small plastic pellets, which are sent to LabCycle’s manufacturing partner to be turned into new lab equipment, such as 100% recycled petri dishes. A recent collaboration with the University of Bath’s Innovation Centre for Applied Sustainable Technologies (iCAST) has tested the properties of recycled polystyrene (PS), polypropylene (PP) and polyethylene terephthalate (PET) and shown that the polymers are suitable to go full circle and be used to make new lab consumables.

### Lower environmental impact

With support from the Faculty of Science, iCAST, and the Campus Infrastructure team at the University of Bath, LabCycle has set up a pilot recycling plant in a converted greenhouse on campus and is working on implementing waste recycling for its science and engineering labs as well as working with the local NHS Blood and Transplant to recycle waste from their laboratories. The facility incorporates a sorting system to segregate plastics by colours and materials, and uses a novel decontamination process to remove lab contaminants through a combination

of chemical and mechanical methods, eliminating the need for autoclaving the waste. The process has been developed according to the standards of the NHS, and the health and safety protocols from several research institutes.

Experts from the University of Surrey’s Centre for Environment and Sustainability have collaborated with LabCycle to carry out a Life-Cycle Analysis of various treatment strategies for single-use lab plastic waste, and develop an experimental plan for plastic characterisation post-decontamination. The project demonstrated advantages and the climate impact mitigation potential from LabCycle’s recycling process compared to an autoclave-based recycling process, and LabCycle posits that their process generates 10 times fewer CO<sub>2</sub> emissions compared with sending plastic waste to landfill.

### Founded by PhD researcher

LabCycle was founded by Helen Liang, a researcher who experienced the problem with plastic waste first-hand during her PhD studies at the University of Bath. A University of Bath Innovation Award in 2020 allowed Helen to develop LabCycle with her co-founders, whom she met at a SETsquared training workshop for start-ups. Helen was subsequently awarded a Royal Academy of Engineering and Enterprise Fellowship for her work with LabCycle, providing additional cash for developing the business. Since then, LabCycle has secured around £430,000 in funds to develop the technology and start the commercialisation process and is now looking for partners to manufacture lab equipment on a big scale.

# Logistics and Supply

## Streamlining Storage

Optimising storage in labs can reduce clutter and encourage **more efficient uses** of resources. This helps lower the overall energy and material consumption, and might also lead to more satisfied scientists.

Visit a laboratory and chances are you will see boxes spilling across lab benches, stacking up on shelves and falling out of overstuffed cupboards. Storage is tricky in the lab, as many scientists and stores managers told us, since individual teams prefer and require different products leading to a high volume of almost identical products being stockpiled. The nature of science funding further encourages stockpiling as grants usually provide for the purchase of equipment and goods in large quantities. As new grants are won, research projects start up, and teams move on, stockpiled materials might well stay behind:

“

I will say that we do have a lot of things that probably we don't need to keep anymore... **we got samples from 40 years ago** that no one even knows exist.

Technical Lab Manager

”

Scientists are aware of this and almost everybody we spoke to discussed the challenge. Indeed, in a survey of 6,275 lab workers, Leesman (see p. 82-83) found 'finding and acquiring consumables for day-to-day experimentation' to be the second highest rated activity for importance but amongst the lower scored in terms of how well it was supported. Similarly asked to rate the physical lab features, 'supplies storage'

was ranked fourth in terms of importance but only received a 48% satisfaction rate.

### Optimising storage in labs

Several strategies can be implemented to improve storage and logistics in labs. Developing explicit plans for what goes into centralised versus decentralised storage can help provide consolidated space in the lab - but scientists and stores managers professed that this can be a challenge under current funding models where researchers buy products directly on their grants and are therefore reluctant to put these in centralised stores. The ICR has developed training materials for procurement to address the gap in understanding of procurement practices, how to store, and how to label products.

Keeping track of samples in ULT freezers was another key challenge, with several scientists decrying the lack of efficient inventory practices meaning a large number of samples were taking up energy hungry freezer space. Inventory software like the FreezerPro Sample Management System or eLabInventory software can help here, but as creating an overview in the first place and cleaning out old samples will be time-consuming, organisations must prioritise this and allow staff to set aside the time to do so. When someone leaves the lab, a departure checklist that includes reviewing, organising, labelling, or discarding stored samples can help minimise the accumulation of consumables, samples and reagents and ensure that new lab members have space to store their own supplies.



“

We could **manage things better to keep labs clearer for what we do**, because we have sufficient storage. It would just make it much easier to follow the way you're meant to be doing work.

Technical Lab Manager

”

## Case Study: Specifications - Use of Gases

By implementing proactive, regular maintenance routines on their gas infrastructure, research organisations can detect and address potential leaks, not only enhancing safety but also preventing the loss of valuable gases.

In laboratories, a variety of gases serve crucial roles across different scientific endeavours, facilitating diverse laboratory processes, from chromatography and spectroscopy to cell culture and cryogenic preservation. Nitrogen is employed to create inert atmospheres, prevent oxidation, and preserve samples, while oxygen sustains life in controlled environments and supports oxidation reactions. Carbon dioxide regulates pH levels in cell culture, acts as a buffer in chemical reactions, and fosters plant growth simulation. Helium functions as a carrier gas in chromatography and aids in cryogenic cooling.

### **Origins of gas**

Significant energy usage is involved producing and distributing gases used in laboratory settings. In an interview with Matt Gibbons, Director and Co-Owner of Cryoserve, Specialists in Cryogenic and Compressed Gas Engineering, we discussed the industrial-scale processes required for gas production, highlighting the extensive energy consumption involved. Despite substantial energy usage, Matt believes that there is a lack of awareness among research institutions about the environmental impact of gas usage, due to the low cost of procurement and limited budgets for maintenance.

### **Bulk or bottle?**

Bulk storage of gases presents distinct advantages and challenges compared to using gas bottles. While bulk storage offers cost savings, reduces manual handling, and ensures a continuous gas supply, it requires significant initial investment, strict safety precautions, and specialised infrastructure

for handling and distribution. Challenges such as maintaining gas purity, ensuring proper ventilation, and addressing the risk of leaks and pressure fluctuations are critical considerations. Additionally, handling large volumes of gas necessitates adherence to stringent regulatory standards and continuous monitoring to prevent accidents or environmental hazards. In contrast, gas bottles provide flexibility, portability, and ease of use, but they require frequent replacement, occupy space, and can incur higher operational costs over time. Both storage methods require careful evaluation of factors such as usage volume, frequency, and safety protocols to determine the most suitable option for specific laboratory needs.

### **Proactive prevention**

Cryoserve offers services focused on maintaining gas systems efficiently, thereby reducing waste and carbon footprint. Their approach involves identifying leaks and optimising gas usage through methods such as using acoustic cameras to detect leaks and estimating wastage rates. Acoustic cameras can identify and locate leaks quickly and accurately by capturing high-resolution images of sound sources, to detect leaks in pipelines, valves, and other equipment by pinpointing the specific locations where the sound of escaping gas is most intense. Cryoserve explores sourcing carbon dioxide from sustainable sources such as biogas or industrial flue gas discharge, aiming to reduce environmental impact. Matt highlights cost implications of transitioning to sustainable sources and Cryoserve's efforts to minimise waste in gas distribution, including plans to transition to cleaner vehicle fleets.



# Logistics and Supply

## Supply Chain Engagement

By setting common sustainability targets and working collaboratively with suppliers, labs can effectively address the **Scope 3 emissions in their supply chains**, which constitute the lion's share of their overall carbon footprint.

The impact of Scope 3 emissions in laboratories' value chains is generally much higher than emissions from Scope 1 and 2 (see p. 26-27). Thus, a key challenge for labs will be crafting a successful Scope 3 emission-reduction approach, which requires operational and technological improvements as well as engagement with suppliers in lowering life cycle emissions.

### Strategies for supply chain engagement

We spoke to several scientists and stores managers who had successfully engaged with suppliers to improve procurement. This starts by creating lists of preferred suppliers who prioritise sustainability, ensuring that lab equipment, chemicals, and supplies come from sources with lower carbon footprints (see p. 132-133).

Several labs had developed simple questionnaires, that they were sending out to suppliers to get answers on sustainability allowing scientists to make more informed decision. This approach extends to follow up discussions with suppliers, encouraging them to optimise transportation and packaging to actively reduce emissions.

In the lab, conducting product Life-cycle Assessments (LCAs) can be crucial for understanding the environmental impact of lab products from production to disposal, informing procurement decisions that favour eco-friendly choices (see p. 113-115).

### Responsible procurement frameworks

The Responsible Procurement Group (RPG) is a collaboration of The Alliance for Sustainability Leadership in Education (EAUC) and HEPA (the network for procurement professionals in the HE sector). The purpose of the RPG is to identify and promote best practice on responsible procurement throughout the sector and to stimulate the development of resources, principles and guidance to support members on responsible procurement.

The GHG Protocol supplies the world's most widely used greenhouse gas accounting standards and have developed an overview of the most impactful Scope 3 reporting and reduction strategies.<sup>17</sup> These strategies represent a comprehensive approach to environmental responsibility in procurement and supply chain management, with the potential to create significant positive impacts on decarbonising operations within the laboratory sector.



### Green Procurement

Establish a preference for suppliers who prioritise sustainability. Source lab equipment, chemicals, and supplies from suppliers with lower carbon footprints and environmentally-friendly production processes.

### Conduct Product LCAs

Conduct lifecycle assessments of laboratory products to understand their environmental impact from production to disposal. Use this information to make informed procurement decisions.

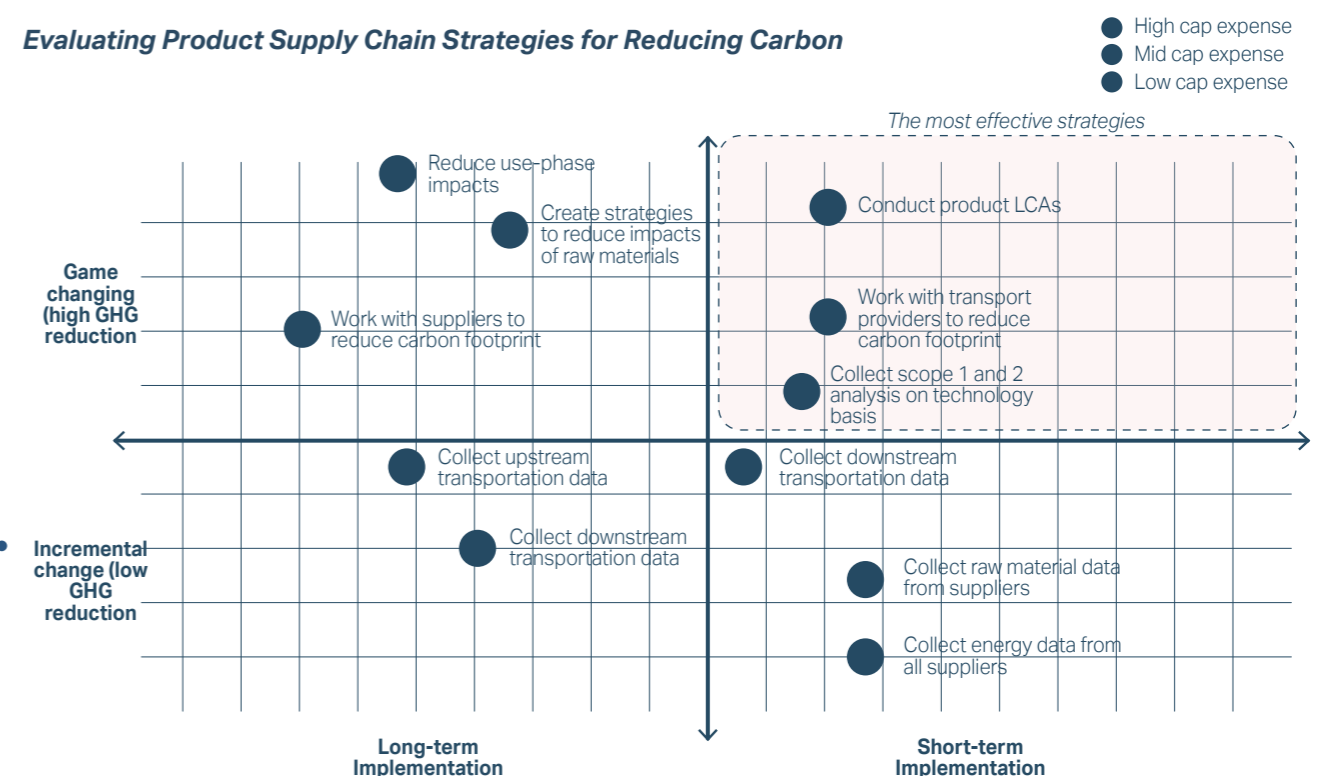
### Work with Suppliers to Reduce Carbon

Only work with suppliers that optimise transportation and packaging and actively reduce emissions associated with the supply chain - encourage them to adopt sustainable practices.

### Sustainability Reports and Tracking

Conduct regular audits and assessments of suppliers, publish annual sustainability reports - share progress, achievements, and areas for improvement with stakeholders.

### Evaluating Product Supply Chain Strategies for Reducing Carbon



## Case Study:

# Open Letter on Supplier Targets from the Sustainable Markets Initiative Health Systems Task Force

The Health Systems Task Force of the Sustainable Markets Initiative, comprising CEOs of leading healthcare companies, has issued an open letter urging suppliers to commit to minimum climate and sustainability targets.

Launched at COP 26 in 2021, this public-private strategic partnership brings together CEOs and leaders from AstraZeneca, GSK, Merck KGaA, Novo Nordisk, Reckitt, Roche, Samsung Biologics, Sanofi, Bupa, Novartis, National Health Service England, the Sustainable Healthcare Coalition, UNICEF, the University of Pavia, and the World Health Organization (WHO).

The initiative aims to decarbonise the healthcare value chain, addressing the sector's significant contribution to global greenhouse gas emissions, which stands between 3-5%, with half emanating from supply chains. In 2023, the initiative circulated an open letter on supplier targets, signed by CEOs of Novo Nordisk, Merck, Sanofi, Novartis, Samsung Biologics, AstraZeneca, GSK, and the Chairman of Roche. The letter urges suppliers to commit to joint, minimum climate and sustainability targets as part of efforts to decarbonise the healthcare value chain.

The targets have been developed collaboratively and are integrating supplier perspectives, seeking to streamline sustainability efforts, reduce complexity, and encourage greener, more efficient, and circular healthcare supply chains. Stronger collaboration with suppliers is emphasised, including support in achieving these goals.

In response to the open letter, companies like Croda, a supplier in the healthcare industry, have expressed strong support for the initiative. Croda has outlined its current status in relation to the supplier targets announced in the open letter. For instance, they

have been assessing and disclosing their Scope 1, 2, and 3 emissions for several years and have set targets aligned with the 1.5-degree pathway of the Science Based Targets initiative (SBTi). They are also working towards eliminating process waste to landfill across their operations by the end of 2024 and have committed to using 80% renewable power by 2030. Additionally, Croda is exploring options for sourcing green heat and has set targets for increasing water efficiency.

These actions demonstrate a commitment from suppliers to align with the sustainability targets set out by the Sustainable Markets Initiative Health Systems Task Force, indicating a collaborative effort across the healthcare value chain to address climate change and its impacts on health.

Initiatives like this, which encourage closer relationship with suppliers, are crucial for laboratories in their journey to decarbonise operations and reduce carbon emissions. By setting common sustainability targets and working collaboratively, labs can effectively address the emissions in their supply chains, which often constitute a significant portion of their overall carbon footprint. Such partnerships enable the sharing of best practices, innovations in sustainable technologies, and the development of more efficient and environmentally friendly processes. This collective approach not only streamlines efforts across the industry but also amplifies the impact of sustainability initiatives, leading to a more substantial and faster reduction in carbon emissions.

### Health Systems Task Force Members Share Joint, Minimum Climate and Sustainability Targets for Suppliers



Sustainable Markets Initiative



#### Dimension



#### Supplier Targets

**Disclose emissions**

**Assess and disclose Scope 1, 2, and 3 emissions by 2025**

**Set science-based targets**

**By 2025, commit to set our near-term targets aligned to the 1.5°C pathway (SBTi)**

**Reduce, recycle and reuse waste and energy**

**By 2025, set targets to reduce waste (including solvents) & energy, and reuse materials in manufacturing**

**Switch to renewable power**

**Commit to switch to at least 80% renewable power by 2030 & make commitment public**

**Switch to renewable heat**

**By 2030, explore options to source green heat**

**Cascade targets upstream**

**Commit to set standards for own suppliers**

**Reduce water usage**

**Set targets to increase water efficiency and commit to adopt water stewardship standards**

**Decarbonise transport solutions (transport suppliers only)**

**Transport suppliers to make SBTi-aligned commitments by 2025 and include green transportation solutions in their core offering by 2030**

By 2025

Continuous beyond 2025

# Improving Operations Summary

## Main Challenges

Despite **large carbon footprints**, there is **little transparency** about what drives this in labs beyond obvious energy heavy building operations, which frustrates efforts to identify and implement meaningful change.

### **Complex regulatory constraints:**

Navigating the regulatory context governing standard operating procedures (SOPs) is challenging, as it requires ensuring compliance with complex environmental regulations. At the same time, organisations must also focus on achieving their sustainability goals. Changing SOP's requires significant resource and investment which can detract from science.

### **High energy demand from building operations:**

Building systems, designed to maintain optimal air quality and temperature, are by far the biggest consumer in laboratory buildings that often require 24/7 operations. The challenge of reducing building energy requires collaboration amongst building owners, occupiers, scientists, and regulatory authorities to implement efficient technologies and practices. Ensuring that SOPs align with regulatory requirements is essential for labs seeking to minimise their environmental impact.

### **High energy demand from equipment:**

The use of energy-intensive equipment and overall lack of understanding of their impact within labs significantly contributes to greenhouse gas emissions. This requires a focused approach on optimising the use of such equipment and exploring alternatives that offer similar capabilities but with lower energy consumption. Despite the significant environmental impact of lab equipment misuse, many scientists remain unaware of its adverse effects on the climate.

### **Difficulty in equipment change:**

Essential lab equipment presents challenges in upgrading to more sustainable options due to financial, technical, or regulatory constraints. Overcoming this involves researching alternative equipment that meet both scientific and environmental standards, and investigating the reuse, refurbishment, and resale of equipment that is typically degraded.

### **Waste and contamination concerns:**

The generation of large amounts of waste, including single use plastics, hazardous chemicals and nonrecyclable materials in labs poses environmental and logistical challenges. Labs need to implement more effective waste management and reduction strategies, emphasising recycling and proper disposal methods. Solving this challenge requires buy in and collaboration with specialist waste contractors able to implement sustainable alternatives.

### **Lack of supply chain transparency:**

Scope 3 emissions from laboratories' supply chains remains by far the largest source of green house gas emissions. A lack of transparency in lab product supply chains regarding environmental impacts of equipment and products hampers efforts to adopt more sustainable practices. Organisations need to be more demanding of greater transparency and sustainability from suppliers.



# Improving Operations Summary

## Main Opportunities

Addressing the environmental challenges in laboratory operations requires integration of sustainability into the **core scientific mission**, optimising energy use in building operations, implementing effective waste management, and driving greater transparency and waste in the supply chain.

### **Optimise building energy use:**

Focus on major energy-consuming operational systems to reduce the carbon footprint by assessing energy efficiency, implementing best practices, and investing in newer technologies. Collaborate with stakeholders to implement energy-efficient building technologies and align SOPs with regulatory requirements.

### **Promote equipment transparency:**

Educate lab users on the environmental and energy impacts of lab equipment to encourage sustainable practices including metering, switching off, and sharing of equipment.

### **Facilitate equipment upgrades:**

Overcome financial, technical, and regulatory barriers to upgrading lab equipment by researching sustainable alternatives and promoting equipment reuse. Ensure new equipment meets both scientific and environmental standards.

### **Streamline lab storage and right-size equipment:**

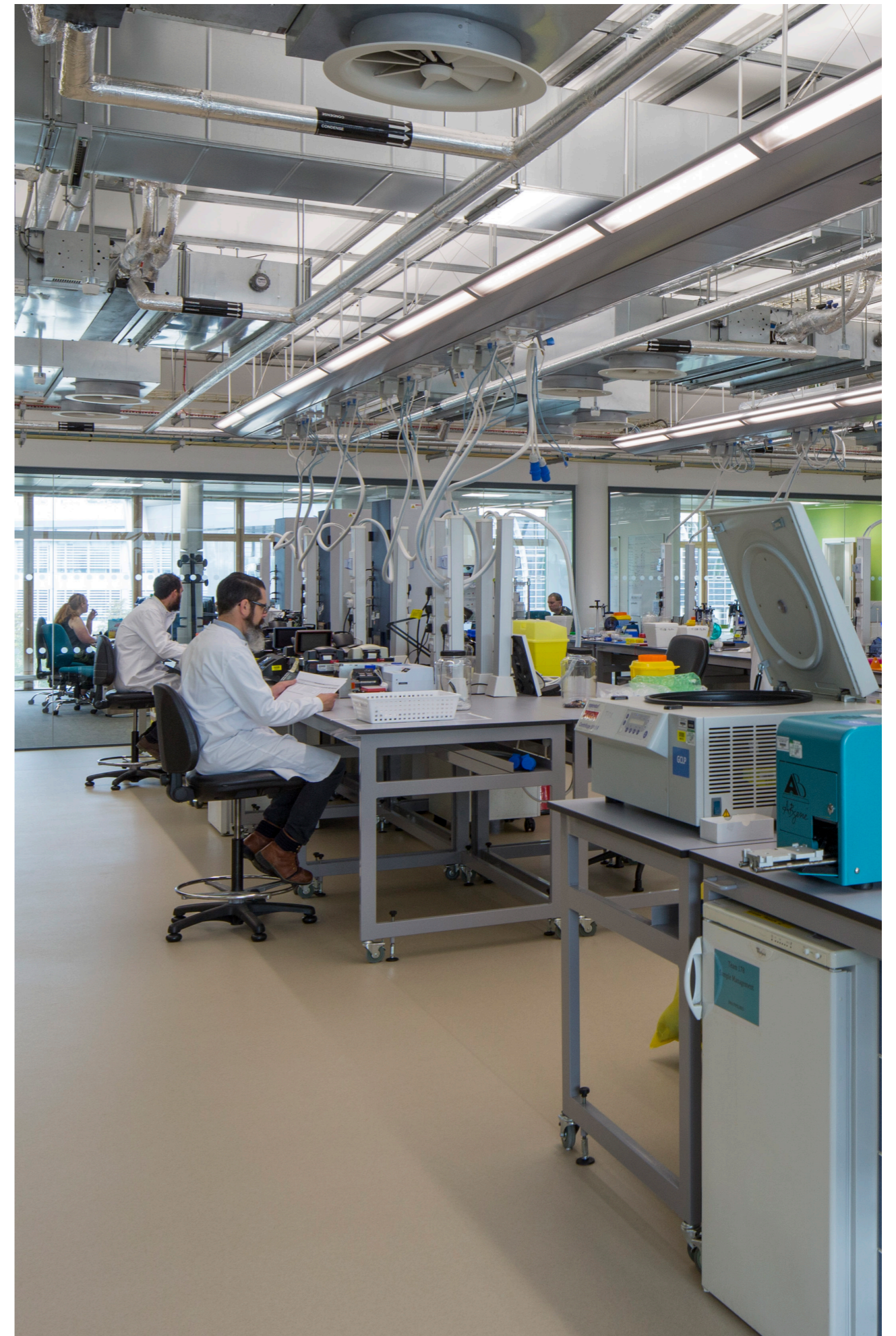
Enhance lab storage and layout to improve efficiency and reduce material and energy consumption. Match equipment size to actual needs, avoiding unnecessary energy use and resource waste.

### **Implement effective waste management:**

Develop waste management strategies focusing on recycling and proper disposal. Collaborate with specialist waste contractors to handle single-use plastics, hazardous chemicals, and non-recyclable materials sustainably.

### **Enhance supply chain transparency:**

Demand transparency from suppliers on environmental impacts for lab users to make informed, sustainable choices in lab equipment and products.



# Roadmap for Change Operations: Energy

## Understand Context (Impact & Challenges)

Labs may have fluctuating occupancy levels and usage patterns, making it **difficult to optimise HVAC systems for energy efficiency** without compromising safety and comfort.

Labs must **adhere to strict safety standards**, including maintaining specific temperature, humidity, and ventilation levels to ensure the safety of occupants and experiments.

Many lab buildings have older, inefficient MEP systems that **may not be easily upgradeable or compatible** with modern energy-saving technologies.

Lab occupants' behaviours, such as **leaving equipment running when not in use** or improperly adjusting HVAC settings, can significantly impact energy consumption.

**Lack of accurate energy usage data** and benchmarks specific to laboratory buildings can make it challenging to identify areas for improvement and track progress over time.

Lab facilities **must comply with various energy codes, standards, and regulations**, meaning staying abreast of changing requirements is complex.

**Limited budgets for energy efficiency initiatives** and competing priorities for research funding may hinder investments in energy-saving measures and technology upgrades.

**Incorporating renewable energy sources** such as solar or wind power into lab buildings **can be challenging** due to space constraints, building orientation, and regulatory barriers.

Specialist equipment like fume hoods, autoclaves, incubators, and refrigerators **require precise environmental conditions and consume significant amounts of energy**.

**Understanding the energy consumption patterns** and environmental impact of such equipment requires detailed analysis and specialised knowledge.

Lab users' behaviours, such as **leaving equipment running when not in use** or **improperly adjusting HVAC settings**, can significantly impact energy consumption.

Researchers and lab personnel **may resist changes to equipment usage habits or procedures**, particularly if they perceive sustainability measures as burdensome or disruptive to their work.

**There may be a lack of comprehensive data on the energy usage and carbon footprint of specific types of specialist equipment**.

Ensuring lab equipment is energy-efficient and properly maintained is crucial. However, **purchasing energy-efficient equipment can be costly, and retrofitting existing equipment may not always be feasible**.

Upgrading to more energy-efficient specialist equipment may involve **significant upfront costs**.

Newer, more energy-efficient equipment **may not always offer the same level of performance or compatibility with existing workflows**, with a perceived risk to research quality or productivity.

While there is increasing recognition of the need for efficiency in lab equipment, **regulatory guidance specific to specialist equipment may be limited**.

Sustainable use of specialist equipment involves not only energy-efficient operation but also **proper maintenance and disposal practices**.

## Raise Awareness

**Engage occupants and foster a sense of ownership and accountability** for resource conservation.

**Develop and implement educational campaigns** to inform lab occupants about the importance of energy conservation, the impact of their operations, and the benefits of reducing energy consumption.

**Organise training sessions and workshops** to educate lab users on energy-efficient practices, such as proper equipment usage, temperature control, and ventilation management.

**Utilise various communication channels**, including email newsletters, bulletin boards and intranet portals, to disseminate information about energy conservation initiatives, tips, and success stories.

**Host interactive workshops and seminars** where lab users can learn about energy-saving technologies, participate in energy audits, and discuss ways to improve energy efficiency in their workspaces.

**Collaborate with other organisations, and academic institutions** to leverage resources and share best practices and lessons learnt.

**Recognise and reward lab users and teams** that demonstrate exemplary energy-saving practices or achieve significant reductions in energy consumption.

**Showcase energy-efficient technologies, retrofits, and best practices** through demonstration projects within the lab facility.

**Provide training and support to researchers** on the proper use and maintenance of specialist equipment.

**Facilitate communication and coordination** among researchers, laboratory managers, and equipment operators to ensure smooth scheduling and usage of specialised equipment.

**Establish clear channels for collaboration**, such as shared calendars, email alerts, or messaging platforms, to notify users of equipment availability, maintenance schedules, or unexpected downtime.

**Conduct reviews of usage patterns and consumption behaviours** to identify opportunities for improvement and optimisation.

**Assess the usage patterns and demand for each piece of equipment** to identify high-demand items and periods of peak usage. Analyse historical data, user feedback, and research schedules to understand utilisation patterns effectively.

**Utilise advanced monitoring and data analytics tools** to track resource usage in real-time and identify trends, anomalies, and opportunities for optimisation.

**Engage researchers in the review process by soliciting feedback, conducting surveys, and organising focus groups** to understand their needs, preferences, and challenges related to equipment use.

**Incorporate researcher input into decision-making processes** and co-create solutions that resonate with their priorities and workflows.

**Conduct lifecycle assessments (LCA)** to evaluate the environmental impacts of lab equipment from cradle to grave, considering factors such as raw material extraction, manufacturing, use, and disposal.

## Prototype & Implement Solutions

**Encourage practices such as turning off lights and equipment when not in use**, adjusting thermostat settings responsibly, and minimising air changes in fume hoods.

**Implement green lab certification programs like My Green Lab, LEAF or Green Impact**, to encourage users to adopt sustainable research practices, and provide a framework for improvement.

**Design energy-efficient heating, ventilation, and air conditioning (HVAC) systems** with programmable thermostats and zone controls to regulate temperature based on occupancy and usage patterns.

**Invest in smart BMS** to monitor and control energy usage in real-time, and identify opportunities for energy savings through data analytics.

**Install high-efficiency fume hoods** equipped with sash position sensors, airflow monitors, and automatic sash closers to minimise exhaust airflow rates and reduce energy consumption without compromising safety.

**Enhance insulation, seal air leaks, and install energy-efficient windows** to improve the thermal performance of the building envelope and reduce cooling loads.

**Install occupancy sensors and smart controls** for equipment to automatically power off or enter standby mode when not in use.

**Continuously monitor usage patterns**, measure key performance indicators, and adjust strategies as needed to ensure ongoing improvement and alignment with sustainability goals.

**Make resource and funding provision** to progress set point reduction in high energy storage equipment like ultra-low temperature freezers.

**Prioritise the purchase of energy-efficient laboratory equipment** with high Energy Star ratings or other certifications. Consider equipment with energy-saving features such as automatic shutoff and low-power modes.

**Consider the lifecycle cost and energy consumption of equipment** when making procurement decisions.

**Implement a reservation system or scheduling software** that allows researchers to book equipment in advance based on their experiment schedules.

**Set rules and guidelines for equipment reservations**, including maximum booking durations, advance notice requirements, and penalties for no-shows or cancellations without notice.

**Establish a priority booking system to ensure equitable access to high-demand equipment**. Assign priority levels based on factors such as project deadlines, seniority, and the criticality of experiments.

**Allocate dedicated time slots or priority access periods for specific research groups, departments, or projects** to accommodate urgent or time-sensitive experiments.

**Use scheduling data and utilisation metrics** to optimise resource allocation and minimise idle times. Identify opportunities to consolidate experiments, group similar tasks, or share equipment between research groups to maximise efficiency.

**Implement flexible scheduling policies** that allow for dynamic adjustments based on change.

## Monitor & Control

**Implement real-time monitoring systems for energy** to track consumption and identify inefficiencies promptly.

**Utilise BMS to centralise control and monitoring of various building systems**, share data on common platforms to allow lab users and managers to understand and adjust settings based on occupancy, weather conditions, and energy demand.

**Install smart meters and submeters** to disaggregate energy and water usage by specific equipment, areas, or research groups for more granular analysis of consumption patterns.

**Conduct regular energy audits and assessments** to identify opportunities for energy savings and efficiency improvements.

**Establish KPIs to measure progress toward sustainability goals and objectives** with quantifiable metrics and track performance.

**Solicit feedback from laboratory occupants through surveys, focus groups, or suggestion boxes** to assess satisfaction levels, identify concerns, and gather suggestions for improvement.

**Establish feedback mechanisms**, such as suggestion boxes, online forums, or surveys, to solicit input from lab occupants regarding energy-related issues, ideas for improvement, and feedback on existing initiatives.

**Conduct regular performance reviews, stakeholder consultations, and lessons learned sessions** to identify areas to refine of the building systems.

**Monitor equipment usage and performance metrics regularly** to identify bottlenecks, inefficiencies, or opportunities for improvement.

**Encourage lab users to actively monitor and adjust equipment settings** based on energy consumption data and participate in energy-saving initiatives.

**Implement energy monitoring systems** that collect real-time data on energy usage, allowing lab managers to track energy consumption patterns and identify areas for improvement.

**Collaborate with users to interpret findings**, develop action plans, and implement targeted interventions to reduce resource consumption.

**Integrate sensors with building management systems** to automatically adjust equipment settings based on occupancy, schedule, and energy demand.

**Install submeters on lab equipment** to monitor energy consumption at a granular level.

**Track key indicators** such as utilisation rates, downtime, reservation accuracy, and user satisfaction levels.

**Utilise remote monitoring technology** to access equipment energy usage data and control settings from a centralised dashboard or mobile app.

**Conduct periodic reviews and performance evaluations** to assess the effectiveness of scheduling strategies, identify areas for optimisation, and implement continuous improvement initiatives accordingly.

**Designate trained personnel or lab specialists to oversee ongoing equipment usage, troubleshoot technical issues, and provide assistance** as needed during experiments.

# Roadmap for Change

## Operations: Waste

### Understand Context (Impact & Challenges)

**Biohazardous Waste Identification and Categorisation:** Accurate identification and categorisation of biohazardous waste are crucial for its proper handling and disposal.

**Regulatory Compliance:** Compliance with strict regulations governing the handling, transportation, and disposal of biological waste is mandatory.

**Risk of Contamination:** Improper handling and disposal of biological waste can lead to contamination risks.

**Segregation and Packaging:** Proper segregation and packaging are necessary to prevent cross-contamination and ensure safe handling of biological waste.

**Storage Challenges:** Space, containment, and safety are key challenges in storing biological waste.

**Treatment Limitations:** Treatment options such as autoclaving, incineration, or chemical disinfection are available, but some biological wastes require specialised methods.

**Environmental Impact:** Improper disposal of biological waste can lead to soil, water, and air contamination, causing environmental harm.

**Public Perception:** Handling and disposal of biological waste can affect public perception and the reputation of laboratories and research institutions.

**Training and Education:** Laboratory personnel need adequate training to ensure awareness of biohazardous waste management practices and compliance with safety protocols.

**Chemical Waste Management:** Disposal of diverse chemical wastes requires specialised knowledge and infrastructure.

**Economic Challenges:** Small quantities of chemical waste make it economically challenging to implement sustainable disposal methods.

**Limited Storage:** Limited storage space for chemical waste can lead to the accumulation of hazardous materials if disposal options are not available.

**Regulatory Navigation:** Complying with stringent regulations is time-consuming and requires expertise.

**Research Protocols:** Scientists must adhere to waste management protocols to minimise disruptions to research activities.

**Cost of Sustainable Methods:** Sustainable disposal methods like treatment, recycling, or incineration can be costly.

**Safety Risks:** Improper handling or disposal of chemical waste poses serious safety risks, including exposure to toxic, corrosive, or flammable substances.

**Specialised Training:** Lab staff need specialised training to handle chemical waste safely and understand sustainable disposal practices.

**Coordination and Communication:** Coordinating disposal efforts and communicating best practices across departments or research groups can be challenging.

**Innovative Disposal Methods:** Developing innovative disposal methods such as on-site treatment technologies or closed-loop recycling systems requires investment.

**Environmental Planning:** Minimising environmental impacts while maximising resource recovery requires careful planning and implementation of sustainable disposal strategies.

### Raise Awareness

**Regular Training Sessions:** Organise frequent training sessions and workshops focused on the safe handling, segregation, packaging, and disposal of biological waste.

**Comprehensive Coverage:** Cover topics such as biohazard identification, regulatory compliance, risk assessment, and emergency response procedures in training programs.

**Ongoing Education:** Maintain ongoing training programs to continuously educate staff on risk assessment, waste segregation, and emergency response.

**Hands-On Demonstrations:** Provide practical exercises and hands-on demonstrations to reinforce learning and ensure comprehension among laboratory personnel.

**Safety Briefings:** Conduct safety briefings and toolbox talks before experiments to remind staff of proper waste management practices.

**Real-Life Examples:** Use case studies, incident reports, and real-life examples to illustrate the risks and consequences of improper waste handling.

**Continuous Improvement:** Foster a culture of continuous improvement by regularly reviewing and evaluating the effectiveness of training efforts.

**Transparency and Engagement:** Ensure transparency, accountability, and community engagement to build trust and address public concerns.

**Feedback Integration:** Incorporate lessons learned, feedback, and emerging challenges into future initiatives to enhance awareness-raising activities.

**Chemical Waste Management Training:** Conduct regular training on proper chemical waste management, including handling, storage, labeling, and disposal.

**Practical Exercises for Chemical Waste:** Provide hands-on demonstrations and practical exercises specific to chemical waste management.

**Open Communication:** Encourage open dialogue among lab personnel to discuss chemical waste management issues, challenges, and best practices.

**Active Participation:** Promote active participation in discussions and problem-solving activities to improve waste management practices.

**Plastic Waste Education:** Organise educational sessions on the environmental impact of plastic waste and the importance of reducing plastic use in labs.

**Lifecycle and Pollution of Plastics:** Cover topics such as the lifecycle of plastics, environmental pollution, health concerns, and regulatory requirements.

**Case Studies and Success Stories:** Share case studies and success stories of laboratories that have reduced plastic use to inspire team members.

**Supply Chain Review:** Evaluate the sustainability credentials of suppliers and prioritise sourcing from those offering sustainable alternatives to plastics.

**Cardboard Waste Reduction:** Organise sessions to discuss the environmental impact of cardboard waste and promote sustainable packaging alternatives.

**Polystyrene Waste Education:** Educate lab personnel on the environmental impact of polystyrene waste and the benefits of adopting sustainable alternatives.

**Gas Usage Awareness:** Raise awareness about the environmental and financial implications of inefficient gas usage and promote proactive measures to reduce waste.

### Prototype & Implement Solutions

**Invest in Infrastructure and Training:** Allocate resources to develop effective waste management systems, including infrastructure, technologies, and personnel training, to ensure regulatory compliance.

**Peer-to-Peer Mentoring:** Establish mentoring programs where experienced staff guide newcomers on proper waste management practices.

**Encourage Open Communication:** Foster a culture of continuous learning and improvement through open communication and knowledge sharing among colleagues.

**External Collaboration:** Partner with environmental agencies, waste management companies, and research institutions to exchange knowledge and stay informed on emerging trends in biological waste management.

**Comprehensive Documentation:** Develop and distribute guidelines, SOPs, and safety manuals detailing best practices and regulatory requirements for handling biological waste.

**Accessible Documentation:** Ensure that all waste management documents are easily accessible and regularly updated for laboratory personnel.

**Visual Aids:** Create and display posters, infographics, and signage in lab areas to highlight key waste management practices and challenges.

**Chemical Waste Management Documentation:** Provide detailed guidelines, SOPs, and safety manuals for chemical waste management, ensuring they are accessible and updated.

**Prominent Signage:** Install clear signage in laboratories to remind personnel of proper waste disposal practices and locations of waste collection points.

**Label Waste Containers:** Use informative labels on waste containers to indicate contents, hazards, and disposal instructions, ensuring proper segregation and handling.

**Sustainability Connection:** Emphasise the link between proper waste management and the organisation's sustainability goals, promoting responsible stewardship.

**Integrate Sustainability Principles:** Incorporate sustainability into lab operations, selecting eco-friendly alternatives and supporting recycling initiatives.

**On-Site Treatment Methods:** Implement on-site treatment methods to neutralise or detoxify chemical waste before disposal.

**Reduce Plastic Use:** Lead by example in reducing plastics in labs, switching to reusable alternatives and implementing recycling programs.

**Practical Tips for Plastics:** Provide practical tips and resources for identifying and implementing alternatives to plastics.

**Collaboration for Plastic Reduction:** Encourage team collaboration to identify innovative solutions for reducing plastic use and promoting sustainability.

**Set Clear Goals for Plastic Reduction:** Establish and communicate clear goals and measurable metrics for reducing plastic use in labs.

**Reduce Cardboard Waste:** Minimise the use of cardboard packaging, promote reusing boxes, and seek sustainable alternatives.

**Training for Cardboard Waste Reduction:** Offer training sessions on reducing cardboard waste and provide resources for sustainable packaging solutions.

**Reduce Polystyrene Waste:** Implement strategies to minimise polystyrene use, seek alternative materials, and promote sustainable practices.

### Monitor & Control

**Interactive Workshops:** Organise workshops, quizzes, or games focused on biological waste management methods implemented to engage lab personnel and monitor success.

**Group Discussions:** Incorporate group discussions, brainstorming sessions, and problem-solving activities within weekly lab communications to ensure continuous feedback.

**Solicit Feedback:** Gather feedback from lab personnel on their understanding of waste management improvements and progress against targets.

**Feedback Mechanisms:** Use surveys, suggestion boxes, or anonymous methods to collect input and identify areas for enhancement on current and proposed initiatives.

**Recognition Programmes:** Recognise and reward lab personnel for exemplary practices in waste management with awards, certificates, or performance acknowledgments.

**Incentives:** Use incentives to motivate participation in waste management initiatives, such as proper segregation and compliance with protocols.

**Waste Tracking Software:** Implement software to streamline waste collection, tracking, and reporting, enhancing transparency and accountability.

**Chemical Waste Recognition:** Acknowledge lab personnel who demonstrate best practices in chemical waste management, similar to biological waste.

**Regular Assessment:** Regularly evaluate the effectiveness of awareness efforts through surveys and feedback, adjusting strategies as needed.

**Stakeholder Engagement:** Engage stakeholders, including researchers, suppliers, and vendors, in monitoring and evaluating waste management initiatives.

**Continuous Improvement:** Foster a culture where team members feel empowered to experiment with and implement new sustainability ideas.

**Define Metrics:** Establish specific metrics and KPIs to measure the effectiveness of initiatives aimed at reducing plastics use.

**Celebrate Achievements:** Recognise and reward team members for leadership and innovation in sustainability, celebrating milestones and contributions.

**Ongoing Support:** Provide continuous support, guidance, and feedback to team members on reducing plastics use and implementing sustainable practices.

**Regular Review:** Regularly review progress, solicit feedback, and adjust strategies to ensure alignment with sustainability goals.

**Conduct Audits:** Perform regular audits and assessments to evaluate the success of waste reduction initiatives and identify areas for improvement.

**Supply Chain Engagement:** Continue to engage with supply chain to continually review available procurement options and bring suppliers on the sustainability journey.

**Measurable Metrics:** Establish metrics for tracking cardboard usage reduction and adoption of sustainable packaging alternatives.

**Recognition for Efforts:** Provide regular feedback and recognition to team members contributing to waste reduction and overall lab sustainability.

**Life Cycle Assessment:** Use Life Cycle Assessment to evaluate the environmental impact of waste reduction initiatives, refining strategies based on performance data and feedback.

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# 04. Better Buildings

## 04. Better Buildings

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# Introduction

## The Design Challenge

By identifying design principles that have the **biggest impact on carbon**, teams can strike a balance between general guidelines and tailored recommendations to optimise laboratory design effectively.

### **Strategic briefing and design**

With a large pipeline of labs under development and in planning (see page 38-39), getting the business case right is essential to ensure the long-term viability of new laboratory buildings. Understanding the occupier and market is key to setting out the right brief for design and evaluating trade-offs emerging in the design process. In this chapter, we review both how to get the brief right at the earliest stages of development and considerations for low-carbon design throughout the development stages.

By prioritising sustainable design principles built into the laboratory's infrastructure, the building's carbon footprint will be reduced while also driving down operational costs for tenants; making the facility as attractive as possible to prospective occupiers.

Amenities such as shared equipment facilities, shared collaboration spaces as well as efficient logistics and storage strategies will contribute to a social work environment that enhances the overall appeal of the building to its occupants.

The layout and functionality of the laboratory space must align with the specific needs of scientific research while maximising efficiency and resource utilisation. At this stage, strategic advisory in design and project delivery is critical to ensure that the brief is set right with a deep understanding of the science to be undertaken.

By enabling the right level of flexibility and adaptability in the building, organisations will be able to optimise space according to their experimental

requirements. However over designing for flexibility and adaptability that is not utilised in the future is inherently wasteful and should be avoided - striking the balance is key.

### **Adapt & Flex**

By adopting a balanced approach to adaptability and flexibility, teams can create low-carbon labs that meet the needs of tenants and stakeholders without sacrificing sustainability.

Adaptability and flexibility are essential considerations when constructing and refurbishing labs, but they must be balanced with the risk of overdesigning, which can lead to wasteful and unsustainable outcomes. Designers must prioritise thoughtful design and infrastructure decisions that strike a balance between flexibility and resource efficiency to minimise carbon emissions throughout the facility's lifecycle. Rather than defaulting to highly flexible layouts and structures, focus should be on optimising space utilisation and functionality without unnecessary complexity. This approach involves designing efficient, multipurpose spaces that can accommodate a variety of research needs while minimising the need for frequent reconfigurations. By adopting a less-is-more mentality, we can reduce the embodied carbon associated with excessive construction materials and building systems.

Instead of constantly chasing the latest technologies and trends, we should prioritise durability, longevity, and energy efficiency in building systems and equipment. Investing in high-quality, low-maintenance infrastructure that is designed

to withstand evolving needs and technological advancements can minimise the need for frequent upgrades and renovations, thereby avoiding both operational and embodied carbon emissions over time.

### **The challenge of "lab-enabled" spaces**

The concept of providing lab-enabled spaces is a recent concept that is potentially wasteful if these spaces turn out to be used for lower specification labs or more typical office purposes. Considering the divergent needs of the different branches of science occupiers, the decision of whether to design a building with lab-enabled capabilities has become a perplexing challenge - there are complex trade-offs between embodied and operational carbon, market dynamics, and the changing nature of laboratory spaces due to advances in technology and innovation in research. Compared to offices, lab-enabled buildings tend to have higher embodied carbon due to the additional materials and complex systems required to support anticipated laboratory functions that may not be required in the future. This raises questions about the long-term sustainability benefits versus the upfront environmental cost.

### **Understand the market**

The market competition is fierce, and the lack of standard specifications risks some lab-enabled spaces possibly becoming prematurely obsolete, as occupiers find better-specified spaces. If demand is uncertain or leans towards alternative uses like offices, the resources expended on lab enablement might go to waste. Laboratories tend to have high tenancy turnover rates - researchers move,

occupiers grow and contract, science methods change, and the functions of laboratory spaces can shift rapidly. Building a lab-enabled facility that may later transition back to office use or another function raises questions about the practicality and sustainability of such investments. Often, these changes can render lab-enabled spaces ineffective or even counterproductive.

### **To spec or not to spec, that is the question**

An alternative route to market for laboratory investors and asset owners is to provide fully fitted "speculative" spaces to suit certain types of occupier. This method generally enables speed to market and occupation that suits some occupiers that require less specialisation of their space, however it requires an in depth understanding by designers and investors of the science type and its needs. As with lab enabled spaces, the risk of over-specifying is high.

### **Specialisation vs. generalisation**

Another option in laboratory design is whether to create hyper-specialised labs for a specific type of science or research, or maintain flexibility across spaces. Creating specialised spaces allows tailoring of labs according to a common goal, which can be supported by generic lab spaces for a wider range of users and uses. Specialisation can enhance functionality but may limit flexibility and future adaptability. Striking the right balance requires vision and understanding of future needs, but is crucial to ensure that a building remains relevant and sustainable over time.

# Strategic Considerations

## Developing an Ecosystem

By fostering partnerships, engaging with stakeholders, and providing supportive infrastructure and services, developers can build a dynamic ecosystem driving positive impact and **long-term success** for a laboratory complex.

Developing an ecosystem around laboratory developments is vital to foster collaboration, innovation, and sustainability within the scientific community. An ecosystem encompasses a network of stakeholders, including researchers, academic institutions, government agencies, industry partners, and community organisations, working together around shared goals and common challenges. Creating an ecosystem involves more than just constructing physical infrastructure; it requires cultivating a supportive environment conducive to scientific discovery and environmental stewardship.

### Create space for collaboration

Projects should foster partnerships and collaboration opportunities among laboratory users, supported by design choices that facilitate knowledge exchange and interdisciplinary research initiatives, and providing access to resources and support services that enable researchers to thrive.

We increasingly see a premium on provision of shared amenities and services that enhance the overall experience for laboratory users and promote collaboration and networking opportunities. These may include coworking spaces, conference facilities, networking events, and access to specialised equipment and technical support services. By creating a dynamic and interconnected ecosystem, asset owners can attract top talent, foster innovation, and position their laboratory complex as a hub for cutting-edge research and sustainability leadership.

### Leverage the power of people

Establishing strategic partnerships with academic institutions, research organisations, and industry stakeholders is key. By forging collaborative relationships with universities, research institutes, and technology hubs, asset owners can tap into a pool of expertise, talent, and funding opportunities to support innovation and entrepreneurship within the laboratory. These partnerships can also facilitate technology transfer, commercialisation of research findings, and industry-academic collaborations, driving economic growth and societal impact.

Meeting social aspects of sustainability and ESG increasingly involves actively involving local communities, schools, and non-profit organisations in scientific outreach programmes, environmental education initiatives, and sustainability awareness campaigns. By fostering a sense of ownership and pride in the laboratory complex, investors can create a supportive and inclusive environment that benefits both the scientific community and the wider society.

### Build a cluster

Clustering is a strategic approach to building low-carbon labs to create synergistic environments that maximise collaboration, innovation, and sustainability within the scientific community. This model involves a systematic process of identifying, attracting, and nurturing a cluster of related businesses, organisations, and institutions in close proximity to one another to create a thriving ecosystem.

### Cluster generation

Cluster generation involves identifying target markets, establishing partnerships, providing supportive infrastructure, and marketing the cluster's sustainability. Continuous evaluation ensures long-term success, driving innovation and positioning the labs as leaders in the low-carbon economy.



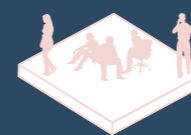
#### 01. National/Global Context

- Market Access and Trade Agreements
- Intellectual Property (IP) Protection
- Ethical and Social Responsibility
- Global Talent Mobility
- International Collaboration and Partnerships
- Global Health Security Preparedness



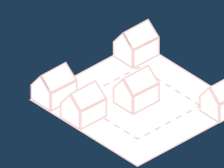
#### 02. Regional Context

- Policy and Regulation
- Investment in R&D
- Regional Specialisms
- Infrastructure Development
- Talent Development
- Access to Funding
- Collaboration with Academia & Government



#### 03. Cluster Generation

- Strategic Location
- Physical Infrastructure
- Network & Ecosystem
- Local Partnerships
- Workforce Development
- Business Environment
- Access to Funding & Capital
- Talent Mobility
- Technology Transfer & Commercialisation
- Affordable Housing
- Community Engagement



#### 04. Campus Level Assessment

- Strategic Planning and Vision
- Physical Infrastructure
- Academic & Research Excellence
- Technology Transfer and Commercialisation
- Industry Partnerships and Collaboration
- Entrepreneurship and Innovation Ecosystem
- Talent Development and Education
- Sustainability and Environmental Responsibility



#### 05. Technical

- Infrastructure and Facilities
- Information Technology & Data Management
- Collaboration Platforms
- Biotechnology and Laboratory Automation
- Regulatory Compliance & Quality Assurance
- Environmental Sustainability & Green Technologies
- Biosecurity and Biosafety



#### 06. Brief

- Occupational No
- Nett Internal Area
- Demise Splits
- Functional Uses & Adjacencies
- Infrastructure Requirements
- Operational Scenario Planning



#### 07. Product

- Sustainability Positioning
- PR & Marketing Campaign
- Sales Strategy
- Occupier Analysis
- Social Value Strategy

# Strategic Considerations

## *Developing the Right Product and Brand*

Developing the right product for the science and technology market requires a **strategic blend** of environmental consciousness, functionality, and market appeal to occupiers.

By understanding the composition of laboratory users, assessing market demand drivers, and anticipating future trends, investors and developers can design and position their laboratory facilities to meet the evolving needs of the scientific research community while promoting environmental sustainability and driving market differentiation.

### ***Understand the demand***

Understanding demographics and demand is crucial to ensure the alignment of the facility with market needs and future mandate for science use. Demographics provide insights into the composition and characteristics of potential laboratory users, including researchers, academic institutions, government agencies, and private enterprises. Analysing demographic data such as age, education level, professional background, and research interests will inform decisions regarding facility design, equipment selection, and amenities to cater to the diverse needs of laboratory users.

Assessing demand dynamics within the scientific research community will help investors gauge the market potential for low-carbon laboratory spaces. This involves identifying key drivers influencing demand, such as funding availability, research priorities, technological advancements, and regulatory requirements. Understanding the market landscape with in-house capability and specialised advisory will enable asset owners to anticipate emerging trends, identify niche opportunities, and tailor their offerings to meet current and future demand for sustainable laboratory facilities.

Demographics also play a significant role in shaping demand for low-carbon laboratories, as occupiers increasingly prioritise environmental sustainability and corporate social responsibility in their decision-making. As we have discovered through our interviews, the younger generation of scientists have a heightened awareness of environmental issues and preference for eco-friendly products and services. They are the ones driving senior management to embed sustainability into their organisations. By catering to the younger generation's values and preferences, we can enhance the appeal of low-carbon laboratory spaces and differentiate them in the marketplace.

### ***Partner with the right people***

Government initiatives, industry partnerships, and academic collaborations will influence demand for sustainable labs by incentivising or mandating the adoption of sustainable practices. Research funding programmes are more frequently requiring projects that incorporate environmental sustainability criteria, prompting occupiers to seek out laboratory facilities that align with these requirements. Industry partnerships and academic collaborations drive demand for collaborative research spaces equipped with state-of-the-art infrastructure for interdisciplinary research and innovation.

### ***Create a sustainable brand***

Branding focus should be on positioning the new or refurbished lab building as a flagship facility for sustainability and innovation. This involves crafting a distinct brand identity that reflects the building's



Cobot, 3XN/GXN

commitment to environmental stewardship, technological advancement, and scientific excellence. Leveraging sustainable technologies and eco-friendly certifications will validate the facility's sustainability credentials and attract tenants who prioritise environmental responsibility, but sustainable operations must remain at the core.

Effective marketing and communication strategies will be essential to promote the facility to potential tenants and investors. Creating a sales and marketing strategy aligned with the technical requirements and adaptability of the building and the wider ecosystem should focus on wellbeing and sustainability within the context of life, science, and healthcare at its core, providing a network of interest broader than the facility itself.

Highlighting the project's eco-friendly features, state-of-the-art facilities, and collaborative research

opportunities will generate interest and drive demand within the scientific community. Engaging in partnerships with academic institutions, research organisations, and industry stakeholders further enhances the project's credibility and visibility within the occupier market.

### ***Flex the terms***

Providing occupiers with customisable leasing options and flexible terms is important, but it's also crucial to avoid overcommitting resources to accommodate uncertain future demands. Offering flexible and modular lease agreements will allow tenants to scale their operations incrementally as they grow, rather than providing excessively large or overbuilt spaces from the outset. This approach minimises waste and ensures that resources are allocated efficiently, reducing the carbon footprint of the facility.

# Strategic Considerations

## Understanding the Occupier

A deep understanding the science that occupiers will undertake is paramount, as it informs investment and design decisions **tailored to the specific needs** and operations of various scientific disciplines.

Each branch and sub-branch of science poses distinct challenges and requirements that must be accommodated to ensure optimal functionality and efficiency within the laboratory space.

### Biology

Biology laboratories necessitate specialised equipment for cell culture, microscopy, and genetic analysis, which may consume significant amounts of energy and resources. Design must accommodate the unique spatial and utility requirements of biological research, such as dedicated tissue culture rooms, cold storage facilities, and sterile workspaces.

### Chemistry

Chemistry labs demand stringent temperature controls, ventilation systems, and chemical storage facilities to ensure safety and regulatory compliance. Designers must consider the energy-intensive nature of chemical reactions and equipment usage when designing laboratory layouts and selecting building materials. Implementing energy-efficient fume hoods, chemical waste treatment systems, and hazardous material storage solutions can significantly reduce carbon emissions while maintaining a safe and productive research environment.

### Physics labs

Physics labs require precision instrumentation, vibration isolation systems, and controlled environments to conduct experiments with accuracy and reliability. Designers should prioritise energy-efficient heating and cooling systems, acoustic

insulation, and stable power supply infrastructure to minimise disruptions and optimise experimental conditions.

### Specialised labs

Additionally, applicable to all labs, integrating renewable energy sources and energy recovery systems can further reduce carbon emissions associated with powering complex scientific instruments. More specialised facilities like high containment labs, cell and gene therapy labs, and manufacturing facilities, require specialised infrastructure to support their processes and delicate operations. Key requirements include dedicated spaces for cell culture, genetic analysis, and molecular biology techniques, equipped with instrumentation such as bioreactors, flow cytometers, and gene editing tools. These facilities must adhere to strict regulatory standards to ensure the safety and efficacy of the experiments, which makes it challenging to prioritise sustainability and minimise their environmental footprint. Implementing renewable energy sources and energy recovery systems can help reduce carbon emissions associated with powering complex scientific instruments.

Sustainable building materials and practices, along with advanced waste treatment systems, will contribute to a reduction in carbon footprint of operations. The more specific the design can be, the more it can mitigate environmental impact at the outset, but it must balance this with flexibility to suit other users in the future - the aim should be to narrow the spectrum of possible users but without getting too narrow.

## Case Study:

Collaboration with occupiers brings carbon innovation and performance for British Land.

Creating space for collaboration between owners and occupiers is crucial to decarbonising new and existing assets. Matt Webster, Head of Environmental Sustainability at British Land, discusses how building long term partnerships can support innovation.

### Change through collaboration

Decarbonisation of new and existing buildings require closer relationships between building owners and science occupiers: "True change will only be possible through collaboration with customers, who are trying to achieve their own sustainability goals," Matt Webster explains, stressing that British Land welcomes occupiers with high demands to asset performance and energy use, electrification, and renewable energy procurement.

### Addressing the performance gap

The commercial building sector must eliminate the performance gap between a building's targeted level of designed operational performance and its actual performance. Matt explains that this is a general problem in for commercial real estate, but can be a particular challenge in the UK due to the disconnect between base build and on-floor systems. Addressing this, British Land has established BL:Connect, an open data platform capable of sharing real-time insights into building operations. Matt explains that this can be particularly relevant for dynamic lab environments, continuing: "when buildings are seen as holistic systems, it's much easier to run them more efficiently in our experience." BL:Connect has the potential to facilitate open dialogue between British Land, building engineers, and lab operators, ensuring that building systems are aligned to meet evolving needs efficiently. A new approach to owner-occupier partnerships In some situations, it can be difficult to put performance requirements into leases, which is why British Land has been trailing an approach where

a memorandum of understanding (MOU) on asset performance supplements leases to structure collaboration with occupiers. This is crucial Matt explains, as early dialogue sets the stage for the relationship with their customers. Through the MOUs British Land and occupiers commit to explore ways of setting and meeting more ambitious targets than can be enshrined in leases. The results have been positive. Continuous dialogue ensures better performance, adjusting fit-outs, and sharing data for ongoing improvement. MOUs should set clear ambitions, outline collaboration intentions, shared information, and performance targets. They should encompass operational and whole-life carbon analysis, and certifications the tenants are aiming for.

### Sustainability as identity and brand

Occupier drivers for setting up MOUs with British Land are tied to corporate sustainability goals including Science-Based Targets (SBTi) and providing employees with a positive, sustainable work environment, Matt explains. This includes social aspects of ESG and developing ambitions for responsible custodianship of the public realm and how buildings and amenities can contribute to wider benefits such as contributing to local job skills development and shared space initiatives. Buildings with strong sustainability credentials attract tenants seeking new approaches to meeting corporate and social impact goals. As British Land explores ways of meeting their 2030 climate ambitions, tenants are encouraged to engage early, discussing space functionality and productivity requirements from the start to achieve better performance

# Strategic Considerations

## Future Horizon Needs & Modelling

By adopting a forward-thinking approach to needs assessment and scenario modelling, investors and asset owners can ensure their laboratory projects remain **innovative, competitive, and impactful** in the years to come.

When developing low-carbon labs, anticipating future needs and modelling potential scenarios is essential for ensuring long-term viability and relevance in a rapidly evolving landscape. Future modelling involves forecasting emerging trends, technological advancements, regulatory changes, and stakeholder preferences to inform strategic decision-making and investment in laboratory development.

By conducting needs assessments and scenario modelling, investors can identify critical factors shaping the future of scientific research and innovation. This includes analysing shifts in research priorities, funding opportunities, interdisciplinary collaborations, and global challenges such as climate change, public health, and sustainable development goals. Building low-carbon laboratories and facilities that adequately meet the expectations of scientists, supporting environmental and collaborative behaviours is a key component of de-risking development projects.

Understanding these dynamics will enable investors and developers to align their laboratory projects with emerging needs and opportunities, ensuring they remain at the forefront of scientific advancements and societal impact.

### Keeping up with technology

Technological advancements will play a significant role in shaping the future of low-carbon laboratories, as innovations in energy-efficient equipment, renewable energy systems, smart sensors, and data analytics continue to transform research

practices and laboratory operations. By integrating cutting-edge technologies into laboratory design and infrastructure, developers can enhance energy efficiency, optimise resource utilisation, and facilitate data-driven decision-making for researchers.

### Regulatory evolution

Regulatory frameworks and sustainability standards are evolving to address growing concerns about environmental impacts and carbon emissions associated with scientific research activities. Investors must stay abreast of regulatory developments, sustainability certifications, and industry best practices to ensure compliance and demonstrate their commitment to environmental stewardship. This involves engaging with regulatory agencies, industry associations, and certification bodies to navigate complex regulatory landscapes and uphold the highest standards of sustainability in laboratory design and operation.

### Future gazing

Scenario modelling allows investors to explore alternative futures, assess risks and opportunities, and develop resilient strategies to adapt to changing market conditions and stakeholder preferences. By considering a range of scenarios, from ambitious carbon reduction targets to disruptive technological innovations, investors and developers can future-proof their laboratory projects and position them for long-term success in a rapidly changing world.



Forskaren, 3XN/GXN

“

We test things out at the moment. So it's been a little bit of money spent with a little bit downside if stuff goes wrong. You've **learned something quickly**, which we need because real estate is really slow.

Development Lead

”

# Design

## Key Design Parameters

By adopting a balanced approach to adaptability and flexibility, teams can **create low-carbon labs** that meet the needs of tenants and stakeholders without sacrificing sustainability.

### Getting adaptability right

Adaptability and flexibility are key considerations when constructing and refurbishing labs, but they must be balanced with the risk of overdesigning, which can lead to wasteful outcomes. Designers must prioritise decisions that seek to balance flexibility and resource efficiency to minimise carbon emissions throughout the facility's lifecycle.

Uncertainty drives the demand for adaptability and flexibility in assets. As one development lead told us: *"The unknown is considered scary."* They believed the UK laboratory market was still immature at the moment with lack of clarity about occupier needs, products and market, and relevant price points.

One answer to this might be 'gold-plating', where teams seek to consider all possible future needs and design for that. This approach is problematic for several reasons. It is costly in both capital and carbon, and even with deep sector knowledge, teams are bound to get some things wrong. A better approach will be to consider what the least costly baseline will be, and which strategies can be integrated to allow for some degree of future adaptability recognising that this comes with additional investment. This 'additive design' approach can enable teams to minimise upfront embodied carbon that may never be utilised in the life of the building. The goal during design should be to make decisions when the best information is available and some decisions might be best pushed to a later stage when there is some degree of clarity about occupier types and needs.

By adopting a less-is-more mentality, teams can reduce the embodied carbon associated with excessive construction materials and building systems. Rather than defaulting to highly flexible layouts and structures, focus should be on optimising space utilisation and functionality.

### Building good bones

Smart zoning and servicing and a flexible interior can introduce the ability to adapt to changes over time and creates longer-lasting building. To create additional value, a design could be built on a modular lab system where all elements can plug in and out. This adds to the overall ecosystem and creates a building that is easier to maintain, reuse and recycle. The lab layout should be able to be moved and create new spaces customised for the users.

Efficient laboratory design mandates a focused waste management system, featuring strategically positioned bins, clearly defined contamination zones, and direct integration with Building Operations and Health (BOH) systems. Plentifully placed bins ensure convenient waste disposal and encourage responsible habits. Zoning contamination levels within the lab establishes controlled areas for specific waste types, preventing cross-contamination and bolstering safety. Seamless integration with BOH streamlines waste disposal, offering real-time monitoring for enhanced efficiency. This streamlined waste management not only cultivates a cleaner, safer lab but also contributes to operational efficiency and regulatory adherence.

### What to prioritise during design

Design teams should prioritise durability, longevity, and energy efficiency in building systems and invest in high-quality, low-maintenance infrastructure designed to withstand evolving needs and technical advancements. Below are key design concerns impacting the balance of adaptability and carbon:

- **Adequate floor-to-floor heights:** calculated as the dimension between the top of slab of a floor to the top of slab of the floor above (typically 4m or more).
- **Grid sizes that work for lab functionality:** a lab's layout and functionality is all based on its grid
- **Space for a goods lift and Back of house facilities:** as labs require significant back of house space and loading capacity which is able to fit laboratory equipment and its frequent movement.
- **Sufficient storage layout and facilities:** for laboratory consumables, equipment, and fittings. Also consider opportunities to consolidate less used storage space like biobanks, freezer storage, server rooms, and archiving.
- **Circulation space for logistics and safety:** major routes should be typically no less than 1.5m wide and link to fire egress routes or exits. Large machinery and equipment also need to be able to be transported throughout the building.
- **Robust floor build-ups for vibration requirements:** laboratories often necessitate thicker slabs with enhanced vibration resistance to maintain precision and stability for scientific equipment.
- **Efficient and futureproof zoning:** zoning for contamination levels within the lab establishes controlled areas for efficient structures, servicing and specific waste types, preventing cross-contamination and bolstering safety.
- **Futureproof risers:** As labs require a lot of additional space for ventilation, servicing, and power requirements, risers with excess capacity should be considered
- **Modular lab design for flexibility:** a design could be built on a modular lab system where all elements can plug in and out. The lab layout should be able to be moved and create new spaces customised for the users.



I think you can make the decision about **good bones** based on more fundamental things that you know.

Development Lead



## Case Study: Structured University Governance to Promote Sustainable Habits in Research

At UCL East, Dr Jason Millichamp plays a pivotal role in delivering projects on the new campus in line with the university's established project governance structures. **Enabling sharing of spaces and resources** has been key for developing the new campus in Stratford.

With his original background in managing electrochemical engineering labs, Jason oversees the design and development of lab facilities on the new UCL East campus, ensuring alignment with the UCL Sustainability Strategy. His responsibilities extend from initial planning to operational implementation, with a focus on fostering collaboration and breaking down silos within the university. *"It's about understanding when to be specialist and when to be generic,"* Jason explains, *"when you're designing, you will lock into design requirements quite early on, but it will be years until that design actually comes to fruition, so you'll never get the details right perfectly, but what's important is your overall design strategy allows the spaces to evolve as the users do"*

### Running a strategic and holistic process

Jason's involvement begins early in the project lifecycle, actively participating in both the briefing and design stages of new lab facilities. Looking ahead to Phase 2 of the UCL East Campus, which involves constructing six buildings over the next 30 years, Jason engages with decisions on what elements to "lift and transform" from the central London campus, and what to build anew.

Liaising between the Estates teams, design team, contractors and end-users, Jason ensures that designs meet the practical needs of researchers, academics, and lab technicians. This coordination is essential for reconciling diverse requirements, such as safety and fire strategies, which may vary across disciplines.



Marshgate Atrium, UCL East

As projects progress through the structure of RIBA work stages, Jason facilitates strategic meetings with multidisciplinary teams to ensure alignment with project and UCL sustainability goals before advancing to subsequent phases. These structured "stage-gates" are critical for evaluating progress and making necessary adjustments, fostering a cohesive approach to implementation. At each gateway, the project team undertakes a review of what has gone well, the lessons learned, and anything missed or incurred 'design drift' that requires addressing in the next stage.

### Enabling sharing between research groups

From a sustainability perspective, Jason focuses on creating efficient lab spaces aligned with shared goals, promoting optimal resource utilisation.

“

It's about understanding when to be **specialist and when to be generic...** when you're doing the design, you will lock in to a design quite early on... and it will be years until that design actually comes to fruition, so you'll never get it perfectly right.

”

Dr Jason Millichamp, UCL

Lab designs accommodate various research fields, emphasising shared resources to minimise duplication and enhance efficiency. Rather than the traditional university department and faculty approach when providing space, UCL East has established "entities" that allow tailored spaces with a common goal.

Centrally managed and bookable teaching labs are provided for the widest ranges of users, while smaller specialist teaching labs with higher or more bespoke infrastructure demand requirements are used to support them. Specific research labs such as for Advanced Propulsion or Manufacturing Futures are tailored to the specialist areas such as inventing novel battery materials or electric motors for the next generation of electric vehicles or manufacturing

steps to create personalised medicines. Each new space is built specific to the research needs but covering the widest range of traditional university departments or faculties possible, thus maximising efficiency and reducing waste.

Through organic decision-making processes driven by stakeholder engagement, Jason has influenced alignment of differing requirements in safety and fire strategy, lab operational procedures as well as managing prioritisation in capital equipment spending across the lab facilities to reduce duplication, this process has lead back into design decisions such as creating shared characterisation labs used by all due to the repetition in equipment needs. Changing the way a university structure works creates new operational challenges that the UCL East team are finding their feet with as they develop the new site.

In operation, UCL East is providing users with read-only access to the Building Management System (BMS) data, as well as data gathered by one of its entities that specialises in connected environments, to build real-time awareness and understanding of the operational impact of the decisions made while operating in the labs. The team use LabCup, a laboratory inventory management solution that simplifies the tracking and reporting of inventory data, providing real-time information on inventory levels, storage conditions and compliance. These initiatives promote a positive environment to the better use of equipment and chemicals, booking and sharing to encourage the most efficient use.

# Design

## Adapting Existing Buildings

Building less and repurposing existing structures not only **minimises the embodied carbon footprint of construction**, but also promotes long-term sustainability and energy efficiency.

The simplest way to reduce carbon is to build less. Wherever possible, retain structures, reuse materials, and minimise construction.

By building fewer new lab facilities and instead repurposing existing underperforming assets, developers can minimise the large environmental impacts associated with the production of new construction materials, transportation of materials to the site, and the energy-intensive construction process itself. Projects might also save time on site by reducing parts of the demolition and construction process.

To do this efficiently, developers and their consultants must define the appropriate extent of redevelopment, along with cost estimates and the embodied carbon spent, against trade-offs in the future assets and operational energy reductions. For many underperforming buildings, it is rarely an either-or approach but a question of thoughtful analysis informing a combined approach of partial demolition and new build. Stripping back to the original superstructure while adding additional floorspace, can result in significant new construction, but analysis of embodied carbon in different parts of the existing structure can enable significant carbon savings through a targeted approach.

When undertaking significant redevelopment, a key goal should be to maximise the future asset lifespan to ensure that large expenditures of capital and carbon pay offs by minimising needs for future interventions.



Victoria House, Oxford Properties and Pioneer Group

“We saw the potential impact that this had for the performance of the asset, and we said no, **we need to do this to give this flexibility to future tenants.**”

Development Lead



## Case Study:

Lessons learned converting a 100-year-old neoclassical building to highly sustainable lab spaces with Oxford Properties' Pierre-Etienne Accarier.

Victoria House on Bloomsbury Square in London will be a flagship science offering. Led by Director for Real Estate at Oxford Properties' Pierre-Etienne Accarier, the building has been thoughtfully transformed to provide lab spaces that can meet the **highest sustainability criteria**.

### Developing ESG-aligned brief for Victoria House

Once completed in autumn 2024, Victoria House will contain 300,000 sq. ft. of state-of-the-art laboratory and workspace, including 20,000 sq. ft. of incubator space, 10,000 sq. ft. of data storage suites, and amenities such as gyms, roof terraces, and heritage meeting rooms.

Transforming the 100-year-old building has required a flexible approach, sensitive to the challenges and opportunities of the building itself, explains Pierre-Etienne: “The project has really allowed us to understand the conditions that enables a good lab conversion while working with our partners Pioneer Group to improve operational performance.” Aided by Arup, the development team turned Oxford Properties' portfolio-level ESG strategy and policies into a series of targets for the project, including BREEAM Excellent certification and a minimum of EPC B rating. Additional goals were developed into a tracker for the project, which was managed by Arup, including opportunities for circular reuse of relevant MEP systems, diverting 98% of waste from landfill, and community outreach around STEM in the surrounding Camden borough.

### Good bones for a lab conversion

Victoria House is Grade II listed and required a fine-tuned approach to its transformation, but several aspects of the building structure enabled successful redevelopment according to Pierre-Etienne. The building atrium made it possible to introduce additional risers required for the life science conversion – including ventilation for labs and fume

stacks for fume hood cupboards – without any loss of Net Internal Area (NIA). In addition, the atrium provides good natural daylight into the building and ensures that no workspaces become too deep.

Another asset of the building is the roof, where the development team have found space – without compromising two roof terraces and existing MEP plant – to offer dedicated tenant plant space, allowing future tenants access to install their own equipment, such as condensers and generators.

### Futureproofing to make building EPC A enabled

Originally EPC D, the building has been EPC A enabled, which means putting in fully electric infrastructure with an air-source heat pump system, heat recovery on all laboratory and office ventilation systems, variable air flow provision to reduce energy consumption, upgrading of the central plant, and installing of smart meters.

“From a technical point of view, the fundamental change was air source heat pumps for improving the building energy consumption profile,” Pierre-Etienne emphasises. This means that the building can now comfortably reach EPC B. As some existing retail tenants in the building rely on gas burners, and EPC A requires a fully electrical building, this was not currently feasible. However, the team prioritised additional investments enabling a future EPC A rating, including future proofing of risers, low voltage and high voltage switchgear, space for liquid nitrogen generation, and chemical waste storage. “We wanted to make sure that nothing in the design blocks

## Case Study:

Lessons learned converting a 100-year-old neoclassical building to highly sustainable lab spaces with Oxford Properties' Pierre-Etienne Accarier.



Victoria House, Oxford Properties and Pioneer Group

*getting to EPC A, so that if we recapitalise the asset in the future, we know we can do it."*

### **Variable airflow to meet tenant requirements and green leases**

Mechanical engineers KJ Tait developed a strategy switching from Constant Air Volume (CAV) systems on all floors for ventilation to Variable Air Volume (VAV) systems in order to add flexibility for tenants to improve energy consumption.

*"Four air handling units feed the whole building," explains Pierre-Etienne, "So there is a fixed amount of air to distribute, but if a tenant on a floor uses less, and another uses more, we want to be able to understand and meet that."*

Installing variable air handling is key to this, as is granular data on tenants' use patterns. Writing the specifications for the Building Management System, KJ Tait prioritised investing in a robust system while having additional cash to spend on regular check-ups of the system to ensure accuracy.

Accurate data is key to Oxford Properties' approach of connecting asset and property management teams with tenants, explains Pierre-Etienne: *"From an operational point of view we will be collaborating with tenants to refine their lease, where we for example can factor in air change rates in the green leases."*



Victoria House, Oxford Properties and Pioneer Group

# Design

## Adapting Existing Buildings

Turning an **underperforming asset** into a high-end lab building with **an extended lease on life** requires careful consideration of how to fit lab requirements into the existing bones of the building.

When undertaking a lab conversion, design teams must carefully analyse the existing structure to identify pain points and inform creative ways of fitting lab requirements around existing conditions.

### Futureproofing performance by design

Laboratories often require more robust structures than office buildings to meet loading requirements and minimise vibration. With up to 50% of a building's structural up-front embodied carbon (lifecycle stages A1-A3) embedded in existing floor slabs,<sup>1</sup> design teams should consider how to reuse these where possible. They can do so by identifying problematic zones in the existing structure, adding structural reinforcement and bracing and adding screed to help dampen vibrations.

Labs need a lot of additional space for MEP and servicing translating into floor-to-floor heights (calculated as the dimension between the top of slab of a floor to the top of slab of the floor above) often required to be 4 meters or more. This can be a challenge in older buildings not designed for lab purposes. To maximise available floor-to-floor height for MEP systems, floor and ceiling finishes can be stripped back from existing office structures. By stripping away non-essential materials such as raised access flooring, and false ceilings, more space can be unlocked for the installation of specialised laboratory equipment and accommodating the complex infrastructure required for MEP systems.

Labs require a lot of additional space for vertical ventilation, servicing, and power requirements,

which can be a challenge to fit within existing risers. When transforming a building, design teams should consider how to expand risers, with provisions for excess capacity where possible, to futureproof the asset for changing tenant and leasing arrangements. Utilising existing atriums is one efficient way of solving this, that we have seen, but not all buildings will have this opportunity and will require careful intervention in the existing core and floorplate instead.



**Reusing tired buildings is a sure way of avoiding carbon emissions and waste.** The additional resources inherent in lab spaces illuminate a pertinent tension about where is best for society to expend carbon emissions. It's an important conversation, and **one we need to start having now.**

Adam Ozinsky, Senior Associate,  
Sustainability Engineer, GXN



## Case Study:

### Euston Tower by 3XN/GXN for British Land, London, England



Euston Tower, 3XN/GXN

Euston Tower in the London Borough of Camden is a compelling case for the transformation of existing, vacant and under-utilised buildings into lab-enabled facilities, in a way that minimises carbon emissions, resource use, and waste.

But meeting the demand for lab spaces is a double-edged sword.

Unlike speculative offices which are well defined, labs vary greatly in their requirements depending on the field, users, organisation, etc. There are no industry-agreed specifications, like the British Council for Offices (BCO) Guide to Specification.

The basic lab requirements of more robust structures, increased floor-to-ceiling heights, and more power and ventilation allowances, result in increased embodied and operational carbon emissions compared to offices. This is exacerbated by potential overprovisioning, in the absence of standard specifications and requirements.

Strategic planning is key to mitigating unnecessary

carbon emissions (a speculative specification if you will). On Euston Tower it was important to deliver a world class science and technology building befitting of its unique location in the Knowledge Quarter. This resulted in a scheme that comprises 517,000 sqft of workspace including 177,000 sqft of lab-enabled space (NIA).

The lab enabled spaces were consolidated in the lower portion of the building stack, and the floor-to-floor height optimised, such that it remained appropriate for office use, providing future flexibility. On the floors, the lab-enabled floorplates were strategically zoned to rationalise the extent of the floorplate that is subject to the more onerous structural criteria, which required only a single additional column row and a thicker floor build up. The principle of "additive design" was adopted to minimise upfront embodied carbon that may not be utilised. The design dynamic response is higher than would be typical in a lab, and the structure has been designed to accommodate retrofitting "dynamic hangers" which couple to the slab above, should an occupier require improved vibration performance.

# Design

## Massing, Logistics and Structure

Prioritising **flexibility and scalability in the super-structure** allows lab spaces to adapt to changing research needs over time without the need for extensive renovations or demolitions.

### Massing and logistics

A well-designed lab building is arranged to balance efficiency and ensuring it is a desirable workplace. Laboratories are characterised by their need to accommodate specialised equipment, frequent movement of laboratory furniture, and the transportation of materials and equipment both within and outside the building.

Efficiency in the core is paramount given the substantial demand for riser space for ventilation and power as well as back of house space and loading capacity. A critical aspect of this efficiency involves the seamless integration of waste logistics within the back of house space. Waste generated during laboratory procedures needs to be managed efficiently, necessitating well-designed systems for collection, sorting, and disposal.

Centralising storage facilities on the ground floor reduces the distance for material transportation to and from the back of house area. This proximity streamlines logistics, expediting the movement of supplies, waste, and equipment, ultimately enhancing operational efficiency.

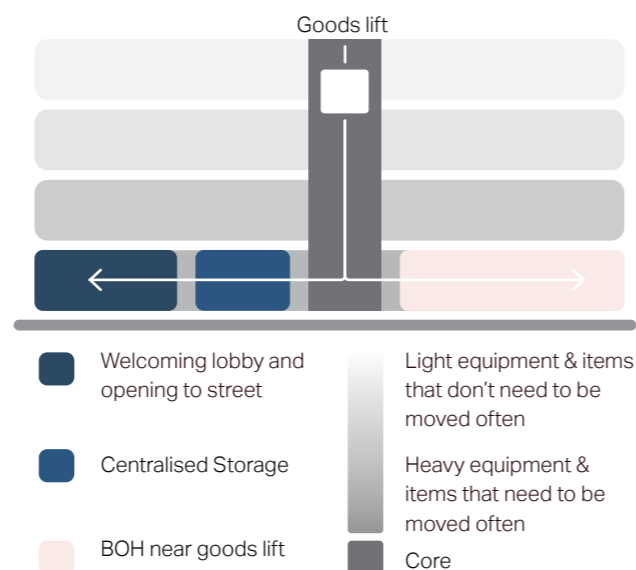
### Structural efficiency

Lab buildings have unique requirements for loads and vibrations, which translates into additional structural constraints during design.

Simple strategies like placing heavy equipment on lower levels for structural efficiency, designing a welcoming and public-oriented ground floor, and providing spaces for write up and additional

amenities all enhance the building's appeal. Allocating lighter functions to upper floors can optimise structural performance by concentrating lab floors with heavier load-bearing requirements and larger floor to floor heights in the lower levels.

However for larger or shared buildings this strategy might not be preferable and meeting logistics and structural needs requires a more integrated approach. To meet different requirements, building design can incorporate flexible structural systems that can accommodate various loads and configurations, reducing the need for extensive structural alterations in the future. A flexible structural system should allow for variation in floor build ups across the floorplate and structural reinforcement where needed.

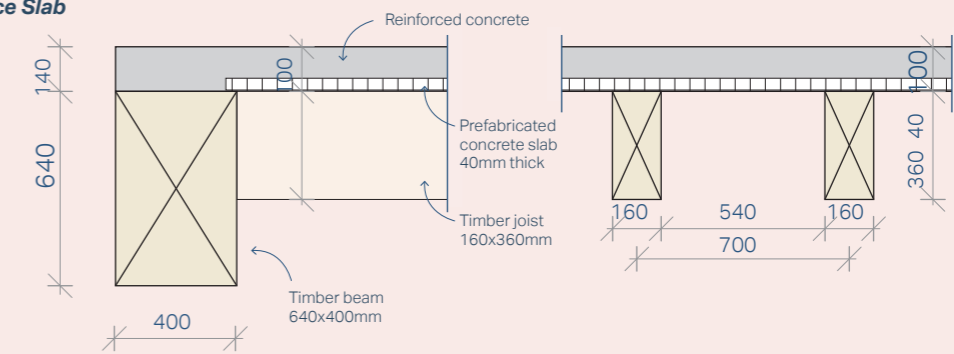


# Case Study:

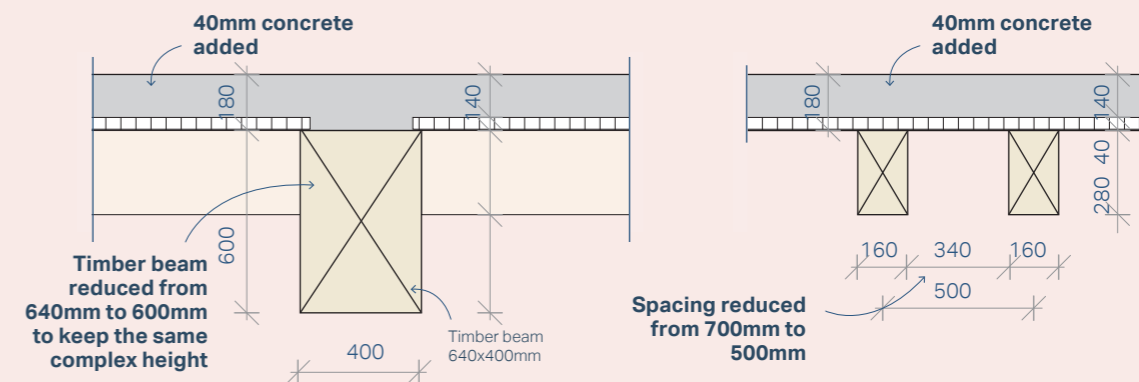
## EPFL by 3XN/GXN, Lausanne, Switzerland



Typical Office Slab



Reinforced Slab for Labs



Buildings with lab spaces like EPFL Ecotope need to be able to host various functions such as office write up space, cafeterias, and workshop space to name a few. Such variety in programmes means there is an equal variety in vibration requirements to consider throughout the building.

### Selecting the right floor build-up

Throughout EPFL Ecotope's design process, a number of strategies were considered when nominating appropriate functions to each floor. Selecting the right floor build-up came down to balancing how much added material was needed to meet vibration requirements and how this affected embodied carbon and cost.

In some cases, having a different programme on each floor may seem to make sense in terms of construction, whereby the floor build-up would be consistent over one floorplate. EPFL Ecotope not only shows how timber constructions can meet certain vibration requirements for labs, but also how one floorplate can have a mixed build-up and, therefore, a mixed set of programmes.

### Meeting vibration requirements

On EPFL Ecotope, the programmes and their required space were determined early which then informed the minimum quantity of additional material needed to meet the vibration requirements for the lab spaces. When compared to the buildup designed for the office spaces, the lab spaces needed an additional 40mm of concrete topping, as well as more joists since their spans were reduced to meet vibration requirements and improve its structural integrity. Instead of making the entire floorplate to meet the vibration requirements needed for labs, a lot of unnecessary concrete pours and additional timber were saved by designing multiple build-ups over one floorplate.

This strategy is useful when there is an underlying or pre-existing knowledge the programmes might not shift for a long time. Whereas, if there is a demand or desire for more lab space in later years, it may make more sense to design a floorplate to meet the maximum vibration requirements to improve programme flexibility.

# Design

## Zoning and Capacities

Strategic zoning for lab space offers a way to **co-locate similar activities with the same technical performance requirements**, and can also allow for future flexibility within defined and well-served zones.

When designing a lab building, a key consideration is how to effectively zone the building for the needs of various lab and office functions and ensuring structural and servicing requirements, without overdesigning. The current trend in commercial lab design is for a split of either 50:50 or 60:40 lab to office ratio, depending on the type of science and extent of data/computing work to be undertaken in the facility, anticipating future needs in work practices. The closer the design can answer the needs of specific activities and equipment in each zone, the less risk of over-specifying the whole floorplate.

### Understand the needs of the occupier

Viable strategies include locating low and ultra-low vibration spaces in the 'quietest' part of the building and site for analytical equipment, imaging and equipment for micro-/nano-scale work that requires lower vibration levels. Other vibration-sensitive equipment can be located on the stiffer areas of the floorplate closer to cores and columns, higher in the building, without requiring overly robust structural build-up of new, or modification of existing structures. Local stiffening can be undertaken during fitout of spaces with local stiffening rods where required for specific equipment. Overdesigning the entire structure to accommodate potential vibration-sensitive uses is highly costly in terms of cost and carbon, which will unlikely be required by occupiers, and come with great waste. Developing the design of a new three-building commercial science development in London, the proposed floor slab thickness was reduced from 325mm down to 275mm by reducing the vibration criteria from

response factor (RF) 1 across the entire floor plate, to RF1 on 75-80% of the floor plate. This resulted in a circa 20-25% saving in embodied carbon from construction of slabs, plus further savings in columns/foundations due to lighter structure. Occupiers will be provided with "heat maps" to show areas of stiffer floor for any sensitive equipment, and options to stiffen local areas if required. This strategy allows the designers to create flexible spaces for the facility to optimise construction performance and technology, not only minimising the initial carbon footprint but also aligning with less onerous requirements for fire and vibration typically associated with offices.

### Timber for zoning

The key advantage of zoning user timber lies in the reduced need for concrete pours, making it environmentally conscious at the outset. However, this has associated risks for developers; if there are significant tenancy changes, the fixed zoning will not allow for programmatic shifts easily turning office space into lab space. If some occupiers, such as an anchor tenant, are known, this zoning can be made more bespoke enabling a more integrated mix of spaces to take into account the structural performance of the building across individual floors. The balance between environmental considerations and operational flexibility will vary from project to project, and a degree of compromise may be necessary to meet the varied demands of commercial spaces within the ever-evolving landscape of lab design.

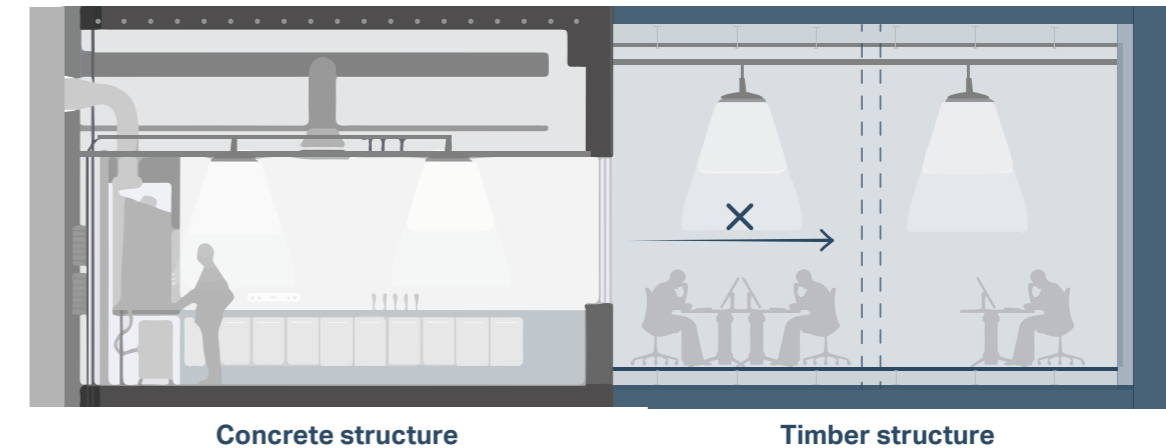
### Scenario 01: Concrete build-up for labs and timber structure for offices/write up spaces

#### Pro:

Relies on more regenerative materials, minimises concrete pours and utilises soft spots for vertical transformations/adaptability

#### Cons:

Labs spaces have certain vibration requirements meaning they cannot expand into spaces that have less structural integrity i.e. write up spaces with a timber structure



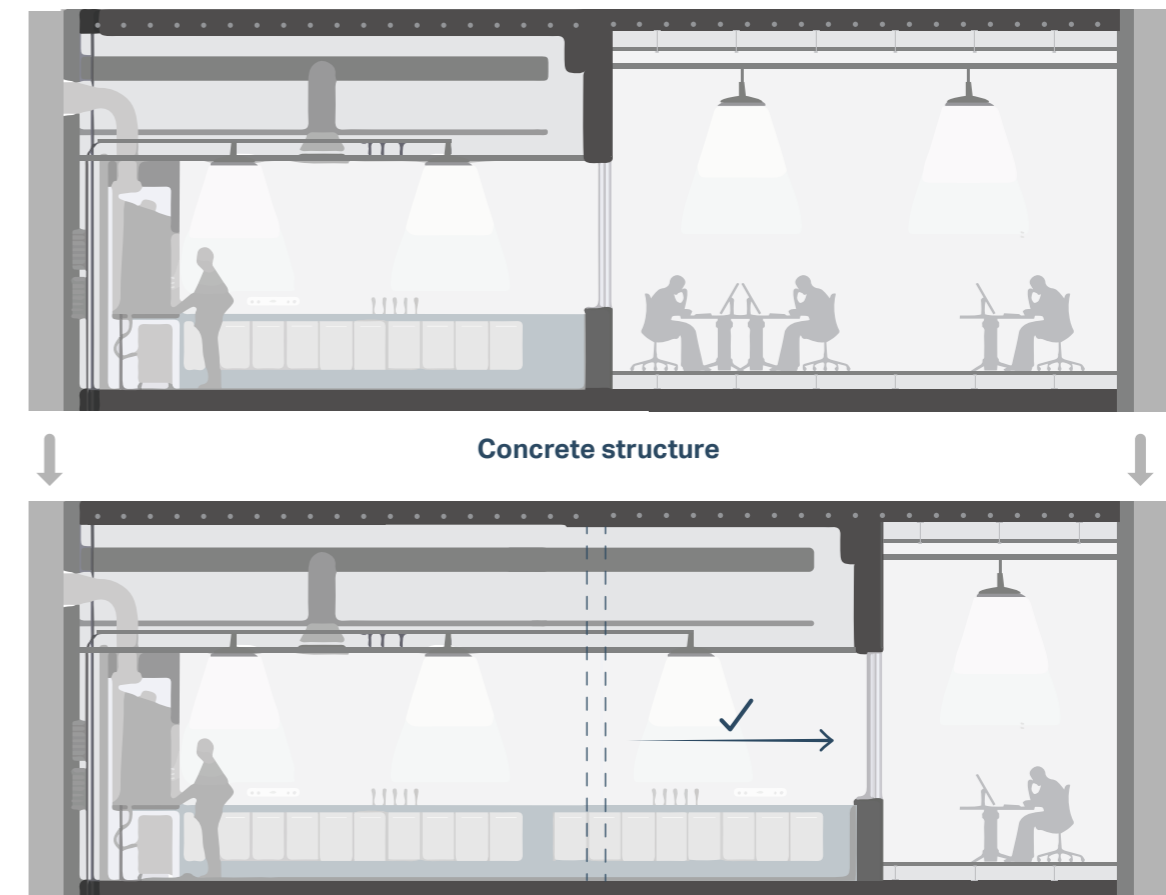
### Scenario 02: Concrete structure for both lab and office/write up spaces

#### Pros:

Programmatic shifts require less structural changes. This is more commercially viable for tenants if they expand and develop

#### Cons:

May mean there are more concrete pours than required



# Design

## Structural Grid and Flexibility

The structural grid fundamentally dictates the lab space's spatial optimisation and efficiency - it serves as the underlying framework that influences the layout of the entire building, and can improve ease of movement, and **adaptability**.

A building's grid not only provides stability to the structure but also facilitates a standardised organisation of laboratory components, allowing for specialised equipment and workstations to be located and used effectively. Every element, from bay layouts to bench configurations, adheres to the grid, ensuring a cohesive and efficient arrangement. A well-chosen grid can improve ease of movement, and adaptability, creating a well-orchestrated environment.



Grid sizes and spans further impact possible floor build-up choices and a grid must therefore support low carbon alternatives in both lab and office zones.

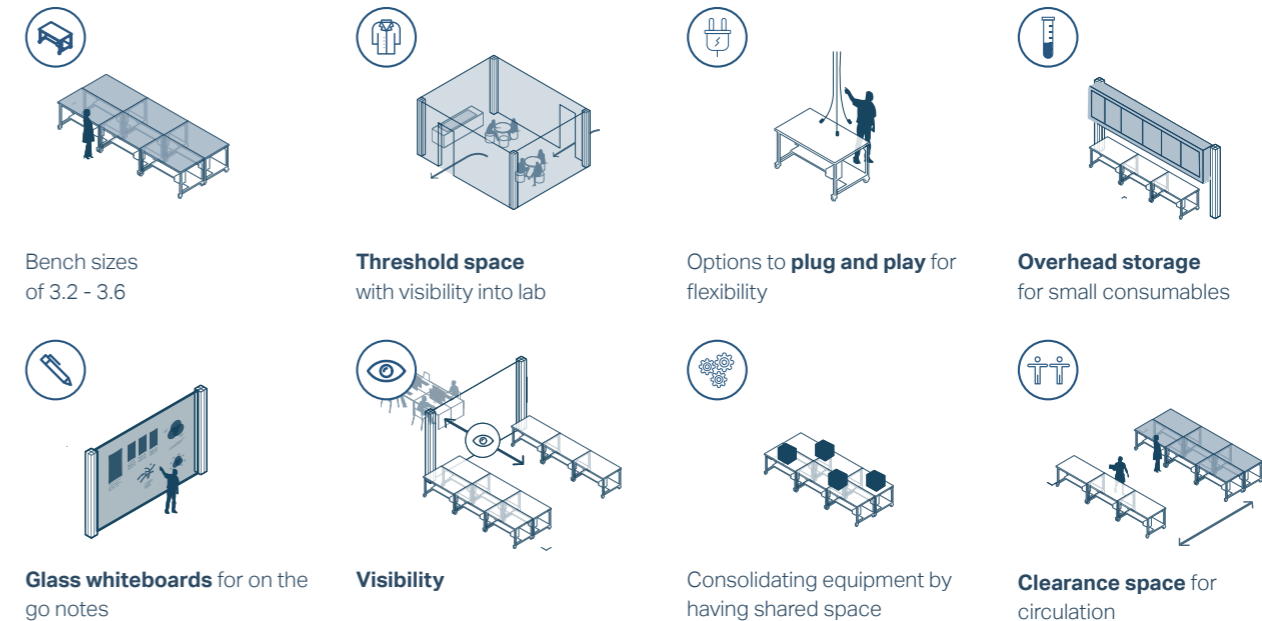
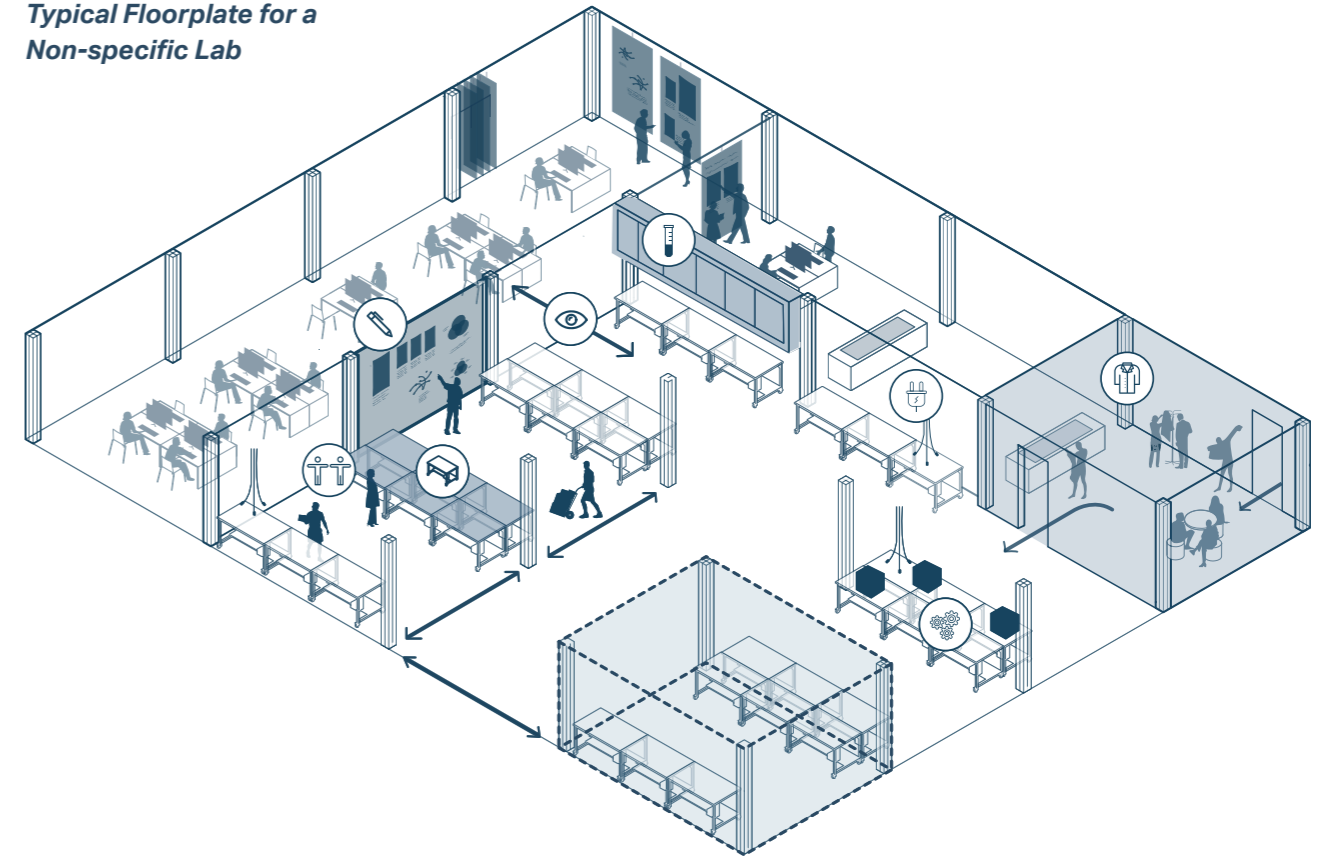


The structural grid in laboratory buildings is typically governed by the most efficient spacing of lab benching. While the benching can be independent of the grid, there is often a relationship between columns and bench runs for ease of connection to drainage, which is typically provided near to columns.



Cobot, 3XN/GXN

Typical Floorplate for a Non-specific Lab



# Specifications

## Low Carbon Material Specification

The potential to avoid or reduce carbon emissions are greater the earlier teams start designing for low carbon. However, savings are possible at every stage and **specifying low carbon materials remains key** to decarbonising buildings.

### Lightweight buildings bring down carbon

Embodied carbon is the carbon generated in the production, maintenance, and deconstruction of a building. This includes emissions relating to the extraction, processing, and transport of building materials and systems used in construction and day-to-day operations. As the UK energy grid decarbonises and the next generation of buildings are moving away from fossil fuelled buildings, these will produce far less carbon emissions in operation and minimising embodied carbon in construction and operation will be key to meeting ambitious environmental targets.

Designing for low embodied carbon entails designing lightweight, simple structures that can still meet the robust structural and performance requirements of labs. When it comes to specifying low-carbon materials, design teams should aim to select the lowest-carbon options available to them in their region. This often requires after discussion about what is feasible with their supply chain.

### The Construction Materials Pyramid

The Construction Materials Pyramid to the right provides an overview of the upfront embodied carbon (A1-A3) associated with different materials widely used in construction based on available Environmental Product Declaration data.<sup>2</sup> It does not, however, include service life, which should also be taken into account, but in general the aim should be to use as many materials from the lower part of the pyramid as possible, minimising use of materials from the top part.

### Early supply chain engagement is crucial

Unlike savings due to design, specification savings are only taken once the material has been delivered to site and the element constructed. In procurement, there is a risk of specification change and this can have detrimental impact on carbon performance. Contractors can safeguard against this by engaging early and often with the supply chain.

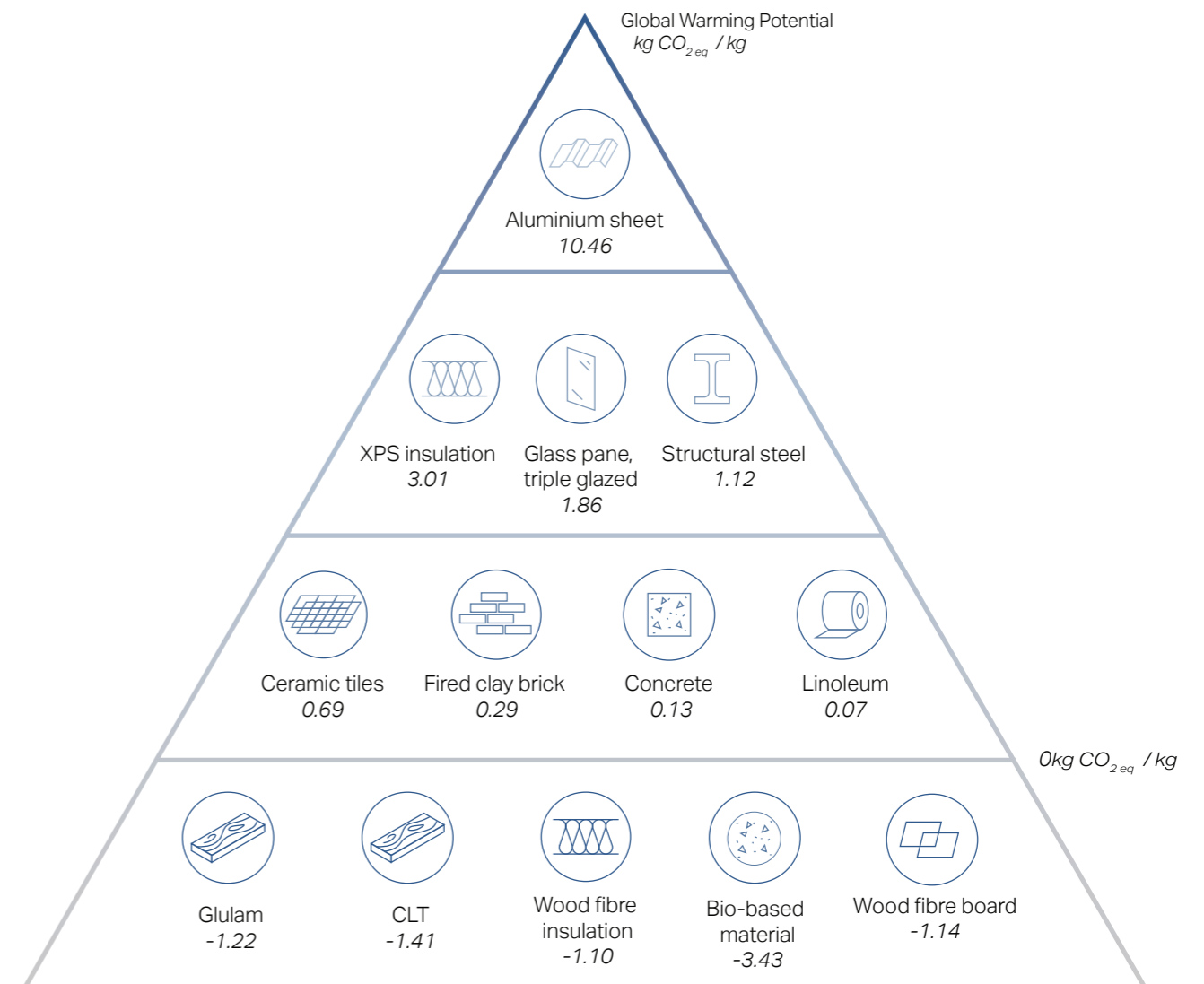
### Building Material Passports - tracking materials

A building material passport provides an active data management system which gives the building owner the ability to access relevant information about any product or component in the buildings.

This becomes important for managing whole life embodied carbon as a better overview of materials can ensure better maintenance and enable reuse between buildings in a portfolio.

To create a building material passport, organisations should set out aims for data collecting, consider what data is required to enable future reuse.

Construction Materials Pyramid published by Centre for Industrialised Architecture (CINARK) at the Royal Danish Academy



# Specifications

## Servicing Strategy

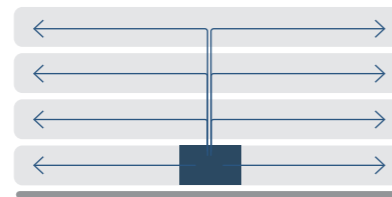
Thoughtful consideration of both the location and sizing of MEP systems in lab buildings is crucial for minimising their carbon impact by **enhancing operational efficiency and reducing resource consumption.**

Alongside labs and offices, engineering and plant space must also be accommodated within a research facility. The footprint of this typically ranges between 15-20% of gross internal area.<sup>3</sup>

Designing the MEP layout for possible lab expansions and spatial adaptability is crucial. The MEP design should allow the opportunity for offices (which require lower ventilation rates) to still have the technical capability to ventilate for a lab function in case there are programmatic shifts over the building's time. Another option is to separate MEP systems based on the programmatic breakdown of the building. Having a separate ventilation strategy for office spaces means there's less space that needs to be ventilated at the same intensity as labs, and allows an option for passive ventilation strategies - this might be desirable for longterm occupiers, but makes the building fit for a smaller range of potential future tenants.

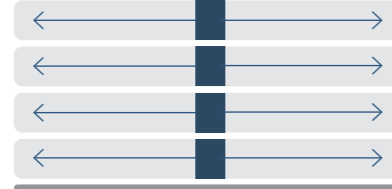
Laboratories are more heavily-serviced than offices, and the plant space required to service laboratories should be considered in the design. On-floor plant for an occupier is possible but comes with a loss of usable area and potential restrictions. In turn, having a centralised plant room requires more operational energy to move the air further distances.

### Centralised plant arrangement



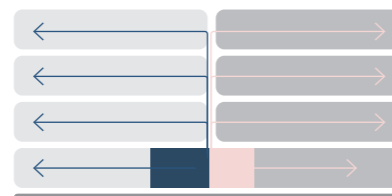
*Efficient for maintenance, closer to BOH, but more operational energy required to move air throughout across further distances*

### Floor by floor plant arrangement



*Less operational energy required and can specify air changes per floor but more equipment and harder to maintain*

### Plant arranged per zone



*Less operational energy required and can specify air changes per zone but more equipment and harder to maintain*



# Specifications

## Low Carbon MEP Strategies

Optimising the design and operation of ventilation systems in labs can achieve **significant energy savings** while maintaining optimal lab conditions. Collaboration between stakeholders, effective communication, and the adoption of innovative technologies are essential for success.

By fine-tuning these systems, labs can achieve significant energy savings as long as they uphold the necessary temperature and air quality standards. This optimisation not only reduces operational costs but also aligns with broader sustainability goals. By investing in efficient HVAC systems, labs can minimise their environmental footprint without compromising on functionality.

Investing in energy-efficient equipment and regularly maintaining mechanical systems will further enhance energy conservation efforts in laboratories, helping to mitigate the challenges associated with their 24/7 operations.

Despite the difficulties posed by the continuous operations of laboratories, there are alternative strategies that can be considered to optimise energy usage.

### **A gradual approach**

One such approach involves adjusting ventilation rates, a strategy that has shown promising results in various facilities.

The process typically begins with a thorough assessment of existing ventilation systems and energy usage. By analysing data and considering safety requirements, engineering teams identify opportunities to optimise ventilation volumes. This may involve reducing air change rates in line with regulatory standards while ensuring adequate air quality and circulation within lab spaces.

Despite potential challenges such as user resistance and regulatory hurdles, many teams have successfully implemented these energy-saving measures. Through careful planning and gradual adjustments, they have achieved significant reductions in energy consumption while maintaining a safe working environment.

### **Think outside the lab box**

One of the primary methods employed to conserve energy in mechanical systems is the implementation of nighttime setback modes. These modes involve reducing ventilation rates during off-peak hours, such as at night, when labs may be unoccupied. However, the effectiveness of this strategy can be hampered by the continuous, round-the-clock operations common in many laboratory settings.

### **Demand control**

Implementing advanced control systems capable of dynamically adjusting ventilation rates based on real-time occupancy data and air quality measurements is one effective strategy. Through the utilisation of sensors and automation, these systems can accurately tailor ventilation to match actual demand, thereby maximising energy savings without compromising safety or comfort.

Additionally, employing systems that monitor environmental parameters and adjust air supply and exhaust delivery based on indoor contaminant levels and thermal load can further optimise indoor environmental quality and energy efficiency.



### **Talk to the people**

Effective communication and collaboration between facility managers and lab occupants are pivotal for the success of energy-saving initiatives. Negotiating with users ensures that any changes made to ventilation systems are in harmony with their work requirements and safety concerns. Engaging engineering teams in decision-making processes empowers lab occupants to contribute their insights, fostering a sense of ownership over energy efficiency efforts. This collaborative approach not only enhances the effectiveness of energy-saving strategies but also cultivates a culture of sustainability within the team.

# Better Buildings Summary

## Main Challenges

There is uncertainty surrounding **the trade-offs** between market demands, provision of flexible, fully fitted, and lab enabled space, and embodied and operational carbon when designing and constructing laboratory buildings

### Market immaturity, uncertainty about product:

With the market for fully fitted and lab enabled space evolving fast, developers lack clear knowledge about market and product fit leading to challenges with overdesign and long-term asset viability. Laboratories vary in terms of activities, risks, and technical needs, which complicates development and implementation of standard specifications and products.

### Energy efficiency in high-performance labs:

Designing energy-efficient, high-performance laboratories is challenging, not least if the future occupier is unknown, due to the complex and energy-intensive nature of lab activities, and the specific requirements of different types of lab occupiers. Lab facilities require precise environmental controls and often house equipment that consumes significant energy, posing a challenge in balancing the need for technical performance with energy efficiency.

### Trade-off between adaptability and carbon:

Deciding whether to design a building with lab-enabled capabilities brings up an uncertainty surrounding the trade-offs between embodied and operational carbon. Designing a building to be lab-enabled typically requires more materials, MEP, and energy to operate, however, lab enabled space might end up used for offices or other purposes, rendering the effort and resources invested in lab enablement wasteful.

### Complexity repurposing existing assets for labs:

Transforming existing commercial buildings into laboratories involves navigating numerous technical and design complexities. Office buildings often lack the necessary features to support specialised lab functions, such as controlled environments or specific utility requirements. Careful assessment of the existing building structure and servicing is necessary to identify the significant modifications required to meet the stringent standards of laboratory environments.

### Balancing carbon and operational efficiency in refurbishments:

Achieving a balance between reducing the carbon footprint in the refurbishment process and ensuring operational energy efficiency in labs is challenging. This includes considerations like material choices, construction methods, and the integration of energy-efficient technologies. The goal is to minimise the environmental impact during the refurbishment phase while also ensuring that the transformed labs operate efficiently and sustainably.

### Integrating sustainable building materials:

Integrating sustainable building materials and practices in lab construction is challenging due to the specific requirements of laboratory spaces, including vibration criteria and health and safety standards. The need for durability, safety, and specific technical functionalities often limits the use of certain ecofriendly materials, like timber, making it difficult to align lab construction with decarbonisation goals.



# Better Buildings Summary

## Main Opportunities

Adopting a **balanced approach to product and market fit**, alongside adaptability and low carbon design choices, teams can create lab buildings that meet the needs of occupiers without sacrificing long term sustainability.

### **Ensuring commercial viability in lab design:**

Designing laboratories with an eye on commercial viability requires an understanding of both current and future needs of the research and innovation sector. To ensure commercial viability, lab spaces should not only functionally efficient and adaptable to changing research needs but also attractive to potential occupants from a commercial standpoint by having the right location, links to research clusters, attractive design choices and the right mix of amenities.

### **Adaptive and flexible lab design:**

Implementing flexible and adaptive design in laboratories can enable long-term asset viability by allowing buildings to meet the changing needs of science occupiers, who often have a high turnover. This involves creating serviced space that can be modified to accommodate new equipment, technologies, or research methods while reducing the need for resource-intensive alterations in the future, and requires careful balancing with added carbon costs of adaptability.

### **Optimising structure and layout for efficiency and flexibility:**

Getting the 'bones' right is key to ensuring an efficient and long-lasting lab building. The building design must include considerations of lab layouts and zoning, load-bearing capacities, vibration requirements, variable air changes, and the facilitation of efficient back-of-house and logistics within the space, ensuring that the structure supports both current and future lab functions.

### **Prioritising the reuse of existing structures:**

Transforming underperforming assets into labs or lab-enabled space can breathe new life into unloved buildings while reducing carbon emissions related to new construction. Successful transformation requires careful analysis at the early design stage to maximise the reuse of existing structure and materials, and implement functional zoning, servicing, and potential reinforcement to meet minimum standards by working with, rather than against, the asset.

### **Cost-benefit analysis for sustainable refurbishments:**

Performing a thorough cost-benefit analysis is crucial to determine the most sustainable approaches to lab refurbishments. This analysis should consider the environmental impact of building services and materials, the energy efficiency of design choices, and the long-term operational costs. The focus is on identifying strategies that not only make economic sense but also align with sustainability goals, ensuring that the refurbished labs are both environmentally responsible and cost-effective.



# Roadmap for Designing Labs

## Reporting/Output Timelines

RIBA Stages

Stage Focus

Design Considerations

Output & Actions

### 0 Strategic Definition

This stage is about understanding project specific opportunities and constraints which may impact the whole life carbon of a project. Here the focus should be on early discussion to raise awareness of carbon drivers for a project.

**Review opportunities for existing building retention** (as appropriate). Consider different levels of retention, some is better than none.

**Identify potential carbon 'hot spots' related to retention level**, site restrictions, logistics, basement requirements, massing options, structural systems, tenancy, fit-out scope, vibration requirements and others.

**Review potential to reduce the risk of potential carbon hot spots** - what should be studied when and by whom. Identify the necessary stakeholders to engage at the right time.

**Analyse current and future needs of the scientific community**. Focus on balancing technical requirements with market demands, ensuring the labs remain relevant and sustainable in the long term, both environmentally and economically.

**Conduct a market analysis** to understand what design criteria and material specification can potentially be challenged to reduce embodied carbon without invoking market risk.

**Analyse existing carbon benchmarks** and discuss suitable benchmarks for the project based on the discussion of the topics above.

If existing building on site our fit-out - **conduct early analysis of potential end of life destination for existing materials**.

Early feasibility of reuse potential if existing building is on site.

Early reporting on carbon hot spots, opportunities and constraints.

Report on potential carbon benchmarks.

### 1 Preparation and Brief

This stage is where the project team is brought onboard and where key directions for performance requirements, as well as carbon targets should be set.

If existing building on site - **engage necessary stakeholders to conduct a pre-redevelopment study** for optimal retention rate. This should consider carbon, cost, marketability and future adaptability. Analysis should focus on lab enabled design criteria.

**Review program and zoning opportunities** based on grouping different requirements, and utilising existing building where possible. Discuss impact on carbon, cost and marketability.

**Review potential carbon 'hot spots'** with the whole project team. Discuss opportunities and constraints.

**Conduct early workshop on massing, basement, grids, program, logistics, building services and future adaptability**. Discuss what carbon opportunities or constraints these may result in.

**Review design criteria** with the whole project team. Ensure to involve leasing agents and cost consultants.

**Discuss a suitable carbon target and budget** for the different building categories with the whole project team.

If existing building on site - **conduct a pre-demolition audit of material** and determine potential end of life destinations.

**Identify key reussable materials and products** within the site and outside.

If existing building on site:

Pre-Redevelopment Audit  
Pre-Demolition Audit.

All projects:

Workshop with whole project team on carbon.

Analysis of potential carbon hot spots and reduction strategies.

Set carbon target and budgets.

### 2 Concept Design

This stage is where the project team should focus on optimisation of the design through exploration and evaluation of different carbon levers.

**Review programme to optimise adjacencies and zoning** based on users, carbon and cost.

**Identify design-driven carbon saving opportunities** focusing on identified carbon hot spots from previous stage.

**Key carbon drivers** to review include basement approach, spans, load capacity, floor to floor height, load paths and simplicity of structure.

At a minimum **conduct carbon evaluation studies of grid and structural systems, facade and MEP system**.

**Evaluate materials based on holistic performance**. Some materials, like timber, have a low carbon footprint but also low load bearing capacity and acoustics performance which may result in greater material quantities for labs to compensate for this - explore options to find the right balance.

Use generic material data to **conduct initial carbon assessment**.

**Review cost plan is aligned with carbon assessment**.

**Identify carbon saving opportunities and costs** associated with them.

If existing building on site - **start engagement with reuse networks** to enable identified end of life routes for existing materials. Include key reusable materials site in the design and cost plan.

Early carbon assessment of whole building according to Royal Institution of Chartered Surveyors (RICS). Be mindful of underestimating the complexity of the design and construction process and likelihood of changes. The design team should consider an overall factor to prevent underestimation at this stage

Elemental carbon assessment for structure, facade, building services and fit-out.

Identified carbon saving opportunities and costs associated with each opportunity

If existing building, reuse and upcycling opportunities report

### 3 Developed Design

In Developed Design the focus is on further reducing carbon through detailed studies of the design and procurement opportunities.

**Continue exploring design-driven carbon saving opportunities** using the carbon assessment from previous stage to guide focus areas.

At minimum **conduct detailed carbon evaluation fo structural efficiencies, facade optimisation and building services**. Consider the whole life impact in the studies.

**Refine design with more detailed material investigation for structure, facade and MEP**. Consider their holistic impact on the building, carbon and lifespan.

**Review maintenance and accessibility strategy for building elements** which may need replacements during tenant cycles or the building lifespan. Avoid unnecessary materials having to be replaced.

**Discuss and agree possible use of specific material data in carbon assessments**.

**Review cost plan is aligned with material specification assumptions and carbon assessment**.

**Identify carbon saving opportunities** and include them for comment by tendering contractors.

If existing building on site - **include deconstruction scope in tender documents for contractor**. **Conduct necessary audits of materials** for potential reuse on site.

Updated carbon assessment of whole building according to RICS. Full assessment conducted as part of planning application.

Summary of evaluated carbon reduction strategies.

More detailed carbon saving opportunities through specification and procurement with cost and program associated with each opportunity.

Whole Life Carbon and Circularity Employer's Requirements for tender.

### 4 Technical Design

At this Stage the main contractor has generally been appointed and will work with the project team to embed carbon reduction in approach to procurement and specification.

**Early engagement with contractors and supply chain** on material specification opportunities

**Identify opportunities for carbon savings** with contractors for transport and site activities

**Review cost, programme and risk impacts** for carbon saving opportunities

**Review carbon assessment alignment with specification in tender packages**

**Embed carbon performance targets within tender documentation**, where possible

**Agree carbon reporting** for planning and contractual fulfillment

**Include scope for material passport in tender documentation**. Outline what data to be collected and for what materials.

If existing building on site - **initiate demolition** (soft strip may be earlier) and **salvage materials identified for reuse on site or elsewhere**.

Updated carbon assessment based on detailed building design information should be used in reporting for planning. It should exactly mirror the information on which the building is priced and be issued with the tender.

### 5 Manufacturing and Construction

In this stage the main contractor will work to realise the carbon strategy in the delivery of the project.

**Continue to monitor supply chain** for possible specification opportunities

**Reporting of carbon throughout the construction**.

**Variations to specifications should be reported** with comparison against original carbon target.

**Material passport documentation** for key reusable materials.

Regular reporting against carbon targets and material passport strategy.

### 6 Handover and Close Out

The hand over stage is where the final carbon assessment will be conducted and reported. This is also an important stage for sharing lessons learnt.

**Report and review of final carbon results**

**Report and review material passports**. Handover to tenants/building operator where suitable.

**Share lessons learnt within project team**.

Final carbon assessment based on as built documentation. Also to be submitted for planning if applicable.

### 7 In Use

Reducing carbon in the in use stage focus on engaging with tenants and building operators to drive operational efficiency, resourceful maintenance and reuse of materials.

**Engage tenants to reduce emissions and waste associated with fit outs**. Introduce the material passport for the lab space if applicable.

**Seek opportunities for material reuse, upcycling, recycling**, and the like associated with fitout or tenant turnover and ongoing maintenance

**Track and measure MEP systems**, source advanced control systems and sensors to ensure efficient heating, ventilation, and air conditioning (HVAC) systems.

For example - determining the appropriate air change rate per hour based on actual building occupants, and reducing the ACH when the building is unoccupied via a 'night setback' mode, can significantly reduce overall energy consumption.

Outline strategy for reducing in use embodied carbon emissions

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# Acknowledgements

## Thank You

### **ADC Therapeutics**

- **Lisa Skelton**, VP Global Project Management
- **Paul Hogg**, Vice President, Medicinal Chemistry
- **Ian Kirby**, Director of Protein Chemistry
- **Pedro Luís Alves**, Scientist
- **Ben Leatherdale**, Bioanalytical Scientist
- **Francesca Zammarchi**, Head of Pharmacology

### **ARUP**

- **Tim Fry**, Business Leader, Science UKIMEA

### **BioIndustry Association (BIA)**

- **Ekin Ece Erkan Kaplan**, Membership and BD Executive
- **Alina O'Keeffe**, Associate Director, Marketing & Communications

### **The Biotechnology and Biological Sciences Research Council (BBSRC)**

- **Joan Shadwell**, Programme Manager

### **British Land**

- **Kath Ames**, Life Science Operations Manger
- **Luke Kelly**, Project Director
- **Gareth Roberts**, Head of Development - Innovation & Life Science
- **Matthew Webster**, Head of Environmental Sustainability, British Land

### **University of Cambridge**

- **Marita Walsh**, Head of Chemistry Operations and Estates, Department of Chemistry

### **Cryoserve**

- **Matt Gibbons**, Director & Co-Owner

### **Domainex**

- **David Cronk**, Chief Operating Officer

### **The Francis Crick Institute**

- **Emma Nye**, Head of Experimental Histopathology

### **GSK**

- **Duncan Parsley**, Site operations Director

### **Imperial College London**

- **Paul Foley**, Commercial & Operations Activities Director
- **Peter Beard**, Commercial Manager
- **Claire Goode**, Property Development Manager

### **Innovate UK**

- **John Topliss**, Head of Property and Capital Portfolio

### **The Institute of Cancer Research (ICR)**

- **Simon Francis**, Director of Estates and Facilities
- **Lisa O'Fee**, Sustainability Advisor
- **Richard Woods**, Head of Sustainability, Health & Safety

### **Leesman**

- **Mike Walsh**, Development Director
- **Peggie Rothe**, Chief Insights & Research Officer
- **Kamrul Shikdar**, Analyst

### **Multus**

- **Réka Trón**, Co-founder and COO

### **Norwich Bioscience Institute**

- **Andrew Peck**, Head of Facilities and Interim Buildings and Asset Manager
- **Steven Guy**, Deputy Head of Facilities

### **Norwich Research Park**

- **Nick Goodwin**, Chief Operating Officer at Anglia Innovation Partnership LLP
- **Jonathan Barnard**, Development Director
- **Matthew Poll**, Director of Estates & Facilities for City College Norwich, Paston College and Easton College

### **Oxford Properties**

- **Emma Downey**, Director, Development Life Science & Office
- **Hala El Akl**, Vice President of Sustainable Investing and Operations
- **Pierre-Etienne Accarier**, Director - Real Estate
- **Antara Woodring**, Vice President, Life Sciences (Europe)

### **The Pirbright Institute**

- **David Shadwell**, Senior Capability Leader
- **Ben Williams**, Programme Manager - Estates Management Services
- **Anthony Clarke**, Capability Projects Manager
- **Jane Adams**, Housing & Facilities Manager
- **Nicole Doyle**, Postdoctoral Researcher
- **Michael Boylan**, Inventory & Supply Chain Manager
- **Emily Kinsella**, Environmental Scientist
- **Miriam Windsor**, Head of Research Services
- **Olga Kotik**, CL2 Laboratory Manager
- **Jim Chadwick**, PhD Student
- **Ryan Waters**, Named Veterinary Surgeon and Named Training and Competency Officer
- **Jason Tearle**, Biorisk Technical Lead

### **RFC Power**

- **Tim von Werne**, Chief Executive Officer

### **University College London (UCL)**

- **Dr Jason Millichamp**, Lead Research Manager
- **Ben Stubbs**, Head of Sustainability (Built Environment)
- **Andrea Hodgetts**, Sustainable Research Manager

### **Watts Sustainability**

- **Peter Watts**, Director



***Transforming to Zero***

White Paper

Published by GXN and 3PM

Published Digitally, June 2024

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