RESTRICTED COMMERCIAL INFORMATION

Energy and Carbon Management Plan for London School of Hygiene and Tropical Medicine:

LSHTM response to climate change

Final version for SLT

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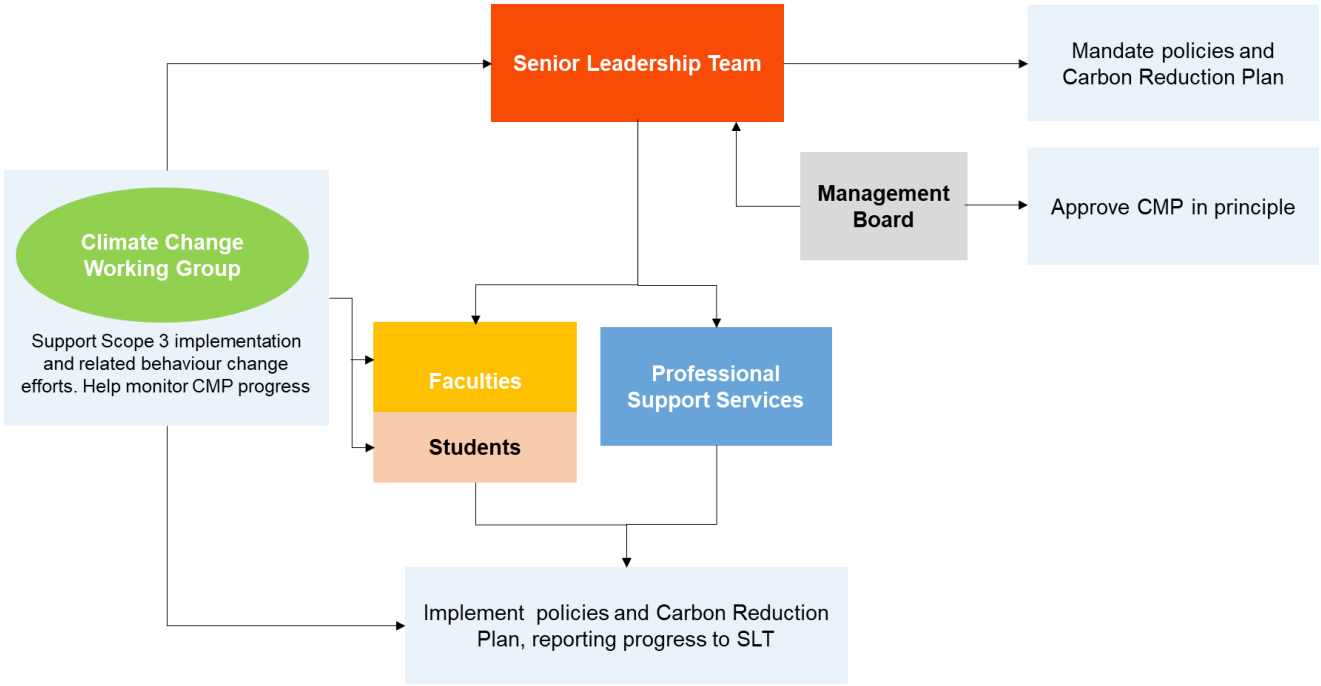
[Peter Piot’s foreword on this page]

Executive Summary

This new Carbon Management Plan sets out an emissions reduction trajectory towards achieving carbon neutrality by 2030, with a milestone review in 2025 – and includes:

- updated targets and actions to help reduce LSHTM's carbon emissions to near zero
- covers the three types or scopes[1] of carbon emissions:
    - **Scope 1**: direct emissions from owned or controlled sources, i.e. fuels burnt on-site such as natural gas, LPG or petroleum-derived fuels
    - **Scope 2**: indirect emissions from the generation of purchased energy, e.g. electricity, district heating or steam
    - **Scope 3**: indirect emissions arising from purchased services and goods, i.e.an organisation's supply chain.
- includes actions/targets to reduce business travel particularly air miles, the impacts of purchasing, and considers the role that carbon off-setting can play in the overall effort to reduce carbon emissions

To be successful the new CMP needs to be fully owned and implemented at every level of the institution. The diagram below summarises how the CMP will be approved and implemented, illustrating responsibilities and lines of reporting:



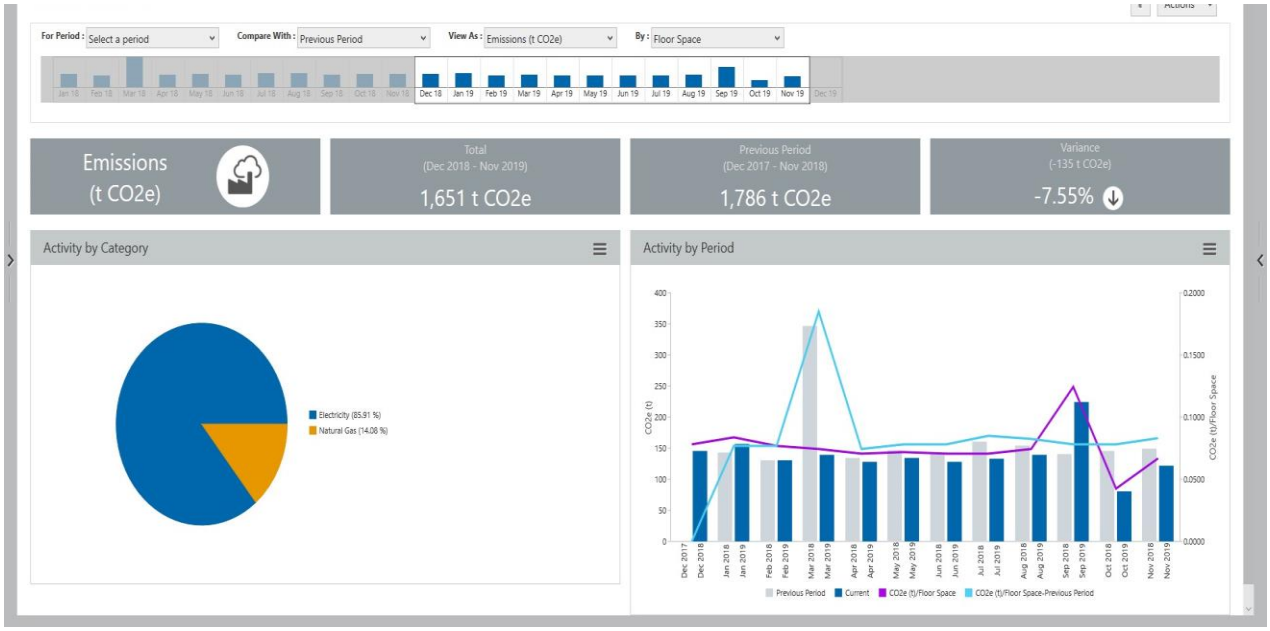
The new CMP integrates directly with LSHTM's Environmental Management System (EMS) and related policies, procedures and processes to enable effective carbon emissions reduction outcomes. Some of these policies and procedures, especially those for procurement

[1] https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf

and travel, have been updated to reflect the increased emphasis on emissions reduction towards carbon neutrality.

Carbon Reduction Action Plan

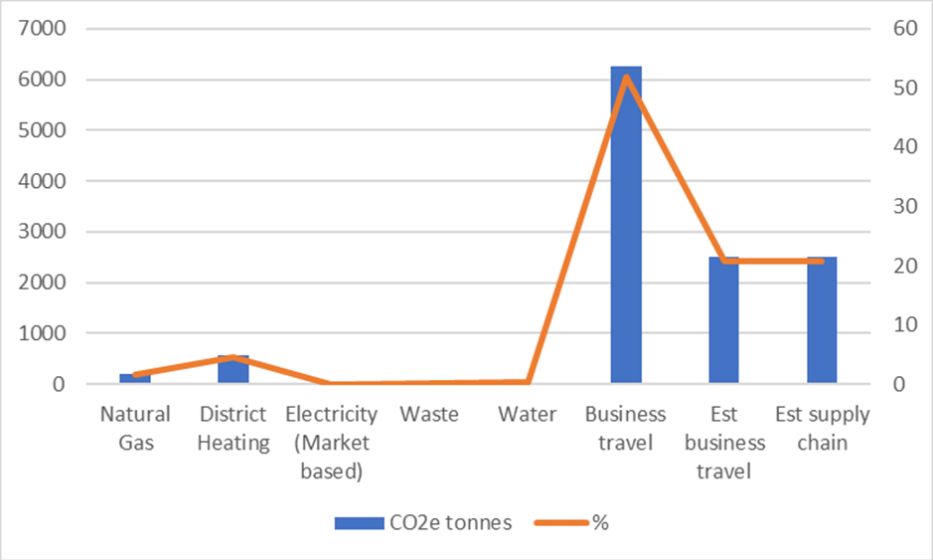
The Action Plan will be made publicly available via a **Sustainability Portal** on the LSHTM web site and intranet. This provides access to live data and regular progress reports by building, by emissions scope and in aggregate, enabling tracking of progress towards carbon neutrality:



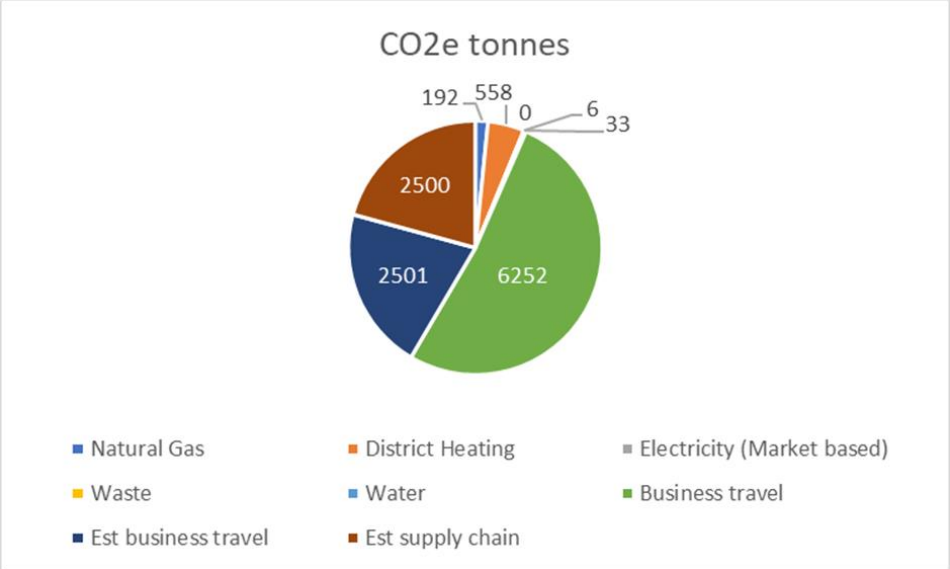
The following table and graphs summarise LSHTM's 2018/19 carbon footprint. ***Because of business travel under-reporting by some 40% and the lack of supply chain carbon data these elements have been estimated.*** The Plan's purpose is to fill these data gaps to enable a new baseline to be established and a trajectory towards carbon neutrality by 2030.

Scope	Source	CO_2e in tonnes	%
Scope 1	Natural Gas	192	2
Scope 2	District Heating	558	5
Scope 2	Electricity (Market-Based)	0	0
Scope 3	Waste	6	0
Scope 3	Water	33	0
Scope 3	Business travel	6,252	52
Scope 3	*Est business travel*	*2,501*	*21*
Scope 3	*Est supply chain*	*2,500*	*21*
	Totals	**12,042**	**100**

Figure A: LSHTM's total annual carbon footprint for reporting year 2018-19



Figures B & C: LSHTM's illustrated total annual carbon footprint for 2018-19



The updated carbon footprint makes if evident that business travel constitutes around 70% of LSHTM's annual carbon emissions. This could be even greater because business travel is currently under-recorded, and it has not been possible to establish the proportion of scope 3 emissions arising from other bought goods and services. It is very clear, however, that business travel presents a significant challenge to LSHTM and significant systemic changes are required to better monitor and manage this source of emissions.

Interpretation of LSHTM's carbon profile strongly suggests that it should be considered a global institution that 'happens to be based in London' as this perspective more aptly reflects the institution's operations and global reach. By taking a similar approach to managing travel emissions to that of other global institutions, such as the United Nations and its agencies, it is

possible to make the necessary changes to current practice whilst ensuring LSHTM's core business functions continue effectively.

To this end the following table provides recommendations on reducing LSHTM's carbon emissions – all scopes – but especially scope 3 emissions.

Setting science-based targets

With the aim of achieving carbon neutrality by 2030, the trajectory for reducing annual emissions is provided below. To monitor progress a mid-term target for emissions reduction by 2025 is also given. When measures to reduce emissions from each source or scope have been fully implemented it will still not be possible to completely reduce or avoid emissions, especially from scope 3 sources. On that basis these **residual** emissions can be offset to achieve a net zero[2] carbon footprint, i.e. carbon neutrality. A robust, well-evidenced approach to carbon offsetting is being scoped as a related initiative, due to report to SLT in Spring 2020. Accurate, scientifically assessed carbon reduction targets create a solid foundation for LSHTM to aim for into the future. This report aligns future targets using the Science Based Targets[3] Initiative (SBTi) tool, which ensures LSHTM's reduction strategy is aligned with the latest climate science.

Using the Science-Based Target initiative's (SBTi) 'Absolute Emissions Reduction Approach towards achieving a 1.5-degree global temperature reduction, LSHTM needs to reduce its Scope 1, 2 and 3 carbon emissions by 50.4% by 2030. This is achievable through realising continued improvements in annual performance. Because of the issues in accurately measuring scope 3 supply chain emissions from procurement and business travel, LSHTM will not sign up to formally meeting the SBTi targets until further progress is made in obtaining accurate emissions information from key suppliers.

The SBTi emissions reduction scenarios do not recognise carbon offsetting because its goal is to encourage robust target-setting to actively reduce emissions. The best approach for LSHTM to take is to work towards meeting the SBTi target, using 3rd party carbon assurance to annually verify residual carbon emissions after all measures to reduce annual emissions have been taken. The residual emissions can then be offset with the aim of achieving the optimal benefits towards LSHTM's strategic vision and objectives for climate resilience health and well-being. The SBT details are provided on the next page, followed by the summarised Carbon Reduction Plan towards meeting the targets set for 2025 and 2030.

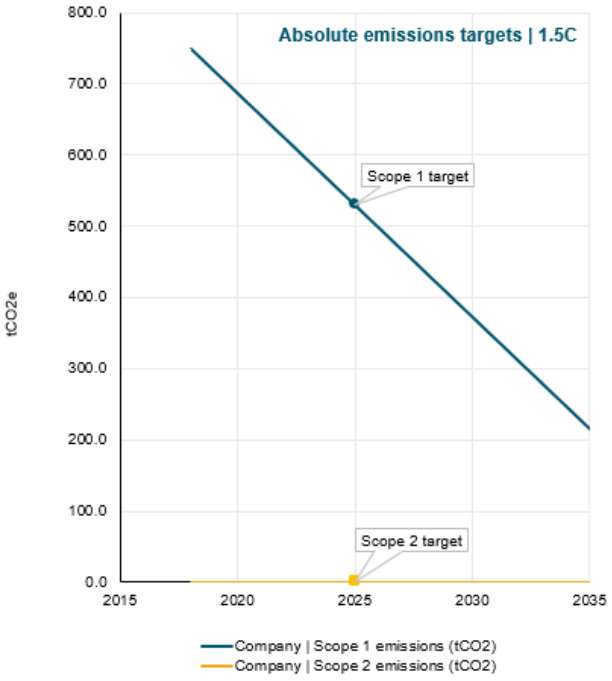
[2] 'Net zero' means that any emissions are balanced by absorbing or reducing an equivalent amount from the atmosphere.

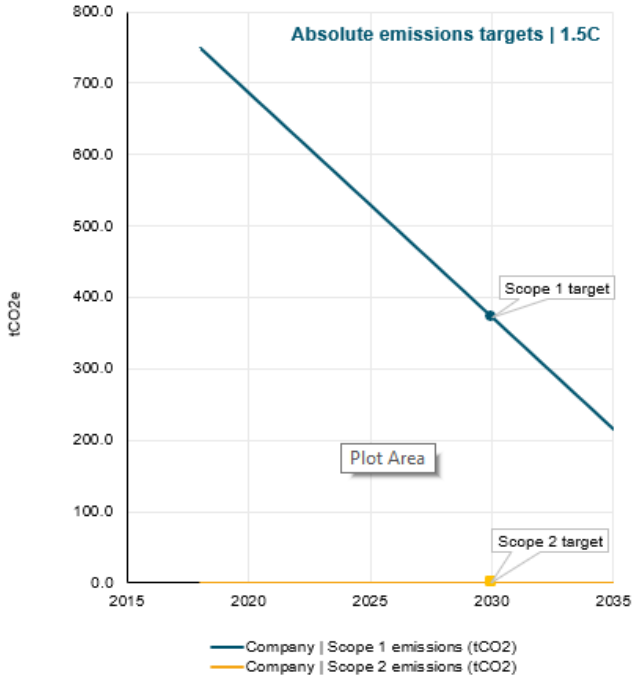
[3] A greenhouse gas (GHG) emission reduction target can be considered 'science-based' if the emission reductions it stipulates are in line with keeping the global temperature increase well below 1.5°C compared to pre-industrial temperatures.

Scope 1 and 2 SBT reduction targets: 50% reduction by 2030

	Base year (2018)	Target year (2025)	% Reduction
Scope 1 emissions (tCO2e)	750	530	29.4%
Scope 2 emissions (tCO2e)	0	0	0.0%
Scope 1+2 emissions (tCO2e)	750	530	29.4%

	Base year (2018)	Target year (2030)	% Reduction
Scope 1 emissions (tCO2e)	750	372	50.4%
Scope 2 emissions (tCO2e)	0	0	0.0%
Scope 1+2 emissions (tCO2e)	750	372	50.4%





Scope 3 SBT reduction targets

	Base year (2018)	Target year (2025)	% Reduction
Scope 3 emissions - 2C (tCO2e)	11,292.0	10,319.8	8.6%
Scope 3 emissions - 1.5C (tCO2e)	11,292.0	7,972.2	29.4%

	Base year (2018)	Target year (2030)	% Reduction
Scope 3 emissions - 2C (tCO2e)	11,292.0	9,625.3	14.8%
Scope 3 emissions - 1.5C (tCO2e)	11,292.0	5,600.8	50.4%

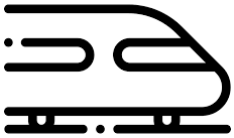
Goal: A 50% reduction by 2030 of carbon emissions across Scope 1,2 and 3.

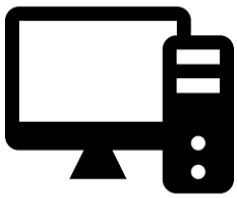
Scope 1: Emissions from direct combustion on-site			
Location	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
All London buildings 	Council and SLT to agree to a building services review which investigates system changes to accommodate low carbon heat at LSHTM, with a near to medium term view to moving away from gas fired heating	Develop a time-bound working proposal to guide implementation. In the interim procure partly renewable 'green gas' when tendering for gas supply	Estates Department. Further action is needed to bring additional carbon benefits and realise an Estate that is carbon-free
	Develop a Space Heating Policy for LSHTM to outline the heating provision and control strategy and building classification – such as official opening hours of different buildings.	Policy in place	SLT to mandate policy to Faculties and support teams who must then implement the policy
	Review the Energy Efficiency Opportunities identified in Section 3. This includes low cost technical and behavioural opportunities to reduce energy usage.	Prioritise and commit to investment in energy management and efficiency measures (again to be time-bound, timescales)	The Climate Change Working Group, supported by SLT and Estates, develop and implement a programme of behaviour change.
	Implement ISO 50001 certification system for long-term energy savings.	ISO 50001 external certification achieved by end of 2021	SLT and Estates Department to progress, working closely with the Climate Change Working Group and the Take Action climate network
	Energy (and sustainability awareness) training for all staff incorporated into Staff Development Plans (a rolling programme similar to say, equality & diversity training for example)	No. of staff trained in energy awareness in 2020	SLT and Estates Department to implement training programme (also integrated into induction process).

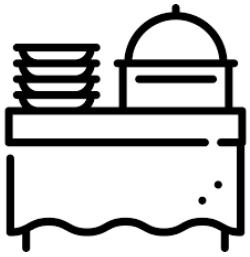
Scope 2: Emissions from electricity, district heat and steam			
Location	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
All London buildings 	Purchasing 100% renewable electricity and investing in energy efficiency measures including: • low cost technical and behavioural opportunities to reduce energy usage • Investing to achieve annual improvements in energy efficiency to reduce cost and drive efficiency • Updated Engineering Standards to achieve higher energy efficiency standards and lower life-cycle carbon costs of technologies being implemented.	% of renewable electricity purchased/yr - included as part of EMS and sustainability reporting Behaviour change programme in place by August 2020, with agreed outcomes Measure and report the % improvement in energy intensity (electricity, natural gas, district heat) per m^2 in Estate buildings Standards fully implemented Standards fully implemented	SLT and Estates Department have implemented this measure, the next activity is to diagnostically review usage and behaviours to decrease the baseload. Climate Change Working Group and the Take Action climate network to progress behaviour change programme, working closely with the SLT / Estates department. SLT and Estates Department. Energy efficiency designated a priority for all infrastructure and projects, both existing and planned. Estates department, signed off by SLT by August 2020

Scope 3: Supply chain emissions			
Source	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
Procurement **[High Priority]**	Council and SLT to agree joint financial and sustainable procurement policy by December 2019.	Policy in place	SLT to mandate policy to Faculties and support teams by end of January 2020

	Faculties to mandate good practice procurement using PO system Integrated finance and carbon accounting and procurement systems developed	% of orders placed using a PO per Faculty//Dept/team All POs tracked via Agresso or similar	Faculty Heads and FOOs to ensure policy is adhered to by all academic, research and administrative staff. Finance and Procurement monitor PO practice on a monthly basis Monthly reports issued to Climate Change Group to review and follow-up as appropriate with specific Faculty/Project teams to encourage adherence to the policy and systems. This could include investigating 'user issues' and problems from a user perspective.
Waste 	Improve waste collection in Keppel Street to match good practice in Tavistock Place. Waste reduction targets set per building and per waste stream 'Take back schemes' for waste packaging and equipment to reduce waste arisings where possible	CO_2e per tonne/annum of: • WEEE • Hazardous waste • Paper and card • Cardboard • Food/ organic waste • Plastics (with the aim of eliminating single use plastics) • Metals • Glass	Waste segregation good practice mandated in Keppel Street by SLT, monitored by Estates Estates team & Procurement set waste reduction targets using supplier take-back schemes as far as possible Estates/support services monitor waste arisings per building, raising any issues with the Climate Change Working Group, Head of Sustainability & SLT Head of Sustainability to collates data for reporting and work on any issues with Faculty and Support Services

			staff as appropriate/required.
Water & wastewater 	Conduct water audit and set efficiency targets per building Monitor water usage per building	• Cubic metres per month and in aggregate for the reporting year • Intensity – potable water emissions in CO2e Kgs/m2 or per CO2e Kgs/capita • Intensity (trade effluent emissions in CO2e Kgs for the building as a whole as an EMS requirement)	Estates/Support services to undertake and implement findings of water audit Estates/Support services to monitor water usage per building against agreed targets – Head of Estates to raise any issues with the SLT Head of Sustainability to prepare quarterly reports for EMS rand CMP purposes, supported by the Laboratory Managers.
Construction & refurbishment 	• Commission low to zero build and refurbishment projects using procurement process to establish low carbon sustainability targets, ensuring carbon performance is considered as key criteria at the tendering stage of building / infrastructure projects Identify pre-work carbon emissions foot-print requirement for each project Undertake post-completion/post-occupancy evaluation of emissions, using this to inform future project specifications and approach	• BREEAM NC and BREEAM Refurbishment ratings for low carbon • Aspire to SKA fit-out Gold rating for low carbon • Design stage: Embodied carbon emissions – absolute and intensity/m2 –	Estates team, working in partnership with Design lead, lead contractor and consultants team. Report performance data to SLT and Head of Sustainability Monitor building use with Faculties to determine design specification goals for user comfort, energy and water efficiency are being met.
Business travel **[High Priority]** 	Travel policy agreed by March 2020 and protocols developed by May 2020 Monitor business travel by mode and frequency or trips per individual (Bookings via Travel Service as far as possible)	• CO2e tonnes/annum by type of flight (domestic, short haul from UK, long haul from UK and international/non-UK) • CO2e tonnes/annum by national rail miles travelled	Council and SLT to agree travel policy and mandate travel protocols for all faculties and research projects to be in place for the 2020/21 reporting year

 	Agree targets for reducing business travel to a 'reasonable minimum' Expenses cannot be claimed without providing full trip details (mode, miles and emissions)	• CO2e tonnes/annum by Eurostar/International rail miles travelled • CO2e tonnes/annum by London underground miles travelled • CO2e tonnes/annum by London Taxi/Taxi miles travelled • CO2e tonnes/annum by hire/lease car (taking engine size into account) miles travelled • CO2e tonnes/annum by hotel overnights (taking location into account) • CO2e tonnes/annum per faculty per mode (as above) • CO2e tonnes/annum per 'frequent traveller(name & unique LSHTM Identifier) academic/employee'	Faculty Deans to mandate good practice travel booking and expenses claims within every School/Dept and Research Team with support of the FOOS by March 2020 Travel Service Provider(s) report monthly to an agreed format (as specified by the Head of Sustainability) SLT to monitor adherence to travel policy and protocols, taking action to implement these as required.
ICT hardware 	ICT procurement standardised across the organisation, i.e. all purchases are made through the formal procurement process to generate a recorded PO as required above for Procurement generally.. All ICT assets to be tagged by their unique device code number, enabling faculty, research project and support service inventories to be generated and maintained. Engage with suppliers to get an emissions LCA footprint as part of the product specification as far as possible Set-up formal procedures for effective WEEE take-back (for remanufacturing) by the supplier as far as possible to	• Carbon inventory of devices (by make, type and production emissions) per Faculty and research programme • Carbon inventory of devices (by make, type and production emissions) per research project not accounted for in a faculty inventory • Nos and % of devices returned to supplier per annum under a take-back agreement – per faculty and research programme plus in total per annum • % of storage met off-site at data centres powered by 100% renewable electricity –	ICT to work with Procurement to agree specification and main supplier(s), with no POs accepted for alternatives unless an ICT approved business case has been signed off. This set-up to be fast-tracked from January 2020 Faculties to undertake 'asset inventory' with ICT support. All new devices must be added to the inventory managed by ICT. ICT to confirm how when the inventory can be implemented to enable reporting to start during 2020. Procurement to specify that suppliers must provide embodied

	reduce LSHTM's WEEE waste. Long term strategy planning to utilise off site data storage moving away from on-site data centres		emissions per device as far as possible at point of order placement, and provide a take-back service for old and 'beyond economic repair' devices SLT to receive monthly/quarterly reports on progress and level of adherence to the procurement process for IT devices
Catering 	Supplier engagement programme to develop evidence based, quantified CO2e emissions per item or unit of product, making this information a requirement of future tendering activities as far as possible. Phase out hard to re-use or hard-to-recycle packaging and minimise product packaging Provide information on innovations and successful low carbon initiatives to the existing supplier network to encourage further supply chain improvements.	• CO2e kgs/item or unit of product supplied • Nos and % of suppliers operating a reusable packaging system to minimise waste • Nos and % of suppliers using 100% recyclable packaging • Amount/% of food waste sent for composting or similar bio-processing, e.g. biogas	Catering team, with support from Procurement and the Head of Sustainability, to undertake a supplier survey for specific evidence of carbon footprint and/or carbon intensity of products. Catering team continue working closely with suppliers to improve recyclability of packaging and reduce non-essential packaging, switching to re-usable crates and totes as feasible/practicable Catering report monthly/quarterly to SLT on reducing food & packaging waste, on carbon emissions info from suppliers, with support from Head of Sustainability (systems integration with procurement & finance may be required).
Lab consumables	Working in close partnership with the new waste management contractor, identify which labs and types of lab waste could be further reduced through smarter procurement and better	• % of lab suppliers contacted about the sustainability of their products and product packaging	All labs and Lab managers to join the Lab Sustainability Group (or have representation in the group). Progress to be reported to the FOOs,

	usage; developing enhanced lab policy and protocols as appropriate. Develop a lab procurement protocol and a mandated list of preferred suppliers for specific consumables and equipment Take-back schemes set-up with suppliers of specific equipment so that these items can be returned for re-manufacturing at the end of their useful life, further reducing waste arisings. Aim to consolidate lab deliveries with other members of the Bloomsbury Group, reducing traffic emissions. Resolve storage issues and re-instate the lab 'swap shop' initiative.	• %/No of lab suppliers operating take-back schemes for used and unused products and equipment; this would reduce waste arisings • % and type of lab products with validated sustainability credentials, e.g. ACT or Ecolabel • Annual carbon emissions from lab waste by type (provided by main waste contractor) • If possible, emissions from waste per laboratory	Management Board and, ultimately SLT, especially if problems persist and need senior intervention. Lab managers to work with Procurement to develop an agreed list of low carbon lab consumables, using ACT and direct engagement with suppliers to identify low carbon products and packaging. Lab managers to work with Procurement and waste contractor in producing monthly/quarterly reports on progress. Estates Support Services and procurement department to work with Lab Sustainability group to resolve delivery logistics and storage issues.
Office stationery 	The Office Depot 'green alternatives' office supply catalogue becomes the mandated source of all office consumables. Office Depot is required to provide information about the carbon efficiency of their products and encouraged to improve this information over time. Ideally this should be a condition of contract.	• % of products purchased from the Office Depot 'green alternatives' list with the aim of achieving 100% • % of products with a known carbon intensity value, i.e. emissions per item or per kg, aiming for 100% • % of total procured items for which annual scope 3 carbon emissions can be calculated, aiming for 100%	Variation to existing contract set up by Procurement and mandated across LHSTM so that only the 'green alternatives' list of products is used. Procurement work with Office Depot to establish the embodied carbon in different products as a condition of contract. This should be reviewed at least annually, with encouragement to Office Depot to always offer better products at competitive prices.

Investments 	Keep a watching brief on the investment portfolio and sources of financial gifts/donations to avoid involvement in any activities that would undermine LSHTM's objective for working towards achieving carbon neutrality by 2030. In particular, look to completely divest from fossil fuel and related high carbon commodity investments as soon as practicable.	% investment in high carbon commodities – should ideally be zero	Finance to monitor, notifying SLT and Council when and how action needs to be taken

The Green Consultancy will be pleased to provide further detailed investigations and any implementation support that may be needed to address the issues identified in this report.

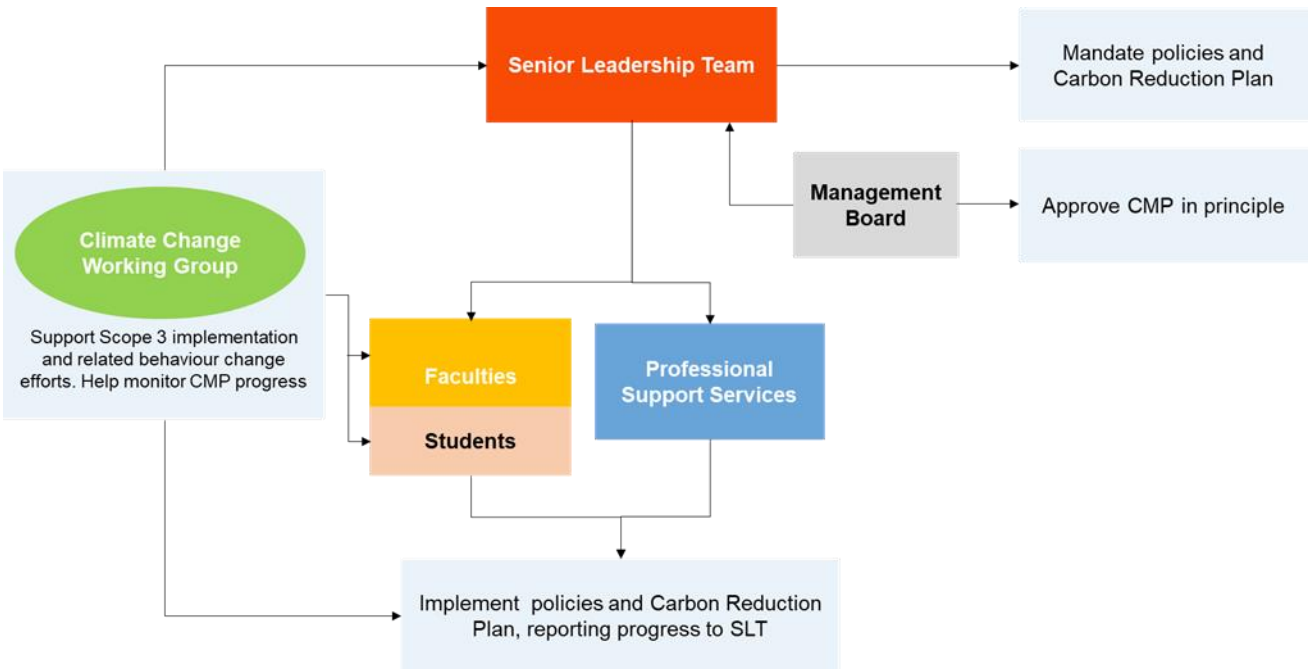
1 Introduction

Carbon reduction has been a driver across the higher education (HE) sector since 2007/08, starting with the HE carbon management programme to help universities develop Carbon Management Plans (CMPs) for meeting quantified reduction targets. The London School of Hygiene and Tropical Medicine's carbon management efforts have focused primarily on effective energy management of LSHTM's London estate. The decision was made recently by LSHTM's Council and the Senior Leadership Team (SLT) to develop a new CMP during 2019 in response to the UK Parliament's declaration of a national climate change emergency in May 2019. Another critical driver for a new CMP includes LSHTM's setting up of the new Centre on Climate Change and Planetary Health to help in identifying solutions to the impact of environmental change on human health. Building on more than 25 years of LSHTM's environment-health research, the Centre will advance research across several major themes that include understanding the direct and indirect effects of environmental change on public health, identifying the potential co-benefits to public health of carefully-designed climate-mitigation actions, and developing innovative solutions to enable populations to adapt healthily to future environmental change. Last, but not least, this new CMP is also in response to academic and student concerns about the climate emergency, coming in particular from the Climate Change Working Group and the Planetary Health Network, and the importance they place on LSHTM's global role. The Climate Change Working Group has a specific role to play in helping to implement the CMP and this is highlighted in Section4.

The new CMP is needed to set out an emissions reduction trajectory towards carbon neutrality from 2019-2030 with a milestone review in 2025. This new plan:

- includes updated targets and actions to help reduce LSHTM's carbon emissions to near zero
- covers carbon emission scopes 1, 2 and 3
- includes actions/targets to reduce business travel particularly air miles, the impacts of purchasing, and considers the role that carbon off-setting can play in the overall effort to reduce carbon emissions

To be successful the new CMP needs to be fully owned at every level of the institution. Its scope, key performance indicators (KPIs) and reporting responsibilities set out in this report need to be agreed and approved by Council and delegated to the SLT and the faculties so that every school, each research and support services team and the student body play their part. The diagram below summarise how this needs to happen:



The new CMP integrates directly with LSHTM's Environmental Management System (EMS) and related policies, procedures and processes to enable effective carbon emissions reduction outcomes. Some of these policies and procedures, especially those for procurement, have been updated to reflect the increased emphasis on emissions reduction towards carbon neutrality.

2 Establishing a new carbon emissions baseline

Carbon emissions measurement is standardised across the globe using the Greenhouse Gas (GHG) Protocol established by the World Resources Institute (WRI)[4]. The GHG Protocol is further endorsed by international standards and certifications for measuring and verifying or assuring carbon footprint calculations:

- **ISO14001:2015 - Environmental Management Systems (EMS)**, which LSHTM is independently audited and certificated to. This standard requires enhancement of environmental performance to meet regulatory compliance obligations and the achievement of environmental objectives set by top management, i.e. LSHTM's Council, implemented via the SLT. Because a new performance objective towards carbon neutrality is being planned for the CMP, LSHTM's EMS, is the primary tool for meeting this objective. EMS procedures and processes will need revisiting and mandating to meet this important objective
- **ISO14064: 2018 Greenhouse gases measurement** - compliance with this standard will comply with monitoring and reporting requirements set within the EMS
- **ISO14065: 2013 Greenhouse gases** - specifies principles and requirements for 3rd party auditors to undertake validation or verification of greenhouse gas (GHG) assertions. This is commonly known as independent carbon assurance.

Using these standards, their good practice principles and criteria, LSHTM's carbon emissions can be accurately defined, robustly measured and managed; what isn't being measured cannot be adequately managed so enhancing existing EMS procedures will be critical to success.

The main standard used in structuring LSHTM's updated CMP is the GHG Protocol's Corporate Reporting Standard (2004, revised 2015). This uses the following principles as the basis for data collection, reporting and managing emissions over time:

Table 1: GHG Protocol Reporting Principles

GHG Protocol Principles	Objectives
Relevance	Ensuring that LSHTM's GHG inventory appropriately reflects its GHG emissions and serves the decision-making needs of users – both internal and external to LSHTM.
Completeness	Accounting for and reporting on all GHG emission sources and activities within the agreed GHG inventory boundary or system, disclosing and justifying any specific exclusions.
Consistency	Using consistent methodologies to allow for meaningful comparisons of emissions over time, transparently documenting any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

[4] https://www.wri.org/our-work

Transparency	Addressing all relevant issues in a factual and coherent manner, based on a clear audit trail. This includes disclosing any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.
Accuracy	Ensuring that the quantification of GHG emissions is systematic, neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. The aim is to achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Establishing LSHTM's 'system boundary' for effective emissions management and reporting

An important first step is to establish LSHTM's complete system or inventory boundary for carbon emissions management. Carbon emissions are measured in terms of scopes 1 to 3, as defined by the GHG Protocol:

- **Scope 1:** direct emissions from owned or controlled fuel sources such as natural gas, petrol, diesel, etc.
- **Scope 2:** indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting organisation
- **Scope 3:** all other indirect emissions that occur in a company's value chain, e.g. water supply, waste arisings, bought products and services including business travel, catering, laboratory and office consumables, etc

The current CMP's emissions inventory only covers scope 1 and 2 emissions for LSHTM's buildings (heating and power systems) in London. Figure 1 below illustrates LSHTM's **full** carbon boundary covering all three scopes, clearly demonstrating that LSHTM has a global footprint when taking into account all of LSHTM's facilities and the goods and services it purchases. This is true for virtually every organisation, with scope 3 emissions generally accounting for at least 60% or more of the entity's total carbon footprint.

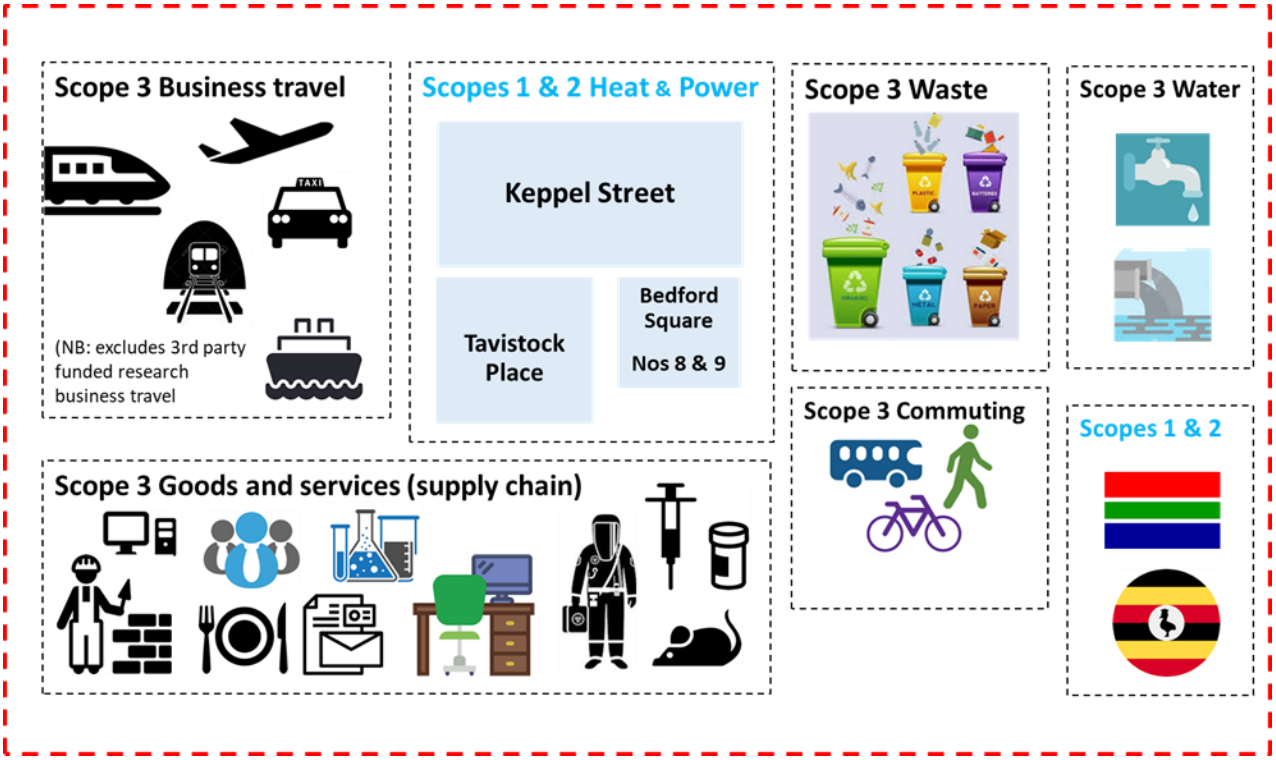


Figure 1: LSHTM's system boundary for carbon emissions (GHG) reporting.

The new CMP needs to measure and manage scope 3 emissions as far as practicable and this require s effective data collation systems with responsibilities appropriately assigned across LSHTM.

For the time being LSHTM's overseas estate, i.e. its facilities in Uganda and Gambia, will be omitted from the new CMP carbon inventory until reporting activities are fully integrated into LSHTM's EMS (which is currently only certificated for UK estate and operations) and scope 3 emissions accounting is well in-hand. The intention is to commission a CMP for both Uganda and Gambia Research Centres once robust data collation and reporting processes are established for London; it will then be possible to roll-out the EMS and reporting system to the rest of LSHTM's facilities overseas.

2.1 Relationship to funding bodies and research partner carbon-reporting

It is important that LSHTM's Council, its support services teams and faculties recognise how LSHTM's carbon reporting activities operate in relation to other organisations, especially its main funders and research partners. Each of these entities have their own system boundary for carbon reporting that will be very similar to LSHTM's.

Funding received by LSHTM, or any of its leading academics, that is designated for specific research activities, including projects overseas, will generate carbon emissions from business travel, lab and specialist equipment, IT hardware and mobile devices, etc. Because funders or research partners are paying for the research they own these emissions, not LSHTM. It is, however, critically important that LSHTM applies the same carbon measurement and carbon emissions reduction criteria to these activities for not only good practice but also reputational reasons. Exactly how LSHTM factors these emissions into its carbon footprint needs to be agreed between the faculties and support teams as a governing principle from the outset.

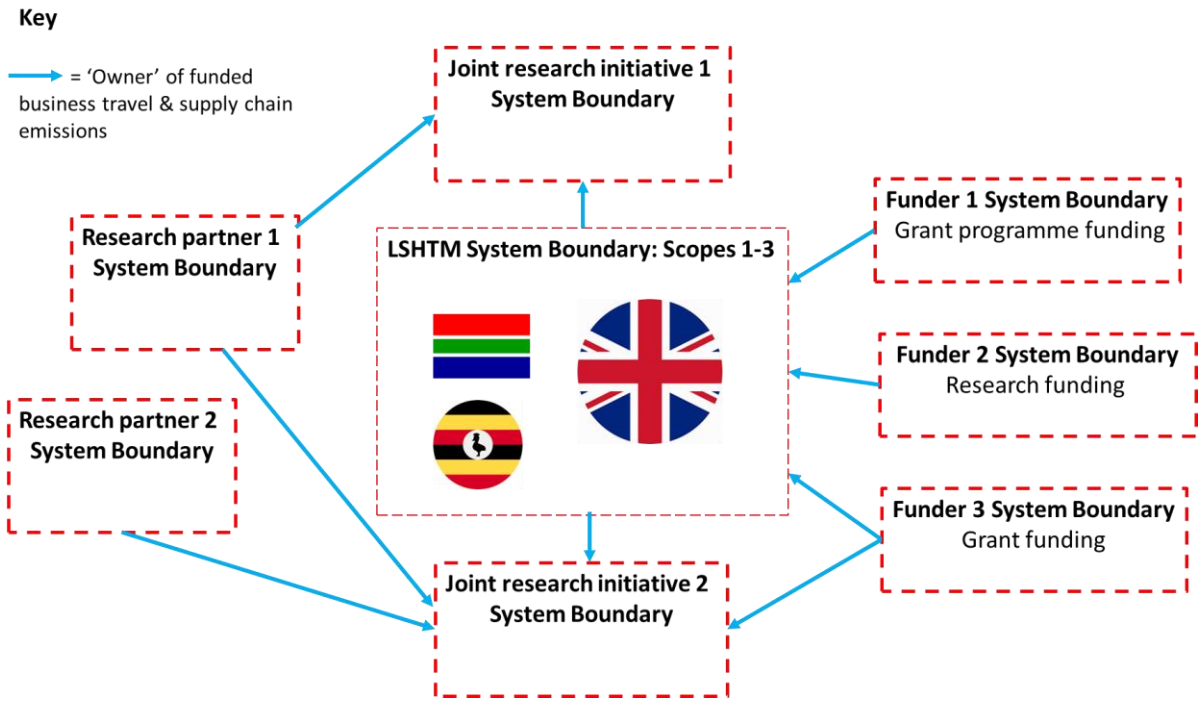


Figure 2: Organisational carbon system boundary relationships covering funded research work.

Figure 2 illustrates how different organisational system boundaries relate to each other, with the blue arrows showing the ownership of flows of carbon emissions, depending on which entity is paying for research activities. All funders own the emissions created by grant recipients, so where funders are increasingly specific about how they wish LSHTM to manage and report research project emissions, these need to be factored into the project application and post-completion evaluation using LSHTM's reporting systems; because each funder will 'own' these emissions they are increasingly likely to require LSHTM's implementation of projects to be carbon efficient and accountable.

The majority of funders do not currently ask for details of a research project's likely carbon budget (**Appendix 1)** but this is very probably going to change in the near future as national declarations of a state of climate emergency spread. It is important that LSHTM is fully prepared to meet the demand for this type of information by being able to provide robust evidence for effective carbon accounting that meets funders' criteria for resource efficiency and cost-effectiveness to avoid or minimise adverse impacts. On that basis, the Climate Change Working Group is ideally placed to raise funders awareness of the issues and to help to build capacity amongst funders to LSHTM's advantage.

2.2 Determining materiality for data gathering and reporting

LSHTM needs to put in place robust measures for regular, on-going data collection and reporting and this is relatively straightforward for scope 1 and 2 emissions. Measuring scope 3 upstream and downstream supply chain emissions can be complex so it is important to put in place user-friendly data gathering systems and procedures that fully comply with the GHG Protocol and related global standards. Because LSHTM already has an EMS certificated to ISO14001 this makes it much easier to enhance the existing EMS procedures to enable scopes 1 to 3 carbon accounting.

The GHG Protocol explains that "*information is considered to be material if, by its inclusion or exclusion, it can be seen to influence any decisions or actions taken by users of it. A material discrepancy is an error (for example, from an oversight, omission or miscalculation) that results in a reported quantity or statement being significantly different to the true value or meaning. In order to express an opinion on data or information, a verifier would need to form a view on the materiality of all identified errors or uncertainties*". Generally, errors or discrepancies of less than 5% are considered not to be material to an organisation's overall carbon footprint unless this prevents it from achieving a target.

Noting that the new CMP needs to account for all scopes of emissions, establishing the proportions of emissions for each scope presents some difficulties. As for many other Higher Education Institutions (HEIs), LSHTM's scope 3 emissions will account for between 60-80% of its total annual carbon footprint, much of this will be down to building construction and refurbishment, catering and other consumables with business travel accounting for possibly around 70% of scope 3 emissions (Sections 4 and 5). A rough indication of what these proportions might be can be considered by reviewing LSHTM's expenditure for the reporting year 1St August 2018 to 31st July 2019:

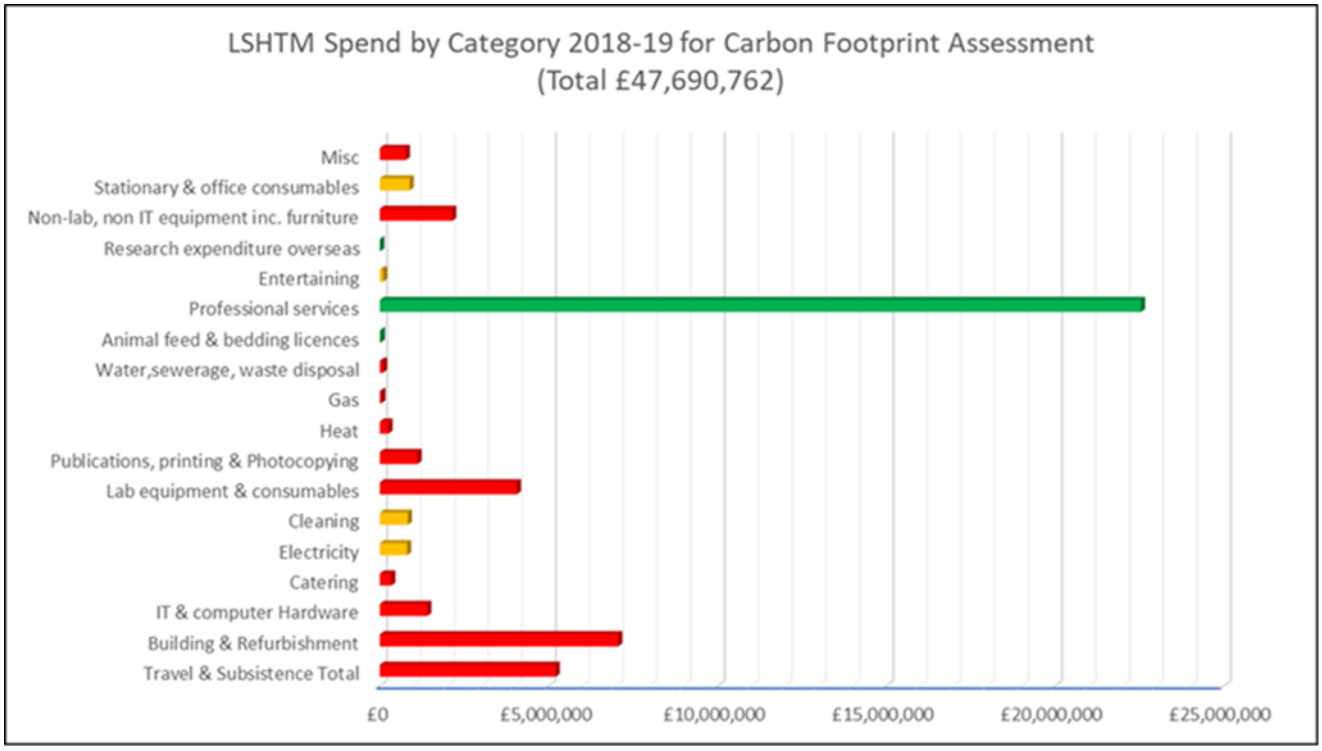


Figure 3: Likely carbon emissions impact in different annual expenditure categories

Key:

- = High carbon activities, goods and services from a supply chain perspective
- = Medium carbon [NB: electricity is in this category because the grid is de-carbonising]
- = Low carbon
- = Unknown items of expenditure not categorised/easy to categorise.

Professional service fees account for the bulk of LSHTM's expenditure and these are associated with low levels of emissions. Items such as construction, refurbishment, catering and ICT hardware can be traced back to energy intensive primary production systems, so these have a relatively high carbon impact per product.

Business travel is a high carbon activity because of the flights involved. When considering total expenditure on expenses alone for the last reporting year, the financial breakdown demonstrates the dominance of expenses used for travel, of which 85% was for flights. Figure 4 also highlights the large amount of expenses for items that should be purchased using the Purchase Order system or the main travel service providers for that it's easier to estimate scope 3 carbon emissions. Some 8% of expenses could not be allocated to a specific expenditure category within Agresso because Finance were provided with insufficient information.

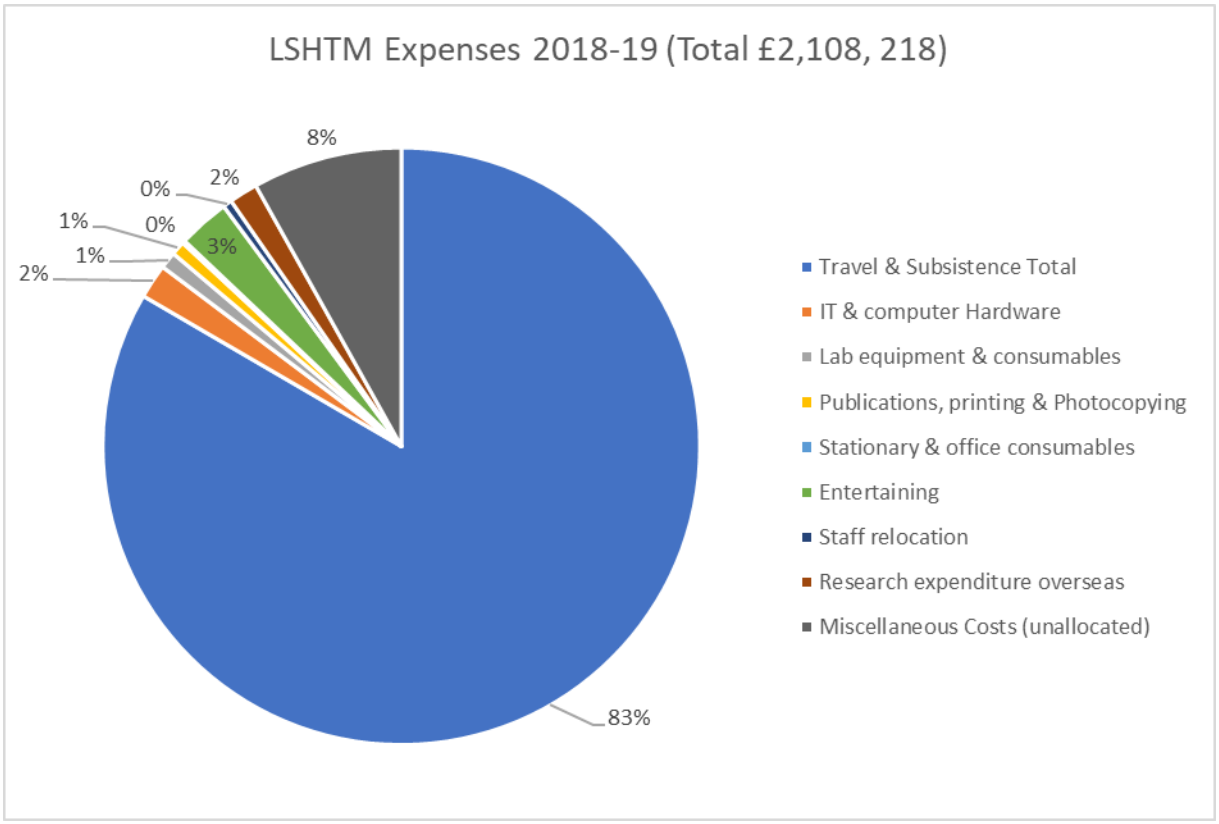


Figure 4: Annual expenses allocated by category of expenditure, strongly suggesting many items would be better purchased using the correct procurement system for the purposes of scope 3 emissions reporting

All scope 1 and 2 emissions from heating and power (100%) have been accurately calculated using energy metering data and fuel billing information. **Section 3** of this report provides the updated energy and carbon baseline for scopes 1 and 2 for LSHTM's UK estate.

All scope 3 emissions for water supply, waste-water management, waste arisings have been calculated using service provider data and conversion factors. Business travel data from the main service providers includes carbon emissions by mode and can be accurately calculated using booking information. Because only 50% of all travel bookings currently go through these service providers, these reliable data have been extrapolated to estimate total travel emissions for the reporting year as a % of the total known footprint. This information is provided in **Section 4** of this report covering all scope 3 sources of emissions. The scope 3 known emissions baseline will be improved for reporting year 2019/20 and LSHTM should be aiming to fully account for these by reporting year 2020/21.

The most problematic source of scope 3 emissions comes from the bulk of procurement activities for laboratory, ICT hardware and mobile devices, catering and other bought goods (**Appendix 2** gives scope 3 reporting categories). The Climate Change Working Group has a role here to build awareness and capacity amongst academic teams and research projects about the issues. Ideally, each supplier needs to be mandated to provide LSHTM with well-evidenced information to show how emissions have been calculated per unit/item or weight of goods provided. Some suppliers can do this readily so their contribution can be immediately incorporated into the scope 3 supply chain footprint. For the rest, LSHTM will need to fully engage with supply partners and vendors, working closely with them to literally map out supply chain carbon risks and opportunities. This should be an on-going programme of engagement to mutually benefit all parties, with 100% of suppliers contractually required to provide these data by 2030 if not before. This highlights the huge importance for all departments and teams across LSHTM needing to follow agreed, mandated procurement procedures so that annual expenditure and categories of goods can be accurately tracked and investigated. Priorities for doing so are expanded on in **Section 4** and recommended actions are presented in **Section 5**.

3 The LSHTM (UK) estate: achieving carbon reduction targets

Keppel Street, Tavistock Place and 8-9 Bedford Square make up LSHTM's UK estate. This section addresses actions that could be taken to meet the "50% reduction by 2030" target, over the course of this Carbon Management Plan. In order to achieve carbon reduction targets as set out in this Carbon Management Plan, low carbon electricity, low carbon heat, better energy management, and increased energy efficiency are all essential. Section 3 considers each of these separately. It includes a commentary on the existing baseline and intensity reporting, presenting an updated baseline and analysis of LSHTM's Scope 1 and 2 emissions in 2018/19.

3.1 Review of baseline and existing reporting

The UK has cleaned up its electricity mix faster than any other major world economy. More than half of UK electricity now comes from low-carbon sources, such as solar, wind and nuclear. In 2015, when LSHTM began their carbon reporting, each kilowatt hour of electricity generated in the UK had a carbon intensity of 0.412 gCO_2e/kWh. This important metric – the "carbon intensity" of the electricity system – has fall by nearly 60% in 2019, where the latest emissions factors published by Defra indicate a carbon intensity of 0.255 gCO_2e/kWh.

LSHTM should update its carbon baseline to reflect up to date emissions factors, which give a clear and scientifically accurate picture of LSHTM's overall carbon footprint. Absolute emissions reductions against the 2018/19 baseline should be set for the forthcoming Carbon Management Plan and its commensurate future reduction targets.

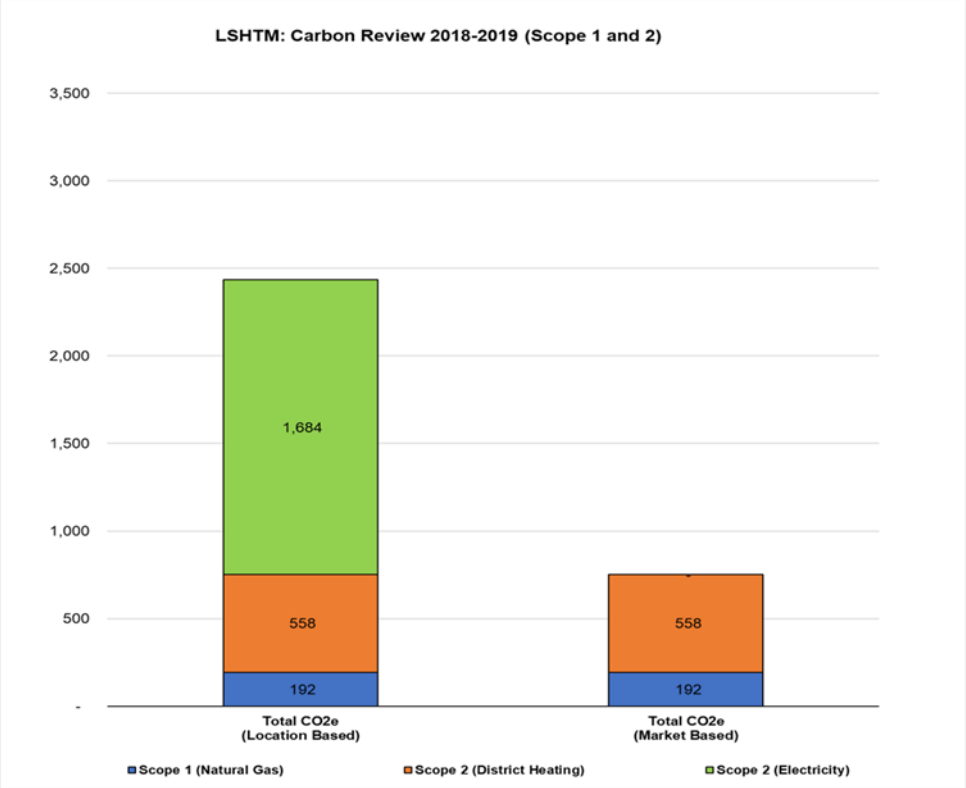
3.2 Baseline emissions for 2018/19

Scope 1 emissions are those associated with the onsite combustion of fuels – in the case of LSHTM this is primarily natural gas. Scope 2 emissions are those associated with purchased electricity, steam, heating & cooling – electricity and district heating generate Scope 2 emissions at LSHTM. The 2018/19 Scope 1 and Scope 2 emissions baseline from use of natural gas, electricity and district heating are outlined below in Figure 5. Emissions from the supply of district heating account for 74%, with 26% from natural gas. Emissions from electricity are reported as zero, using the market-based reporting method[5]. Across its London estate in 2018/19, LSHTM has procured 100% renewable electricity, that is renewable energy guarantee of origin (REGO) backed, which allows for rigorous and on-going assurance of the renewable electricity.

LSHTM should use the market-based emissions approach and report the 100% renewable fuel mix of their electricity supply in their carbon reporting. This allows LSHTM to benefit from reporting zero carbon emissions from electricity.

[5] **Market-based:** employs an emissions factor specific to the electricity purchased. The market-based approach enables electricity from renewable electricity to be reported as zero emissions. The GHG Protocol Scope 2 guidance enables companies reporting their carbon emissions to gain recognition for using renewable power.

	Total CO2e (Location Based)	Total CO2e (Market Based)
Scope 1 (Natural Gas)	192	192
Scope 2 (District Heating)	558	558
Scope 2 (Electricity)	1,684	-
Total	**2,434**	**750**



Figures 5: LSHTM's (UK) Scope 1 and 2 emissions for reporting year 2018-2019

In 2021, LSHTM will leave the district heating scheme and instead install and operate their own boiler and steam plant. This will reduce all Scope 2 emissions to zero but will require an increase in Scope 1 emissions as district heating is replaced by on-site combustion of natural gas. New standalone boiler plant will be installed as a direct replacement to the district heating scheme, provide heating to Keppel Street. The science-based targets that have been developed for LSHTM out to 2030, consider this increase and have set an ambitious Scope 1 reduction target. This will be the key area to focus on and is addressed in Section 3.4.

3.3 Low carbon electricity

The LSHTM procures low carbon electricity through its electricity supply agreement. This serves to reduce its total carbon footprint each year. Purchasing renewable electricity enables LSHTM to communicate its sustainability ambitions with all stakeholders (students, investors and funders, employees, suppliers etc.). Under this Carbon Management Plan, it will also ensure LSHTM meets its carbon reduction goal on the journey to a carbon-free future. **LSHTM should continue to purchase renewable electricity long term into the future to support their carbon reduction targets, which will not be realised without ongoing use of renewable electricity. Purchasing renewable electricity each year is currently reducing LSHTM's carbon footprint by 1,684 tonnes CO_2e. However, purchasing renewable electricity does not preclude taking steps to reduce electricity use, and thereby demonstrating sustainability leadership.**

3.4 Low carbon heat

Providing heat without the local combustion of fossil fuels will be a key challenge to the decarbonisation of the LSHTM estate in the future. The targets laid down in this carbon management plan mean emissions from heat need to be approximately 50% lower by 2030, to ensure carbon reduction is in line with the latest climate science.

While the ongoing purchase of renewable electricity ensures emissions from electricity consumption can be reported as zero-carbon, the Estate will have to tackle their long-term approach to the provision of heat, as existing heating comes from natural gas combustion – either onsite or through the district heating scheme. Furthermore, in 2021 LSHTM will exit the district heating scheme and return solely to heat from on-site natural gas combustion. New standalone boiler plant will be installed as a direct replacement to the district heating scheme and used to provide space heating from gas fired low temperature hot water boilers for heating and hot water, in Keppel Street, Tavistock Place and Bedford Square (across the UK estate).

Low carbon heating options fall into three main categories: electric heating, including electrically driven heat pumps; lower carbon gases; and district heating[6]. All possible options for heat decarbonisation are likely to be more expensive than the baseline use of natural gas – both in terms of capital cost and ongoing operating costs. The carbon reduction pathways developed by Committee on Climate Change and the wider UK Government rely on a significant uptake in commercial heat pumps in the next 10-15 years to deliver low carbon heat. The carbon case for using heat pumps to generate heat is made stronger due to the speed of grid decarbonisation, which is reducing its emissions each year, and the technology is very likely to play a growing role in London, both as part of heat networks (e.g. using waste heat as a source) and as building-only heating systems.

New buildings and infrastructure projects in the planning stages such as Tavistock Place re-development offer an opportunity to generate faster changes in moving away from natural gas. To achieve the science-based carbon reduction targets set out in this Carbon Management Plan, all medium to long term options for low carbon heat should be investigated by the Estate team. It is difficult to understand the full technical and commercially feasibility and the associated costs of low carbon heat without a comprehensive study. This would serve to assess what the exact technology mix and necessary system changes to domestic hot water (DHW) and low temperature hot water (LTHW) will be in the future. Heat pumps can provide low carbon heat if they are properly designed and installed. Achieving a low heat supply temperature is key to maximising heat pump efficiency and is this something LSHTM will have to review, as the medium temperature hot water (MTHW) currently supplied by the district heating scheme (circa 90°C) and natural gas boilers is unattainable from electric heat pumps.

Future of Bloomsbury Heat and Power Scheme

The Bloomsbury Heat and Power Consortium (BHPC) was established in the late 1990s to supply heat energy and electrical power to five independent universities based in Bloomsbury, London Borough of Camden. Though it is recognised that in the short term, the LSHTM will move away from the Bloomsbury district energy scheme, over the long term this could change. Changes to UK building regulations will require a transition away from gas-CHP based district heating to lower carbon heat sources. The outlook in the UK is that gas-CHP will no longer be supported as a credible means of achieving decarbonisation due to its decreasing environmental credentials. The BHPC could make use of multiple different technologies to deliver low carbon heat and could make use of numerous types of generation technologies, including electric heat pumps, biomass boilers, and waste heat. **The LSHTM should continue to engage with the BHPC over the long-term about the decarbonisation of the district heating system, and future technological make-up of the scheme.**

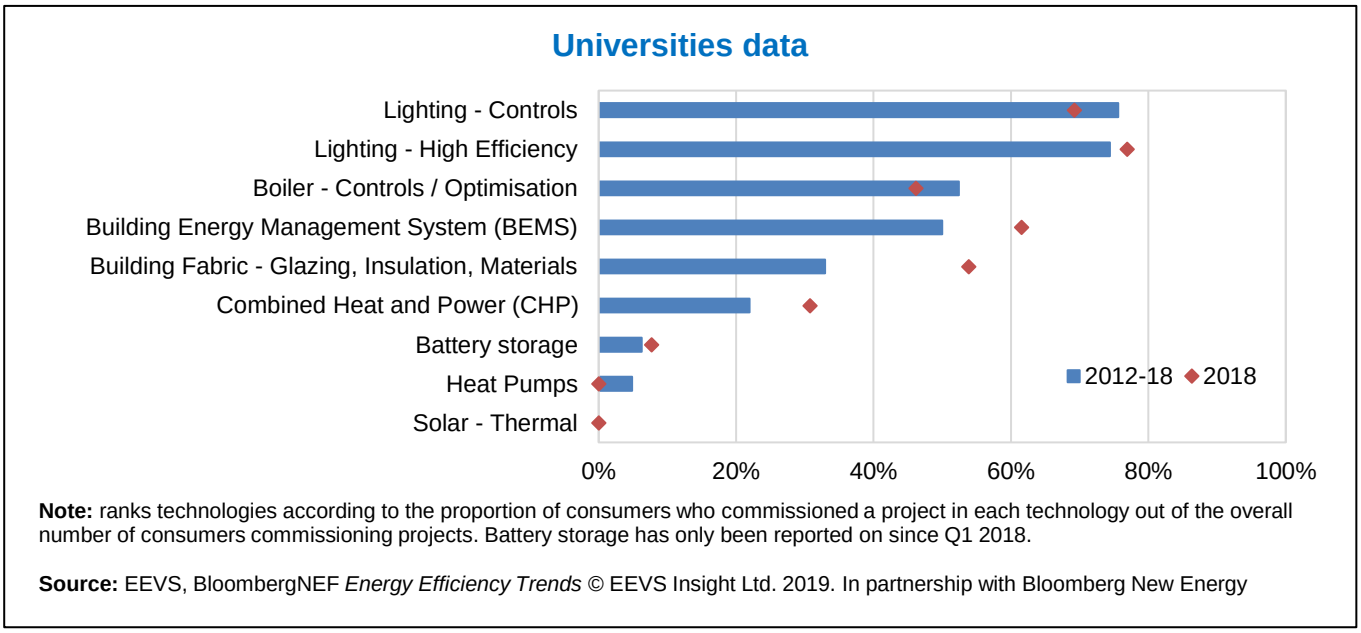
[6] A heat pump is a device that can transfer heat from a low temperature source, such as ambient air, water, the ground or waste heat, and raise it to a higher useful temperature.

3.5 Energy management and efficiency

The cleanest, greenest source of energy is the unit that is saved due to energy management and efficiency. The widespread deployment of energy efficiency measures across LSHTM UK's buildings will be a key pillar of any credible strategy to be carbon-free by 2030. Studies highlight that without energy efficiency the total cost of decarbonising heat will be vastly greater than with it [7]. This section starts by analysing energy efficiency measures that were commissioned across UK universities between 2012-2018, to place LSHTM's opportunities and level of ambition in a wider context.

3.6 Uptake of energy efficiency in UK universities

For context, Figure 1 presents the uptake of energy efficiency measures across UK Universities (2012-2018 vs 2018 average). The University sector has varied and diverse estates, both in terms of age and use. This ranges from mixed-use buildings, to halls of residence and lecture theatres, sports facilities and research labs. It is evident that traditional building service energy efficient projects prevail (lighting and controls). The impact of the loss of the Renewable Heat Incentive (RHI) can be seen by the significant drop in heat pumps installed from 2012 to 2018.



Note: ranks technologies according to the proportion of consumers who commissioned a project in each technology out of the overall number of consumers commissioning projects. Battery storage has only been reported on since Q1 2018.

Source: EEVS, BloombergNEF *Energy Efficiency Trends* © EEVS Insight Ltd. 2019. In partnership with Bloomberg New Energy

Figure 6: Energy efficiency trends technologies data for the higher education sector in 2019

3.7 Energy profiling and benchmarking

Benchmarks are taken from the CIBSE's ECON 19 Energy Consumption Benchmarks. The best fit benchmark for LSHTM is for a general office. Energy benchmarking is a useful tool to analyse the energy performance of the LSHTM estate.

3.7.1 Keppel Street

Keppel Street's total energy use of 392 kWh / m² for both electricity and heating fuel (district heating and natural gas) is much greater than CIBSE's good practice benchmarks.

[7] https://www.iea.org/publications/reports/PerspectivesfortheCleanEnergyTransition/

London School of Hygiene and Tropical Medicine, Keppel Street Benchmarking

	Floor Area (m^2)	Annual energy consumption				ECON 19 benchmarks kWh/m^2	
		kWh	Cost	p/kWh	kWh/m^2	Good practice	Typical
Electricity	23517	5,457,700	£0	0.000	232.1	97	178
Heating Fuel	23517	3,756,256	£0	0.000	159.7	128	226
Total		**9,213,956**	**0**		**392**	**225**	**404**

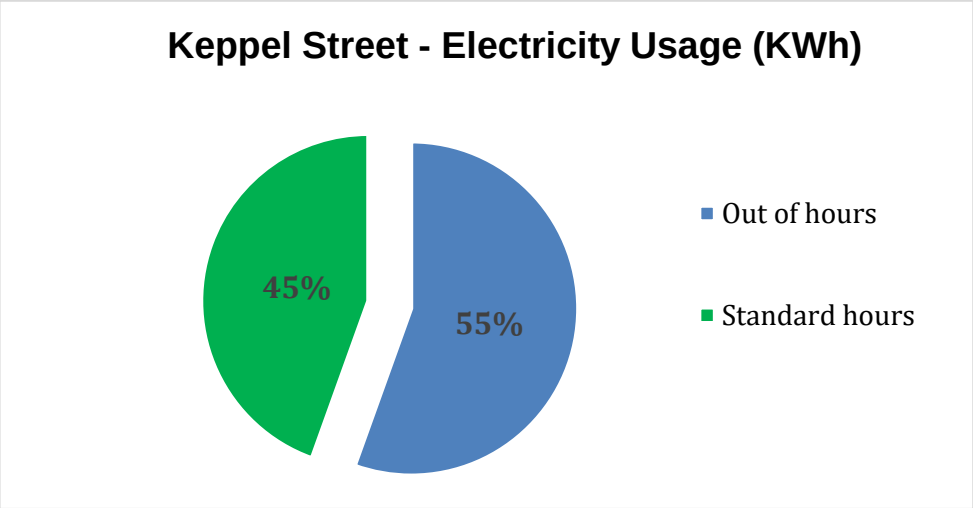


Figure 7: Keppel Street electricity usage for 2018/19 reporting year.

Half-hourly electricity data analysis has indicated that notably fully 55% of electricity is consumed at Keppel Street outside of core facility hours (Monday - Friday, 08:00 - 20:00). **This is a very high proportion. At times throughout the year notably from Jan - April 2019, there is no real difference between day/night/weekend/weekday usage, where the overnight baseload usage is high. This indicates that significant energy savings are available at Keppel Street.**

3.7.2 Tavistock Place

An energy benchmark of Tavistock Place highlights energy use of 282 kWh / m². Energy usage is higher than the good practice benchmark, though natural gas being lower is understandable as some of the heating at Tavistock Place comes from AHUs, powered by electricity. Gas use is not a constant with a large amount directly linked to heating and seasonal demands there is also a base load demand that can be seen in the summer months where heating demands are significantly reduced. The control of the levels of heating and the sequencing of the four boilers is provided from the Trend BMS control system.

London School of Hygiene and Tropical Medicine, Tavistock Place Benchmarking

	Floor Area (m^2)	Annual energy consumption				ECON 19 benchmarks kWh/m^2	
		kWh	Cost	p/kWh	kWh/m^2	Good practice	Typical
Electricity	4100	777,452	£0	0.000	189.6	97	178
Heating Fuel	4100	377,252	£0	0.000	92.0	128	226
Total		**1,154,704**	**0**		**282**	**225**	**404**

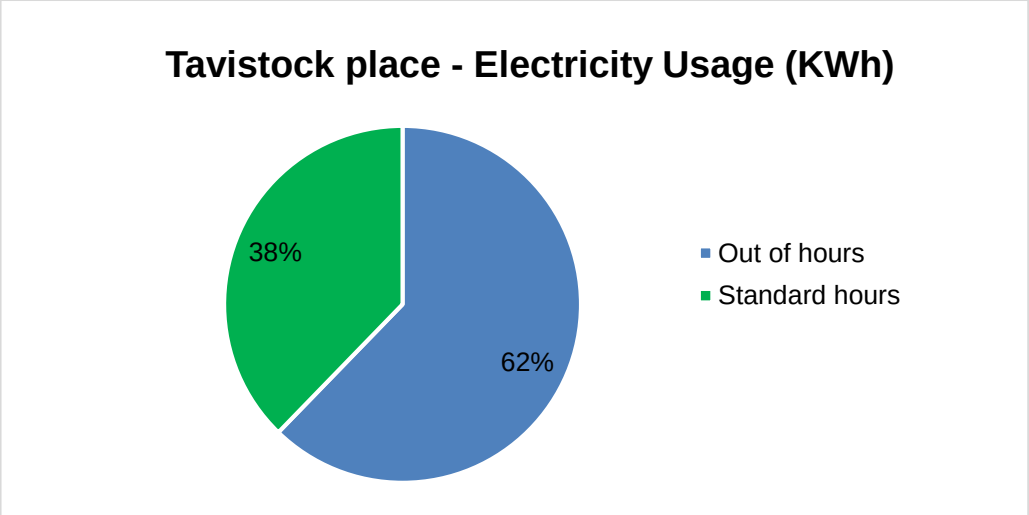


Figure 8: Tavistock Place electricity usage for 2018/19 reporting year.

Half-hourly electricity analysis has indicated that notably 62% of electricity is consumed at Tavistock Place outside of core facility hours (Monday - Friday, 08:00 - 20:00). This is a very high proportion. Reducing the baseload by ensuring lighting and office equipment are turned off overnight and at weekends could have a significant effect on the building annual energy consumption. **This indicates that significant energy savings are available at Tavistock Place**

Both Keppel Street and Tavistock Place have good sub-metering systems so the focus for reducing the baseload electricity usage requires a more detailed, diagnostic review of building user behaviours in relation to air-handling units, pumps, motors, etc and calibration of the BMS. This is especially relevant for the laboratories with systems in use over 24-hour periods in Keppel Street

3.8 Opportunities

The Keppel Street and Tavistock Place buildings of the LSHTM estate have been surveyed by Ethan O'Brien of TGC for energy conservation opportunities. In total 18 costed opportunities have been identified with a total potential saving of 920,764 kWh[8]. **This equates to around an 9% saving in energy used, and an overall reduction of 216 tonnes CO_2e.**

Opportunity No.	Site	Recommendation	kWh Saving	£ saving	Capital Cost (£)	Simple payback	Suggested Implementation Year	Total Carbon Saving (tCO_2e)
Opportunity 1.1	Keppel Street	LED lighting retrofit (including units and installation cost)	75,329	£ 9,793	£ 37,731	3.9	2020	19
Opportunity 1.2	Keppel Street	Improve AHU control: adjust settings and fit variable speed drive & controls to air handling units	210,240	£ 14,585	£ 27,100	1.9	2020	54
Opportunity 1.3	Keppel Street	Passive infrared (PIR) sensors in infrequently occupied areas (bathrooms, kitchens, stairways)	18,792	£ 2,443	£ 3,750	1.5	2020	5
Opportunity 1.4	Keppel Street	Implement Space Heating Policy to reduce energy waste	30,930	£ 419	£ -	Immediate	2020	8
Opportunity 1.5	Keppel Street	Improve energy management practices including a formalised management system, especially for the laboratories.	165,838	£ 16,885	£ 10,000	0.6	2020	42

[8] See Appendix 4 for backing calculations and data; furthermore, see the supporting excel database which includes all calculations used to quantify the energy opportunities.

Opportunity 1.6	Keppel Street	BMS Optimisation of the McQuay Chillers	15,768	£	2,050	£	500	0.2	2020	4
Opportunity 1.7	Keppel Street	Improve insulation on steam lines, generator valves and pipework	4,800	£	480	£	450	0.9	2020	1
Opportunity 1.8	Keppel Street	Lower compressed air generating pressure in portable compressors	2,046	£	266	£	-	Immediate	2020	0.5
Opportunity 1.9	Keppel Street	Put water coolers on timer switch	3,000	£	390	£	100	0.3	2020	0.8
Opportunity 1.10	Keppel Street	Chillers - Implement floating head pressure control on refrigerant chillers	24,570	£	2,336	£	2,500	1.1	2020	6.3
Opportunity 2.1	Tavistock Place	Passive infrared (PIR) sensors in infrequently occupied areas (bathrooms, kitchens, corridors, stairways)	5,638	£	733	£	1,350	1.8	2020	1.4
Opportunity 2.2	Tavistock Place	Insulate exposed hot pipework, valves, flanges in Plant Room and Calorifier Room	11,605	£	464	£	500	1.1	2020	3.0
Opportunity 2.3	Tavistock Place	Adjust set point temperature of AHU in data centre	21,024	£	2,313	£	-	Immediate	2020	5.4

Opportunity 2.4	Tavistock Place	Avoid dual heating and cooling	29,016	£	2,910	£ -	Immediate	2020	7.4
Opportunity 2.5	Tavistock Place	Address dysfunctional lighting control system	31,098	£	4,043	£ -	Immediate	2020	7.9
Opportunity 2.6	Tavistock Place	Install ground source heat pump (GSHP) and localised point of water heaters	267,070	£	19,595	£ 288,000	14.7	2022	49.0
Opportunity 2.7	Tavistock Place	Reduce the need for heating and cooling through draught proofing	1,000	£	40	£ 75	1.9	2020	0.3
Opportunity 2.8	Tavistock Place	Put water coolers on timer switch	3,000	£	390	£ 100	0.3	2020	0.8
Total	**18 Measures**		**920,764 kWh**	**£**	**80,133**	**£ 372,156**	**4.6 years simple payback**		**216**

The Green Consultancy will be pleased to provide further detailed investigations – including investment grade proposals – and any implementation support that may be needed to address the issues identified in this report.

3.9 Delivering low carbon in LSHTM buildings

Mitigating climate change and delivering a low carbon estate require a combination of low carbon electricity, low carbon heat, better energy management and investment in energy efficiency.

TGC's headline recommendation is that LSHTM adopt a 50% reduction target in Scope 1 and 2 emissions by 2030, against a 2018 baseline. The '50% by 2030' carbon reduction plan seeks to halve Scope 1 and 2 emissions at LSHTM.

At the interim review phase in 2025, LSHTM can look again at this reduction target, potentially making it more ambitious.

	Base year (2018)	Target year (2030)	% Reduction
Scope 1 emissions (tCO2e)	750	372	50.4%
Scope 2 emissions (tCO2e)	0	0	0.0%
Scope 1+2 emissions (tCO2e)	750	372	50.4%

Figure 9: Science Based Scope 1 and 2 Target (50% reduction by 2030 is required)

The LSHTM must invest to save energy and allow efficiency gains to play a greater role in reducing energy demand to the lowest possible level. It is likely with heat pumps delivering low carbon heat, a greater role for solar PVs in offsetting on-site the residual carbon emissions. It is acknowledged that roof space at LSHTM is an issue. Looking towards 2030, very low levels of total on-site carbon emissions can be delivered if very high standards of energy efficiency are achieved. Given LSHTM's estate strategy which will focus primarily on periodic refurbishment into the foreseeable future three key priorities should be at the centre of the Estates projects and infrastructure strategy. It is an opportunity to achieve a range of financial, environmental and corporate responsibility goals and would send a powerful message out to multiple stakeholders, that it is committed to moving ambitiously to address its climate change impacts.

4 Managing supply chain impacts

LSHTM's supply chain scope 3 carbon emissions comprise the activities and sources illustrated in Section 2, with further information provided in Appendix 2. These are examined in the following sub-sections by first considering the current situation and how this may need to change to enable full reporting of material supply chain carbon impacts.

When organisations set carbon emissions reduction targets they initially focus on scope 1 and 2 emissions because these are directly under their control. Clearly, however, any organisation's scope 3 emissions are often much greater so ambitious scope 3 targets play an integral role in an organisation's carbon reduction strategy. The Carbon Disclosure Project (CDP) states that "*doing so demonstrates performance and leadership*" in managing supply chain risks and opportunities in ways that directly address the needs of all stakeholders, including investors and funders. Establishing scope 3 business risks and setting appropriate reduction targets will enable LSHTM to better understand whether its current business model is compatible with a low-carbon future. Investing time and effort in establishing its scope 3 footprint will enable LSHTM to modify and enhance its business strategy towards achieving climate resilience.

Clearly, scope 3 emissions are the most challenging component of an organisation's carbon reduction strategy. LSHTM needs to use the new CMP for constructing a scope 3 inventory and baseline to assess which scope 3 emissions sources should be prioritised and, where possible, set reduction targets for each.

Figure 10: GHG Protocol Scope 3 reporting guidelines

In this section of the report, for each source of scope 3 emissions the most appropriate key performance indicators (KPIs) and methods of data collection for reporting purposes are recommended. The following sub-sections also provide guidance on the measures that need to be in place for reporting scope 3 emissions from 2019/20 onwards. Responsibilities assigned and agreed across LSHTM are covered in **Section 5**.

4.1 Procurement

Methods of procurement have a substantive impact on how successfully carbon emissions, particularly scope 3 emissions, can be measured and effectively managed. Setting appropriate requirements and asking the right questions at tender stage of the purchasing process is the most efficient way of ensuring resource efficiency and effectiveness. Doing so achieves real value both from a cost and carbon perspective. Focusing on securing low carbon goods and services as outcomes of the procurement process means that all procurement decisions can be structured to meet the GHG principles for carbon accounting. A good procurement process makes it possible to successfully implement a CMP.

The Management Board and SLT need to prioritise effective procurement as the critical factor in managing scope 3 emissions in order to have a chance at achieving carbon neutrality. LSHTM's current procurement set-up, however, appears to be substantively under-resourced and difficult to successfully manage because strict adherence to appropriate procedures is not in place. This is in the process of being rectified with a new joint policy being issued by the Heads of Finance and Procurement, so that all orders comply with a sustainable procurement policy and are made by nominated post-holders using a Purchase Order (PO). Procurement without a PO makes carbon management highly inefficient because emissions cannot be tracked and measured, defeating the purpose of the CMP.

The following sub-sections consider major sources of scope 3 emissions, why they should be quantified, how they should be measured and how this could be done; highlighting why effective procurement procedures are essential.

4.2 Waste minimisation and management

What needs measuring and why

LSHTM has a legal responsibility to ensure that any waste arisings are stored, transported and disposed of without harming the environment in compliance with the Waste 'Duty of Care' regulations. This means that all of its waste is designated as 'trade waste' and must be appropriately managed to:

- Prevent the unauthorised or harmful disposal of waste (such as fly-tipping or disposal of hazardous chemicals down drains);
- Ensure that when waste is transferred, it is transferred only to an authorised waste carrier and is accompanied by a written description (Waste Transfer Note) for appropriate treatment (recycling, incineration or landfill).

- Monitor waste arisings to reduce waste and its related carbon emissions

Disposing of waste to landfill can give rise to harmful greenhouse gas emissions and is not resource efficient so LSHTM has an objective to achieve zero waste to landfill. Recycling of materials is far more cost and carbon-efficient so it's important that LSHTM ensures waste is appropriately segregated and sent for re-use and recycling as a priority, with incineration for residual waste as a last resort. ***Waste is best minimised at source by applying sustainable procurement measures, buying goods with a high recycled content that can be 100% recycled when past their useful life. This also applies to all packaging***.

Many used goods and packaging can be returned to the original supplier under a take-back arrangement to promote recycling as part of a circular economy. This helps to greatly reduce carbon emissions from waste by promoting resource efficiency and reinforces the importance of having good purchasing controls.

Recommended KPIs

CO2e per tonne/annum of :

- Waste electrical and electronic equipment (WEEE), unless devices can be returned to the supplier, i.e. removing waste from LSHTM's carbon inventory and waste management costs
- Hazardous waste (solid and chemical)
- Paper and card
- Cardboard
- Food and other organic waste
- Plastics (with the aim of eliminating single use plastics from this waste stream)
- Metals
- Glass

Waste management data can be reported per building and in aggregate for LSHTM as a whole, as illustrated in the charts below:

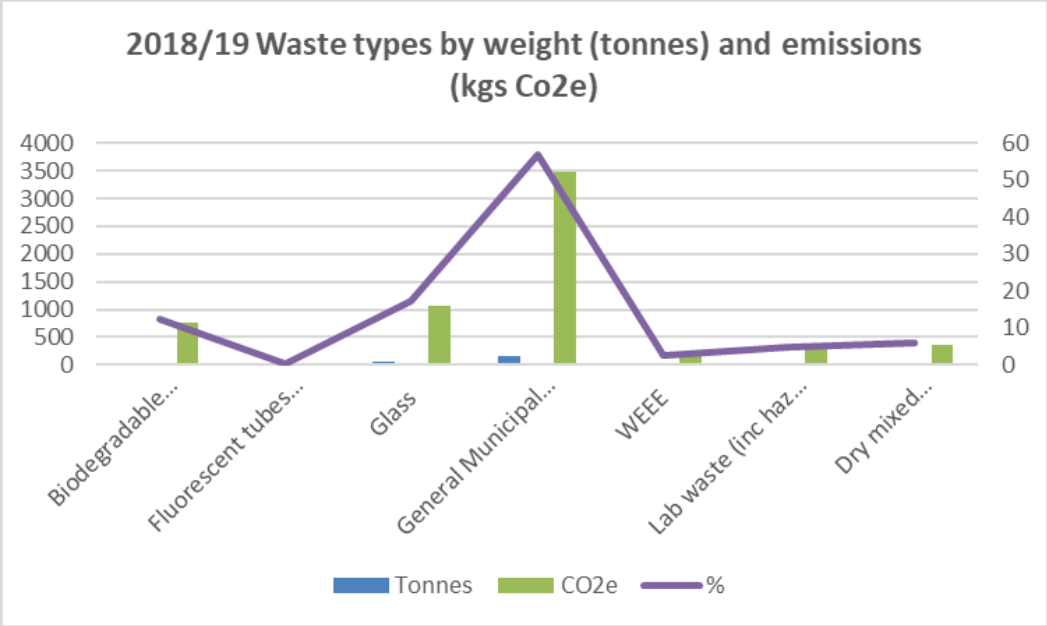


Figure 11: Waste arisings by type shown as annual tonnage and carbon emissions

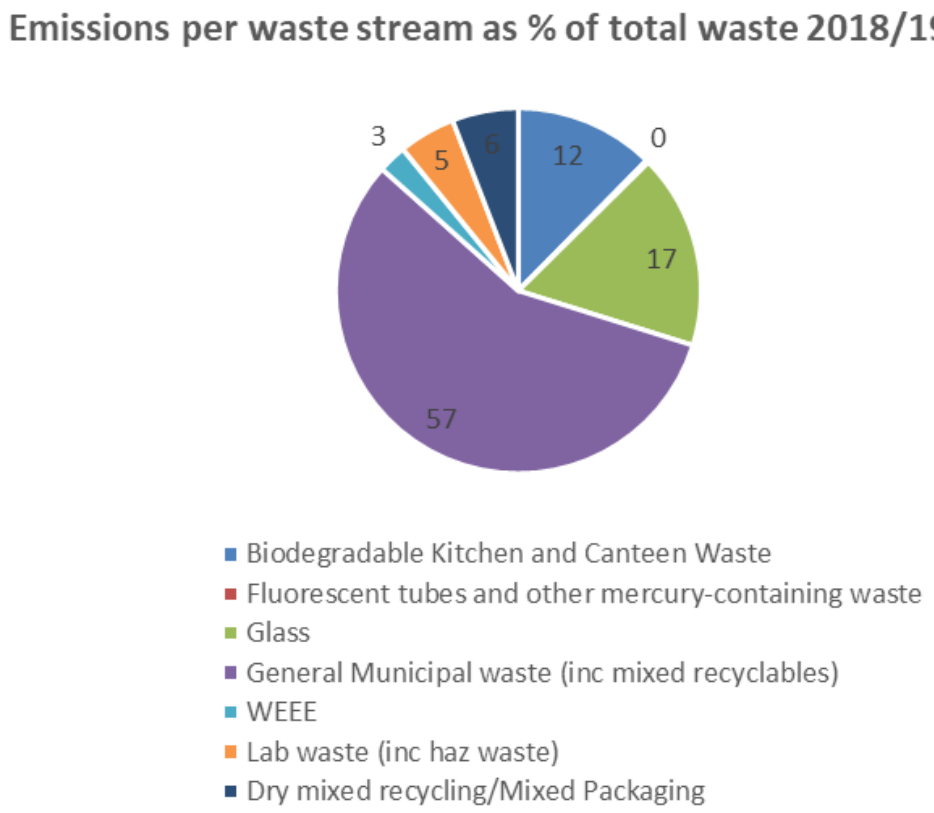


Figure 12: Annual emissions from waste shown as % by type

Current situation appraisal

The current waste management contract is up for re-tendering so this is a good opportunity to secure a single provider who will produce monthly and annual reports on all waste stream arisings and their respective carbon emissions. These data should ideally be provided per building as well as by type of waste. A brief walk through parts of Keppel Street suggests that waste segregation is not as good as it needs to be to avoid recyclable waste being mixed up with general municipal waste for incineration; this is not resource efficient and creates higher carbon emissions. This is in marked contrast to Tavistock Place which had exemplary waste segregation using clearly marked, conveniently located communal bins and no individual desk bins.

Figure 13: Typical desk bin containing mixed waste in a single use plastic bag

Desk bins defeat the purpose of having recycling bins. Their contents are collected as general waste for incineration. Good office practice – found across the public sector and most HEIs - is to remove all desk waste bins and make it mandatory to appropriately use the recycling bins provided. Regular checks on bins will soon highlight in which locations staff and students are failing to follow the right procedure.

Figure 14: Clearly marked glass recycling but indeterminate waste bin in Keppel Street bar area

Figure 15: well-marked segregated waste bins in corridor and foyer areas found in both Keppel Street and Tavistock

Figure 16: Kitchen in Keppel Street with clearly marked bins next to an indeterminate waste bin, creating confusion

Recommended actions

In compliance with the requirements of LSHTM's EMS procedures, waste segregation needs to be improved in Keppel Street to increase the amount of recyclable waste being sent for processing.

A waste bin audit for Keppel Street should be undertaken so that it is brought up to the standard observed in Tavistock Place. The objective would be to remove all unnecessary individual desk bins and unmarked general waste bins, ensuring that clearly marked recycling bins and general non-recyclable waste bins are placed at convenient locations within all areas. This could be accompanied by appropriate pre and post audit communications to staff and students.

KPI reporting per building should be made available to staff and students each month to encourage correct waste segregation, with 'naming and shaming' for locations where this isn't happening. The new waste provider should be able to help with activities for encouraging better waste segregation behaviours.

Periodic waste auditing would be best carried out by the facilities management team with student members of the Planetary Health Network, providing feedback to the Faculties and the procurement team. This will help to track how improved ordering with the aim of minimising unnecessary waste packaging and products is helping to reduce waste arisings.

4.3 Water and waste-water supply

What needs measuring and why

Potable mains water supplies create carbon emissions because of the energy used in extracting and supplying mains water from groundwater sources and river catchments. Similarly, effluent treatment processes for treating wastewater to return it to river catchments uses substantial amounts of energy. For any large institution like LSHTM, mains water use

and the amount of wastewater created from its operations needs to be resource efficient and management is best effected via LSHTM's EMS procedures.

Recommended KPIs

- Cubic metres per month and in aggregate for the reporting year
- Intensity – potable water emissions in CO_2e Kgs/m2 or per CO_2e Kgs/capita
- Intensity – trade effluent emissions in CO_2e Kgs/laboratory – *to be reviewed for agreement*.

Current situation appraisal

The current service provider Castle Water is able to provide good monthly data per building for LSHTM's London estate , split into categories for potable water supply, sewerage and trade effluent (from Keppel Street's laboratories). The data illustrated below provide the carbon emissions water and wastewater footprint for the reporting year 2018/19:

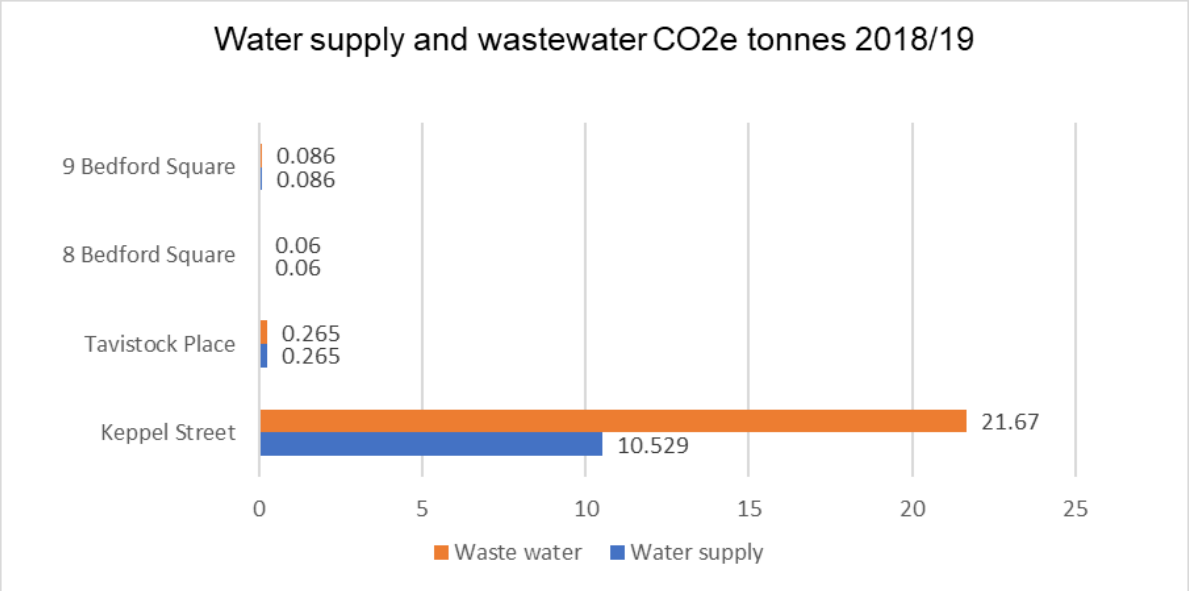


Figure 17: Proportions of emissions for annual water supply and wastewater usage

Keppel Street clearly creates the most water supply and wastewater emissions, with the laboratories being the only source of trade effluent. This is illustrated in the pie chart for Keppel Street:

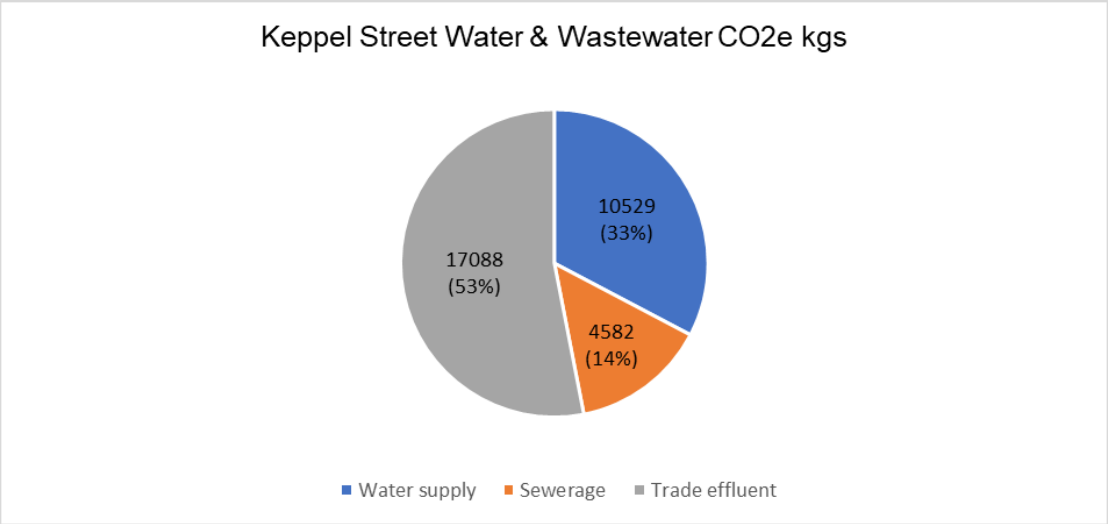


Figure 18: Proportions of emissions for annual water supply and wastewater usage for Keppel Street

The scope 3 emissions for water supply and waste-water treatment will increase slightly with the completion and occupancy of the new building at Tavistock Place in reporting year 2020/21. This may well require a re-baselining exercise for scope 3, given that further supplier engagement and a better understanding of business travel emissions management should be well in-hand.

Recommended actions

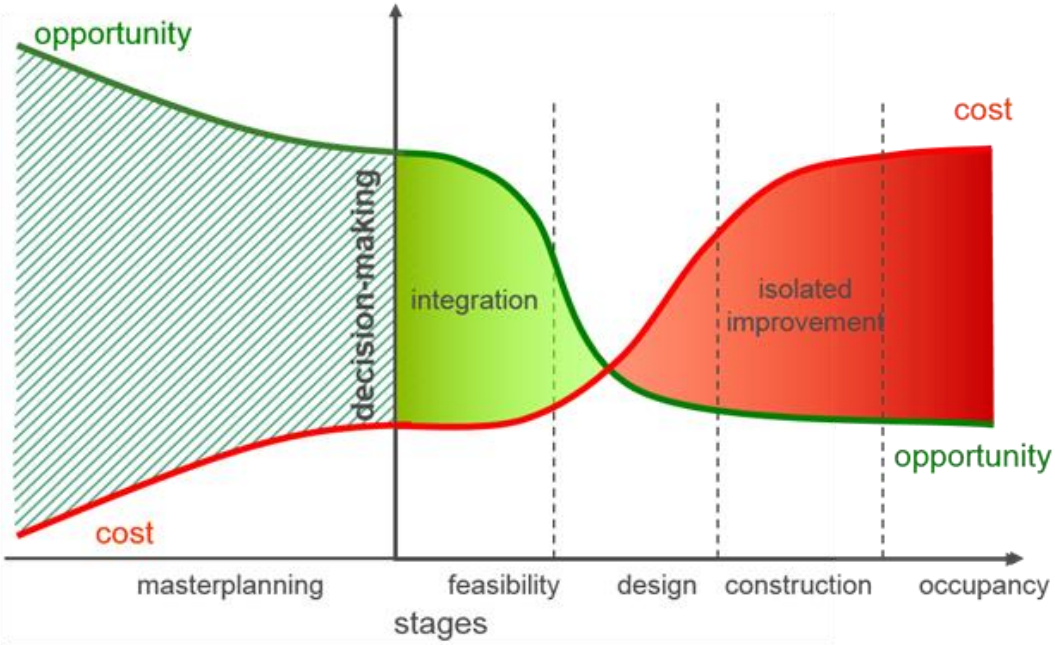
If continuing with the current service provider it would be worth establishing if they can provide monthly and annual reports per building and in aggregate. This information can then be readily uploaded to LSHTM's EMS portal for easy viewing and interrogation.

If not already undertaken, a water usage audit per building is advisable to ensure that water efficiency has been optimised to reduce related carbon emissions.

4.4 Construction and refurbishment

What needs measuring and why

Energy efficiency and low to zero carbon performance starts at the earliest design stages of a construction or refurbishment project. The Buildings Research Establishment (BRE) advise that the biggest operational energy and carbon savings are obtained by making this a focus of the design:



[Source: BRE 2013]

Figure 19: BRE cost curve illustrating the benefits of designing in sustainable low carbon construction

This cost curve illustrates that the biggest operational cost savings are secured early in the design process, i.e. retrofitting for low carbon is more expensive and less efficient. According to a new report by the World Green Building Council (WGBC), buildings are currently responsible for 39% of global energy related carbon emissions: 28% from operational emissions, from energy needed to heat, cool and power them, and the remaining 11% from materials and construction. The WGBC's goal is that by 2030, all new buildings, infrastructure, and renovations will have at least 40% less embodied carbon with significant upfront carbon reduction, and all new buildings must be net zero operational carbon.

Sections 3.7 and 3.8 of this report set out specific issues that need addressing in each of LSHTM's buildings, emphasising the importance of achieving very low levels of total on-site carbon emissions by pursuing very high standards of energy efficiency. To re-iterate, the School's estate strategy of planned, periodic refurbishment should be based on three key priorities that need to be at the centre of the Estates projects and infrastructure strategy:

Priority 1: Energy conservation. Changing wasteful behaviour to reduce demand.

Priority 2: Energy efficiency. Using technology to reduce demand and eliminate waste.

Priority 3: Utilisation of renewable. Using renewable resource technology.

These priorities can be used to underpin the delivery of the following KPIs, agreeing specific scores in advance at the pre-assessment stage. This will help in identifying specific design solutions as costed options for taking forward, possibly in phased approaches to ultimately deliver the best outcomes from a low to zero carbon perspective, taking embodied carbon emissions into account as well as building fabric, modular design and re-usability.

Recommended KPIs

- Carbon footprint of all new construction and refurbishment projects (estimated using Bill of Quantities, etc) estimated at pre-assessment and evaluated at post-occupancy
- SKA Gold or Silver Standard rating for new refurbishment/fit-out projects, ***incorporating a focus on low to zero carbon materials and products***.
- BREEAM New Construction energy and emissions rating as appropriate (pre and post occupancy assessment).

Current situation appraisal

LSHTM is atypical of most HEIs in that being based in central London and comprising listed buildings, there are considerable constraints to site expansion. With the completion of the new building at Tavistock Place LSHTM's estate strategy will focus primarily on periodic refurbishment into the foreseeable future. The buildings audit has identified a number of issues and opportunities to inform the estate strategy going forwards that are set out at section 3.7.

Recommended actions

See table at section 3.7, the approach set out needs to be translated into design specifications and requirements when tendering for future refurbishment projects. Tenderers should ideally be challenged to respond to the three priorities and encouraged to provide innovative and cost-effective measures to meet them.

4.5 Business travel

What needs measuring and why

Business travel comprises all modes of travel on business purposes by employees, researchers and consultants under contract to LSHTM. It also includes overnight hotel stays so as these data become more widely available, with the UK government source of carbon conversion factors being the default unless more location-specific data is available, reliably accurate business travel reporting is possible.

Air travel is more carbon intensive than other modes because of the distances involved and the type of fuel used. According to the United Nations' sixth update of its Global Environment Outlook (March 2019), aviation accounts for around 2% of anthropogenic CO_2 emissions. This would rank air travel among the top 10 global emitters worldwide if aviation were a country. Forecast growth in aviation means that emissions from this source are increasing. The International Civil Aviation Organization (ICAO) estimates that aviation's 2020 emissions will

be 70% higher than in 2005 and could increase by a further 300%-700% by 2050 without any action. Aviation could then be responsible for between 4% and 15% of global CO_2 emissions. Clearly LSHTM needs to be able to measure and appropriately manage its business travel emissions from flying.

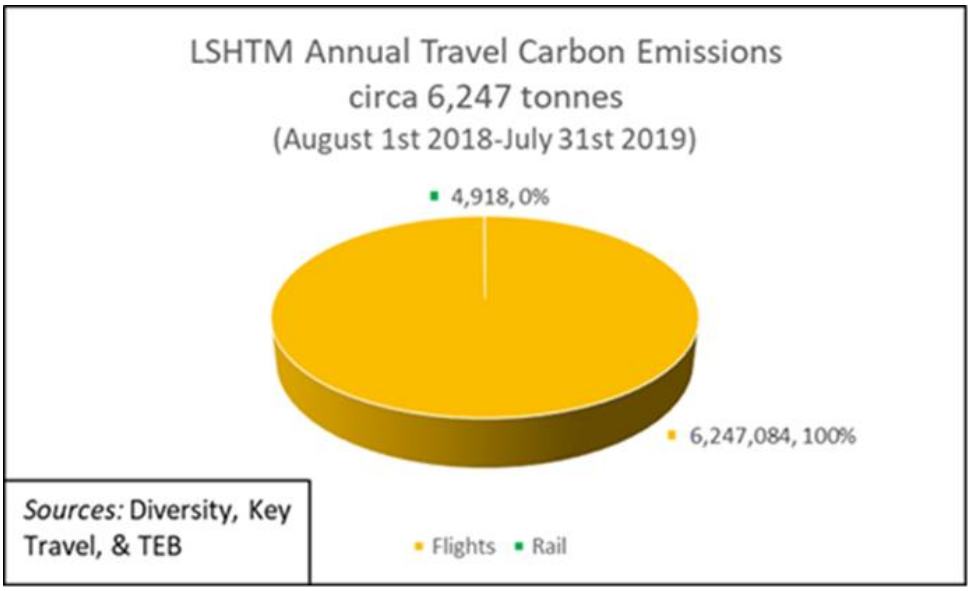
Because business travel is integral to LSHTM's research and teaching purposes as a leading institution with a global reach, it is of high materiality to LSHTM's annual carbon footprint. Measuring LSHTM's business travel emissions by mode, by faculty and by type of academic activity is necessary to measure and effectively manage this aspect of its carbon impact.

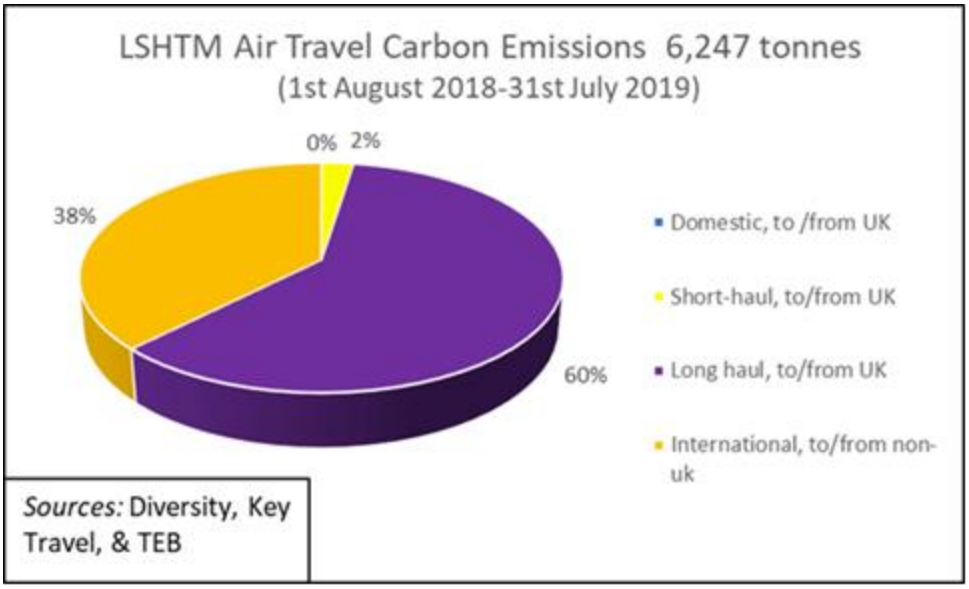
Recommended KPIs

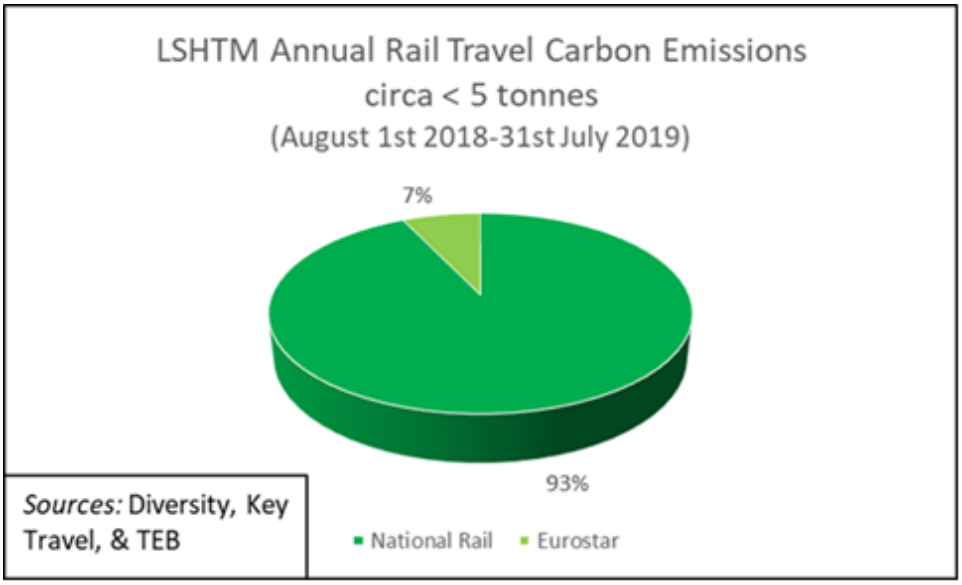
- CO_2e tonnes/annum by type of flight (domestic, short haul from UK, long haul from UK and international/non-UK)
- CO_2e tonnes/annum by national rail miles travelled
- CO_2e tonnes/annum by Eurostar/International rail miles travelled
- CO_2e tonnes/annum by London underground miles travelled
- CO_2e tonnes/annum by London Taxi/Other Taxi miles travelled (including overseas)
- CO_2e tonnes/annum by hire/lease car (taking engine size into account) miles travelled
- CO_2e tonnes/annum by hotel overnights (taking location into account)
- CO_2e tonnes/annum per faculty per mode (as above)
- CO_2e tonnes/annum per 'frequent traveller(name & unique LSHTM Identifier) academic/employee'

Current situation appraisal

LSHTM currently has 4 main travel service providers, three of which account for over 90% of service-booked flights and can readily provide carbon emissions data per traveller/booking if this information is asked for, whilst the third is not set-up to do so readily but has managed to supply usable information to TGC on request. For the purposes of updating the CMP these suppliers were asked to provide the necessary data for measuring LSHTM's business travel footprint for the reporting year August 2018- Jul 2019, the results are given below. This is not a full dataset for the reporting year however, because a large proportion of employees do not use these services and prefer to book direct themselves to secure cheaper flights. This is because the cost of flights can impact on project budgets so direct booking is seen as a way to keep costs down. Furthermore, some funders and third parties may also be responsible for booking travel direct rather than via LSHTM, making it harder to track 100% of emissions from business travel.

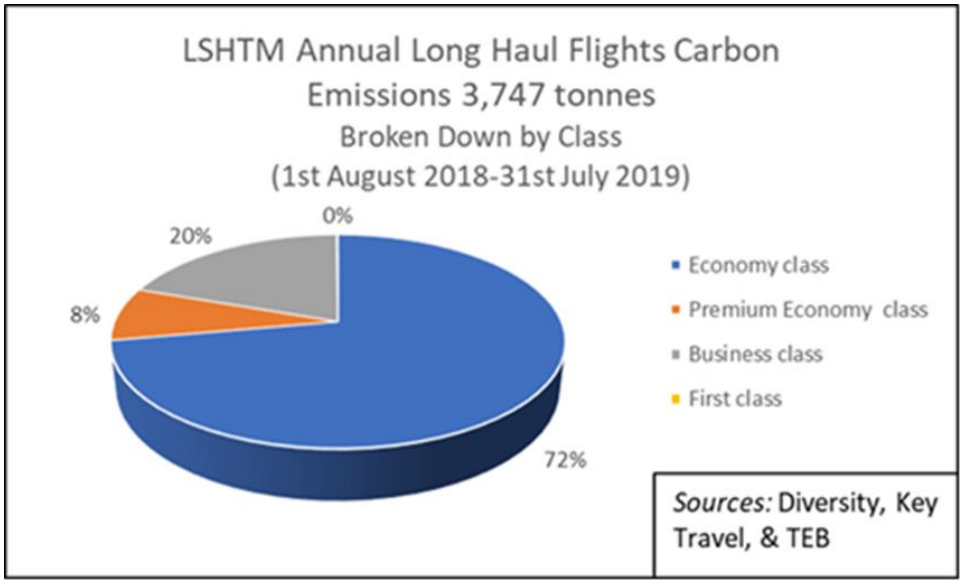






Figures 20 to 24: Analysis of 2018/19 business travel footprint (flights and rail) using travel service data (expressed as CO_2e tonnes with radiative forcing[9] included)

[9] Radiative forcing and problems in calculating aviation emissions https://www.carbonbrief.org/explainer-challenge-tackling-aviations-non-co2-emissions



Most research staff travel up to 75% of their time and there are increasing concerns about "the validity of offsetting travel emissions"' when there needs to be a more in-depth examination of LSHTM's business travel to "reduce unnecessary emissions". ***Who needs to travel, how often and by what mode are questions that need resolving through agreed travel protocols and mandated booking and expense claim procedures.*** Less than 1% of recorded flights were domestic (within the UK) and only 2.5% were short haul from the UK to Europe. European flights, however, accounted for 153 tonnes CO2e and some of these flights may have been possible via Eurostar and connecting services as a low carbon alternative means of travel.

Rail travel per passenger kilometre is far less carbon intensive than flying. For example, taking Eurostar to Paris rather than flying uses 90% less carbon emissions than taking a flight.

Whilst rail travel to most of LSHTM's business trip destinations is not possible, or not very practical, it should be the preferred means of transport for business travel within the UK and specific European trips easy to make using Eurostar.

Recommended actions

LSHTM is inviting tenders for a single preferred travel service provider to begin operating from early 2020. This new service has been tasked with providing emissions data per passenger booking, per km/mode and per faculty, etc to provide a full monthly analysis of travel patterns, plus an annual aggregated analysis per year. To collate as much of the travel data as possible to generate a robust annual footprint, LSHTM needs to:

- Using the new Travel Policy, develop agreed travel procedures/protocols for academics within each faculty and service support teams to follow when developing programme and project budgets involving business travel, for booking travel through the preferred provider as far as possible, and in agreeing who needs to travel and for what purpose. To avoid confusion over passenger names it would be advisable for whoever is booking travel to provide both the passenger name and their unique staff/employee number.
- Where third parties book business travel for and on behalf of School staff, these trips need to be recorded by the third party (mode, distance, emissions) so that the % of such trips can be quantified. This could be done under a MoU or similar formal agreement.
- When employees book their own travel for whatever reason, they should be required to provide the data needed to record the trip and its carbon emissions on the expense claim (i.e. distance, mode - including type of flight – the emissions created in terms of Kgs CO_2e/km). The expense claim form will need to be re-designed to enable this and be

capable of recording taxi, hire car and all forms of public transport both in the UK and overseas. When employees use their own car for business travel they should record distance and carbon emissions per trip when claiming fuel on expenses using the re-designed expense claim form. Claim forms should not be processed until the full journey information is provided.

- Agree project protocols with funders and partners to determine how business trips can be reduced by switching to teleconferencing facilities (using the new Zoom room facilities) for non-milestone regular interim catch-up meetings/discussions.
- Agree how to off-set **residua**l annual business travel emissions once these have been assured/verified by an accredited third-party auditor.

4.6 Commuting

What needs measuring and why

Depending on the size and geographic spread of an HEI's workforce and student accommodation, commuting can be a substantive source of scope 3 emissions, particularly if the majority of employees and students commute by car. Most campus based HEI's provide subsidised public transport and cycle facilities to reduce the need to travel by car and so reduce commuting emissions.

Recommended KPIs

- CO_2e tonnes/annum by mode for student commute (rtn journey from accommodation to LSHTM)
- CO_2e tonnes/annum by mode for employee commute (rtn journey from home to LSHTM)
- CO_2e tonnes/annum by mode for overseas student 'commute' at start and end of each term (from home to London & rtn)

Current situation appraisal

LSHTM does not provide off-site student accommodation and the overwhelming majority of all students and employees are thought to commute using public transport, walking and cycling. On this basis employee and student commuting is not felt to contribute significantly to scope 3 emissions, neither are emissions from commuting relevant to LSHTM's business goals, i.e. they are not felt to be material.

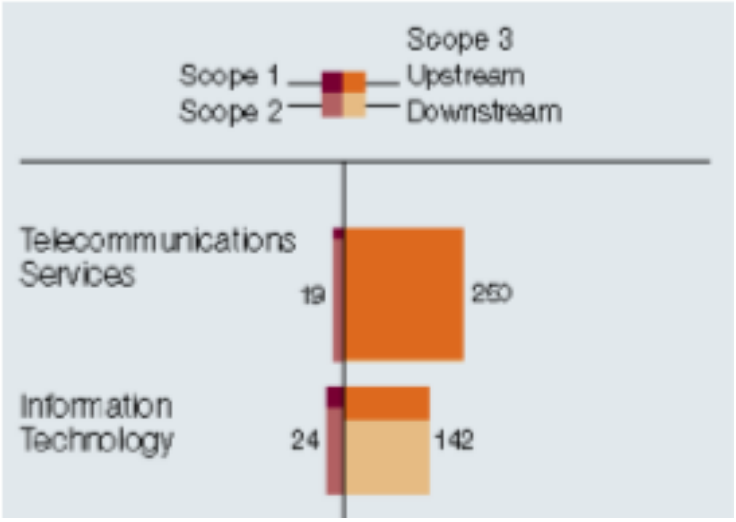
Recommended actions

Whilst not a priority, it would be worth LSHTM's HR Department asking for commuting journey details for all staff members who drive to work. This should include type of car/engine size and fuel consumption (miles per litre/gallon) as well as the total daily commuting distance.

For non-UK international students, LSHTM's Registry team (liaising with each faculty office) could require students to provide their 'term travel' flight emission details per leg/one-way trip and total numbers of flights per academic year. These data could be kept on each student's record and would enable each faculty to estimate the annual emissions per international student and in total for all such students for each reporting year. This information would help determine if this source of emissions is material to LSHTM's annual carbon footprint and identified residual emissions could also be suitable offset each year.

4.7 ICT hardware, mobile devices and similar goods

What needs measuring and why



ICT hardware and similar electronic devices have a supply chain based on extractive metal ore and rare earths mining activities. These are energy intensive industries some of which are often connected with specific environmental and human rights issues, but they are all characterised by a substantive scope 3 carbon footprint:

Figure 25: Relative Magnitude of Scope 1, 2 and 3 Emissions for ICT and telecommunications

[*Source: CDP 2013*[

This graph is based on CDP data for the S&P 500 American firms including the world's largest ICT suppliers. It demonstrates the immense emissions footprint created by the ICT sector's supply chain, making it imperative that these ore-based extractive industry materials are managed as sustainably as possible, ideally within a closed loop circular economy set-up.

Recommended KPIs

- Carbon inventory of devices (by make, type and production emissions) per Faculty
- Carbon inventory of devices (by make, type and production emissions) per research project not accounted for in a faculty inventory
- Nos and % of devices returned to supplier per annum under a take-back agreement – per faculty

Current situation appraisal

There is no ICT devices procurement framework agreement for pricing and take-back controls, neither is it currently possible to mandate purchase orders to restrict purchasing to preferred suppliers. Currently most devices tend to be replaced on a 4 yearly cycle and there is disjointed advice about how best to manage WEEE. Most devices are either Dell of Toshiba but Dell is the preferred supplier for the majority of applications. This includes computers, laptops and servers within a 'whole system' approach to procurement and re-manufacturing within a closed-loop set-up. Ideally it would make considerable sense to dispense with the on-site data centres as these are energy-hungry and resource intensive to manage.

The ICT department is involved in the procurement of photocopiers (all of which are leased) and similar shared devices but are not as heavily involved in their management and usage as would be preferred. There are some 500 handset devices in use that are either Apple or Samsung models; these are high performing brands in terms of sustainability and carbon performance.

Recommended actions

The current IT supply contract is up for renewal so this is the ideal time to better define the requirement from a carbon emissions reduction and reporting perspective. The following actions are required:

- Standardise the current procurement of ICT across LSHTM so that purchase are only made through the formal procurement process to generate a recorded PO.
- All bought assets can then be recorded/tagged by their unique device code number, enabling the require faculty and support service inventories to be generated and maintained.
- All procured items should be provided with an emissions LCA footprint by the supplier as part of the product specification as far as possible
- Formal procedures for effective take-back (for remanufacturing) or recycling as WEEE via the waste management set-up need to be mandated; these materials are valuable resources that are legally required to be fully recycled.

4.8 Catering (food and drink) consumables

What needs measuring and why

The IPPC reports (IPPC, 2019) that farming and forestry account for between 21-37% of total net anthropogenic GHG emissions and this figure will continue to rise without changes to way we use land. The IPPC goes on to state that sustainable land management can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation. It can also contribute to mitigation and adaptation, reducing and reversing land degradation, at scales from individual farms to entire watersheds, providing cost effective, immediate, and long-term benefits to communities. This supports several Sustainable Development Goals (SDGs) with co-benefits for climate adaptation and carbon mitigation.

Selecting low carbon food and drink products as part of a carefully managed procurement process will enable LSHTM to be confident that its catering activities are helping to reduce scope 3 emissions. As a HEI with a student body LSHTM's catering activities are a material contribution to its scope 3 footprint. It will be essential to develop close working relationships with valued suppliers to develop a better understanding of different products' carbon footprints, quantifying these in CO2e kgs per unit of product as far as possible.

Recommended KPIs

- CO_2e kgs/item or unit of product supplied
- Nos and % of suppliers operating a reusable packaging system to minimise waste
- Nos and % of suppliers using 100% recyclable packaging
- Amount/% of food waste sent for composting or similar bio-processing, e.g. biogas

Current situation appraisal

LSHTM's catering manager has already contacted each main supplier asking for relevant information about their sustainability approach and activities to measure and monitor their own carbon emissions. Work has also been done to provide more sustainable, healthy choices on the menu (the 'planetary picks' is an award-winning initiative) and to reduce non-essential packaging and phase out single use plastics.

An initial review of the main catering suppliers by TGC (**Appendix 3**) found many excellent practitioners in terms of assurance schemes, e.g. Marine Stewardship Council (MSC) certificated fresh fish supplies. There were, however, some issues around packaging, for example the fresh fish supplier uses hard-to-recycle polystyrene boxes and does not operate a take-back scheme for these. Very few of the suppliers contacted were able to provide much information on what they are doing to reduce their carbon footprint. None provided information about the carbon emissions per unit of product.

Recommended actions

- Work with each main supplier to develop evidence based, quantified CO_2e emissions per item or unit of product, making this information a requirement of future tendering activities as far as possible.
- Similarly, work with existing suppliers to phase out hard to re-use or hard-to-recycle packaging and to minimise product packaging to remove excess materials, especially single use plastics
- Provide information on innovations and successful low carbon initiatives to the existing supplier network, celebrating achievements with the aim of encouraging further supply chain improvements.

4.9 Laboratory equipment and consumables

What needs measuring and why

Laboratories have a high carbon impact from an energy usage perspective alone. It is also is important that lab managers make informed purchasing decisions with the aim of reducing their facility's footprint in terms of consumables used with the aim or reducing waste; reducing waste reduces carbon emissions. Whilst glass is an ideal material for vessels and has excellent recyclability as a sustainable material, it is more expensive than plastics and is obviously more prone to breakages. Furthermore, because borosilicate glass is resistant to chemicals, contaminants, and drastic temperature changes this makes it hard to recycle and dispose of. Plastic, on the other hand is much lighter, more durable and performs well in terms of resistance to leakage and permeability. But many of the characteristics that make plastic an ideal material for lab vessels and equipment makes it a poor choice from a sustainability perspective. Making the right purchasing decisions can have a big impact on the sustainability performance of a research laboratory.

A gradually increasing number of lab equipment manufacturers are able to provide good information about the total environmental and ethical impact of their products from raw materials sourcing, manufacturing and disposal covering:

- Renewable energy use
- Shipping impact
- Packaging impact
- Recycled content

Recommended KPIs

- % of lab suppliers contacted about the sustainability of their products and product packaging
- %/No of lab suppliers operating take-back schemes for used and unused products and equipment; this would reduce waste arisings
- % and type of lab products with validated sustainability credentials, e.g. ACT (see below)
- Annual carbon emissions from lab waste by type (provided by main waste contractor)
- If possible, emissions from waste per laboratory

Current situation appraisal

Set up by Deborah Coles with support from Ola Bankole, the Lab Sustainability Group has done much to bring energy management under tighter control through the use of a freezer policy and better procurement practice. When it comes to general consumables most of LSHTM's research groups simply purchase as and when they need to. There have been ideas

for consolidating deliveries with Birkbeck and SOAS and a draft policy was produced but nothing has been actioned. One of the biggest issues is lack of storage space for lab consumables, making frequent deliveries a necessity; this causes higher emissions from delivery vehicles. A lab equipment 'swap shop' was set-up to encourage re-use and reduce wastage but this scheme has fallen into abeyance largely due to problems with lack of immediate storage space.

Plastic equipment is preferred to glass as it can be safely used once and disposed of, i.e. not need to wash and sterilise compared to glass. Steps have been taken to use smaller packs of sterile pipettes with the aim of reducing wastage. Too much waste is currently considered to be going to autoclave disposal (see 4.2 above; 5% of LSHTM's waste is lab waste but not all of this is hazardous). Resolving this situation is best done in discussion with the waste contractor and may require a different bin collection set up and lab protocol to change user behaviour.

Recommended actions

American-based non-profit organisation My Green Lab has developed the ACT (accountability, consistency and transparency) global label that LSHTM could use for requesting product information from suppliers, if not already doing so. This would make it easier to choose safe, sustainable products because all ACT-labelled products are independently audited by 'Sustainability Made Simple' and verified by My Green Lab. The ACT label requests information about energy used in product manufacturing, including whether renewable energy is a factor. More information about ACT and sustainable consumables and lab equipment can be found at https://act.mygreenlab.org/consumables.html

Working in close partnership with the new waste management contractor could help in identifying which labs and types of lab waste could be further reduced through smarter procurement and better usage; developing enhanced lab policy and protocols should be the main objective.

Develop a lab procurement protocol and a mandated list of contracted suppliers for specific consumables and equipment; these items should only be procured, any divergence from using this list would need prior senior authorisation. All procurement will need to be undertaken via LSHTM's main procurement team using POs and mandated processes.

Where feasible, take-back schemes should be set-up with suppliers of specific equipment so that these items can be returned for re-manufacturing at the end of their useful life. This will further reduce waste arisings.

Review the potential for consolidating deliveries of consumables and lab equipment with other members of the Bloomsbury Group to reduce road miles and related emissions. This may need to address the lack of storage issues and the potential for re-instating the lab 'swap shop' initiative that has fallen into abeyance.

4.10 Office stationery and consumables

What needs measuring and why

Many office stationery products are underpinned by the oil industry and large-scale timber and pulp production as most items comprise paper or plastic-based materials or a combination of both, with varying levels of recycled content. These industries can be high carbon emitters so using the procurement process to specify low carbon, easy-to-recycle products can make a big difference to supply chain carbon impacts. Selecting suppliers that are working towards becoming part of the circular, low-carbon economy through improved manufacturing and closed-loop production processes further reduces supply chain impacts. LSHTM's main supplier is Office Depot, an American based global group that offers a fairly complete range

of ‘eco-friendly’ office supplies. Getting information from Office Depot about the carbon efficiency of their ‘green office’ supplies should be LSHTM’s strategy going forwards, so that carbon emissions can ultimately be calculated for this source of bought goods..

Recommended KPIs

- % of products purchased from the Office Depo ‘green alternatives’ list with the aim of achieving 100%
- % of products with a known carbon intensity value, i.e. emissions per item or per kg, aiming for 100%
- % of total procured items for which annual scope 3 carbon emissions can be calculated, aiming for 100%

Current situation appraisal

LSHTM’s Procurement team are working towards agreeing specific delivery days with Birkbeck and SOAS to consolidate deliveries with the aim of reducing unnecessary road miles and ad-hoc partial loads. Whilst this is much more cost-effective and ultimately more carbon effective by reducing transport emissions, it is proving difficult to collate departmental orders and implement an easy way to disaggregate deliveries. One of the main issues to overcome is the lack of standardisation in what is being ordered by different departments and research projects. This needs to be resolved by restricting orders to an agreed shortlist of products and also possibly agreeing who in each School and which Unit Administrators can place an order, using the PO process, i.e. an order cannot be placed without an approved PO.

Recommended actions

The Office Depot ‘green alternatives’ office supply catalogue or listing should be the mandated source of all office consumables, i.e. ordering goods from elsewhere should not be possible. This contractual arrangement would need to be set up via the Procurement Team and strictly adhered to by all of the faculties and their schools. Research projects would also need to use the same mandated green stationery list. Setting up a digital purchasing app with Office Depot that only allows the appropriate goods to be bought could be one way of enabling this approach.

As a main supplier Office Depot should be contacted asking for information about the carbon efficiency of their products. This may well not be easy for this supplier to respond to at first but over time they should be able to provide a robust indication of carbon emissions for LSHTM’s annual supplies of office goods; this should be set-up as a partnership/supplier agreement for mutual benefit and could be made a condition of contract.

4.11 Investments

What needs measuring and why

Investment in extractive and energy intensive industries responsible for high carbon emissions, e.g. coal, oil and gas, and pharmaceuticals, or sectors responsible for causing high levels of carbon emissions, e.g. non-sustainable timber and intensive farming enterprises are to be avoided. Heavy investment in such activities can substantively undermine good practice in operational emissions management.

Current situation appraisal

LSHTM’s investment portfolio is split across two main investment managers and neither have any direct holding in ‘sensitive areas’ such as oil, gas and related sectors. A small proportion is in pooled funds which may include fossil fuels, but this is less than 1% of the total and is closely monitored by LSHTM’s investment committee.

Recommended actions

Keep a watching brief on the investment portfolio to avoid involvement in any activities that would undermine LSHTM's objective for working towards achieving carbon neutrality by 2030. Ethical, sustainable investment platforms are rapidly improving their scope and can offer increasingly attractive rates of interest, with many beginning to outperform more traditional investment funds including oil, gas and coal enterprises.

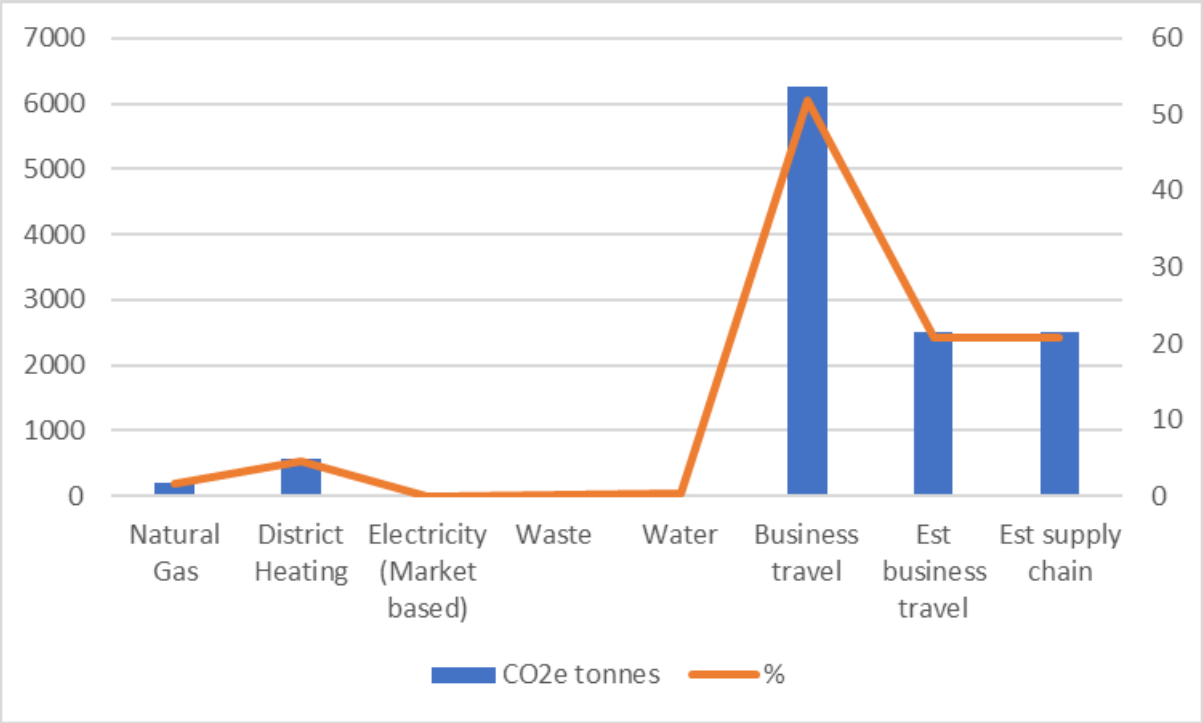
In particular, LSHTM should look to switch funds to completely divest from fossil fuel and related commodity investments as soon as practicable.

5 The Carbon Reduction Action Plan

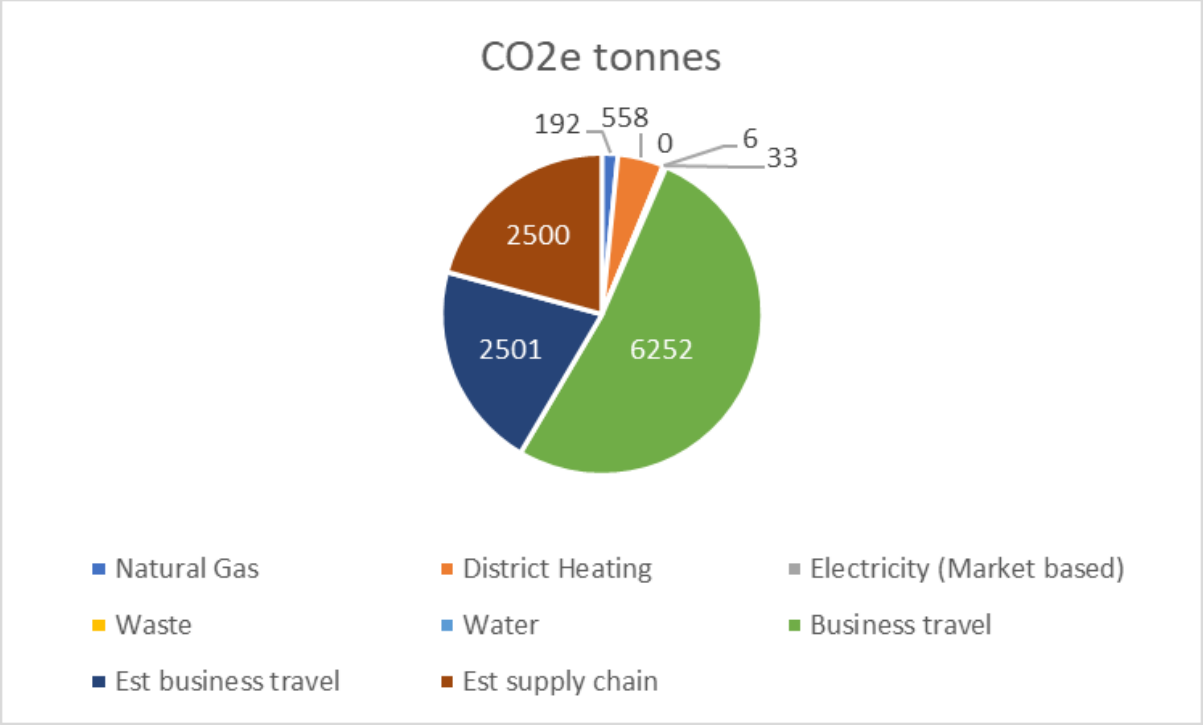
The following table and graphs summarise LSHTM's 2018/19 carbon footprint. ***Because of business travel under-reporting by some 40% and the lack of supply chain carbon data these elements have been estimated.***

Scope	Source	CO2e tonnes	%
Scope 1	Natural Gas	192	2
Scope 2	District Heating	558	5
Scope 2	Electricity (Market based)	0	0
Scope 3	Waste	6	0
Scope 3	Water	33	0
Scope 3	Business travel	6252	52
Scope 3	*Est business travel*	*2501*	*21*
Scope 3	*Est supply chain*	*2500*	*21*
	Totals	**12042**	**100**

Figure 26: LSHTM's total annual carbon footprint for reporting year 2018-19



Figures 27 & 28: LSHTM's illustrated total annual carbon footprint for reporting year 2018-19



The updated carbon footprint makes it evident that business travel constitutes around 70% of LSHTM's annual carbon emissions. This could, however, be even if greater because business travel is currently under-recorded, and it has not been possible to establish the proportion of scope 3 emissions arising from other bought goods and services. It is very clear that business travel presents a significant challenge to LSHTM and significant systemic changes are required to better monitor and manage this source of emissions.

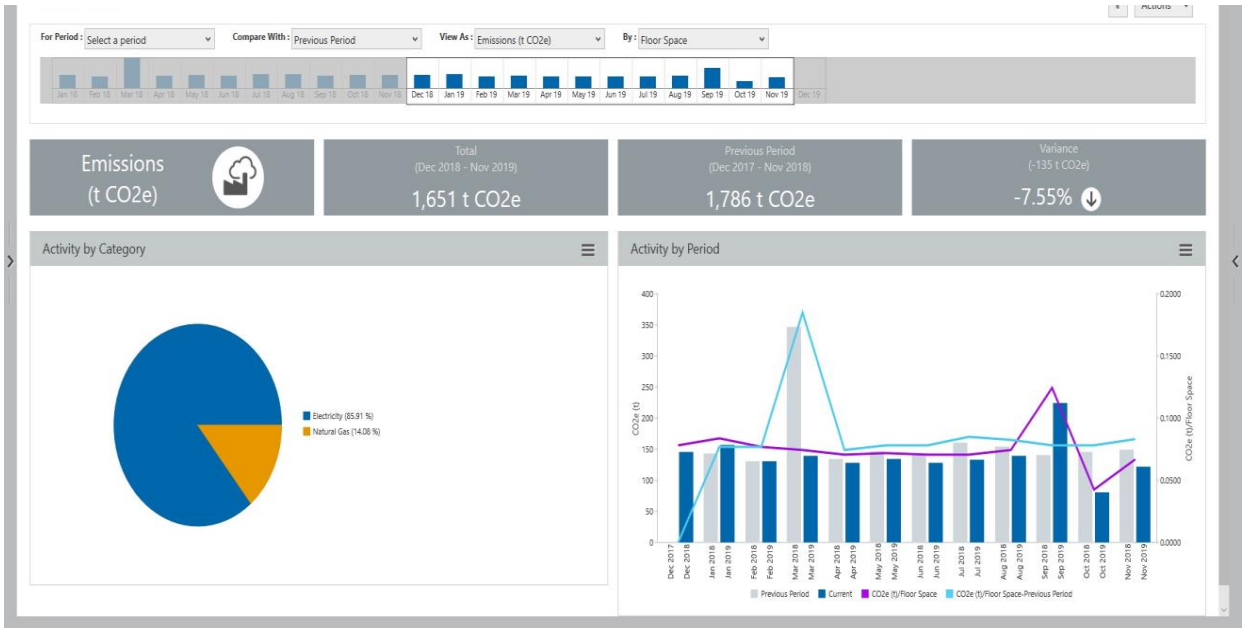
Interpretation of LSHTM's carbon profile strongly suggests that it should be considered a global institution that 'happens to be based in London' as this perspective more aptly reflects the institution's operations and global reach. By taking a similar approach to managing travel emissions to that of other global institutions, such as the United Nations and its agencies, it is possible to make the necessary changes to current practice whilst ensuring LSHTM's core business functions continue effectively. To this end the following table provides recommendations on reducing LSHTM's carbon emissions – all scopes – but especially scope 3 emissions.

Based on the audit findings and recommended KPIs set out in Section 4, we advise that LSHTM uses the Carbon Reduction Action Plan to put in place enhanced reporting measures. This will give LSHTM time during reporting year 2019/20 to establish effective new policies, protocols and procedures for effective data collation and also for encouraging the necessary behavioural changes towards establishing a new low carbon culture.

Taking this approach will enable LSHTM to set a meaningful carbon emissions baseline for carbon reporting purposes from 2020/21 onwards. Setting 2020/21 as the baseline reporting year will also avoid having to account for the capital investment and emissions associated with the new development at Tavistock Place, which is clearly not part of a typical reporting year. Once the new building is up and running in 2020/21, its operational emissions can be incorporated into the new baseline.

LSHTM's Sustainability Portal

The Carbon Reduction Action Plan data collection process and reports will be made publicly available via the **Sustainability Portal** on the LSHTM web site and intranet. This provides access to live data and regular progress reports by building, by emissions scope and in aggregate, enabling tracking of progress towards carbon neutrality:



The following table explains the plan in more detail, providing metrics and responsibilities.

Scope 1: Emissions from direct combustion on-site			
Location	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
Keppel Street and other buildings	Council and SLT to agree to a building services review which investigates system changes to accommodate low carbon heat at LSHTM with a near to medium term view to moving away from gas fired heating	Develop a time-bound working proposal to guide implementation. In the interim procure partly renewable 'green gas' when tendering for gas supply	Estates Department
	Use the Space Heating Policy to outline the heating provision and control strategy, and building classification – such as official opening hours of different buildings.	Policy actively being implemented	SLT to mandate policy to Faculties and support teams who must then implement the policy
	Review the recommended opportunities identified in Section 3 – Energy Efficiency Opportunities. This includes low cost technical and behavioural opportunities to reduce energy usage.	Prioritise and commit to investment in energy management and efficiency measures (again to be time-bound, timescales)	The Climate Change Working Group, supported by SLT and Estates, develop and implement a programme of behaviour change.
	Implement ISO 50001 implementation. An ISO 50001 certified system will provide longevity of energy savings.	ISO 50001 external certification achieved by end of 2021	SLT and Estates Department to progress working closely with the Climate Change Working Group and the Take Action climate network
	Energy (and sustainability awareness) training for all staff incorporated into Staff Development Plans (a rolling programme similar to say, equality & diversity training for example)	No of staff trained in energy awareness in 2020	SLT and Estates Department to implement training programme (also integrated into induction process).

Scope 2: Emissions from electricity and district heat and steam			
Location	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
Keppel Street and other buildings	Continue purchasing 100% renewable electricity and investing in energy efficiency measures including: • low cost technical and behavioural opportunities to reduce energy usage • Investing to achieve annual improvements in energy efficiency to reduce cost and drive efficiency • Updated Engineering Standards to achieve higher energy efficiency standards and lower life-cycle carbon costs of technologies being implemented. This will include specifying a light yield (lumens / watt) that rules out fluorescent tubes and ensures LED lighting will be installed as part of re-development works • specify highest efficiency IE4 motors where possible[10]. There is no policy around purchasing high efficiency motors or reassessing the correct size of motor	% of renewable electricity purchased/yr - included as part of EMS and sustainability reporting Behaviour change programme in place by August 2020, with agreed outcomes Measure and report the % improvement in energy intensity (electricity, natural gas, district heat) per m^2 in Estate buildings Standards fully implemented	SLT and Estates Department have implemented this measure Climate Change Working Group and the Take Action climate network to progress behaviour change programme, working closely with the SLT and Estates department. SLT and Estates Department. Energy efficiency designated a priority for all infrastructure and projects, both existing and planned. (technologies exist that can reduce electricity demand)

[10] The average annual energy consumption for an individual motor at LSHTM is estimated at 20,000 kWh. This has a material impact on energy usage.

	required to meet the current load.		Estates department, signed off by SLT by August 2020
Scope 3: Supply chain emissions			
Source	**Management requirements**	**KPIs**	**Management & Reporting Responsibility**
Procurement [High Priority]	Council and SLT to agree joint financial and sustainable procurement policy by December 2019. Faculties to implement good practice procurement using PO system	Policy in place % of orders placed per Faculty/School/Dept/team with a PO tracked	SLT to mandate policy to Faculties and support teams by end of December 2019 Faculty Heads and FOOs to ensure policy is adhered to by all academic, research and administrative staff. Finance and Procurement to monitor practice on a monthly basis, once systems integration functionality and/or personnel brings together all the disparate systems to enable validation and target feedback to specific departments (or individuals), ideally having this in place by January 2020 Heads of Finance and Procurement to raise any issues with SLT and COO. (the above would give them (and us) the 'intelligence' to be able to raise said issues) Monthly reports to be issued to Climate Change Group to review and follow-up as appropriate with specific

			School/Project teams to encourage adherence to the policy and systems. This could include investigating 'user issues' and problems from a user perspective. The Climate Change Group could be tasked with setting up a culture change initiative for this purpose.
Waste	Improve waste collection in Keppel Street to match segregation practice in Tavistock Place. Set waste reduction targets per building and per waste stream Set up 'take back schemes' for waste packaging and equipment to reduce waste arisings where possible Monitor waste arisings per building	CO2e per tonne/annum of : • WEEE • Hazardous waste • Paper and card • Cardboard • Food/ organic waste • Plastics (with the aim of eliminating single use plastics) • Metals • Glass	Estates team, Faculty Heads and FOOS to mandate waste segregation good practice in Keppel Street Estates team to set waste reduction targets per building, using supplier take-back schemes as far as possible Estates/support services to monitor waste arisings per building. – Head of Sustainability to raise any issues with the SLT Head of Sustainability to collate data for preparing quarterly reports and work on any issues with Faculty and Support Services staff as appropriate/required.
Water & waste-water	Conduct water audit and set efficiency targets per building Monitor water usage per building	• Cubic metres per month and in aggregate for the reporting year • Intensity – potable water emissions in CO2e Kgs/m2 or per CO2e Kgs/capita • Intensity (trade effluent emissions in CO2e Kgs for the building as a whole as an EMS requirement)	Estates/Support services to undertake and implement findings of water audit Estates/Support services to monitor water usage per building against agreed targets – Head of Estates to raise any issues with the SLT Head of Sustainability to collate data for preparing quarterly reports as part of the EMS requirement,

			working closely with Laboratory Managers.
Construction & refurbishment	Commission low to zero build and refurbishment projects using procurement process to establish targets. Identify pre-work carbon emissions foot-print requirement for each project Undertake post-completion/post-occupancy evaluation of emissions, using this to inform future project specifications and approach	• BREEAM NC and Refurbishment rating for low carbon • SKA fit-out rating for low carbon • Embodied carbon emissions – absolute and intensity/m2	Estates team, working in partnership with Design lead, lead contractor and consultants team. Report performance data to SLT and Head of Sustainability Monitor building use with Faculties to determine design specification goals are being met in terms of user comfort, energy and water efficiency.
Business travel [High Priority]	Travel policy and protocols should be developed and agreed Monitor business travel by mode and frequency or trips per academic (Bookings via Travel Service as far as possible) Agree targets for reducing business travel to a 'reasonable minimum Expenses cannot be claimed without providing full trip details (mode, miles and emissions)	• CO2e tonnes/annum by type of flight (domestic, short haul from UK, long haul from UK and international/non-UK) • CO2e tonnes/annum by national rail miles travelled • CO2e tonnes/annum by Eurostar/International rail miles travelled • CO2e tonnes/annum by London underground miles travelled • CO2e tonnes/annum by London Taxi/Taxi miles travelled • CO2e tonnes/annum by hire/lease car (taking engine size into account) miles travelled • CO2e tonnes/annum by hotel overnights (taking location into account)	Council and SLT to agree travel policy and mandate travel protocols for all faculties and research projects to be in place for the 2020/21 reporting year Faculties to implement good practice travel booking and expenses claims with support of the FOOS as soon as Travel policy is agreed, i.e. early 2020 Travel service provider to report monthly to an agreed format (as specified by the Head of Sustainability) SLT to monitor adherence to travel policy and protocols, taking action to implement these as required.

		• CO2e tonnes/annum per faculty per mode (as above) • CO2e tonnes/annum per 'frequent traveller(name & unique LSHTM Identifier) academic/employee'	
ICT hardware	ICT procurement standardised across the organisation, i.e. all purchases are made through the formal procurement process to generate a recorded PO as required above for Procurement generally.. All ICT assets to be tagged by their unique device code number, enabling faculty, research project and support service inventories to be generated and maintained. Engage with suppliers to get an emissions LCA footprint as part of the product specification as far as possible Set-up formal procedures for effective WEEE take-back (for remanufacturing) by the supplier as far as possible to reduce LSHTM's WEEE waste.	• Carbon inventory of devices (by make, type and production emissions) per Faculty and research programme • Carbon inventory of devices (by make, type and production emissions) per research project not accounted for in a faculty inventory • Nos and % of devices returned to supplier per annum under a take-back agreement – per faculty and research programme plus in total per annum	ICT to work with Procurement to agree specification and main supplier(s), with no POs accepted for alternatives unless an ICT approved business case has been signed off. This set-up to be in place by January 2020 Faculties to undertake 'asset inventory' with ICT support. All new devices must be added to the inventory (checked by Procurement or ICT team?) on delivery and devices to be removed from the inventory when replaced by supplier or similar. ICT Department to advise how quickly this could be completed to enable reporting to start during 2020. Procurement to specify that suppliers must provide embodied emissions per device as far as possible at point of order placement, and provide a take-back service for old and 'beyond economic repair' devices SLT to receive monthly/quarterly reports on progress and level of adherence to the

			procurement process for IT devices
Catering	Work with each main supplier to develop evidence based, quantified CO2e emissions per item or unit of product, making this information a requirement of future tendering activities as far as possible. Work with existing suppliers to phase out hard to re-use or hard-to-recycle packaging and to minimise product packaging to remove excess materials, especially single use plastics Provide information on innovations and successful low carbon initiatives to the existing supplier network, celebrating achievements with the aim of encouraging further supply chain improvements.	• CO2e kgs/item or unit of product supplied • Nos and % of suppliers operating a reusable packaging system to minimise waste • Nos and % of suppliers using 100% recyclable packaging • Amount/% of food waste sent for composting or similar bio-processing, e.g. biogas	Catering team, with support from Procurement and the Head of Sustainability, to undertake a supplier survey asking each main supplier to provide specific evidence about the carbon footprint and/or carbon intensity of their products. Catering team to continue working closely with suppliers to phase out hard to recycle packaging and to reduce non-essential packaging, switching to re-usable crates and totes as feasible/practicable Catering to agree a monthly/quarterly reporting format to SLT regarding food waste, packaging waste and carbon emissions info from suppliers, with support from Head of Sustainability (NB: Catering supplier engagement and procurement needs an integral part of the business integration management set-up to enable easier monitoring, management and reporting)
Lab consumables	Working in close partnership with the new waste management contractor, identify which labs and types of lab waste could be further reduced through smarter procurement and better usage; developing	• % of lab suppliers contacted about the sustainability of their products and product packaging • %/No of lab suppliers operating take-back schemes for used and unused products and	All labs and Lab managers to become part of the Lab Sustainability Group (or have representation in the group) so they will implement recommendations and monitor progress. Progress should be

	enhanced lab policy and protocols as appropriate. Develop a lab procurement protocol and a mandated list of preferred suppliers for specific consumables and equipment (any divergence from using this list would need prior senior authorisation) All procurement should go via LSHTM's main procurement team using the PO system. Where feasible, take-back schemes should be set-up with suppliers of specific equipment so that these items can be returned for re-manufacturing at the end of their useful life. This will further reduce LSHTM's waste arisings. Review the potential for consolidating deliveries of consumables and lab equipment with other members of the Bloomsbury Group to reduce road miles and related emissions. Lack of storage issues and the potential for re-instating the lab 'swap shop' initiative neds addressing.	equipment; this would reduce waste arisings • % and type of lab products with validated sustainability credentials, e.g. ACT or Ecolabel • Annual carbon emissions from lab waste by type (provided by main waste contractor) • If possible, emissions from waste per laboratory	reported to the FOOs, Management Board and, ultimately SLT, especially if problems persist and need senior intervention. Lab managers for each lab to work with Procurement to develop an agreed list of low carbon lab consumables, using ACT and direct engagement with suppliers to identify low carbon products and packaging. Lab managers to work with Procurement and waste contractor in producing monthly/quarterly reports on progress. Estates Support Services and procurement department to work with Lab Sustainability group to resolve delivery logistics and storage issues.
Office stationery	The Office Depot 'green alternatives' office supply catalogue or listing should be the mandated source of all office consumables. Setting up a digital purchasing app with Office Depot that only allows the appropriate goods to be bought could be one way of enabling this approach.	• % of products purchased from the Office Depot 'green alternatives' list with the aim of achieving 100% • % of products with a known carbon intensity value, i.e. emissions per item or per kg, aiming for 100% • % of total procured items for which annual	This contractual arrangement would need to be set up via the Procurement Team and strictly adhered to by all of the faculties, their schools and research programmes/projects so that only the 'green alternatives' list of products is used. Procurement to work with Office Depot to establish

	Office Depot should be requested to provide information about the carbon efficiency of their products and encouraged to improve this information over time. Ideally this should be a condition of contract.	scope 3 carbon emissions can be calculated, aiming for 100%	the embodied carbon in different products should ideally be a condition of contract. This should be reviewed at least annually, with encouragement to Office Depot to always offer better products at competitive prices.
Investments	Keep a watching brief on the investment portfolio to avoid involvement in any activities that would undermine LSHTM's objective for working towards achieving carbon neutrality by 2030. In particular, look to completely divest from fossil fuel and related high carbon commodity investments as soon as practicable.	% investment in high carbon commodities – should ideally be zero	Finance to monitor, notifying SLT and Council when appropriate action needs to be taken

Helping to achieve the Sustainable Development Goals (SDGs)

The following table explains which of the 17 SDGs the CMP will help to the LSHTM to achieve. As the CMP is implemented and data collation and reporting improves to allow for credible carbon offsetting, it should be possible to add further SDG goals:

SDG	Theme and relevance
	Ensure availability and sustainable management of water and sanitation for al - water management is covered in the CMP (Scope 3) towards improving sustainable water management in addition to reducing carbon emissions
	Ensure access to affordable, reliable, sustainable, and modern energy for all – (Scopes 1 and 2) energy efficiency is a priority for the CMP, as a core part of LSHTM's sustainability strategy
	Make cities and human settlements inclusive, safe, resilient and sustainable – the new CMP (all scopes) will help towards making London more sustainable and resilient, safer in terms of air quality.
	Ensure sustainable consumption and production patterns – engaging directly with its suppliers (all scopes) is a primary goals towards carbon mitigation and climate resilience.
	Take urgent action to combat climate change and its impacts – this is the primary purpose of the CMP (all scopes)
	Conserve and sustainably use the oceans, seas and marine resources for sustainable development – by directly engaging with catering suppliers (scope 3) to reduce single use plastics and the sustainable procurement of fish and related products.
	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably managed forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss – reducing consumption and by engaging directly with suppliers (scope 3) of timber and paper-based and food products, towards securing sustainable low carbon methods of production.
	Strengthen the means of implementation and revitalise the global partnership for sustainable development - LSHTM is using the CMP to help implement the SDGs in terms of how it operates/manages itself, as well as through its core purpose for education and research for a more sustainable planet.

Setting science-based targets

With the aim of achieving carbon neutrality by 2030, the trajectory for reducing annual emissions is provided below. To monitor progress a mid-term target for emissions reduction by 2025 is also given. When measures to reduce emissions from each source or scope have been fully implemented it will still not be possible to completely reduce or avoid emissions, especially from scope 3 sources. On that basis these **residual** emissions can be offset to achieve a net zero[11] carbon footprint, i.e. carbon neutrality. A robust, well-evidenced approach to carbon offsetting is being scoped as a related initiative, due to report in Spring 2020.

[11] 'Net zero' means that any emissions are balanced by absorbing or reducing an equivalent amount from the atmosphere.

Accurate, scientifically assessed carbon reduction targets create a solid foundation for LSHTM to aim for into the future.

This report aligns future targets using the Science Based Targets[12] Initiative (SBTi) tool, which ensures LSHTM's reduction strategy is aligned with the latest climate scient. **Using the Science-Based Target initiative's (SBTi) 'Absolute Emissions Reduction Approach towards achieving a 1.5 degrees global temperature reduction, LSHTM needs to reduce its Scope 1, 2 and 3 carbon emissions by 50.4% by 2030. This is achievable through realising continued improvements in annual performance.**

Any organisation making a formal commitment has a 24-month period in which to provide their scopes 1-3 annual carbon-footprint for SBTi independent validation. It should be noted, however, that an organisation's suppliers are required to provide their own SBT target within 5 years of a formal scope 3 target being accepted by the SBTi.

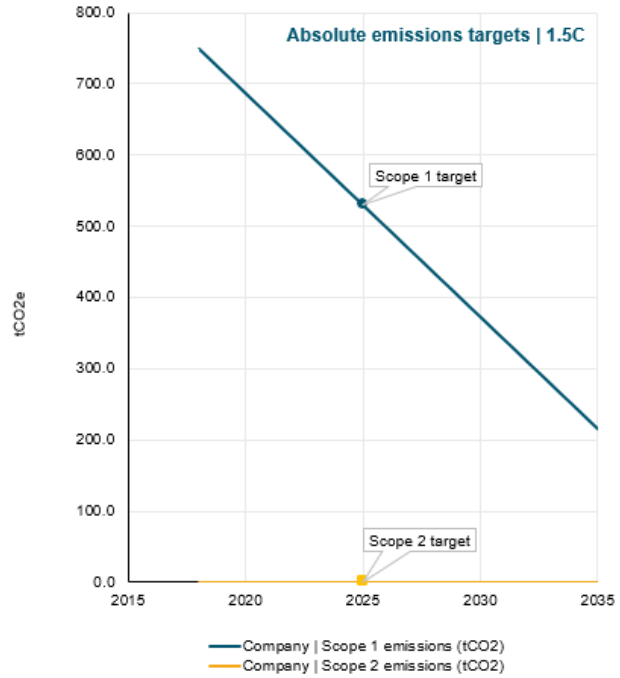
The SBTi emissions reduction scenarios do not recognise carbon offsetting because its goal is to encourage robust target-setting to actively reduce emissions. The best approach for LSHTM to take is to work towards meeting the SBTi target, using 3rd party carbon assurance to annually verify residual carbon emissions after all measures to reduce annual emissions have been taken. The residual emissions can then be offset with the aim of achieving the maximum benefits towards LSHTM's strategic vision and objectives for climate resilience health and well-being. The SBT emissions reduction trajectories are provided on the next page for information.

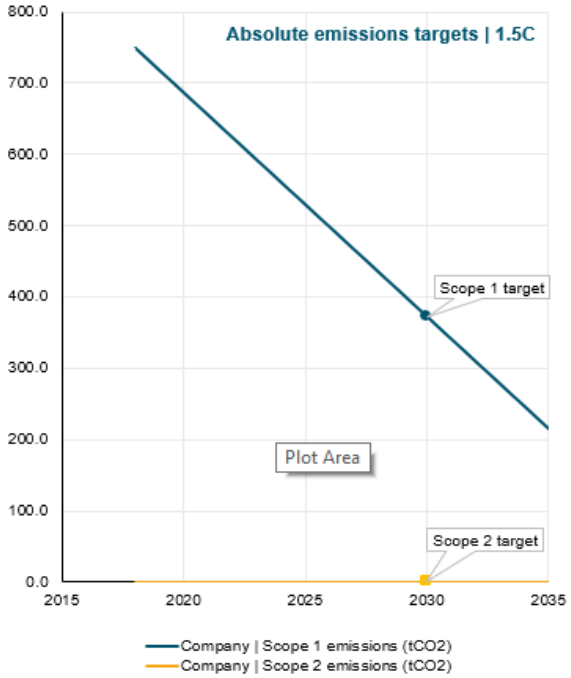
Because of the current issues in accurately measuring scope 3 supply chain emissions from procurement and business travel, LSHTM will not sign up to formally meeting the SBTi targets until further progress is made in obtaining accurate emissions information from key suppliers. Once the new carbon reporting baseline has been agreed, LSHTM could also consider signing up to a formal science-based target by entering into a written commitment with the Science Based Targets initiative (SBTi).

Scope 1 and 2 SBT reduction targets

	Base year (2018)	Target year (2025)	% Reduction
Scope 1 emissions (tCO2e)	750	530	29.4%
Scope 2 emissions (tCO2e)	0	0	0.0%
Scope 1+2 emissions (tCO2e)	750	530	29.4%
	Base year (2018)	**Target year (2030)**	**% Reduction**
Scope 1 emissions (tCO2e)	750	372	50.4%
Scope 2 emissions (tCO2e)	0	0	0.0%
Scope 1+2 emissions (tCO2e)	750	372	50.4%

[12] A greenhouse gas (GHG) emission reduction target can be considered 'science-based' if the emission reductions it stipulates are in line with keeping the global temperature increase well below 1.5°C compared to pre-industrial temperatures.





Scope 3 SBT reduction targets

	Base year (2018)	Target year (2030)	% Reduction
Scope 3 emissions - 2C (tCO2e)	11,292.0	9,625.3	14.8%
Scope 3 emissions - 1.5C (tCO2e)	11,292.0	5,600.8	50.4%

	Base year (2018)	Target year (2030)	% Reduction
Scope 3 emissions - 2C (tCO2e)	11,292.0	9,625.3	14.8%
Scope 3 emissions - 1.5C (tCO2e)	11,292.0	5,600.8	50.4%

Goal: A 50% reduction by 2030 of carbon emissions across Scope 1,2 and 3.

6 Useful references and sources of further information

IPPC (2019) Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

Science Based Targets initiative web site: https://sciencebasedtargets.org/step-by-step-guide/

WBCSD & WRI (2015) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition). Washington USA

UNEP (2012) Making policies work for Sustainable Travel: A Sustainable United Nations study.

UN Joint Inspection Unit (2017). Review of Air Travel Policies in the United Nations System: Achieving efficiency gains and cost savings and enhancing harmonization. Geneva.

The Green Consultancy will be pleased to provide further detailed investigations and any implementation support that may be needed to address the issues identified in this report.

Appendix 1: Main funders' approaches to sustainability & carbon

Main Funders	Funder approach to sustainability	Carbon Footprint?	Carbon Impacts of their Grant/ Research Funding Programmes?	What Are They Asking of Grant Applicants re environmental Impacts Measurement and Avoidance/ Minimisation, Especially Carbon Impacts?	No. of Projects	Budget to LSHTM
UKRI	UKRI is committed to ensuring that sustainability is '*embedded in everything we do*'. This is primarily their UK estate, with business travel a voluntary reporting item. Partner for UN's Sustainable Development Goals, e.g. UKRI was directly referenced as contributing to SDG Goal 9: Industry, Innovation and Infrastructure through its commitment to raise spend on research and innovation to 2.4% of GDP by 2027. NERC's contribution to Goal 9 though its 'Unlocking the Potential of Groundwater for the Poor (UPGro)' programme and Goal 13: Climate Action through it's 'Engaging Environments' initiative'	Yes- PDF Sustainability Performance https://www.ukri.org/files/about/ukri-sustainability-report-2018-2019-council-split-for-web-hyperlink-160719-pdf/ Working with procurement provider UK SBS for sustainable procurement down the supply chain, but not clear if carbon is a priority focus.	Environmental sustainability strategy looking at direct activities and through funding decisions, but little evidence of carbon impacts and climate change being a consideration for most grant programmes. The Global Challenges Research fund is investigating Equitable Access to Sustainable Development to create new knowledge and drive innovation that helps to ensure that everyone across the globe has access to secure and resilient food systems, sustainable health and well-being, inclusive and equitable quality education, clean air, water and sanitation affordable, reliable, sustainable energy. There are no criteria for how research teams should mobilise to reduce their carbon footprint.	No information seems to be available yet.	146	£116,358,495
Wellcome Trust	'*We are committed to protecting the environment and improving the environmental footprint of our buildings.*'	Yes, but because the Trust is required to meet the mandatory requirements of the Carbon Reduction Commitment Energy Efficiency Scheme (CRCES)	No information seems to be available yet/ cannot find.	No information seems to be available yet/ cannot find.	76	£68,520,392
National Institute for Health Research (NIHR)	Dedicated to the sustainability of the health care system and committed to meeting the targets set by the UK Climate Change Act	NIHR Carbon Reduction Guidelines The recommendations of the document fall under two main headings: sensible study design and reducing the environmental impact of the NHS through research. A summary of the recommendations for researchers https://www.nihr.ac.uk/documents/the-nihr-carbon-reduction-guidelines/21685	Measuring the NHS footprint but no mention of others. States that further research is required to look at the carbon footprint of NIHR funded studies and their impacts.	A little- Carbon Reduction Guidelines are provided for researchers conducting research funded by the NIHR outlining approaches to help reduce emissions from health research; the guidelines are high-level and suggest that researchers will understand/know how to reduce carbon impacts.	67	£67,987,066
Bill & Melinda Gates Foundation	Partner of the UN's Sustainable Development Goals.	Partner of UN sustainable development although nothing specific about how they do this, including reducing carbon emissions.	All their grant partnerships must comply with the UN's goals and policies, but again nothing explicit on website about how this is to be achieved.	Have a thorough applicant process in which they look at direct and indirect costs and processes of each project but a search for carbon mitigation and climate resilience returned zero results.	57	£76,271,397

Commission of the European Community	Partner of UN's Sustainable Development goals. Leading body of legislation and strategies for future climate/ energy, economic and environmental sustainability	Yes- categorised it overall and by country. https://ec.europa.eu/eurostat/web/sdi/climate-action	They have been measuring carbon footprints of policies and grant funding since 2011. See commission's- science for environment policy	Asking for complete transparency along the supply chain- applicants have to comply with their environmental and business laws. LSHTMJ already does this so by implication research activities should be included. This is not, however, clear.	42	£122,916,267
US Federal Agencies	Have Office of Federal Sustainability- council on environmental quality. Looks at energy and environmental performance across the federal government as well as the implementation of programmes.	Graphs on energy use and waste including greenhouse gas emissions. https://www.sustainability.gov/government_data.html#s12 however- no search results for carbon emissions or carbon footprint. Can view individual departments performances but current federal administration is not explicitly mitigating emssions.	No information seems to be available yet. Details of some past research projects have failed to fully address these issues, e.g. replacing wood biomass stoves with LPG to improve in internal air quality and reduce particulates health issues. LPG is 'cleaner' but fossil-fuel derived and can only be a short-term fix for this reason.	No information seems to be available yet.	28	£11,175,255

Appendix 2: Scope 3 reporting categories[13]

Scope 3 category	Upstream supply chain emissions source	Details
1	Purchased goods and services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 - 8
2	Capital goods	Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year
3	Fuel- and energy-related activities not included in scopes 1 or 2	Not applicable to LSHTM
4	Upstream transportation and distribution	Not applicable to LSHTM
5	Waste generated in operations	Disposal and treatment of waste generated in LSHTM's operations in the reporting year (in facilities not owned or controlled by it (i.e. Waste management and treatment companies)
6	Business travel	Transportation of employees & students for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)
7	Employee & student commuting	Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)
8	Upstream leased assets	Operation of assets leased by the reporting company (lessee) in the reporting year and not included in scope 1 and scope 2 – reported by lessee
Scope 3 category	**Downstream supply chain emissions source**	**Details**
9	Transportation and distribution of products sold by the reporting company in the reporting year	Not applicable to LSHTM
10	Processing of sold products	Not applicable to LSHTM
11	Use of sold products	Not applicable to LSHTM
12	End-of-life treatment of sold products	Not applicable to LSHTM

[13] Source: The Scope 3 Standard (WRI & WBCSD 2011)

13	Downstream leased assets	Not applicable to LSHTM
14	Franchises	Not applicable to LSHTM
15	Investments	Operation of investments (including equity and debt investments and project finance) in the reporting year, not included in scope 1 or scope 2

Appendix 3: Initial review of catering suppliers

Overleaf (formatting issue)

Supplier name	2018/19 spend	Supplier's corporate approach to sustainability	ISO14001: 2015 certification or similar certifications, e.g. Ecolabel, etc	Supplier carbon footprint evidence	TGC recommendations
Angel Human Resources Plc	£83356	Have a corporate responsibility set-up, went paperless in 2017. Reduced carbon footprint through web-based communications systems, minimising business travel wherever feasible.	No	No evidence available on their website.	Send simple survey asking questions about emissions management, etc
Kent Frozen Foods Ltd	£57639	Sustainable pricing. Local goods sourced. Strive to reduce food miles. Recognise importance of environmental practice.	Part of Sysco group. CSR goals based around people, products and planet. Working with WWF	Nothing on their website but SySco has a little bit more informati on on emissions in their annual report.	Send simple survey asking questions about emissions management, etc
Prescott-Thomas Limited	£40103	Seasonal foods. Doesn't have anything on website. Client statement- adhere to low levels of acrylamide. Committed to "*following sustainability principles and enforcing practice across all operations*". Working towards ISO14001 and ISO9001. Traceability of all products, as well as recyclable packaging- cardboard boxes and brown paper bags.	BRCGS Standard for Storage & Distribution, Red Tractor, Soil association certified.	No but vehicles fitted with 'blu' containers.	Send simple survey asking questions about emissions management, etc
Raynor Foods Limited	£38670	Locally sourced foods, attended sustainability palm oil forum. Zero waste to landfill factory recycling all waste and energy. 100% recyclable packaging- looking at biodegradable in the future.	Packaging compliant with EU labelling legislation and environmental standards. ISO 14001 certified, BRC certified and	No.	Send simple survey asking questions about emissions management, etc

			certified food supplier.		
Hills Prospect Plc	£33490	Committed to environmental sustainability by identifying and addressing environmental aspects resulting from its activities, products and services. e.g. Reduce emissions, fuel and energy consumption. On site electricity generation from Solar photovoltaic 250kWh array Raising drivers' awareness of fuel economy, Certificate of Competence (CPC) training for all drivers 35 hours every 5 years. Waste Packaging Recycling (meeting waste recovery and recycling obligations as required by The Producer Responsibility Obligations.	Compliant to ISO 14001	No.	Send simple survey asking questions about emissions management, etc
Nivek Catering Suppliers Ltd	£30263	social and economic importance of protecting the environment; that its commitment to this must encompass all activities and that it should be prepared to lead by example in promoting a sensitive, considered attitude to the environment. http://www.nivekonline.co.uk/environmental	ISO9001 and ISO4001 standards. Bpi.recycled products, paper and plastics for food and drink etc.	No.	Send simple survey asking questions about emissions management, etc
Smiths Coffee Company	£29436	Nothing specific on their website.	Sustainable products- Fairtrade, Organic Soil Association, rainforest alliance. (but don't apply to all products).	No.	Send simple survey asking questions about emissions management, etc
Fresh Fro Ltd	£21246	Appear not to have a website ?		No	Send simple survey asking questions about emissions management, etc

West Horsley Dairy LTD	£18971	State that Directors place their Corporate Social & Environmental performance high on the Company agenda. Mitsubishi Canter Duonic Eco Hybrid delivery vehicle used 40% less fuel than conventional lorries. Fleet Operator Recognition Scheme (FORS) sustainable best practice for freight operators who deliver/ provide services.	BRC Global Standard and FORS Gold standard accreditation. Red tractor and Local Sourcing. Soil association certified.	No.	Send simple survey asking questions about emissions management, etc
Smithfield (Wholesale Butchers) Limited	£15664	Doesn't say anything about environmental policy or sustainability.	No relevant certifications on website.	No.	Send simple survey asking questions about emissions management, etc
Canapes Direct Ltd	£14351	Doesn't say	SALSA Approved. EU Registered.	No.	Send simple survey asking questions about emissions management, etc
JJ Food Service Limited	£13629	Nothing specific. Appears that they are trying to be sustainable in their production and supply chain. Just installed 1000 solar panels at Sidcup branch.	MSC certified sustainable seafood, Certified Food Supplier, bsi; ISO9001, ISO14001, ISO50001.	No.	Send simple survey asking questions about emissions management, etc
Nisbets	£11999	Eco-friendly, have their own environmental objectives; achieve 0% landfill (recycle 98%), reduce paper waste, reduce energy and water consumption, promote sense of corporate and social responsibility.	Gold trusted service award. PEFC (Programme Endorsement of Forest Certification).	No but just installed solar panels and are tracking new progress.	Send simple survey asking questions about emissions management, etc
JD´s Food Group	£9816	Doesn't say anything about environmental or social responsibilities.	No sustainable certification listed.	No.	Send simple survey asking questions about emissions management, etc
DDC Foods Ltd	£7764	Doesn't say anything about environmental or social responsibilities.	No sustainable certification listed.	No.	Send simple survey asking questions about emissions management, etc
Langford & Chamberlyne Ltd	£7420	Doesn't say anything about environmental or social responsibilities.	No sustainable certification listed. Just CEDA,	No.	Send simple survey asking questions about

			cedabond and ESPO.		emissions management, etc
Worldpay (Streamline)	£6321	American multi-national with a social responsibility programme but nothing about managing environmental impacts	No information	No.	Send simple survey asking questions about emissions management, etc
Barbican Supplies Ltd	£5669	No sustainable or environmental policies/ objectives stated on website.	Red Tractor, EEC approved.	No.	Send simple survey asking questions about emissions management, etc
R A Garner	£4440	Doesn't say anything about environmental or social responsibilities.	No sustainable certification listed.	No.	Send simple survey asking questions about emissions management, etc
Probrand Ltd	£4347	Doesn't say anything about their sustainability practices.	ISO/ IEC 27001 and ISO 14001:2015, B2B	No.	Send simple survey asking questions about emissions management, etc
Haines Farm Eggs	£4081	Traceability on all products. But, does not state anything about sustainability practices.	HSQC- no other certificates.	No.	Send simple survey asking questions about emissions management, etc
Elpro (Oakwood Corporation Limited)	£3914	'In conducting our business, we seek to minimise our impact on the environment and maintain strong relationships with all our stakeholders.' No other mention of environmental or other sustainable policies.	Chartered secretary in public practice. No other certifications.	No.	
Checkit Limited	£3870	Nothing explicit on their website	B2B, no evidence of any other standards or certifications	No.	Send simple survey asking questions about emissions management, etc
Vegetarian Express Limited	£3659	Eco-friendly vehicles, some foods very sustainable. No specific area/ link that outlines their sustainable values.	ISO14001, ASCB, B Corporation.	No.	Send simple survey asking questions about emissions management, etc
Lodge Cleaning Services Limited	£3360	Doesn't say anything about their sustainability practices.	N/A	No.	Send simple survey asking questions about emissions management, etc
Planner Catering (Equip Hire)	£2,835	Set annual Objectives and Targets to manage environmental business risks effectively, monitor and where possible, reduce environmental impacts on both the local and	Certificated to ISO 9001:2015, ISO 14001:2015	No.	Send simple survey asking questions about emissions management, etc

		wider environment and are also aligned with their Future Development Plan.	and OHSAS 18001:2007		
Cook and Lucas	???	Sustainable fishing/ sourcing, reducing environmental impacts, but use hard to recycle polystyrene packaging (provided by one of their suppliers).	Global Standard for food safety level A. BRC and MSC certified.	No.	Send simple survey asking questions about emissions management, etc

Appendix 4: Detailed energy efficiency opportunities

All costs and savings are quoted as budget figures unless otherwise stated and are estimated to be accurate within +/- 30%. A full spreadsheet database of all calculations and backing data is also attached to this report. Note carbon savings from reducing electricity consumption utilise the UK grid carbon intensity per kWh saved. As previously outlined, carbon emissions from electricity can be reported as zero emissions but energy opportunities have assumed a carbon saving.

Keppel Street

Opportunity 1.1	**Keppel Street**	**LED lighting retrofit (including units and installation cost)**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	75,329	£9,793	£37,731	3.9
Total	**75,329**	**£9,793**	**£37,731**	**3.9**
Current Situation	Due to the building layout, lighting is during all occupied times, giving high energy use. Lighting at Keppel Street is mainly traditional T8 fluorescent ceiling mounted lights. Much of the lighting in the office areas and corridors is T8 low frequency fluorescent 600 mm quad tube fittings rated at around 76 Watts per fitting; and 200 x 200 four tube T8 recessed fluorescent luminaires. There appeared to be a high number of luminaires that were below the optimum level of light for the luminaire; light output from fluorescent tubes diminishes with age until failure occurs.			
Opportunity	As part of ongoing improvement works, a major LED lighting retrofit should be implemented. This lighting retrofit would remove unnecessary light fixtures. LED panel luminaires can produce savings of up to 50% compared to the traditional 200 x 200 four tube T8 recessed fluorescent luminaires. Approximately 200 T8 tube fittings can be replaced with LED equivalent tube lights. LED 600 x 600 panels will cost around £40 per unit to fit including controls. It has been assumed that lighting controls will reduce the operational time of the lighting by around 30%. A full lighting survey would need to be carried out to fully identify and cost the replacement of traditional luminaires with LED's. A further observation is that the LSHTM Engineering Standards should be updated to specify a light yield (lumens / watt) that all but rules out fluorescent tubes, ensuring that Engineering Standards drive change.			

Opportunity 1.2	**Keppel Street**	**Improve AHU control: adjust settings and fit variable speed drive & controls to air handling units**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	210,240	£14,585	£27,100	1.9
Total	**210,240**	**£14,585**	**£27,100**	**1.9**
Current Situation	Keppel Street has multiple air handling units providing treated air, this is achieved by preheating the incoming air if required and then the final stage heating or cooling to provide a supply air at the designed temperature. These air handling units are controlled through the sites Building Management Systems. The AHUs run in places for 24 hours a day. Not all AHUs / pumps / motors / fans are VSD controlled. Recent changes to legislation mean that operators of HVAC chillers and refrigeration equipment should review their equipment and the availability of replacement condenser fans. Since 2017, all new condenser fan motors used on new chillers and condensers are required to meet the International Electrotechnical Commission (IEC) motor efficiency regulations and the Energy-related Products Directive 2015 (ErP). This has pushed manufacturers to look at the overall efficiency of fans and account for the entire fan, including the control electronics, motor, bell mouth and impeller and to define minimum efficiency requirements for the fans.			
Opportunity	Fitting a VSD and timer controls to the AHUs that do not currently have them fitted will reduce energy consumption. With a VSD (variable speed drive) the input/extraction rate can be reduced at times when air change activity is low and increased as required. Timer control can be used to automate this but can be overridden if required. There is potential to remove all the existing AC fans and replaced them with the latest design IE4 Super Premium EC fans which have built in speed controls making them perfect for HVAC applications.			

Opportunity 1.3	**Keppel Street**	**Passive infrared (PIR) sensors in infrequently occupied areas (bathrooms, kitchens, stairways)**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	18,792	£2,443	£3,750	1.5
Total	**18,792**	**£2,443**	**£3,750**	**1.5**
Current Situation	Much of the lighting in the office areas and corridors is T8 low frequency fluorescent 600 mm quad tube fittings rated at around 76 Watts per fitting. The lighting is controlled by manual switching and lights were on next to windows although good natural light was available. Lighting can be responsible for up to 40% of a building's electricity use. Efficient lighting control systems (such as passive infrared sensor, lux or daylighting sensors) are a major contributor to energy efficiency in industrial/office/retail/non-residential spaces, ensuring no unnecessary lighting is kept on. Savings on lighting energy consumption are possible with effective lighting controls – the exact amount will depend on several factors. There are opportunities across the hospital to install PIR sensors in infrequently occupied rooms (meeting rooms, kitchen, toilets etc). - the North courtyard does not have PIR control in unoccupied spaces - South courtyard has a time schedule (users have local control) - all stairways that currently do not have PIRs fitted should have.			
Opportunity	Fit presence detectors and natural light sensors and dimming controls for lights near to windows. This is especially important in infrequently occupied area such as bathrooms, kitchens, stairways etc. The less time the lights are on, the lower the electricity bill will be. Furthermore, when lights are left on to no purpose, it is a particularly iconic, visible and tangible example of energy waste. Failure to adequately tackle it in an organisation damages wider ambition and results in sustainability claims being rather tenuous.			

Opportunity 1.4	Keppel Street	Implement Space Heating Policy to reduce energy waste		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity				
Natural Gas	10,464	£3,093		Immediate
District Heat	30,930	£419		Immediate
Total	**41,394**	**£3,512**	**£0**	**Immediate**
Current Situation	The majority of heating to LSHTM buildings is supplied via district heating or natural gas boilers, feeding a network of radiators. There is very little control over this system, but it is set to maintain an ambient temperature in occupied buildings. Currently, unlike other higher education facilities, the London School of Hygiene and Tropical Medicine does not have a specific Space Heating Policy, which specifies the operating hours of the heating systems. Throughout the course of the site survey, evidence of poorly applied energy management practices has been noted.			
Opportunity	There is a significant opportunity to reduce demand for space heating at LSHTM, even considering the poor quality of the building fabric, through the implementation of a structured Space Heating Policy, which could reduce heating operating hours. Academic buildings and zones within LSHTM buildings should classed as either 5 day or 7 days buildings and the heating systems should be mandated to run between a target set of hours as decided by Facilities Management. It is noted that the types and locations of buildings and control systems along with other variables such as room exposure (north, south, east, west) or the room internal heat sources (lights, people, computers, equipment) are all factors that have an impact on overall temperature. The Space Heating can help mitigate any concerns that individual staff or students have about heating levels, by outlining that in exceptional circumstances portable heating equipment can be provided to certain categories of residents and staff whose health and welfare are significantly affected. Consultation with all building users on potential changes under a space heating policy is essential and should be at the forefront of any policy development. A Space Heating Policy could lead to a 2.5% reduction in non-baseload natural gas and heat primarily through reducing the hours of space heating. To outline the heating provision and control strategy and building classification – such as official opening hours of different buildings.			

Opportunity 1.5	Keppel Street	Improve energy management practices including a formalised management system

Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	62,352	£8,106		Immediate
Natural Gas	26,161	£1,046		Immediate
District Heat	77,325	£7,733		Immediate
Total	**165,838**	**£16,885**	**£10,000**	0.6
Current Situation	Management at LSHTM have explored some of the basic strategies to improve energy efficiency, however there is much more that could be done. Discussions with staff at the site visit highlighted that investment in energy saving has always been a challenge, and most projects implemented have been no / low cost options. Evidence of poorly applied energy management practices were noted on the audit.			
Opportunity	LSHTM should be commended for an effective ISO 14001 environmental management system. However, it is recommended that a university wide energy awareness campaign is undertaken. This should be a multifaceted approach to behavioural change through improved energy awareness. However, further energy awareness training and changing behaviours can - almost in all cases - yield energy savings. Mechanisms of encouraging engagement include awareness posters, switch off notes, toolbox talks, improved energy communication and formalised training. It is thought that through an improved site awareness overall variable (non-baseload) energy consumption could be reduced by 2.5% in the office environment.			
	To drive change within LSHTM, it is recommended that an ISO 50001 externally certified formalised energy management system is implemented in the medium term. A successful energy management system should also cover the following areas: - Implementing a dedicated energy policy - Creating and reviewing a legal register with reference to energy - Undertaking a full energy review and identifying significant energy users - Setting energy performance indicators, objectives and targets - Undertaking energy training - Communicating the management system internally and externally - Having a suggestions scheme in place - Formalising a document management system with energy sections - Outlining good practice for operational control - Putting in a mechanism to identify energy performance deviations - Developing an energy design and procurement procedure - Conduct internal audits - Identify and rectify any nonconformities - Undertake an energy section within a dedicated management review			

	Strategic energy management practices will reduce LSHTM's carbon emissions in an organised way.

Opportunity 1.6	**Keppel Street**	**BMS Optimisation of the McQuay Chillers**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	15,768	£2,050	£500	0.2
Total	**15,768**	**£2,050**	**£500**	**0.2**
Current Situation	Keppel Street has a number of air handling units providing treated air, this is achieved by preheating the incoming air if required and then the final stage heating or cooling to provide a supply air at the designed temperature. These air handling units are controlled through the sites Building Management Systems. The control of the levels of heating/cooling and the sequencing of the air handling units is provided from the BMS. this control system provides final air delivered at the designed set point. An investigation into operation and performance of the BMS was performed as part of this audit. identify alterations to the control strategy which will optimise building operation whilst maintaining a comfortable working environment for occupants. Set-points, time schedules, weather compensation, sensor accuracy, graphics accuracy and control methodology were reviewed, whilst also commenting on the usability of the system, day to day operation and maintenance.			
Opportunity	The site has a complicated chilled water-cooling system with part of the cooling provided by large McQuay Chillers and other parts of the system supplied by small multistage Dakin chiller sets. The BMS showed a chilled water flow temperature of 6.96°C with a return of 7.78°C, shows that there is little or no real load on this chilled water system. Review of McQuay chiller operating temperatures to ensure the system is operation within the optimum range.			

Opportunity 1.7	**Keppel Street**	**Improve insulation on steam lines, generator valves and pipework**

Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
District Steam	4,800	£480	£450	0.9
Total	**4,800**	**£480**	**£450**	**0.9**
Current Situation	Keppel Street uses steam for its sterilizing processes. There are two Certuss Steam Generators located in the basement plant room. Steam generators could be switched off at night but are left on to act as backup for the district heating system. The system insulation on the steam generator pipework is generally good, however there are areas where insulation is missing. A number of flanges and elbows in the steam and condensate return lines were observed as not insulated. A five-meter length of 2.5-inch diameter steam pipe feeding the hot water tank was uninsulated. At this point there are a number of uninsulated flanges, valves and significant lengths of flexible pipework. The steam pipework will be at a temperature of around 170^{o}C.			
Opportunity	It is recommended to insulate flanges, elbows and pipe on steam and condensate return systems. For 9 bar steam loss on 2.5-inch uninsulated pipe is 800 W/m. With 1 inch of insulation this will drop to 80 W/m. Assume uninsulated pipe, flanges and elbow is equivalent to 10 meters of 2.5-inch pipe, annual operation is 500 hours and boiler efficiency is 75%. Saving = (800-80) x 10 x 500 x 0.001 x (1/75%) = 4,800 kWh. Assume cost of £20 per meter to install insulation.			

Opportunity 1.8	**Keppel Street**	**Lower compressed air generating pressure in portable compressors**

Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	2,046	£266	£0.00	Immediate
Total	**2,046**	**266**	**0**	**Immediate**
Current Situation	Currently the compressed air in the portable compressed air units is generated at 7.6 barg. No equipment was identified on site that needed air at 7.5 barg. Around 10% of industrial electricity is used to produce compressed air - though it is not expected to be as high for LSHTM. On average 30% can be saved some at little or no cost. Compressed Air is an expensive resource and it is important not to waste it.			
Opportunity	Air supply pressure should be reduced and could possibly be reduced to 6.5 barg. It would be best practice to reduce the pressure in small increments over time until issues are experienced. Reducing the generating pressure of compressed air by 10% can save 5% of the generating cost. Assume the pressure can be reduced to 6.8 barg then an energy saving of 5% should be achievable to undertake the same tasks. Additionally, conduct a leak survey using an ultra-sonic detector, prioritise leaks by severity and fix. Assume - 7 x 4kW compressors in use for 4 hours per day, five days a week = 7*3*4*261 = 187972 kWh per annum usage (reduce by 7% overall) Total saving = 2,046 kWh			

Opportunity 1.9	**Keppel Street**	**Put water coolers on timer switches**

Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	3,000	£390	£100	0.3
Total	**3,000**	**£390**	**£100**	**0.3**
Current Situation	There are multiple water coolers (assumed 10 for this calculation) used for dispensing drinking water across the site (with an assumed average load of 100W) which is currently operational 24/7.			
Opportunity	Add a plug splitter and plug in timer and put the water chiller off of this circuit as well as the vending machine, interlinking the cooler with the timing programme 23:00-06:00.			

Opportunity 1.10	**Keppel Street**	**Chillers - Implement floating head pressure control on refrigerant chillers**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	24,570	£ 2,336	£2,500	1.1
Total	**24,570**	**£ 2,336**	**£2,500**	**1.1**
Current Situation	The refrigerant chillers currently used static head pressure control. This means they will not be operating optimally during colder weather. LSHTM Facilities Team should check whether the head pressure of all refrigeration system is set too high by comparing the actual head pressure with the expected head pressure based on condenser design and the ambient air temperature.			
Opportunity	Condensing pressure is a function of ambient temperature. Head pressure is controlled by cycling or varying the speed of condensing fans. Implement floating heat pressure control on the refrigerant chillers. It has been assumed that R134a refrigerant at 20 barg can be reduced to 10 barg 50% of the time.			

Tavistock Place

Opportunity 2.1	**Tavistock Place**	**Passive infrared (PIR) sensors in infrequently occupied areas (bathrooms, kitchens, corridors, stairways)**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	5,638	£733	£1,350	1.8
Total	**5,638**	**£733**	**£1,350**	**1.8**
Current Situation	Lighting can be responsible for up to 40% of a building's electricity use. Efficient lighting control systems (such as passive infrared sensor, lux or daylighting sensors) are a major contributor to energy efficiency in industrial/ office / retail /non-residential spaces, ensuring no unnecessary lighting is kept on. Savings on lighting energy consumption are possible with effective lighting controls – the exact amount will depend on a number of factors. There are opportunities across Tavistock Place to install PIR sensors in infrequently occupied rooms (meeting rooms, kitchen, bathrooms, stairways and corridors etc). This would work in conjunction with the reformed central lighting control system. It is estimated that approx. 30 PIRs would provide control for all infrequently occupied spaces in Tavistock Place.			
Opportunity	Fit presence detectors in all infrequently occupied spaces. Lighting controls can ensure that artificial lighting is provided only at the right time, in the right place and in the right quantity. Implementation cost: cost of units (£15 per sensor x 30 units); labour £400 (assumes 2 days) = £850 Energy savings: assume that PIRs turn lighting off in each of 30 rooms for extra 5 hours per day, every working day of the year (261 days) = 5,638 kWh/year. This is conservative and there could be a considerably higher saving.			

Opportunity 2.2	**Tavistock Place**	**Insulate exposed hot pipework, valves, flanges in Plant Room and Calorifier Room**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Natural Gas	11,605	£464	£500	1.1
Total	**11,605**	**£464**	**£500**	**1.1**

Current Situation	Tavistock Place uses low temperature hot water for the primary source of space heating, this is provided from 4 Potterton Paramount 80 gas fired boilers. The Low temperature hot water is generated up to 80°C and circulated through Variable temperature (VT) circuits and Constant temperature (CT) circuits. The boilers and pumps are controlled via a Trend Building Management System (BMS). The system insulation on the heating pipework is generally average, however there are areas in both the Calorifier Room and Boiler Room where insulation is missing. The missing insulation is primarily in the area of valves and pumps, with multiple exposed areas were identified including flanges, valves and pipework. These should be insulated to the same standard as the rest of the heating pipework. The heat loss from uninsulated valves is the equivalent of 1 metre of uninsulated pipe of the same diameter. There is uninsulated two-inch diameter pipe that runs from the hot well to the boiler economiser and around 3m that runs from the economiser to the boiler vessel. This pipework is at >80^{o}C surface temperature.
Opportunity	Insulating hot pipework will reduce losses and improve the heating system efficiency. Insulation to flanges and valves should be installed to allow easy removal and refitting to allow for maintenance. Install insulation on the pipework from the boiler vessel to the calorifier to reduce heat loss. It has been assumed that the pipe surface is 86°C, (measured on the day) the temperature is the boiler house is 20°C (though it was much higher on the day due to the heat loss from the lack of insulation), the boiler operates for 8400 hrs a year, the natural convection coefficient is 5 W/m2K, the boiler is 90% efficient and 80% of the heat loss is saved due to the addition of 25mm of insulation. Energy saved = 25m x 0.05m x 3.14 x 0.005 kW/m2K x (80oC - 20oC) x 8400 hrs x 80% x (1/90%) = 11,605 kWh/yr. Estimated cost of insulation is £20 per meter installed = £345 + contingency = £500

Opportunity 2.3	**Tavistock Place**	**Adjust set point temperature of AHU in data centre**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	21,024	£2,313		Immediate
Total	**21,024**	**2,313**	**0**	**Immediate**

Current Situation	Cooling temperatures within the data centre are set to 19°C and achieving approximately 21°C, as measured during the site visit. The server room was designed to serve the needs of old, larger, servers which require lower temperatures to operate effectively. There is also excess cooling capacity installed to serve legacy equipment. The AC units are operating 24/7, 8,760 hours per annum. The system of 2 x Denco close control downflow units, and 4 x Denco condenser units is estimated to be in the region of 15 kW. Therefore, current consumption is (15 kW x 8760 hours) 131,400 kWh/year.
Opportunity	According to The Carbon Trust, adjusting HVAC set points by just 1°C can reduce energy bills by up to 8%. Increase server room temperature set points to 21°C to achieve temperatures of 23°C. The servers will be able to operate well within their required operational range at this temperature. This will reduce the cooling temperature by 2°C, with associated energy input savings of approximately 16%. Increase the temperature set point for the server room to 24°C. Monitor server temperatures to ensure they are not over-heating.

Opportunity 2.4	**Tavistock Place**	**Avoid dual heating and cooling**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	19,436	£2,527		Immediate
Natural Gas	9,580	£383		Immediate

Total	**29,016**	**2,910**	**0**	**Immediate**
Current Situation	Poor control of heating and cooling is the cause of excessive energy consumption in many commercial and higher education buildings. Good control not only saves energy but also maintains a consistently comfortable environment for building occupants, as well as reducing plant running and maintenance costs. During the survey areas of dual heating and cooling were taking place when both systems are operational in the office areas. These are currently supplied via both VRV cassettes and radiators off the wet system. Heating and cooling operating at the same time in the same space is a poor example of energy management. It is also a no-cost behaviour changes saving that can be easily implemented.			
Opportunity	The VRV units are not often used for heating, with the portable heaters and wet system being preferred. At the time of visiting the thermostatic radiator valves were set to 6 throughout. Ensure all rooms are only supplied via one heating source by isolating the radiator and heating the offices using the HVAC system only. Heating and cooling operating at the same time in the same space is a poor example of energy management. It is also a no-cost behaviour changes saving that can be easily implemented. A general rule of thumb is that for every 1°C the temperature setpoint is reduced a saving of 10% in heating will be achieved.			

Opportunity 2.5	**Tavistock Place**	**Address dysfunctional lighting control system**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	31,098	£4,043		Immediate

Total	**31,098**	**£4,043**	**£0**	**Immediate**
Current Situation	The lighting control system in Tavistock Place is not working correctly. The LSHTM maintenance team acknowledge this. The existing system which governs the light fixtures is time controlled (which is on the face of it sensible given the spaces are consistently occupied) and is set to ensure all lights stays on all the time during occupancy hours. There is no manual control possible of lighting by staff and students in Tavistock Place. During the audit, at least 10 rooms had all lights on and no activity happening in the lecture or meeting rooms.			
Opportunity	By addressing the engineering and systems issues with the lighting control system, and activating manual switches which can allow local control, it is estimated that the time where lighting is needed can be reduced by 20% (therefore 20% savings are possible on lighting costs).			

Opportunity 2.6	**Tavistock Place**	**Install ground source heat pumps (GSHP) and localised point of water heaters**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity				
Natural Gas	267,070	£19,595	£288,000	14.7
Total	**267,070**	**£19,595**	**£288,000**	**14.7**

Current Situation	Natural Gas is used to provide space heating from gas fired low temperature hot water boilers for heating and hot water at Tavistock Place. Natural gas heating will ultimately have to be replaced by heat pumps. There is a need for mechanical design of building services to evolve, particularly to enable lower supply temperatures to ensure heat pumps work efficiently.
Opportunity	Install a GSHP and localised point of water heaters as part of the Tavistock Place redevelopment. In the same way that a pump is used to move a fluid up hill, a heat pump is used to increase the temperature of a low temperature heat source (e.g. air or ground) to that of a high temperature heat sink (e.g. hot water for radiators) using electricity. Ground source heat pumps are very well suited to commercial buildings, especially those which have a need for cooling in summer as well as heating in winter - such as Tavistock Place. Heat from the ground is absorbed at low temperatures into a fluid inside a loop of pipe (a ground loop) that's buried underground. The fluid then passes through a compressor that raises it to a higher temperature, which can then heat water for the heating and hot water circuits of the house. The cooled ground-loop fluid passes back into the ground where it absorbs further energy from the ground in a continuous process as long as heating is required. Assume: - 20% contingency has been built in to CAPEX cost - Ground temperature 9-15°C continuously at 15m depth - GSHP will provide an income through the Government's Renewable Heat Incentive (RHI). Ofgem will pay 9.36 pence per kWh generated every quarter for the next 20 years. A well designed, installed and operated heat pump can be very energy efficient. Over time, as grid electricity is increasingly sourced from renewables, the electricity used by heat pumps will also become lower carbon. It also has a co-benefit of improving local air quality. Individual heat pump providing domestic hot water at 60˚C, which is lower than the current temperatures. The use of low temperature distribution systems and emitters, the method used to generate domestic hot water and the correct installation and commissioning of heat pump systems can all help to deliver low carbon emissions and operational energy costs. Heat pumps should not be seen as direct like-for-like replacements for gas-fired CHP.

Opportunity 2.7	**Tavistock Place**	**Reduce the need for heating and cooling through draught proofing**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	0	£0		
Natural Gas	1,000	£40	£75	1.9

Total	**1,000**	**£40**	**£75**	**1.9**
Current Situation	Air infiltration is an issue at Tavistock Place. Cold air is entering the building around the door that exits to the cafe and other window frames. It was approximately 3mm in width. There are other areas such as vents and windows where draught proofing could be employed			
Opportunity	If the building is draught-free, heating systems don't have to work so hard to achieve the desired ambient temperatures. A brush strip or rubber seal should be applied to the door. • Reduce air infiltration: draught-proof, draught lobbies, doors & windows closed Assume implementation cost: 10 metres of strip costs £20; 1 hour fitting £30 = Total cost £50. This measure will save approximately 1000 kWh of natural gas each year. Payback in 1.3 years.			

Opportunity 2.8	**Tavistock Place**	**Put water coolers on timer switch**		
Energy Input	Annual Energy Saving kWh	Annual Cost Saving	Implementation cost	Payback Years
Electricity	3,000	£390	£100	0.3
Total	**3,000**	**£390**	**£100**	**0.3**
Current Situation	There are multiple water coolers used for dispensing drinking water across the site (with an assumed average load of 100W) which is currently operational 24/7.			

Opportunity	Add a plug splitter to the plug in timer and put the water chiller off of this circuit as well as the vending machine, interlinking the cooler with the timing programme 22:00-06:00.

To discuss any aspect of this report, please call **John Treble** on **01761 419081** or email **John@GreenConsultancy.com**

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