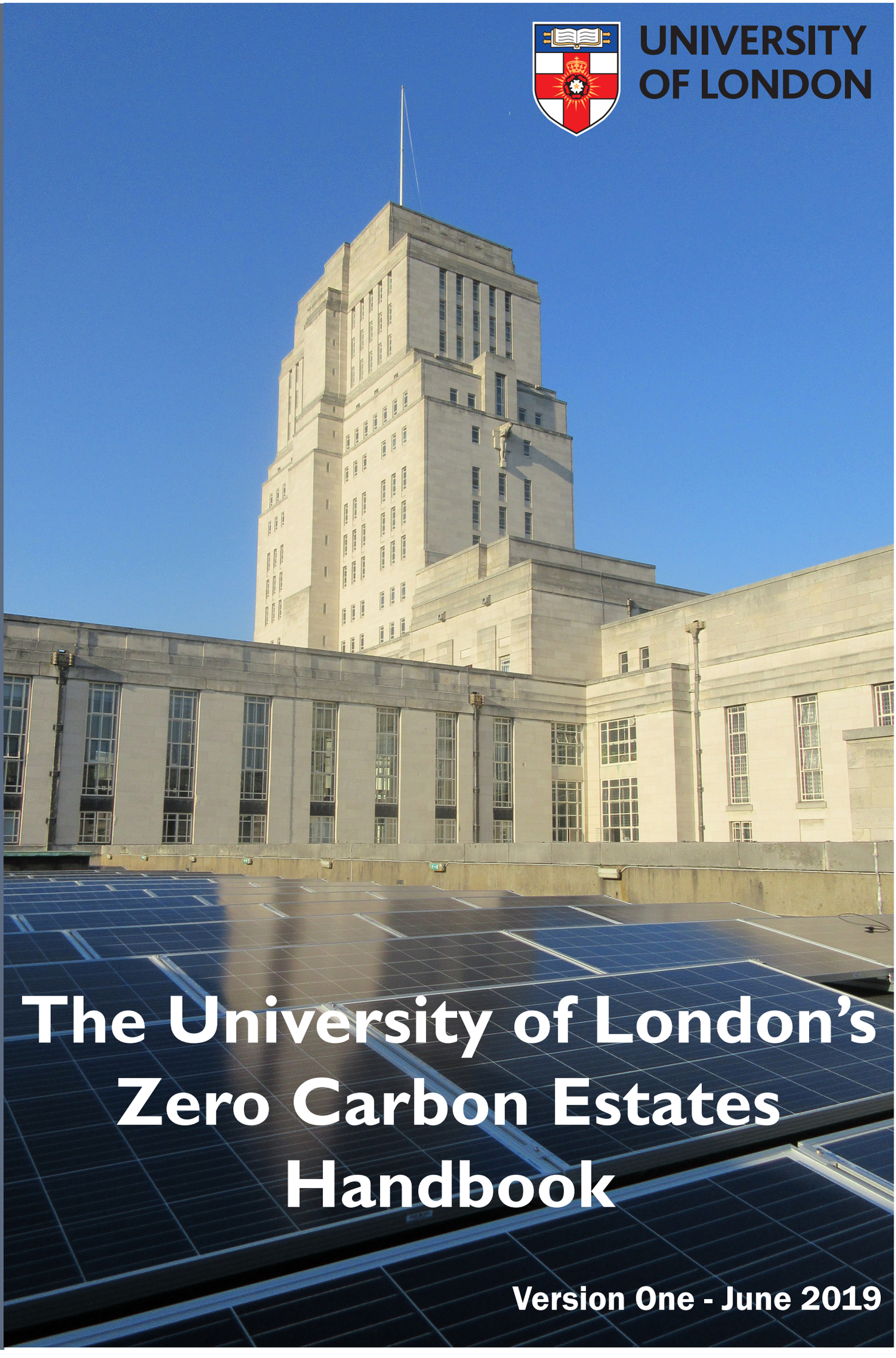

UNIVERSITY OF LONDON

The University of London's Zero Carbon Estates Handbook

Version One - June 2019

The University of London's Zero Carbon Estates Handbook

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Foreword

By John Bailey

Director of Estates at Plymouth Marjon and former Head of Sustainability at University of London

The world is on a precipice. In a special report by the Intergovernmental Panel on Climate Change it states 'limiting global warming to 1.5°C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport and cities. Global net human-caused emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO2 from the air. (IPCC, 2018)'

The University of London aims to lead the Higher Education (HE) sector in responding to the urgent need for action on climate change, bringing together the willing, the innovative and the professional staff and policy makers who will ultimately enact the higher education sector's response to climate change. The first step in this was to invite over 200 people from higher education, local government, architecture and design to Senate House in London to create the foundations for a document that can be used as a tool for guidance in achieving net zero emissions in the built environment.

This document is a starting point and should be improved, expanded and refined as our knowledge, ambition and ability to achieve zero carbon grows. It is envisaged that further events will take place, more case studies will emerge and more collaboration in tackling climate change will lead to this becoming an increasingly powerful tool for estates and sustainability professionals.

The University of London has a long history of being a leader in many aspects of development in the Higher Education Sector. It is the 3rd Oldest University in England and many Universities across the country started off offering University of London degrees.

We have continued to innovate and address the key challenges facing our country and communities that our academics work and in this publication we feel that we are doing our bit to address the biggest challenge facing humanity at the moment, that is the creation of a sustainable way of living and protecting our planet.

I would like to thank all the organisations and individuals who attended the Zero Carbon Challenge event and whose knowledge contributed to our zero carbon target and the information contained within this handbook.

We have started on a journey to Zero Carbon and adopted a target date of 2036, when the University will be 200 years old. We hope this work will go a long way toward us and others flourishing in the next 200.

Introduction

This document aims to tool up the UK & Ireland's higher education professionals, to consider how to influence their universities on the drive toward zero carbon. It focuses on considerations for driving down universities' carbon emissions through the built environment. It is presented in four sections:

Following the introduction and context, the first main section draws together the lessons from the **University of London's Zero Carbon Challenge event**. It details the zero carbon interventions that were recommended for five building types, including refurbishments and new builds. It is laid out so it can be incorporated into an invitation to tender to ensure zero carbon approaches are included when universities go to market with capital projects.

Section two applies the lessons from the Zero Carbon Challenge event to the University of London, publishing the first iteration of the University's zero carbon strategy. The strategy has not yet been formally approved, however the University hopes to improve it and adopt it in the coming months.

Section three is the yellow pages for zero carbon services. It lists the details and contact information of all the architects, consultants and companies that attended the Zero Carbon Challenge event.

Section four lies outside of this document. It is an excel calculator which determines the net present value of carbon reduction interventions. It is intended to help institutions build the business case for achieving zero carbon.

While this document has been created for the University of London's estate, it is intended to be useful for all building owners, developers, architects and designers and we hope will be utilised, added to and improved. The document is publicly available, we only ask that you acknowledge its use and keep us informed of any changes and improvements you make to it.

Please contact us at: sustainability@london.ac.uk

Context

The Global Challenge

In December 2015, the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change set out an ambition for the countries of the world to limit global warming to 1.5 °C. Despite this, countries have been slow to set science based targets that would meet the ambition of the COP21 Paris Agreement.

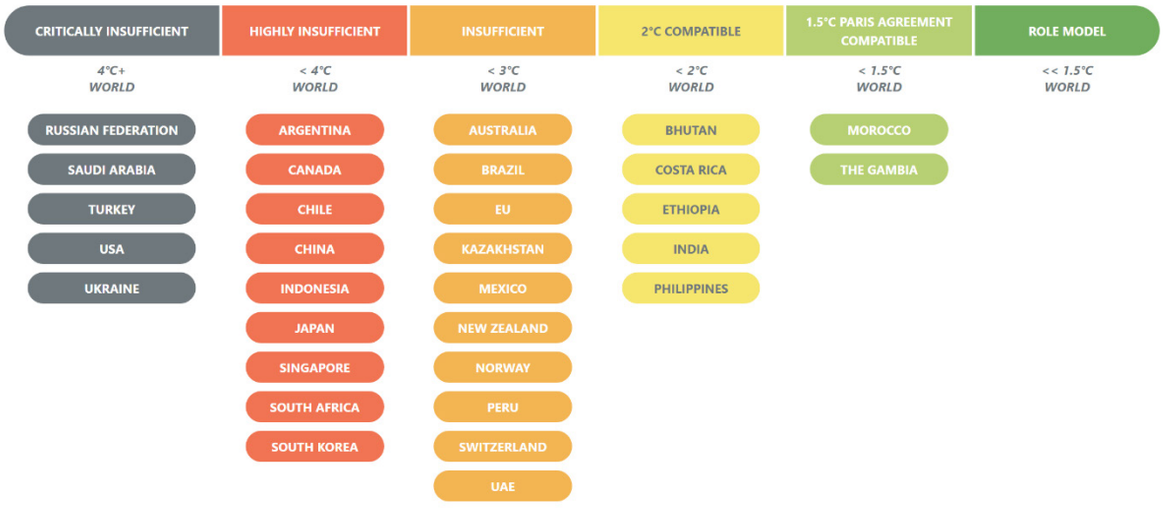

Figure 1: Countries Policies Rated Against the COP21 Paris Agreement (climateactiontracker.org)

It is clear that while politicians and policy makers are willing to make bold statements about ensuring global warming policies are strong enough to respond to the problem, in practice the policies implemented on the ground do not currently go far enough. Globally, organisations, businesses, cities and communities will need to pick up the slack and deliver a significant response in cutting carbon emissions.

The Climate Action Tracker (climateactiontracker.org) is an independent scientific analysis by three research organisations which has mapped national policy against various scientific projections of global warming. Their table shown in Figure 1 below demonstrates how far short current global policy is from meeting the COP21 target.

UK & London

In 2008 the UK government passed the Climate Change Act, which commits the UK to achieving an 80% reduction in carbon emissions by 2050 compared to 1990 levels.

More recently, in May 2018 the Greater London Authority (GLA) released the London Environment Strategy, London's first integrated environment strategy. The document calls for London to be a zero carbon city by 2050, with all new buildings being zero carbon by 2019.

However, drivers for change are not only coming from government and local authorities. Following the actions of the Extinction Rebellion and the Global School Strike for Climate led by Greta Thunberg, pressure on the government and institutions to take decisive action on climate change is growing. In light of this the UK Parliament, the GLA and numerous towns, cities and institutions across the UK have declared a climate emergency. However, there still remains no agreed definition of what this means, with different organisations working to ward their own carbon neutral aims.

UK Universities

With the UK Government having ratified the COP21 agreement, UK Universities need to prepare to be zero carbon by 2050. The University of London, and the HE sector has a responsibility, not only to meet the targets and aims set out by COP21, but to also lead as a sector, demonstrating to the students and academics living, learning and teaching in our campuses that the sustainable future we require is achievable.

The HE sector in the UK emits 1.949m tCO2e from its estates and operations and has over 1.946m students enrolled (Higher Education Statistics Agency (HESA), 2018). The UK has many of the world's top universities (Times Higher Education, 2016) and a huge potential to influence the generations that will be steering businesses, governments and organisations towards the global 2050 targets. Setting a strong example now, in the way universities approach reaching zero carbon has the potential to ripple out into society.

'Across the sector there is a sustained level of capital expenditure which continued to exceed £3bn in the year 2016/17' (AUDE, 2018). Assuming the current growth and expenditure continues, this means that UK Universities will be investing £30-50bn on their estates over the next 10 years.

It is vital that this capital spend contributes towards zero carbon estates and does not worsen the effects of climate change.

The HE sector is particularly well positioned to respond to the challenges of investing in their estates. Across the sector, many universities are the owners, developers, occupiers and operators of their buildings. This is in contrast to many businesses that lease their premises and developers who are often building to sell and have little motivation to see the benefits of reducing carbon (i.e. lower utility bills and operating costs). Universities are much more able to take into consideration the long-term benefits that zero carbon buildings are able to bring. It is also likely they will see the cost benefit of investing realised many times over during the building's lifetime.

This puts universities in a unique position to lead the country and the globe on the path toward zero carbon.

Low Carbon Building Design Requirements

Introduction

This document is intended to be included with invitations to tender for capital projects on the University of London's estate. Including both new builds and refurbishments.

It outlines the reduction in energy consumption each refurbishment is required to achieve and the low level of energy consumption each new build needs to achieve for the University to reach its target of net zero operational carbon by 2036.

It also outlines the design approaches and features the University expects contractors to consider in their tenders in order to achieve the required low energy demand. For each design approach listed, a reference is given to University of Oxford's Sustainability Design Guide where further information on each concept can be found.

Finally, this section provides the example of at least one comparable project which has achieved the required level of carbon reduction for each building type.

If you would like an editable version of this document to include in your own invitations to tender, please contact sustainability@london.ac.uk.

Refurbishment Design Requirements

Heritage Assets

Heritage assets are considered to be the listed buildings on the University of London estate.

Any heritage asset is unlikely to receive any further refurbishment before 2036. The University of London's target for refurbishments of Heritage Assets is to achieve an 88% reduction in its energy consumption and carbon emissions after refurbishment.

Requirements

- Maintain or be sympathetic toward the external and internal aesthetics in line with the building's specific heritage listing.
- Achieve Passivhaus Enerphit certification.
- Reduce the long-term deterioration of the building fabric.
- Provide quality spaces appropriate for the building's main usage.
- Ensure a comfortable environment for the building's users now and in future warmer climates.
- Be flexible and able to integrate with future energy generation sources.

All refurbishments of Heritage Assets must aim to achieve the Passivhaus Enerphit standard. Where this is not possible, the contractor must show that this approach has been considered, show why it is not possible, then incorporate as many of the design features listed below as is achievable within the building's context. Further to that the project managers will need to include business case analysis of the options and demonstrate clearly why the Enerphit standard is not achieveable.

The refurbishment must also aim to reduce the embodied carbon in the project through considering the whole life carbon of chosen materials, transportation and the proposed building works and techniques. There remains limited guidance on achieving whole life zero carbon, however the Enterprise Centre at the University of East Anglia is an examplar project in this regard.

Design Features

- Where possible, capitalise on the buildings design to maximise use of natural light.
- Create a new high performance air tight envelope around the building, and where this isn't possible, upgrade the existing fabric whilst retaining its character.
- Increase and improve insulation of the building's walls, floor and roof.
- Reduce thermal bridging throughout the building.
- Minimise heat loss through windows by installing triple, double or secondary glazing. Potentially dismantle original windows and then reconstruct with secondary glazing.
- Install Mechanical Ventilation Heat Recovery (MVHR).
- Ensure all required lighting is provided by LEDs.
- Ensure all lights are operated by Passive Infrared (PIR) sensors
- Remove gas fired boilers and heat the building using ground or air source heat pumps. Where this is not possible, install high efficiency boilers with flue gas heat recyclers.
- Utilise solar PV and solar thermal energy where possible. If necessary hiding behind facades to preserve the building's external aesthetic.
- Install battery storage.
- Utilise SMART controls.
- Install screens to visualise energy use to users to encourage behaviour change.
- Reduce the refurbishment's embodied carbon through the choice of materials, techniques and how the refurbishment is carried out.
- Refurbish existing furniture, and ensure all new furniture is of high quality, built to last past 2036 using sustainably sourced materials and is easy to maintain in-house.
- Install and utilise rainwater harvesting.
- Where possible, create accessible rooftop gardens or green roofs.
- In residential buildings, design the building as a communal space. Providing TVs and entertainment solely in communal spaces to reduce energy demand.
- Ensure quality Post Occupancy Evaluation (POE) for at least one year.

The University of Oxford's Sustainability Design Guide References

- Passivhaus – 2.1 pg 5
- Passivhaus/Fabric Performance – 2.3 pg 5-7
- Air tightness – 2.4 pg 8
- Thermal comfort – 2.6 pg 10
- Ventilation and Cooling – 2.7 pg 11
- Controls – 2.8 pg 12
- Renewables – 2.12 pg 16
- Water – 2.13 pg 17
- Materials and Equipment – 2.14 pg 18
- Building User Guide – 2.22 pg 26
- Historic Buildings – 2.23 pg 27

Successful Case Studies

- New Court, Trinity College, Cambridge

Georgian Properties

Any Georgian building is unlikely to receive a major refurbishment again before 2036. The University of London's target for refurbishments of Georgian properties is to achieve at least an 80% reduction in their energy consumption and carbon emissions.

Requirements

- Maintain or be sympathetic toward the building's internal and external Georgian aesthetic in line with the building's heritage listing.
- Achieve Passivhaus Enerphit certification.
- Reduce long term deterioration of the building's fabric.
- Provide quality spaces appropriate for the building's main usage.
- Ensure a comfortable environment for the building's users now and in future warmer climates.
- Be flexible and able to integrate with future energy generation sources.

All refurbishments of Georgian properties must aim to achieve the Passivhaus Enerphit standard. Where this is not possible, the contractor must show that this approach has been considered, show why it is not possible, then incorporate as many of the design features listed below as is achievable within the building's context. Further to that the project managers will need to include business case analysis of the options and demonstrate clearly why the Enerphit standard is not achieveable.

The refurbishment must also aim to reduce the embodied carbon in the project through considering the whole life carbon of chosen materials, transportation and the proposed building works and techniques. There remains limited guidance on achieving whole life zero carbon, however the Enterprise Centre at the University of East Anglia is an examplar project in this regard.

Design Features

- Capitalise on the building's design to maximise use of natural light.
- Create a new high performance air tight envelope around the building, where this isn't possible, upgrade the existing fabric whilst retaining the building's Georgian character.
- Increase and improve insulation of the building's walls floor and roof.
- Reduce thermal bridging throughout the building.
- Minimise heat loss through sash windows by installing triple, double or secondary glazing. Where necessary, dismantle the original windows and then reconstruct with secondary glazing.
- Install Mechanical Ventilation Heat Recovery (MVHR).
- Ensure all required lighting is provided LEDs.
- Ensure all lights are controlled by Passive Infrared (PIR) Sensors.
- Utilise solar PV and solar thermal energy, angled behind facades to maximise energy generation and retain external aesthetic.
- Utilise SMART controls
- Where possible remove gas fired boilers and heat the building using air or ground source heat pumps. Where this is not possible, install high efficiency boilers with flue gas heat recyclers.
- Remove gas appliances and replace with electric.
- Install screens to visualise energy use and encourage occupants' behaviour change.
- Reduce the refurbishment's embodied carbon through the choice of materials, techniques and how the refurbishment is carried out.
- Refurbish existing furniture, and ensure all new furniture is of high quality, built to last past 2036 and is easy to maintain in-house.
- Install and utilise rain water harvesting.
- Install green roofs or accessible rooftop gardens.
- Ensure quality Post Occupancy Evaluation (POE) is carried out for at least one year.

- In residential buildings, design the building as a communal space. Providing TVs and entertainment solely in communal spaces to reduce energy demand.

University of Oxford's Sustainability Design Guide References

- Passivhaus/Fabric Performance – 2.3 pg 5-7
- Air tightness – 2.4 pg 8
- Thermal comfort – 2.6 pg 10
- Ventilation and Cooling – 2.7 pg 11
- Controls – 2.8 pg 12
- Renewables – 2.12 pg 16
- Water – 2.13 pg 17
- Materials and Equipment – 2.14 pg 18
- Building User Guide – 2.22 pg 26

Successful Case Studies

- 119 Ebury Street, Grosvenor Estate

Modern Buildings

Any existing modern building (post-19th century) is unlikely to have more than one major refurbishment before 2036. The University of London's target for refurbishments of odern buildings is to achieve between 69% and 76% reduction in their energy consumption and carbon emissions.

Requirements

- Achieve Passivhaus Enerphit Certification.
- Reduce long term deterioration of the build's fabric.
- Provide quality spaces appropriate for the building's main usage.
- Ensure a comfortable environment for the building's users now and in future warmer climates.
- Be flexible and able to integrate with future energy generation sources.

All modern building refurbishments must aim to achieve Passivhaus Enerphit certification. Where this is not possible, the contractor must show that this approach has been considered, show why it is not possible, then incorporate as many of the design features listed below as are achievable within the building's context. Further to that the project managers will need to include business case analysis of the options and demonstrate clearly why the Enerphit standard is not achieveable.

The refurbishment must also aim to reduce the embodied carbon in the project through considering the whole life carbon of chosen materials, transportation and the proposed building works and techniques. There remains limited guidance on achieving whole life zero carbon, however the Enterprise Centre at the University of East Anglia is an examplar project in this regard.

Design features

- Capitalise on the building's design to maximise use of natural light.
- Install solar shading which reduces solar heat gain during the summer and maximises it during the winter.
- Create a new high performance air tight envelope around the building, where this isn't possible, upgrade the existing fabric where achieveable.
- Increase and improve insulation of the building's walls floor and roof.
- Reduce thermal bridging throughout the building.
- Minimise heat loss through windows by installing triple or double glazing, prioritising north facing and exposed facades.
- Install a Mechanical Ventilation Heat Recovery (MVHR) system to ensure user comfort and reduce heat loss.
- Ensure all required lighting is provided LEDs.
- Ensure all lights are controlled by Passive Infrared (PIR) Sensors
- Install solar PV and solar thermal energy to appropriate facades and south facing roofs.
- Utilise SMART controls.
- Remove gas fired boilers and heat the building using air or ground source heat pumps. Where this is not possible, install high efficiency boilers with flue gas heat recyclers.
- Remove gas appliances and replace with electric.
- Install screens to visualise energy use and encourage occupants' behaviour change.
- Reduce the refurbishment's embodied carbon through the choice of materials, techniques and how the refurbishment is carried out.
- Refurbish existing furniture, and ensure all new furniture is of high quality, built to last past 2036 and is easy to maintain in-house.
- Install and utilise rain water harvesting.
- Install green roofs or accessible rooftop gardens.
- In residential buildings, design the building as a communal space. Providing TVs and entertainment solely in communal spaces to reduce energy demand.

- Install gym equipment which collects kinetic energy and use it to power the building.
- Ensure quality Post Occupancy Evaluation (POE) for at least one year.

University of Oxford's Sustainability Design Guide References

- Passivhaus – 2.1 pg 5
- Passivhaus/Fabric Performance – 2.3 pg 5 -7
- Thermal Comfort – 2.6 pg 10
- Ventilation and cooling – 2.7 pg 11
- Controls – 2.8 P. 12
- Renewables – 2.12 pg 16
- Water – 2.13 pg 17
- Biodiversity and Landscaping – 2.18 pg 22

Successful Case Studies

- Erneley Court, Manchester
- Cedar Court, Glasgow

New Builds Design Requirements

Academic Buildings

Any new build is unlikely to receive a major refurbishment before 2036 therefore they need to be fit for 2036 today. All new academic buildings will aim to achieve zero operational carbon zero whole life / embodied carbon.

Requirements

- Achieve Passivhaus certification.
- Ensure a comfortable environment for the building's users now and in future warmer climates.
- Provide flexible use spaces allowing lectures, group work, solo study and research.
- Be prepared to integrate learning technologies of the future.
- Be flexible and able to integrate with future energy generation sources.

All new builds must achieve Passivhaus certification. Where this is not possible, the contractor must show that this approach has been considered, show why it is not possible, then incorporate as many of the design features listed below as are achievable within the building's context. Further to that the project managers will need to include business case analysis of the options and demonstrate clearly why the Enerphit standard is not achieveable.

The development must also aim to reduce the embodied carbon in the project through considering the whole life carbon of chosen materials, transportation and the proposed building works and techniques. There remains limited guidance on achieving whole life zero carbon, however the Enterprise Centre at the University of East Anglia is an examplar project in this regard.

Design features

- Ensure the building has a low form factor.
- Consider angular blocks and tiered design to aid natural ventilation and cooling.
- Ensure an orientation which capitalises on solar gain without overheating the building and reduces heat losses.
- Install solar shading which reduces solar heat gain during the summer and maximises it during the winter.
- Install high levels of quality insulation in the buildings walls, floor and roof.
- Minimise heat loss through windows by installing triple glazing, prioritising north facing and exposed facades.
- Design out thermal bridges.
- Create a high performance air tight envelope around the building.
- Install screens to visualise energy use to users, encouraging behaviour change.
- Install a Mechanical Ventilation Heat Recovery (MVHR) system to ensure user comfort and reduce heat losses.
- Ensure all required lighting is provided LEDs.
- Ensure all lights are controlled by Passiv Infrared (PIR) Sensors.
- Install solar PV and solar thermal energy to appropriate facades and south facing roofs.
- Heat the building using air or ground source heat pumps.
- Do not install gas appliances, only electric.
- Install a geothermal loop to release excess heat during the summer and bring in needed heat during the winter.
- Install screens to visualise energy use and encourage occupants' behaviour change.
- Reduce the refurbishment's embodied carbon through the choice of materials, techniques and how the refurbishment is carried out.
- Utilise off-site prefabricated construction techniques.

- Utilise second hand furniture and ensure all new furniture is of high quality, built to last past 2036 and is easy to maintain in-house.
- Install and utilise rain water harvesting.
- Install green roofs or accessible rooftop gardens.
- Install and utilise rain water harvesting.
- Ensure quality Post Occupancy Evaluation (POE) is carried out for at least one year.
- Install gym equipment which collects kinetic energy and use it to power the building.
- Install accessible rooftop gardens to reduce the urban heat island effect.

University of Oxford's Sustainability Design Guide References

- Passivhaus – 2.1 pg 5
- Thermal Comfort – 2.6 pg 10
- Ventilation and cooling – 2.7 – pg 11
- Renewables – 2.12 - pg 16
- Water – 2.13 - pg 17
- Controls – 2.8 - pg 12
- Water – 2.18 - pg 17
- Biodiversity and Landscaping – pg 22

Successful case studies

- University of East Anglia, Enterprise Centre

Residential Buildings

Any new build is unlikely to receive a major refurbishment before 2036, therefore they need to be fit for 2036 today. All new residential buildings will aim to achieve zero operational carbon zero whole life / embodied carbon.

Requirements

- Achieve Passivhaus certification
- Provide a comfortable living, working and social environment for students now and in future warmer climates.
- Utilise space intelligently to allow for a variety of rent costs within the building.
- Be flexible and able to integrate with future energy generation sources.
- Achieve 100% space utilisation.

All new builds must achieve Passivhaus certification. Where this is not possible, the contractor must show that this approach has been considered, show why it is not possible, then incorporate as many of the design features listed below as are achievable within the building's context. Further to that the project managers will need to include business case analysis of the options and demonstrate clearly why the Enerphit standard is not achieveable.

The development must also aim to reduce the embodied carbon in the project through considering the whole life carbon of chosen materials, transportation and the proposed building works and techniques. There remains limited guidance on achieving whole life zero carbon, however the Enterprise Centre at the University of East Anglia is an examplar project in this regard.

Design features

- Ensure the building has a low form factor.
- Consider angular blocks and tiered design to aid natural ventilation and cooling.
- Ensure an orientation which capitalises on solar gain without overheating the building and reduces heat losses.
- Install solar shading which reduces solar heat gain during the summer and maximises it during the winter.
- Install high levels of quality insulation in the buildings walls, floor and roof.
- Minimise heat loss through windows by installing triple glazing, prioritising north facing and exposed facades.
- Design out thermal bridges.
- Create a high performance air tight envelope around the building.
- Install screens to visualise energy use to users, encouraging behaviour change.
- Install a Mechanical Ventilation Heat Recovery (MVHR) system to ensure user comfort and reduce heat losses.
- Ensure all required lighting is provided LEDs.
- Ensure all lights are controlled by Passiv Infrared (PIR) Sensors.
- Install solar PV and solar thermal energy to appropriate facades and south facing roofs.
- Heat the building using air or ground source heat pumps.
- Do not install gas appliances, only electric.
- Install a geothermal loop to release excess heat during the summer and bring in needed heat during the winter.
- Install screens to visualise energy use and encourage occupants' behaviour change.
- Reduce the refurbishment's embodied carbon through the choice of materials, techniques and how the refurbishment is carried out.
- Utilise off-site prefabricated construction techniques.
-

Utilise second hand furniture, and ensure all new furniture is of high quality, built to last past 2036 and is easy to maintain in-house.

- Install and utilise rain water harvesting.
- Install green roofs or accessible rooftop gardens.
- Install gym equipment which collects kinetic energy and use it to power the building.
- Install accessible rooftop gardens to reduce the urban heat island effect.
- Design the building as a communal space. Providing TVs and entertainment solely in communal spaces to reduce energy demand.
- Ensure quality Post Occupancy Evaluation (POE) is carried out for at least one year.

University of Oxford's Sustainability Design Guide References

- Passivhaus – 2.1 pg 5
- Thermal Comfort – 2.6 pg 10
- Ventilation and cooling – 2.7 pg 11
- Renewables – 2.12 pg 16
- Water – 2.13 pg 17
- Controls – 2.8 pg 12
- Biodiversity and Landscaping – 2.18 pg 22

Successful case studies

- Corby Housing Project

The University of London's Draft Zero Carbon Strategy

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Introduction

The world is on a precipice. The special report from the Intergovernmental Panel on Climate Change states, "limiting global warming to 1.5°C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050." (IPCC, 2018)

The Greater London Authority (GLA) has echoed this appeal in the 2018 London Environment Strategy. They aim for London to be a zero carbon city by 2050 by promoting better insulated, more efficient buildings, more efficient, cleaner heating systems and by ensuring all new developments are zero carbon from 2019.

To avoid the catastrophic impacts of breaking the 1.5°C threshold, it is clear all organisations and businesses must act now. However, the University of London has a large estate with a varied building stock, made up of historic Grade II* listed, Georgian, post war and brutalist buildings. So how can the University respond to this challenge?

That is the aim of this strategy document, to map out the University of London's route to net zero operational carbon. Showing how it can be achieved by the 200th anniversary of the University's foundation in 2036, through increasing buildings' energy and fabric efficiency, removing the data centre, upgrading the district heating network and improving behaviour change.

As well as achieving this ambitious target, the University aims to lead a path nd facilitate it for others. This strategy is part of a suite of documents and tools which the University of London is providing open source to all universities, businesses and estates so the knowledge the University has gained can be shared to increase its impact. This information is shared in the knowledge that we can only make a tangible difference to the future of our planet if we all act together.

Defining the University's Zero Carbon Target

In spite of the attention the necessity for carbon emissions reduction is currently receiving, there remain multiple definitions of zero carbon. This section outlines the definition the University of London has adopted, sets the target's scope and defines the University's drivers for undertaking this work.

The University's Zero Carbon Target

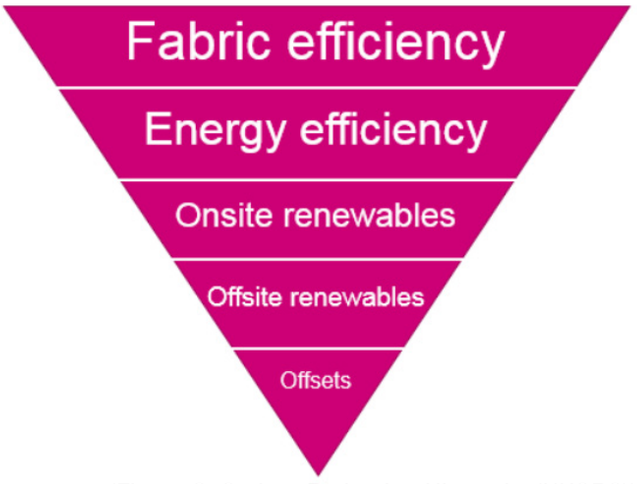
For the University of London to achieve net zero operational carbon across its London estate by 2036.

Net Zero Operational Carbon Definition

The University of London has adopted the UK Green Building Council's (UKGBC) two tier definition of zero carbon, which defines net zero operational carbon as:

"When the amount of carbon dioxide emissions associated with a building's operational energy on an annual basis is zero or negative. Using the World Green Building Council's definition, a net zero operational carbon building is highly energy efficient and fully powered from on-site and/or off-site renewable energy sources and offsets."

The definition includes a hierarchy of how net zero operational carbon should be achieved, which the University of London has also adopted.



(Figure 2: Carbon Reduction Hierarchy (UKGBC))

This means that by 2036 all of the University of London's buildings should create zero CO2 emissions on an annual basis from their lighting, ventilation, hot water, appliances, heating and cooling. This should be achieved in line with the hierarchy shown in figure two. Promoting fabric and energy efficiency and only using minimal offsets once all means of on and offsite renewable energy production have been exhausted.

At the time of writing this report it has been decided that achieving net zero operational carbon is the right target for the University of London. This is because there is a wealth of knowledge of how it can be achieved in the fields of Sustainability and the Built Environment. Furthermore, the standard has been achieved both with and without the use of offsets on multiple individual buildings.

However, the UKGBC's definition of zero carbon also includes a second tier, net zero whole life carbon, which they define as:

"When the amount of carbon emissions associated with a building's embodied AND operational impacts over the life of the building, including its disposal, are zero or negative."

It has been decided that this definition of zero carbon should not be adopted by the University of London at this stage as there is not yet sufficient understanding or existing examples of how to achieve this goal in practice. However, this should be reappraised each time this strategy is updated. Once there are sufficient successful examples of net zero whole life carbon buildings, the scope of this strategy should be expanded and this definition adopted. This strategy will be updated every five years.

Scope

This strategy focuses solely on the University of London's scope one and scope two carbon emissions.

At this stage, the University have not included scope three emissions within this target. These emissions are understood to be more difficult to reduce as although the University can influence

them they cannot directly reduce them.

However, as scope three emissions are generally recognised to be considerably larger than organisation's scope one and two emissions, the University recognises the importance of reducing them. Therefore, the University will firstly work to quantify their scope three emissions and work with the HE sector to create a mutually agreed definition of which emissions are and are not included in scope three. The University will then report on and work to reduce these emissions.

The physical scope of the strategy is the same as the buildings which are covered by the University's Environmental Management Strategy (EMS). This covers the buildings in the Bloomsbury estate, where the University of London provides the FM services including the Egham Library Depository and the accommodations owned and operated by the University.

The scope will be reassessed at each review of the strategy. Details of this strategy's review structure can be found on page 26 of this document.

Drivers

While the environmental benefits of achieving net zero operational carbon are clear, there are multiple co-benefits to achieving this target. The University's key drivers in setting this ambitious aim are as follows.

- **Environmental:** By reducing CO2 emissions, the University will play its part in averting or reducing the worst effects of climate change.
- **Comfort and wellbeing:** If approached correctly, low carbon buildings achieve very high comfort levels, which have been proven to improve the wellbeing of their occupants.
- **Financial:** This reduction in CO2 emissions will be achieved though reducing the University's energy consumption. This reduction in consumption will in turn reduce the University's annual gas and electricity bills. With energy costs expected to continue rising, modelling suggests that by 2036 the University will have saved up to £15.6m on energy.
- **Reputational:** With students becoming increasingly guided by their environmental principles and many other Universities working to reduce their emissions, the reputational risk of not reducing carbon emissions at the University of London is great. Conversely, the potential reputational benefit of continuing to lead that way and share best practice on achieving zero carbon in the higher education sector is immense.

Baseline Emissions

2010 Baseline

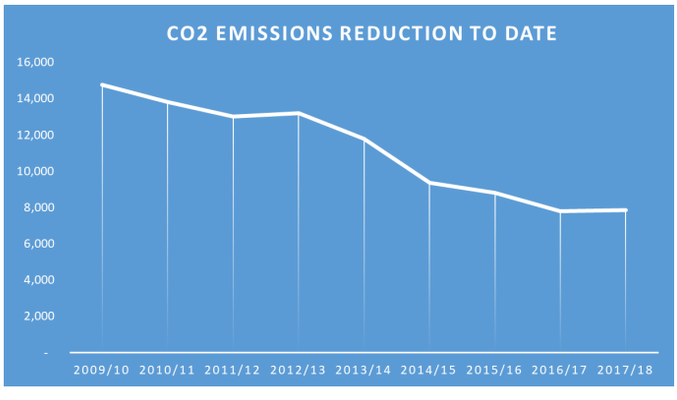
The University's baseline emissions are from the 2009/10 academic year. This year was chosen as it is the earliest year for which the University has reliable, complete and readily accessible data. This is the baseline against which the University's progress to date on reducing carbon emissions has been measured.

Consumption data is gathered using the T-mac server and converted to CO2 emissions using the Department for the Environment Farming and Rural Affairs (DEFRA) conversion factors. In 2009/10 the University of London emitted 14,766 tonnes of carbon dioxide (CO2).

The University's Progress to Date

As of the 2017/18 academic year, the University has achieved a 47% reduction in carbon emissions against the 2009/10 baseline. This has reduced the annual emissions to 7,866 tonnes of CO2.

This 47% reduction was achieved through space



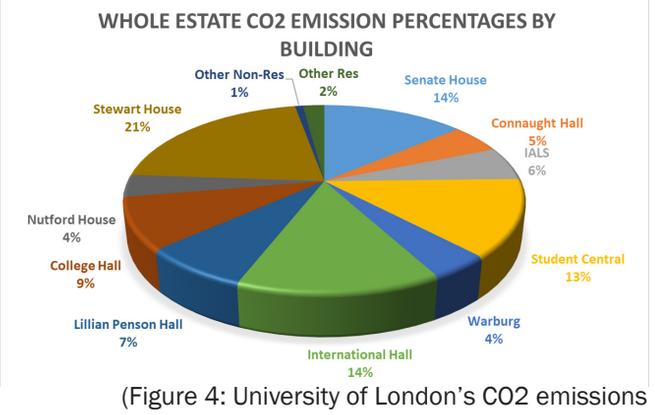
(Figure 3: University of London's CO2 emissions reductions 2009/10 – 2017/18)

rationalisation, voltage optimisation, insulation of plant, installation of new boilers, behaviour change and the decarbonisation of the grid.

Emissions Breakdown

To guide future energy conservation and emission reduction projects, an assessment of the estate was carried out using the metered data from 2017/2018 to ascertain how emissions breakdown across the major buildings on the estate.

Broadly, it found that 59% of emissions came from non-residential buildings and the remaining 41% of emissions were produced by the residential estate. When looked at in more detail, the assessment found that emissions broke down across the estate as shown in figure four.
As well as showing the more energy intensive



(Figure 4: University of London's CO2 emissions Breakdown)

buildings which should be assessed in the more immediate term, it also exposed the impacts of certain activities and infrastructure. For instance Stewart House has 50% higher emissions than the next two buildings. Much of these emissions are produced by the University's two data centres which are housed there and make up 47% of the building's annual emissions. Further to that, Student Central has the third largest emissions, 45% of which are produced through heating the swimming pool.

This understanding has helped to guide the approach and order of the works carried out to achieve the net zero operational carbon target.

Emissions Targets

To test the feasibility and find the best approach to achieve zero carbon by 2036, three emissions reduction scenarios were modelled.

For all the modelling, the continued decarbonisation of the grid and the inflation of energy prices were not taken into account. Although these areas will influence the University's annual CO2 emissions and energy costs, the University does not have any control over their progress. However, the Department for Business Energy and Industrial Strategy (BEIS) project that by 2035 CO2 emissions from the grid will have reduced by 72% - 80%. Also, based on an analysis of the inflation of the University's energy costs between 2008 and 2018, energy prices could be up to 61% higher by 2036.

The following section contains details of the three models that were produced.

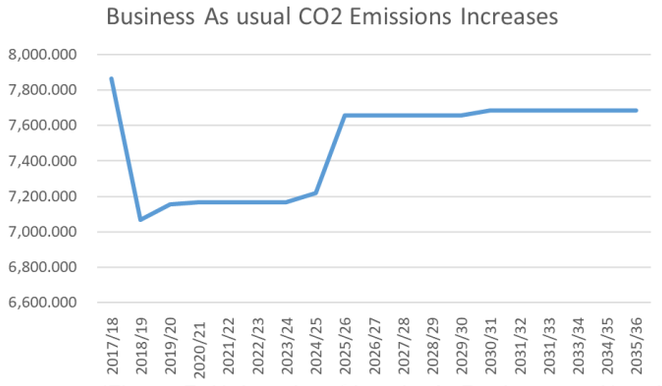
Modelling

Scenario One: Business as usual emissions to 2036

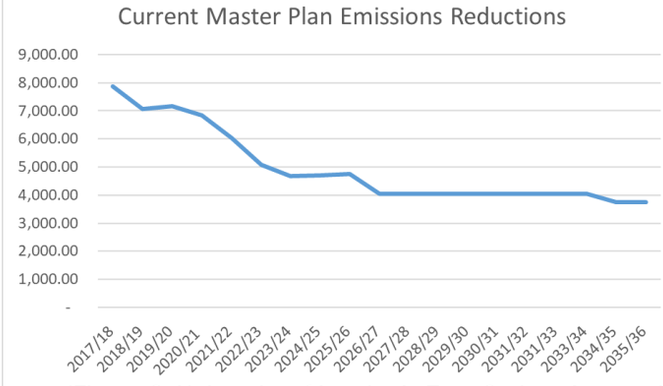
This scenario assumes that:

- the University's ongoing Energy Performance Contract (EPC) is completed;
- all the leased properties that are set to return to the University come back without any carbon saving measures carried out;
- all the planned new builds are constructed without any specific measures to reduce their carbon emissions.

If the University were to take this approach, annual CO2 emissions would reach a low of 7,066t CO2 (52% reduction) in 2018/19. Then, as leased properties return to the University and new developments are completed, annual emissions would increase to 7,684t CO2 (48% reduction) in 2030/31 and plateau there. By 2036, this approach would cumulatively cost the University £35,287,602 in energy bills.



(Figure 5: University of London's Business as Usual CO2 emissions (2017/18 – 2035/36))



(Figure 6: University of London's Zero Carbon Approach to the Current Master Plan CO2 emissions (2017/18 – 2035/36))

Scenario Two: Zero Carbon Approach to the Current Master Plan

This scenario is based on taking a low carbon approach to the implementation of the University's 2016 – 2036 master plan. To ascertain the emissions reductions each master plan project could achieve, the model applies the emissions reductions achieved on existing Passivhaus and Enerphit standard developments on similar building types and applies the same percentage savings to the University's master plan projects. The savings for each building were then phased in the timeframe at which they are expected to be completed.

This scenario also includes the returning buildings from scenario one, but assumes each building's refurbishment achieves carbon savings due to their refurbishment in the Master Plan. It also includes the expected savings from reducing the carbon intensity of the University's district heating network and removing the data centre.

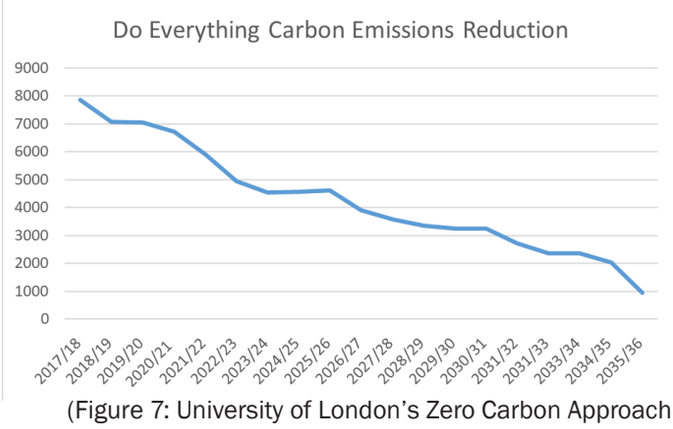
For a full list of the carbon saving interventions included in this scenario see appendix one on page 26.

If the University were to take this approach, a 76% reduction in carbon emissions would be achieved by 2036, leaving annual emissions of 3,734t CO2. Up until 2036, this approach would cumulatively cost the University £22,748,019 in energy bills, saving over £12.5m when compared to Scenario one.

Scenario three: Zero Carbon Estate

As well as including all of the low carbon interventions and developments included in scenario two, this scenario looked at the emissions breakdown across the University's estate in the previous section and included further developments across the 17 years of the Master Plan to further reduce the University's carbon emissions.

For a full list of the interventions included in this scenario see appendix two on page 27.



(Figure 7: University of London's Zero Carbon Approach to the expanded Master Plan CO2 emissions (2017/18 – 2035/36))

If the University were to take this approach, a 93% reduction in carbon emissions would be achieved by 2036, leaving annual emissions of 961t CO2. Up until 2036, this approach would cumulatively cost the University £19,621,740 in utilities bills, saving over £15.5m when compared to scenario one.

Having carried out this assessment, it is clear that the University should progress with scenario three. This scenario will create the greatest level of carbon emission reductions, require the

least carbon offsetting and provide the biggest financial saving for the University. This will both be more environmentally beneficial and save the university money by reducing future offset costs and energy bills.

Furthermore, by carrying out the emissions saving measures as part of the Master Plan, the refurbishments won't only reduce emissions and future proof the buildings for the UK's climate future, they will also improve the buildings themselves enhancing the University's building stock. Finally in taking this approach and ensuring virtually all the building's on the University's estate are low carbon, it will mean the University avoids any future financial levies on carbon emissions.

Scenario three is the approach outlined in the following implementation plan.

Implementation Plan

The implementation plan for achieving net zero operational carbon at the University of London can be broken into two parts which will run concurrently, the zero carbon approach to the master plan and specific carbon reduction projects.

The Zero Carbon Master Plan

The University's zero carbon target will form a key pillar of the update to the University's master plan. This will guide decisions on the new builds that will be constructed, the refurbishments that will be carried out and the phasing of the different projects. The master plan will of course have to take into account the other concerns such as requirements for academic and bed spaces, maintaining the heritage of the properties and the cost of the works. However, the zero carbon strategy will form a key part of the updated master plan.

The update to the Master Plan is ongoing at the time of writing this document. However, in order to achieve the 93% reduction in carbon emissions outlined in scenario three, all the refurbishments will need to achieve at least a 69% reduction in energy consumption and all the new builds must aim to achieve net zero operational carbon upon completion.

See appendix two for details of the energy consumption reduction rate required on each refurbishment and details of an existing project which has achieved this reduction. For details of the minimum kWh/m2/year required from each new build and information regarding the existing projects which have achieved this consumption see appendix three.

Passivhaus

To achieve these reduction targets, the University will aim to achieve the Passivhaus standard on all new builds and the Enerphit standard on all refurbishments. All capital projects must aim for these standards in the first instance. Where achieving these standards is not possible, each project has to show that the possibility of taking the Passivhaus approach has been robustly explored and prove why it is not achievable. In this case, they must still look to include as many of the Passivhaus approaches as well as the design approaches outlined in the accompanying Low Carbon Building Design Requirements document as is feasible.

A Passivhaus building is defined as "a building in which thermal comfort can be achieved solely by post-heating or post-cooling the fresh air flow required for a good indoor air quality, without the need for additional recirculation of air." (Passivhaus Institut)

The Passivhaus approach requires five key elements to be considered and included in a building's design.

- ***Orientation and Shape***
  - The building needs to be oriented to benefit from thermal gains while avoiding overheating and have a good form factor.
- ***Insulation***
  - The building needs to be heavily insulated throughout to avoid thermal losses through the roof, floor, walls and windows.
- ***Air Tight Building Envelope***
  - The building needs to be air tight to avoid undesirable air infiltration into or out of the building.

- ***Quality Glazing***
  - Ensuring all of the glazing is at least double and if possible triple glazed, while also ensuring that there are not too many glazed south facing facades as this could lead to overheating in the summer.

- ***Ventilation***
  - The building needs to be mechanically ventilated to ensure user comfort and to reduce heat loss through the use of heat exchangers.

Where Passivhaus is the recognised standard for new builds, Enerphit is the standard that the Passivhaus Trust have designed for refurbishment projects. Enerphit is defined as a slightly relaxed standard for retrofit projects, where the existing architecture and conservation issues mean that meeting the Passivhaus standard is not feasible.

All the case study projects shown in appendices one and two, have taken the Passivhaus or Enerphit approach to reduce their energy consumption, thus proving the that large reductions in energy consumption can be achieved using this approach. The Passivhaus approach has also been shown to have a considerably lower performance gap than other design approaches which aim to reduce energy consumption.

Finally beyond the proven energy reduction benefits, the Passivhaus approach has been shown to offer a high level of user comfort. This is because Passivhaus buildings offer thermal comfort all year round, utilise natural light so offer bright, naturally lit spaces, have very low levels of noise pollution due to their thick insulation and provide great air quality due to the mechanical ventilation.

However, to ensure the user comfort it is important that all building occupants are trained on how the building works and how best to operate within it. Therefore, following the completion of all Passivhaus and Enerphit projects, the sustainability team will run training sessions with the buildings users to ensure they benefit from the improved user comfort. Where projects are carried out in halls of residence this training will be carried out with new residents annually.

Full details of the Passivhaus and Enerphit approaches can be found on the Passivhaus Trust website: www.passivhaustrust.org.uk

Post Occupancy Evaluation

To ensure the low performance gap and the required energy and carbon savings are achieved, the University will ensure that post occupancy evaluation (POE) is carried out on all projects for at least ne year. This will allow the sustainability team to monitor the energy usage and ensure the projects achieve the required level of emissions reductions. Through carrying out POE any issues can be identified and rectified, guaranteeing the build quality and ensuring the required carbon savings are achieved.

Carbon Reduction Projects

As well achieving reductions in energy consumption and the resulting CO2 emissions through the implementation of the Passivhaus and Enerphit standards in the Master Plan, there are several specific projects which will help the University achieve net zero operational carbon by 2036.

Energy Performance Contract

In 2018, the University of London entered into an Energy Performance Contract (EPC) with Bouygues. The first phase of this project is underway at the time of writing this strategy. This phase is being carried out in Senate House, Stewart House, College Hall and International Hall and the works include: updates to the Building Management Systems (BMS), LED lighting upgrades; the installation of Solar PV and adiabatic chillers and insulation works. This project is expected to achieve annual savings of 800t CO2. These savings will first be shown in the University's 2018/2019 carbon figures and will be fully actualised in the 2019/2020 figures.

Scenario three and its 93% reduction in carbon emissions also includes a second phase of this project which would be carried out at Student

Central. This phase would include LED lighting upgrades throughout the building and the installation of a BMS system. The early modelling of these works suggest annual carbon savings of 97t CO2.

Although it is expected that Student Central will receive a full refurbishment before 2036, this is one of the later projects in the 2016 Master Plan. Therefore, Student Central was selected for the project as it can leverage good carbon savings in the short term and achieve financial payback before a larger refurbishment is carried out. Student Central is also the building with the 4th highest carbon emissions on the estate (fig 3), and is the building with the highest emissions which was not included in phase one of the EPC.

Upgrading the District Heating Network

The University of London is part of the Bloomsbury Heat and Power Consortium (BHPC) along with Birkbeck, the School of Oriental and African Studies (SOAS) and University College London (UCL). The consortium has a district heating network comprising of Combined Heat and Power (CHP) boilers, traditional gas and oil boilers. This network currently heats the Institute of Advanced Legal Studies (IALS), Stewart House, College Hall and Student Central and also powers the IALS building.

As the existing plant is reaching the end of its life, the consortium are undertaking a project to upgrade and expand the plant. Within this project, reducing the carbon emissions from the network are one of the key requirements. Although the project is at an early stage at the time of writing this strategy, early modelling suggests the University's annual carbon emissions will reduce by 974t CO2 for the first eight years of the plant's life, with these savings then increasing to 1,071t CO2 for the rest of the network's 50 year lifetime.

It is these figures that have been included in the modelling for scenarios two and three. However, it is likely that the project will achieve greater savings in the future as new technologies become available and more affordable but for this strategy the prudent approach was taken to include the lower estimated savings.

Removing the Data Centre

The final element of the implementation plan to achieve net zero operational carbon by 2036 is the removal of the University's data centre.

This project is being overseen by the University's IT team and therefore sits outside of the Master Plan. This plan is at an early stage, but the intention is for the University's data centre to be migrated to cloud computing.

The Data centre is currently housed in Stewart House, the largest carbon emitter on the estate (Fig.3). Annually the data centre consumes 2,751,775kWh of energy. Therefore, removing the data centre from the university and turning to cloud computing would save 779t CO2 each year, reducing the university's emissions by 5% and saving the University an estimated £344,742 annually.

In terms of the University's ambitions to achieve net zero operational carbon, this project would be a large leap in the right direction. Yet, it is recognised that even cloud computing does have related scope three emissions. So in future targets and iterations of this strategy, these emissions would need to be addressed. However, by moving the data centre out of its current central London basement location, to a location where it can be more efficiently cooled it is expected that the cloud computing approach would achieve much lower scope three emissions than the current approach.

Further Potential Works

The elements above are those approaches and projects included in the modelling for scenario three. However there are three further projects which have not been explicitly included as the feasibility and carbon saving modelling has not yet been carried out. However as work on the strategy progresses, the inclusion of these projects should be considered.

Student Central Swimming Pool

The pool in Student Central has a large impact on the building's carbon emissions. At the time of writing this strategy, no feasibility study

has been carried out to explore more efficient ways of heating the pool space and water or the resulting CO2 savings. However, there is technology available and existing case studies which have reduced pools energy consumption by up to 80%.

Senate House Heat Mats

Senate House is currently electrically heated by large radiators which heat up travertine panels. The University's Capital Projects Team have recently begun exploring the feasibility of heating the panels with electric heat mats in place of the current arrangement. This upgrade is expected to be more energy efficient and create the space to increase the insulation on the external walls, two developments which would reduce energy usage and the University's CO2 emissions. However, at this stage, the savings figures have not been calculated and so have not been included in the modelling.

Power Purchase Agreement (PPA)

As the University is located in central London and has limited space, there are only restricted opportunities for onsite renewables. Therefore, off site renewables will likely be required to cover the University's remaining energy demand. One potential opportunity here is to enter into a PPA. Due to the cost required to enter a PPA, the University would likely look to enter an aggregated PPA, where funds are gathered from multiple funders.

This approach could be used to cover any remaining demand that cannot be removed through greater efficiencies and so avoid or reduce the requirement for offsetting. Furthermore, this approach could be used by the University to go beyond operational zero carbon and have a positive impact by producing more renewable energy than is consumed on the estate.

Offsetting

Based on the current modelling, by 2036 the University will still be emitting 961t CO2 annually, 7% of the 2010 baseline. However, due to the continued decarbonisation of the grid this percentage will likely be lower. For prudence, all of the modelling in this strategy is based on the grid not decarbonising any further than the 2018 levels. It is also possible that technological developments over the next 17 years will assist the University in achieving full decarbonisation.

However, in line with the UKGBC's definition of net zero operational carbon, any remaining emissions will have to be offset and this is the approach the University will take.

Offsetting will only be carried out once the University has achieved all it can in through improving the fabric and energy efficiency of its buildings and once it is generating as much power as is feasible through on and off site renewables. This is in line with the UKGBC's carbon reduction hierarchy in figure two.

If the University does require offsets to achieve its net zero operational carbon target by 2036, they will ensure to only offset their remaining emissions through regulated and Gold Standard certified renewable energy schemes.

Programme Management

Zero Carbon Steering Group

To ensure the successful achievement of this strategy the University will form the University of London Zero Carbon Steering Group and a programme board. The Steering group will meet annually and the Programme Board every three months until the target has been achieved to review progress and ensure the strategy remains updated.

The steering group will be made up of key stakeholders to ensure that risks and issues are brought to the fore quickly. Monitoring the energy use and carbon emissions of the building is relatively simple and already built into the University's processes.

Role	Responsibilities	Participants	RACI*
Programme Sponsor	• Champion the project	Pro-Vice Chancellor (Operations)	I
Senior Responsible Officer	• Ultimate decision-maker • Provide project oversight and guidance • Review/approve some project elements	Director of Property & Facilities Management	R
Programme Director (also sits on programme board)	• Provide overall project direction • Provides direction to the Project Manager(s) • Reviews project deliverables • Ultimately responsible for delivery of the programme	Sustainability Manager	A
Programme Board	• Delegated authority to manage project(s) in accordance to the project plan • Serves as liaison to the Steering Group and submits updates • Supervises consultants and contractors • Direct/lead team members toward project objectives • Commits resources	Technical Services Manager Head of Capital Project Associate Finance Director Energy Manager	R
Zero Carbon Steering Group	• Understand the user needs and business processes of their area • Act as consumer advocate in representing their area • Communicate project goals, status and progress throughout the project to personnel in their area • Provide knowledge and recommendations • Helps identify and remove project barriers • Assure quality of products that will meet the project goals and objectives • Identify risks and issues and help in resolutions	SMT representative Student Representative Staff Representative HE Critical Friend Local community representative Local authority representative	C

Review Structure

Progress against the plan will be reported on externally through the annual University of London Sustainability Report, with updates provided at the steering group meetings by the University's Sustainability Manager. The report will go to the University's Board of Trustees before publication each year.

The strategy should be reviewed and updated at a minimum of every five years. At each review, along with an assessment of the progress to date, the scope of the strategy will be reassessed. At each review it will be considered whether the scope should be expanded to include whole life carbon and scope three emissions, with this decision being taken when there are clearly defined approaches to achieving these goals.

The reviews will also assess the 'Further Projects' section to see if these can be added into the central implementation plan and whether further projects or technologies should be added to this section.

Appendices

Appendix One: Scenario Two Carbon Saving Interventions

Development	Required Consumption Reduction	Existing Case Study Project
EPC Project Phase One	800 tonnes CO2 p.a.	N/A
Warburg Refurbishment	80%	119 Ebury Place, London
Dilke House Refurbishment	80%	119 Ebury Place, London
Warwickshire House Refurbishment	80%	119 Ebury Place, London
Bonham Carter House Refurbishment	80%	119 Ebury Place, London
Lillian Penson Refurbishment	69%	Cedar Court, Glasgow
Student Central Refurbishment	69%	Cedar Court, Glasgow
Stewart House Refurbishment	69%	Cedar Court, Glasgow

Appendix Two: Scenario Three Carbon Saving Refurbishments

Development	Required consumption reduction	Existing Case Study Project
EPC Project Phase One	800 tonnes CO2 p.a.	N/A
Warburg Refurbishment	80%	119 Ebury Place, London
2-20 Gower Street Refurbishment	80%	119 Ebury Place, London
Dilke House Refurbishment	80%	119 Ebury Place, London
Egham Library Depository Refurbishment	76%	Erneley Court Manchester
EPC Project Phase Two (Student Central)	102 tonnes CO2 p.a.	N/A
Warwickshire House Refurbishment	80%	119 Ebury Place, London
Bonham Carter House Refurbishment	80%	119 Ebury Place, London
Lillian Penson Refurbishment	69%	Cedar Court, Glasgow
Student Central Refurbishment	69%	Cedar Court, Glasgow
Connaught Hall Refurbishment	80%	119 Ebury Place, London
Nutford House Refurbishment	80%	119 Ebury Place, London
College Hall Refurbishment	80%	119 Ebury Place, London
Senate House Window Replacement	33%	SOAS North Block
Stewart House Refurbishment	69%	Cedar Court, Glasgow
International Hall Refurbishment	69%	Cedar Court, Glasgow

Appendix Three: Scenario Three Carbon Saving New Builds

Development	Required kWh/m2/year consumption	Existing Case Study Project
20 Russell Square	36kWh/m2/year	University of East Anglia Enterprise Centre
Intercollegiate Teaching Block	36kWh/m2/year	University of East Anglia Enterprise Centre
Woburn Terrace Infill	36kWh/m2/year	University of East Anglia Enterprise Centre

Zero Carbon Yellow Pages

The penultimate section of this document provides the details of all of the companies, architects, consultants and designers that attended the Zero Carbon Challenge event at the University of London and contributed to the knowledge and information in this document.

The intention is that this becomes a catalogue sustainability and estates professionals can use when looking for contractors or consultants who have an interest and understanding of how to achieve zero carbon.

Architects

5th Studio

Zero Carbon Contact: Oliver Smith
Position: Director
Email: oliver@5thstudio.co.uk
Number: 0207 837 7221
Description of services: Sustainable retrofit of existing, particularly historic and listed buildings. Creative design – integrating building physics analysis, environmental systems and fabric solutions with user requirements and behaviours to deliver low energy refurbishment of built heritage, monitoring and reporting on performance in use.

ADP

Zero Carbon Contact: Liz Jarrett | Karen Turnbull
Position: Associate Director | Sustainability Leader
Email: liz.jarrett@adp-architecture.com | karen.turnbull@adp-architecture.com
Number: 0207 089 1720 | 01935 810 620
Description of services: BREEAM services

Allies and Morrison

Zero Carbon Contact: James Woodall
Position: Sustainability Manager
Email: jwoodall@alliesandmorrison.com
Number: 020 7921 0100
Description of services: Full Architectural Services. In-house environmental performance analysis.

ArchitecturePLB

Zero Carbon Contact: Rachel Shaw
Position: Director
Email: rachelshaw@architectureplb.com
Number: 020 7940 1888
Description of services: ArchitecturePLB design long life loose fit buildings. We achieve zero carbon and carbon negative through Passivhaus certified design and have previously designed to meet Zero Carbon Hub standards.

Ayre Chamberlain Gaunt
Zero Carbon Contact: Dominic Gaunt
Position: Director
Email: dominic.gaunt@acgarchitects.co.uk
Number: 07803 126450
Description of services: Ayre Chamberlain Gaunt are an award winning architectural practice providing:
Early stage feasibility and capacity studies for zero carbon development and construction project business case planning.
Architectural services for zero carbon refurbishment, redevelopment and new build construction projects.
Master planning and design code guidance for zero carbon estate planning and management.

BPR
Zero Carbon Contact: Lizzie Hinton
Email: ehinton@bprarchitects.com
Number: 02087 859 983
Description of services: We work in close collaboration with university estates and stakeholders to develop BREEAM Excellent Buildings for the Higher Education Sector. Our understanding of different construction techniques and alternative technologies allows us to tailor our design responses to suit the specific requirements of each client we work with.

Collective Works
Zero Carbon Contact: Khuzema Hussain
Position: Partner
Email: kh@collectiveworks.net
Number: 0203 770 3174
Description of services: We have experience using reclaimed materials to create temporary spaces. These include a 200-person theatre for the Old Vic in London and a public pavilion for the London Festival of Architecture. These kinds of projects were delivered with a combination of a main contractor and volunteers.

David Morley Architects
David Morley Architects
Zero Carbon Contact: Matt Parford
Position: Business Development and Communications Manager
Email: matt.parford@dmarch.co.uk
Number: 0207 611 5238
Description of services: Architectural services/ Breeam ('AJ100 Awards: Sustainable Practice of the Year')

FCBStudios
Zero Carbon Contact: Nick Hodges
Position: Associate Architect
Email: nick.hodges@fcbstudios.com
Number: 01225 852 545
Description of services: Architectural design with emphasis and experience in highly sustainable development, including One Planet Living, Passivhaus and BREEAM Outstanding.

Grimshaw Architects

Zero Carbon Contact: Alexander Grigull
Position: Associate
Email: alexander.grigull@grimshaw.global
Number: 0207 291 4214
Description of services: Grimshaw strives to design creative and technically challenging solutions, embedding sustainability in our architectural approach from the outset at every scale - from master planning to buildings and interiors.
The Eden project is one example demonstrating our ethos which has been brought to a variety of projects across the globe, including buildings for the University of Southampton, Cambridge University and Duke University, all with the ambition to make a real difference whilst providing users with buildings that provide some kind of joy.

Haworth Tompkins

Zero Carbon Contact: Alexandra Politis
Position: Bid Coordinator
Email: alexandra.politis@haworthtompkins.com
Number: 020 7250 3225
Description of services: Underlying our core strengths is a commitment to delivering sustainable buildings. Our in-house sustainability team evaluates all projects at each design stage and provides training and knowledge transfer within our office. We provide architectural design, feasibility studies, masterplanning, interior and landscape design in a range of sectors including education, culture, workspace and housing, and are experienced with a number of sustainable design standards such as BREEAM and Passivhaus, both in new build and refurbishment projects. Our ambition to innovate has delivered the first naturally ventilated theatre auditorium (Everyman, Liverpool – Stirling prize winner 2014). We are an institutional supporter of the London Energy Transformation Initiative, a network of built environment professionals which are working collaboratively to put evidence-based recommendations for policy makers.

IBI Group

Zero Carbon Contact: Andrew Fursdon
Position: Architect
Email: Andrew.fursdon@ibigroup.com
Number: 0207 079 9900
Description of services: Architectural design | healthy campus design | master planning | design team lead

Levitt Bernstein

Zero Carbon Contact: Matthew Goulcher
Position: Managing Director
Email: hello@levittbernstein.co.uk
Number: 02072 757 676
Description of services: We provide low and zero carbon architectural and landscape design (new build and refurbishment) - championing passive design solutions to reduce energy demand ahead of implementing technological fixes. Our work also extends to carrying out post-occupancy evaluations to learn from and improve the performance of our buildings.

MCW
Zero Carbon Contact: Peter Williams
Position: Director
Email: pwilliams@mcwarchitects.com
Number: 01223 792 500
Description of services: Master planning - Campus Rationalisation - Revitalisation of Estates - Architecture

Pascall+Watson
Zero Carbon Contact: Nigel Craddock
Position: Education Sector Lead
Email: nigel.craddock@pascalls.co.uk
Description of services: Pascall+Watson are an award-winning international design practice which offers forward-thinking architecture as well as master planning, design management, interior design, wayfinding, visualisation and BIM expertise across a diverse array of building typologies.
We aim for carbon reduction across all of our education sector projects, achieving BREEAM Excellent and Outstanding accreditations and Passivhaus Standards.
Nigel Craddock, Pascall+Watson's Education Sector Leader and Director for Sustainability, is an expert in sustainable design and has been invited to join the Government Task Force on Carbon Reduction.

Purcell
Zero Carbon Contact: Peter Buist
Position: Partner
Email: Peter.buist@purcelluk.com
Number: 01206 244 844

Rock Townsend Architects
Zero Carbon Contact: Sally Thompson
Position: Associate
Email: studio@rocktownsend.co.uk
Number: 020 7261 9577

Stanley Bragg Architects Ltd
Zero Carbon Contact: Andrew Cullen
Position: Associate Architect
Email: Andrew.Cullen@stanleybragg.co.uk
Number: 01206 571 371
Description of services: We lead design teams with the aim of delivering low and zero carbon new build and refurbishment projects, being aware at all RIBA stages of works, from helping with the brief preparation and early feasibility studies through planning, technical design and completion.
We treat each project individually and our highly experienced and knowledgeable team will explore the wide range of solutions and by thinking outside the box, will propose flexible solutions tailored the project constraints and budget.
We are BIM ready, on The Green Register for refurbishes and have experience in BREEAM excellent and passive design solutions that reduces demands for energy consumption of the buildings.

Studio Lisboeta
Zero Carbon Contact: Paula Trindade
Position: Principal Architect
Email: paula@studiolisboeta.com
Number: 07961811250
Description of services: Small scale architectural and design practice with a sustainability ethos.

Tate Harmer Architects
Zero Carbon Contact: Jerry Tate
Position: Partner
Email: jtate@tateharmer.com
Number: 07970 101 328
Description of services: We provide architectural services and specialise in sustainable buildings and natural environments.

Woods Bagot
Zero Carbon Contact: Debby Ray
Position: Associate Principal
Email: debby.ray@woodsbagot.com
Number: 07565 866 214
Description of services: We are architects, so design buildings to zero carbon brief or provide feasibility studies for campus wide spatial efficiencies and analysis (using Superspace analytics).

Consultants

AESG
Zero Carbon Contact: Phillipa Grant
Position: Head of Sustainability
Email: p.grant@aesg-me.com
Number: 0208 378 8762
Description of services: AESG offers energy and sustainability consultancy services for the built environment. This includes design for net zero, carbon footprint assessment, strategy planning and renewable energy advisory services. With members of our award winning team acting as ambassadors for the Living Building Challenge, we are driven to support and lead the transition to a net zero future.

Arup
Zero Carbon Contact: Stephen Hill | Neil Evans
Position: Associate | Engineer
Email: stephen-d.hill@arup.com | Neil-A.Evans@arup.com
Number: 020 7755 4365 | 011 7976 5432
Description of services: We have experience in Strategic Carbon Management for University estates, and have worked with a number of Universities to develop their Carbon Management Plans, including Warwick and most recently St George's University of London. We are experienced in the design and delivery of low carbon buildings, as well as optimising the performance of existing buildings in use. With a 'board room to boiler-room' approach, we bring clarity and pragmatism to the energy and carbon agenda and help clients to measure and manage the risks and opportunities it presents.

BDP
Zero Carbon Contact: Philip Gray
Position: Chair
Email: philip.gray@bdp.com
Number: 020 7812 8288
Description of services: Environmental and building services engineering, energy strategy consultancy including compliance and predictive modelling, environmental management including carbon foot-printing and accounting, and environmental assessment services.

Couch Perry & Wilkes
Zero Carbon Contact: Dr Stephen Ball | Carl Standley
Position: Director | Head of Sustainability and Innovation
Email: stephen.ball@cpwp.com | carl.standley@cpwp.com
Number: 0121 709 6600 | 0203 870 4790
Description of services: CPW are a leading Environmental Building Services Consultancy with considerable experience in delivering very low energy/zero carbon buildings and infrastructure. We provide end-to-end services: concepts and master planning, detailed design, post occupancy optimisation. Alongside our MEP services, specialist teams provide for: Certified PassivHaus consultancy, building physics, energy modelling and BREEAM. SMART Infrastructure: power systems, embedded generation and battery storage. Lighting design and daylight analysis

Currie & Brown
Zero Carbon Contact: Adam Mactavish
Position: Sustainability Consultant
Email: Adam.Mactavish@curriebrown.com
Number: 0207 061 9240
Description of services: Currie & Brown's sustainability team are able to provide performance optimisation services by formulating cost effective strategies that identify opportunities to meet energy and carbon targets. We conduct Low or Zero Carbon (LZC) feasibility studies to evaluate various alternatives, and identify the option which delivers the best value.

Elementa
Zero Carbon Contact: Simon Ebbatson
Position: Principal
Email: simon.ebbatson@elementaconsulting.com
Number: 07734 048010
Description of services: As Engineers in sustainability and building services we give life to high performance buildings and communities that respect and enrich the earth. We accelerate the shift towards environmentally responsive design by making sustainable designs affordable.

Gleeds Management Services Ltd.
Zero Carbon Contact: Ed Resek
Position: Senior Project Manager
Email: ed.resek@gleeds.co.uk
Number: 07970 485 338
Description of services: Along with the Sustainability team at Gleeds Advisory, Gleeds Project Management is helping clients in the HE sector assess their estate, identify sustainability targets, and execute plans for change and rejuvenation. This includes a number of recent state of the art new builds, as well as refurbishment and/or re-utilisation of existing facilities. In 2017 Gleeds was proud to be providing services to half of the universities in the UK.

Greengage
Zero Carbon Contact: Mike Harris | Rob Miller
Position: Associate | Associate
Email: mike.harris@greengage-env.com | rob.miller@greengage-env.com
Number: 07825 437 883 | 07788 656 150
Description of services: We are a specialist sustainability consultancy providing services in energy, energy modelling and advice, renewable energy, district heating, sustainable design, Life Cycle Analysis and more.

Max Fordham
Zero Carbon Contact: Joel Gustafsson
Position: Partner
Email: j.gustafsson@maxfordham.com
Number: 01223 240 155
Description of services: M&E Engineering - With our integrated approach, we offer the full scope of traditional mechanical, electrical, public health and lift engineering design services.
Building Physics - By studying how heat, air, moisture and light move through a building we can design engineering systems that work for the building and its users.
Sustainable Master planning - Our approach to infrastructure and strategic decisions makes a large contribution towards improving efficiency and reducing environmental impact.

Mott MacDonald
Zero Carbon Contact: Saud Muhsinovic
Position: Global Practice Leader for Higher Education Facilities
Email: saud.muhsinovic@mottmac.com
Number: 020 7651 0364
Description of services: We offer a fully integrated consultancy advice focussed on delivery of zero-carbon outcomes. Tailored around specific needs of each client, our services include the front-end advisory related to carbon strategy, feasibility advice for LZC technologies, planning procurement and management of LZC projects, specialist LZC cost advice, LZC urban design & energy masterplanning, design of LZC engineering solutions for buildings and infrastructures, zero-carbon transport advice, design of renewables/LZC energy systems, zero-carbon retrofits, carbon assessments and certification.

PowerTherm Solutions

Zero Carbon Contact: Cian O'Riordan
Position: Energy Consultant
Email: coriordan@powertherm.ie
Description of services: PowerTherm Solutions is an energy and engineering consultancy. We assist our clients identify energy saving opportunities, implement energy saving projects and implement energy management systems, and sustain their energy savings over the long term. We have been working with Ireland's largest universities since 2004.

QODA Consulting

Zero Carbon Contact: Joel Callow
Position: Technical Director
Email: joel.callow@qodaconsulting.com
Number: 07879 369070
Description of services:

- Certified Passivhaus Designers in-house
- Expert team of low and zero carbon technology designers including feasibility and system design
- Building Physics services
- Full mechanical and electrical design service
- District, site and building scale
- Higher Education track record including Passivhaus

Integrated Environmental Solutions (IES)

Zero Carbon Contact: Naghman Khan
Position: Smart Cities Lead
Email: naghman.khan@iesve.com
Number: 07973 258 643
Description of services: Applying smart city modelling and analytics principles to campuses. Modelling and optimising the campus energy grid, supply and demand sources. Optimising the energy, environmental and operational aspects of a campus.

JAW Sustainability

Zero Carbon Contact: Jess James | Lucy Walsh
Position: Director | Director
Email: jess@jawsustainability.com | lucy@jawsustainability.com
Number: 07828 255 491 | 07815 892 636
Description of services: Zero carbon energy strategies. Life cycle analysis.

Rider Levett Bucknall

Zero Carbon Contact: Stephen Scott
Position: Partner - National Head of Education
Email: Stephen.scott@uk.rlb.com
Number: 07887 867 552
Description of services: We provide whole life cost / carbon modelling to identify the best value for money option for reducing carbon based on the specific circumstances of individual built estates. This can range from simple carbon emission / whole life cost modelling to assessments of embodied carbon and cost.

Targetting Zero LLP

Zero Carbon Contact: Simon Sturgis
Position: Managing Director
Email: simon.sturgis@targetingzero.co.uk
Number: 07798 503 877
Description of services: Simon Sturgis provides Strategy and Policy advice on creating a low 'Whole Life carbon' built environment. This includes both embodied and operational carbon strategies (Scopes, 1, 2, and 3) for individual building projects as well as university estates. Simon Sturgis is author of the RICS official guidance 'Whole life carbon assessment for the built environment, and the RIBA guidance on the same topic. Clients include: Warwick University, WWF, Google, and the Grosvenor Estate. See www.targetingzero.co.uk for more information.

Construction

Etude

Zero Carbon Contact: Thomas Lefevre
Position: Director
Email: thomas.lefevre@etude.co.uk
Number: 020 3176 4464
Description of services: We are sustainability engineers specialising in low energy design and construction (incl Passivhaus) and carbon management plans (incl. Zero Carbon pathways).

ISG

Zero Carbon Contact: Martyn Fletcher
Position: Head of Sustainability
Email: Martyn.Feltcher@isgplc.com
Number: 07855 006 901
Description of services: As a principal contractor we work with our supply chain partners to identify low and zero carbon materials and technologies that support our clients' sustainable building requirements.

Multiplex Construction Europe Ltd

Zero Carbon Contact: Dr Eva Gkenakou | Pavan Juttla
Position: Sustainability Director | Sustainability Manager
Email: eva.gkenakou@multiplex.global | pavan.juttla@multiplex.global
Number: 02038 292 447 | 0771 562 9700
Description of services: As a principal contractor, we know the whole Zero Carbon picture as our services span upstream to downstream of the construction phase. We can provide the technical knowledge and the supply network required to create a Zero Carbon building. By engaging with universities, architects and designers early, we can advise on how to design-out carbon and eliminate emissions for the lifetime use of the building. Our own target is for 100% renewables and a drastic reduction in carbon, so we keep up-to-date with the latest low-carbon technologies and can share our insight. With our knowledge of construction processes and building materials, we can identify ways to eliminate carbon during the build-phase and beyond. We can also support the creation of building user guides to inform staff, students and visitors of how to use the building to achieve Zero Carbon.

Vinci Construction UK
Zero Carbon Contact: Rob Humphrey
Position: Senior BDM
Email: rob.humphrey@vinciconstruction.co.uk
Number: 07784 216 256
Description of services: Design and build or traditional contractor with experiencing delivering highly efficient and low carbon buildings.

Expedition
Zero Carbon Contact: Judith Sykes
Position: Director
Email: Judith.S@expedition.uk.com
Number: 020 7307 1039
Description of services:

- Everything we do is focussed on transforming the practice of the construction industry, to improve productivity, sustainability and deliver social value.
- We do this by developing practical approaches to infrastructure renewal and through buildings that are beautifully designed, simple to maintain and promote the wellbeing of users.
- We are the Useful Simple Trust, a design consultancy working across engineering, architecture, sustainability and communications on estate planning, public realm, infrastructure and building design services.

Designers

AECOM
Zero Carbon Contact: Alan Fox
Position: Technical Director
Description of services: Zero Carbon Building Design

AKSWard
Zero Carbon Contact: Matt Walker
Position: Project Engineer | Head of Building Surveying
Email: matt.walker@aksward.com
Number: 020 7236 0161
Description of services: A structural design for a building, been super/sub structure and civil information with a focus on reducing carbon

HOK
Zero Carbon Contact: Hannah Douglas
Email: hannah.douglas@hok.com
Description of services: Net Zero Energy ready designs allowing off-site energy generation within the same grid.

Energy Services

Bryt Energy

Zero Carbon Contact: Ben Tutt
Position: Business Development Manager
Email: Ben.Tutt@brytenergy.co.uk
Number: 07741 872 412
Description of services: Bryt Energy, part of the Statkraft Group, is a passionate, future-focused energy company, on a mission to take our community on a carbon-reducing journey. Our power is zero carbon and 100% renewable, using only Wind, Hydro and Solar energy sources to power UK businesses. Whether it be on-site generation, battery storage or optimisation controls, we are at the forefront of the clean energy technology revolution.

Lightsource BP

Zero Carbon Contact: Neil Beaumont
Position: Senior Account Manager
Email: neil.beaumont@lightsourcebp.com
Number: 07894 806132
Description of services: Financing, design, development and installation of Solar PV generating assets; structured as Power Purchase Agreements (PPA).

iESCo/powerPerfector

Zero Carbon Contact: Greg Martin
Position: Head of UK and International Sales
Email: gmartin@iesco.co.uk
Number: 07392 086985
Description of services: Switchroom solutions including voltage optimisation and power facto correction

Interiors

BW: Workplace Experts

Zero Carbon Contact: Kim Morgan | Charlotte Murray
Position: Head of Environment & Sustainability | Business Development Manager
Email: kim.morgan@wearebw.com | Charlotte.murray@wearebw.com
Number: 07557 430 863 | 07557 037 815
Description of services: We are a fit out contractor with extensive experience of meeting the BREEAM, WELL, LEED and Ska environmental standards.

Willmott Dixon Interiors
Zero Carbon Contact: Stephen Hyde
Position: Sales and Marketing Manager
Email: stephen.hyde@willmottdixoninteriors.co.uk
Number: 07970 738 591
Description of services: Our aim is to reduce our carbon emissions and help our supply chain to do the same. We are offsetting our carbon emissions to make ourselves carbon neutral. We are proud holders of the Carbon Trust standard and sustainability is embedded in everything we do.

Organisations

Carbon Free Group
Zero Carbon Contact: Greg Chant-Hall
Position: Director
Email: greg@carbonfreegroup.com
Number: 01304 851 755
Description of services: The Carbon Free Group is a member-based company that provides a platform for innovation to deliver more sustainable, higher performance, lower cost solutions at a deferred risk. To date we have 130 member companies, all of which are at the cutting-edge of R&D and provision of specific low carbon solutions. We help member companies to scale-up (with financial and management support), and then deploy their services on our projects, including zero-carbon buildings and block-chain enabled smart-grids. We also use our projects to instigate behavioural change.

Innovation Gateway
Zero Carbon Contact: Henry Majed
Position: Director
Email: henrymajed@innovationgateway.com
Number: 07900 413 243
Description of services: The Innovation Gateway is an alliance of leading organisations working together to reduce the operational costs and environmental impacts of their buildings by improving their ability to source, select and validate innovation. Partners including Tesco, Heathrow, RBS, Kingfisher, Unite Group, Places for People, Nottingham City Council and others share experience and performance data across diverse industries and efficiently source innovations they need to address their challenges. The partners have saved millions of pounds in energy costs, tens of thousands of tonnes of CO2 and over a billion litres of water through innovations they have sourced.

Passivhaus Trust
Email: info@passivhaustrust.org.uk
Number: 0207 704 3502
Description of services: Advice on Passivhaus and low energy buildings

Products

Milliken

Zero Carbon Contact: Matt Tombs
Position: National Account Manager
Email: Matt.tombs@milliken.com
Number: 07860 552 333
Description of services: UK manufacturer of Carbon Neutral Carpet Tiles and Luxury Vinyl Tiles. Carbon Negative company capable of recycling old flooring. Named as one of 2018 World's Most Ethical Companies.

Seeley International

Zero Carbon Contact: Sarah Higgs
Position: Sales Manager UK & Ireland
Email: shiggs@seeleyinternational.com
Number: 07484 529863
Description of services: We are a high end manufacturer of Evaporative Cooling solutions. Our products provide cooling with COPs >10 with no compressors or refrigerant. There are products in our portfolio for every application and suitable for new or refurbishment projects.

VES LTD

Zero Carbon Contact: Joe Gergely
Position: Head of University Accounts
Email: Joe.gergely@ves.co.uk
Number: 07557 539 505
Description of services: Air Handling Unit Refurbishment, Fan Energy Upgrades, Return on Investment Calculations.

Software

Fabriq

Zero Carbon Contact: Colin Ma
Position: COO
Email: sales@fabriq.space
Number: 020 3355 1174
Description of services: Fabriq provides a fully-hosted SaaS (Software-as-a-Service) platform for the tracking and management of nearly any sustainability-performance metric for any type of building or organisation. The Fabriq OS platform combines flexible monitoring and data-import capabilities with a class-leading user interface for advanced analytics and reporting, and was designed for those who are committed to pro-actively managing sustainability performance.
Find out more at https://fabriq.space/

Siemens
Zero Carbon Contact: Parth Mehta
Position: Campus Lead
Email: parth.mehta@siemens.com
Number: 07808 822 140
Description of services: Distributed energy, micro-grids, finance, engineering, energy efficiency, building technologies such as BMS, Fire, security, Room occupancy rates.

Waste

Veolia
Zero Carbon Contact: Julie Gallagher
Position: Group Energy Efficiency Manager
Email: juliegallagher2@gmail.com
Number: 07952 910 120
Description of services: Veolia help organisations cut their emissions, reduce costs and energy consumption. Working across all sectors, from commercial and public to retail, healthcare, education, and manufacturing. Veolia are able to handle all elements of any organisation's energy requirements. Fund and guarantee savings to offering a full life cycle replacement.

Net Present Value Calculator

As the fourth section of this document, the University of London has created a Net Present Value (NPV) calculator. The Excel calculator can be used to calculate the NPV of carbon cutting projects. It works on all scales, from individual projects right up to whole thirty year strategies.

The NPV calculator is intended to help Sustainability and Capital Projects Teams develop the business case for their zero carbon targets by showing the return on investment achieving the targets offer.

To obtain an editable version of the calculator contact sustainability@london.ac.uk

The Future

This document is intended to be a starting point for the discussion between the HE sector and industry on achieving zero carbon. The intention is that there will be future Zero Carbon Challenge events which will lead to updates and new iterations of this document as knowledge increases and the conversation develops.

At this stage, it is recognised that this document does not explore whole life and embodied carbon and through its estates focus largely ignores scope two and three carbon emissions. Therefore, these areas are suggested as a starting point or any updates to this document and as themes for future events.

We hope this document proves helpful in developing zero carbon strategies and in achieving targets which have already been set. If you have any questions or recommended updates or amendments, please contact sustainability@london.ac.uk.

Zero Carbon Challenge

Visual minutes provided by Woven Ink - hello@wovenink.co.uk