Estate Operations

Carbon Management & Sustainability Activities Report
2017–2018
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EXECUTIVE SUMMARY

The seventh edition of our Carbon Management and Sustainable Activities Report describes another year of expansion for the College. Student numbers have increased, as have our property footprint, turnover and income. Despite this our overall carbon emissions have fallen below 2009 levels – the first year for which we recorded them.

This has been as a result of several factors – we have continued to benefit from a fall in emissions from electricity supply by over 15%, our new Combined Heat and Power (CHP) system started to produce electricity and data processing operations which have historically taken place at South Kensington, were relocated to a more energy efficient offsite data centre in Slough. (We acknowledge of course that the College still bears the responsibility for the impact of our data centre operations although the emissions are now reported by others.)

We announced in last year’s report that we were moving away from monitoring our activities purely in terms of absolute targets, towards a reporting system based on Key Performance Indicators (KPIs) and using total estate electrical consumption as our measure, our demand for energy has decreased.

The fact that some of our electricity is produced on site means that some of this consumption is “hidden” by our carbon emissions figures – the way that we and other higher education institutions are required to report our emissions to the Higher Education Statistics Agency (HESA) means we declare carbon emissions from the gas associated with the CHP plant but not the electricity generated and consumed on site.

The continued development to report again this year, is the “Greening Imperial” initiative which is described in the final section of this year’s report. Greening Imperial was created to encourage the staff and student community to incorporate sustainability into College activities. The initiative begun in late 2016 and the group presented its findings and recommendations in early 2018. The creation of the Greening Imperial steering group is an initiative which has the potential to change the way the College addresses sustainability and to engage a much wider group in the effort to reduce the College’s environmental impact.

The Greening Imperial steering group consists of academics, staff, the Students Union and students who are trying to push sustainability and action on climate change forward at Imperial

FURTHER INFORMATION

If you would like to know more about any of the initiatives described in our report or have your own ideas about how the College can further improve, contact Andy Hammond, a.hammond@imperial.ac.uk.
Carbon emissions across our estate are now at their lowest level since we began collecting and reporting. Our emissions from electricity consumption fell in 2017/2018 mainly as a result of the reduction in the carbon factor for electricity. As the graph below demonstrates there has been a substantial improvement in the levels of emissions from electricity as more of the electricity the UK uses is generated from wind and solar power. Gas-fired electricity generation is still significant, but in 2017 for the first time more than half of UK electricity was supplied from nuclear and renewables. In 2016 wind farms were responsible for more electricity generation than coal-fired power stations. We like to think that College academics and alumni have had a significant impact on the way the UK addresses climate change and that it is not to fanciful to suggest that the reduction in our emissions can be attributed in part to their work.

Carbon emissions were particularly high in 2016/2017 as a result of our South Kensington CHP system being out of commission while the engines were replaced. The new, more efficient engines started generating in February 2017, so just over 6 months benefit is reflected in our carbon emissions (and explains our increasing gas consumption). The new engines reduced emissions by c. 2,000TCO2e and we anticipate the benefit rising to 4,000TCO2e in a full year. You can read more about the new system below.
The move of data processing operations, which have historically taken place at South Kensington, to a more energy efficient offsite data centre in Slough also caused a reduction. This project is described in further detail below.

**KEY PERFORMANCE INDICATORS**

We have selected what we feel are the three most significant key performance indicators to reflect our current position.

The information used to formulate these is taken from our annual financial accounts and our annual report to the Higher Education Statistics Agency (HESA) which gathers a large data set from the university sector on behalf of HEFCE.

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<tr>
<td></td>
<td>4,926</td>
<td>5,474</td>
<td>5,337</td>
<td>5,645</td>
<td>3,883</td>
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</table>

We have chosen kWh electricity per capita (staff and students combined) on the basis that kWh electricity is a constant measure, where carbon factors fluctuate by year. Our experience tells us that electricity consumption is the most easily influenced by staff and student behaviors. Electrical consumption per capita has decreased over the past academic year. Later in the report you will see the data we are able to collect on a building by building basis and we hope that the combination of the dissemination of this data alongside a new focus on sustainability as a result of the “Greening Imperial Initiative will lead to a further reduction of these numbers in future years.

<table>
<thead>
<tr>
<th>TC02e/m2 space (GIA)</th>
<th>2013/2014</th>
<th>2014/2015</th>
<th>2015/2016</th>
<th>2016/2017</th>
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<tr>
<td></td>
<td>0.160</td>
<td>0.157</td>
<td>0.163</td>
<td>0.131</td>
<td>0.108</td>
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As we increase the size of the estate and as the proportion of new buildings built in line with the London Plan, building regulations and government targets for energy reduction increase, we should expect to see the average emissions per square meter of space fall to reflect higher standards in building elements such as insulation, the effect of new technologies and the introduction of more renewables into the energy mix. New building at White City are being built to higher standards of energy efficiency than the existing estate. The following Building Research Establishment Environmental Assessment Method (BREEAM) have been or will be targeted at White City:

- Wood Lane Studios (Block B) - achieved an ‘Excellent’ rating.
- Molecular Sciences Research Hub (Block C) - achieved an ‘Excellent’ rating.
- I-Hub (Block D) - on target to achieve a ‘Very Good’ rating
- Uren Biomedical Engineering Hub (Block E) - on target to achieve a ‘Very Good’.

The primary explanation for the reduction however is the unanticipated fall in the carbon factor for electricity and it may be that in future years we substitute a KPI less influenced by outside factors rather directly reflecting College action.

<table>
<thead>
<tr>
<th>TC02e per £m of expenditure</th>
<th>2013/2014</th>
<th>2014/2015</th>
<th>2015/2016</th>
<th>2016/2017</th>
<th>2017/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100.631</td>
<td>91.278</td>
<td>94.256</td>
<td>80.308</td>
<td>63.614</td>
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</table>
Expenditure rather than income is used as a measure of College activity to eliminate the impact of any operating surplus retained. The fall in this year primarily due to the reduction in the carbon factor for electricity and it may be that in future years we substitute a KPI more directly affected by our actions.

SOUTH KENSINGTON CHP PROJECT

In 2015 The College committed to replacing the Combined Heat and Power (CHP) system at South Kensington. CHP is a low carbon technology that generates Electricity while using the heat by product of the electricity generation for useful purposes. It’s a very efficient and cost effective means of generating heat and power.

South Kensington Electricity Mix (2017-18) kWh

<table>
<thead>
<tr>
<th>kWh</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,955,675</td>
<td>23%</td>
</tr>
<tr>
<td>63,577,371</td>
<td>77%</td>
</tr>
</tbody>
</table>

Electricity from CHP | Electricity from Grid

Having invested over £10 million replacing the South Kensington Combined Heat and Power (CHP) system in 2015 the new CHP system operated through its first academic year in 2017/18. The 9MW (electric) CHP engines supplied 77% of the campus’ electricity demand over the course of the year, the balance of the electrical demand was imported from the National Grid. The fiscal benefit of the CHP in the year 2017 was £5.2M and saved a considerable amount of carbon.

South Kensington Electricity mix

South Kensington Monthly Power Mix By Month

- CHP Electricity
- Grid Electricity
- Total Site Load
One of the benefits of the new CHP system over the old system is improved system efficiency, this is partly by better electrical efficiency but also the improved ability to utilise otherwise wasted heat that is created as a by-product of the electricity generation. To realise the maximum potential benefit of this the College continued to invest in developing the district heat network over the course of the year to better utilise the heat particularly over the summer when there is lower heating loads.

**EXTENSION OF SOUTH KENSINGTON HEAT NETWORK TO SOUTHSIDE AND EASTSIDE**

In early 2017 the Medium Temperature Hot Water (MTHW) network which provides heats and hot water to the South Kensington campus was extended under Exhibition Road and across to Eastside and Southside Halls of Residence.

The project involved installing approximately one kilometer of insulated district heating pipe from beneath City and Guilds Building to Eastside via Southside, at a cost of approximately £450k. Each leg of the system is metered and parameters such as water temperature to and from the building, the flow rate of water and the heat load of the building are recorded - these values are data logged every 15 minutes providing useful information for future energy savings initiatives and improvements.

Previously the halls were heated by local gas boilers. Concurrently we were unable to utilise all the heat produced as a byproduct of the CHP process. Post project this waste heat now heats the halls and the additional load on the CHP system allows us to operate it CHP system longer in the summer generating further financial and carbon savings.

Utilising the waste heat from the CHP engines reduces emissions by c. TCO2e by 166 Tonnes per annum and saves the College c. £75k a year. We anticipate the project will save the College circa £75k per annum. Operationally the new system provides resilience – the existing boilers are maintained as backup should they be required in the event of a system failure.

The viability of connecting Princes Gardens Northside is currently being assessed; this would include Ethos sports Centre, 8-15 Princes Gardens and Weeks Hall.
Over the course of the year the Domestic Hot Water System (DHW) in Sherfield and Electrical and Electronic Engineering buildings was upgraded. The old system was based on less efficient ageing steam infrastructure. As part of the district heat network improvement works this system has been replaced with a system that heats the DHW using the water based district heating system not the steam system making it more reliable, more cost effective and easier to maintain that the legacy system. Making this change has the added benefit of utilising (otherwise un-utilised) ‘waste’ heat from the CHP engines and in some months of the year, mainly over the summer, this heat would otherwise have been wasted. By doing this we burn less gas to deliver the same amount of useful heat and thus the cost and carbon benefits follow. We intend to do more of this kind of work in the future.
Legacy steam system (foreground steam plate heat exchanger and in the background two hot water storage vessels)

District Heat Network heat stations that each generate HWS, these two are located in Sherfield building plant room.
As part of the District Heat Network improvements works at South Kensington the primary network pumps have been replaced. These pumps pump the ‘primary’ heating fluid around the entire District Heat network, this then heats the buildings on the campus from Sir Earnest Chain Building, to Huxley to Royal School of Mines to Weeks Hall and so on. It also provides domestic hot water to many buildings.

The pumps were replaced to support increased loads that have been added over recent years and also to support future planned works and subsequent loads. These works were also required to ensure that the pumps operate in a ‘Duty-Standby’ configuration, so if one pump fails then the other can provide the heating load requirements of the campus thus improving resilience to the whole campus.

**NEW DISTRICT HEATING NETWORK PUMPS**

Type of the replacement network pump

Design image showing the configuration of the two primary network pumps
SMART METERING

The College continues to invest in smart metering technologies and is expanding the scope of the system to include more residences and campuses. The system dataloggers at 15 minute intervals from over 1,100 meters. These meters measure electricity, gas, heating hot water and steam. Power and heat quality are also measured and data logged. We record heating water temperatures, flow rates, and on our high voltage network amps and other parameters are recorded. Collecting this data allows us to make informed decisions, prioritising capital investment and assessing the success or impact of specific projects. In 2018 we are planning to upgrade our software to make this data available to the College community through various displays and reporting methods.

The graphs below show sources of electricity used to meet the demands of South Kensington over the period when the Combined Heat and Power system was commissioned in early 2017 and the total electrical load of the South Kensington City and Guilds Building Data Centre over the period when large portions of the computing load was migrated to our offsite Data Centre in Slough.

Below the total electrical load of the South Kensington City and Guilds Building Data Centre over the period as large portions of the computing load was migrated to an offsite Data Centre in Slough.

Example 3 demonstrates the breakdown of energy consumption (gas and electricity) over several campuses. (Data from White City is not yet available.)
The electrical load by building over an academic year for each building at South Kensington (with Burlington Danes at Hammersmith for reference), stacked by highest annual consumer first.
BUILDING ENERGY MANAGEMENT SYSTEMS

DATA ANALYTICS

Building Energy Management Systems (BEMS) are used to operate building service – Heating, Ventilation, Air Conditioning and Lighting etc. They store a vast amount of information about building performance but until recent years this information has not been used to reduce energy consumption in buildings.

The College has embarked on a series of pilot projects, using various data analytics systems which make use of this data, to identify those which will provide the best energy savings solutions to us. The overall aim of data analytics is to identify buildings that are not performing to their maximum efficiency and not providing optimal comfort conditions to occupiers. By optimising the efficiency of a building it is anticipated that:

- Energy and operating costs can be reduced
- A constant comfort level can be attained
- Reliability and efficiency of technical equipment in buildings can be increased
- The life of technical equipment in buildings will be extended via reduced running hours
- Impact on the environment can be reduced

Our first project monitors space temperatures against agreed temperature setpoints and compares building occupancy time zones with the agreed time zones. The results can be used to identify settings that can be reset to original values thus reducing operating costs, carbon emissions and overall energy consumption of a building. This project is being run in all buildings on the South Kensington Campus, initially run for a year with the option of extending for a further 3 years and beyond if the system proves successful in identifying system conflicts and can provide energy savings. Potential energy savings from the pilot project are estimated at 5% of systems energy consumption.

The BTP reset is now complete, and the next stages are to review if the setpoints currently selected are appropriate, possibly considering adaptive comfort, and where necessary modification of software to improve perceived comfort, whilst still improving energy efficiency.

Other systems being considered and evaluated for suitability are ‘Ecopilot’, and ‘ABEC Analytix’.

Ecopilot is a software platform which integrates with the BEMS, by using real time indoor data, raw weather forecasts and in-depth knowledge of the thermodynamics of the building. This allows for the utilisation of internal free energy instead of following the outside air temperature or a fixed model. Ecopilot aim to reduce the energy consumption of a building by up to 40%.

Due to a reorganisation of the Engineering, Energy and Environment Team the department has gone through a programme of rationalisation of BEMS/energy projects, in an attempt to clarify where a project is making measurable improvements, and thus the Ecopilot project was put on hold.

ABEC Analytix is an advanced fault detection and diagnostics (FDD) software solution which monitors a building’s electrical and mechanical systems and environment on a real-time basis to identify issues that could impact on its operational performance and energy efficiency.

This is implemented by linking to the building’s Building Energy Management System (BEMS) to continually read the required data, e.g. temperatures, plant statuses, plant commands, occupancy statuses, valve positions etc. This data is transferred to a cloud-based application which is configured to apply various “rules” to the data to determine if the plant is not performing effectively and efficiently. If this is found to be the case, various actions are taken to inform stakeholders (e.g. by email) and the cost of the poor operation is also calculated.

From the FDD logs, various reports are available for users to identify the most serious issues e.g. according to frequency of problem, costs etc. so the most appropriate and effective action can be prioritised to resolve the issues found.
This system is now complete and the results presented to the team, this was very well received and will be reviewed further for consideration for further investment and trials.

“OPERATIONAL EXCELLENCE”
The aims of the College’s Operational Excellence (OE) Programme are “to reduce duplicated effort and inefficient processes to better support the College's mission while meeting the needs and expectations of staff and students”. One of the projects being undertaken under the aegis of the OE programme is the rationalisation of BEMS alarms. Alarms are generated when plant and equipment fails or operates outside its optimal parameters. Due to the number of alarms generated by the system alarms are sometimes overlooked and so the opportunity to return plant to normal operations as quickly as possible is missed. By identifying HVAC equipment in fault more quickly the faults can be rectified, and the system returned to normal operation, thus preventing systems operating inefficiently. An example is the sequence control of boilers. Boiler efficiency is greater at low fire. In a multiple boiler arrangement the failure of one or more boilers would mean the remaining boilers would operate at high fire to maintain the required heat output, using more energy.
This project is ongoing and further updates will be presented in next year’s report.

ROOM BOOKING INTEGRATION
An important function of the BEMS is to set occupancy times for heating, ventilation and air conditioning (HVAC) equipment serving intermittently used spaces such as meeting rooms and lecture theatres. Until around 5 years ago the difficulty in programming the room times to suit bookings meant that for the most part the equipment was left operational when the rooms were empty. We then moved to manual input of bookings times, which is time consuming and results occasionally results in errors. To alleviate these issues a BEMS specialist was contracted to develop a bespoke system so that HVAC equipment would only be called for when room bookings have been entered in to the College’s room booking systems.
Working closely with colleagues in ICT the new system was installed for Sherfield Building bookings, and following a successful trial was rolled out across the estate.
The College continues its commitment to recycle as much waste as possible, recognising our obligation to limit our environmental impact and demonstrate social responsibility.

**WASTE AND RECYCLING KEY PERFORMANCE INDICATORS**

**Waste and Recycling KPI**

Our objective is to continue to move waste up the waste hierarchy. Generally speaking, the higher the waste moves up the hierarchy, the better the environmental benefits (fewer CO2 emissions).

As there are 7 categories being assessed (in the Estate Management System), it will not always be obvious how successful this has been.

To measure the success, we have applied a ranking to each of the categories (a higher figure for the preferred options) and used this to calculate an overall figure (each percentage achieved being multiplied by the ranking figure).

The ranking does not indicate any relationship between the benefits of the different disposal methods, but it does create a method to demonstrate that, overall, the waste is moving up (or down the hierarchy). As long as the overall score increases then we have achieved moving waste up the hierarchy.

This year our results are very similar to the previous one. However, we fall slightly short on the aim to move our waste up the hierarchy.
## Weight (tonnes)

<table>
<thead>
<tr>
<th></th>
<th>Recycled</th>
<th>Reused</th>
<th>Composted</th>
<th>AD</th>
<th>Recovered</th>
<th>Incinerated</th>
<th>Disposed</th>
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<tbody>
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<td>Electrical</td>
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<td>40.634</td>
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<td>0.075</td>
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<tr>
<td>Glass</td>
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<tr>
<td>Hazardous</td>
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<tr>
<td>Organics</td>
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<td>1323.660</td>
<td>111.080</td>
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<td>109.023</td>
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<td>11.354</td>
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**Total:** 117.775 1323.660 111.080 48.800 2301.377 0.000 218.143 4120.835

## %age

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<th>Recycled</th>
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<td>1%</td>
<td>96%</td>
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<td>5%</td>
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## Carbon Emissions from waste (vs landfill equivalent) t CO₂e

General waste is not shown in the chart as the figures are too vast for the scale of the other items.
STUDENT HALLS REUSE SCHEME

Students are encouraged to donate all unwanted goods before their departure at the end of the academic year. A reuse scheme was set up 2 weeks before the end of term in June to capture any unwanted items such as clothing, shoes, bags, books and small electrical items which managed to capture around 4 tonnes of material that otherwise would have been disposed of as general waste. This figure is comparable to previous years.

Food donations were also collected in all halls of residence. 110 boxes of food were donated to the Trussell trust food bank in Notting Hill to be distributed to those in need. We estimated around a tonne of food being donated which £8,000 worth which made significant contribution to the Foodbank as well as avoiding unnecessary waste.

The donated items were put to good use by British Heart Foundation and the Trussell Trust.

WARP-IT

This initiative recently introduced to Imperial College is a redistribution network (very much like Ebay or Freecycle), enabling individuals/departments within an organisation to give away or loan unwanted items to others within the organisation and beyond. The scheme also saves money by allowing items on offer to be claimed.

The system is useful for many unwanted or underused resources and particularly suitable for furniture and office consumables. The scheme brings the unused into use, saves money, frees up space, diverts resources from landfill, reduces carbon emissions and saves on the costs of removal and disposal.

Warp-it redistribution network continues to be a useful tool to facilitate reuse. It allows users to offer and claim items that are surplus to requirements. This avoids items becoming waste in the first place; saving money and avoiding carbon emissions.

This year the scheme had 193 transactions saving 26.24 tonnes of CO2 and reusing 5.72 tonnes of what would otherwise have become waste. These figures show a 35% increase in transactions on last year.

BIN SENSORS

Bin sensors have been installed in all waste and recycling carts across all campuses. This allows the Waste & Recycling team to obtain accurate data of how much waste and recycling is being collected from each site and that collections are being done to the required schedule.

Sensors also allow us to streamline collections throughout the College and arrange extra collections when required at busy times. It also has the potential to reduce transport requirements where possible.

CO2 EMISSIONS FROM WASTE AND RECYCLING

The graph below shows our carbon emissions from waste versus the carbon which would have been generated from disposal via landfill. The reduction is significant and the benefit of recycling can clearly be seen. General waste is not shown in the chart as the figures are too vast for the scale of the other items: 43 tonnes vs 774 tonnes CO2.)
The Information and Communications Technology (ICT) Department continues to deploy more efficient PCs and has improved processes for recycling waste from packaging to ensure as much as possible is reclaimed.

ICT continues the administration of the power saving scheme, encouraging users to not opt out of the auto power off scheme needlessly. The scheme allows users to have their machines go to sleep when they are not using them and then wake them up remotely if they need to login to them if they are away from the office.

Some departments have also reduced the number of cluster machines they provide – this has been possible as many students now use their own devices to access the colleges ICT systems.

ICT now has large equipment recycles bins where for old electrical equipment and cabling which is sent off for recycling.

**AV**

We have fitted 153 occupancy sensors to lecture theatres, so that AV systems are only on and using power when they’re needed, by default turning off after 2 hours of no use.

**NETWORK INFRASTRUCTURE**

Standardisation of equipment enables the re-utilization of parts of the network infrastructure thus avoiding re-purchasing (cabinets are a good example, we can wheel them in and out of comms rooms as we re-fit or change them). Utilization of Single Mode fibre (OS2) enables College to upgrade to ever increasing bandwidth without having to strip out all the existing cabling, and most of the copper cabling removed from Imperial College that is no longer needed by ICT is now recycled and not thrown away. An agreement to allow the increase of comms room temperature allowances from 18-21 deg to 18-25 deg. And the utilization of chilled water cooling (where possible) in comms rooms as a more ecological method against the use of traditional DX units. We have done away with most of the PVC (toxic smoke and poor flammability) cabling and are actively pursuing BS7601 standard at the highest rating of fire resistance and least level of toxic and acid smoke and droplets in case of a fire.

**DATA CENTRE**

The Data Centre Team is carrying out a server decommissioning exercise to remove older systems and has to date withdrawn 4 x 42u racks of equipment, saving 25kW of power. All equipment which is decommissioned is treated in line with the Waste Electrical and Electronic Equipment recycling regulations.

The Data Centre Team has initiated a project to investigate moving further hardware to our more energy efficient co-location data centre, further reducing the load at South Kensington.
Our total power consumption in South Kensington datacentre CAGB is now 422kW, down from 1.2MW at its peak. PUE is around 1.74 at present. In Slough our PUE in hall 1 is remarkably similar, 1.7. However, the bulk of our equipment in hall 4 is achieving a PUE of around 1.25. This disparity is the change in cooling methods between the original Infinity model (cold aisle containment) and Virtus (hot aisle containment). We will always use hot aisle containment going forward, so we can expect a figure nearer to the claimed 1.2.

PUE for Slough over the last 3 months:

![Graph showing PUE for Slough over the last 3 months]

More details on the cooling efficiencies at our Slough data centre can be found here [https://virtusdatacentres.com/why-virtus/data-centre-cooling](https://virtusdatacentres.com/why-virtus/data-centre-cooling)

**RESEARCH COMPUTING**

With the migration of the Research Computing Service (previously known as the High-Performance Computing (HPC) ICT have transferred 600kW of HPC load to a more energy efficient co-location data centre. Our partner data centre is purpose built and is therefore able to achieve much higher Power usage effectiveness (PUE). PUE is a ratio of how efficiently a data centre uses energy, specifically, how much energy is used by the computing equipment (in contrast to cooling and other overhead). Our partner centre has a much higher with an expected PUE of 1.25. This has also allowed the data centre to decommission our onsite 600kW C02 cooling system as it is no longer needed.

The graph below shows the impact of these changes on the amount of power we use in South Kensington for running the Data Centre.
We must of course recognise that carbon emissions associated with our ever increasing requirements for data processing still exist and remain our responsibility.

**SERVER VIRTUALISATION**

The ICT Department continues to reduce the environmental impact and cost of computing through the use of virtualisation. We currently have 1,011 of 1,533 servers owned by ICT as virtual servers, representing 66% of our server estate (this is an improvement of 3% on last year).

**CLOUD SERVICES**

ICT continue to use “Software as a Service” providers where appropriate as opposed to running servers onsite when implementing a new applications. We have initiated a project to review current onsite services with a view to moving some to the cloud and so further reducing the power used to support onsite infrastructure.

**PRINTING SERVICES**

The ICT print service has seen an increase in active users as we try to encourage people to use the central print service, this has a benefit it that it reduces the use of less efficient personal printers and ink supplies. Even with the increase of active users we have still seen a consistent number of pages being printed, which highlights over time of the ongoing reduction of the number of pages printed per user, reducing the paper and ink supplies used.
We have also observed a reduction in the number of pages users are photocopying along with an increase in the number of pages that are being scanned by the print service, this has highlighted that users are more likely to require electronic copies of their documents as opposed to physical paper copies, and has resulted in a reduction of paper and ink supplies needed.
We continue to implement initiatives which encourage staff and students to lead healthier lives. We have an ongoing program of applications throughout the year of compost teas sprays and 100% organic fertilisers.

Benefits of Compost Tea Typical sports turf root zones that have been used as a receptacle for chemicals over the years are effectively dead, these rootzones contain the limited biology suitable for **poa annua**, a grass that survives and thrives because of constant seeding and high nutrient water and pesticide inputs. Poa annua is also easily kicked out as it is shallow rooting, requires heavy watering. The aim is to encourage and promote the more reliable and resilient, stronger grasses (Perennial Rye Grass) to become the dominant species which we are achieving through the use of compost tea applications.

All plants rely on relationships with soil microbes that promote healthy growth. These symbiotic plant microbe systems, in which grasses, except **poa annua**, apply about 20% of its energy to root formation and leaks about 30 per cent of the energy they produce through their roots to feed the microbes forming the soil food web, have evolved over millions of years. In return the microbes convert the proteins and carbohydrates that leak out of the root back into plant food available at the right time for optimum plant growth.

Soil microbes have a range of mechanisms to protect the grass against pathogen attack, aid in the decomposition of toxins, and produce plant growth hormones. The net result of this is that grass grown in a healthy food web is stronger, needs less inorganic fertiliser and water, suffers less from disease, fairy rings and dry patch and tends towards perennial grasses not **poa annua**.

**What is in compost tea?**

Tea contains all the soluble nutrients extracted from the compost, but also contains all the species of bacteria, fungi, protozoa and nematodes in the compost. Not all the individuals in the compost, but representatives of all the species in the compost are found in the compost tea. Making sure only beneficial species are present in the compost is therefore critical. For sports turf we look for fungal dominance which is perfect for the encouragement of Perennial ryegrass.

**Lighting**

Where lighting is failing we are replacing with energy efficient LED lighting, the latest example of this is in the squash courts, the lighting is generally on all day and therefore the upgrade to LED lighting will be more energy efficient. The lighting is also much whiter giving users a better experience.
Cups
Plastic and paper cups are no longer used at water fountains reducing the amount of waste considerably.

HALLS OF RESIDENCE
Residential Services continue to implement ways to improve our sustainability across all 3 Villages. During 2018 we have re-upholstered 47 desk chairs, 23 sofas, 20 tub chairs and 10 seating cubes across all halls. This has prevented these items of furniture from entering the waste stream. We also re-furbished and re-upholstered 84 desk chairs in Southside hall using a new fabric called ‘Camira Rivet’. This fabric is made from recycled plastic bottles. 22 x 500ml plastic bottles make 1 metre of fabric. We are testing this fabric and collating feedback from the new students and, if well received, we may look at using this fabric more for future furniture refurbishment works.

Working with FM we continue to facilitate a student re-use scheme at the end of the academic year. Students donate items at designated donation points located in each hall to be re-used. These items are collected by the British Heat Foundation and re-used in their charity shops. At Woodward Buildings a permanent BHF charity donation bin has been installed in the basement area which is available to students to donate unwanted items instead of disposing of them through the hall waste.

During the Summer we replaced 200 shower cartridges in Southside halls, they were 10 years old and becoming less efficient. The new shower cartridges have improved water efficiency in the en-suite showers. We are now looking at a project to replace the shower cartridges in Eastside halls which is coming up to 10 years since opening.
We have replaced all cooker hoods in Southside halls, 24 double headed hoods, with the latest energy efficient model. The old hoods were 10 years old and had become less efficient, taking longer to extract and filter air so students were keeping the hoods on for long periods at the maximum rate. We are currently in a programme of replacing over 950 mattresses in student bedrooms. This project includes the removal of the old mattresses. The contractor chosen for this project has committed to recycle the old mattresses. They have a UK wide network of licensed recycling companies which they use. This means that the old mattresses can be recycled at the nearest point to College saving carbon emissions. Recycling will involve the strip down of the old mattresses. The old springs, filling and fabric are all recycled back into bedding or used in flooring. All steel and metal components are recycled.

We have installed 2 Dyson energy efficient hand dryers in communal areas which saves on hand paper towels usage.

Working with FM and taking into consideration feedback from students, the heating strategy in our halls has been altered from a time tabled on/off system to a temperature sensitive system that reacts to external temperature. This is more energy efficient as it means we no longer have to heat an entirely cold building at different times throughout a 24-hour period as the new system keeps a level temperature when the external temperature drops below 16 degrees. It also means that the heating doesn’t come on at all if the temperature doesn’t warrant internal heating.

**CATERING AND EVENTS**

From 1 October, single-use plastic cups were no longer be provided at Campus Services’ water dispensers. Staff and students are encouraged to bring their own reusable bottles, or purchase one from food outlets on campus or the Student Union shop. Last year, 850,000 single-use plastic cups were given away, so this change will have a significant positive impact. In addition, to help reduce the number of disposable takeaway cups and boxes on campus, reusable coffee cups for the purchase of hot drinks in barista outlets are encouraged, and the Library Café on South Kensington campus are trialing a ‘Bring your own container’ initiative where staff and students can bring in their own clean containers for the purchase of food.

**EARLY YEARS CENTRE**

Children are made aware of sustainable practices through our various initiatives which include the harvesting of rain water for use on their vegetable garden, composting, recycling of clothing, toys and other items.

The importance of recycling is conveyed to the children through art classes and education and by using recycled waste e.g. fairy liquid bottles and egg boxes, we can watch the children using their imaginations to create and build.

Parents are encouraged to recycle children’s clothing and we rely on donations of books and toys.

Food for staff and children is locally sourced and is cooked to order, taking into consideration the likes, dislikes and allergies of each child and so reducing food waste.

Paper usage is reduced by the use of reusable whiteboards, for planning the weekly curriculum activities. Digital photos are taken and stored electronically, in preference to paper records. Children use donated paper and pre-used paper for drawing and art work.
We are currently trialing the use of glass milk bottles which replace the non-recyclable type that were used previously, if successful this would have a positive impact on our waste.

ENVIRONMENTAL MANAGEMENT
ECOCAMPUS AND ISO 14001 - ENVIRONMENTAL MANAGEMENT TRAINING

Several sessions of the National Examinations Board in Environmental Safety and Health (NEBOSH) Environmental Awareness at Work course were run by the Energy and Environment Team in 2016/17. We first launched the course to our staff in 2015, when it was well received. This introductory qualification, aimed at anyone who needs a basic understanding of environmental issues in the workplace, has been attended by over 100 staff members from the various teams within the Estates and Campus Services departments.

The benefit of the course has been to provide a general awareness of environmental issues to staff to enable them to think about how their individual roles and activities impact the environment and how improvements could be made. In addition, a wider awareness of how sustainability benefits are economic and social as well as environmental should also encourage a change in approach to many of Estates and Campus Services activities and processes.

We will look to run this course again as there has been a number of new staff appointed.

IMPERIAL UNION / STUDENT EATS

Last year a group of Imperial College students were successful in an application to the NUS Student Eats scheme and launched a food buying group. The scheme provides £1,000 for startup costs, training and mentoring for those who join, with the aim of encouraging students to create food based enterprises within universities to embed sustainable food into student life.

The aims of the Imperial Food Co-op are “to take away the hassle and the cost of buying food that’s more sustainable. We make Fairtrade, Organic and Local Food easily accessible by holding regular stalls on campus selling a wide range of food from pasta to nuts to chocolate spread. Buying food directly from our wholesaler means we can sell it with around a 25% discount off the RRP.” After a successful first year the Food Co-op is up and running again for the second year with a weekly stall on Thursdays in the Sir Alexander Fleming Building foyer.

They have also been able to expand their range of products to include lentil, porridge oats, fruit jerky and vegan pesto. They also promote a more waste/packaging free shopping style by...
encouraging customers to bring their own containers or providing a small supply of emergency re-usable containers for people to borrow and bring back.

MEAT FREE MONDAYS

Note: This campaign ran as a trial in January 2019, with the results of the survey and overall decision not to continue the campaign detailed in the DPFS blog found at the link below https://www.imperialcollegeunion.org/blogs/deputy-president-finance-services/meat-free-monday-verdict

The Facts

What: Every Monday venues across campus will be switching their meat (excluding fish) dishes for vegetarian alternatives. [Sandwiches not included]

Why: To encourage you to eat meat one less day a week, by making your Monday meals vegetarian, in order to reduce our human impact on the globe

Where: South Kensington Campus (Pieminister, Senior Common Room [SCR], 568, hbar, Library Café, College Café, SAF Café, Queens Tower Rooms [QTR], Fuel), Charing Cross Campus (Reynolds), Silwood Campus, and Hammersmith Campus (Wolfson Restaurant)

When: Every Monday in January 2019

We also have a full list of events going on in January and recipes for you to try at home to help support your participation in this campaign, as well as a feedback survey where you can voice your opinions!

Background

With global meat consumption on the rise, there is more and more research into the impact this will have on our world. The United Nation's Food and Agriculture Organization states that livestock are responsible
for 14.5% of global greenhouse gases produced. However, during the Climate Summit 2014 it was highlighted that ‘reducing methane emissions would create tangible benefits almost immediately’. One simple fix to this: spend one day fewer a week eating meat. Not only would this reduce methane emissions from animals but cut down on CO2 and nitrous oxide gas production too.

Reducing our weekly meat consumption has many benefits, including health improvements and financial ease. But taking a step back to look at the wide picture, working together to reduce the world meat consumption also has environmental, social, and animal welfare impacts. Knowing this, various students and clubs came together with College and the Union staff to create the Meat Free Monday Campaign! This campaign combines initiatives from Greening Imperial, Environmental Society (ESoc), VegSoc, and Animal Protection & Education Society (APES), as well as input from multiple PhD and Masters student groups.

What’s going on around campuses?

As well as outlets replacing their meat options with fish and vegetarian options on Mondays, get prepared for a month of events, activities and pop up stalls. Catch students and staff at lunch times on stalls explaining the campaign, showing you why it's worth taking part, and giving tips on how to continue Meat Free Mondays at home. Or, join them in the evenings for joint events with our student clubs and societies.
Sustainable Building Management, Maintenance and Construction

Estates Engineering Team

The Estates Engineering Team works alongside colleagues to ensure that sustainable engineering options are considered across College construction schemes, both small and large. In addition the Team supports and promotes the following initiatives:

**Approved Supplier Forum for Sustainability**

A workgroup set up to embrace, produce, encourage and maximise sustainability and wellbeing for every project by each key supplier at every stage of the current RIBA plan of works. This is to enable environmental cost saving opportunities to be considered and captured at the early stages (with the onus on the suppliers to provide options for consideration).

**Approved Supplier Forum for Whole Life Cycle Costing**

In this group cost managers work with project suppliers to assess project beyond just capital cost and include energy and sustainability as part of the decision making process.

**Working with the National Building Specification**

Working with other public and private sector organisations to formulate and produce information and sustainability data for incorporation into the National Building Specification (including BIM toolkit and BIM model).

**Working with the Royal Institute of Chartered Surveyors (RICS)**

The Team participated in the production of the RICS ‘SKA’ Higher Education benchmarking tool to capture sustainability opportunities in Higher Education building refurbishment projects. Now published by RICS.

**Work with ‘Greening Imperial’**

Working the Imperial Greening Team, Architects in incorporating wider sustainability and wellbeing vision/strategy for the Colleges campuses.

**‘Power-Over-Ethernet’ Lighting**

Ethernet cables connect PCs, routers and switches at a local network level. Power-over-Ethernet (PoE) lighting uses these cables to carry low voltage electricity to power luminaires. This technology is already in use in phone and surveillance camera systems. Advances in LED lighting now allow the use of low wattage luminaires thus improving energy efficiency by c. 11%.

We are trialling this new lighting system with improved controls in one of our offices in the Sherfield Building. The outcome of our local trials will determine whether we recommend the installation of PoE lighting more widely across the estate. In addition to energy efficiency improvements, PoE lighting has other advantages over traditional systems.
• Reduction in installation time and labour costs by eliminating expensive skilled installation team
• Reduction in the number of lighting distribution boards
• The lighting temperature can be ‘tuned’ to mimic natural daylight, helping to simulate the circadian rhythms, thus improving the wellbeing of the occupants.

The illustration below shows tuneable white light temperature in use in typical office.

![Tuneable white light temperature](image)

**MAINTENANCE OPERATIONS**

**SIR ALEXANDER FLEMING BUILDING (SAF)**

**Existing Belt Drive Chilled Water Pump**  **Replacement Direct Drive Chilled Water Pump**

As part of a life cycle replacement of major central plant heating and chilled water circulating pumps. The building infrastructure supports majority of the business critical research space, Lecture Theatres and offices. The pumps replacement was carried out without the disruption to services as this was one of primary requirement to assure that the critical environmental condition was maintained throughout the works.

The base build pumps required high maintenance, frequent unplanned breakdowns leading to impact on the research and main components were replaced on multiple occasions over the last 18 years to keep the building infrastructure operational.

The existing main heating infrastructure was supported by 10 pumps with belt drive electric motors duty
ranging from 11 to 55Kw whilst the chilled water distribution system consisted of 6 chilled water pump motor
duty ranged from 7.5 to 55kw.

The existing belt drive pumps were replaced with modern direct drive centrifugal pumps which are more
reliable, requires low maintenance, more energy and cost efficient along with the pump speed control has
resulted in more than 15% energy saving over the old belt drive pumps.

The replacement works was completed over 10 weeks period which required detailed planning and
movement of large pumps weighing in excess of 500kg each.

SHERFIELD GREAT HALL VENTILATION PLANT

The Great Hall is used for multiple purposes for conferencing, examination, exhibitions etc which has an
over 700 seating capacity. The ventilation system was installed in 1960's and due to obsolete air handling
components it was proving challenging to maintain comfortable environment conditions during low and
high ambient temperatures.

The existing AHU consisted of a large centrifugal fans propelled by an externally mounted belt driven
electrical motor that supplied conditioned air in to space and a large amount of return air was exhausted to
atmosphere making the system inefficient.
To maximise the energy efficacy, the replacement AHU consisted of thermal wheel to utilise the energy from the exhausted air which eliminated the requirement of frost coil to pre-heat air during low ambient temperature or large cooling demand in the summer. In combination with direct drive fans along with Co2 sensor, the fan speed is varied to suite the occupancy resulting in further energy saving of more than 45% in comparison to old AHU.

The building cooling infrastructure consist of mixture of steam absorption, water and air cooled condenser located on the roof. As part of the end of life plant replacement under phase 1, the existing electric water cooled chiller located on the west facing roof has been replaced with the latest drive technology compressor. The new chiller is capable to operate between 20 to 100% duty as opposed to existing chiller which had a fix speed. In combination with higher operating condenser temperature & compressor speed control, the resultant energy saving of circa 20% is achieved.
Biodiversity

Bees - The Imperial College Apiary Project

The Imperial Apiary project, located in the Secret Garden at South Kensington and managed day-to-day by the College Environmental Society (ESOC) remains very active, producing a significant amount of honey each year.

Planting Schemes

The College’s planting schemes are carefully chosen, with drought tolerance in mind wherever possible as Consideration is given to provision of benefits to wildlife, such as natural habitat and sources of foods.

Eastside and Southside rear gardens have been replanted with drought resistant planting to economise on watering and to provide natural habitat for insects. These areas are chemical-free zones, relying on rainwater for irrigation. A former planting scheme of Cistus and Rosemary was unfortunately almost completely consumed by Rosemary beetles and so needed to be replaced this year.

The green roof matting on Eastside and Southside balconies is planted with grasses and wildflowers to give protection to the resident ducks. Tomatoes and vegetables are grown on the balconies to provide food for wildlife.

Ethos Sports Centre courtyard and rear gardens have drought tolerant, perennial planting to attract. Shade tolerant flower seeds are trialled in these areas. Trees, Jasmine and Ivy provide natural habitats for wildlife, with Ivy providing food for the local bees. The rear garden of the Sports Centre has been sown with wildflowers.

Weeks Hall rear garden has drought tolerant Jasmines, Ivy and Honeysuckle – these areas are rarely disturbed and so provide an excellent habitat for wildlife. A raised vegetable bed is a source of sustenance for birds and bugs.

The Sunken Garden at the College main entrance is planted with a drought resistant scheme, with the seed heads providing food for wildlife.

The Queen’s Lawn patio and the shrub beds outside the Library are designed for drought resistance and flowering over three seasons, providing habitat for birds, bugs, butterflies, moths and bees. The installation of raised platforms to support the marquees which are erected from time to time on the Queen’s Lawn has reduced the frequency of re-turfing required and this in turn has enabled a huge water saving. The lawn is aerated and re-seeded as required to maintain quality as a leisure facility for staff and students.

Raised planted beds in Dalby Court, ACE Extension courtyard garden, Falmouth Gate, Callendar Road and the Queen’s Gate bicycle park are all drought tolerant and provide bug habitats. Verbenas added to the Dalby Court planters provide seeds for birds. One of the raised beds in Dalby Court has been replanted as a Victorian-style knot garden with edible herbs providing food for wildlife and staff and students.
The 170 Queens Gate garden lacks light due to the numerous perimeter trees so many species of plants are carefully selected for survival under these conditions. Shade tolerant, perennial planting such as woodland bulbs are successfully grown, with the trees providing natural habitat for wildlife.

Flowers Building has a spectacular roof garden with an impressive array of perennial wildflowers and drought tolerant grasses, providing habitat and nesting material for birds (see right).

The Charing Cross garden areas have been planted with perennial three season planting, providing seed heads for feeding birds. The soil there is particularly dry, so drought tolerance is a major factor in the choice of plants. The recently refurbished Wilson House has a sedum roof and the rear courtyard has been planted with wildflower

At the Royal Brompton Campus, there are numerous shrubs providing berries for birds. The perennial garden at Guy Scadding has Lavender, Echinacea and Rudbeckia (2.5 season flowering). These and the Climbing Hydrangea provide food and natural habitat for birds. All are tolerant to drought conditions.

Perennial herbs have been planted on the Woodward Building herb garden which can be enjoyed by all.

**BUG HOTELS**

Wherever possible, trees which have naturally fallen are cut into lengths and the logs piled to provide bug hotels. This is especially successful at the Silwood Park Campus where there is a plentiful supply of fallen timber, and in the Secret Garden at South Kensington.

The wood chipper at Silwood Park has proven useful for disposing of smaller tree limbs which are unsuitable for bug hotels and the resultant wood chippings are laid on the surface of the formal flower beds as a natural weed inhibitor. By using the chipper, there is no need to resort to bonfires to keep piles of dead timber to a reasonable level.

**MULCH MOWING AND FERTILISERS**

Mulch mowing of the Prince’s Gardens park area, which commenced two years ago, enables seed distribution and promotes lawn growth, habitat and foodstuff for birds. The mulched grass cuttings act as a natural feed for the lawn, eliminating need for chemicals.

The Secret Garden is also mulch moved to return nitrogen to the soil. Leaves on the flower beds are not collected to encourage worms to aerate. The beds where previously Roses were grown have now been sown with wildflowers
RECYCLING PLANTS

Plants which have become too large for their positions are, wherever possible, split or re-used elsewhere around the campus. Plants are sometimes relocated for aesthetic reasons in prime locations such as main entrances where the planting is required to be changed a number of times annually to retain visual interest. Plants are changed regularly in areas such as Dalby Court or the raised flowerbed by the Gatehouse entrance. The plants are rotated to avoid wastage.

FOOD WASTE COMPOST

Compost produced from food waste from the College’s South Kensington Campus (processed through our in-house composting unit), is mixed with last season’s leaf mulch and used on the flowerbeds as a natural soil improver. As a result no further fertilisers are required to feed the soil.

Green- and brown-waste piles located in the Secret Garden are shredded at least once a year, then left to mulch down naturally. This mixture is used for numerous purposes, such as levelling lawns which are to be re-turfed or re-seeded and topping up the levels of soil on planted areas.

SILWOOD PARK MEADOWLAND

Work to clear self-seeded saplings in Rush Meadow and Water Meadow in Silwood Park to maintain meadowland status for the benefit of Life Sciences research is ongoing.

SILWOOD PARK WILD AREAS

A large proportion of the Silwood Park Campus, which covers in the region of just over 100 hectares, is left uncultivated for the purpose of study by the Life Sciences Department, supplying habitat to numerous species.

SWEEPING OF HARD LANDSCAPED AREAS AT SOUTH KENSINGTON

The electric sit-on sweeper purchased a year ago to maintain clear roads and pathways on the South Kensington campus has proven to be a great success. This is a more sustainable method of clearing the areas than the petrol blowers previously used, or other types of diesel sweepers available.

TREE SURGERY

A survey of the condition of the College’s trees at all sites is carried out annually by specialists - any surgery recommended is carried out. This is essential, not only to ensure the safety of people and property in the vicinity of the trees, but also to maintain the health of the trees, and the wildlife habitats which they supply.
Greening Imperial update for Carbon Management & Sustainability Activities Report Greening Imperial is a cross-campus and community initiative that aims to transform Imperial into a university that is a pioneer and exemplar in sustainability, ultimately becoming one of the most sustainable and respected universities globally. The motivation for this initiative comes from a realisation that historically the College has lagged behind its peers and that significant demand exists amongst students and staff for the College to improve its ethical and environmental policies, practices and performance.

The Greening Imperial steering group consists of academics, staff, the Students Union and students who are trying to push sustainability and action on climate change forward at Imperial. Over the last twelve months a significant amount of activity has taken place under the banner of Greening Imperial which has laid the foundation for future improvements in the sustainability performance of the College.

During the summer of 2017, a staff and student survey was conducted that received over 850 responses. The responses showed that:
- 98% think we should be acting on sustainability and climate change and doing more
- 98% think we should spend more money on sustainable infrastructure
- 91% are dissatisfied with our national performance in terms of sustainability
- 85% felt Sustainability should be led by the President, Provost or a Sustainability Director
- 65% said they would like to be involved in future greening initiatives.

The survey data was written-up into a 100-page report together with a shorter version that was presented to the Provost’s Board in February 2018. The paper was positively received by the Provost’s Board and as a result, the position of Director of Sustainability is expected to be created in late 2018. The new Director of Sustainability will be essential in providing the long-term strategic direction and targets for improvements in the environmental performance of the College.

While awaiting the appointment of the Director of Sustainability, the Greening Imperial steering group have identified short-term improvements and engaged with the relevant areas of the College to enact the following changes:
- Removal of single-use plastic cups from the catering outlet water stations across all campuses – saving up to 850,000 cups/year
- Trial of ‘bring your own container’ for takeaways from the Library Café on South Kensington campus
- Trial of the replacement of plastic bottles with metal cans in selected catering outlets
- Monthly Greening Imperial newsletter to 110+ staff and students interested in sustainability
- Introduction of a Greening Imperial Twitter profile (@greenimperial) and Yammer Group to share ideas within and between students and staff.

NEXT STEPS

“GREENING IMPERIAL”

While awaiting the appointment of the Director of Sustainability, the Greening Imperial steering group have identified short-term improvements and engaged with the relevant areas of the College to enact the following changes:

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Branding for the removal of single-use plastic cups from water dispensers
In addition, Greening Imperial has formed a close partnership with the Students’ Union Environmental Society to run monthly visits for students and staff to the allotment in the Secret Garden. Providing access to green space is a long-term objective of Greening Imperial, particularly as it can have significant benefits for the mental wellbeing of students and staff.

Staff and students clear out the pond in the Environmental Society allotment

Forthcoming changes (likely to be introduced in the last few months of 2018) include:

- Coffee cup levy (25p surcharge for using a disposable cup) to encourage the use of reusable coffee cups
- Wooden instead of plastic single-use cutlery
- Setting-up a working group between academics from a variety of departments and the White City development team to try and feed the expertise within college into the development of the new campus –so it can be used as a ‘Living Lab’

The first steps towards the stated goal of Greening Imperial have been taken but there is a lot more work to do and it’s essential that this momentum is built-upon over the next months and years to ensure that Imperial can truly become one of the most sustainable and respected universities globally.

The Greening Imperial Steering Group are as follows:
Alyssa Gilbert – Grantham Institute – Climate Change and the Environment
Andy Hammond – Head of Engineering, Energy and Environment
Claudia Caravello – Imperial College Union
Daniel Hdidouan – Centre for Environmental Policy
Dr Iain Staffell – Centre for Environmental Policy
Professor Joanna Haigh [Chair] – Grantham Institute – Climate Change and the Environment
Professor Geoffrey Maitland [Chair] – Department of Chemical Engineering
Dr Neil Jennings – Grantham Institute – Climate Change and the Environment
Nic Dent – Waste and Recycling Manager
Professor Richard Templer – Department of Chemistry & Grantham Institute – Climate Change and the Environment