Business Case Name	**Carbon Management Programme: Report on Progress in 2015/16**
Submission date	6th Jan 2017
Date of relevant CIPB Meeting	16th Jan 2017
	Not previously submitted.
Submitted By	Martin Wiles & John Brenton (Sustainability)
Type of Submission	Capital funding
Brief Outline of Project With Strategic Objectives	This paper comprises a report on progress on carbon management works
Benefits expected	Substantial savings in utility costs and carbon emissions.
Dependency Projects? (if any)	
Constraints (if any)	The key constraint is the narrowness of the time windows in which to install interventions if building users are not to be inconvenienced
Change Management impact	None
Anticipated start date	1st Aug 2016
Anticipated end date	31st July 2017

Authorisation

Appropriate authoriser (DVC, Dean, Registrar, Finance Director)	Patrick Finch, Director of Estates
Name, contact details and signature of contact in Estates Office	Martin Wiles and John Brenton, Sustainability: m.r.wiles@bristol.ac.uk, john.brenton@bristol.ac.uk
PVC Education approval	Not applicable

Carbon Management Programme:
Report on Progress and Request for Funding for Small Works and Update on Liquid Nitrogen Works
Report for CIPB 16th Jan 2017 Deadline 6th Jan 2017

UPARC passed the University of Bristol's Carbon Management Plan (CMP) in 2010, earmarking £20m of spend on reducing costs and carbon over the next 10 years with a mean payback of 7 years.

In September 2014, we presented a proposal for a number of works of the following three years that was subsequently agreed. These were:

- A Small Works programme of local low-cost, short-payback measures. - Electrically heated halls - Lighting works - Fume Cupboards	- Renewable Energy, particularly solar energy & air source heat pumps - New burners on older boilers - Combined heat and power

Here we report on progress the CMP, including plans for works until the end of 2016/2017 and note progress on the District Heat Project,

In Summary

Programme	**Spend Approved**	**Spend to Date**	**Spend by end of 16/17**	**Payback period**	**Comments**
Small Works: local low-cost, short-payback measures	£300k/yr Annually	ongoing	£300k	Mean 3 years	Many small works undertaken
Electrically heated halls	£910k Oct 2014	£535k	£910k	6 years	Final works - Badock 1-5 controls and heat pumps by Summer 2017
Fume Cupboards	£980k	£213k	£500k	2.5 years	Concept proven. Faster rollout now possible
Lighting works	£2,000k	£1,189	£1800k	Mean 7 years	Projects identified and designed. Faster rollout now possible
Renewable Energy	£600k	£10k	£270k	7 years	Will be used primarily for heat pumps. Last install Summer 2018
New burners on older boilers	£230k	£70k	£230k	7 years	Concept proven. Faster rollout now possible
Combined heat and power	£635k	£0k	£0k		Looking at more impactful options
Liquid Nitrogen	£145k	zero	£145k	1 year	Full spend may not be necessary

Carbon Emissions

Emissions from buildings inside our operational control fell sharply last year, due mainly, it has to be said, to a lower carbon electricity supply and a warmer winter. Emissions in 2015/16 were at 42,525tCO2, an 8.7% reduction on 2005/6 last year as compared with a 0.2% reduction the previous year. Electricity consumption dropped by 1% and gas consumption by 8%. Between years we had a 5% increase in staff and a 1% increase in student numbers.

Works undertake in the second half of 2016 are expected to deliver savings greater than growth

Small works

We were granted £300k in 2016/17 for the "Small Works" group of CMP investments. A number of measures, with a package payback of three years, have been made in the last 12 months including:

- Converting standby generators at Bio-Medical to avoid peak rate electricity. This project is nearly complete –filters will be installed by Christmas. This alone will save £77k a year on a £100k spend.
- Supporting lab users in the purchase of the more efficient equipment wherever cost effective.
- Enhancing energy efficiency measures during new builds and refurbishments. These can be delivered alongside other works at marginal time and thus financial cost.
- Installing networked meters to identify and rectify poorly-performing equipment and buildings.

Within year £300k has been spent and savings should be in line with the 3 year payback expected.

Liquid Nitrogen (LN2)

Bulk LN2 is currently bought for Chemistry under the UTIL contract. It is kept in two tanks between Engineering and Chemistry. Market testing revealed that significant costs savings were available through moving to a framework. To accommodate deliveries the 2015 framework supplier insisted we move the delivery point at a cost of £145k.

A new framework is now available via SUPC and it we have been able to access significantly lower framework prices via our incumbent supplier, making savings of £120k a year.

However, as part of the process of procuring the new framework, the supplier has identified necessary works to improve the safety of the current compound

We therefore ask to retain the option of spending a sum up to the £145k previously requested to make safety improvements to the nitrogen compound. We will provide a report to CIPB with works undertaken.

Electrically heated halls – agreed Oct 2014

Our electrically-heated halls - Hiatt Baker, Badock, Goldney, Hawthorns - use 10% of our electricity.

We proposed installing control technology to eliminate overheating and to reduce temperatures of unoccupied spaces and stored water during expensive national peaks. Also, we proposed replacing immersion heaters with air-source heat pumps[1] (ASHPs) to provide hot water at Hiatt Baker and Badock. **Our projected cost was £910k with a payback time of 6 years.**

Progress to date is as follows:

[1] en.wikipedia.org/wiki/Air_source_heat_pumps

- Controls were installed in Badock 6 and 7, Hiatt Baker Main and Hawthorns in Summer 2016.
- ASHPs have been installed in Badock 6, 7, 9 and 10, in addition to the initial installation at Block 8.

Similar works in Badock 1-5 will be undertaken as soon as we can get access, between now and Summer 2017 and we are looking at the possibility of taking some electrical water heating at Goldney onto gas. That will take us to the end of this budget line, and all should be committed by the end of 2016/7.

Spend to date has been £535k. Weather corrected data for Stoke Bishop for the halls already treated suggests savings of £8k a month in the heating season and £3k a month in the non-heated months, with an additional £5k sacing on carbon tax. This is currently a 6.5 year payback but this will improve on forecast rises in electricity costs so this is in line with savings expected. Feedback shows that preventing overheating noticeably improves the student experience. Further ASHP installs will take place under the renewables budget.

Spend to date £535k. Estimated annual saving £83k. Payback 6.5 years.

Lighting works – Agreed Feb 2013

We've estimated that lighting consumes 8GWh or 13% of our total electricity. Lighting use peaks during expensive network peaks in winter evenings: it could be responsible for £1m of spend.

In Feb 2013, CIPB agreed the deployment of new lighting costing £2m by 2016-17, with payback of 7 years. A project manager was employed in order to cut design costs.

Implementation is ongoing. Typical projects include:

- Replacement of older fluorescent tubes with LEDs
- Controls for lighting with difficult to access switches, some of which had been on continuously for years;
- Better control for skyline buildings that have reputational value in being unlit.

To Dec 2016, £1,190k has been spent and installed, with a further £466k in design, plus the salary for the engineer (£145k over three years). This leaves £200k to spend over the next four months.

Savings from these investments will total £360k, giving a simple payback of 6 years.

Delivery is speeding up. Some projects were rejected when investigation showed they would not deliver the paybacks required, or that implementation was too disruptive.

User feedback to date has been very positive.

Key installations to date have been: Synthetic Chemistry labs, Chemistry stairwells and corridors, several halls, Wills Memorial library.

Next, we plan a complete re-appraisal of lighting at Langford. This site sees high power prices compared with our other sites, and has a high proportion of old lighting on the cusp of failure. It therefore presents many opportunities for introducing efficient fittings with far better control.

Spend to date £1310 installed and being installed. Est Saving £185k/yr. 7 year payback.

Fume Cupboards – agreed Oct 2014

Fume Cupboards are a key tool for providing a safe environment for many types of scientific investigation; there are over 500 cupboards across the estate. If not used properly, they extract expensively heated and conditioned air out of buildings unnecessarily. We proposed, as appropriate:

- Replacing older wooden fume cupboards with modern units.

- Replacing fixed speed units with variable speed units to allow reduced air flow volumes
- Installing or re-commission variable speed drives on fans
- Fitting automatic motorized sash closers or indicators to show when sashes are open.
- Better connection with building management systems and fireman switches
- Reduce the standard opening across all fume cupboards from 500mm to 400mm.

CIPB agreed to fund £980k, with a payback time of 2.5 years, to undertake the proposed works.

Awareness work on the safety and environmental benefits of keeping fume cupboards closed has been carried out in Synthetic Chemistry.

Dorothy Hodgkin Building Works to improve the efficiency of cupboards in DHB were undertaken in January 2016. . We have been seeing gas and electricity reductions of around £4k a month since then, against a capital spend of £55k, close to a one-year payback in this case.

Synthetic Chemistry Air-handling improvement work has started in Synthetic Chemistry, ensuring that all equipment works in response to demand rather than working at a constant rate. £213k has been spent on these works to date. They are now complete and commissioning of the system is underway and expected to be finished by the end of Jan 6th.

Churchill-Langford and Chemistry have been identified as next installations, and we will use the learning from this project to inform similar works in Biomedical Science.

Have plans to replace 22 ducted Biosafety cabinets with recirculating models in Biomedical - saving £22k/yr on electricity "at the plug" and an estimated £50k/yr on avoided use of heating, ventilation and air conditioning systems at a cost of cost of £149k, with a payback of two years.

Spend to date £213k. Estimated saving £85k/yr. Payback 2.5 years

Air Source Heat Pumps and Solar Electricity – agreed Jan 2015

In January 2015, CIPB agreed to make £150k available in 2014/15 and 15/16 and £350k in 2016/7 to be spent on air source heat pumps and solar panels and, with a payback time of less than 10 years.

Air Source Heat Pumps can be used to replace immersion heaters at sites with electrically heated water. We propose to install four ASHPs at Hiatt Baker at a cost of £260k in Summer 2017 with a payback of 6 years. We could install ASHPs at Goldney also, but this is a difficult site to treat and we still need to ensure that the appropriate paybacks and carbon savings can be achieved. The Goldney site will be re-wired and re-piped in Summer 2018.

Solar electricity (PV) panels require very low maintenance and can often be sited unobtrusively. The University currently has 475kW of solar and produces 0.6% of its electricity from this source.

Since our proposal, the government have drastically reduced Feed-in tariff payments for solar. This has made small scale solar at the University's sites, where electricity is relatively cheap, unviable. However, there is a still a case for large scale solar at Langford, where an array of 200-400kW would be cost effective, if the land is available. We are looking into this.

No spend yet. Estimated £270k and 45k/yr saving by end of 2016/7

Combined heat and power – agreed in principle Sept 2014 with delivery proposed for 15/16

We originally proposed installing a combined heat and power plant at Wills Hall to provide heat for that building and lower cost electricity to electrically-heated halls at a cost of £635k.

We then assessed whether competing technologies could produce bigger savings for the same amount of money, particularly electrical storage at Langford-Churchill to avoid peaks, or more solar.

Biomass We are exploring options for biomass following successful projects at Lancaster and Cranfield Universities. The current low cost of gas, and uncertainty surrounding subsidies, as well as air quality considerations – from delivery lorries – constrain the number of possible sites.

Small Scale CHP A number of small scale CHP units have recently become available which could offer a very short payback solution in the right location

Storage Electrical Storage offers a way of storing electricity when it is cheap, either from on-site generation or lower tariff periods, and using it at expensive periods. We are investigating a shared benefit commercial model as an entry point to this emerging technology, with no initial outlay.

We will bring a view on these potential projects later in the year and expect a spend of £635k with a 7 year payback, as previously.

No spend yet. Later paper with plans for spend to go to CIPB

New burners on older boilers – agreed Oct 2014

Several larger boilers at the University have well over a decade of life ahead but use older burner technology. We have successfully installed a first phase of new, digitally controlled, correctly sized burners in these boilers to increase efficiencies.

An extended programme was agreed to install new burners at Chemistry and Synthetic Chemistry, Royal Fort House and Queens Building.

The projected cost was £230k, with a payback time of 7 years.

In the summer 2015 installed one burner each at Chemistry and Synthetic Chemistry, Royal Fort House and Queens Building. Now these have been adequately tested we are rolling out the rest.

This work is being scheduled, and it is expected to be complete by the end of 16/17.

Cost £230k. Saving £33k/yr. Payback 7 years.

Bristol District Heat Project

Bristol City Council is currently planning or installing a number of district heat networks across the city. In these, heat from a low carbon source, usually gas-CHP, is transported via hot water pipes to a number of buildings. This type of project is supported by the economies of scale that come from using large CHP units. Because any heat source that can provide heat as hot water can be used, it may be in the future that heat will come from waste heat from industrial processes.

Savings will come as savings on heat costs, carbon tax savings and avoided costs of new boilers.

The University, the Hospital and The City Council have been investigating the possibility of the University receiving heat from a Council-run network

The best buildings for us to recruit for this would be Southwell St, ASSL, Computer Centre, Sports Centre, Senate, New Hawthorns and Physics, as these are large buildings not currently run by CHP. Feeding these buildings will require careful integration with the Tyndall Ave Public Realm works.

Funding for heat mains on University land could be from the City Council followed by a margin on a heat charge, or from internal funds. We are investigating the best method to deliver this legally and will report to CIPB on progress as soon as we have a view on the legal landscape, the financial benefits, the quantity of heat available and the technical options for connection

The Future

The University has an aspiration to become a net zero campus by 2030. As time goes on:

- Policy is for the UK electricity supply to decarbonize, yet become more expensive as infrastructure is renewed. Current UK policy is for electricity, which is responsible for the emission for 450g/kWh now, to reduce to 100g/kWh in 2030.
- Gas will reduce from 0.184g/kWh as more biogas is injected into the grid, but the difference may not be more than 10%, due to the low availability of biogas feedstock.

This means that it is likely that producing electricity from gas CHP will be relatively carbon-intensive, though this will still be a useful technology in the medium term

Ignoring growth, our emissions would reduce from 43,000tCO2 now to 21,000tCO2 in 2030, with 2/3 of emissions coming from heat in 2030, as opposed to 2/3 of emissions coming from electricity now.

In future then, the aims of our carbon management plan will be to:

1) Reduce exposure to high electricity costs and reduce emissions quickly by reducing the use of electricity, through conservation, efficiency, storage and generation

2) Reduce our heat demand through insulation and control; generate more of our own heat, and make use of low carbon district heat networks, whether our own or via third parties.

Financial Viability

Paybacks have been assessed using gas and electricity prices at 2016 levels. These will increase over the next few years, even if wholesale prices fall, due to planned rises in "non-commodity costs" incurred to refresh UK energy infrastructure and to disincentivise electricity consumption at peaks. It is likely that commodity prices will increase if the pound remains at low levels.

Small works will be delivered in order to deliver a whole package payback of 3 years.

Each project will be subjected to financial viability tests to check for a mean 7-year payback. The project outcome, including savings realised, will be logged by Sustainability and presented in an annual report to CIPB, in reports to the Director of Estates and in reports to Estates Committee.

Risks

There have been slippages in delivery particularly where the operation needs of building users have had to be prioritized, or where there have been changes in government incentive schemes,

Small Works we have a broad range of projects at an advanced stage and can deliver these in 16/17

Liquid nitrogen tariff works – Prices have been reduced but we would like the option to use funds previously agreed to undertake health and safety improvements identified as necessary by the supplier.

Reburnering Phase 2 This work has been scheduled and should be complete by the end of 16/17

Electrically Heated Halls The control element of this is 80% complete: only Badock Blocks 1-5 are still to be done, between now and Summer 17.

Fume Cupboards Survey work on Chemistry, Langford-Churchill and Biomedical could reveal barriers, but the techniques and installations have largely been proven.

Solar Energy/Heat Pumps Installation of heat pumps is now proven technically and from the point of view of financial benefit. Physical access and complementarity with other works will be determinants of the speed of roll out. We continue to look for opportunities for solar deployment.

Wills Hall CHP or Successor – A project of this magnitude and payback is still likely for 16/17, though a parcel of smaller scale CHP, biomass and storage projects may be more appropriate.

Lighting - To Dec 2016, £1,190k has been spent and installed, with a further £466k in design, plus the salary for the engineer (£145k over three years). This leaves £200k to spend over the next four months.

The programme depends on an ongoing commitment to energy analysis and management

Equality, Diversity and Health and Safety Issues

- Safety standards will be improved with new fume cupboards providing complete containment.
- Projects involving hot water production will adhere to regulations for control of legionella.
- The proposal has no effect on the University of Bristol's equality and diversity programme.

Recommendation:

We request that CIPB note progress on Carbon Management works

Prepared by John Brenton, Chris Jones, Martin Wiles.

Project Sponsor: Patrick Finch