OCTOBER 2016

BRIGHTON AND HOVE CITY COUNCIL

STREET LIGHTING INVEST TO SAVE

PROJECT BUSINESS CASE

Table of Contents

1 INTRODUCTION

1.1 PROJECT OVERVIEW

1.1.1 Brighton & Hove City Council (BHCC) is planning to implement a street lighting invest to save programme though the application of new energy efficient LED lighting technologies as well as the application of the latest British and European Road Lighting Standards.

1.1.2 This work has been carried out in conjunction with a consultant, WSP/Parsons Brinckerhoff. This is an abridged version of a full technical report supplied to the Street Lighting Team, and available if required.

1.1.3 In conjunction with an energy efficiency programme, the council aims to invest in new technology to enable a smart city environment utilising lamp posts as the primary location for this equipment where appropriate. This area of work was not part of the initial remit and has in the main been carried out internally by the council's street lighting manager with interest from internal ICT team.

1.1.4 This report summarises the various options available to BHCC and should be considered as a guidance upon which to make fully informed decisions according to the city's needs. The aim is to create a lighting service which minimises energy consumption, whilst achieving lighting and service levels appropriate to the needs of the BHCC residents, tourists and businesses in terms of safety and amenity.

1.1.5 This business case is underpinned within the full report by the following:

- Understanding the existing lighting asset and its operation,
- Understanding the progress made to date
- An overview of the number of different solutions required to meet the demands of a diverse stock across the city,
- Understanding and application of the proposed technologies,
- Understanding the design process and application of adaptive lighting and dimming solutions,
- Understanding the requirement for a proposed smart city solution and the areas of interest to the council,
- Evidencing the potential savings and payback periods.

1.1.6 As requested the project has been considered over a three year deployment period and takes into consideration recent energy saving and service improvements initiatives already developed by BHCC.

1.2 EXECUTIVE SUMMARY

1.2.1 The annual energy and carbon consumption summaries below (Figures 1 & 2) demonstrate that there has been a decrease in energy and carbon consumption over the past three years. This is due to lighting improvements made using modern technology, including LED.

1.2.2 In energy and carbon terms, the report indicates that potential savings through the use of LED technologies in conjunction with the application of current good lighting practice could bring energy savings of approximately 4,370,000 KWh as well as savings of 2,360 tonne of CO_2.

1.2.3 In financial terms, based on current electricity prices, this equates to £471,472 and £41,344 per annum respectively should all potential savings elements be implemented, a total of £512,817 per annum.

1.2.4 Based on current contractual rates, the works costs to implement this project equate to approximately £6,954,450 for the electrical and control equipment with an additional allowance of £1,000,743 to take account of replacing a number of existing columns at the end of their useful life, and the need for additional columns in particular streets to bring the lighting levels up to the required performance levels.

1.2.5 The total capital requirement is £7.956m funded from unsupported borrowing (£6.954m) and LTP (£0.900m) and the supporting financial figures are based on a three year programme with even drawdowns over the period.

1.2.6 Based upon these figure the project is currently looking at a payback period of just over 13.5 years. Repayment will be over 14 years.

1.2.7 A number of different funding streams have been considered, Salix, Green Investment Bank and Public Works Loan Board

1.2.8 Given the payback period currently estimated at over 13 years Salix were effectively ruled out as they look for a quicker return on their loan. Detailed discussions were held with the Green Investment Bank and BHCC financial staff. Following this the finance team took the view that the most appropriate method of funding this project is through unsupported borrowing.

1.2.9 A glossary of terms is provided at the rear of this document.

2 CURRENT ASSET POSITION

2.1 UNDERSTANDING THE CURRENT POSITION

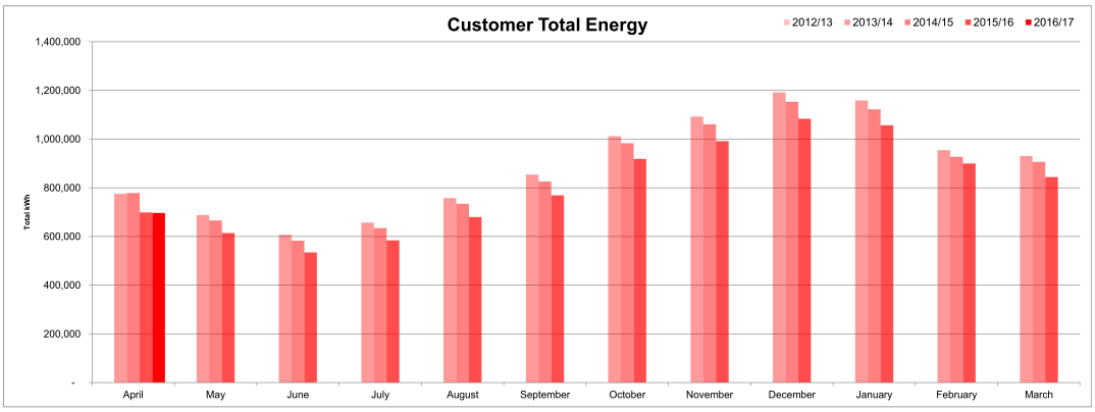
2.1.1 In order to develop the overall business case it is important that BHCC understand and evidence the current base line data upon which the business case will be developed. The bedrock for this is BHCC Mayrise street lighting asset management inventory.

2.2 CONFIRMING THE CURRENT ASSET DATA BASE

2.2.1 The council is happy that the street lighting inventory has a high level of accuracy and this has been confirmed by Power Data Associates (PDA). PDA undertakes the role of Meter Administrator for BHCC to use the inventory data in order to calculate the monthly energy bill. As part of their role they regularly review the inventory to check for any anomalies within it, for example a lamp type and corresponding wattage that do not correlate or an Elexon energy code that is incorrect based upon the stated lamp and control gear type. These errors are flagged up where they occur for attention of BHCC and at present the database is considered accurate by PDA.

2.2.2 The following chart (**Table 1**) supplied by PDA shows the street lighting energy consumption for the year 2015/16 as well as comparing it to the consumption on a month by month basis for the past three years. As can be seen there has been a decrease in energy consumption over the past three years and in part this relates to the LED installations and other improvement works that have been undertaken.

Table 1 Power Data Associates energy consumption chart.



2.2.3 As part of the development of the BHCC business case WSP/Parsons Brinckerhoff undertook an independent review of the data held looking to compare the numbers of columns within the streets, their height, light source and associated attributes. This has been undertaken through both on site surveys as well as desk top inventory and Google Street View assessments (only streets indicated as post 2015 on Street View were considered); these have then been compared with the inventory. This work has found a good correlation between what is on site and the asset data base records.

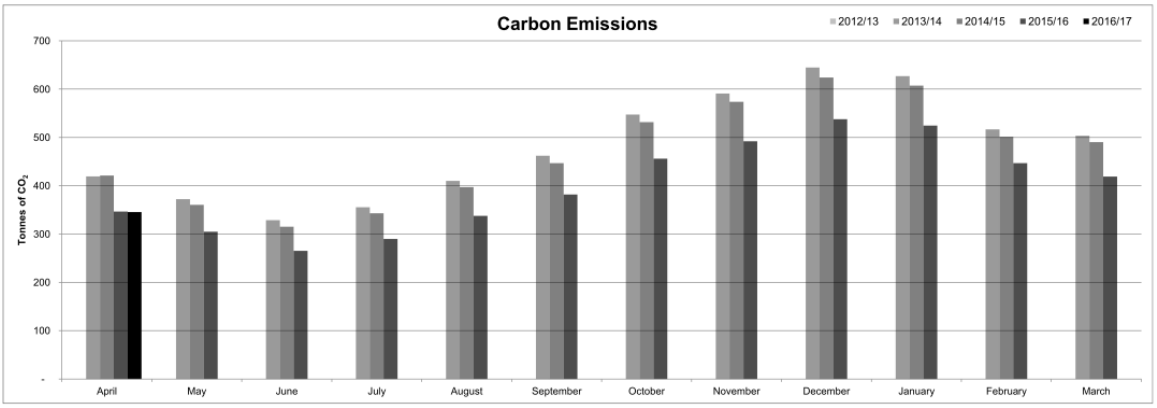
2.2.4 Based upon the inventory data and PDA report the annual electrical load (May 2015 to April 2016) was 9,671,366 kWh. Energy consumption, the annual unmetered energy consumption is calculated using the following formula.

Estimated annual consumption (EAC) = $\frac{\text{Circuit Watts x Annual burning hours x Number of units}}{1{,}000}$ = kWh

2.2.5 BHCC's current energy tariff is 10.79 p/ kWh so based upon the electrical load advised by PDA this equates to an annual energy expenditure of £971,822.00 for the year 2015-16. This only takes account of street lighting columns, bollards and illuminated signage.It is noted that BHCC's annual budget for 2016-17 is just under £1 million.

2.2.6 **Table 2** shows the Carbon footprint for the current lighting asset as advised by Power Data Associates. The Carbon Reduction Commitment Energy Efficiency scheme (CRCEE) in 2015/16 charges £16.10 per tonne of CO_2 where 1 KWhr equates to 0.49636 kg CO_2. As can be seen there has been a decrease in carbon consumption over the past three years.

Table 2 Power Data Associates carbon consumption chart.



2.2.7 Based upon the inventory data and the PDA report the annual carbon footprint (May 2015 to April 2016) was 4,800 tonnes of CO_2.

2.3 CURRENT IMPROVEMENT WORKS

2.3.1 BHCC have over the past few years been focussing on replacing their underground cable network and age expired equipment through annual LTP allocated funds. To date approximately 50% of the city's cable network has been replaced and work is ongoing, including Royal Pavilion Gardens, Kingsway and Marine Parade Whilst these schemes are not producing savings in terms of carbon or energy usage, they are essential to update and maintain assets across the city and to reduce ongoing future maintenance costs.

2.3.2 A number of LED lighting installations have been implemented which have essentially been on a whole road basis. All have proved to be successful, with some positive feedback from stakeholders. Schemes have been installed in Dyke Road Avenue (over 57% reduction in energy and carbon), Montpelier Road (over 69%) and Ditchling Road amongst others and have indicated that LEDs are a valid and acceptable lighting solution.

2.3.3 The majority of subways within BHCC have been upgraded to LED lighting.

2.3.4 A number of the streets have been re-lit / refurbished over the past five years using the CPO white metal halide light source and electronic control gear, including London Road from city centre to A23 (40% energy and carbon reduction), Stanford Avenue (52%), The Drive and Grand Avenue amongst others. These installations have provided a good level of energy reduction compared to the light source they replaced. Whilst these streets are not outside the scope of this business case it would be recommended that they are not considered for refurbishment / upgrade until the end of the five year LED deployment period.

2.3.5 **Table 3** provides a summary table of BHCC's main non-LED lighting asset. The following list of equipment has been used for the purpose of determining BHCC's business case. It is a high level summary of each main lamp type, wattage and associated circuit watts.

Table 3 Summary of BHCC non LED lighting asset.

Lamp type	Wattage	Quantity	Elexon wattage	As a % of stock
SOX	35	3575	58	20%
	55	1723	77	10%
	90	1017	130	5%
	135	97	178	0.54%
SON	50	823	62	4%
	70	4798	90	26%
	100	722	114	4.6%
	150	1152	165	6.4%
	250	367	262	2%
CPO	45	596	51	3.3%
	60	209	67	1.2%
	90	1081	99	6%
	140	1223	158	7%
CDO / CDM	50	20	59	0.1%
	70	321	79	1.8%
	250	117	180	0.7%
	210	12	229	0.07%
	250	81	262	0.5%
MBFU	80	76	102	0.4%

2.3.6 This equates to a total of 18,010 lighting points, with orange low pressure sodium (SOX) light source forming just over 35% of the lighting stock under consideration.

2.4 HERITAGE EQUIPMENT

2.4.1 The term ' heritage equipment' encompasses the heritage seafront cast iron columns, and all other cast iron units across the city

2.4.2 There are no plans to remove any of this existing equipment and replace it with standard posts. However it should be noted that where a cast iron column is removed as a result of structural failure or for any other reason, it will not necessarily be replaced on a like for like basis due to the high cost involved in the purchase of cast iron equipment.

2.4.3 We have a potential solution in place to adapt the existing cast iron columns in a number of streets and are currently undertaking a trial scheme on Second Avenue where the posts will be extended to a height of 5 metres and a small wide lensed LED lantern attached. Units in streets of this type will then be painted black.

2.4.4 The Lower Promenade is not affected by the Invest to Save proposal. The Arches and Shelter Hall are currently undergoing major refurbishment work and new lighting for the Lower Promenade is being delivered as part of these projects.

2.4.5 In addition Valley Gardens is still under consideration for development and any lighting requirements are expected to be funded from that budget and will be considered separately.

2.4.6 The heritage large cast iron columns on the seafront will be treated separately. Solutions are being looked at to install an energy efficient solution in keeping with the column style, and appropriate to provide the correct lighting levels on a busy A class road.

2.5 HOUSING DEPARTMENT EQUIPMENT

2.5.1 It was agreed by the Departmental Modernisation Board in April 2016 to include Housing Department stock within the remit of the invest to save business case.

2.5.2 The Housing Department has not fully collated their inventory and work is currently under way to carry out full site surveys to determine the full asset network. It is expected that this work will be completed by the end of October 2016.

2.5.3 At this point in time the Housing Department can accurately account for 60 units. An asset verification exercise is due to commence on the 60 units confirmed which will provide a more accurate overall view of the equipment. This work will be undertaken by the incumbent street lighting contractor.

2.5.4 It is believed that the Housing Department is responsible for potentially double that number of units. Thus for the purpose of the report at this stage it has been assumed that their inventory consists of 120 number 35W SOX lanterns mounted on 5m columns and supplied by a private cable network rather than being UKPN supplied

2.5.5 The proposal for Housing is based on one for one replacements of all their existing equipment as they have confirmed that there has been no regular maintenance of the equipment undertaken in recent years.

2.5.6 Based upon the above, the current electrical load is estimated at 28,900KWh per annum with an associated carbon footprint of 15.6 tonnes. This equates to £3,120 and £272 respectively giving an annual energy cost of £3,392 per annum.

2.5.7 The savings through changing to LED lanterns and adaptive lighting will be in the order of 9,875kwh and 93 tonnes of CO2 which equates to an approximate saving of £1,158 per annum or 68%

2.5.8 The cost for the works is estimated and in the order of £137,246, allowing for the replacement of all equipment and the replacement of the private cable network.

2.5.9 The payback period based on 120 columns works out at approximately 59 years which is longer than the life expectancy of the equipment and therefore not viable based upon an invest to save strategy.

2.5.10 Should the existing cable network not need replacement then the costs reduce to an estimated £34,000 with a payback period of 21 years.

3 TECHNOLOGY REVIEW

3.1 INTRODUCTION

3.1.1 It is an important part of any energy saving review that the technologies and operational strategies currently in place with BHCC are fully understood. This will enable the forward requirements to be assessed in order to bring about the energy, carbon and operational savings required and give confidence in the overall business case model.

3.1.2 Energy consumption reduction is not achieved by new technologies alone but also through the application of design and operational aspects. It is important that any consideration for change demonstrate and evidence that all of the approaches have been duly considered.

3.1.3 As part of the review the consultant has liaised through various contracts and projects with other authorities undertaking similar programmes / trials to gauge their understanding of lessons learnt. This has included the use of specific technologies, systems and design practices that may be taken and made applicable to BHCC's own requirements.

3.1.4 Authorities considered have included but not limited to:

- Wirral Council,
- Bournemouth Borough Council,
- Westminster City Council,
- Kent County Council,
- London Lighting Engineers Group (LoLEG).

3.1.5 WSP/PB have carried out technical reviews for the Green Investment Bank regarding submissions for invest to save LED replacement strategies and have compared the potential savings they are indicating with the work developed for BHCC.

3.1.6 There are various aspects to be considered and understood as part of the energy saving approach and these include:

- New energy efficient technologies such as LEDs,
- Control systems such as Central Management Systems(CMS),
- Application of design and Standards as well as adaptive lighting strategies,
- The consideration for Smart City technologies.

3.2 NEW ENERGY SAVING TECHNOLOGIES SUCH AS LED$_S$

3.2.1 BHCC have started to consider LED lighting as an option and as mentioned above a number of streets are now lit with LED light sources, and in addition have also utilised other technologies and solutions:

- The installation of 3,230 CPO white light lanterns
- The installation of over 1,100 LED lanterns
- A trial of a Central Management System (Harvard LeafNut), approximately 600 units
- Small trial areas of part night dimming
- Photocell replacement programme

3.2.2 The existing lighting column stock has been structurally tested and over 3,200 columns have been replaced within the past 5 years.

3.2.3 LED light sources bring a number of benefits to the lighting service as follows:

- LED light sources have a high efficacy (relationship between the energy in and the amount of light generated),
- LEDs being a white light source bring the benefit of being able to design to lower lighting levels, as permitted by British Standards.
- Long operational life.
- Based upon the long life the routine lantern cleaning interval can be increased from 3 yearly to 6 yearly.

3.2.4 There are some aspects of LEDs that do require consideration as follows:

- LEDs require drivers, similar to current lamp technology ballasts in order to provide the right drive currents and voltages. The drivers do not have the operational life of the LEDs so will require replacement; current operational life times vary depending upon supplier and range from 6 to 12 years plus.
- In order to undertake the electrical testing of the column every six years, an operation that with lamp technologies is currently undertaken from the column base, the LED lantern needs to be electrically disconnected from the internal column cable. This requires access to the lantern to undertake the isolation. Depending upon the lantern this can be a simple process as the electrical connections can be isolated when the lantern is opened. The reason for this is that the testing may 'blow' the electronics within the LED lantern. This can be combined with a six yearly lantern cleaning operation.
- It is important to ensure a warm colour temperature; around 3,000 kelvins are considered for residential / public mixed use areas with 4,000 kelvins for principal roads.

3.3 UNDERSTANDING THE OPTIONS

3.3.1 All roads within BHCC have been assessed for lighting classification and equipment style. These have then been collated into like streets and then each group of like streets had a questionnaire sheet developed for it. This essentially lays out the performance requirements for each class and type of road within BHCC and requires the manufacturers to consider their products and advise on their options.

3.3.2 In order to determine the potential energy and carbon consumption savings through the adoption of LED lighting within BHCC, WSP/PB have:

- Reviewed LED lanterns based upon the work undertaken with LoLEG regarding new technologies,
- Considered the details of the LED lanterns being used on other projects within the UK
- Issued and assessed questionnaires and product detail submissions from various LED manufacturers approached,
- Undertaken calculations based upon the details of various roads within BHCC to determine the most appropriate LED solutions to achieve the required lighting class.

3.3.3 Many existing lanterns within BHCC are either of bespoke design or have a good service life remaining and it would not be good asset management practice to consider replacing them within the early stages of the project deployment period. It is therefore worth considering what LED retro-fit options may be considered and used within these lanterns. This option is currently being assessed by the council in partnership with a number of manufacturers.

3.3.4 It is important when considering retro-fit LED systems for lanterns that they not only fit within the lantern and operate but that the optical performance of the LED within the lantern is equivalent to or better than the lamp technology it is replacing.

3.3.5 As discussed with BHCC representatives the project is essentially looking to a one for one upgrade regime where achievable in order reduce costs. A new electrical connection to a column can at times be close to 50% of the cost of the supply and installation of the unit. A one for one regime therefore reduces electrical connection costs.

3.3.6 It is noted that a number of the streets in BHCC are very wide and a one for one approach is unlikely to bring these streets up to the required Standard of lighting performance. In these cases the following approach has been agreed:

- Many streets are fairly wide and lit with 5m standard steel columns at a wide spacing so an LED solution may not be viable. BHCC have advised that increasing the mounting heights is not a solution and it has been agreed that perhaps 1 in 4 streets should be listed for a new installation to ensure funding exists for all outcomes.

- On 20mph roads that it is appropriate to look to a risk assessment and potential departure from Standards where roads are wide and column spacing is large.

3.3.7 **Table 4** provides an indication based upon our investigations of BHCC streets of the energy that may be saved by changing lamp based technology to LED technologies.

Table 4.

Existing lamp and gear type	Existing Circuit Wattage	LED replacement circuit wattage	Percentage decrease in energy
Low Pressure Sodium			
35w SOX	58w	25w	57%
55w SOX	77w	36w	53%
90w SOX	130w	65w	50%
135w SOX	178w	127w	29%
	Average reduction		**47%**
Ceramic Metal Halide – CDO / CDM			
50w CDO / CDM	59w	29w	51%
70w CDO / CDM	79w	38w	52%
150w CDO / CDM	180w	75w	58%
210w CDO / CDM	229w	115w	50%
250w CDO / CDM	262w	171w	35%
	Average reduction		**48%**
Ceramic Metal Halide - CPO			
45w Ceramic Metal Halide - CPO	51w	29w	43%
60w Ceramic Metal Halide - CPO	67w	48w	18%
90w Ceramic Metal Halide - CPO	99w	71w	28%
140w Ceramic Metal Halide - CPO	158w	113w	28%
	Average reduction		**29%**
High Pressure Sodium			
50w SON	62w	29w	53%
70w SON	90w	38w	58%
100w SON	114w	65w	43%
150w SON	165w	115w	30%

250w SON	262w	171w	35%
	Average reduction		40%
Mercury			
80w MBFU	102	71w	30%
	Average reduction		**30%**

3.4 CONTROL SYSTEMS

3.4.1 A Central Management System (CMS) is a tool that can facilitate energy, carbon and operational efficiencies for an authority as it enables both maintenance reporting as well as control for when the lighting is operational.

3.4.2 In terms of maintenance reporting, the benefits a central management system will give are:

- Reduced night patrols.
- Fault conditions identified which can be linked directly into the maintenance operations
- Strengthens inventory accuracy as each asset will have a node upon it so can be identified.
- Better customer service through improved fault reporting and repair times.

3.4.3 In terms of control, currently undertaken by the use of photocells the benefits of a central management system will be:

- Controlling the operation of individual lamps through accurate switching on and off times,
- Fine tune burning hours trimming, turning the lights on just when they are needed,
- The operation of adaptive/dimmed lighting levels (the reduction in lighting levels at times of reduced traffic flows or increasing lighting levels to improve public safety as late night venues close or during public events).

3.4.4 Monitor and report on energy use; at present the CMS is used just to report on and off times to the Meter Administrator but it is hoped that through national discussions currently underway that the systems will be developed such that they can monitor the energy used and effectively become a meter, resulting in more accurate energy bills from the provider.

3.4.5 At this present time there are essentially five main CMS providers that have a good market penetration and proven operation within various UK Authorities either through trials or as whole installations.

3.4.6 BHCC have trialled the Harvard system and have found it has been successful to a degree, but that the manufacturer seems to have moved their interest towards the retail sector and interior lighting. Recently a number of other authorities within the UK have experienced commissioning and operational problems with the system.

3.4.7 A CMS essentially consists of nodes located on each item of lighting equipment. These then communicate to a local controller which depending upon supplier can communicate to a maximum of 256 (Harvard LeafNut) to 10,000 (Telensa) units. The controller in turn communicates to a central server. The careful planning of controller locations within an authority is key to the roll out and effective communication to ensure that each item of equipment can be ‘contacted’. These systems communicate via wireless systems / protocols. A wireless system communicates via radio frequency between the controller and the transceivers directly or through a ‘mesh’ network.

3.4.8 All system cost models are very different with the majority requiring an annual service charge based upon the numbers of controllers and transceivers installed within a local authority's boundary. Others only have an annual maintenance / support charge based upon assumed monthly support hours for an engineer. Obviously these costs can be off set against any reduction in night scouting and energy savings.

3.4.9 Depending upon the system the number of controllers required may present a high risk to the end user when the annual maintenance agreement is based upon the number of controllers used. A number of authorities are reporting a higher than expected number of controllers for the Harvard CMS installations and therefore due consideration should be made of placing a capped maintenance agreement based upon an agreed number of controllers.

3.5 SMART CITIES CONSIDERATIONS

3.5.1 It is a requirement of the project that the development of the LED street lighting and control system also looks to the future in terms of facilitating SMART City technologies. This is a term that covers a wide range of topics from those that may aid BHCC in terms of their service but also increase the potential for revenue income through permitting other users to use the lighting infrastructure for SMART System use.

3.5.2 There are various solutions available in the market place and BHCC Street Lighting is working with internal partners to collate data needs to help determine requirements.

3.5.3 Examples of such technologies may include but not be limited to sensors that communicate to monitoring / communication devices mounted on the columns that also control the lighting. These sensors could be associated with measuring the condition of:

- Gullies; each gully being monitored so they are only cleaned when required,
- Air pollution; monitoring and reporting of air condition and pollen count,
- Rubbish bins; monitoring of when they require empting, perhaps more for industrial bins rather than residential, and:
- Parking availability which is advised to the motorist via their phone or Sat Nav.
- Motion sensors (lighting on demand, pedestrian footfall)
- Traffic speed and density monitoring
- Temperature and humidity monitoring – can be used to optimise emergency road gritting

3.5.4 Apart from sensors, columns may also be used to integrate other technologies of benefit to BHCC and citizens, including:

- City-wide Wi-Fi
- Cellular (4G/5G) masts
- CCTV/number plate recognition

3.5.5 It is therefore important when considering a CMS that the system should consider future requirements and be open to facilitate these as and when they are required. The CMS should be able to integrate, or share data with other platforms via open APIs – this could, for example, allow predictive analytics software to determine the likelihood of asset failure. BHCC are in discussion with a range of providers who are looking to offer such a service / system.

3.6 ELECTRIC VEHICLE CHARGE POINTS

3.6.1 Electric Vehicle (EV) charge points are a major consideration for most Local Authorities in that they provide a valuable service and promote sustainable travelling.

3.6.2 One such supplier of column mounted charging systems is Ubitricity who produce a system by way that:

- Smart technology is in the charging lead, meaning the charging socket can be less intelligent and therefore smaller (and cheaper)
- Column door is replaced with a bespoke one containing a simple socket
- Quick to install (around 3 minutes or less)
- Can identify a Socket not being used and move it to a better location
- Smart lead contains an MID approved meter

Smart cable

Sample installation

Simple socket

3.6.3 Whilst some Authorities such as the London Borough of Hounslow have implemented a trial of these, other authorities are wary of this approach. The following considerations and associated costs need due consideration:

- The electrical supplies to columns are PME (live, neutral and combined earth) and these supplies are not permitted for EV points. The electrical Regulations require the supply to EV points to be what is termed TT (live and neutral with the customer providing their own local earth, via earth rods or earth mats). This will come at a cost and it can be questionable if the client (BHCC) earthing can be installed such that the defined resistance values can be achieved and maintained due to varying ground conditions.
- Street lighting supplies are un-metered as the electrical load is deemed predictable. If an EV point is added to the column then the un-metered agreement is no longer valid and a metered supply is required.
- The interior of the column may not be able to accommodate the equipment required for the charging system as well as metering separate meter, thus may require the columns being replaced.
- Consideration must be given to the existing electrical infrastructure within the street (i.e. the DNO services) as to whether the power is adequate to accommodate the additional electrical loading required for EV points?
- Such columns would need to be located at the front of the footway so as not to require charging leads crossing the footway potentially causing a safety issue to pedestrians.

4 DESIGN AND SPECIFICATION

4.1 APPLICATION OF DESIGN AND STANDARDS

4.1.1 It is important that any exterior lighting projects from the design through to installation are compliant with the requirements of the Construction Design and Management Regulations 2015, CDM[2015]. Good Practice guidance is available from the Institution of Lighting Professionals (ILP) in relation to design competencies and from Highway Electrical Registration Scheme (HERS) in terms of installation, electrical and maintenance aspects of the work.

4.1.2 Good design applying the lighting design Standards BS5489-1 and national guidance forms is a critical element to achieving energy efficient lighting solutions. Design should be undertaken by competent lighting personnel ensuring that the Standards are being applied. This aligns to the principles of Ultra Efficient Lighting (UEL) *"the right light, in the right place, at the right time, with the right control system"* as well as the European Commission's Green Public Procurement (GPP) approach to provide sustainable public lighting.

4.1.3 The Standards present a good scope to bring about additional energy and carbon savings through:

- A change in the assignment of lighting class to be applied to a road / street area, the existing road and footway gazetteer description matched closely to the road and footway hierarchy descriptions within the Standards,
- The application of a risk based design approach to define the lighting requirements to local needs / activities,
- The ability to reduce lighting levels through the application of white light, an approach termed S/P ratios which relates to how bright the eye perceives a lit road under different white light sources,
- The ability to adapt the lighting to suit the task, this permits the lighting class to be changed as road or street area use is reduced. The reduction is based upon the use of the areas concerned and still retains a defined lighting class of performance.
- The ability to turn the lighting on when it is required, termed trimming.

4.1.4 Use of white light sources are now generally chosen for residential roads. This follows research into the improved visual performance of white light sources; essentially a road lit with a white light source looks brighter to the human eye. BS5489-1:2013 recognises this and allows an adjustment to be made for white light sources in subsidiary roads, essentially permitting the designer to light to a lower level which is perceived as being as bright as when lit to the required level under SON.

4.2 TRIMMING (REVIEW OF SWITCHING ON / OFF TIMES)

4.2.1 In general street lighting switches on when the light levels fall to 70 lux and this has always been taken as the standard for this operation. However the original reason for this was linked to the run up time required for the lamps and gear to achieve their required operational output. With developments in lamps and gear this process is now quicker.

4.2.2 As such, Authorities are now considering reviewing the switch on lighting level and a number are adopting a value of 55 lux (some even extending to 35 lux). Whilst this may not sound much the saving can be fairly significant depending upon the Authorities latitude and hence day lighting hours (dawn to dusk). Generally changing from 70 to 35 lux will put back the switch on and off times by some 10 to 15 minutes per unit which equates to around 91 hours per annum. In residential areas this can be extended further to switch lighting on at 20 lux as the design levels required within the areas are in the order of 10 lux, the lighting effectively being switched on and off precisely when required.

4.2.3 Energy savings through trimming can only be achieved by operating under half hourly trading arrangements which requires a CMS to be in place.

4.2.4 The BHCC energy tariff is made up of two components the first being the cost to produce the energy and the second being the cost of distributing the energy within the UK. The latter is termed Distribution Use of System (DUoS) charges.

4.2.5 The cost of distribution varies during the day in relation to consumer demand. For the street lighting sector it is split into three bands black, yellow and green with black being the most expensive and reflects largest network demands. Green is the lowest reflecting lowest network demand, essentially off peak.

4.2.6 Between November and February street lighting is using energy during the black DUoS period which is normally during early evening and the costs are disproportionate to consumption.

4.2.7 Anything that can reduce the use of energy during the black DUoS period can have a significant impact on the load profile. The application of trimming is a key factor in this.

4.2.8 Through trimming, BHCC may save 15 minutes of operation per day per column which equates to 91 hours per annum. When considered against BHCC's 18,010 column's under this business case this equates to 1.639M hours per annum.

4.3 ADAPTIVE LIGHTING / DIMMING

4.3.1 An authority through its efficiency review could look to introduce a City wide adaptive lighting / dimming strategy to align to the principles of Ultra Efficient Lighting (UEL) *"the right light, in the right place, at the right time, with the right control system"* as well as the European Commission's Green Public Procurement (GPP) approach to provide sustainable public lighting. The strategy would be a major contributor to managing an authority's future revenue budget through ensuring that the correct lighting levels are applied to meet the tasks being lit; essentially ensuring that the roads are not over lit and light is not wasted.

4.3.2 It is imperative to remember that before adaptive lighting can be implemented, full consultation should be carried out with all relevant stakeholders and risk assessments in accordance with Step 2 of the BS5489-1:2013 design process. There are certain areas where adaptive lighting might not be implemented or can be considered but with extra caution based upon a specific site risk assessment as indicated below.

Application	Part-night / switch off	Dimming
Conflict areas	No	Yes
High street crime	No	No
CCTV	No	Only if CCTV system permits and following consultation
Special security areas	No	Only following consultation
Areas adjacent to public entertainment, licensed premises, shops, clubs etc.	No	Yes, can also consider increasing levels when clubs close

4.3.3 The ILP has undertaken detailed research analysing data for residential areas through which a clear lighting profile became apparent. For these areas once the lighting switches on it should operate at 100% output until 22:30. This is the time that has been identified as the acceptable time to implement dimming.

4.3.4 From 22:30 until 06:00 the lower lighting class can be applied which equates to an approximately 25% reduction in energy and carbon. It should be noted at this point that there is not a direct link between the amount of money and energy saved.

The lighting should return to 100% output from 06:00 until dawn, to allow for the increase in both pedestrian and vehicular traffic flow.

4.4 CONTROLLING ADAPTIVE LIGHTING

4.4.1 Adaptive lighting can be implemented in a number of ways as follows:

- Preset dimming through the use of dimming photocells which will send a signal to the ballast at a defined time of night to dim the lighting. These units are essentially a one off pre-programmed item which will require replacement if the adaptive lighting periods / times are to change.
- Preset dimming through intelligent ballasts. The ballast can be programmed such that they 'know' the time of year and will dim the light output at a defined time of night. These units are essentially programmed before installation and the majority can be re-programmed if the adaptive lighting periods / times are to change.
- Central Management System. The CMS allows a fully flexible adaptive lighting installation to be commissioned with the times of changing lighting levels programmed through the server and communicated to each lighting column. This permits different profiles for during the week and weekends, permits changing the lighting regime to accommodate events where the full light output may be required and facilitates trimming.

4.4.2 Based upon approaches within other authorities we have based the business case on the dimming of 60% of the streets within BHCC and used the core hours recommended by the ILP and advised earlier.

4.5 PART NIGHT LIGHTING

4.5.1 From BHCC's perspective there is no consideration at this time for the application of a full switch off but in the future there may be consideration for some part night installations, for example where areas abut against the South Downs. Any such consideration would not be undertaken without appropriate consultation. The ILP have produced a guidance document on the risk assessment approach to be considered / followed when considering any part night considerations and this has been included within Appendix G

4.5.2 For the purpose of this business case should part night lighting within the areas advised be considered then it will mainly affect approximately 20% of the existing 35 and 55 Watt SOX lighting. If a part night strategy is to be applied then it is expected that the areas considered will be lit at full output between dusk and 22.30 where the lighting will then be adapted (dimmed) to the next lowest lighting class until 00.00 (midnight) when it will be turned off. In the early mornings the lighting will be turned back on to full output from 06.00 until dawn. Where this is applied then the energy and carbon savings will amount to approximately 75 to 80% compared to the current energy use.

4.6 ENVIRONMENTAL CONSIDERATIONS

4.6.1 One major benefit of lighting level reduction is the associated reduction in energy and consequently potentially polluting carbon CO_2 emissions.

4.6.2 Through the applicable choice of lantern and mounting arrangement upward light can be minimised to reduce sky glow. This can affect the view of the night sky which is particularly relevant to astronomical observatories. The application dimming or part night switch off will also aid the reduction of unnecessary light during the night.

4.6.3 As with upward light reduction, efficiently designed lanterns and mounting arrangements will minimise unnecessary light intrusion into adjacent properties or areas.

4.7 ALTERNATIVE POWER CONSIDERATIONS

4.7.1 The use of solar power is growing as a sustainable method for the production of electricity and a number of suppliers have considered the installation of solar panels on lighting columns. One such provider is Scotia who produce a square column in cross section with solar panels on three sides starting from 1.5m above ground level (anti vandal considerations). When installed the column is set up such that the panels are positioned to make the best use of the suns position through the day. When these first appeared on the market the way forward was to use what is termed the ‘feed-in tariff’ arrangements which is where the solar system feeds any electricity not required during daytime into the national grid for which the producer gets paid. Electricity can then be drawn back when required.

4.7.2 At the outset the feed in tariff was in the order of 45p/kWhr paid for energy generated and energy ‘drawn back’ later cost in the order of 10p/kWhr so at that time there was the potential for a business case based upon the charge for the sale of energy against the electrical load taken provided that the column could generate sufficient energy.

4.7.3 At the time of investigation it was considered that at best with good sun light access to the panels (i.e. no shadowing from buildings etc. which is unlikely in a lot of instances) that a 10m SunMast could generate 276 kWh/yr.

4.7.4 From a general perspective we have seen feed-in tariff rates fall as the scheme has been far more successful than the government ever expected so payback considerations are diminishing. It would be more appropriate to install such units on top of a building with full sun light access rather than a lighting column.

4.7.5 It should also be noted that if a solar unit is installed based upon feed-in arrangements that there is still the high cost of connection to the mains electricity supply.

5 FINANCIAL BUSINESS CASE

5.1 ENERGY RATES

5.1.1 It is important to consider electricity costs and predicted changes to tariffs in the future, within the payback assessment calculations. The council's current energy tariff is £0.1079p kWhr and we need to understand how this may change.

5.1.2 **Table 9** has been developed from Department of Energy & Climate Change (DECC) figures and looks to the street lighting energy market up to March 2024. The table considers low through to high energy rate changes (pink cells) and advised on a media price based upon these (blue cells) with the year on year % increase being shown (whitecells).

5.1.3

Table 9, DECC energy forecast.

	Mar-15	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24
Cost of Electricity (low)	8.97	9.42	9.92	10.07	10.37	12.05	11.78	12.37	12.60	13.01
Cost of Electricity (reference)	9.58	10.52	11.29	11.29	11.40	12.77	12.90	13.52	13.83	14.37
Cost of Electricity (high)	10.19	11.89	12.73	13.00	13.45	14.84	14.97	15.54	15.66	15.97
Av cost of Electricity	9.58	10.52	11.29	11.29	11.40	12.77	12.90	13.52	13.83	14.37
% Increase on year		9.8%	7.3%	0.0%	1.0%	12.0%	1.0%	4.8%	2.3%	3.9%

5.1.4 It will be noted that March 2020 indicates a 12% increase in energy. This is to be expected as the Chancellor George Osborne announced in his 2016 budget that he will abolish the carbon reduction commitment (CRC) and raise the Climate Change Levy (CCL) from 2019 to compensate. The Treasury will increase the main rates of the CCL from 1 April 2019 to "cover the cost of CRC abolition in a fiscally-neutral reform".

5.2 EVIDENCING THE POTENTIAL SAVINGS AND PAYBACK PERIODS

5.2.1 Payback is based upon the cost of the changes to the street lighting asset against the energy and operational savings that these changes will return. It is therefore a factor of the value of the current asset in terms of energy consumption and reactive / routine maintenance operations against the costs of the new equipment in terms of materials and installation as well as the new energy and operational costs.

5.2.2 It should be noted that payback is the breakeven point at which the cost of investment breaks even with savings and all clients should ensure there is a period of earned savings made before any further consideration is made for future savings on the installation.

5.2.3 Through moving from a lamp-based light source to an LED based upon the current control regime the electrical load can be reduced by up to 4,369,530kWh, which is achieved through intelligent control systems, trimming and dimming.

5.2.4 In terms of cost, moving from a lamp based light source to an LED based upon the current control regime reduces the energy cost by £471,472 per annum which is achieved through intelligent control systems, trimming and dimming.

5.2.5 **Table 11** shows the predicted Carbon Reduction Commitment costs as advised by DEC for the coming years. It should be noted as advised above that the CRC payment stops for 2020 and in then incorporated into the Climate Change Levy (CCL).

Table 11, DECC predicted CRC payments until 2022.

CRC

	Mar-15	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20	Mar-21	Mar-22
£/tCO2e	£15.70	£ 17.49	£ 19.28	£ 21.06	£ 22.85	£ 24.64	£ 26.43	£30.00

5.2.6 The move from a lamp-based light source to an LED based upon the current control regime reduces the carbon footprint by 2,179 Tonne CO_2. When we consider the application of trimming and adaptive lighting (dimming) as well this reduces the current electrical load by 2,363 Tonne CO_2.

5.2.7 In terms of cost, moving from a lamp-based light source to an LED based upon the current control regime reduces the carbon cost by £41,344 per annum, achievable through the applications stated above.

5.2.8 A total energy and carbon saving of £512,817 per annum can therefore be achieved.

5.2.9 It should be noted that the above savings are also based upon the full application of the British Standard for road lighting, BS5489-1:2013 which permits a reduction in lighting level when using white light.

5.2.10 Overall, as can be seen based upon the inventory provided, the potential electrical load savings across the whole lighting asset through the introduction of LED technologies equates to around 43% but increases to 60% when trimming and adaptive lighting (dimming/part night switch off) is considered.

5.2.11 The savings on the CPO lamp technologies (17% of stock) are lower at 29%, as the CPO lamp already has a high level of energy efficiency. This is in comparison to the other light sources such as High Pressure Sodium (SON) where savings of 30% to 58% and SOX where savings of 29% to 57% are both achievable.

5.3 FURTHER CONSIDERATIONS

5.3.1 In future there may be consideration given to some part night lighting, for example in areas which abut the South Downs. If considered then it is expected that this will mainly affect approximately 20% of the 35 and 55 Watt SOX lighting. If a part night strategy is to be applied then it is expected that the areas considered will be lit at full output between dusk and 22.30 where the lighting will then be adapted (dimmed) to the next lowest lighting class until midnight when it will be turned off. In the early mornings the lighting will be turned back on to full output from 06.00 until dawn.

5.3.2 If this approach is undertaken in addition to the saving strategies already identified then it is anticipated that the overall energy and carbon savings will be in the order of 60%.

5.3.3 This will provide an additional saving of £6,515 per annum thus providing an overall saving of £519,332 per annum.

5.3.4 In addition the existing 1,100 street lights that have already been converted to LEDs under the trial installations need to be considered with respect to their operational profiles. Once these lanterns have been fitted with an intelligent control then their profile can be set to include trimming and adaptive lighting. This will bring an additional £8,026 per annum saving.

5.4 PAYBACK

5.4.1 In order to estimate the payback upon investment for a move to LED lanterns the current BHCC street lighting rates have been considered. The core contract requirements are not available so a number of assumptions have had to be made. It should be noted that, as discussed later, payback is the breakeven point at which the cost of investment breaks even with savings and all clients should ensure there is a period of earned savings made before any further consideration is made for future savings on the installation.

5.4.2 The installation costs are provided in Appendix I.

5.4.3 These costs have been compared to other local authorities that are looking to similar projects and could be considered comparable to BHCC with an average lantern installed cost of £335.

- Bournemouth Borough Council, undertaking a Salix funded project to replace 16,627 street lights plus other funding of £1,000,000 for lighting column and £448,000 for illuminated signage. Their average installed lantern costs being £377.
- Wirral, looking at a cost of £320 per lantern fitted.

5.4.4 The current maintenance regime is based around a three yearly bulk clean and change which is based upon the current lamp and ballast technologies. Moving to LEDs will remove the requirement for a lamp change but the lantern will still require a routine clean. It is suggested that this operation should move to a six yearly frequency which will then link with the electrical testing regime and provide further operational and efficiency savings.

5.4.5 Colas (the incumbent contractor) have advised that based upon the trial installations and experience on other projects that there would be a potential saving on the bulk clean and change cost of circa £170,000 per annum. This figure relates to when the whole programme has been completed and would therefore be approximately £57,000 per annum whilst the programme is in progress.

5.4.6 In addition to the above savings a reduction in reactive maintenance would be expected in the medium to long term future following completion of the project. However, it is not possible to accurately predict figures at this stage, particularly as the new core contract requirements are not yet procured.

5.4.7 The payback period based upon the anticipated work costs and the core approach to changing to LEDs with adaptive lighting but not part night lighting is estimated at:

- Payback based upon changing to LED lanterns and CMS control equates to 13.6 years.
- Payback period based upon changing to LED lanterns, CMS control and lighting columns 15.4 years.

5.4.8 If the existing LED installations and also part night lighting are also considered then the revised payback periods will equate to:

- Payback based upon changing to LED lanterns and CMS control equates to 13 years.
- Payback period based upon changing to LED lanterns, CMS control and lighting columns 15 years.

5.4.9 The project at this time is being considered for a 3 year deployment and based upon this the CPO installations would be considered towards the end of the whole deployment period. This is based upon the CPO installations being fairly new and comparatively energy efficient at this time. By the time the final year of the project is achieved then these installations will be a substantial way through their life span and should be considered for replacement / upgrade.

5.4.10 Payback calculation notes:

- Savings have been considered based upon expected PECU / CMS array data, i.e. 4,059 burning hours per annum as the savings and change from 70/35 lux to photocell 35/18 lux have been considered earlier.
- In addition to the saving through energy there should be a reduction in reactive maintenance operations as the LED supplier data shows the equipment to be more reliable in operation than the current lamp and magnetic control gear used.
- It should be noted that the payback period is based upon the current energy tariff paid by BHCC of 10.79p kWhr and then the forecast energy prices advised by DECC as discussed in section 5.1.
- CRCEE has been based upon the current 2015/16 rate of £17.49 per tonne of CO_2.

5.5 LIKELY WORK REQUIREMENTS

5.5.1 BHCC need to consider the condition of the whole asset and the work required to columns, supply connections and lanterns to ensure that the project looks to provide the right level of lighting for each street and road.

5.5.2 Considering the work undertaken in the past three years it would not be viable to:

- Upgrade / replace the CPO lighting installed within the past 3 years within the early stages of the 3 year project programme as it may not have a better LED solution and the CPO was installed as an energy reduction measure over the then existing lighting,
- Older CPO installations may have a valid LED solution as the lantern is still well within its operational life so from an asset management perspective a retro-fit option may be preferable. In part this depends where the lanterns sit within the deployment programme. If a 3 year programme is to be considered then in year 3 some of these lanterns may then have a valid replacement requirement based upon their then age.

5.6 FINANCIAL BUSINESS CASE FUNDING OPTIONS APPRAISAL

5.6.1 The Green Investment Bank(GIB) provides a loan facility to support spend to save schemes for low carbon, energy saving projects. The key benefits of these loans include interest rate certainty, the ability to draw down funding in line with cash flow requirements for up to five years and the ability to defer repayments in line with estimate cost savings (subject to rolled up interest) at the point of agreeing financing of the project. These loans have been used by a number of authorities across the country to support appropriate projects. However, each authority's financial position is different at the point of decision and prevailing market conditions may make other options more attractive

5.6.2 Although there are considerable benefits to the GIB loan facility, the associated costs of this loan include arrangement fees, commitment fees for any deferred drawn downs of resources and monitoring fees in addition to rates greater than current Public Works Loan Board (PWLB) borrowing at the point of fixing the interest rate. It has been estimated that the fees associated to the GIB loan facility would be £0.090m and the interest rate could be between 0.5% and 1% higher than PWLB rates at the point of agreeing the loan. PWLB rate currently attracts an additional 0.20% discount known as a certainty rate; interest rates are at historically low levels and the projected rates from the council's treasury advisors are that they will remain so during the investment period of this project. It is therefore considered that the interest rate risk is limited and therefore a loan facility with GIB would not provide value for money in this instance. The council's cash flow management position and the ability to access historically low interest rates on PWLB borrowing over the duration of this project outweigh the benefits of the GIB loans highlighted above.

5.6.3 A 'do-nothing' approach has also be considered. The proposed scheme is forecast to generate service savings (although not to the level identified in the ISFP), and therefore a do nothing approach would not allow these savings to be generated. Future year modelling of inflation and energy price estimates suggests that to do nothing would result in service pressures in the long-term of up to £0.050m per annum by 2030; this is in addition to the unachieved savings target. The proposed scheme would help mitigate this risk as it reduces the amount of electricity required for the street lighting portfolio.

5.6.4 Attached below is the Financial Business Case Summary including capital costs and funding and revenue implications.

Capital Funding	2017-18	2018-19	2019-20	**Total**
	£'m	£'m	£'m	**£'m**
Capital Expenditure:				
Electrical Works	2.318	2.318	2.318	**6.954**
Columns and Connections	0.334	0.334	0.334	**1.002**
Total Capital Costs	**2.652**	**2.273**	**2.273**	**7.956**
Funded by:				
Unsupported Borrowing	2.352	2.352	2.352	**7.056**
LTP Capital Grant	0.300	0.300	0.300	**0.900**
Total Funding	**2.652**	**2.652**	**2.652**	**7.956**

Revenue Implications	2017-18	2018-19	2019-20	2020-21
	£'m	£'m	£'m	£'m
Additional Salary Costs	0.046	0.046	0.046	0.000
Reduction in Bulk Lamp Clean and Change Costs	0.000	(0.067)	(0.133)	(0.200)
Reduction in Electricity Costs	0.000	(0.157)	(0.314)	(0.472)
Reduction in Carbon Reduction Commitment Costs	0.000	(0.014)	(0.028)	(0.041)
Borrowing Repayments	0.000	0.159	0.328	0.499
Total Revenue Implications	**0.046**	**(0.033)**	**(0.101)**	**(0.214)**

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6 ASSET MANAGEMENT

6.1 ASSET MANAGEMENT

6.1.1 Public lighting is a long life asset with columns having a typical design life of 40 plus years, lanterns 20 years and light sources 4 plus years. It is best managed as such with service improvements being introduced to suit the design life i.e. when asset become life expired and with due consideration to maintaining an even revenue maintenance / refurbishment budget year on year introducing efficiencies as they are or become applicable without inadvertently introducing any long term problems through poor asset management and change regimes.

6.1.2 The Government have been encouraging Authorities to develop a Highway Infrastructure Asset Management Plan (HIAMP) which in turn is supported by Maintenance Management Plans for Highways, Structures and Public Lighting.

6.1.3 The London Lighting Engineers Group (LoLEG) through funding from the London Transportation Asset Management Board (LoTAMB) have produced a framework document for London Authorities to guide them through the process of developing their own Public Lighting Maintenance Management Plan (PLMMP) and this is available through the LoLEG web site www.loleg.co.uk WSP | PB were part of the LoLEG panel developing this system and have implemented it within Westminster City Council.

6.1.4 The introduction of LED technology will not only bring additional energy savings but also enable advantages to be taken of the change to 'life cycles'. The Revenue funded activities could be changed to the following:

- 6-yearly 'Clean' (to ensure quality light is emitted from the lanterns)
- 12-yearly 'LED Driver' change
- 2-yearly General Inspection (Visual)
- 6-yearly 'Detailed Inspection' (TR22 Structural Assessment)
- 6-yearly Electrical Integrity Testing
- Reactive Maintenance

6.2 INTRODUCING ENERGY SAVINGS AND EFFICIENCIES

6.2.1 BHCC are looking to a programme of energy and carbon savings whist managing the street lighting service delivery. The timescale for the deployment of efficiency saving equipment and techniques for this need to be carefully considered from the point of view of good asset management.

6.2.2 It may be tempting to look to funding to replace as many lanterns and columns within BHCC as possible within a short time scale. This will, as discussed later, bring large energy and carbon consumption savings as well as service improvements such as an initial reduction in reactive maintenance. However it should be understood that a 'do it now' approach whist bringing these large scale savings now will potentially mean that no further energy savings can be achieved in the future downstream from the investment period.

6.2.3 It may therefore be better to look at the application of good asset management and bring in efficiencies through new technologies and good operational practices such that year on year investment can be made with year on year energy and carbon consumption savings.

7 EQUALITIES/IMPLICATIONS

7.1 EQUALITIES IMPACT ASSESSEMENT STATEMENT

7.1.1 In respect of the following areas it is not considered that there are any issues that would disproportionately disadvantage any particular protected characteristic group:

- Legislation
- Environmental impact
- Maintenance requirements
- Design
- Replacement works
- Added value
- Light sources
- Future strategy

7.1.2 The following provides explanation:-

Legislation	The council clearly intends to comply with all legal requirements and statutory duties and codes. No particular protected characteristic group will be affected by the compliance with legal requirements
Environmental Impact	The council is committed to providing a sustainable environment for the residents and stakeholders in the city. This commitment has been historical and seeks to benefit all. No particular protected characteristic group will be impacted.
Maintenance Requirements	The council has in place a set of processes and procedures that allow for an effective and sustainable maintenance regime. This regime benefits all residents. Therefore, no protected characteristic groups experience the council's approach to the maintenance of street lighting differentially.
Design	Designs are undertaken to ensure streets are lit to appropriate levels and in line with national guidance and British Standards according to each street's classification and usage. Therefore no protected characteristic groups experience the council's approach to design in relation to street lighting differentially.
Replacement Works	Replacement works are planned in advance and comply with requirements in respect of traffic management, and parking suspensions and other statutory requirements. This is of benefit to all residents. Therefore no protected characteristic groups experience the approach to replacement works in relation to street lighting differentially.
Added Value	Added value is about ensuring that design, maintenance and environmental impacts are considered in order to consider current standards and specification as well as minimise future maintenance costs. This benefits all residents. Therefore no protected characteristic groups experience the council's approach to added value in relation to street lighting differentially.
Light sources	The council is committed to using the most efficient method of illumination to minimise energy and carbon usage and to reduce electricity costs. This benefits all residents, and thus no protected characteristic groups experience the council's approach to added value in relation to light sources in relation to street lighting differentially.
Future Strategy	The council is committed to continuing to reduce energy and carbon emissions and to work jointly with colleagues and partners to provide city wide benefits, such as smart cities technology. This benefits all residents. Thus no protected characteristic groups experience the council's approach to future strategy in relation to street lighting differentially.

7.2 OTHER IMPLICATIONS

7.2.1 Each street is designed individually to meet British Standards and other national guidance in respect of road lighting.

7.2.2 Any specific issues relating to individuals are dealt with on a case by case basis. We will be notifying customers of upcoming improvements and provide contact details.

7.2.3 Consultation with Sussex Police will be undertaken where needed and guidance sort from them in respect of crime areas and need for CCTV coverage.

7.2.4 There are some common standards relating to Smart Cities which are currently being consulted on. These will be kept in mind and applied where/when appropriate.

7.2.5 All requirements relating to permitting, traffic management, road closures and parking suspensions will be adhered to.

APPENDIX A

INVEST TO SAVE FUNDERS APPROACH

CORE APPROACH

The funders will each have their own requirements for application and some focus purely on funding for energy saving equipment, light sources, control equipment, lanterns and the like whereas others will also include for other assets such as lighting columns and electrical connections. Some may also look to the sustainability of the installation with regard to good asset management avoiding potential downstream issues.

All funders adopt the same basic approach to how the loan is considered and paid back which is generally through the energy usage and Carbon Reduction Commitment (CRC) savings achieved.

At present funders do not take into account savings in maintenance and reactive operational savings brought about through reviewed operation procedures.

FUNDERS CORE REQUIREMENTS

When considering any funding option it is important that a due diligence review has been undertaken, essentially ensuring that the existing asset is known and understood such that the existing base line energy and carbon can be accurately determined as this will be used to aid the prediction of any savings.

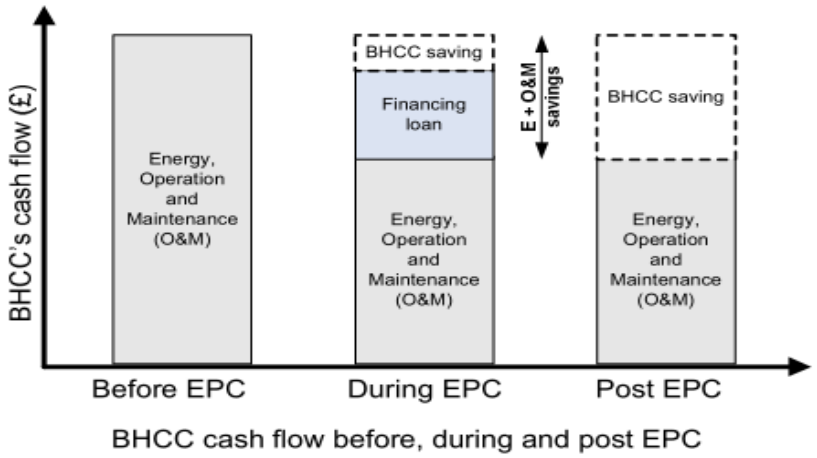
The review of new technologies / energy reduction strategies should be undertaken such that the required performance requirements are met in terms of lighting levels, suitability of the proposed technologies i.e. LEDs such that future energy and carbon costs can be determined.

The energy and carbon savings can then be calculated based upon the predicted electrical and carbon costs and the known existing costs.

The installation costs and project period can be established based upon the technologies and lighting strategy to determine year on year installation costs.

Payback is based upon the cost of the changes to the street lighting asset against the energy and operational savings that these changes will return. It is therefore a factor of the value of the current asset in terms of energy consumption and reactive / routine maintenance operations against the costs of the new equipment in terms of materials and installation as well as the new energy and operational costs.

The following chart indicates the cash flow process before, during and after the Efficiency Procurement Contract (EPC). It should be noted that actual energy and carbon savings to BHCC will not be achieved until the end of the EPC period. During this period there will be a reduction in energy and carbon costs as the new technologies are deployed but these savings are used to fund the loan. There may also be operational routine and reactive maintenance savings during the EPC period brought about by the use of more reliable and longer lasting equipment, these are shown as the BHCC savings during the EPC.



BHCC cash flow before, during and post EPC

It should be noted that through the way that public lighting energy is procured using un-metered supplies that energy savings are not immediate and are only made when the inventory is updated and submitted to the energy supplier for agreement. This may be on a 6 or 12 monthly basis. It should therefore be appreciated that the savings introduced through the new technologies in the first year of deployment will only be recognised and achieved in year two of the EPC and so on.

Payback is the breakeven point at which the cost of investment breaks even with savings.

INTEREST RATES

When considering any funding option it is important that interest rates are understood and what may happen to them in the future. The following table has been provided by BHCC for this purpose.

Year of project	1	2	3	4	5
Financial Year	2017-18	2018-19	2019-20	2020-21	2021-22
Interest Rate for each year	3.40%	3.66%	3.88%	4.17%	4.47%

The following table provides a high level comparison of the three funding options.

Loan Provider	Funded		Loan payments				
	Energy saving equipment	Column & connections	Energy savings	Carbon savings	Operational savings	Payback post drawn down	Payment periods (Yrs)
Salix Finance	Y		Y	Y *		Y **	5
Green Investment Bank	Y	Y	Y	Y *		Y **	20
Public Works Loan Board	Y	Y	Y	Y *	Y		25

Notes:

* Carbon savings are at the Council's risk as the CRCEE scheme is likely to be removed and the carbon cost incorporated into the Energy Climate Levy.

** The loan payments commence upon energy savings being achieved.

APPENDIX B

GREEN INVESTMENT BANK

OVERVIEW

The Green Investment Bank (GIB) is 100% owned by the government although privatisation is being considered, and has some £3.8bn to invest in green technologies to accelerate the UK's transition to a green economy, although there are currently considerations to privatise it.

A number of Authorities are looking to the GIB and Glasgow and South-End-on-Sea have progressed with a project and funding requests with a number of other authorities in the process of applying for funding.

The GIB do lend on commercial terms.

The GIB see street lighting as being a key market for them to consider and have developed a specific application process, mainly due diligence and technical requirements for any Authority looking to bid for funding. The GIB don't just look at the primary energy and carbon savings but also look to consider secondary environmental effects and causes and good asset management is one of these considerations.

Funding from the GIB is not limited to just the energy efficient equipment, as is the case with Salix funding, but can consider the rest of the infrastructure such as the columns, connections and underground cabling although payment is still through the energy and carbon savings. Repayments are matched to energy savings.

It is permissible to include CO_2 reduction through the Carbon Reduction Commitment Energy Efficiency scheme (CRCEE) within the savings. However this must be at a considered risk as there are current proposals to scrap the CRCEE scheme and bring the carbon cost into the Climate Levy charge which forms part of the energy tariff

The GIB does not have any prescribed delivery roll out for the investment but from examples seen would consider programmes of up to a 5 year implementation plan with a 20 year loan period. Interest is only payable once the funding is drawn down for . GIB recognise that payback periods may well be of the order of 6 to 16 years.

The benefits of GIB funding include:

- Rate certainty, this is a fixed rate loan facility (from signing to final repayment) with a transparent pricing mechanism providing low all-in interest rates;
- Cash flow matching drawdown periods of up to five years to match forecast project spend;
- Repayment deferral interest rolled up during installation and repayments only commence once this is complete (essentially once savings are starting to be made, repayments would commence based upon an agreed schedule and would normally be considered to start six months after each phase of the works is completed. This would require the BHCC inventory being updated on a six monthly basis to ensure that the savings are being achieved;
- Profile of repayments debt repayments profiled to match forecast savings for up to 25 years; and
- Ease of execution – standard loan documentation, developed with local authorities, and guides to streamline investment process.

APPENDIX C

PUBLIC WORKS LOAN BOARD (PWLB)

OVERVIEW

Public Works Load Board (PWLB) moneys are provided by Act of Parliament, drawn from the National Loans Fund and rates of interest are determined by the Treasury. The Board's accounts are audited by the Controller and Auditor General whose reports on them are laid before Parliament.

The consideration of a loan from the PWLB is that repayments are not linked to energy savings and as such a business case can be developed based upon total revenue savings which will include the associated energy and carbon savings but also savings achieved through operational savings brought about through new / revised routine maintenance operations and potentially reactive maintenance through the use of more reliable and longer life equipment.

It should also be considered that the PWLB loan is also not linked to any specific measures such as energy reduction as required under both Salix Finance and the Green Investment Bank. The PWLB could therefore be used in conjunction with Salix Funding to cover the cost of non-energy saving infrastructure required for the project, the loan being paid back through operational savings.

The notes comparing GIB and PWLB should be considered as essentially the PWLB loan payments commence from when the loan is first drawn down whereas Salix and GIB repayments commence once savings start to be achieved.

APPENDIX D

REFERENCE DOCUMENTS

British Standards

BS 5489-1: 2013	Code of practice for the design of road lighting
BS EN 13021-2	Road lighting, performance requirements

Highways Agency documents

TD 34/07	Design of road lighting for the strategic motorway and all-purpose trunk road network
TA 49/07	Appraisal of new and replacement lighting on the strategic motorway and all-purpose trunk road network
IAN 167/12	Guidance for the removal of road lighting

Institution of Lighting Professionals

TR12	Lighting of pedestrian crossings (1997)
TR25	Lighting for traffic calming features (2002)
TR27	Code of practice for variable lighting levels on highways
PLG 02	Application of conflict areas

ILP document ‘Guidance on the reduction of obtrusive light’ (2012)

Other documents

EU Green Public Procurement (GPP) criteria for street lighting

EU Energy related Products (ErP) Directive

TfL CMS road dimming profiles report (draft)

CIE 150 Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, (2003)

CIE 126, Guidelines for Minimising Sky Glow (1997)

GLOSSARY

Lamp types

SOX, Low Pressure Sodium light source, providing a monochromatic orange light.

SON, High Pressure Sodium light source providing a golden light

CDM / CDO, Metal Halide lighting source providing a white light

CPO Philips CosmoPolis lamp, a metal halide light source providing a white light with a good operational life span

LED, Light Emitting Diode solid state lighting source providing a white light source

Colour Temperature

A measure of how warm or cool a light source appears.

Lantern

The term used to describe the lantern or unit that contains the light source and optical components.

Unmetered Supplies Operator (UMSO)

The UMSO is part of the Licensed Distribution System Operator (LDSO), also known as the Distribution Business or Network Operator. The UMSO is responsible for looking after all of the Unmetered Supplies on its Network. The UMSO makes new connections and decides what equipment is suitable for treatment as an Unmetered Supply. The UMSO provides a summarised inventory to the MA for Half Hourly traded UMS or calculates an Estimated Annual Consumption (EAC) for Non Half Hourly traded UMS. In Brighton & Hove, this is UK Power Networks (UKPN), who are responsible for the majority of electrical cabling in the city,

Meter Administrator (MA)

The MA is responsible for providing Half Hourly consumption data into Settlement. This is the consumption of a particular customer in kWh, for each half hour of every day. The Supplier will appoint the MA for Settlement purposes.

BSCCo (the Balancing and Settlement Code Company, the role fulfilled by ELEXON)

It is responsible for ensuring that the processes within BSCP520 ‘Unmetered Supplies Registered in SMRS’ are carried out effectively. BSCCo is also responsible for issuing Charge Codes and Switch Regimes to customer such as product manufacturers and county councils that have an Unmetered Supply inventory. BSCCo also coordinates the Central Management Systems (CMS) approval process.

Unmetered Supplies User Group (UMSUG)

An expert group reporting to the Supplier Volume Allocation Group (SVG) advising them on the UMS arrangements under the Balancing and Settlement Code (BSC). Their work includes reviewing Charge Code applications, advising on changes to the relevant BSC subsidiary documents

Switch Regimes

Switch Regimes are 3 digit codes that allow the operating hours for equipment to be determined. This information together with the power information obtained from the Charge Code allows annual consumption (kWh) to be calculated.

The Switch Regime is a component of the Detailed Inventory submitted by the Customer to the UMSO. This is then used by the UMSO (for NHH Customers) or the MA (for HH Customers) to determine the consumption.

Charge codes

A Charge Code is simply a 13 digit number which represents a specific type of UMS equipment. It is used by UMSOs and MAs to look up the power value (known as circuit watts) associated with the equipment and calculate consumption.

Charge Codes are required so that the energy consumption of the equipment can be recorded as accurately as possible. Equipment shall not be connected to the Distribution Network without first being issued with a Charge Code.

Standard lighting equipment has the following structure:

Digits	Description.
1 and 2	Identifies the lamp type.
3, 4, 5 and 6	The nominal lamp wattage (typically the power value printed on the lamp e.g. a 100W SON) N.B. this is not the same (usually less than) as the circuit watts.
7	The control gear type.
8,9 and 10	Allows equipment with the same full circuit watts to have a different charge code.
11, 12 and 13	The dimming level, i.e. the percentage of full load (N.B. '100' = full circuit watts).

APPENDIX E

INSTALLATION COST ASSESSMENT

Brigton Hove Lighting Strategy **Bill of Quantities**

70016163 - Brighton and Hove City Council
02/06/2016 Electrical aspects (luminiare and control)

Item	Item Description	Quantity	Unit	Cost	Total
	Series 200: Road Lighting Site Clearance				
200.002	Take down Lantern and remove to tip Any lantern any mounting height	18010	No.	£10.80	£194,508.00
1300.013	Micro Luma 12 LED Dali Post Top GREY, Nema	5212	No.	£160.00	£833,920.00
1300.014	Micro Luma 20 LED Dali Post Top GREY, Nema	7700	No.	£165.00	£1,270,500.00
1300.015	Mini Luma 40 LED Dali Post Top GREY, Nema	1879	No.	£205.00	£385,195.00
1300.016	Luma 1 60 LED Dali Post Top GREY, Nema	3278	No.	£240.00	£786,720.00
1300.017	E/O for Heritage Unit / retro fit	1800	No.	£300.00	£540,000.00
1300.018	Install Lanterns Install any lantern up to 12m mounting height	23	No.	£56.59	£1,301.57
1300.019	Install Lanterns Install any lantern 10m mounting height	3577	No.	£50.78	£181,640.06
1300.020	Install Lanterns Install any lantern 8m mounting height	5946	No.	£49.47	£294,148.62
1300.021	Install Lanterns Install any lantern up to 6m mounting height	8464	No.	£43.65	£369,453.60
	Series 1400: Electrical Work for Road Lighting				
14.001	Extra over on any lanterns for supply and installation of CMS node	22741	No.	£70.00	£1,591,870.00
14.002	Extra over on any lanterns for supply and installation of CMS controller - Telensa	4		£5,000.00	£20,000.00
					£6,469,256.85

70016163 - Brighton and Hove City Council

02/06/2016 Lighting columns, brackets and connections

Item	Item Description	Quantity	Unit	Cost	Total
	Series 200: Road Lighting Site Clearance				
200.001	Take down and remove to tip 8, 10, 12 or 15m flange plated rooted column with single or double arm bracket - any projection.	600	No.	£75.01	£45,006.00
	Series 0600: Earthworks				
	Series 1300: Road Lighting Lanterns and Brackets				
1300.001	Installation of street lighting units. Rooted galvanised steel column numbered complete with lantern control gear , photocell, isolator, fuse all wiring to Isolator/tails. Commission Any lantern 12m mounting height <2m bkt	900	No.	£196.96	£177,264.00
1300.010	6M POST TOP COLUMN (5MM BASE) CU PHOSCO FOREST	900	No.	£167.27	£150,543.00
1300.012	Replace Existing bracket with new Single arm bracket up to 1 metre projection on 5 or 6 metre column.	100	No.	£28.11	£2,811.00
	Series 1400: Electrical Work for Road Lighting				
14.001	Extra over on any lanterns for supply and installation of CMS node on luminiare		No.	£139.38	£0.00
14.002	Extra over on any lanterns for supply and installation of CMS controller			£589.95	£0.00
	DNO WORKS				
TRANSFER	Includes up to 2mtrs excavation to locate the original pot ended cable,trenching and duct laying to the new apparatus including reinstatment in all other composite surface types. Includes service joint,service cable and cut out and includes terminating th	900	No.	£617.00	£555,300.00
					£930,924.00