South Cambridgeshire District Council

High Level Assessment

SOUTH CAMBS HALL

RE:FIT 3 ENERGY PERFORMANCE CONTRACTING FRAMEWORK

BOUYGUES ENERGIES & SERVICES

LOCAL PARTNERSHIPS

South Cambridgeshire District Council

WELCOME!

Firstly, thank you for registering your interest in the Cambridgeshire RE:FIT Programme! We hope that this High Level Assessment meets your expectations from joining the programme.

This document provides an overview of the sites we have surveyed, highlighting specific challenges at individual sites. You can also find generic description of the generic measures that we have proposed and the rationale behind the technology.

If you have any queries please feel free to call us

01223 781 380

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Document Control

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Author	Miles Messenger
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Changes	N/A

PROJECT **BRIEF**

South Cambridgeshire District Council (SCDC) has commissioned Bouygues E&S to undertake a High Level Assessment on the South Cambs Hall for an Energy Performance Contract under the RE:FIT 3 Framework. The Project Brief provided by SCDC sets out the senior leaders' ambition to showcase investment in green energy generation and energy efficiency. The Council's recently formed Climate Change and Environment Advisory Committee (CCE Committee) has agreed that Green Energy Investment will be one of the priorities within its Workplan 2018-2020. This property is the headquarters of SCDC, representing a large proportion of carbon emissions of the organisation. Thus, the investigation into CO_2 reduction and renewable energy opportunities at this site is a priority.

Scope: The investigation shall include the main Hall building and surrounding car park. It should also consider options for including Cambourne Business Park in scope. Various financing options shall be included for SCDC's consideration. It has been requested that the investigation should include an examination of the viability of solar canopies located with carpark. This should also include any complimentary approaches that may be offered through battery storage and EV charging point technologies.

Project Objectives:

- Reduction of environmental impact (including reduced CO2e emissions etc.)
- Savings on energy and water bills
- Long-term revenue stream and Return On Investment to be re-invested in green energy
- Increased energy self-sufficiency for the organisation

Minimum Targets: Minimum expectations in terms of energy demand reduction, generation, carbon emissions abatement are currently unknown due to a lack of previous comparative SCDC projects. The HLA will help to shape the Council's expectations for this and future projects, and will be used to identify the most effective set of measures for the achievement of project objectives. Expectation that there fossil-fuelled grid-supplied electricity demand reduced to zero from current …%. If grid connection is a problem, expectation that there be an option to create a micro-grid generation and distribution to EV charging points, LED lighting for carports and potentially sale of energy to neighbouring buildings in business park.

Financing & Investment Criteria: Whilst there is an obvious minimum requirement for any financial investment to be recovered, SCDC is currently open minded as to the period of time over which this takes place. It has initially been indicated that we may seek to achieve 7% RoI over period of 20 years (this is the average existing risk threshold although no formally-agreed threshold exists). Funding source from the SCDC Renewables Reserve Fund (and potentially from the Public Works Loan Board, depending on scale of investment needed)

A decision to proceed to the IGP phase will not be purely dependent on the level of financial gain, but will also take into account the environmental benefits.

Base Parameters:

Table 1: Energy Tariffs

Utility	Tariff Rate	Inflationary Factor	Carbon Factor
Grid-supplied Electricity (day)	£0.15235 / kWh	4% per annum	0.412 $kgCO_2e$ / kWh
Grid-supplied Electricity (night)	£0.10591	4% per annum	0.412 $kgCO_2e$ / kWh
Natural Gas	£0.0261 / kWh	4% per annum	0.184 $kgCO_2e$ / kWh
Fuel Oil	£0.0364 / kWh	6.49% per annum	0.268 $kgCO_2e$ / kWh
Water	£1.5373 / m^3	2.83% per annum	0.344 $kgCO_2e$ / m^3

With regard to Feed In Tariffs, Renewable Heat Incentives and other renewables subsidies, this High Level Proposal has been formed on the basis of installation being completed in the summer of 2019 and is, to the best of our knowledge, applicable at the time of publication.

Client Specifications: SCDC has set out the following electrical specifications:
All electrical installation works must comply with the following:

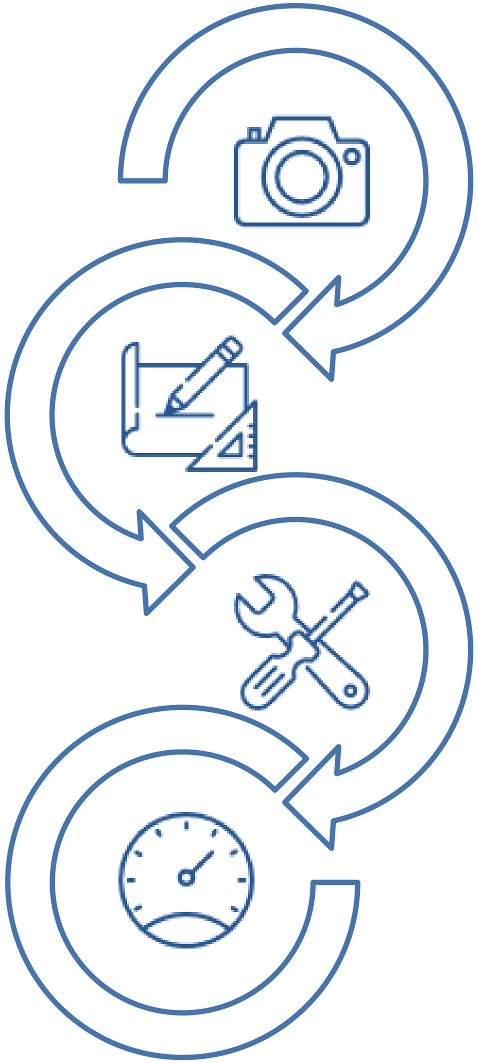
- IEE Wiring regulations
- Electrical regulations 18th edition
- Electricity at work regulations 1989
- Management regulations
- Consideration should be given to the BREEAM regulations to ensure any alterations do not adversely affect our rating

All mechanical works must comply with the Puwer Regulations.

In the absence of any other SCDC specific quality specifications or workmanship standards, we have based our specifications on that included in the original Invitation to Tender. We have also incorporated our company standards, which are in many cases of a more stringent criteria than that of our clients'. Should the Council wish for us to incorporate any additional technical requirements, this may be evaluated prior to the IGP.

VAT: All business cases shall exclude VAT from all utilities, goods and services.

THE **DEVELOPMENT PROCESS**



01. HIGH LEVEL ASSESSMENT (HLA)

We undertake initial site surveys to assess the energy performance of the asset(s), identify energy conservation measures and prepare an initial business case

02. INVESTMENT GRADE PROPOSAL (IGP)

We undertake detailed and targeted energy analysis of the asset(s), develop scopes, specifications and outline designs for energy conservation measures, obtain firm prices for the works and create a robust and comprehensive business case

03. IMPLEMENTATION

We finalise design and obtain approvals, mobilise, procure and coordinate the installation and commissioning of the project. This includes H&S management and associated statutory obligations

04. MEASUREMENT & VERIFICATION (M&V)

Bouygues E&S has a duty to monitor and report on the performance of the measures, with formal 'annual reconciliations' each year to demonstrate achievement of the Savings Guarantees.

DELIVERABLES

The outcomes of the business case (namely, the savings and payback period) form requirements of the contract agreement that must be improved upon at the Investment Grade Proposal stage

The IGP forms part of the contract agreement, committing us to deliver the project scope for the agreed capital cost and within the agreed timescales. The savings set out in the business case are bound into a Savings Guarantee, which exists for the payback period.

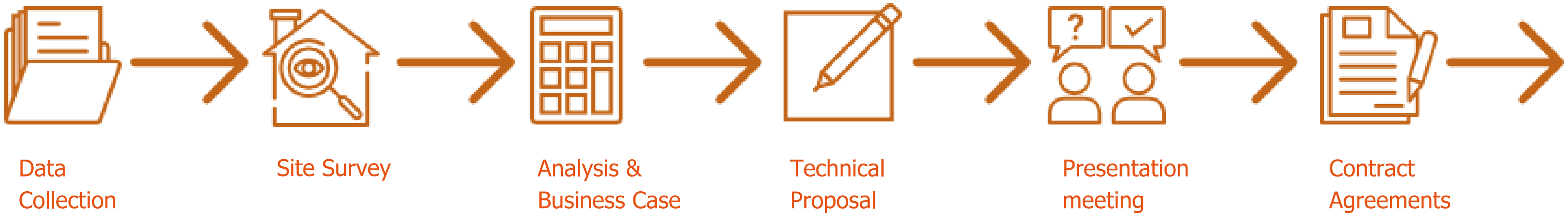
The 'works completion' is a formal milestone that marks the completion of our responsibilities in practical delivery, the start of the warranty period and commencement of the Savings Guarantee period.

THE **HIGH LEVEL ASSESSMENT**

As briefly mentioned above, the overarching purpose of the HLA is to 'set the goalposts' of minimum expectations that Bouygues E&S must meet at IGP stage. Whilst this is the main output deliverable, the HLA involves engineering investigations, options appraisals and feasibility studies, the development of a business case and supporting technical proposals. Bouygues E&S puts significant effort into this early stage, as we recognise the importance of having a firm footing and strong foundations the build the project on. We endeavour to establish a 'best value' technical proposition for each client that meets both programme requirements and local objectives. We seek to identify and account for technical and commercial risks wherever possible, or at least ensure that these are clearly communicated.

Our Energy Engineers have undertaken Surveys of South Cambs Hall. The purpose of this survey was to obtain a good understanding of the factors affecting the energy performance of the schools, the energy infrastructure and asset conditions. This has enabled us to establish 'Energy Conservation Measures' (ECMs) i.e. interventions to save energy, or generate renewable / low carbon energy on site.

Using our bespoke modelling tools, we have established potential energy savings, revenues, capital and operational costs associated with each ECM concept. We utilise our business case model to evaluate various combinations of ECMs to arrive at the optimum solution. This business case model provides various financial appraisals, carbon savings, the minimum Savings Guarantees and maximum payback period.



WHAT HAPPENS **NEXT**

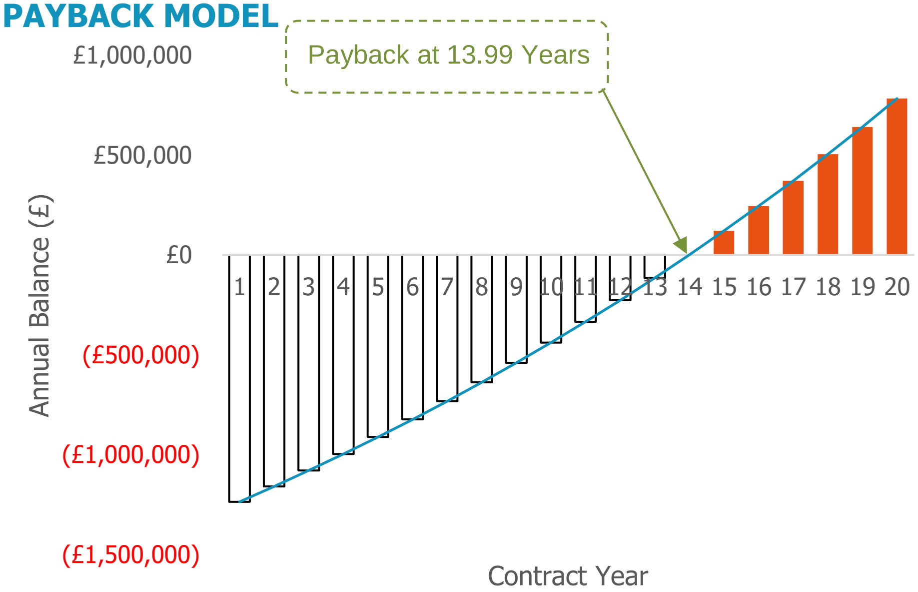
Presentation Meeting: We met with the Cam Academy Trust to present this HLA, discuss our technical rationales and answer any queries regarding the programme and proposal. This, coupled with the HLA documentation should empower the trust to make an informed decision on how best to proceed with the programme.

Decision to Proceed: Cam Academy Trust will confirm your decision to proceed to IGP stage via email to CCC and Bouygues E&S representatives. It should be noted that this decision is only to move to IGP stage and does not commit the trust to go forward to installation.

Contract Agreement: Our Contracts Manager will work with CCC's Programme Manager to prepare the contracts for the IGP. This contract will commit Bouygues E&S to deliver a compliant IGP and, on the proviso that this is achieved, commit the trust for remunerating the IGP fees, should the trust choose not to proceed to works.

HIGH LEVEL PROPOSAL **HEADLINES**

PAYBACK MODEL



KEY METRICS

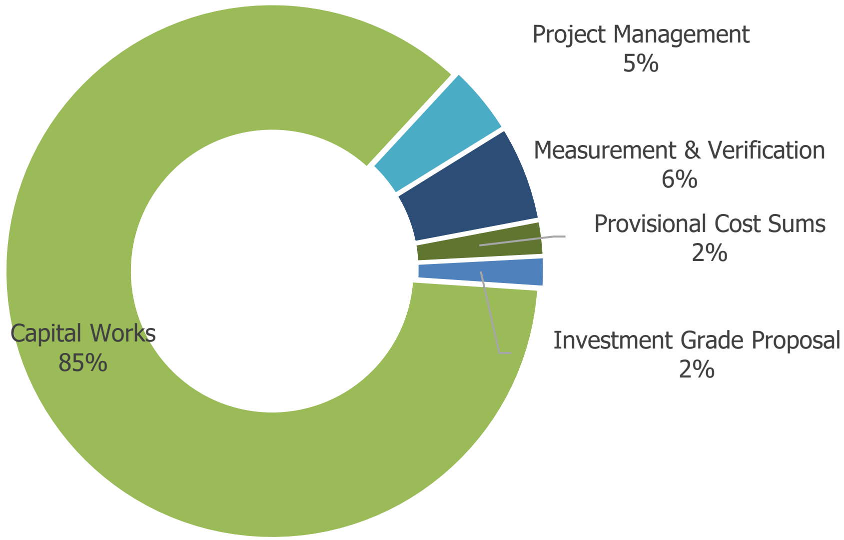
PROJECT CAPITAL COST	£1,311,068
PAYBACK PERIOD	13.99 years
OPERATING COST INCREASE	£4,950/yr
RENEWABLE ENERGY	570,907kWh/yr
CARBON EMISSIONS SAVING	212TCO$_2$/yr
ENERGY SAVING	691,981kWh/yr

* Based on the inclusion of the '120kW' solar car port option and not the 275kW option.

It is noted that the operating cost increase does not account for maintenance savings as these do not form part of our guarantee.

The business case is modelled with no VAT addition to either goods and services or energy.

CAPITAL COST PIE



ENERGY CONSERVATION MEASURES.

ECM 01: Solar Car Port System

Rationale

General

Installing solar systems above surface and multi-storey car parks is becoming increasingly popular. The area above a car park is an otherwise unexploited brownfield site that can be used to generate renewable energy. Solar carports can enhance the car-parking experience in a number of ways, as well as improving the economic and environmental performance of the asset.

Photovoltaic (PV) Cells convert solar radiation to electricity through a process known as the photoelectric effect. The electricity generated by the PV cells is Direct Current (DC). An inverter (or series of inverters) is connected to the PV array to convert DC power to Alternating Current (AC) electricity, allowing the PV array to be integrated with the site's mains electricity infrastructure.

The renewable energy generated by a 'grid tied' PV array can therefore feed into the mains electricity system and be consumed on site, offsetting power demands from the grid. Any surplus electricity may be exported to the mains grid, subject to the agreement of the Distribution Network Operator and the systems' arrangement. The 'offset' in electricity imported from the grid shall generate a direct cost saving (the renewable power generated by the solar PV is free).

Thanks to UK Government subsidies, the broad applicability of solar PV and a continued reduction in technology cost, the installed capacity of solar in the UK has grown exponentially over the past decade. According to government statistics, there was just 31.7MW of installed capacity in January 2010, compared with over 13,000MW by December 2018.

The continued reduction in UK Government subsidies has slowed uptake over recent months. By April 2019, no subsidies will be available for new solar PV installations. However, as a consequence of continued reduction in installed price, increased mains electricity prices and evidence of prolonged long system lifespans means that subsidies are no longer needed in order to achieve a reasonable return on investment.

In comparison to conventional rooftop and ground-mounted solar PV systems, the cost of a solar car port system is marginally higher, due to the additional materials required and installation labour. However, although reliant on the same core product, there are distinct differences between the systems. There are several advantages of car ports over the above, which may outweigh the impact of the additional cost for certain organisations. Ultimately, it's a long-term investment in green technology, bringing an opportunity to perform a variety of functions.

For SCDC Hall

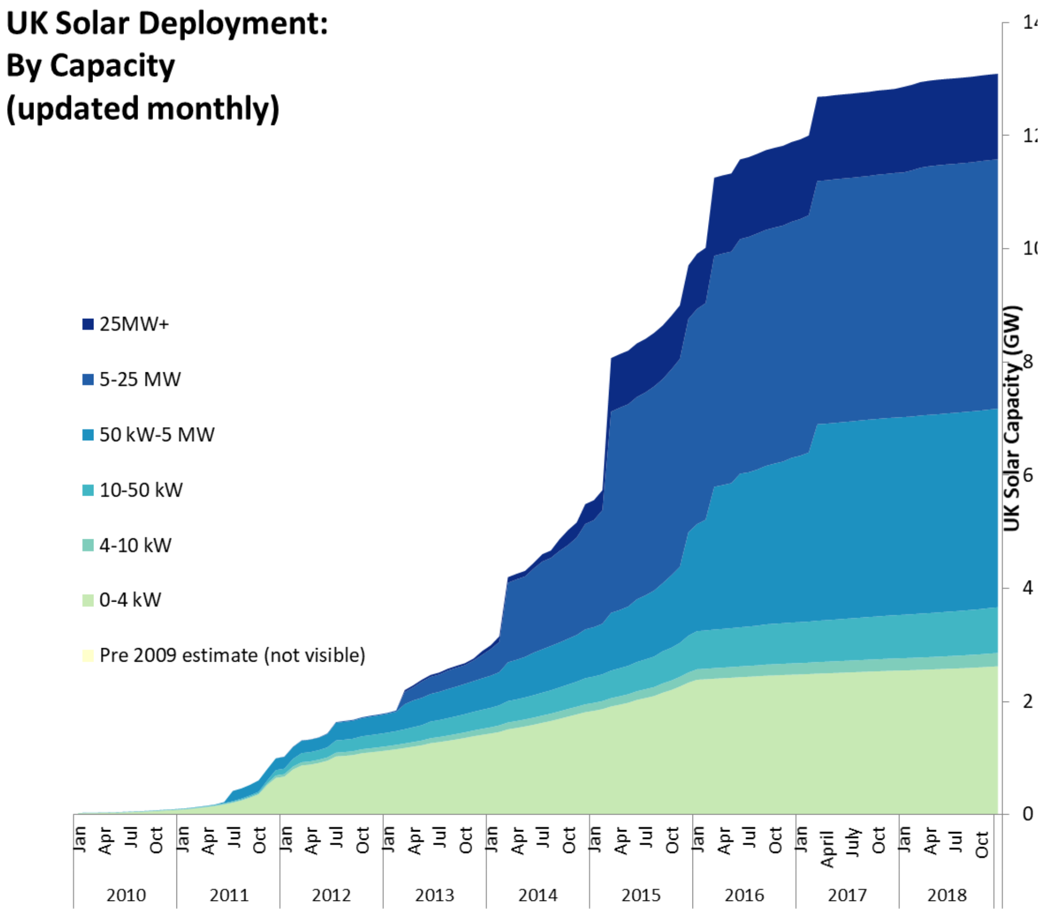
As set out in the brief, SCDC is keen to explore this measure as part of the High Level Assessment. This solution has the potential for significant on-site renewable generation and create long-term revenues.

A large staff car park area is positioned to the north west of the Hall. This covers an area of approximately 4,000m^2. The area serves solely as a car park for the Hall and is highly utilised by council staff and visitors. Given the need to provide parking, it is highly likely that the car park will remain necessary for many years to come. There is a very low chance of this area being developed for other uses.

Although the south westerly area of the car park suffers from shading from the Hall, particularly during the winter season, the car park is otherwise unshaded. The close vicinity of the Hall to the car park means that a proportion of the electrical connection may be made to the Hall mains electricity supply. Accordingly, the power generated by a solar PV array may directly offset the mains electricity demands.

As discussed above, solar car ports bring several opportunities to incorporate other smart technology, including electric vehicle chargers, high-efficiency LED lighting, parking bay sensors, CCTV and various condition sensors. It is suggested that electric vehicle chargers (EVC) would be of particular benefit in this application, as discussed in ECM 07 (EV Chargers).

Finally, it is noted that the car park is due to be resurfaced in the near future. This brings an excellent opportunity to minimise the cost of civil works and trenched services installation associated with the car ports, as these works may be factored into the main works without major increase. In addition, the resurfacing brings an opportunity to review the existing parking bay layout and consider alternative layouts to optimise the car port design (noting that the total number of car parking spaces must remain unchanged).



Outline Proposal

We have undertaken a review of the existing car park to establish options for car port arrays in each row of parking bay. This considered the design form of car port, the orientation and pitch of the solar PV array and potential system capacity. A simulation model was prepared using PVSyst software to establish the potential quantity of electricity generated over the course of the year. This model incorporates the Hall building in a 3D model and thus accounts for the impact of shading. A copy of the model is appended to this High Level Assessment.

Hourly generation profiles were created, which uses location-specific solar irradiance data. This high resolution of data is needed in order to quantify the mains electricity savings and assess the profile of surplus power i.e. when the volume of electricity generated is greater than the electrical demands from the building. The historic half-hourly electricity data recorded by the Hall meter was used to form this analysis.

A total of 6 possible arrays have been identified, with a combined capacity of circa 275kW. We eliminated two parking bay areas due to shading impacts – these include the bays closest to the Hall building and the South Westerly edge. The system is formed of two car port designs, namely single-bay and double-depth car ports, as shown below. The latter is marginally more cost-effective, due to the higher capacity of solar PV in comparison to structural requirements of the car port. However, as a large proportion of the existing car park layout is formed of single-depth parking bays, the single-depth car ports account for the majority of potential capacity. The marked aerial image (right) shows the proposed layout, noting that the double-depth arrays are shown in purple and blue and the single-bay car ports are shown in yellow and orange.

We have arrived at two possible system options, namely a 120kWp system, which is formed of double-depth car ports only and a 275kW system, which includes both double-depth and single-bays. Both options have been included in the HLA business case to enable comparison by SCDC. In both case, the vast majority of electricity generated by the system will be consumed on site, although as expected, the proportion of exported power is higher with the 275kW system.

The proposal is based on a steel-framed car port design, with piled foundations. The array shall be formed of tier 1 275W solar PV modules, which shall be connected via DC cables to high-efficiency string inverters, mounted at the end of each array. An AC distribution board terminal shall be installed alongside the inverters, which shall in turn connect to the site's electricity infrastructure. The AC distribution board shall be equipped with several additional circuit ways, which shall be assigned to new under-canopy LED lighting (as discussed below), Electric Vehicle chargers (as discussed in ECM 07), security CCTV and spares for future expansion. The AC cabling between the distribution board and the site's electricity infrastructure shall be contained in trenched ducts (by others, see below scope of works).

The existing SON-lamp column lighting will be removed and new ultra-high-efficiency LED luminaires will be installed to the underside of the car ports to provide lighting of the car park. There will be a marginal reduction in power demands due to this upgrade, although this has not been quantified and included in the business case.

New metering shall be installed to measure the volume of electricity generated by the system. The inverters shall be equipped with remote communication systems, allowing continued monitoring of the systems' performances.

It is noted that the proposed resurfacing works brings an opportunity to change the parking bay layout, which may serve to optimise the car port design. It is advised that discussions are held between SCDC and Bouygues E&S to determine the scope of this opportunity.

We have not included for landscaping in our proposal, as we believe that the majority of existing landscaping can remain unchanged. As indicated above, we have not included for trenched ducting, on the proviso that SCDC may incorporate this into the scope of the resurfacing works.

Full planning permission will be required for this installation. The submission may require several specialist investigations and reports, as well as designs and statements. We would recommend that the application be submitted as part of the Investment Grade Proposal.

A G99 application for connection must be made to the Distribution Network Operator, due to the connection of an electricity generator with a capacity of greater than 16A/phase. We propose that this is undertaken as part of the Investment Grade Proposal.

Scope of Works

- The Investment Grade Proposal fee shall include options appraisals, outline design and specification of the Solar Car Port System and LED lighting installation, works package tendering and detailed energy modelling.
- Budget costs have been made for additional investigations and enabling, such as geotechnical studies and ground investigations, planning applications, building control applications, test boreholes, consultancy services and desktop studies have been made in the project costs. These may be completed at IGP stage by variation to the IGP.
- The scope shall include the technical design, supply, installation, commissioning and testing of the car port system as described above, including construction materials and labour, modifications to existing systems and utilities connections.
- The scope of works shall not include for resurfacing of the car park or trenching, ducting or landscaping, on the proviso that this shall be undertaken by SCDC.

Specification Notes

- The solar PV modules shall be tier 1 bloomberg rated and shall have a performance warranty of no less than 80% at 25 years.

- The inverters shall be high-efficiency MPPT string type and shall be supplied with a warranty of no less than 10 years.

- The car port structure shall be designed by a chartered structural engineer and shall conform to all relevant design standards, including EuroCode. The car port shall be fabricated and installed by a reputable UK-based fabricator and shall be supplied with a warranty of no less than 20 years.

- The LED lighting shall be designed to maintain equal or greater average lux levels across the car park and shall have a luminous efficacy of no less than 100llm/W.

- The electrical systems designs shall comply with all relevant standards, codes of practice and regulations, including those highlighted by SCDC.

- The system shall not result in any loss of car parking capacity.

Key Assumptions & Risks

Clearly, there are many aspects that may impact feasibility that we simply cannot clarify at this stage and therefore have made reasonable engineering assumptions to form the business case. We propose to undertake the necessary investigations to clarify these assumptions and confirm feasibility as part of the Investment Grade Proposal stage. A technical risk register shall be formed to categorise the risks associated with these assumptions and the appropriate course of action to control them. A project development plan will be developed to 'front load' clarification of major risks, so as to minimise the council's exposure to development costs before feasibility is confirmed.

The key assumptions made in developing this proposal are broadly summarised below:

- That the Distributon Network Operator confirms that no reinforcement works are required in order to facilitate connection.
- That Planning Permission is granted for the solar car ports
- That the ground structure is suitable for typical piled foundations
- That there are no atypical environmental aspects of the site
- That the resurfacing works may be coordinated with the installation of the car ports and that SCDC includes appropriate enabling works within the scope for resurfacing, as set out above.
- That there are no material changes in base equipment and labour rates, exchange rates and inflation

Whilst we accept that there are numerous hurdles to overcome, we remain cautiously confident that the project will be feasible and that the budgets and saving calculations presented in the HLA business case are appropriately conservative.

ECM 02: 300kW Ground Source Heat Pump

Rationale

General

The Climate Change Act (2008) requires an 80% reduction in greenhouse gas (GHG) emissions relative to 1990 levels by 2050. The UK is on track to meet short-term emissions targets, but is unlikely to meet longer term targets without additional policies. While emissions from electricity production have fallen significantly, there has been much less progress in reducing emissions from heating.

The gas network delivers more than twice the energy of the electricity grid and supplies 23 million consumers. Unlike the electricity grid, the 'energy mix' of the gas network remains virtually unchanged, as does the carbon emission factor. The burning of natural gas for heating contributes 14% of the UK's greenhouse gas (GHG) emissions. Accordingly, in order to meet the UK's GHG emissions targets, we must either find alternative means of generating heat, or look to decarbonise the gas network. Although significant efforts are being made to develop solutions for network decarbonisation, the actual contribution of 'low carbon gas' represents less than 1% of the supply at present and there is great uncertainty as to the ultimate offset that may be achieved.

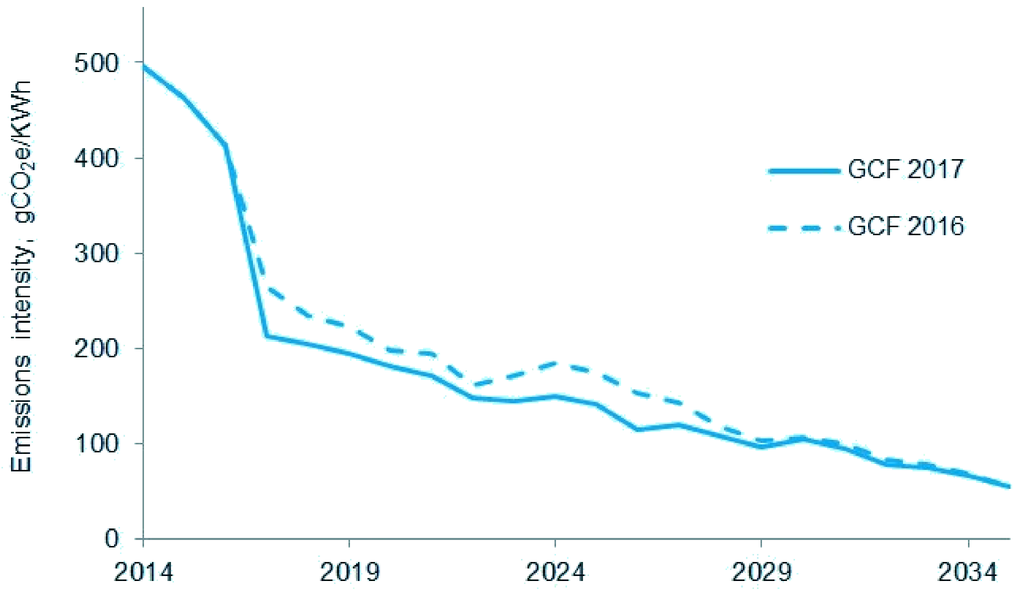
The current low or zero carbon alternative forms of heating broadly include biomass / biogas combustion or heat pumps. There are various permutations of both technology forms which make them more or less suitable to different applications. There are distinct pros and cons of each technology option, which may affect a selection, such as fuel supply availability, spatial availability, accessibility, thermal profile, energy tariffs, local planning opinions and client preferences.

Heat pumps recover heat from surrounding environments, using a refrigeration cycle to generate temperature disparities between the heat source, sink and system. Much like a refrigerator removes the heat from its contents and releases the heat at the condenser, a heat pump removes heat from the 'source' and releases it to the point of use. As with a refrigerator, electricity is required in order to drive the refrigerant compressors. However, thanks to the refrigerant effect and decades of technological advancements, the electrical energy used in driving these compressors is a fraction of the heat reclaimed. This fraction varies depending on the application but is typically a quarter to a third i.e. three to four units of heat are generated from one unit of electricity.

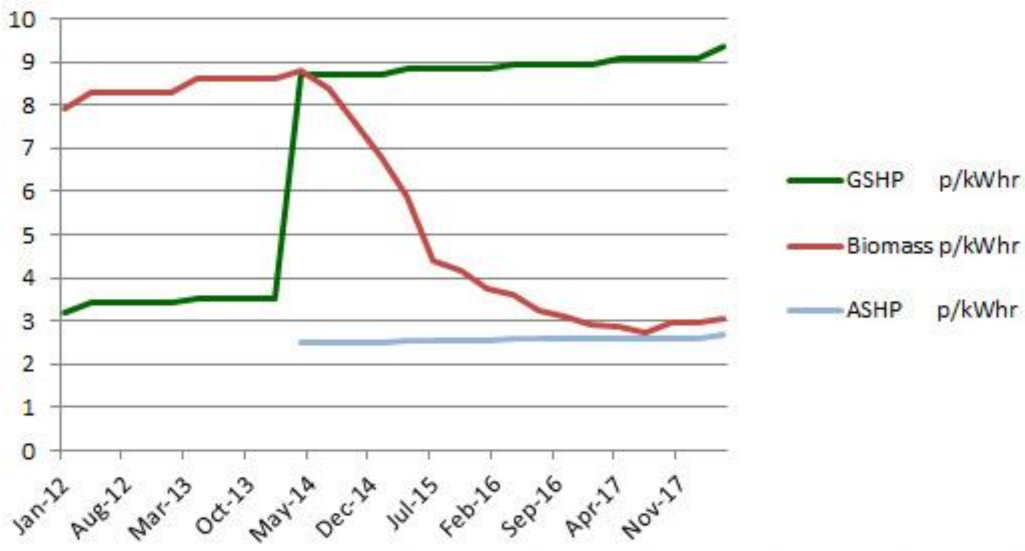
The 'sources' may be broadly categorised as ground, air or water. Likewise, heat is commonly transferred to either air or water.

As the source is 'renewable', it is classed as a renewable technology, despite the fact that it uses electricity. Nevertheless, the carbon emissions are still lower than natural gas and, given the continued 'decarbonisation' of the electricity grid, the carbon efficiency is set to improve over time. The below graph shows the department of Business, Energy and Industrial Strategy's projection over the next 15 years.

Using today's carbon emissions factors, a heat pump will typically contribute 0.077 - 0.1kgCO_2/kWh. However, in ten years, this will reduce to circa 0.038-0.052kgCO_2/kWh based on BEIS' projections. In comparison, the carbon factor applied to natural gas is 0.184kgCO_2/kWh, although when factoring boiler efficiency losses, this increases to around 0.2252kgCO_2/kWh.



As heat pumps are recognised by the UK Government as a renewable form of heating, they are eligible for Renewable Heat Incentive. This means that owners of eligible systems may register with RHI and receive payment for every unit of heat generated over the next 20 years. The rate received depends on the type and capacity of system installed, as well as the amount of heat generated (a two tiered system is operated). At present, 'ground source heat pumps' (GSHP) receive vastly preferential rates. Thus, although investment costs are often higher than air source heat pump (ASHP), the longer term return on investment is often better. GSHPs suffer less from seasonal climatic variants than ASHPs, thus generally being able to operate at very low temperatures (when heat is needed the most). They are often able to operate at marginally higher system temperatures, which are better suited to conventional heating systems.



To summarise, the rationales for considering heat pumps as a retrofit to gas boilers are (a) significant carbon abatement potential and (b) a net lower operating cost, thanks to renewable heat incentive subsidies.

For SCDC Hall

In order to achieve the ambitions of SCDC to make significant carbon emissions savings, it is necessary to implement a low carbon alternative to the gas condensing boilers as the main heat source. Due to the above rationales, we have selected heat pump as the preferred form of renewable heat, accepting that other forms may be considered as part of a more detailed options appraisal at Investment Grade Proposal stage.

The existing condensing gas boilers were efficient for their day (2000). However, not only has subsequent technological advancements improved boiler efficiency but, the boilers are not operating at their condensing efficiency. As such, they are consuming more gas than is necessary, achieving a seasonal efficiency of perhaps 80-83%. Boilers tend to have a lifespan of circa 20 – 25yrs (CIBSE Guide M), so lifecycle replacement is inevitable in the next 5 or so years.

The Hall is equipped with a large Airedale chiller, which is located on the roof. This serves air handling units and active beams with cooling during the summer months. Similarly, the chiller is now nearly 20yrs old and is also reaching the end of its serviceable life. The installation of a reversible heat pump brings the opportunity to generate chilled water, which may be used to offset the duty placed on the existing chiller, thus extending its useful life. However, as explained, the specification of a reversible heat pump is subject to further due diligence and cost appraisal.

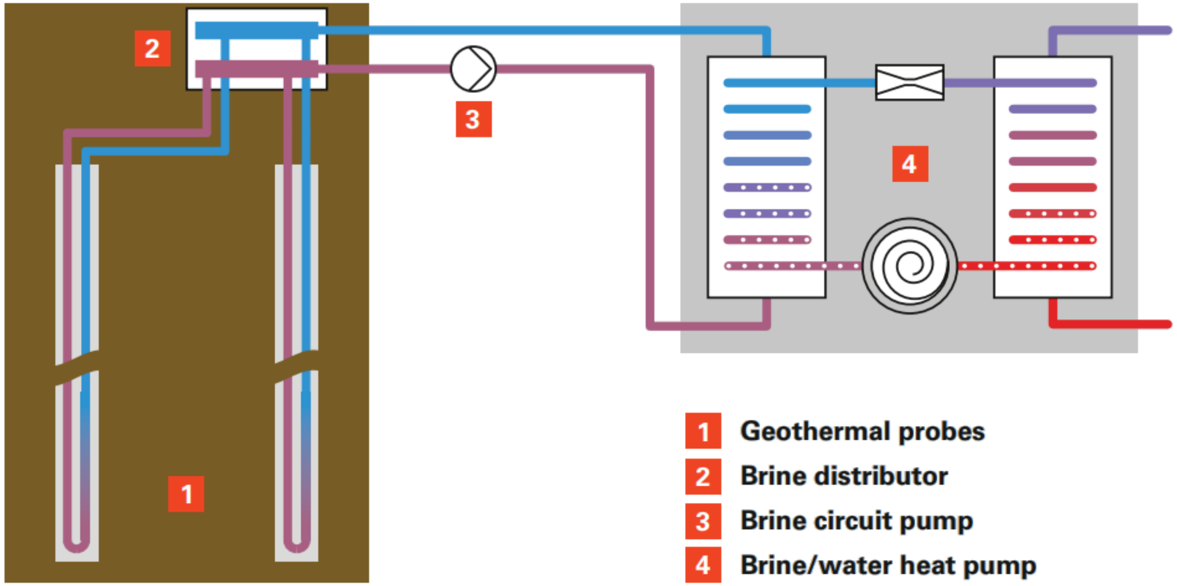
The system is currently not well suited to heat pumps, due to high operating temperatures. However, it is possible to reduce the operating temperatures for the vast majority of the year – this will be achieved through a new operating strategy delivered by the proposed BEMS.

Importantly, the installation of additional renewable electricity generators provides the opportunity to use the surplus electricity.

The feasibility for this measure will depend heavily on the ground make-up, predominantly as this will dictate the rate of extraction of heat from each borehole. The left-hand figure shows a map of the geology of Cambourne. As can be seen, the initial observations suggest that the ground is mainly sandy clay, mudstone and bedrock. With reference to benchmarks, we may expect the thermal conductivity of between 40 and 50W/m, which is about average.

Outline Proposal

We propose the installation of a packaged closed loop GSHP system with a combined heat output of 300kW to connect into the space heating and hot water systems. Due to spatial limitations within the Hall building, the GSHP equipment will be housed in a new packaged plantroom, positioned near the building (the precise location is subject to discussion with SCDC and relevant stakeholders). The heat loops will be formed of an array of vertical boreholes with piped u-shaped exchanger probes. The depth, spacing and number of boreholes that form the array will be subject to design, heat exchanger desktop studies and borehole thermal response testing, although it is estimated that a total of between 15 and 20 150m deep boreholes will be required, based on our initial observations on ground make-up. It is proposed that these boreholes are positioned in the car park area and coordinated with both the solar car ports and proposed resurfacing works. They shall remain accessible for maintenance via manhole covers.



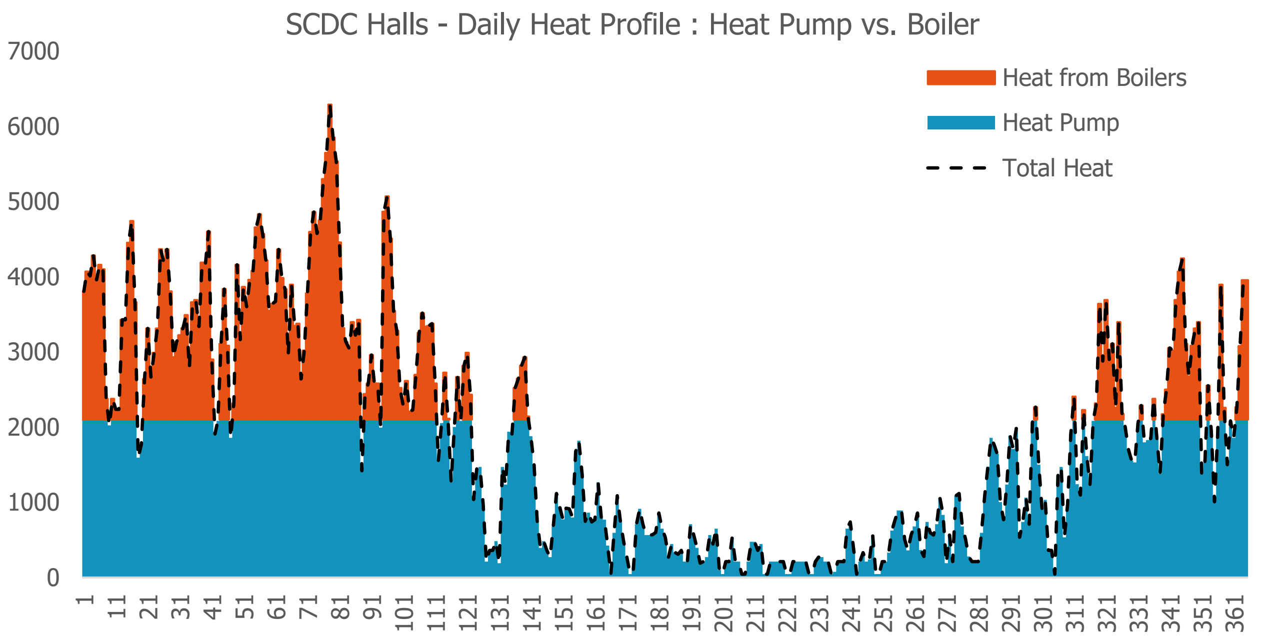
The GSHP will be formed of multiple heat pump units, which act in cascade to match output with loads. These will connect to a new primary hydronic heating plant system, which will enable the transferral of heat from the heat pumps to the existing heating and hot water systems. New pre-insulated external-grade pipework will be installed between the two plantrooms and trenched along the ground to the building, then rising on the external façade of the building (our proposal is to position the riser at the North Westerly elevation, so as to avoid visual impact from most public viewpoints. New circulation pumpsets, pressure units, expansion and valve arrangements will be installed to suit.

A large thermal energy store (2 x 20,000L) will sit external to the plantroom and shall connect into the new primary heating system. The purpose of this component is to allow to run the heat pumps and charge the system during off-peak electricity tariffs and discharge the stored heat during peak tariff. This will also allow for smoother operation of the heat pumps, reducing on/off cycling of the compressors. These stores will be insulated to a high degree, thus minimising the conductive heat losses.

The heat pump plantroom will be in the form of a 30ft ISO container. This may be cladded or finished in a range of colours and materials, such as timber or CIPS cladding, any RAL colour or graphic design. No specific allowances have been made in this regard, noting that the final finish will be subject to further discussion with SCDC. This container will sit on new pad foundations.

The system will be fully integrated with the proposed BEMS, which will enable the BEMS to control associated plant in accordance with the heat pumps and vice versa. The BEMS will be programmed to allow the heat pump to act as lead heat source, thus minimising the load and gas consumed by the extant boilers. Adaptions will be made to the heat distribution system controls, such as the air handling strategy and variable temperature control. This will ensure compatibility with the temperature regime of the heat pump.

The heat pumps will be specified to achieve a peak flow temperature of 65DegC. This is somewhat lower than the current operating temperature of 81DegC, noting that the system was originally designed to operate at 70DegC. A full design assessment will be undertaken as part of the IGP to confirm system compatibility. The system will have a minimum seasonal Coefficient of Performance (COP) of 3.3. This means that for every unit of electricity consumed, 3.3 units of heat will be generated. We have undertaken initial energy modelling to determine the volume of heat that may be generated by the GSHP and the volume of gas avoided – This is a daily model, which has been grafted from monthly meter readings provided by the council. Our initial analysis suggests that circa 70% of the gas consumption may be avoided, although will look to improve upon this at IGP stage.



The system will comply with the Renewable Heat Incentive Regulations and thus the council will be eligible to receive RHI payments for the next 20 years.

Scope of Works

- The Investment Grade Proposal fee shall include options appraisals, outline design and specification of the GSHP plant and mechanical interface, works package tendering and detailed energy modelling.
- Budget costs have been made for additional investigations and enabling, such as geotechnical studies and ground investigations, planning applications, building control applications, test boreholes, consultancy services and desktop studies have been made in the project costs. These may be completed at IGP stage by variation to the IGP.
- The scope shall include the technical design, supply, installation, commissioning and testing of the 300kW heat pump system, including construction materials and plantroom, modifications to existing systems and utilities connections.
- The scope of works shall not include for resurfacing of the car park, on the proviso that this shall be undertaken by SCDC.

Specification Notes

- The design and works shall comply with the Ground Source Heat Pump Association's GSHVBS Vertical Borehole Standard, Closed-loop Vertical Borehole Design Installation and Materials Standards, Thermal Pile Standards, MCS MIS 3005 Heat Pump Systems, the Environment Agency's Environmental ground source heating and cooling good practice guide, all relevant CIBSE Guides and technical memoranda.

- The design and works shall comply with all relevant legislation and regulations, including the Building Regulations, Health & Safety at Work Act and Renewable Heat Incentive Regulations.

- The system shall be able to provide 300kWt of heat at no less than 65DegC to the system. The seasonal COP shall be no less than 3.3.

- The refrigerant shall be R134A, R1234Ze or R744, depending on the level of ODP requirements agreed with client

Key Assumptions & Risks

Clearly, there are many aspects that may impact feasibility that we simply cannot clarify at this stage and therefore have made reasonable engineering assumptions to form the business case. We propose to undertake the necessary investigations to clarify these assumptions and confirm feasibility as part of the Investment Grade Proposal stage. A technical risk register shall be formed to categorise the risks associated with these assumptions and the appropriate course of action to control them. A project development plan will be developed to 'front load' clarification of major risks, so as to minimise the council's exposure to development costs before feasibility is confirmed.

The key assumptions made in developing this proposal are broadly summarised below:

- That the ground is suitable for heat recovery and has a typical thermal conductivity

- That the installation is straightforward, with no complexities. The siting of the equipment is reasonable and minimises the length of energy distribution systems

- That the existing heating and hot water systems may operate at a peak temperature of 65DegC

- That there is sufficient spare electrical capacity for the GSHP

- That the RHI scheme remains in place and the tariffs remain equal or higher

- That Planning Permission may be granted without costly conditions

Whilst we accept that there are numerous hurdles to overcome, we remain cautiously confident that the project will be feasible and that the budgets and saving calculations presented in the HLA business case are appropriately conservative.

ECM 03: Building Energy Management System (BEMS) Renewal

Rationale

General

Commercial heating, ventilation, air conditioning and hot water systems come in all shapes and sizes, designed specifically for the building served. The plant itself must be controlled to cater for the changing demands of the spaces served.

The principle objective of building automation is to ensure that the plant is controlled to maintain the correct conditions with minimal energy expenditure. This is of particular importance when it comes to energy intensive facilities, such as larger, fully conditioned offices.

Whilst mechanical plant was conventionally controlled via analogue / mechanical controls, we are now able to deploy sophisticated digital building automation solutions, without it costing the earth. This technological advancement brings about an excellent opportunity to avoid energy wastage and enhance facilities management practices.

'Demand led' software strategies, trend logging and simplified user interfaces allow us to understand your building's needs and control heating, ventilation and air conditioning systems more effectively. BEMS is able to automatically learn thermal characteristics of the building and make adjustments to how it controls the plant. The system is able to constantly evaluate its performance and adapt control settings accordingly.

Significant improvements have been made in the human interfaces, thus making it easier for site managers to adapt system control settings to align with the site's needs. This brings broader benefits, such as alarms when plant equipment fails, alerts where systems underperform and historic trend data to allow for in-depth analysis.

Through successful BEMS, we are able to ensure that mechanical plant equipment consumes the minimum quantity of energy to meet demands. Our energy engineers and specialist supply-chain have the expertise and experience to develop and implement innovative controls solutions.

For SCDC Hall

The Hall is currently served by a relatively complex heating, cooling and ventilation system, comprising a perimeter convector system, mechanical ventilation system with variable air volume control, active heated / chilled beams, radiators, underfloor heating and fan convectors. A central chiller provides cooling via chilled water to the mechanical ventilation system and fan convectors. Two modulating condensing gas boilers provide heat to the various heat emitters listed above. The systems have been designed with energy efficiency in mind, albeit that the installation dates back to around 2000, so some of the design strategies are somewhat dated. Moreover, the major plant equipment also dates back to the original construction and no longer meets the efficiency standards of today.

There are several excellent energy efficiency features, such as zoned control of the HVAC systems, including the use of 2-port motorised control valving and variable speed driven pump and fan motors. These all have the capability of minimising their energy use to meet condition demands. The main ventilation system is equipped with CO_2 sensors, temperature sensors and other condition monitors, with the intention of ensuring that the systems may be controlled to meet the appropriate conditions.

As with the plant equipment, the Building Energy Management System that is currently installed dates back to the original construction. This TREND IQ2 system would have been highly sophisticated and technologically advanced for its era and has many good qualities. The system has extensive control over the HVAC installation and offers a graphical front-end supervisor, which is accessible via the Facilities Manager's desktop PC. However, it is now dated by modern standards and is no longer manufactured or supported by TREND. Like many other microprocessors and software, the technology used around the millennium may still function but is unable to deliver that of a concurrent system.

Interrogation of the BEMS controls during the initial High Level Assessment revealed several significant opportunities for improvement. This ranged from simple systems adjustments to more complex engineering software modifications. Given the size and complexity of the plant it controls, even minor efficiency improvements can have a material impact on operating costs. Examples of excessive energy demands and opportunities for saving include the following:

- The daytime heating temperature setpoint is 23DegC, which exceeds the standard setpoint for offices
- The 'modulating' gas boilers do not appear to monitor properly and are operating to maintain 81DegC, well above condensing temperature
- The air handling unit fan motor VSDs are set at high frequencies and do not appear to modulate, thus causing excessive electricity demands (the supply fan is running at between 18 and 20kW).
- The time schedules for the plant equipment are excessive and do not align with building occupancy
- The chilled water pumps do not have VSDs and thus run at 100% irrespective of cooling demand
- The volume control dampers of the main air supply system appear not to close when both temperature and air quality requirements are satisfied
- The AHU01 thermal wheel control appears not to work properly – disabled when it should be operational
- The boiler outside air temperature hold-off is set to 19DegC, which is far too high and causing the boilers to operate when not required
- The compensation curves of the variable temperature circuit and underfloor heating circuit are excessively high
- The current control strategy gives rise to conflicting operations between heating and cooling systems

These are just examples; we are confident that other issues may be highlighted through more in-depth analysis at Investment Grade Proposal stage.

In addition, we recognised the opportunity to extend the BEMS to control additional plant, or modify the control function. However, as a consequence of the IQ2 range being obsolete, extension of the existing system is not possible.

Replacement of the BEMS with a concurrent system seems virtually inevitable, if not for the purpose of energy efficiency but for future resilience and lifecycle. However, if planned and designed with energy efficiency as a priority, significant energy savings may be achieved, as well as operational broader improvements. Hence, the rationale for the inclusion of this measure is to minimise energy expenditure of HVAC plant through effective control, whilst renewing lifecycle and improving operational resilience. This also brings opportunities to incorporate new plant, such as the Ground Source Heat Pump proposed as ECM 02.

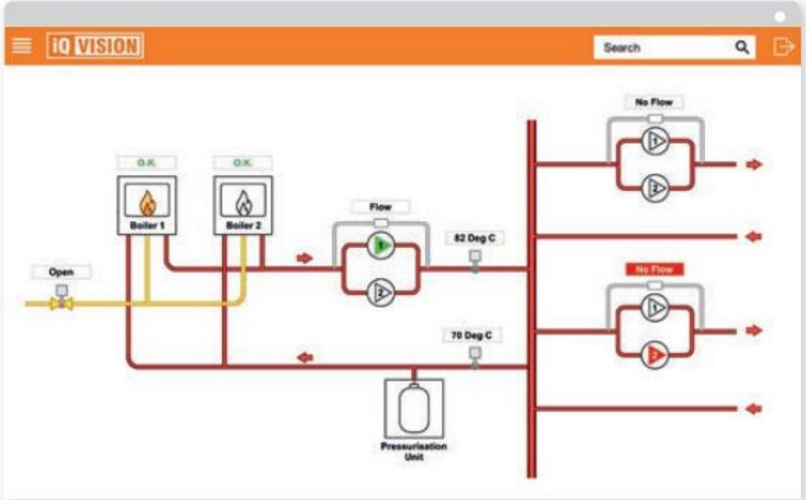
Outline Proposal

We propose the removal of all TREND IQ2 controller and 963 supervisor and replacement with a concurrent BEMS product range. Our business case is based on the system being upgraded with the TREND IQ4 / TON8 system, due to the broad compatibility with field equipment and wiring infrastructure.

This includes replacement of the main outstations located in the plantroom. A new control strategy will be developed to complement the existing plant arrangement and ensure effective 'demand driven' control. System specific control strategies will be developed for each air handling unit, particularly those larger units that are responsible for the majority of system energy demands i.e. AHUs 01, 02 and 03. New condition sensing equipment will be installed where necessary, such as humidity sensors, air quality sensors and occupancy detectors. Psychrometric control strategies will be developed, to ensure that the right conditions are maintained, whilst avoiding over-conditioning.

As noted above, the majority of pumps and fans have been equipped with variable speed drives. Whilst these will have helped to moderate the electrical consumption of the motors, the majority of them are commissioned to maintain a constant speed, typically at 45Hz and above. Hence, there is an opportunity to introduce variable speed control where appropriate, to maximise the energy savings available from this equipment as part of the new BEMS installation – at present, it is believed that the BEMS does not have analogue control (modulating) but only digital (on/off) and consequently, it is unable to vary the speed of each motor in light of changes in conditions and demands. As noted above, the main chiller pumps (7.5kW twin run/standby) are DOL with no VSD control. Whilst a minimum flow rate must be maintained across the chiller whenever the chiller is operable, the installation of VSDs brings the possibility of recommissioning the valving to reduce pressure losses and reduce pump speeds, thus reducing the electrical loads placed on the motors.

The BEMS will also be expanded to communicate with the proposed GSHP (via BACNet, Modbus, M-Bus or KNX as appropriate). Consequently, the BEMS will be able to measure the CHP's output and performance, thus being able to make appropriate decisions on the operation of relevant equipment (such as the boilers and demand-side plant). This will result in increased hours of operation of the GSHP and avoidance of loads placed on the gas boiler plant, thus helping to minimise the mains electricity demands of the building.



A new centralised TREND IQ Vision (or equivalent) front-end graphical interface will be introduced to enable central management of the BEMS installation across the site. This will provide centralised data logging, archiving, alarming, trending, master scheduling, system-wide database management, and integration with enterprise software applications, as well as live schematics of each HVAC system. This will open up the possibility of secure remote access, should SCDC wish to explore options for offsite 'bureau' management. The TREND IQ Vision is 'futureproof', in that it is designed to be compatible with current and future building services equipment. We will invite SCDC to engage in the design of the graphical interface, to ensure that it is aligned with the needs of the site management.

Our in-house TREND qualified engineers will develop the design strategy for the above system. We will engage with our existing TREND systems house supply chain partners to tender for the work, as well as the incumbent service partner, should this be the wish of South Cambs District Council. This will ensure that we achieve best value for money, in both the design and specification of the equipment and the procurement of the works.

It is acknowledged that the costs set out in the HLA Business Case are estimates, with sufficient contingency budget to accommodate for uncertainties over extent of modifications required. This should not be treated as a competitive quote but a budget to achieve the desired outcomes.

Scope of Works

- Undertake thorough review of all mechanical plant assets installed across the facility and the existing TREND IQ2 control strategy
- Develop new 'demand driven' control strategy and systems design
- Remove existing TREND IQ2 outstations, including relevant expansion capacity to accommodate additional plant as required
- Install new TREND IQ4 outstations in situ of existing outstations in existing control panels
- Modify field controls infrastructure to suit for proposed systems design
- Develop new front-end graphical interface in accordance with that agreed with the site management
- Implement new remote access interface (if agreed)
- Test & commission

SCDC will be responsible for installing a new LAN Patch-point in the vicinity of each controller. We will coordinate with the ICT specialist to confirm IP addresses and security settings. This will follow the same protocol as that of the existing system, so is expected to conform to SCDC's data security requirements.

Specification Notes

- The BEMS shall be TREND IQ4 and IQ Vision or equal equivalent and shall be capable of that set out in the Outline Proposal.
- The Contractor shall be a registered systems house of TREND Controls (or as applicable to the chosen manufacturer)
- The control strategy shall be designed in accordance with all relevant regulations, standards and industry codes of practice.

Key Assumptions & Risks

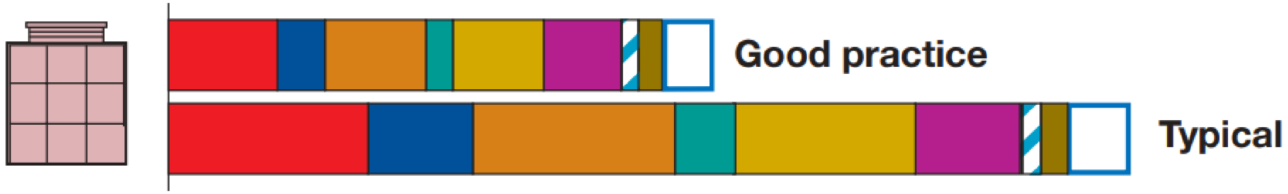
- It is assumed that the field equipment is in sound condition and good working order. No allowance has been made for significant replacement of field components, although it is acknowledged that sufficient budget allowances have been made for the odd failed sensor or actuator. A full audit will be conducted to ensure that any failed equipment is identified ahead of installation.
- It is assumed that SCDC will provide suitable ICT LAN connection points adjacent to each outstation to allow networking. Bouygues E&S will not incorporate this into the scope of work, due to the need to ensure alignment with the ICT infrastructure and security protocols.
- It is assumed that the site is clear of asbestos. Should there be any risk of asbestos being present, a Refurbishment & Demolition survey will need to be conducted for the areas concerns

ECM 04: AHU EC FAN UPGRADES

Rationale

General

As discussed earlier in this proposal, HVAC typically contributes to a major proportion of a fully serviced office's annual energy demands. According to CIBSE's Energy Consumption Guide 19 (which was published at around the time of construction), the electrical demands of fans and pumps can contribute to between 15% and 20% of the annual energy expenditure. The need to constantly provide fresh air to the office space means that ventilation and heating equipment must operate for the duration of occupancy. Air handling units are used to mechanically ventilate these areas, providing filtered fresh air, heat and cooling. The electrically driven fans operate continuously and typically require the largest motors, other than the pumps.



There have been several significant technological advancements in the design of fans and motors over recent years. Accordingly, retrofitting older fans with new energy efficient fans has become a common energy intervention, particularly in larger mechanically ventilated offices. As these fans tend to be large and operate for extensive hours, the business case for retrofit replacement can be very economically attractive.

DC motors are around 30% more efficient than AC motors because the secondary magnetic field comes from permanent magnets rather than copper windings. An AC motor consumes additional energy solely to create a magnetic field by inducing a current in the rotor. The result is that a DC motor requires 30% less energy to create the same rotational power. Moreover, AC motors are designed to operate at a certain point on their performance curve which coincides with their peak efficiency. Either side of this operating point, the efficiency can drop off considerably. EC motors on the other hand have an almost flat efficiency curve which varies relatively little across the speed range, a range which is not limited by synchronous speeds or as susceptible to voltage fluctuations as an AC motor. This makes the EC fan much more flexible in terms of being able to use the same product to match the performance requirements of different applications while still benefitting from increased efficiency.

However, the use of modern electronics in controlling the motor has opened up many other possibilities which contribute to using less power. Doubling the speed of a motor increases its power input by a factor of 8 so it's very wasteful to run a fan faster than is required. If you can tailor the fan speed to match the demand, the potential for energy saving is huge. Hence, when coupled with an effective 'demand driven' BEMS control strategy, the savings can be very high indeed.

The available range of AC input EC fans is expanding all of the time. There are axial and centrifugal fans, forward curved and backward curved, single inlet and double inlet, single phase and three phase and they are often directly interchangeable with their AC equivalents.

For South Cambs Hall

As noted earlier in the proposal, South Cambs Hall's construction was completed in circa 2003 and many of the original HVAC equipment remains in commission. This includes the air handling plant, which is showing early signs of wear. The largest air handling units are AHU 01 and 02, which serve the main office areas. These are equipped with centrifugal fans with belt-driven motors, which fall well short of modern energy efficiency standards. The motors are equipped with variable speed drives, which have the potential to reduce the power drawn from the motors. However, as discussed earlier, these are generally configured to maintain a constant speed which is close to the maximum, thus only delivering a fraction of their potential.

During our high level survey, we noted the power drawn by each motor by interrogating the VSD. AHU 01 supply fan was drawing 19kW at 49.5Hz; the extract fan was consuming 4kW at 30Hz. AHU 02 supply and extract fans were consuming 3.55kW and 2.67kW respectively. The combined constant power drawn from these motors is of a scale that warrants investment. The power drawn from other AHUs is considered to be too small to warrant investment i.e. the payback periods would be too long.

Our initial observations suggest that retrofitting with fans with EC/DC motors would be feasible.

Outline Proposal

We propose the removal of the existing centrifugal fans serving AHU 01and 02 supply and extract systems. These shall be replaced with new backward curve centrifugal fans with EC/DC motors. The new fans will be capable of delivering equal air flow rates and pressures, so as to ensure that the design conditions can be maintained.

The fan arrangement will be designed to be compatible with the existing AHU casing, thus avoiding the necessity for replacement. Whilst the casing is showing signs of wear, it is our initial view that the casing has sufficient remaining life to postpone replacement. However, as part of the Investment Grade Proposal, a detailed inspection of the AHUs will be undertaken to confirm that the extant equipment is in good working order. We will also review the filtering arrangement, to determine whether further efficiencies may be gained through moving to an arrangement with a lower pressure loss.

The new EC fans will be capable of directly varying the speed of the motors, thus replacing the function of the VSDs. The BEMS control strategy discussed in ECM 03 will be implemented to enable the speed to vary in accordance with demand. Appropriate alterations will be made to the control and power wiring to accommodate for the new fans.

Specification Notes

- The EC fans shall be designed to be capable of delivering equal flow rates and pressures to that of the existing fans
- The EC fans shall be manufactured by a reputable company with an established UK presence
- The EC fans shall be specifically designed to operate in the environmental conditions and shall have appropriate protective coatings and finishes
- The EC fans shall be ErP2015 compliant and IE3 efficiency class as a minimum
- The EC fans shall comply with all relevant regulations, standards and industry codes of practice

Key Assumptions & Risks

- It is acknowledged that the AHUs are to be retained under this ECM. Whilst further investigations will be undertaken to provide an informed view of the condition of the extant equipment, we cannot assume any risk on any future failures of other parts of the ventilation system
- It is acknowledged that the installation of the fans will require temporary shutdown of the AHUs. This will need to be carefully coordinated around site operations, so as to minimise any impacts or loss of revenue. We propose to set out and agree an installation methodology as part of the Investment Grade Proposal.

ECM 05: Chiller Modifications & Enhancements

Rationale

General

It is well documented that reducing the discharge pressure of a refrigeration compressor is desirable to improve energy efficiency. Discharge pressure is maintained by switching fans on and off to control the flow of ambient air through a condenser, the wide swing in discharge pressure as a result of cycling these fans can substantially reduce compressor efficiency.

Improvements in fan and motor design mean that the replacement of existing condenser fans with the latest EC fans will increase airflow through the condenser while consuming less energy at a lower noise level. The increased airflow allows a lower discharge pressure to be maintained increasing compressor efficiency. The increase in airflow increases heat rejection, which also improves resilience and cooling capacity at high ambient temperatures. This is a major issue in many buildings where poor chiller location leads to the short cycling of hot air from the condenser outlet back into the condenser inlet.

EC fan motors can be speed controlled, this allows the use of intelligent control algorithms to further optimise compressor efficiency, maintaining accurate discharge pressure dependant on cooling demand and ambient air temperature. The mechanical shock of constantly cycling fans, (sometimes several times a minute) severely shortens their life expectancy; it is not unusual to experience condenser fan failures after less than 5 years operation. Speed controlled EC fans have a life expectancy of 40,000 hours, typically 8-12 years of operation.

Chillers require continuous chilled water flow whenever in operation in order to deliver cooling to the chilled water and to prevent freezing or damage to the compressor. This need to maintain a constant volume means that pumping demands are often relatively high – they cannot vary with demand. However, the originally installed pumps will inevitably be marginally overspecified, so as to ensure that design flow rates are maintained. The inclusion of commissioning valves are used to create pressure and thus reduce the flow rate to that required. Consequently, the pumps are working harder than necessary in order to create the desired flow. An alternative is to install a variable speed drive, release the pressure and reduce the speed of the pump by reducing the frequency. In doing so, significant energy savings may be achieved.

For SCDC Hall

As discussed above, South Cambs Hall is served by a relatively old large chiller, which is located in the roof plant area. The chiller is an Airedale USC type, which is a good quality chiller and energy efficient for its era. However, this falls well short of modern chiller efficiency standards. Wholesale replacement with a new efficient chiller would be very expensive and would not yield a good return on investment. However, retrofitting of specific components, such as the condenser fans and controllers can provide good efficiency improvements and yield good returns on investment.

The existing circulation pumps are equipped with two DOL 7.5kW motors. They operate at 100% whenever the chiller is in demand. The commissioning valves appear to have been commissioned to reduce the flow rate. Over the course of the year, we calculate that the pumps consume circa 8,000kWh, which represents around 1.5% of the entire site’s electricity demand.

Outline Proposal

We propose the replacement of the existing 10 voltage regulated AC condenser fans with 10 new EC fans. These shall be specified for this specific Airedale USC chiller and shall be fully compatible with the extant components. A new EC fan modulating controller will be installed, with intelligent algorithms to minimise energy expenditures. The chiller shall be inspected to ensure that the refrigerant levels are optimum, that the condenser coils are in good condition and that the condensers are working to their optimum efficiency. The chiller shall be recommissioned with the new EC fans to ensure optimum efficiency.

A pre and post ‘Climacheck’ COP test will be conducted, to verify that the desired part-load efficiencies have been achieved.

We propose the installation of two new 7.5kW Variable Speed Drives to the existing chilled water pumps. The chilled water circuit shall be recommissioned to achieve the design flow rates, using the VSD to reduce the speed of the motors accordingly.

Scope of Works

- During the shutdown, each existing fan will be removed and replaced by a suitably sized / designed EC fan.
- Prior to shutdown EC fan control panels are mounted and all interconnecting cabling installed., this includes a new 2-core screened cable connected between EC fans on each refrigeration circuit to provide a speed control signal.
- During shutdown, all electrical cables will be removed from existing fan motors and re-terminated to the replacement EC fan motor. Existing control panel will be modified to supply each EC fan with a mains 3-phase voltage through a suitably rated over current / short circuit protection device.
- An insulation test will be carried out to prove the integrity of existing cable insulation and connections to the EC fan motor.
- All fans will be tested for correct direction, and minimum / maximum speed control operation.
- Refrigeration operating parameters will be monitored and EC fan controller programmed to maintain optimum operating conditions.

Specification Notes

- The VSDs shall be fully compatible and optimal for the existing pumps. They shall be supplied by a reputable manufacturer with an established UK presence and shall have a warranty of no less than 3 years.
- The EC fans shall be designed to be capable of delivering equal flow rates and pressures to that of the existing fans
- The EC fans shall be manufactured by a reputable company with an established UK presence
- The EC fans shall be specifically designed to operate in the environmental conditions and shall have appropriate protective coatings and finishes

- The EC fans shall be ErP2015 compliant and IE3 efficiency class as a minimum
- The EC fans shall comply with all relevant regulations, standards and industry codes of practice

Key Assumptions & Risks

The greatest uncertainty associated with this measure is the annual duty and associated consumption of the chiller. We note that a submeter is installed for the chiller plant and we intend to obtain and analyse this data as part of the Investment Grade Proposal. In addition, whilst the O&M information has allowed us to identify the make and type of chiller, the documentation does not identify the type of condenser fans used. As part of the Investment Grade Proposal, a more intrusive survey of the chillers will be necessary in order to confirm the exact model. Appropriate conservatisms have been built into the business case to cover any eventuality.

ECM 06: Internal Lighting LED Lighting Upgrade

Rationale

General

Lighting has been a key focal point for energy efficiency for many years, as it commonly contributes a substantial proportion to a building's energy use and operational cost. Lighting technology continues to move forward, with a continual focus to improve the efficacy of lamps and luminaires to reduce power demands, and increase the level of sophistication of automated controls in order to avoid unnecessary usage.

The advent of Light Emitting Diode (LED) technology has brought about a dramatic step change in energy efficiency in lighting. With the availability of cost-effective LED technology, we are able to deliver a substantial reduction in energy demand and reduce the operational cost of the building. Automated controls, such as occupancy / absence detection and daylight sensing enables us to minimise unnecessary operation of lighting systems, without relying on user input. This, twinned with LED technology can result in associated electricity consumption savings in excess of 80%.

For SCDC Hall

As previously mentioned South Cambs Hall was built in circa 2003, for its time the array of T5, CFL & 2D fittings with a mixture of DALI dimming and occupancy sensing would've been considered extremely modern. The technology has since advanced and while the sensing and dimming capabilities will be retained, LED retrofit will yield surprising electricity savings compared to the existing fittings.

We would like to propose a like for like retrofit e.g. swapping a 600x600 panel with an LED equivalent panel, which ensures that the same lighting provision is provided by the new LED fitting.

There are a number of options that we could look at regarding LED Lighting upgrades, most of the light fittings at SCDC Hall is architectural twin T5 fittings which will not necessarily have a direct replacement that would be easy to retrofit into the existing aperture. This leaves us with the option of either re-lamping these fittings with LED tubes & changing the ballast to yield immediate energy savings or alternatively we could engage with our supply chain partners in order to design and supply a bespoke retrofit to install in place of the existing fittings.

Outline Proposal

We have reviewed SCDC's lighting designs in order to formulate our proposals. We have carried out early engagement with our lighting suppliers to discuss the feasibility of a bespoke solution for SCDC. We propose a full LED Lighting retrofit with the exception of the low energy consuming CFL fittings with PIR's in the WCs due to a low payback, these can be included if desirable to SCDC. At the moment we have specified for bespoke fittings in place of the architectural T5's however this may change as we continue to scour the market for the best possible solutions.

We will use a clamp on ammeter and carry out pre and post installation tests to verify that the LED lighting is yielding the savings we had previously anticipated.

Scope of Works

- Prior to installation, lux tests will be carried out in various locations throughout the Hall that will provide baseline illuminance levels. We will carry out a second lux test after the installation to ensure these have been matched or exceeded.
- The lighting circuits will be isolated before the existing fitting is removed
- The new fitting shall be installed in the existing aperture and all making good shall be carried out
- The existing fitting shall be removed from site and disposed in line with WEEE Regulations

Specification Notes

- Light fittings will be compatible with any lighting controls at SCDC including PIR's & DALI dimming
- The fittings specified shall either match or exceed the existing LUX levels

Key Assumptions & Risks

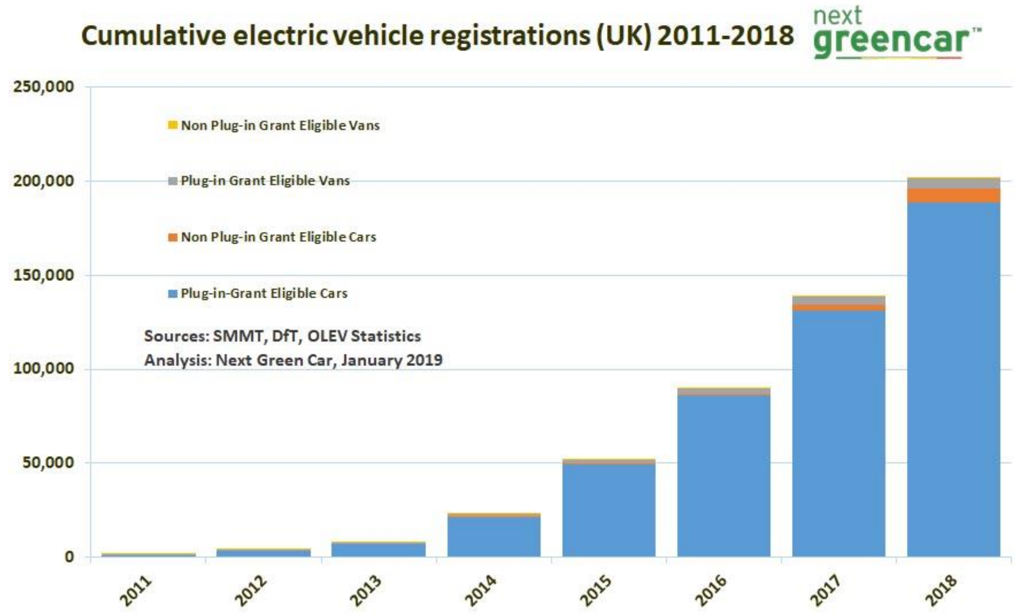
We have assumed that the existing lighting is fit for purpose and meets all current wiring and lighting regulations. The greatest uncertainty surrounding the proposed LED lighting retrofit is gathering sufficient information on the buildings occupancy. The motion sensing capability throughout South Cambs Hall will likely mean that different areas of the same floor will have different run hours, to overcome this we propose to install a number of sensors in the IGP stage in order to confirm the expected run hours of the LED Lighting

ECM 07: Electric Vehicle Chargers

Rationale

General

The last four years have seen a remarkable surge in demand for electric vehicles in the UK. New registrations of plug-in cars increased from 3,500 in 2013 to more than 195,000 by the end of January 2019. There has also been a significant increase in the number of pure-electric and plug-in hybrid models available in the UK with many of the top manufacturers in the UK now offering a number of EVs as part of their model range. According to the Future Energy Scenarios published by National Grid, there could be as many as 36 million electric vehicles by 2030.



According to UK Government figures, transport is now the largest contributor to greenhouse gas emissions at 26% (based on 2017 figures). This is whilst energy supply emissions have fallen by over 50% since 1990 levels. Whilst there have been substantial improvements in fossil-fuelled car efficiencies over this period, the number of cars on the road has almost doubled.

Electrification of vehicles appears to be the way forward. So long as the grid continues to de-carbonise, the carbon efficiency of electric vehicles compared to that of comparative fossil-fuelled cars is minimal. Whilst hydrogen fuel cells may offer a medium to long-term alternative to electric batteries, there is great uncertainty over whether or not this will ever be sufficiently economical to sway the trend.

Clearly, such enormous uptake in electric vehicles will place additional pressure on the electricity network. National Grid estimates that EV could lift the UK's peak electricity demands by 5-8GW by 2030, which represents a rise of between 9-14% compared to 2017 levels. Hence, whilst there are unquestionable benefits to the 'electrification of transport', the means by which they are to be powered is of critical importance.

For SCDC Hall

As noted above, there is a 4,000m^2 staff and visitor car park at SCDC Hall. From our observations and discussions with building occupants, this car park appears to be highly utilised throughout the year. Hence, given the increase in electric vehicles, it seems highly likely that there will be a natural demand for EV charging facilities.

Through conversations with key SCDC representatives, it is understood that there is broad support for the electrification of transport and, that SCDC wishes to promote uptake in the community. Hence, it seems appropriate to consider means of incentivising staff and visitors to make the switch.

It is assumed that many vehicles are left in the car park for the duration of the working day, hence presenting a good opportunity to recharge batteries. This negates the need for 'rapid chargers' (>20kW), which means that fast chargers (7-20kW) may be more suitable. Installation of EV chargers opens up broader potential future opportunities in the provision of transportation for SCDC, such as pool car provision or private hire.

Integration of electric vehicle charging facilities with the proposed solar car port system provides a convenient means of charging EV with renewable energy generated on site. Consequently, this means that the impact of EV charging placed on the electricity network is minimised.

Outline Proposal

We propose the integration of suitable electrical infrastructure and car port design features to facilitate electric vehicle chargers. This means that SCDC will be able to introduce EV chargers in lieu of increases in demand in future.

We also propose the introduction of four 3-phase 11kW smart fast chargers. These chargers will be compatible with the majority of today's electric vehicles and will be equipped with an IEC 62196 Socket with the Mode3 charging standard. The chargers shall be mounted to the column of the EV car port structure and shall be connected to the site's AC electrical distribution infrastructure via the AC distribution board mounted to the end of the car port.

The EV chargers shall be Wifi enabled, to allow remote access and connectivity to EV apps, such as Zap Map or Ecotricity. This will also allow future integration with the site's energy management systems, to optimise power output with availability of renewable electricity. Note, whilst this has not been incorporated to the scope and specification of the current proposal, it is our intention to investigate options to integrate solutions as part of the Investment Grade Proposal.

It is noted that we have not incorporated any financial savings or costs associated with the EV chargers, on the premise that SCDC will be able to pass through electricity consumption and operational costs to the consumers. Also, we have not incorporated any increases in electricity demands, as we are unable to quantify (or guarantee) the usage associated with the chargers. Accordingly, this measure is a 'cost' to the project only.

Scope of Works

- Inclusion of suitable electrical infrastructure and car port design features to accommodate proposed and future fast EV chargers
- Supply and installation of four 11kW EV chargers
- Provision of suitable wifi infrastructure to accommodate for EV chargers
- Commissioning and testing of the four EV chargers

Specification Notes

- The EV chargers shall be capable of delivering up to 11kW of charging power
- The EV chargers shall be equipped with an IEC 62196 Socket
- The EV chargers shall be wifi enabled, to allow 'pay as you go' charging, remote communication with charging apps and future integration with energy management systems
- The EV chargers shall be column mounted type, so as to allow integration with the car ports
- The EV chargers shall conform to LVD 2014/35/EU, EMCD 2014/30/EU, EN 61851 -1 and 22, as well as all applicable BSEN standards and regulations
- The EV chargers shall be CE Certified

Key Assumptions & Risks

There are no major risks or assumptions associated with this measure, other than that set out in ECM 01. However, it is acknowledged that the EV chargers may require connection to the site's Local Area Network and it is assumed that SCDC's ICT department will support us in devising an arrangement to make suitable secure connections.

OTHER ECM CONCEPTS FOR CONSIDERATION

The below section provides a summary of the other measures that have been considered for inclusion in the High Level Assessment but have subsequently been omitted. This may have been due to incompatibilities with other ECMs, technical or commercial uncertainties, or less favourable economics. Whilst excluded from the base HLA, we would be keen to discuss these concepts with SCDC, to obtain an understanding of whether or not there is interest in pursuing further as part of the Investment Grade Proposal. For the avoidance of doubt, the costs and savings associated with these measures have not been included in the High Level Business Case.

20kW Gas Fired Combined Heat & Power unit (CHP)

Combined Heat and Power (CHP) is the onsite generation of electricity, and utilisation of the heat that is created in the process and which would otherwise be wasted.

CHP systems are far more efficient than fossil-fuelled power stations. This is because conventional gas or coal fired power stations waste the heat they generate, whereas a CHP system's waste heat is recovered and used on site. The fuel conversion efficiency of a power station is ~40%, whereas a CHP may yield over 85%. The economic benefit of CHP technology has driven technical development and innovation.

Small-scale CHP, as proposed here, takes the form of a gas-fired engine, driving an electrical generator, whose output is grid-synchronised to permit connection to the site's main electricity network. Heat is removed from the engine jacket and exhaust gases by circulating water, which is diverted from the chosen existing boiler system.

Widespread UK rollout has proven CHP as a means of delivering carbon and cost savings. As electricity is typically between 4 and 5 times the price of gas, on-site conversion of perhaps 25-35% of energy held in the gas to electricity can be highly economically attractive, so long as the heat generated in the process may be utilised on site. Whilst recent figures published by BEIS show that mains electricity carbon emissions have reduced (thanks largely to renewables and low carbon generation such as this), a significant difference between CHP-generated electricity and mains electricity remains (0.184kgCO_2/kg compared with 0.3kgCO_2/kg respectively).

The economic business case for small-scale CHP relies on:

• Electricity and gas tariff differential (the "spark gap")

• Constant electrical and heat energy demands onsite

• Technical feasibility (size, location, existing infrastructure)

Other issues to consider include maintenance, lifecycle and licensing costs, future fuel price projections, etc. Detailed investigation has been undertaken to identify the actual gas and electricity demand offsets based on the CHP's operating characteristics and design, and the site's energy profile.

Analysis of the site’s half-hourly electricity data revealed a relatively high base load of circa 50kWe. However, the site’s thermal demand (i.e. gas consumption) varies heavily over the course of the year. This is due to a relatively low domestic hot water load and high space heating demand i.e. the seasonally dependent loads. Consequently, the CHP would need to be sized to meet the thermal loads and not electrical, so as to avoid oversizing and excessive heat generation.

Notwithstanding, our analysis suggests that there is an opportunity to install a small gas fired CHP. We arrived at a 20kWe CHP being the ‘best fit’ for the Hall, as it would be able to operate continuously outside of the summer and occasionally during summer as well. As a consequence of a very large ‘spark gap’, this measure is reasonably economically attractive, with a payback period of just over 7 ½ years.

The CHP would be sited in the existing plantroom, taking the place of the existing domestic hot water gas boiler. The CHP would be accompanied by a small buffer vessel to ensure smooth operation. The pipework and pumping configuration would be incorporated into the existing infrastructure, so as to ensure that the CHP is able to act as lead heat source. Electrical connection would be made at the existing 3-phase supply control panel within the boilerhouse. Suitable modifications will be made to the G59 relay switching arrangement in the main electrical incomer switchroom. A new high temperature flue would exit at high level and terminate at equal height to that of the existing gas boilers.

The CHP’s control system would interface with the BEMS (via ModBus), allowing the BEMS to supervise the CHP and make decisions on how best to operate the boilers to maximise CHP run time. The CHP’s control system will continually monitor the mains demand of the site, so as to avoid export of surplus electricity during periods of low mains import.

It is expected that the proposed CHP could generate circa 15% of the site’s electricity needs and offset circa 10% of the heat demand placed on the gas boilers.

Our reasons for excluding this measure from the scope of works are (a) impacts to the viability of the solar car ports, due to surplus generation, (b) the fact that CHP still relies on fossil fuel – whilst gas currently has a lower carbon content than mains electricity, this may change in the next few years, (c) technical challenges in moving the CHP to the roof-top plantroom.

Lithium Ion Battery Energy Storage System

Lithium Ion battery technology has reached a point where it is feasible to install large battery systems to charge and discharge in accordance with local, regional and national grid supply and demand profiles. The recent influx of renewable energy sources onto the electricity network has made it very difficult to predict how much electricity will be generated at any given point and thus, battery storage has the potential to act as a ‘buffer’, smoothening the supply with demand. This ability to store and discharge electricity on demand is likely to become increasingly important, if we are to succeed in decarbonising the grid.

Irrespective of the impact of renewables, battery storage has proven to work as a means of stabilising the electricity network and has been able to access a variety of lucrative 'grid services' markets. These include 'Firm Frequency Response', 'Capacity Market', 'Balancing Mechanisms' and 'TRIAD'. The last couple of years has seen a monumental increase in installed capacity, due to the economic business cases being very attractive. Unfortunately, the market has shifted in recent months and many of the revenues previously available to battery storage have been cut or scrapped.

However, the technological advancements and increase in global manufacturing has created other markets and facilitated new applications. In the case of SCDC Hall, the application we investigated was 'behind the meter', in which the battery energy storage system is integrated into the building's electricity infrastructure. The benefits that the battery energy storage system may offer are (a) the ability to store surplus renewable electricity that would otherwise be exported to the grid and, (b) the ability to charge during low mains electricity tariff periods and discharge at high tariff periods. This is referred to as 'arbitrage', where the battery essentially works in a similar way to a storage heater.

Using the models that we developed for the car port PV system, we were able to analyse the volume of surplus electricity, both for the 120kW option and 275kW option. This enabled us to quantify the capacity of storage required to avoid export. In parallel, we undertook a market analysis to identify potential technologies and suppliers, establish installation and operational costs and technical requirements. Our analysis concluded that the peak export volumes that occur on peak summer weekends are of a magnitude that would require a significant battery capacity, which would be disproportionate to the building's electricity demands and would be prohibitively costly. Hence, we sought to establish the most economical capacity i.e. the shortest payback option.

We arrived at a 130kWh 100kW Lithium Ion packages energy storage system as being the best fit. Whilst this system would be capable of recovering approximately 1/3 of surplus renewable electricity, our analysis suggests that the payback period would be somewhat longer than the battery system's lifespan and marginally longer than the overall project payback (thus extending the overall payback when included).

We would be keen to undertake more detailed analysis and engage further with our industry-leading supply-chain, with a view to establishing an economical solution to incorporate battery storage. Hence, our reason for excluding this measure at this initial stage is that we have been unable to develop an economically viable solution.

15kW Wind Turbine

Alongside our development of the solar car port solution, we have investigated options for wind power, an alternative form of renewable energy generation that converts the mechanical energy held in wind into useful electricity. There are several distinct benefits to wind power over solar, namely that the generation profile is different, albeit equally unpredictable i.e. a wind turbine may generate electricity during night-time and throughout the year. A suitably sized wind turbine may offer an opportunity to compliment the solar PV installed on site and proposed.

We have undertaken a review of the half-hourly electricity consumption data for the Hall building, to establish a target capacity based on the building's 'base load' (the average daily low demand). We have also considered the local topology and the visual and environmental impact that a wind turbine might have. Our logic was that a system with a height no greater than the surrounding buildings may be viewed as more favourably by relevant stakeholders.

Unlike solar PV, the capacity of the wind turbine is determined in manufacture and cannot be multiplied to optimise with a site's needs. In other words, whilst we can add or subtract the number of solar PV panels to arrive at an ideal capacity, with wind, we must select a single turbine (or perhaps two) that best aligns with the application. In addition, it is important to ensure that the correct 'class' (IEC 61400-2) of wind turbine is selected, which characterises the wind speed range in which the wind turbine is able to function and the profile of power output against wind speeds within this range.

Historically, the demand for small-scale / low voltage wind turbines has been far less than that of solar PV and, as this is a comparatively small market, there are less manufacturers and suppliers and consequently fewer technology options available. As a result, and factoring all of the above constraints, there are just a few wind turbines available on the market that have the potential to be feasible for the Hall.

Our concept is based on the installation of a 12kW Class IV wind turbine. The turbine is designed to operate in comparatively low average windspeeds of 6m/s, which aligns with that observed in Cambridgeshire. The turbine would have an 18m tower and a total maximum height of 25m. The system would be capable of generating electricity in wind speeds between between 2m/s and 14m/s and able to withstand sustained gusts of up to 42m/s. The peak power output is 12kW, which aligns well with the site's baseload i.e. there is no risk of surplus power being generated, all will be consumed on site.

Whilst subject to further discussion with SCDC, we would propose that the turbine be mounted to the North Westerly edge of the car park area. This area is selected due to the fact that it would not cast shadows on the Hall or surrounding buildings, thus is less likely to cause nuisance when operational (the ‘flicker’ effect of the moving shadows). By positioning the turbine away from the building, the wind is unobstructed.

Unfortunately, like solar PV, the Feed In Tariffs currently available for wind turbine installations is to end in April 2019. Consequently, installations after this date will not receive any subsidies.

Whilst we are very keen to investigate this measure further, our rationales for excluding it at this stage are (a) the visual impact and potential environmental impact, (b) the consequent likely complexities in planning and, (c) uncertainties in the potential energy generation interactions between the proposed solar PV car ports and the turbine. With regard to the latter, this may be clarified through detailed energy studies, which may be undertaken as part of the Investment Grade Proposal.

OPPORTUNITIES TO INCORPORATE LOCAL ENERGY CONSUMERS

An objective that was set out in the Project Brief was to consider additional opportunities that may be available as a result of site locality, including location on Cambourne Business Park and in close proximity to the Cambourne Village College site. This may include, for example, the sale of energy generated by within the Hall site, or incorporating energy conservation measures to other properties in the area to serve the Hall.

Cambourne Business Park

The Cambourne Business Park is a cluster of modern serviced offices, leased to a range of organisations. There are currently six main office buildings, a hotel and the Hall building. When fully developed, the business park will offer a total of 750,000sqft gross internal area. There appears to be one building in development to be constructed, referred to as Building 4010, which will provide the final 45,000sqft of office space. Additional plots 3000, 5000 and 6000 are earmarked in master-planning for development, although no details were found on the scope of this development.

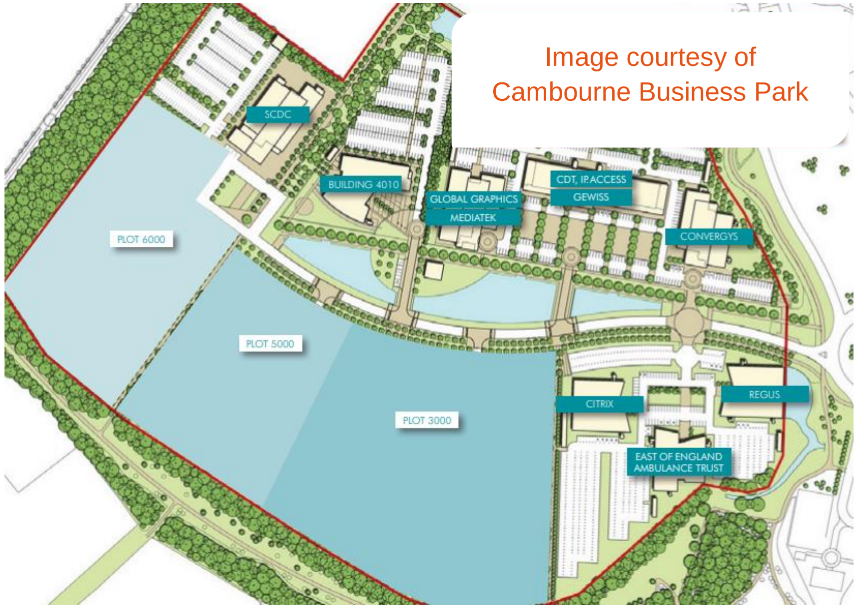


Image courtesy of Cambourne Business Park

The Hall sits in the Westerly end of the existing park, with approximately 130m between the Hall and the nearest building (2030). The proposed Building 4010 would sit between Building 2030 and the Hall.

Our initial judgment is that there may well be an opportunity to extend the scope of the project to incorporate the business park into the scope of the scheme. Opportunities may include, for example, the installation of a larger GSHP to act as a central energy centre, serving renewable heat to the other offices via a Heat Network. However, the increase in heat pump capacity would necessitate the installation of a more sizeable ground heat exchanger – at this scale, it may be necessary to consider 'open loop' ground source, in which groundwater is utilised for heat abstraction.

The proposed solar car port system is not of a scale or capacity that would warrant interconnection with other buildings. Whilst there will be a relatively small surplus of electricity to export, connection would be complex, owing to regulatory constraints. However, there appears to be an excellent opportunity to install solar PV elsewhere on the business park, both as solar car ports and conventional rooftop. There is a multitude of unshaded flat roofspace, which on first observation looks ideal for solar. Several car park areas offer an opportunity for south-facing car ports, accepting that the main car park to the north of the main park may suffer from shading from the office buildings.

We would be extremely interested in exploring these opportunities further. However, due to the lack of technical information and energy data available on the business park, and indeed the objectives and aspirations of the landlord and tenants, it has not been possible to incorporate the business park in the scope of the High Level Assessment. If SCDC shares our interest in exploring this opportunity further, it is suggested that a meeting with the relevant stakeholders is organised to discuss the potential measures and obtain a knowledge of their objectives and interest in collaboration.

Cambourne Village College

Cambourne Village College sits approximately 300m to the West of the Hall building. The College is operated by Cam Academy Trust (CAT), who manage several schools and colleges across Cambridgeshire. Unlike the business park, Bouygues E&S has an established relationship with CAT and, coincidentally is currently in the process of delivering an energy performance contract at Cambourne Village College via the RE:FIT Framework. Consequently, we have a good understanding of the campus, both in terms of energy infrastructure and demand, as well as direct engagement with decision makers.

The College has a population of just over 1,000 pupils and 120 staff. This population has been steadily increasing since it opened in 2013. As the site is relatively new, the energy infrastructure is by and large in line with current standards energy. The site is served by a 30kW solar PV system, although this only contributes a small fraction toward the site's electricity import. The heating system is served by two gas boiler plantrooms, which have a collective capacity of over 1MW (substantially more than that at SCDC Hall). A small air source heat pump acts to pre-heat the domestic hot water, although as with the PV, the overall contribution is relatively minimal. Although we are unable to provide details of the site's current energy spend (due to confidentiality), we can indicate that this is of a scale that warrants consideration for inclusion within the scope of the scheme.

As a consequence of local population growth and projected increases in pupil enrolment, the Trust plans to extend the site to the North East of the existing building. The proposed new buildings would sit to the West of the Hall, at a shorted distance than that of the existing building. Hence, energy infrastructure connections with this new build would be shorted and hence, comparatively economical.

Whilst provisions for including Cambourne Village College does not form part of the base business case, due to the complexity and cost of the scheme, we do foresee an excellent opportunity to incorporate the College and proposed new build into the scope of this project. This is with particular regard to the sharing of heat via a heating main, connecting the energy centre with the college's heating infrastructure.

As indicated for the business park, it may prove to be commercially viable to increase the scale of the energy centre to provide sufficient capacity to export heat to the college under a 'heat purchase arrangement' (HPA).

Via this arrangement, SCDC would sell the renewable heat generated by the energy centre to the College at a rate that is commercially favourable for both parties. SCDC would benefit from this additional income, as well as the RHI payments, whilst the College benefits from marginally lower energy costs, improved resilience and lower carbon emissions.

Should South Cambs District Council wish to explore these opportunities to incorporate either Cambourne Academy or Cambourne Business Park into the scope of the investigation, we would need to discuss arrangements for development and inclusion in the Investment Grade Proposal.

FURTHER READING

THE HLA KEY PARAMETERS

As set out above, the overarching purpose of the High Level Assessment is to set the 'goalposts' or 'Key Parameters' upon which Bouygues E&S commits to improve at the Investment Grade Proposal stage. For the avoidance of doubt, these parameters are set out on the table to the right and are set for the entire portfolio, as opposed to the individual site (as the contract is across the portfolio). Should Bouygues E&S be unable to improve upon these Key Parameters, SCDC may elect not to proceed to the subsequent delivery stages and not to pay the Investment Grade Proposal fee. Should Bouygues E&S fail to meet these key parameters and yet SCDC still decides to proceed to implementation, Bouygues E&S remains eligible to collect the IGP fees.

PORTFOLIO KEY PARAMETERS

Key Parameters	Value	Criteria
Payback Period	9.54 Years	No greater than
Energy Savings	1,540,198 kW	No less than

These Key Parameters have been carefully selected on the proviso that they bind Bouygues E&S to improve the business case, without inhibiting our freedom to identify better opportunities, or enhance those which have already been selected.

Should SCDC wish to vary the scope of works to include other measures that might impact Bouygues E&S' ability to meet the key parameters (such as the inclusion of long-term lifecycle projects), Bouygues E&S will seek to agree a reasonable and proportionate variation to these key parameters with SCDC, so as to afford the necessary freedom and flexibility of the programme, without assuming undue commercial risk.

If SCDC wishes to include other key parameters, Bouygues E&S would be delighted to discuss these requirements and include if agreeable to both parties.

THE SAVINGS GUARANTEE

As aforementioned, the energy savings and renewable energy generation set out in the Investment Grade Proposal business case will be guaranteed by Bouygues E&S under the RE:FIT Energy Performance Contract. These 'Savings Guarantees' are based on the energy volume (kWh) and exist for the duration of the Payback Period.

In accordance with the framework, Bouygues E&S will be required to remunerate SCDC for any shortfalls between the actual savings and the Savings Guarantee in any 'Contract Year'. The remuneration is calculated by multiplying the shortfall by the relevant energy tariff, as set out in the IGP business case. Conversely, Bouygues E&S will not be entitled to claim payment for any surpluses, unless we have previously paid a penalty for a shortfall in a previous Contract Year (this surplus claim is capped at the value of the shortfall payments).

Accordingly, Bouygues E&S is incentivised to be reasonably conservative and cautious in our savings calculations and thus, we expect the savings expectations to be exceeded. The process for evaluating savings and accommodating for changes that inevitably occur during the lifetime of the project is referred to as Measurement & Verification, as described below.

The security of a public procurement framework and Local Authority Backing

We utilise energy management software to monitor the performance of the project. This software is made available to our clients to help them to manage their energy use.

MEASUREMENT & VERIFICATION

Measurement & Verification (M&V) shall be undertaken by Bouygues E&S to evaluate the savings and make reasonable adjustments to account for change. It is essential that this process is transparent, impartial, accurate and repeatable, so as to ensure that all parties can have absolute confidence in the reported performance. Bouygues E&S' M&V approach follows the International Performance Measurement & Verification Protocol (IPMVP), a leading global standard for M&V. The IPMVP sets out protocols for planning measurement techniques, application of routine and non-routine adjustments and reporting performance. Our senior engineers are certified to the IPMVP and have a duty to ensure that Bouygues E&S maintains compliance.

Routine and non-routine adjustments may be made to the savings guarantees to accommodate for changes that occur during the monitoring period. For example, a routine adjustment may be applied to thermal energy savings calculations to accommodate for seasonal variations – in the event of an extremely mild winter, it may be expected that less thermal energy is required for heating, whereas, in an extremely cold winter, more thermal energy will be required. The routine adjustment essentially 'keeps us on the hook'. A non-routine adjustment may be applied to the savings guarantee when an unpredictable or unexpected change occurs that has an impact in energy performance. Examples might include a change in occupancy hours, change in building structure or utilities failure.

In adhering to the IPMVP, we are able to offer any plans or reports to independent specialists for ratification, should this ever be required. As part of the governance and review processes, Local Partnerships reviews our M&V plans and reports, to ensure adherence with the framework and protocol.

We acknowledge that our clients are often unfamiliar with this industry-specific practice and are able to provide specific training sessions or workshops to empower clients. This is typically provided during the IGP phase.

CLARIFICATIONS & ASSUMPTIONS

There are several assumptions that drive the business case. In the spirit of maintaining transparency, we would like to share these assumptions to ensure that all parties are absolutely clear. Whilst the RE:FIT Energy Performance Contracting model provides effective risk transferral, in terms of energy performance, design, installation and commissioning risks, it is acknowledged that there are certain limitations. We have prepared a risk register that identifies the technical risks associated with the specific project at SCDC.

IGP Benchmarking: Bouygues are required as part of the framework to achieve the key performance parameters set out in the business case of the HLA (HLA Business case 'Project Outcomes' tab). These are the minimum energy savings (kW) and the maximum payback period (yrs). This means that for 'like-for-like' scope of works we cannot reduce the associated savings or increase the stated payback for the same ECM's.

Energy Tariffs & Inflationary Factors: We have used those set out in the original framework tender procurement. These tariffs drive the cost savings and hence, the payback and cash flow calculations. It is therefore important that they are at least reflective of what is actually paid, even though they will inevitably differ in the years to come.

Carbon Taxes: Aside from those levies incorporated into the above energy tariffs, we have made no allowances for any savings associated with carbon taxes, such as Carbon Reduction Commitment. Should SCDC wish to incorporate any additional savings, Bouygues E&S is able to incorporate them into the business case for illustration purposes.

Renewable Energy Incentives: any renewable energy subsidy tariffs, such as Feed In Tariffs, Renewable Heat Incentives or export tariffs are estimated based on that applicable at expected time of registration and are to the best of our knowledge at the time of creating the business case. Where available, these rates are based on projections published by UK Government or reputable industry experts. However, the rates are subject to change, due to change in UK Government policy.

Improved thermal comfort

Measured & Reported Savings

Renewable Energy

Improved Image

Reduced Maintenance Costs

Maintenance Savings & Costs: As a rule, Bouygues E&S incorporates budgets for any additional maintenance duties born by our projects into our business cases, so as to provide a robust commercial model. However, we do not account for any maintenance or lifecycle savings, which, in many cases may be considerable (as any asset replacements may often result in a replenished lifecycle or elongated maintenance intervals), as they cannot be guaranteed. Should SCDC wish to account for such savings, Bouygues E&S is able to incorporate them into the business case for illustration purposes.

Existing Maintenance Provision: It is assumed that appropriate maintenance provisions are in place for all existing assets and that maintenance is undertaken in line with statutory requirements and manufacturer's instructions.

Maintenance of new equipment: It is assumed that SCDC will undertake maintenance of the new equipment in line with manufacturer's requirements. Although Bouygues E&S is a leading Facilities Management services provider, we do not typically take on maintenance responsibilities for this type of energy performance contract. Notwithstanding, Bouygues E&S will provide full support in setting up any new or modified maintenance services for the energy conservation measures as part of our 'soft landings' and handover process.

Value Added Tax (VAT): VAT is omitted from our business case, as it is assumed that SCDC is able to recover any VAT charges.

Access to Site for Installation: We assume that installation may be undertaken during normal working hours, accepting that this is subject to coordination with site activities. We have assume that installation will be relatively uninterrupted and that any clearing of spaces (such as removal of furniture) will be undertaken by SCDC.

Information provided by SCDC: It is assumed that SCDC's management team will provide all relevant and available information to Bouygues E&S to enable the preparation of a robust proposal.

Pre-existing Technical Issues: It is recognised that this project will require the adaptation of / modification to / co-reliance with existing assets. As engineering professionals, Bouygues E&S recognises our general duty of care to endeavour to identify any issues with extant assets that might jeopardise the success of the project, or failure to comply with legislative, regulatory or best practice requirements. Notwithstanding, Bouygues E&S cannot take responsibility for any pre-existing issues with the site or assets that do not form part of our scope of works, unless our proposal specifically identifies that resolution of the issue forms part of the scope of works. It is advised that SCDC makes Bouygues E&S aware of any known issues, so as to ensure that we can take appropriate actions to accommodate for them as part of the IGP development.

BREXIT: Appropriate provisions shall be made within the contracts to manage the potential impacts of Brexit on the business case. SCDC and Bouygues E&S will seek agreement on these provisions as part of the Investment Grade Proposal Services Agreement.

Green technology

Reduced Carbon Emissions

Shared **innovation**

Bouygues E&S UK
Future Business Centre
Cambridge
CB4 2HY