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BICESTER HERITAGE

BICESTER HERTIAGE HOTEL
LOW CARBON ENERGY STRATEGY REPORT
02 March 2017

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EXECUTIVE SUMMARY

Ridge and Partners LLP have been appointed by Bicester Heritage to work with Dexter Moran Associates to develop an M&E philosophy and Sustainability Statement for the proposed Bicester Heritage Hotel in Bicester.

This report outlines the proposed sustainable development and low carbon design principles being considered for this project. The strategies have been developed to offer a sustainable development in line with Cherwell District Council planning policy, industry good practice and current Building Regulations. This report includes;

- Energy Strategy and Targets
- Proposed M&E Philosophy and Design Measure
- Low and Zero Carbon Technology Feasibility Study
- Conclusions and Recommendations

Thermal and energy compliance software IES Ve 2016, was used to simulate the proposed building to assess compliance against current Building Regulations (Part L2A). This report displays the analysis carried out, which evaluated and discussed design measures to develop a low carbon energy strategy.

The simulation results estimated the annual energy demand, the potential reduction in energy demand the different low carbon design measures offer, the energy and CO_2 emissions reduction potential low and zero carbon technologies may offer to the proposed Building.

The following design measures are recommended for inclusion in the design development of the proposed Bicester Heritage Hotel:

Passive (“Lean”) Measures:

- Reduction of space heating demand: achieved by reduced U-values and low air permeability. These measures aim to reduce the heat loss through the building fabric and uncontrolled ventilation.
- Exposed high thermal mass building elements to act as an internal temperature regulator.
- Lighting – provision of adequate daylight to lower general lighting heat gains and electricity used.

Active (“Clean”) Measures:

- Heating & Ventilation – Variable speed drives for circulating pumps and fans to ensure an efficient operation in line with demand
- Ventilation – CEN Leakage test AHU and ductwork
- Space heating – High efficiency condensing boilers
- High heat recovery system for all balanced mechanical ventilation system
- Lighting – A LED lighting strategy with automated controls with allowance of daylighting dimming has been proposed.
- Serve all cooling requirements of the proposed building with an ASHP (VRF) type system.

Green Measures:

The following LZC technologies are recommended for the proposed Bicester Heritage Hotel.

- Implement a CHP unit to serve the DHW heat generation, make full use and taking advantage of the low carbon electricity generated by this system.

The design measures summarised above have been included to reduce the overall demand of the building. These recommendations been identified and considered to allow the building to go beyond the energy efficiency and renewable energy targets set by the current Building Regulations.

1. INTRODUCTION AND PROJECT OVERVIEW

Ridge and Partners LLP have been appointed by Bicester Heritage to work with Dexter Moran Associates to develop an M&E philosophy and Sustainability Statement for the proposed Bicester Heritage Hotel in Bicester.

This report outlines the proposed sustainable development and low carbon design principles being considered for this project. The strategies have been developed to offer a sustainable development in line with Cherwell District Council planning policy, industry good practice and current Building Regulations. This report includes;

- Energy Strategy and Targets
- Proposed M&E Philosophy and Design Measure
- Low and Zero Carbon Technology Feasibility Study
- Conclusions and Recommendations

1.1 Building Summary

The Dexter Moran proposal outlines a new hotel development able to be completed in two construction phases as follows;

Phase 1, consists of hotel accommodation (184 rooms), public areas (which includes lobby, reception, restaurant, gym, pool and bar), a conference centre (which includes meeting rooms, a divisible conference room and breakout space) and back of house hotel support areas.

Phase 2, consist of hotel accommodation (106 additional rooms), aparthotel accommodation (which include 58 studio apartments, 55 one bedroom apartments), public areas (which include aparthotel reception areas) and back of house aparthotel support areas.

The strategies proposed will need to be able to accommodate this phased construction approach as well as meeting the full demands of the building at each phase.

2. BUILDING REGULATIONS PART L – CONSERVATION OF FUEL AND POWER

The Building Regulations Approved Document Part L relates to the conservation of fuel and power in buildings and projects requiring building control approval. Part L is provided in four sections, each relating to a different style of development. For this project, Part L2A:2013 which relates to 'new buildings other than dwellings' will apply.

To show compliance with the Part L2A of the building Regulations, Simplified Building Energy Model (SBEM), dynamic simulation model (DSM) and Energy Performance Certificate (EPC) calculations are required for any new building. SBEM/DSM calculations are used to benchmark the predicted building annual performance in terms of carbon missions, and compares these with a notional building which applies current standards set but the UK Building Regulations.

The notional building has the same geometry, location and orientation as the actual building. The activities of individual zones in the building are also identical to the actual building. Specific aspects of the building design are allowed for by selection of the most appropriate NCM (National Calculation Methodology) templates for systems as follows: percentage glazing used, heating, cooling, ventilation, domestic hot water generation, Lighting.

Note that the energy predictions above are for regulated loads only. Unregulated loads (such as small power usage for computers) do no form part of the Part L calculation. It should also be noted that the NCM templates do not accurately reflect the energy sue of the space – they are an approximation so that all spaces of an equivalent use in different buildings can be compared.

The SBEM assessment evaluates the actual building in terms of the following five criteria:

- **Criterion 1** – The predicted rate of carbon dioxide emissions from the building (BER – Building Carbon Dioxide Emission Rate) is not greater than the target rate (TER – Target Carbon Dioxide Emission Rate).
- **Criterion 2** – Reasonable provision has been made to limit heat gains and losses through the fabric of the building, and energy efficient fixed building services and appropriate controls have been specified.
- **Criterion 3** – The building has appropriate passive control measures to limit solar gains and limit or eliminate the need for air conditioning.
- **Criterion 4** – The performance of the building, as built, is consistent with the prediction made in the BER. (As designed performance is based on the systems and equipment specified. Changes of manufacturer or equipment and value engineering changes may affect as built performance.)
- **Criterion 5** – The necessary provisions for enabling energy efficient operation of the building are put in place.

2.1 Energy Targets

The project must comply with the appropriate sections of the Part L2A. In order to demonstrate the compliance required by Part L2A:2013 a Dynamic Simulation Assessment (DSA) needs to be carried out to demonstrate that the Building Emissions Rate BER for the proposed building will be less than the Target Emission Rate TER calculated for a notional building.

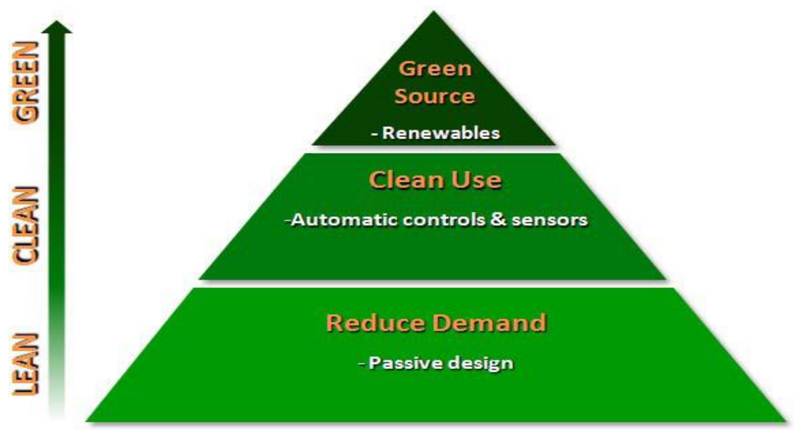
The IES Ve thermal model built for the proposed building takes into account the following:

- Building geometry, location and orientation
- Buildings fabric thermal performance
- Building services strategy
- Domestic Hot water DHW consumption
- Environmental conditions (this includes solar irradiation, wind, and external temperatures)
- Internal heat gains (occupants, computers, lighting and miscellaneous small power (NCM templates used)

3. LOW ENERGY DESIGN STRATEGY

To achieve a truly low energy or low carbon building, the most effective approach to reduce operational energy is to follow the low carbon design principles as described in Chartered Institution of Building Services Engineers (CIBSE) Guide L Sustainability 2007. The following steps describe CIBSEs principles:

- Focus on understating the energy use of the building
- Evaluate the buildings location, orientation, fabric thermal performance and operation to determine measures to reduce the energy requirements of the building. Assess the viability of a natural ventilation strategy and optimize the use of natural daylight ("Passive" design measures: Lean).
- Improve the efficiency of fixed building services (Boiler plant, light fittings etc.) to meet the energy demand in the most effective way possible ("Active" design measures: Clean).
- Study the feasibility of implementing Low Zero Carbon (LZC) technologies to further reduce the CO_2 emissions associated with the energy use of the building studied ("Green" measures).



The Greater London Authority defined an Energy Hierarchy aimed to describe the design process to develop a low carbon energy strategy. The diagram in Figure 1 illustrates the "Lean, Clean and Green" methodology. This framework will be used to develop the energy strategy for the new Bicester Heritage Hotel.

Figure 1 – Energy Hierarchy [REF: Greater London Authority Local Plan (GLA)]

3.1 Methodology

The following steps describe the method used to assess the energy reduction potential the "Lean, Clean and Green" methodology offer and evaluate the potential contribution LZC technology can offer to the energy strategy for the new Bicester Heritage Hotel in Bicester.

- Construction of a base case IES Virtual Environment (IES Ve) thermal model to determine a base point from which to assess potential energy efficiency measures
- Construction of an IES Ve thermal model implementing "Passive (Lean) and Active (Clean)" measures to quantify the energy reduction potential of these measures and estimate the site overall energy requirement (In terms of heating, cooling, auxiliary, lighting, DHW and equipment)
- Assessment of the technical suitability of LZC technologies
- Complete energy iterations to investigate which strategies offer the best suitable possible solution to meet the targets set in section 2.1 above.
- Complete a SBEM/DSM calculation to determine compliance with Part L2A of the Building Regulations.

The following sections describes the Low Carbon design measures considered and proposed for the new Bicester Heritage Hotel.

3.2 Design Measures

This section of the report looked at areas where the building's energy demand can be reduced in order to create an energy efficient design solution. The implications of the Building Regulations are explored, with reference to the technical and functional feasibility of various energy efficiency measures.

3.3 LEAN - Passive design measures

The following design measures were considered to develop the proposed low carbon energy strategy for the new Bicester Heritage Hotel. It has to be noted that this design process is continuously evolving and should be reviewed at the next RIBA stage of work. The key Low Carbon design principles considered covered the following:

- Treatment of elevation in relation to their orientation, which should limit and optimize solar gain.
- Location, Local Weather, Building layout and orientation were all taken into consideration when developing the proposed energy strategy

3.3.1. Building Fabric

Reduced U-values and air permeability are proposed to exceed the minimum requirements of Part L2A and are summarised in the table below. This measure aims to reduce the heat demand through the external fabric of the building due to fabric and uncontrolled ventilation heat losses. In addition to the above, the solar transmittance of all glazing units (G-value) needs to be carefully considered to limit the solar gains and reduce overheating risk. The proposed performance is summarised below in Figure 2

Element	Part L2A Limit	Proposed	Percentage Improvement
	U-Value (W/m^2K)	U-Value (W/m^2K)	(%)
External Walls	0.35	0.18	49%
Ground Floors	0.25	0.15	40%
Roofs	0.25	0.12	52%
Glazing (Windows)	2.20	1.60	27%
Glazing (Doors)	2.20	1.60	27%
Glazing (Roof-lights)	2.20	1.60	27%
Solid Doors	2.20	1.90	14%
Air permeability $m^3.(hm^2)$@ 50Pa	10	5	50%

Figure 2 – External fabric thermal performance

3.3.2. Thermal Mass

The thermal mass of a material is a measure of its ability to absorb, store and release heat. High thermal mass of building components gives a building inertia against temperature fluctuations. It is recommended that high thermal mass materials are considered for the non-translucent internal surfaces in the main reception area of the proposed Bicester Heritage Hotel. Incorporating high thermal mass materials in these areas would act as thermal regulators, storing and releasing heat energy and would aid the ventilation strategy for this space.

3.3.3. Daylight strategy

Adequate access to natural light does not only benefit the visual comfort of building users but it can also reduce the overall energy use for general lighting. This measure has been considered during this stage of work. Further daylight access and daylight distribution assessment should be carried out as the design process develops. At this stage it is proposed that all occupied public areas with access to an external window/glazed unit are fitted with photoelectric sensors which should dim/switch off artificial lighting when appropriate illuminance levels are achieve by natural means.

3.3.4. Ventilation strategy

A mixture of natural, mechanical ventilated and comfort cooled spaces are proposed for the Bicester Heritage Hotel. The current design philosophy and thermal comfort strategy has been developed in line with CIBSE recommended comfort criteria (CIBSE Guide A 2015) and should be assessed the strategy against the CIBSE adaptive thermal comfort criteria as described by CIBSE Technical Memoranda 52: Limits of Thermal Comfort: Avoiding Overheating in European Buildings throughout the detailed design stage of works.

3.3.5. Adaptation to climate change

Climate projections indicate that the United Kingdom is likely to have warmer, wetter winters and hotter, drier summers in the future. Adaptation to these conditions is a crucial feature to add to all new buildings. The following Low Carbon design measures have been proposed as climate change mitigation measures:

- The specification of improved solar control glazing to all south facing glazed units and external shading throughout the building: this measures aim to reduce excessive solar gains in the future and maintaining thermal comfort conditions within all areas in the Atrium.
- Exposed high thermal mass internal finishes, has been proposed to act as thermal regulators. This measure would regulate internal temperatures within occupied spaces in the future to maintain thermal comfort conditions.

3.3.6. Summary

The following passive design measures (“Lean Measures”) have been considered and proposed for the new Bicester Heritage Hotel:

- Reduction of space heating demand: achieved by reduced U-values and low air permeability. These measures aim to reduce the heat loss through the building fabric and uncontrolled ventilation.
- Exposed high thermal mass building elements to act as an internal temperature regulator.
- Lighting – provision of adequate daylight to lower general lighting heat gains and electricity used.

3.4 CLEAN - Active design measures

After reducing the demand of energy through passive design principles, the design team can now focus on meeting the reduced demand with the most energy efficient mechanical and electrical services strategies technically suitable. The following active design measures have been identified for the proposed for the Bicester Heritage Hotel:

- Incorporated improved system efficiencies for the space heating, comfort cooling and domestic hot water services.
- Automatic controls to optimise the Heating Ventilation Air Conditioning (HVAC) services.
- Improved mechanical ventilation heat recovery efficiency.
- Incorporated variable speed drives on pumps and fans.
- Improved general lighting efficiency.
- Included natural daylight photoelectric sensing controls.

3.4.1. Space Heating

All space heating to the proposed public and back of house areas is to be by a low temperature hot water system (LTHW), serving radiators, trench heaters, air curtains and air handling units (AHU) heating coils. Circulating pumps are to have variable speed drives to ensure an efficient operation modulating in line with heat demand. The heat source is to be via high efficiency condensing gas fired boilers.

Space heating to hotel and aparthotel bedrooms and flats is to be via a Fan Coil Unit (FCU system). The heat source proposed for this system to be via a variable refrigerant flow/volume (VRF/VRV) type of system. (Please refer to the low carbon technology section below for more details on the VRF/VRV system)

3.4.2. Cooling

Comfort cooling is to be provided to all hotel bedrooms and conference rooms. At this stage a VRF/VRV type system is to serve the cooling requirements of these spaces. (Please refer to the low carbon technology section below for more details on the VRF/VRV system)

3.4.3. Ventilation

All ventilation equipment (mainly AHUs and duct work) is to meet CEN (Comite Europeen de Normalisation) standards for air leakage. The proposed AHU and extract ventilation plant is to target energy efficient fans and high heat recovery efficiency.

3.4.4. HVAC Controls

It is proposed that all space heating, ventilation and air conditioning services are to be controlled via a central Building Energy Management System (BEMS).

3.4.5. Lighting and Lighting Controls

General lighting in the building is to be via Light Emitting Diode (LED) type lamps. The general lighting design should aim to develop a low power density strategy to meet illuminance standards for hotels. Manual switches, automated controls for unoccupied rooms, absence detection and motion detection type of controls are recommended at this stage.

3.4.6. Domestic Hot Water (DHW)

Stored DHW system is proposed for the Bicester Heritage hotel, DHW is to be stored in insulated tanks. At this stage due to the heat and power demand profiles of the type of building proposed a Combined Heat and Power CHP (low carbon technology) has been considered for the production of DHW. (Please refer to the low carbon technology section below for more details on the CHP system)

3.4.7. Summary

Active Design Measures "Clean Measures":

- Heating & Ventilation – Variable speed drives for circulating pumps and fans to ensure an efficient operation in line with demand
- Ventilation – CEN Leakage test AHU and ductwork
- Space heating – High efficiency condensing boilers
- High heat recovery system for all balanced mechanical ventilation system
- Lighting – A LED lighting strategy with automated controls with allowance of daylighting dimming has been proposed.

3.5 GREEN - Low and Zero Carbon (LZC) Technologies

It is important to understand the buildings energy annual energy consumption in order to assess the suitability of any low and zero carbon technologies. This section presents the assessment carried out to evaluate the technical feasibility of LZC technology for the proposed Bicester Hotel. Table 1 below shows the LZC resources available to provide thermal or electrical energy or both.

Resource	Electricity	Thermal
Natural Gas	Combined Heat & Power	Combined Heat & Power
Air		Air Source Heat Pumps
Solar	Photovoltaic System	
Biomass	Combined Heat & Power	Biomass Boilers/CHP
Ground		Ground Source Heat Pumps
Wind	Wind turbines	

Table 1 – LZC Resources

3.5.1. LZC Technical Feasibility

The following section considers the technical feasibility of LZC technologies to provide energy to the proposed development. This section aims to identify the most suitable LZC technology. Seven of the ten LZC technologies (as shown in table 2 below) are investigated with tidal and wave power excluded as there are no suitable water sources in close proximity to the development to make these technologies feasible. Further technical summaries of the feasible technologies are include in appendix two and three of this report.

LZC Technology	CO_2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Air Source Heat Pumps (ASHP)	Medium	Medium	Location of external condenser units	Technology offers a practical solution to provide low energy and carbon space heating,	**Suitable**
			Noise impact from external condenser units to be assessed	Low Carbon Cooling technology	
			External space required to house condenser units		
Summary				**Technical Suitability**	
ASHP technology technically suitable to provide cooling requirements for the proposed bedrooms.				**Recommended**	
LZC Technology	**CO_2 Savings**	**Cost effectiveness**	**Key Considerations**	**Applicability**	**Suitability**
Combined Heat & Power (CHP)	Medium	Medium	Air quality implication to be considered.	Low CO_2 heat and power generation.	**Suitable**
			CO_2 savings are derived from local production of electricity but is limited by the heat demand.	Sufficient DHW load for an optimal operation.	
			High maintenance cost.		
			Location of CHP plant and buffer vessel to be considered.		
Summary				**Technical Suitability**	
CO_2 savings offered by technology are linked to DHW usage profiles. Heat and power demand profiles of proposed building would ensure an efficient operation.				**Recommended**	

LZC Technology	CO_2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Ground Source Heat Pumps (GSHP)	Medium	Medium	Testing required for ground conditions and obstruction	Technology offers good energy and CO_2 savings.	Feasible
			Consider type of collector system: Vertical or horizontal, close or open loop.	Eligible for Renewable Heat Incentive.	
			Consider a earth works required. Often additional infrastructure costs.	Technology offers low energy/CO2 heating and cooling.	
			Efficiency for heating drops as the output temperature increase so heating systems to be designed accordingly to take full advantage of low carbon heating.		
Summary				**Technical Suitability**	
Due to current land available and high capital cost of installation, technology has been deemed unsuitable.				**Not Recommended**	

LZC Technology	CO_2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Biomass Boilers	High	Medium	Consider large fuel storage.	Technology offer high CO_2 emissions savings.	Feasible
			Consider type of fuel to be used (pallets or wood chips).	Heat demand profiles ideal for an efficient operation.	
			Consider speed of response.	Eligible for Renewable Heat Incentive.	
			Consider air quality and appropriate flue design.	Technology offer low CO_2 heating	
			Consider access for delivery vehicles.		
			Consider frequent maintenance.		
			Consider future fuel supply.		
			Consider space requirements for cleaning and maintenance of biomass boiler.		
Summary				**Technical Suitability**	
CO_2 savings offered by technology are linked to heat generation profiles. At this stage technology deemed feasible but not recommended.				**Not Recommended**	

LZC Technology	CO_2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Solar Photovoltaic Panels (PV)	Medium	Low	Location and orientation of the building or roofs and available area of south facing roof and façade: appropriate integration into roof, façade and shading device.	Suitable roof space to install system	Not Suitable
				Electricity generated to be used on site or exported into the national grid	
			Solar access to the site and potential shading from existing and future obstacles (buildings, trees etc.).	Relative low cost of maintenance	
			Roof access for maintenance.	Simple to installed	
			Consider visual impact of panels.		
			Consider extra loading on roof structure.	Eligible for Feed in Tariffs	
Summary				**Technical Suitability**	
Solar technologies have been deemed not to be suitable for The Bicester Herritage Hotel as the hotel is located next to an air field which may restrict the use of any solar technology located on the roof.				**Recommended**	

LZC Technology	CO_2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Solar thermal heating Panels	Low to medium	Medium	Location, orientation and inclination to be carefully considered.	Eligible for Renewable Heat Incentive.	Not Suitable
			Consider visual impact of panels.	Sufficient DHW load for an optimal operation.	
			Location of water storage to be considered.		
			Low CO_2 emissions savings.		
			Roof access for maintenance.		
			Consider extra loading on roof structure.		
Summary				**Technical Suitability**	
Solar technologies have been deemed not to be suitable for The Bicester Herritage Hotel as the hotel is located next to an air field which may restrict the use of any solar technology located on the roof.				**Not Recommended**	

LZC Technology	CO2 Savings	Cost effectiveness	Key Considerations	Applicability	Suitability
Wind turbines	Low	Medium	Consider location of building.	Small operating cost and low carbon emissions savings	Not Suitable
			Consider local wind conditions.		
Summary				**Technical Suitability**	
The Bicester Herritage Hotel as the hotel is located next to an air field which may restrict the use Wind turbines				**Not Recommended**	

Table 2 – LZC Feasibility

3.5.2. LZCT Feasibility Summary

The following measures have been proposed as suitable for the Bicester Heritage Hotel.

LZC Tecnology	Suitability
Air Source Heat Pumps (ASHP)	Suitable
Combined Heat & Power (CHP)	Suitable
Ground Source Heat Pumps (GSHP)	Not recommended
Biomass Boiler	Not recommended
Solar Photovoltaic Panels (PV)	Not suitable
Solar Thermal Heating Panels	Not suitable
Wind Turbines	Not suitable

Table 3 – LZC recommendation summary

4. DYNAMIC SIMULATION AND ENERGY DEMAND ASSESSMENT

4.1 Integrated Environmental Solutions, Virtual Environment (IES Ve 2016)

In order to estimate the expected annual energy consumption for the proposed development a thermal and energy model has been undertaken using Integrated Environmental Solutions Virtual Environment (IES Ve 2016). This simulation package is used to estimate the energy consumption profile of the building through Simplified Building Energy Model (SBEM) calculations. These calculations are used to demonstrate compliance with the Building Regulations Part L2A.

4.2 Annual energy consumption

The energy demand assessment was based on the modelling carried out, which calculated the predicted annual energy consumption for the new Bicester Heritage Hotel. The simulations carried out were based on the NCM and SBEM UK government approved methodologies.

The following section aims to show a summary of the energy simulations carried out to determine the energy demand and apportionment of the proposed development. From this results it can be concluded that domestic hot water DHW for the proposed building would consume the largest proportion of energy in the building this is displayed in Figure 3 below. Figure 4 displays the energy consumption reduction achieve by implementing the passive and active measures described in section 3.2 above.

4.3 Summary of energy simulation results

4.3.1. Annual energy consumption

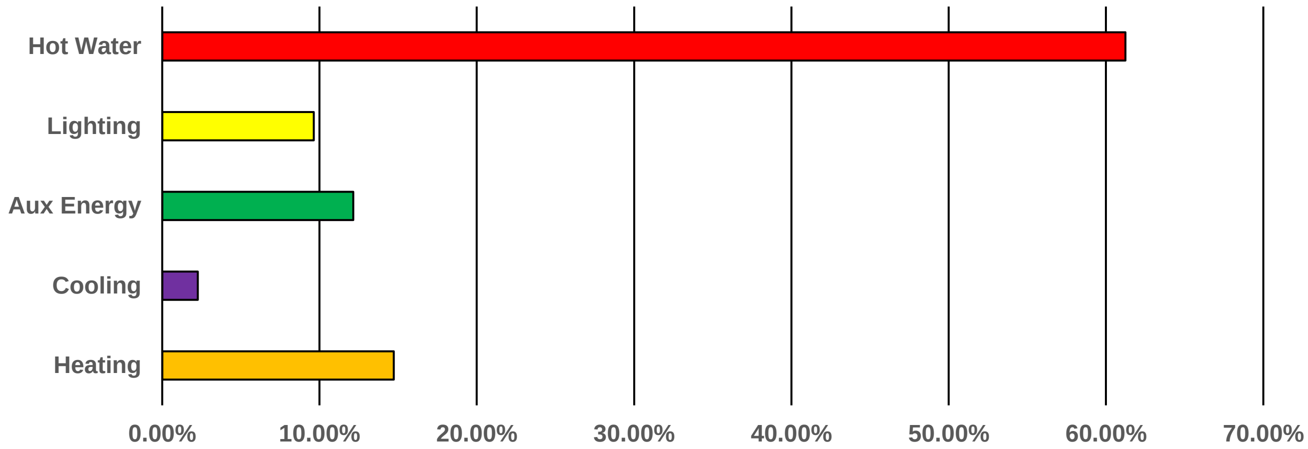


Figure 3 – Baseline estimated annual regulated energy consumption

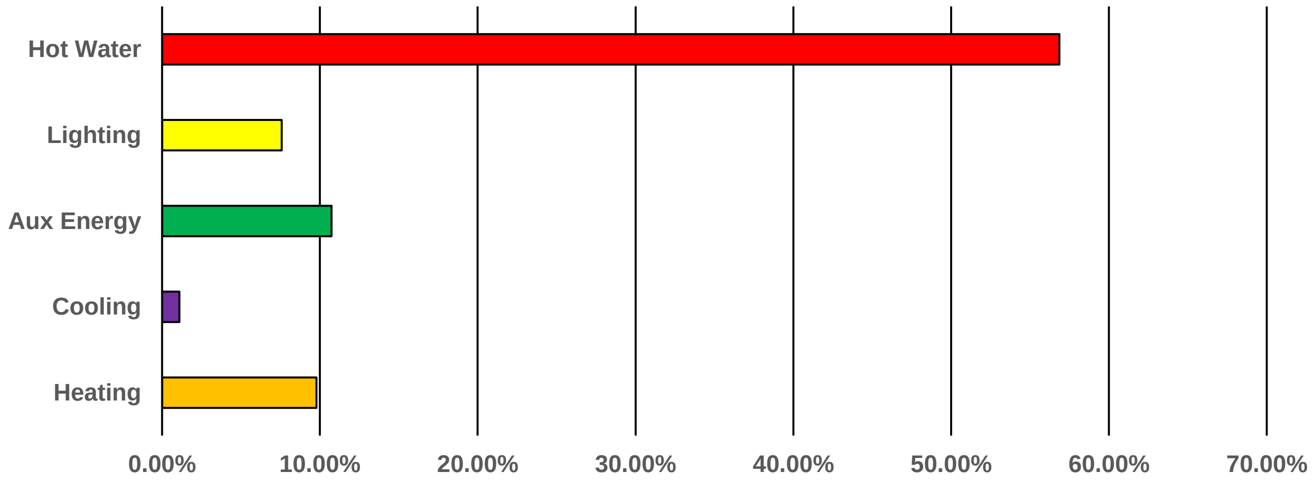


Figure 4 – Passive and active measures estimated annual regulated energy consumption

4.3.2. Energy demand reduction

	Bicester Heritage Hotel - Baseline	**Bicester Heritage Hotel - Passive + Active Measures**
	Phase 1 + Phase 2	**Phase 1 + Phase 2**
Heating + Cooling Demand (MJ)	4,582,413	3,700,059
Primary energy demand (kWh)	9,306,537	7,877,808
Energy demand percentage (%) improvement		19%

Table 4 – Estimated annual energy demand reduction

4.3.3. Carbon dioxide (CO_2) emission reduction.

	Phase 1 + Phase 2 Tonnes CO_2 per annum
Baseline	1,615
Passive and Active Measures	1,369

Green Measures	1,092
Total CO_2 emissions cumulative Savings	20%

Table 5 – Estimated CO_2 emissions after each stage of the energy strategy

4.3.4. Building Regulations Part L Compliance

	Phase 1	**Phase 2**	**Phase 1**	**Phase 2**	**Phase 1**	**Phase 2**
	Baseline		**Passive and Active Measures**		**Green Measures**	
CO_2 emissions rate from the notional building, $kgCO_2/m^2$.annum	70.70	71.50	70.70	71.50	70.70	71.50
Target CO_2 emissions rate (TER), $kgCO_2/m^2$.annum	70.70	71.50	70.70	71.50	70.70	71.50
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	82.70	86.00	69.00	74.20	56.80	57.20
Are emissions from the building less than or equal to the target?	**BER ≥ TER**	**BER ≥ TER**	**BER ≤ TER**	**BER ≥ TER**	**BER ≤ TER**	**BER ≤ TER**

Table 6 – Building Regulation Part L2A compliance summary

The simulations carried out suggested that through the implementation of all passive (lean) and active (lean) measures, a 19% energy demand reduction can be achieved. Through the implementation of the green measures it was estimated that a reduction in regulated CO_2 emissions of 20% can be achieve for both Phase 1 and 2 of the proposed Bicester Heritage Hotel. Further to the above the energy (SBEM) simulations carried out suggested that through the implementation of the Lean, Clean and Green measures proposed, the building would comply with Part L of the building regulations (please refer to appendix one below).

5. CONCLUSION AND RECOMMENDATIONS

5.1 General conclusion

The proposed building was modelled using the UK's SBEM calculation methodology to estimate the likely energy and CO_2 performance against Part L2A and local Bicester Planning Policy. These calculations aimed to support the low carbon energy strategy for the proposed building.

Passive and active design measures have been included to reduce the overall demand of the building. Recommendations to incorporate low carbon technologies have been identified and considered to allow the building to achieve the energy efficiency and renewable energy targets set in section 2.1 above.

5.2 Recommendations

The following design measures are recommended for inclusion in the design development of the proposed Bicester Heritage Hotel:

Passive ("Lean") Measures:

- Reduction of space heating demand: achieved by reduced U-values and low air permeability. These measures aim to reduce the heat loss through the building fabric and uncontrolled ventilation.
- Exposed high thermal mass building elements to act as an internal temperature regulator.
- Lighting – provision of adequate daylight to lower general lighting heat gains and electricity used.

Active ("Clean") Measures:

- Heating & Ventilation – Variable speed drives for circulating pumps and fans to ensure an efficient operation in line with demand
- Ventilation – CEN Leakage test AHU and ductwork
- Space heating – High efficiency condensing boilers
- High heat recovery system for all balanced mechanical ventilation system
- Lighting – A LED lighting strategy with automated controls with allowance of daylighting dimming has been proposed.
- Serve all cooling requirements of the proposed building with an ASHP (VRF) type system.

Green Measures:

The following LZC technologies are recommended for the proposed Bicester Heritage Hotel.

- Implement a CHP unit to serve the DHW heat generation, make full use and taking advantage of the low carbon electricity generated by this system.

APPENDIX ONE: BUILDING REGULATIONS PART L2A COMPLIANCE DOCUMENT

APPENDIX TWO: COMBINED HEAT AND POWER (CHP) TECHNOLOGY SUMMARY

Description

Combined Heat and Power (CHP) units are generally gas fired units which generate electricity and emit waste heat in much the same process as other generators. However, in a CHP unit the waste heat produced is converted into a useful energy source and utilised, thus significantly increasing the overall efficiency of the system. CHP units are typically sized to meet the base heat load of a building, and Chartered Institution of Building Services Engineers CIBSE AM12 – Small Scale CHP in Buildings gives guidance for their design suitability. The general criteria that must all be met are as follows;

- Base load of heat and power exceeding 4000 hours annually (46% of year)
- Base load power demand of approximately 50kW
- Base load heat demand of approximately 80kW
- Extended Daily occupancy

A Combined Heat and Power system is a suitable technology for the proposed Bicester Heritage Hotel due to its annual DHW constant demand profiles.

All CHP calculations and assumption were based on the Energimizer Natural gas fired EM16NG unit.

Thermal efficiency	– 66%
CHPQA Quality Index	– 105 (Minimum required)
Fraction of heat supplied	– 0.34
Fraction of DHW supplied	– 0.66
Heat to Power ratio	– 2 to 1

Figure – Typical CHP unit from Energimizer

APPENDIX THREE: AIR SOURCE HEAT PUMP (ASHP) TECHNOLOGY SUMMARY

Description

Air source heat pumps (ASHP) are an efficient way of providing both heating and cooling to an internal building environment. Low-grade heat, which occurs naturally in the air, is converted to high-grade heat by using an electrically driven or gas-powered pump. If the system utilises a reverse-cycle heat pump, the system can be run in reverse to provide cooling.

The principle of operation revolves around the refrigerant (with a very low boiling point) being heated by the outside air through an evaporator heat exchanger and pumped by a compressor to the indoor heat exchanger whereby it cools and condenses back to a liquid whilst expelling heat into the space. The system is therefore dependent on outside air temperature, and does require a defrost cycle to be implemented in extreme winter conditions to prevent ice build-up on the evaporator.

Air source heat pumps available within the UK at economic prices are electrically driven. A small range of gas driven heat pumps are available, but at a much higher price than their electrically driven counterparts and therefore this report only considers electrically driven ASHPs.

Air source heat pumps are a suitable technology for the Bicester Heritage Hotel. The heating and cooling requirements fit the annual energy profile that suits the implementation of an ASHP system.

All information used and assumed at this stage with regards to VRF system efficiency have been based on the TOSHIBA 3 pipe Heat Recovery Units (SHRMi).

Figure – SHRMi – 3 pipe heat recover outdoor unit