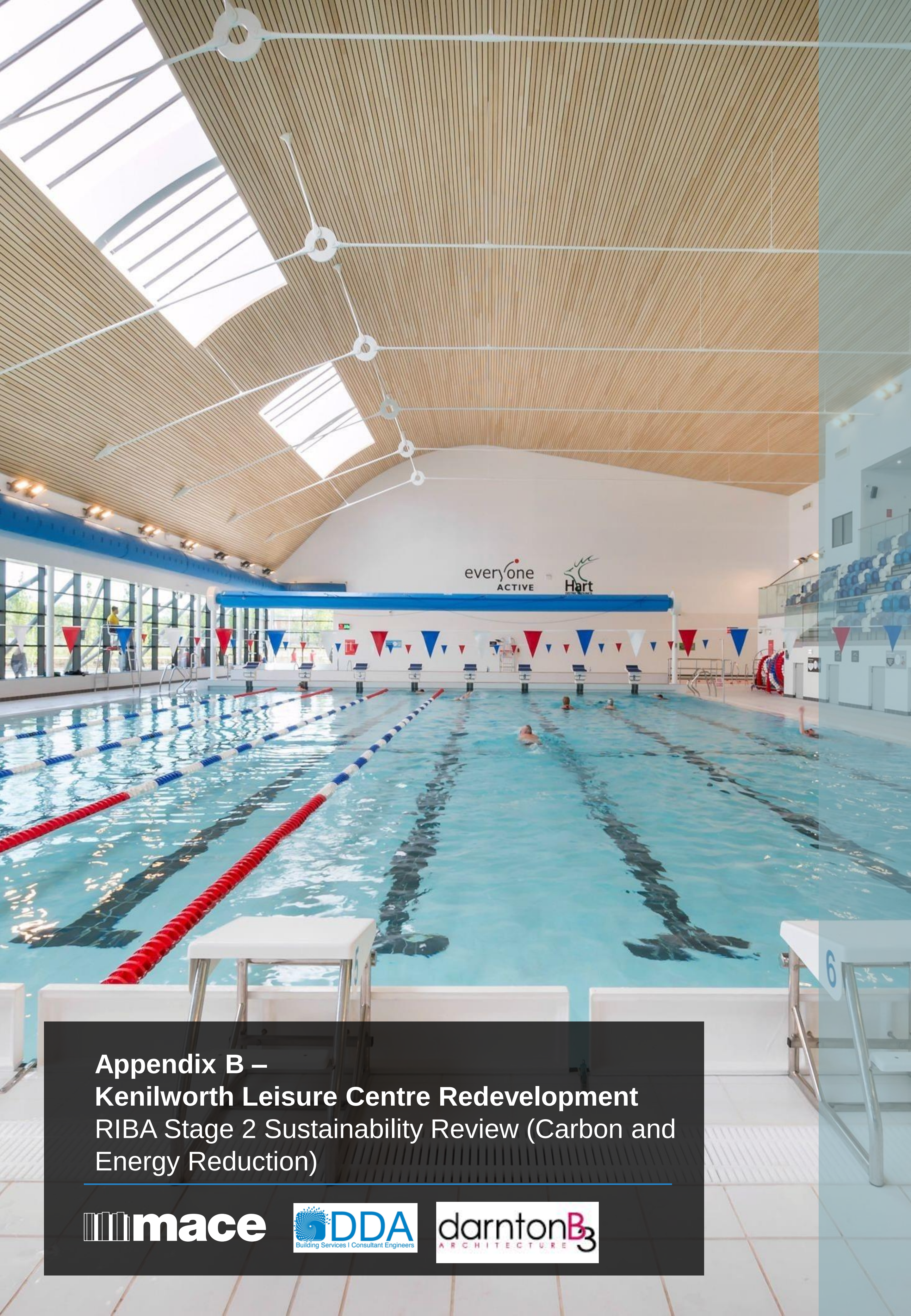


Appendix B –
Kenilworth Leisure Centre Redevelopment

RIBA Stage 2 Sustainability Review (Carbon and Energy Reduction)

Contents

<u>Document Control</u>

Classification	~~Confidential~~ / Restricted / ~~Unclassified~~
Ref	Rev 02 (Client Issue)
Date	02 August 2019
Prepared by	Ashley Holland – Mace
Reviewed by	Josh Barber, Rebecca Chantry – Mace

Executive Summary

Mace have been working on behalf of Warwick District Council (WDC) since June 2018, developing the scope and designs for the proposed redevelopments of Abbey Fields Swimming Pool and Castle Farm Recreation Centre.

Mace were appointed as the lead consultant, providing full multi-disciplinary services including the following core design disciplines;

- Architect – DarntonB3
- Civil & Structural Engineer – Couch
- Mechanical & Electrical Engineer – DDA

At tender the project did not have any specific sustainability requirements or accreditations that needed to be achieved. However, the importance of sustainability was reviewed at the commencement of the project and a further review has been undertaken in this report, noting the advantages and disadvantages of each of the accreditation systems available.

At the commencement of RIBA Stage 2, WDC noted an intention to investigate how the proposed designs could be adjusted to be as sustainable as possible. This involved a specific focus on carbon reduction, which aligns with the Council's wider environmental objectives. As part of the RIBA2 design strategies, each designer has included common best practices and this report looks to build upon this, to review what could be achieved as the RIBA Stage 3 detailed design is progressed.

The two proposed schemes both see an increase in the building's Gross Internal Floor Area (GIFA) and increased facilities. Consequently, at the end of RIBA Stage 2 the proposed schemes show an increase in their proposed energy usage and carbon footprint. However, having undertaken a review of the sustainability options for the M&E systems, as well as the building fabric, the design team have shown that it is possible to reduce both energy consumption and carbon generation at both facilities and thus lower the environmental impact that the current 'base' Stage 2 design will have.

Following this report, the project team have proposed developing a further sustainability strategy by engaging an expert to review the designs and produce a further report as part of the planning application submission. In addition to this, as part of the RIBA Stage 3 design, the team will develop a 3D building model which enables tests to be run on the energy efficiency of the building to gain greater certainty around the current carbon and energy usage proposals that have been included within this report.

1 Introduction

This report seeks to assess and review the predicted energy consumptions of the two leisure centres marked for redevelopment by Warwick District Council (WDC) in Kenilworth, Warwickshire. Under the current appointment, Mace have been tasked by the Council to prepare a report that seeks to provide an overview of potential energy reductions and the implementation of additional renewable energy sources for the proposed leisure schemes. This exercise supports the Council's ambition to become a net-zero carbon organisation by 2025.

The report will identify additional technologies and systems recommended for further client review and/or instruction in the next stage of design. The report is not a sustainability statement but is a review of technologies that could be incorporated into the scheme to assist the Council in achieving its ambition to become a carbon neutral organisation. The report also provides an overview of sustainable assessment methods and processes such as BREEAM, Passivhaus & Standard Assessment Criteria (SAP). Nevertheless, the report is primarily focused on the reduction of the energy consumption and carbon generation of the existing buildings within the current 'base' Stage 2 design, with recommendations provided as to how the base design can be improved as it moves through the next design stages.

2 Sustainability Overview & Planning Policy

Sustainability is a broad term describing a desire to carry out activities without depleting resources or having harmful impacts. This is defined by the Brundtland Commission as *'meeting the needs of the present without compromising the ability of future generations to meet their own needs'.*

Sustainability in building developments is a vast and complex subject and is typically considered by designers from the very earliest stages of design development. This is because the built environment accounts for:

- 45% of total UK carbon emissions (27% from domestic buildings and 18% from non-domestic)
- 72% of domestic emissions from space heating and provision of hot water
- 32% of landfill waste comes from the construction and demolition of buildings
- 13% of products delivered to construction sites are sent directly to landfill without being used

Whilst it is a complex process, predicting the likely environmental performance of a development during the design phase is becoming more important as regulations have increased. Aside from building regulations and government targets for low carbon construction, the National Planning Policy Framework favours granting planning permission for sustainable developments, which can include low-carbon developments and those with resilience to climate change. These sustainability objectives and how they are achieved will be reflected in the planning application, through the design and access statements for the two leisure centres. However, as sustainability is being reviewed at the earliest opportunity, the Council are able to gain a greater understanding of the potential environmental impacts of the projects and implement mitigating strategies.

As noted briefly in the Introduction, the Council are committed to lowering their carbon emissions and becoming a 'net-zero organisation'. The issue of climate change and carbon emissions had already been incorporated as part of the District Council's 2017 Local Plan. This has been emphasised even further by the Council's recent declaration of a 'climate emergency'.

The Local Plan itself notes that all future developments are required to be designed to be resilient to, and adapt to, future impacts of climate change through the inclusion of the following adaptation measures:

a) Using layout, building orientation, construction techniques and materials and natural ventilation methods to mitigate against rising temperatures.

b) Optimising the use of multi-functional green infrastructure (including water features, green roof and planting) for urban cooling, local flood risk management and to provide access to outdoor space for shading.

c) Incorporating water efficiency measures, encouraging the use of grey water and rain water recycling.

d) Minimising vulnerability to flood risk by locating development in areas of low flood risk and including mitigation measures including SuDS.

As part of any planning application for the centres the team will need to set out how the requirements of the policies regarding climate change have been complied with and include any justification for why the above measures have not been incorporated.

It is important to note that at the current stage of design the team will, as best practice, seek to review and include sustainable measures such as SuDS. The additional information that is included within the following sections of this report will seek to increase the commitment of the project to a reduction in carbon outlay and therefore assist the Council in furthering its work in combating climate change.

Within the Council's Planning Policy is included the following statement:

- All non-residential development over 100 sqm is required to achieve as a minimum BREEAM standard 'Very Good' (or any future national equivalent), unless it can be demonstrated that it is financially unviable or a suitable alternative sustainability strategy is proposed and agreed with the Council.

At present the team are not progressing a BREEAM-led process of assessment as the focus remains centred around renewable energy and low carbon generation to meet the Council's targets. The BREEAM process, if it were to be implemented at this stage, would be at an additional cost on top of the current budget when that budget is already constrained.

At present, progressing with BREEAM is therefore likely to be unviable. However, this will need to be a decision made by the Council. It is unlikely that incorporating BREEAM and a focus on carbon reduction concurrently will be viable within the current budgets. To incorporate both, budgets would need a significant increase to allow for both the proposals reviewed in the following sections and the implementation of a complex assessment process.

At this stage it is again important to note that the team are working to produce a scheme that is capable of meeting the required building regulations and further planning requirements regarding sustainable design.

3 Sustainable Assessment Methods

As noted in the previous sections, the majority of this report is centred on lowering the likely carbon generation from the ‘base’ Stage 2 design, to assist the Council in achieving its climate change objectives.

There are a number of sustainable assessment tools and standards available to help assess overall environmental performance, these include:

- BREEAM
- Passivhaus
- SAP - the Government's Standard Assessment Procedure for energy rating of dwellings.
- LEED - Leadership in Energy and Environmental Design, an international green building certification system
- The Code for Sustainable Homes

The following table provides definitions for each of the above:

Assessment Type	Definition
BREEAM Building Research Establishment Environmental Assessment Method	BREEAM is an assessment using scientifically-based sustainability metrics and indices that covers a range of environmental issues. Its categories evaluate energy and water use, health and wellbeing, pollution, transport, materials, waste ecology and management process. Buildings are certified on a scale of ‘Pass’, ‘Good’, ‘Very Good’, ‘Excellent’ and ‘Outstanding’. It is carried out by independent assessors.
Passivhaus	Passive house (Passivhaus in German) is a rigorous, voluntary standard for energy efficiency, which reduces a building's ecological footprint. It results in ultra-low energy buildings that require little energy for space heating or cooling. The standard is not confined to residential properties: several office buildings, schools and supermarkets have also been constructed to the standard. Passivhaus design is not an attachment or supplement to architectural design, but a process that integrates with architectural design. Although it is principally applied to new buildings, it has also been used for refurbishments.
LEED Leadership in Energy Environmental Design	LEED is the most widely used green building rating system in the world. Available for virtually all building, community and home project types, LEED provides a framework to create healthy, highly efficient and cost-saving green buildings.

Assessment Type	Definition
SAP Standard Assessment Procedure	SAP is the Government's Standard Assessment Procedure for Energy Rating of Dwellings. SAP 2005 is adopted by Government as part of the UK national methodology for calculation of the energy performance of buildings. It is used to demonstrate compliance for dwellings with Part L of the Building Regulations (England and Wales) and to provide energy ratings for dwellings.
CSH Code for Sustainable Homes	The Code for Sustainable Homes is a method for assessing and certifying the sustainable design and construction of new homes. It was launched in 2006 to help reduce UK carbon emissions and create more sustainable homes. In 2008, the code became temporarily mandatory with the introduction of Home Information Packs.

The assessment techniques that have been presented above are beginning to allow whole-life costing to form a fundamental part of the design process, as it can be evidenced that higher initial costs can sometimes result in lower long-term impacts and greater long-term benefits.

Whilst the current approach adopted by the team to lower carbon generation follows many of the same principles as an assessment process, we are focused on meeting the Council's specific objectives, rather than following a general and pre-determined sustainable assessment methodology which the above options provide.

A table has been included on the following page noting the advantages & disadvantages of each technique. This is primarily an overview to provide background on assessment techniques for measuring sustainability. To implement any of these techniques would be likely to create an additional requirement for specialist input. In order to meet the Council's commitment to becoming a carbon-free organization by 2025, any technique used would have to be implemented alongside the ambition to minimise the carbon footprint of the buildings.

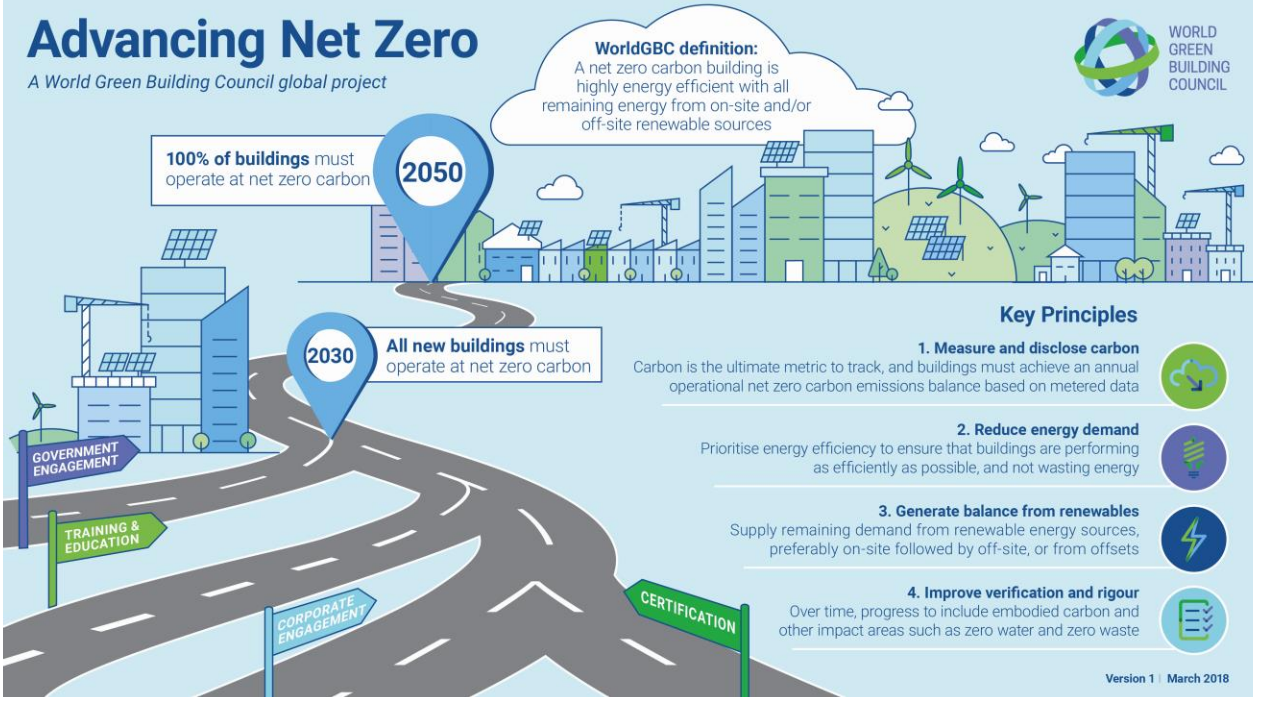
Assessment Tool	Advantages	Disadvantages	Comments
BREEAM	• Buildings are rated and certified on a scale from Pass to Outstanding. • Meets current planning requirements. • Set measurements of sustainability.	• Time consuming exercise. • Requirement for specialist consultants. • Lack of flexibility. • Achievement of 'very good' is difficult. • Increased cost. • Still requires focus on carbon reduction in addition.	• Currently a planning requirement and non-compliance will need to be agreed.
Passivhaus	• A method focused on saving energy rather than reducing generation. • Assists with affordability (no requirement for radiators etc.).	• Not Zero Carbon. • Targeted at homes. • Operation of buildings requires a greater understanding from operator on technology. • Lack of flexibility. • Doesn't use on-site renewables.	• Not a widely implemented process in buildings beyond homes.
SAP	• Supported by the Building Research Establishment (BRE). • Well used Government Standard. • Inclusive of principles being reviewed currently.	• Not carbon focused. • A process for assessment rather than implementation. • Would require specialist sustainability input. • Additional cost along side current exercise (if implemented).	• Could be incorporated as a tool of assessment against the reduction in carbon emissions and overall project sustainability.
CSH	• Government standard. • Known to local authorities. • High 'eco' credentials and assists with the reduction in carbon footprint.	• Not widely used outside of housing developments. • Similar to SAP but more focussed towards housing. • Additional cost alongside current exercise (if implemented).	• Not widely used in construction projects beyond housing developments.

Assessment Tool	Advantages	Disadvantages	Comments
LEED	• Buildings are rated and certified on a points system similar to BREEAM • A suitable alternative • Focused on new builds	• Time consuming exercise • Requirement for specialist consultants • Achievement of ‘top rating’ is difficult • Increased cost • Still requires focus on carbon reduction in addition • Focused on commercial-building projects	• Could be an alternate to BREEAM although the process is very similar in terms of assessment. Would still come attached with viability concerns.

4 Carbon Reduction & Net Zero

The Council has committed itself to being a net zero organisation by 2025. This means, amongst other things, that construction projects being progressed by the local authority will also need to limit and reduce their current carbon omissions. Before a project takes steps to achieving this, it is important to understand the meaning of ‘Net Zero’.

4.1 What is Net Zero?



The World Green Building Council definition of a net zero carbon building is a building that is highly energy efficient and fully powered from on-site and/or off-site renewable energy sources. Whilst on-site renewables have been reviewed as part of this report, unfortunately at this stage we cannot comment on off-site renewable sources as these can not be influenced by the team. Additionally, it is also highly likely that the carbon expenditure attributed to the current designs of Castle Farm and Abbey Fields leisure centres will be higher than the existing buildings. This is partly due to significant building growth, alongside increased and more intensive usage, for example, the ratio of higher consumption areas (such as studios) to lower consumption areas (such as circulation space) will be higher than in the existing leisure centres.

Subsequently, what we are seeking to implement through the body of this report, and through further exploration, is additional mechanical and electrical technologies alongside adjustments to building materials and construction methodologies that would provide more efficient buildings and reduce their carbon generation. Whilst Net Zero is the Council’s overall target, its achievability on the leisure centre schemes will need further review and will ultimately depend on the level of technology that can be implemented. It is unlikely that the schemes will be able to have only on-site generation. A typical sports centre’s energy costs are second only to labour costs, accounting for as much as 30% of total running costs - a higher figure than in most other sectors. However, through the implementation of energy-generating technologies and building material changes reviewed in the following sections, the Council will be able to significantly reduce its likely carbon generation.

5 Castle Farm Sustainability Opportunities

5.1 Introduction to M&E Solutions

This section assesses and reviews the predicted energy consumption of the leisure centres alongside recommendations for energy reductions and the implementation of additional renewable energy sources and technologies. Further sub-sections will review building materials and construction methodologies.

The section also identifies additional technologies and systems recommended for client review. This is with a view towards instructing the team to develop the chosen ideas for inclusion in the next design stage of the project. The summary table at the end of the report breaks down budget costs, energy savings and carbon reductions for recommended systems.

5.2 Energy Consumption

For comparison calculations and illustrative purposes, annual carbon consumption values for the leisure centres have been converted to the equivalent for a long haul flight per person. For information, the notional UK to Australia flight distance is 15,200 km (varies by airport) and a standard long haul flight to Australia can carry 417 people (based on a Boeing 747). As a further benchmarking exercise the final saving figures have also been converted to the equivalent of boiling a given number of kettles.

5.3 Existing Building Energy Consumption

Castle Farm Recreation Centre – Existing	kWh Consumption per annum	Carbon Generation per annum	Equivalent Long-Haul Flight	Annual Cost
Gas:	126,986 kWh	23,095kg	2,875 km	£4,508
Electricity:	65,690 kWh	35,275kg	4,260 km	£9,479.07
Totals:	**192,676 kWh**	**58,370kg**	**7,135 km**	**£13,987.07**

5.4 Energy Costs

For the purposes of this report, electricity and gas costs are assumed to be £0.1443 and £0.0355 respectively. These figures are taken directly from the current utility supply contracts.
These figures have been used to calculate utility costs and cost savings from additional technologies.

5.5 Predicted Building Energy Consumption

Using benchmark data published by the Chartered Institute of Building Services Engineers (CIBSE); “Technical Memorandum 46”, the predicted energy consumption has been calculated as follows for the ‘base’ RIBA Stage 2 design:

Castle Farm Recreation Centre - Predicted	kWh Consumption per annum	Carbon Generation per annum	Equivalent Long-Haul Flight	Annual Cost
Gas:	780,000 kWh	141,960 kg	17,100 km	£27,960
Electricity:	224,000 kWh	120,288 kg	14,500 km	£32,323.20
Totals:	**1,004,000 kWh**	**262,248 kg**	**31,600 km**	**£60,283.20**

The above figures, as previously stated, are based upon benchmark data which does not necessarily reflect the actual annual usage of the building. These values are to be considered worst case predictions and they will be developed into firmer values as the design progresses through RIBA Stage 3.

The predicted energy consumption is higher than the existing usage because the proposed building is larger, and the usage is more intense i.e. the ratio of higher consumption areas such as studios to lower consumption areas such as circulation space is higher than in the existing leisure centre at Castle Farm.

5.6 Integrated Systems

Several systems are already included in the scheme as ‘Good Practice’ to meet the requirements of Building Regulations. These include the following:

- LED lighting throughout.
- Lighting controls throughout.
- Power Factor Correction.
- Energy Metering.
- Air Source Heat Pumps (ASHP) – heating and cooling.
- Heat Recovery Ventilation.
- High Efficiency Motors, Inverter Drives etc.
- Intelligent Building Management System Controls.

5.7 Additional Technologies

A number of additional systems are proposed to be considered for possible inclusion in the scheme as ‘Best Practice’ in order to improve on the carbon performance of the building. These include the following:

- Air Source Heat Pumps (ASHP) – hot water generation.
- Ground Source Heat Pumps (GSHP) – hot water generation.
- Water Source Heat Pumps (WSHP) – hot water generation.
- Combined Heat & Power (CHP) – electricity and hot water generation.
- Solar PV – electricity generation.
- Solar Thermal – hot water generation.
- Biomass Boiler – hot water generation.
- Voltage Optimisation – electricity consumption reduction.
- Wind Turbines – electricity generation.
- Grey Water Harvesting – water consumption reduction.

All of the systems listed have been reviewed extensively with recommendations made as to whether they should be included within the scheme. In order to improve the energy consumption of the 'base' RIBA Stage 2 design, it is recommended that the following additional systems are developed into the scheme. The estimated savings for each of these options is also shown in order to evidence their impact:

Castle Farm Recreation Centre	Gas Consumption	Electricity Consumption
'Base' RIBA 2 Predicted Energy Consumption:	780,000 kWh	224,000 kWh
'Base' RIBA 2 Predicted Carbon Consumption:	262,248 kg (Equivalent to 31,630 km long-haul flight / 3,439,867 kettles boiled)	
Water Source Heat Pumps to provide the building with hot water and heating. This would utilise the local pond. This could be developed further to provide heating and cooling for the building by rejecting internal heat loads in the summer.	-640,000 Kwh	+120,000 kWh
Voltage Optimisation unit to reduce the electricity consumption of the building.		-35,000 kWh
Photovoltaic Panels to generate electricity. It is recommended the roof design and building fabric be developed to consider creating the largest surface area possible to mount/integrate PV panels in order to reduce the grid-supplied electricity consumption.		-33,000 kWh
New prediction for Energy Consumption following implementation of the above systems in comparison with existing design:	**140,000 kWh**	**276,000 kWh**
Carbon production savings compared to the existing design by implementing above systems:	**88,556 kg / annum (Equivalent to 10,700 km long-haul flight / 1,163,660 kettles boiled)**	

5.8 Summary Comments:

- Whilst the electricity consumption has increased, this is based upon the required increase of energy to drive pumps etc. for the water source heating system. This value has been derived from 'rules of thumb' in the absence of a detailed design and should be considered worst case. The increase, however, leads to a decrease in gas consumption.
- The electricity generated from the PV panels could be increased if the available roof area or installation area was increased.
- The energy saved by the voltage optimisation unit is a percentage of the consumed energy and this value would therefore be adjusted in line with any changes to the consumption and production of electricity in the building.
- It is also recommended that water harvesting is implemented to reduce the consumption of potable water on site for uses such as toilet flushing etc.

5.9 Cost

The below table summarises the capital costs of implementing the proposed systems and our recommendations:

System	Budget Capital Cost	Energy Impact	Payback	Carbon Reduction	Recommendation
Water Source Heat Pumps	£225,000	600,000 kWh of hot water generation. 75% of the hot water / heating demand.	10 year payback	111,000 kg Carbon per annum. Equivalent to 7.4 million boiling kettles.	Recommended for further consideration.
Voltage Optimisation	£18,000	35,000 kWh energy saving. Up to 15% reduction in electricity consumption.	3 year payback.	18,000 kg Carbon per annum. Equivalent to 1.25 million boiling kettles	Recommended for inclusion in this project.
Photovoltaic Panels	£25,000	33,000 kWh electricity generation. 15% reduction in grid-supplied electricity consumption.	4.5 year payback	18,000 kg Carbon per annum. Equivalent to 1.25 million boiling kettles	Recommended for inclusion in this project subject to planning conditions and suitable building design.

6 Abbey Fields Sustainable Energy Opportunities

6.1 Energy Consumption

For comparison calculations, carbon consumption values have been converted to the equivalent a long haul flights per person and boiling kettles equivalent.

6.2 Existing Building Energy Consumption

Based upon actual utility bills, the existing leisure centre utility consumption is as per the following table :

Abbey Fields Swimming Pool - Existing	kWh Consumption per annum	Carbon Generation per annum	Equivalent Long-Haul Flight	Annual Cost
Gas:	710,319 kWh	129,278 kg	15,600 km	£22,801.24
Electricity:	294,735 kWh	158,273 kg	19,100 km	£38,374.50
Totals:	**1,005,054 kWh**	**287,551 kg**	**34,700 km**	**£61,175.74**

6.3 Energy Costs

For the purposes of this report, electricity and gas costs are assumed to be £0.1302 and £0.0321 respectively. These figures are taken directly from the current utility supply contracts.

These figures have been used to calculate utility costs and cost savings from additional technologies.

6.4 Predicted Building Energy Consumption

Using benchmark data published by the Chartered Institute of Building Services Engineers (CIBSE); “Technical Memorandum 46”, the predicted energy consumption has been calculated as follows for the ‘base’ RIBA Stage 2 design:

Abbey Fields Swimming Pool - Predicted	kWh Consumption per annum	Carbon Generation per annum	Equivalent Long-Haul Flight	Annual Cost
Gas:	2,400,000 kWh	436,800 kg	52,700 km	£77,040.00
Electricity:	540,000 kWh	289,980 kg	35,000 km	£70,308.00
Totals:	**2,940,000 kWh**	**726,780 kg**	**87,700 km**	**£147,348.00**

The previous figures are based upon benchmark data which does not necessarily reflect the actual usage of the building. These values are to be considered worst case predictions and they will be developed into firmer values as the design progresses through RIBA Stage 3.

The predicted energy consumption is higher than the existing usage because the proposed building is larger, and the usage is more intense. For example, the ratio of higher consumption areas such as studios to lower consumption areas such as circulation space is higher than in the existing leisure centre.

6.5 Integrated Systems

Several systems are already included in the scheme as 'Good Practice' in order to meet the requirements of Building Regulations. These include the following:

- LED lighting throughout.
- Lighting controls throughout.
- Power Factor Correction.
- Energy Metering.
- Air Source Heat Pumps (ASHP) – heating and cooling.
- Heat Recovery Ventilation.
- High Efficiency Motors, Inverter Drives etc.
- Intelligent Building Management System Controls.

6.6 Additional Technologies

A number of additional systems are proposed to be considered for possible inclusion in the scheme as 'Best Practice' in order to improve on the carbon performance of the building. These include the following:

- Air Source Heat Pumps (ASHP) – hot water generation.
- Ground Source Heat Pumps (GSHP) – hot water generation.
- Water Source Heat Pumps (WSHP) – hot water generation.
- Combined Heat & Power (CHP) – electricity and hot water generation.
- Solar PV – electricity generation.
- Solar Thermal – hot water generation.
- Biomass Boiler – hot water generation.
- Voltage Optimisation – electricity consumption reduction.
- Wind Turbines – electricity generation.
- Grey Water Harvesting – water consumption reduction.

All the systems have been reviewed extensively with recommendations made as to whether these should be included. In order to improve the energy consumption of the 'base' RIBA Stage 2 design, it is recommended that the following additional options are designed into the scheme. Estimated savings have also been evidenced to show how this will benefit the scheme:

	Gas Consumption	Electricity Consumption
'Base' RIBA 2 Predicted Energy Consumption:	2,400,000 kWh	540,000 kWh
'Base' RIBA 2 Predicted Carbon Consumption:	726,780 kg (Equivalent to 87,600 km long-haul flight / 9,526,790 kettles Boiled)	
Combined Heat & Power to provide the building with hot water and heating. The initial calculations in this report have been based upon a 50kW heat / 100kW electricity output unit but it is recommended that doubling the size of unit is considered. This would be considered against the final building design and reflect the actual hot water demand for the final pool design. Multiple CHP units are recommended for maximum efficiency.	- 67,000 kWh (adjusted to reflect additional gas to drive CHP unit)	- 53,000 kWh
Water Source Heat Pumps to provide the building with hot water and heating. This would utilise the local pond. This could be developed further to provide heating and cooling for the building by rejecting internal heat loads in the summer.	-640,000 kWh	+ 120,000 kWh
	Note: not included in the totals due to contributing less than ASHP below and is only recommended to incorporate one or the other of these options.	
Air Source Heat Pumps to provide the building with hot water and heating. This has been selected solely for its carbon reduction capabilities and the client should be aware of the excessive payback from a financial consideration. This system, coupled with a CHP would offer a higher efficiency and therefore reduced payback period.	- 860,000 kWh	+ 170,000 kWh to operate the air source heat pumps and water pumps etc -35,000 kWh
Voltage Optimisation unit to reduce the electricity consumption of the building.		-50,000 kWh
Photovoltaic Panels to generate electricity. It is recommended the roof design and building fabric be developed to mount PV panels in order to reduce the grid-supplied electricity consumption.		-33,000 kWh
New prediction for Energy Consumption following implementation of the above systems in comparison with existing design:	**1,473,000 kWh**	**539,000 kWh**

Carbon production savings in comparison to the current design by implementing above systems:	407,432 kg / annum (Equivalent to 49,100 km long-haul flight / 5,339,787 kettles boiled

6.7 Summary Comments:

- The electricity generated from the PV panels could be increased if the available roof area or installation area was increased.
- The energy saved by the voltage optimisation unit is a percentage of the consumed energy and this value would therefore be adjusted in line with any changes to the consumption and production of electricity in the building.

6.8 Cost

The below table summarises the capital cost and recommendations for further consideration.

System	Budget Capital Cost	Energy Impact	Payback	Carbon Reduction	Recommendation
Combined Heat & Power	£95,000	53,000 kWh electricity generation (+ 39,000kWh of gas to drive engine). 11% reduction in grid-supplied electricity	4.5 year payback	74,000 kg Carbon per annum (including offset of additional gas). Equivalent of 5 million boiling kettles.	Recommended for inclusion in the project due to the high hot water demand and duration, allowing the plant to run efficiently.
Voltage Optimisation	£27,000	50,000 kWh energy saving. Up to 15% reduction in electricity consumption.	4.1 year payback.	93,000 kg Carbon per annum. Equivalent of 6 million boiling kettles	Recommended for inclusion in this project.
Photovoltaic Panels	£25,000	33,000 kWh electricity generation. 15% reduction in grid-supplied electricity consumption.	4.5 year payback	18,000 kg Carbon per annum. Equivalent of 1.25 million boiling kettles	Recommended for inclusion in this project subject to planning conditions and suitable building design.

System	Budget Capital Cost	Energy Impact	Payback	Carbon Reduction	Recommendation
Air Source Heat Pumps – hot water generation	£425,000	860,000 kWh of hot water generation (170,000 kWh additional electrical consumption). 36% of the hot water / heating demand.	34 year payback	105,000 kg Carbon per annum. Equivalent of 7 million boiling kettles.	Recommended for further investigation, however implications on the design should be fully considered including; long pay back period, large area for thermal store, large external plant area for condensers and associated weight implications on structure.

6.9 Outdoor Pool/Indoor Pool Utility Consumption Comparison

As a separate calculation, the authors of this report were asked to provide a comparison between the utility consumption and carbon production of a 25m outdoor swimming pool and a 15m indoor pool as included in the designs. The results are shown below. The consumption figures for the outdoor pool are shown at the same temperature as the indoor pool for direct comparison, and then also shown at a more likely temperature for an outdoor pool (22°C). As the outdoor pool has not been included in the current design, these figures are not carried through to the recommended calculations for the new schemes.

15m x 10m indoor pool heated to 27 °C	25m x 10m outdoor pool heated to 27 °C	25m x 10m outdoor pool heated to 22 °C
1,231,380 kWh of additional gas per annum	2,565,380 kWh of additional gas per annum	1,968,806 kWh of additional gas per annum
228,000 kg carbon produced per annum	475,000 kg carbon produced per annum	358,325 kg carbon produced per annum
£39,500 additional utility consumption per annum	£82,500 additional utility consumption per annum	£63,200 additional utility consumption per annum
Equivalent to travelling 27,500 km by long haul flight or 2,990,716 kettles boiled.	Equivalent to travelling 57,285 km by long haul flight or 6,229,933 kettles boiled.	Equivalent to travelling 43,215 km by long haul flight/ or 4,699,774 kettles boiled.

7 Building Materials Review

7.1 Introduction

With the increasing drive to improve sustainability and reduce costs, the selection of building materials and products is becoming ever more crucial. By carefully selecting products and taking into account their intended application, use, effect on building performance and expected service life, the environmental footprint of buildings and their construction can be minimised.

7.2 Tools to assist selection

While there are a variety of commercial tools that can be used to assist product selection, BRE Global's Green Guide to Specification is the most well-known. The Green Guide is based on an independent and industry agreed methodology relevant to construction and used within the context of the overall building assessment tools – the BRE Environmental Assessment Method (BREEAM) and the Code for Sustainable Homes. The tools use a technique known as Life Cycle Assessment (LCA) to determine the combined environmental impact of a range of construction materials and products in the context of a building's construction over the whole life of the building. This is in contrast to many consumer products, which do not take proper account of the service life of the product.

7.3 Life cycle costing

The concept of LCA underpins The Green Guide to Specification through its use of the Environmental Profiles Methodology. To use LCA in The Green Guide, it has been necessary to develop information on the service lives of the materials and components represented in the guide's elemental specifications. This is because every time a material or component is replaced, LCA must measure the environmental impact of the new material or replacement component (as well as the disposal of the old one). If, for example, we take the manufacture and use of a brick wall, the LCA considers the environmental impact associated with:

- The extraction and transportation of clay to the brickworks.
- The manufacture and transport of ancillary materials.
- The extraction and distribution of natural gas for the brick kiln.
- The mining and transport of fuel for the generation of electricity for use in the factory.
- The production and transportation of raw materials for the packaging.
- The manufacture of the bricks at the brickworks.
- The transportation of the bricks to the building site.
- The extraction of sand and the production of cement for the mortar.
- The building of the wall.
- The maintenance of the wall such as painting and repointing.
- The demolition of the wall.
- The fate of the materials in the waste system.

As evidenced in the above list, there is a significant amount of information required to rate even relatively simple construction and it is therefore clear why the standardised methodology of the Green Guide is important to enable an informed decision to be made on construction types.

7.4 Material selection at Castle Farm and Abbey Fields.

On the two Kenilworth leisure projects it is our intention to select materials and constructions with overall Green Guide ratings of A wherever it is possible to do so. This is the highest rating which is given to materials and to constructions which have the lowest overall environmental impact.

Our initial analysis has shown that we expect be able to use only A rated constructions for all of the building elements, floors, walls, roofs, doors etc. The one exception might be the curtain walling, where only timber curtain walling systems achieve the A rating and these may not be suitable in these buildings.

7.5 Building Fabric- Reduction of energy use.

The building fabric can affect the energy use of the building in several distinct ways:

- Insulation levels - How much heat is lost or gained through each of the elements of the construction, walls, floors, roofs, windows and doors.
- Ventilation and airtightness - How much energy is lost though air leaking through the building fabric.
- Orientation - The orientation of a building can affect daylighting, overheating, the need for shading etc.
- Plan form - An efficient plan form can reduce energy use by reducing the relative proportions of the inside to outside interface elements.
- Thermal mass - Choosing the correct thermal mass to control how quickly or slowly the building heats up or cools down.

7.6 Insulation levels

The current building regulations sets minimum insulation levels (U values) for the main elements of the buildings fabric as follows:

- Roof 0.25 W/(m²K)
- Walls 0.35 W/(m²K)
- Floor 0.25 W/(m²K)
- Windows, curtain walling and doors 2.2 W/(m²K)

Increasing the levels of insulation beyond these minimum levels reduces the U values and the amount of heat loss or gain through the fabric. However, the law of diminishing returns applies here and therefore, for each subsequent increase in insulation, the relative amount of energy saved reduces.

To help to inform a decision on the assessment of cost against energy saving, we have prepared some typical constructional sections for each of the building fabric elements based on the Building Regulation requirements, and some achievable increased insulation options. The various options and associated increased costs are shown overleaf. The resultant energy saving and pay back periods will be included when these can be calculated, during RIBA Stage 3.

Construction Materials	U value W/m²k	Additional Cost (Budget estimate)	Energy saving	Payback period
Masonry Wall type A	0.22	£255,150	To be developed during RIBA Stage 3 (requires thermal modelling)	To be developed during RIBA Stage 3 (requires thermal modelling)
Masonry Wall Type B	0.18	£259,200		
Masonry Wall Type C	0.15	£267,300		
Timber clad Wall Type A	0.24	£193,952		
Timber clad Wall Type B	0.18	£196,042		
Timber clad Wall Type C	0.15	£219,032		
Metal Clad Wall Type A	0.24	£100,215		
Metal Clad Wall Type B	0.18	£117,900		
Metal Clad Wall Type C	0.15	£135,585		
Roof type A	0.25	£345,060		
Roof type B	0.18	£383,400		
Roof type C	0.16	£485,640		
Floor type A	0.20	£70,965		
Floor type B	0.19	£82,025		
Floor Type C	0.15	£137,324		

In addition to the above table, we have also produced some build-up sketches to support the above table which can be provided on request. These drawings note the betterment on minimum Building Regulation requirements.

7.7 Air tightness

In well-insulated buildings, ventilation accounts for a major part of the building's heat loss. It is therefore important to eliminate uncontrolled air movement and minimise leaks through the fabric.

The Building Regulations set a maximum air permeability which is allowable in new buildings of this type of 10m3/h.m² at 50Pa. These means that no more than 10m3 of air is allowed to leak out of every square metre of building fabric in an hour (for a pressure difference of 50Pa).

When this standard first came out contractors found it hard to achieve. However, as the contractors have become more experienced they can now easily achieve this figure. Generally speaking, the contractors do not add a cost premium to schemes with an air permeability of 5m3/h.m² at 50Pa which is twice as air tight as the Building Regulation requires.

It is possible to reduce the air permeability further, to say 3m3/h.m² at 50Pa, but this does require considerably more care in construction and does attract a cost premium. This will need to be further explored.

Unfortunately, at this stage it is not possible to understand the Energy Saving as further design works and modelling will need to be undertaken. We will revisit air tightness at the next stage and update the team accordingly.

7.8 Orientation

On both sites the building orientation is largely dictated by the existing site constraints.

At Abbey Fields much of the existing building is retained and the new extensions are required to sit within the footprint of the existing development. This largely defines the building plan form. Within this plan, however, we are able to choose the location of the various elements to make best use of solar gains whilst reducing overheating and glare issues. For example, the café area is located to the south of the building where it can enjoy some solar gain and can spill out onto sunny outdoor seating areas. The more temperature-sensitive multi-purpose room is, by contrast, located to the north east of the building, where it is protected from solar gain to help reduce cooling load.

At Castle Farm the fitness suite and studios are orientated to the east. This helps to give them a presence from the car park and site arrival point but it also helps to minimise unwanted solar gains and reduce cooling loads. Shading is also provided in the form of vertical louvres to control the solar gains through other glazing. The café has glazing to the south to benefit from the desirable gains to this space and also to allow it to open out onto a sunny outdoor sitting area.

As the scheme develops, the size and shading of the glazing will be investigated and optimised using the building's thermal model.

7.9 Plan form

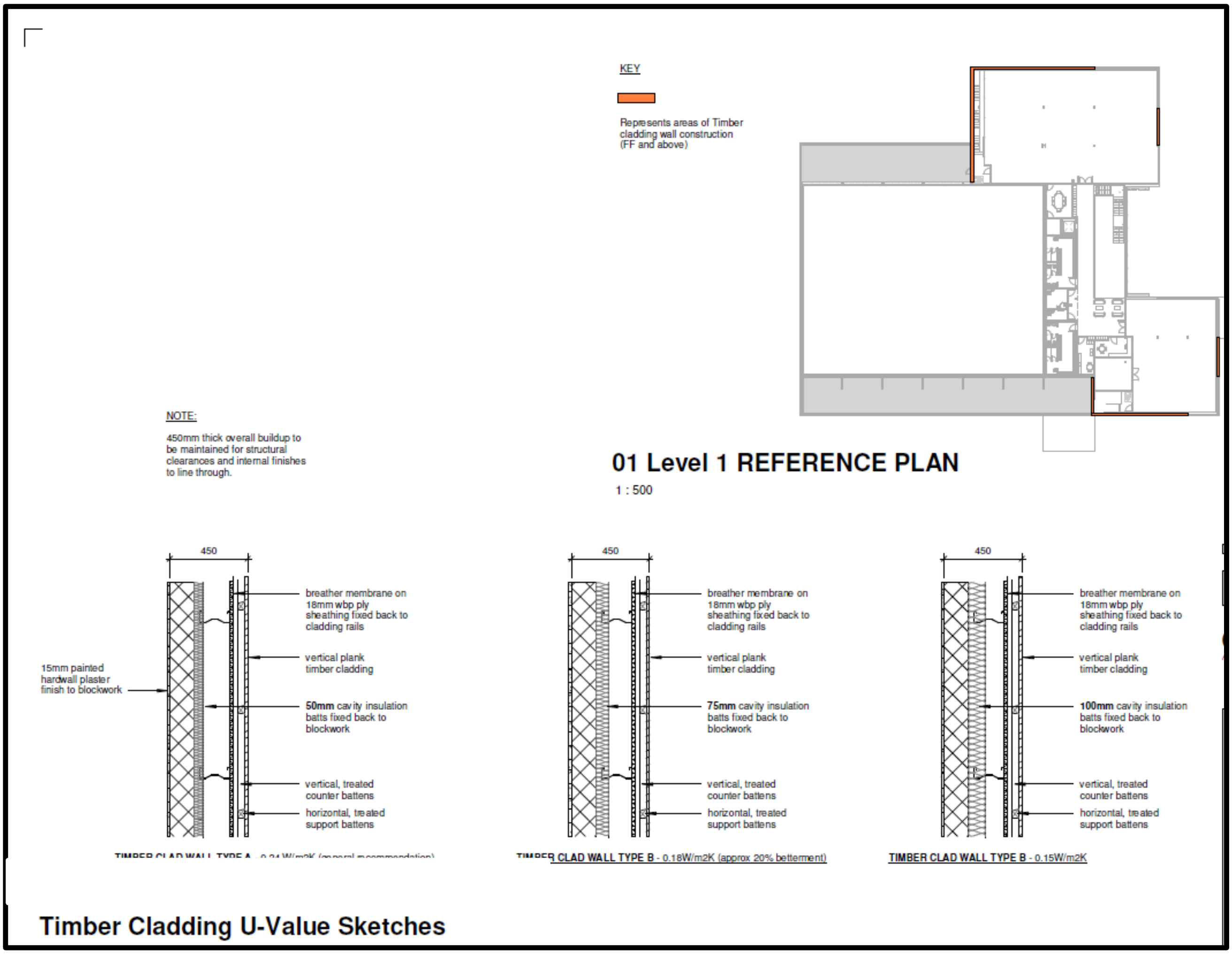
The plan forms for both buildings have been kept very efficient and compact. This has a two-fold benefit. Firstly, it keeps the facilities as small as possible to reduce the required heating/cooling and lighting loads. Secondly, it helps to reduce the ratio of building envelope to building volume which reduces the relative heat loss or gain through the fabric.

7.10 Thermal Mass

Buildings of low thermal mass are very quick to respond to changes in thermal input. This is therefore particularly well suited to buildings which are very intermittently occupied and that need to be heated or cooled for short periods. Buildings of high thermal mass are better suited to facilities which are generally occupied and need to maintain stable conditions. These buildings are slow to react to thermal input which means they balance out the temperature, absorbing some heat during times of high thermal input and discharging it slowly during times of low thermal input.

Leisure centres are occupied for long periods each day and for virtually all days in the year. They are therefore best suited to being buildings of medium to high thermal mass. This is the strategy that we have adopted for both Castle Farm and Abbey Fields. In both cases the internal and external walls are of heavy masonry and the floors are of high mass.

Further exploration of building materials will need to be reviewed at the next stage, once they can be modelled and thoroughly assessed. However, we have indicated through the provision of outline sketches such as the indicative example below that increased U-Values from increased insulation levels will undoubtably help the project to further reduce its carbon generation and energy consumption.



(Example Timber Cladding U Value Sketches in support of previous tables)

8 Construction Methodologies

Whilst at this stage of the design process the focus for the reduction in energy usage and carbon generation is centered around efficiencies, on-site generation and enhanced building materials, there are also sustainable construction methodologies that can be implemented and or incorporated into the design and physical construction of the projects. The following section discusses areas that could be taken forward for further review.

8.1 Reduce Waste

Waste will be anything that goes into a skip and ends up in landfill. For example:

- Unused materials and off-cuts.
- Damaged materials and products.
- Demolition waste.

Therefore, reducing waste can greatly assist a project in reducing its carbon outlay during construction. Some examples of how the project can reduce waste have been included below:

- Industry measures show that 13% of waste is new, unused material. Therefore we can take steps with the contractor to reduce their waste by finding a supplier who accepts returns or exchanges.
- A huge 60% of skipped material is packaging. As a project team we can work with suppliers to take back and reuse packaging.
- Exchange material – what might appear of no value, may be of value to others. There are many exchange schemes available and again working with the right suppliers will help exchange to be possible.
- Poor site conditions increase accidents and can damage materials, leading to waste.
- Contractors should be requested to crush and reuse aggregates where feasible.

Ultimately, limiting waste and reusing materials such as crush reduces the need to buy materials and transport to and from the site. This will help to lower carbon emissions attributed to material production and transport for these projects.

8.2 Dry Lining Waste

As a team we can try to design rooms with the same dimensions as standard sizes of plasterboard. This will reduce cut-offs and wastage of materials, which again mitigates the need to transport away from site. Plasterboard is widely used in construction but is also responsible for some of the largest amounts of waste products generated. It is therefore also important to dispose of plasterboard properly. The following points are also relevant concerning the impact associated with plasterboard waste:

- Plasterboard has to be separated from other materials in a landfill site, and disposal of this waste costs more than disposing of other types of waste.
- Landfill tax and disposal charges increase every year (the more waste produced the more we have to pay in tax).
- Keep the amount of plasterboard waste to a minimum and recycle where possible.
- More trips to and from site equals more carbon generation.

8.3 Reducing Transportation

As noted in the previous points, transporting goods to and from site is one of the largest contributors to a construction project's carbon generation. Therefore a focus on reducing trip generation is important. Examples of how to reduce transportation to and from site are as follows:

- Source building materials locally
- Ask suppliers how building materials were transported

Ultimately, fewer trips mean less emissions – in reducing the number and length of journeys by local procurement and planned delivery schedules the carbon generation attributed to the project will significantly decrease.

There are also added benefits to a reduction of trip generation, these are as follows:

- Using building materials that are locally available reduces haulage costs.
- Purchasing from local suppliers can improve the economy of the local community.
- Reducing impacts from transportation is possible by improving delivery scheduling.
- Minimising trips to and from site saves money and benefits the environment.

8.4 Limit the use of concrete and mortar

Limiting the use of these materials will have a large benefit to the local environment and wider community. They can be extremely disruptive and risk pollution to the immediate vicinity of any project where they are used. The following bullet points note some ways in which the project can limit their impact :

- Minimise onsite concrete dust, air and water pollution by using alternative products or environmentally approved mixtures.
- Take measures to ensure the health and safety of workers on the site (welfare and dust reduction, use of relevant PPE) and the local community.
- Mix off-site or in environmentally-controlled areas on-site.
- To prevent over-ordering of materials, plan the quantities in advance. This will help to limit potential overuse and discarded materials.
- Take care to store these materials correctly to reduce waste and damage.

Avoiding this type of pollution will help protect the environment and reduce the risk of prosecution.

8.5 Use the best materials

The key to using the best materials is focusing on the process of Smart Specification. This will ensure that the contractor is using the correct materials for the job to avoid poor workmanship, which can lead to additional and or revised work and further knock-on implications to costs and budgets.

Areas of note to achieve this are as follows:

- Avoid rework as it costs money and wastes time and materials.
- Use local, natural and sustainable materials and sustainable construction techniques.
- Look out for the Forest Stewardship Council's trademark on timber and wood products indicating that wood comes from a sustainably-managed forest.
- Use renewable or recycled materials to benefit the environment.
- Choose alternatives to UPVC window frames such as ethylene-based plastics or modern timber.
- Avoid materials that have damaging effects on the environment.
- Minimise the use of chemical treatments.

The above can all be picked up in specific building materials specifications and through the selection of specific products and or manufacturers.

8.6 Actively reduce a contractor's carbon footprint

As a team we can actively seek to appoint a contractor that is aware of their carbon footprint and one that is committed to reducing this. In order to ensure this commitment we can ask the contractor through the tender information to undertake the following:

- Actively consider using environmentally friendly alternatives.
- Use low energy forms of construction and consider carbon dioxide (CO_2) arising from site activities.
- Reduce journeys to and from the site by planning work and delivery schedules in order to reduce CO_2 arising from transport.
- Get advice at the design stage on how the buildings can have a positive environmental impact by using the techniques already designed and recommending others.

Some of the above have been recommended within this report as being incorporated into the developing design.

Further to this, contractors can also be asked to implement the following:

- Use hybrid diesel generators onsite.
- Procuring energy efficient cabins for the site. Even with the higher capital cost these cabins can produce life-time savings by reducing energy bills by 40% whilst providing a far more comfortable working environment.

- Using construction plant efficiently, which includes: educating site staff on the fuel efficient use of equipment; collecting and analysing energy data from on-site equipment and enabling all mobile plant to turn off automatically when not being used.
- More fuel efficient driving for freight, waste transport and business travel, and more fuel efficient fleet vehicles.
- Use energy efficient lighting.
- Preferential use of gas over diesel.

9 Added Carbon Reduction

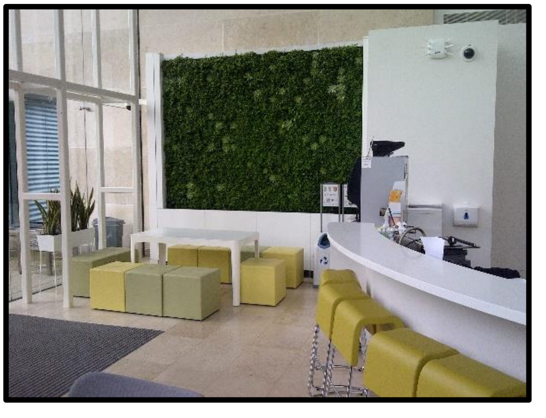
In addition to using the wide range of technologies and building materials discussed in the previous sections, further reviews could be undertaken with regards to the possible inclusion of living or green walls.

As outlined in the Leadership in Energy and Environmental Design (LEED) credentials, a green wall or living wall could provide additional energy and carbon reduction as they can act as a protective barrier, which shields a building from solar radiation and heat penetration. This in turn can reduce the demand on cooling systems and in winter Green over Grey living walls provide an additional layer of insulation, keeping the cold out and warmth in. These features then act to reduce the carbon footprint of a building.

In addition to generating carbon reduction, living walls also provide added health benefits as well as being viewed as mini eco systems, helping to support organisms such as butterflies, bees, ladybirds and small birds, many of which are in decline.

It is therefore recommended that, in addition to the technologies already reviewed within this report, further consideration is given to living walls as an added sustainable benefit.

Examples of this type of technology have been included below:



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10 Summary & Next Steps

This report has sought to assess and review the predicted energy consumptions of the two leisure centres being redeveloped by Warwick District Council (WDC). The report has then further sought to provide a brief overview of potential energy reductions and additional energy sources for the new schemes. This in turn can help to support the Council's agreed climate aspirations and a desire to become a net-zero carbon organisation by 2025. Given the level of design information available and the current stage of the design process we achieved this in three simple steps, as summarized below:

Step 1: Review of Mechanical and Electrical Plant and Additional Technologies

In the first step of targeted carbon reduction we have reviewed and made recommendations of additional technologies that could be implemented into the scheme to reduce what will be an initial carbon increase in comparison to the existing buildings, due to larger buildings and increased use. Recommendations have been made for both centres that would then further reduce the carbon generation and energy consumption of the current 'base' Stage 2 design. The optimum positions have been briefly reviewed below:

Castle Farm:

In order to improve upon the energy consumption of the 'base' RIBA Stage 2 design, it is recommended that the following additional options are developed into the scheme:

- Water Source Heat Pumps
- Voltage Optimisation
- Photovoltaic Panels

The incorporation of these technologies would improve energy consumption as per the table below:

	Gas Consumption	Electricity Consumption
Improved Energy Consumption in comparison to the existing design:	140,000kWh	276,000kWh
Carbon production savings relative to the existing design by implementing above systems:	88,556 kg / annum (Equivalent to 10,700 km long-haul flight / 1,163,660 kettles boiled)	

To implement the above the current budget cost would be circa **£268,000,** however this would significantly reduce energy consumption and carbon production.

Abbey Fields:

In order to improve upon the energy consumption of the 'base' RIBA Stage 2 design, it is recommended that the following additional options are developed into the scheme:

- Combined Heat and Power
- Air Source Heat Pumps
- Voltage Optimisation
- Photovoltaic Panels

The incorporation of these technologies would improve energy consumption as below:

	Gas Consumption	Electricity Consumption
Improved Energy Consumption in comparison to the existing design:	1,473,000kWh	258,000kWh
Carbon production savings relative to the existing design by implementing above systems:	407,432 kg / annum (Equivalent to 49,100 km long-haul flight / 5,339,787 kettles boiled)	

To implement the above the current budget cost would be around **£549,500** but this would again achieve betterment on current energy consumption and a significant carbon production saving.

Step 2: Building Materials

In addition to the possible mechanical and electrical plant installations, further improvement to the building's energy consumption has been reviewed in this section by exploring upgrades to key building fabrics to further assist in targeting carbon reduction.

The building materials section has also sought to clarify potential material constructions and other elements such as Thermal Mass, Building Orientation and Air Tightness. However, key to finding additional benefit in the building's construction will be increased insulation levels.

As noted in section 7, the current Building Regulations set minimum insulation levels (U values) for the main elements of the buildings fabric as shown overleaf:

- Roof 0.25 W/(m2k)
- Walls 0.35 W(m2k)
- Floor 0.25 W/(m2k
- Windows curtain walling and doors 2.2 W/(m2k)

It has been noted within the body of the report that increasing the levels of insulation beyond these minimum levels reduces the U-values and the amount of heat loss or gain through the fabric. However, the law of diminishing returns applies here and therefore for each subsequent increase in insulation, the relative amount of energy saved reduces.

To help to inform a decision on the best balance point of cost against energy saving we have prepared some typical constructional sections for each of the building fabric elements based on the Building Regulation requirements. We have therefore calculated some achievable increased insulation options, some of these have again are summarised below. The various options and associated increased cost are shown below.

At this stage, however, it is not possible to provide energy savings as this will need thermal modelling which cannot be undertaken until mid point RIBA Stage 3. It should also be noted that the U value examples used below are from Castle Farm, as detailing on this building is significantly ahead of Abbey Fields. We have been able to develop fairly accurate alternative constructions for Castle Farm because of the work we had already carried out on the envelope, moving into Stage 3.

Wall construction	U value W/m²k	Additional Cost £	Energy saving	Payback period
Masonry Wall type A	0.22	£255,150	TBC Stage 3	TBC Stage 3
Masonry Wall Type B	0.18	£259,200	TBC Stage 3	TBC Stage 3
Masonry Wall Type C	0.15	£267,300	TBC Stage 3	TBC Stage 3
Timber clad Wall Type A	0.24	£193,952	TBC Stage 3	TBC Stage 3
Timber clad Wall Type B	0.18	£196,042	TBC Stage 3	TBC Stage 3
Timber clad Wall Type C	0.15	£219,032	TBC Stage 3	TBC Stage 3

Step 3 – Construction Methodologies

Whilst at this stage the focus of the reduction of energy usage and carbon generation is centered on systems, on-site generation and enhanced building materials, there are also sustainable construction methodologies that can be implemented and incorporated into the design and physical construction of the projects. The opportunities presented are difficult to quantify in terms of generated carbon reduction at this stage. However, they would go some way to assisting the Council in their goal of Net Zero. It is recommended that these are reviewed further with potential contractors at the next stage, with carbon reduction questions included as part of the contractual tender process.

Next Steps

Further to the information explored within the body of this report, Mace propose the following next steps to continue to develop schemes that can provide a betterment on the current ‘base’ RIBA Stage 2 design. These are as follows:

- Review the contents of this report and provide feedback.
- Council & Design Team to decide whether further sustainability works are required, including the possible appointment of a specialist consultant and or the implementation of an agreed measurement process.
- Task the team to include the recommended MEP equipment noted in step 1, which has already been shown to better the base energy and carbon positions.
- Conduct further reviews into building materials and U-value changes and instruct the architect to include improved U-values at Castle Farm (further consideration required at Abbey Fields prior to implementation).
- At the appropriate stage, seek to include sustainability and carbon reduction questions within the body of the tender documents for contractor input and support.
- Review further opportunities for creating more sustainable buildings such as living walls.

In addition to this, Mace and the wider team would welcome input from the Council on any alternate methodologies that could be reviewed as part of the current and possible future sustainability exercises.