ISBA Operational Zero Carbon Guidance

Revision	Description	Issued by	Date	Checked
P01	Draft for Comment	LA	03/02/2022	BJ
P02	Final Issue	LA	19/05/2022	BJ

https://burohappold.sharepoint.com/sites/051843/02_Documents/04_Reports/ISBA operational carbon guidance - draft.docx

Report Disclaimer

This Report was prepared by Buro Happold Limited ("BH") for the sole benefit, use and information of Independent Schools' Bursars Association - for access by members. BH assumes no liability or responsibility for any reliance placed on this Report by any third party for any actions taken by any third party in reliance of the information contained herein. BH's responsibility regarding the contents of the Report shall be limited to the purpose for which the Report was produced and shall be subject to the express contract terms with Independent Schools' Bursars Association. The Report shall not be construed as investment or financial advice. The findings of this Report are based on the available information as set out in this Report.

Author	**Lucy Anderson**
Date	**19/05/2022**
Approved	**Ben Jones**
Signature	
Date	**19/05/2022**

Contents

1 Study Overview **4**

1.1 Introduction 4

1.2 Carbon Emissions Scope 5

2 Net Zero Principles **6**

2.1 Net Zero Principles for Retrofit 6

2.2 Example Pathway to Operational Net Zero 8

2.3 Net Zero Principles for New Build 10

3 Typical Decarbonisation Strategy Brief **12**

4 Funding & Finance **16**

4.1 Funding & Finance Overview 16

4.2 Example Funding Schemes 16

5 Wider Sustainability Issues & Education **17**

5.1 Integrating Sustainability into the School Values and Curriculum 17

Appendix A Example Energy Survey

Appendix B Example Decarbonisation Pathways

1 Study Overview

1.1 Introduction

The purpose of this Document

Buro Happold were commissioned by the Independent Schools' Bursars Association to provide a template plan which can be used by schools to plan and progress a roadmap towards operational net zero for their member schools. This purpose of the study is as follows:

- Provide a user guide regards the topic of net zero carbon in operation
- Provide an audit template to identify a 2022 carbon footprint baseline and inform an action plan
- Provide the beginnings of an action plan as to how carbon targets could set and delivered
- Describe the fundamentals of operational zero carbon building design
- Provide a document that can be used to upskill and progress the topic to ISBA members

Why target net zero carbon?

The UN climate science panel has said man-made carbon dioxide (CO_2) emissions must fall by 45% by 2030, from 2010 levels and reach 'net zero' by mid-century to give the world a good chance of limiting warming to 1.5°C, and avoiding the worst impacts of climate change. Many institutions are under pressure from internal and external stakeholders to take meaningful steps as a part of this; schools have the additional driver of equipping students to be part of the future zero carbon world.

Net zero and the education sector

Following COP26, sustainability in education has been put front and centre, meaning schools need solutions - now. If the UK is to reach its legally binding target of net zero by 2050, the whole of the education sector must play its part in reducing operational emissions.

Initiative	Description	Target
Government target	-	Net zero by 2050/78% reduction in emissions
Let's go zero	A pledge for further & higher education institutions to reach net zero emissions, which also equips them to set a roadmap with carbon targets	Net zero ASAP
Schools' Buying Club	The Schools' Buying Club (SBC) offers impartial and compliant procurement advice at no cost to schools	–
Race to Zero	A UN backed initiative which aims for higher & further education institutions to pledge to reach net zero emissions as soon as possible	Net zero ASAP

1.2 Carbon Emissions Scope

It is important to define the scope of the carbon emissions that are included within any net zero study. There is increasing shift within the built environment sector towards visibility and measurement of whole life carbon, which takes into account embodied carbon, rather than the traditional and focus on operational carbon emission. The Royal Institute of Chartered Surveyors (RICS) also acknowledges end of life (deconstruction) and circular economy (material reuse) as contributing to the whole life carbon emissions.

For this study, the primary focus is **operational energy use**, however it is important to understand the definitions of both operational and embodied net zero carbon.

What is Operational Net Zero Carbon?

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

What is Embodied Net Zero Carbon?

"When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."

Beyond this, carbon emissions can be categorised into Scope 1, 2 and 3 emissions, which help to define the different types of emissions a school produces in its own operations, as well as its wider supply chain.

Understanding Scope 1, 2 & 3 Emissions

The energy used in buildings maps most closely onto Scopes 1 and 2.

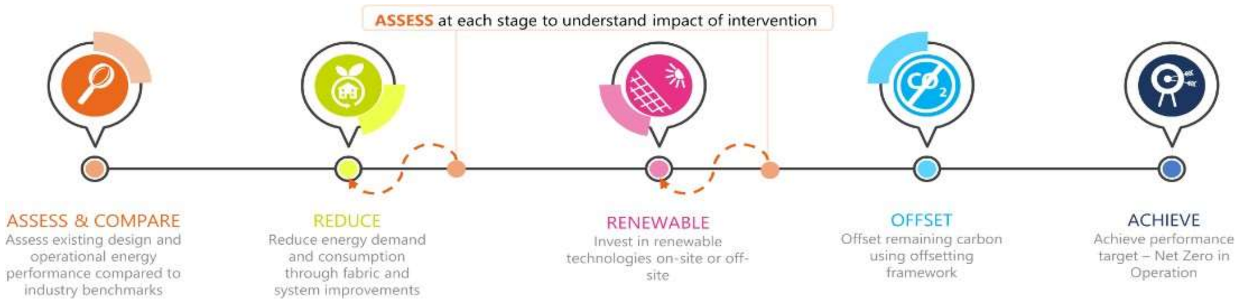
2 Net Zero Principles

2.1 Net Zero Principles for Existing Buildings

The flow diagram below gives a clear indication of the recommended route towards achieving net zero operational carbon, stating high level interventions that should be made at each stage in the process.

It should be noted that this series of works is geared predominantly towards renovation rather than new-build - which is detailed on the next page.

Naturally all of the renewable technology options will have spatial impact and as such, implementation should be carefully coordinated.



ASSESS & COMPARE Energy Use

An initial operational energy assessment should be carried out to determine how the school is using energy and highlight areas where energy can be reduced. The school's energy consumption should be compared against industry benchmarks to determine the magnitude of energy reduction required to meet these benchmarks.

REDUCE Energy Demand

Following initial operational energy assessment, where energy demand can be reduced, it should be. The most cost efficient and quickest way of doing this is to eliminate or reduced unnecessary energy wastage. This was highlighted by the UK Government's Zero Carbon Schools Task Force, who used the following hierarchy;

Simple routes to this include encouraging "energy conscious behaviour", which includes simple moves such as switching off lights and PC's when not in use and can be integrated into the school curriculum, and can have an extremely positive impact on the energy demand of the school, and thus the cost of energy bills. The next step in this is for the school to understand how and where energy is actually used, through effective metering, for instance on a building by building basis, with information on how the energy use varies through the day and between operational times and the school holidays. This is perhaps the most powerful part of energy reduction; we have seen day schools which use more energy over a year when unoccupied than when operational, simply because systems and IT are unwittingly left on overnight or at weekends.

The next step in existing buildings is to implement simple physical interventions such as;

- Improving fabric efficiencies, thereby reducing building loads. This could be done by, for example, applying insulated cladding to the walls or replacing single glazing with double glazing to reduce heating demands.
- Improve system efficiencies such as boiler or heat pump efficiency, utilising heat recovery in the ventilation system and increasing lighting efficiencies where possible. Any of these interventions will reduce the energy demands of the building, and some such as the replacement of lights with LEDs can payback rapidly while also reducing maintenance requirements
- Upgrading controls for all systems to ensure that they default to off (or safe) when they are not needed.

RENEWABLE Energy Supply

Once the building is functioning as leanly as possible, carbon emissions can be further reduced through:

- Removing systems that directly utilise fossil fuels as a heat or electricity source (gas boilers, gas fired calorifiers) and replace with electrically led systems such as heat pumps.
- Connection to low carbon heat networks (if available). Many schools have large estates, and could consider heat networks across a campus.

- On-site renewable technologies that directly feed the building, thereby reducing the buildings metered consumption. Note PV generation could be implemented independently of ‘reduce’ measures, but it is recommended to prioritise ‘reduce’ measures where possible.
- Off-site renewable installations funded by a developer with a portion of their load ‘earmarked’ to offset emissions associated with the building.

OFFSET Remaining Emissions

Any emissions remaining after the above interventions which the school cannot reduce directly, can be offset. This is often done through payment to a government certified scheme; a common example being tree planting schemes.

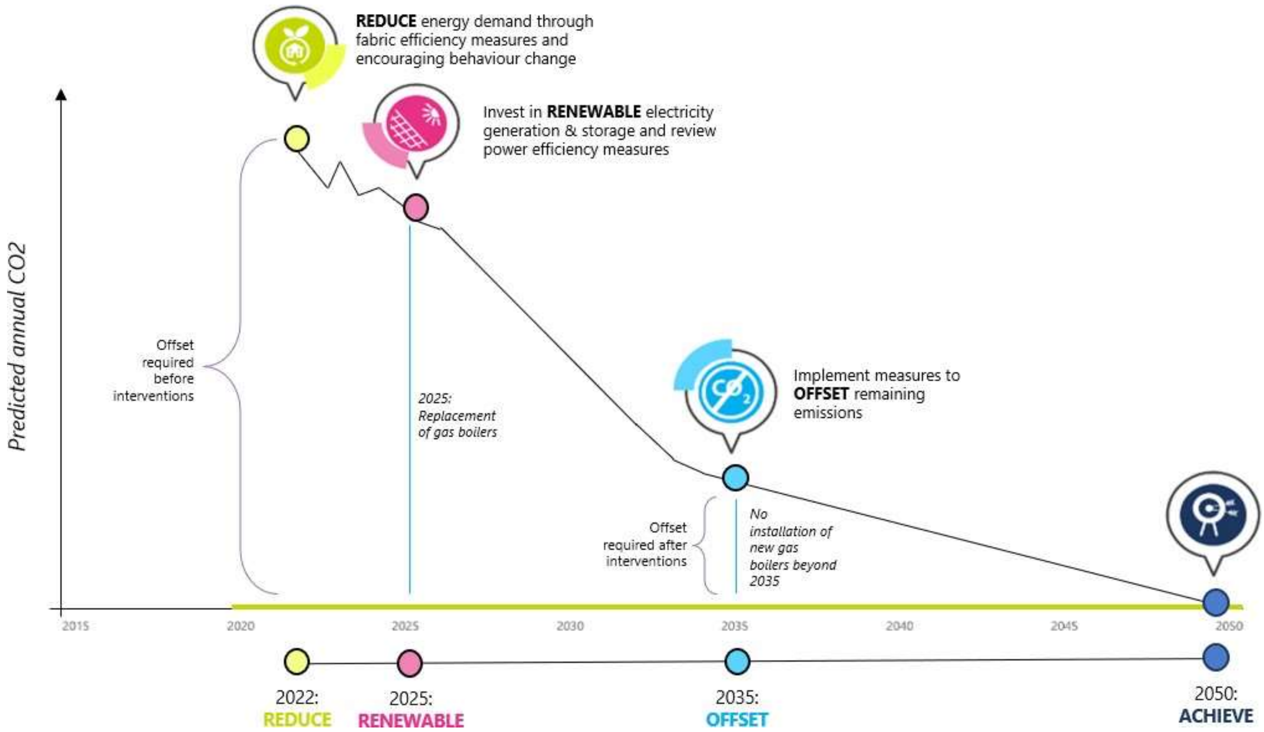
ACHIEVE Performance Target

In order to report on portfolio and building performance and ensure a building is operating as efficiently as it should be, it is important to ensure that the energy consumption and generation of a building is monitored. This requires a comprehensive monitoring and verification strategy with sufficient software and hardware.

2.2 Example Pathway to Operational Net Zero

The following infographic displays an example pathway schools may wish to take in the strive to achieve net zero operational emissions, showing what interventions could be made and when.

Detailed decarbonisation pathway examples for both a typical rural boarding school and a city centre day school can be found in the appendix of this report.



2.3 Net Zero Principles for New Build

There is much that can be done in a new building to enhance its performance. While many local authorities have planning requirements that are more onerous than building regulations require, new buildings should look to go further than this where possible.
In most instance, energy and carbon targets for planning purposes only look at “regulated” energy – that which is consumed by fixed systems, based on standard operational hours. Most buildings consume far more than this, with the difference being called “unregulated” energy. This typically results from the operation of a building being different from the assumptions inherent in the assessment methods, but also because of the inclusion of plug in equipment (e.g. IT, catering equipment, lab equipment etc). The procurement of this equipment must also consider its energy and carbon efficiency if this is to help the overall performance.
Key principles to apply to a new build scheme include;

1. Consider and apply enhanced building fabric performance targets, such as those which form part of the **Passivhaus** or **LETI** principles of design where viable; however, be aware that some of these can conflict with other design aspirations, such as high levels of daylighting.

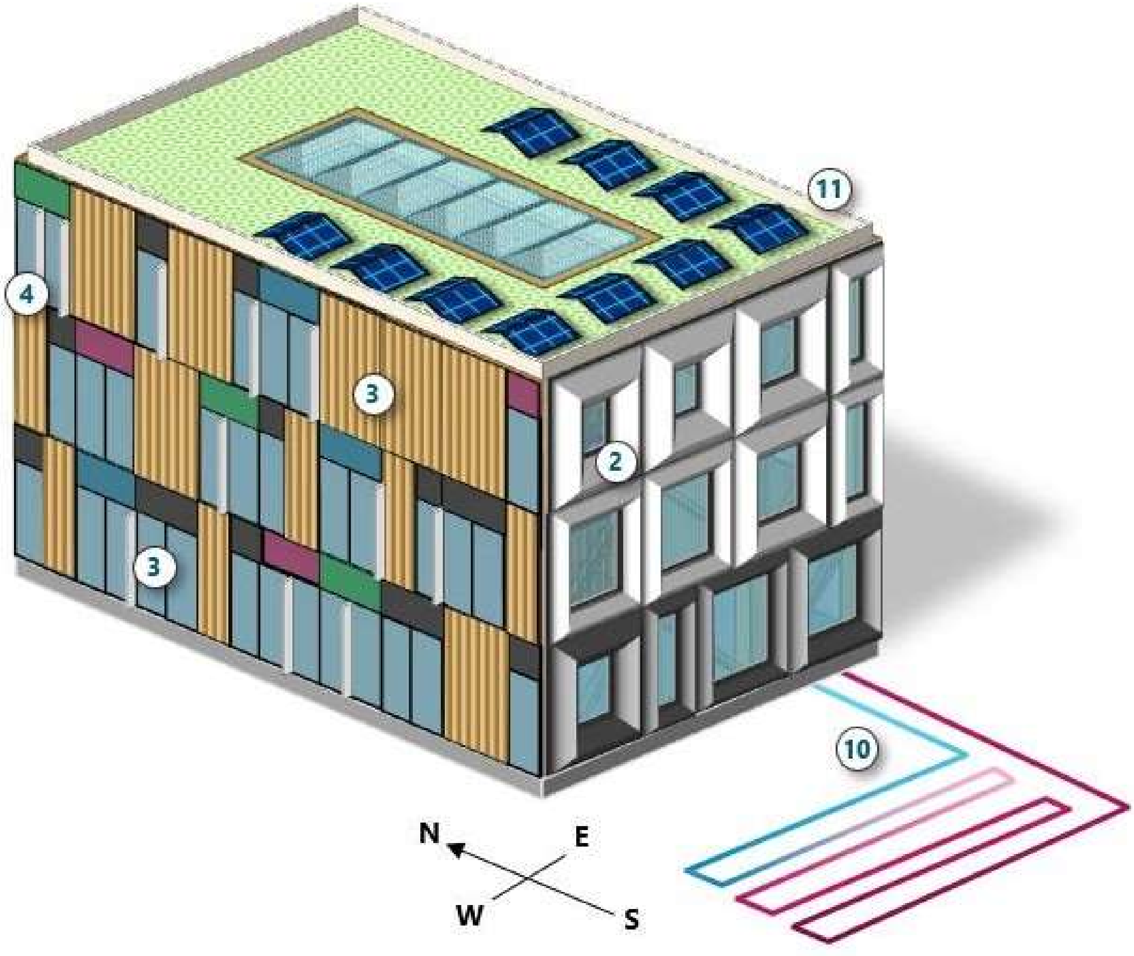
    - **Passivhaus;** Passivhaus is a performance-based set of criteria for low energy buildings, developed in Germany in the early 1990’s. Passivhaus design intends to eradicate the need for space heating and cooling, based on the principle that reducing heating loss as far as possible is the most efficient and inexpensive way to achieve a low carbon building.
      Key features of Passivhaus design include;
        - Super insulation
        - Air tightness as far as possible
        - Minimal thermal bridging
        - Optimisation of passive solar gain
        - Mechanical ventilation with heat recovery
        - Simple compact building design

    - **LETI;** LETI stands for London Energy Transformation Initiative. This comprises of a network of over a thousand professionals who are working to help put London on the path towards net zero. However, the LETI climate emergency design guide has been used by professionals across the UK to reduce both embodied and operational carbon emissions in new buildings. The design guide provides guidance specific to schools, covering 5 key areas;
        - Operational Energy
        - Embodied Carbon
        - The Future of Heat
        - Demand Response
        - Data Disclosure

2. Glazing ratio – higher for daylight (classrooms) 25% to 40% of façade area
3. Facades to respond to local context, with more glazing at lower levels
4. External shading to reduce cooling demands on South and West facades
5. Minimise or eliminate cooling demand through careful consideration of space usage and position
    - Place high gain spaces on the north side of the building

- Utilise thermal mass – for instance through exposed heavyweight elements – to smooth out high gains or hot weather, reducing or eliminating the need for cooling and enhancing comfort in summer.

6. Maximise daylight to reduce lighting demands
7. Photocell and monitoring for daylight dimming in classrooms
8. Ensure that systems default to off when not needed
9. Use natural ventilation for much of the year; but consider how mechanical ventilation with heat recovery can reduce energy consumption in winter and ensure effective night ventilation in summer.
10. Use heat pumps for heating and cooling; depending on demand consider heat pumps for hot water generation or localise heaters
11. Roof top solar PV and potential solar thermal, maximised, in green roof locations



3 Typical Decarbonisation Strategy Brief

The following chapter sets out a typical brief for a decarbonisation study to be carried out on a school. The outcomes of the commission would allow the school to:

- Understand the condition of their existing buildings
- Understand the existing operational carbon emissions of their buildings
- Have clarity as to the options available to decarbonise the school, including:
    - Recommended suite of decarbonisation measures
    - Capital cost of proposed measures
    - Carbon savings of proposed measures against carbon targets
    - Recommended programme for implementation of the measures
    - Impact of the proposed measures on energy costs
    - Any risks associated with the proposals
- Next steps towards implementation of the proposals

This would allow the school to comprehensively plan a set of interventions, including setting of budgets and programmes, empowering them to achieve their decarbonisation targets.

3.1 First Phase – Building/Campus Assessment

The school is looking to assess the best possible solutions for the site and wishes to adopt a holistic approach to decarbonisation. The review should cover the following for each building:

1. ***Review of existing energy consumption data;*** *Gaining an understanding of where and when energy is used, including (where possible) hourly data on a building by building basis*

2. ***Building Condition Survey:*** *A condition survey of the current buildings, considering the age of the heating systems, recommended dates for replacement (life expectancy), condition survey of the glazing, insulation and building fabric.*

3. ***Decarbonised Heating Review:*** *A costed appraisal for all the current/latest heating system options available and suitable for each building.*

4. ***Renewable Energy Generation Assessment:*** *A costed appraisal for on-site renewable energy generation (including but not limited to solar PV and wind generation) where appropriate, to provide electricity to the site and support the decarbonisation of heating systems.*

5. ***Building Fabric Improvements:*** *A costed appraisal for all the current/latest retrofit options suitable for all buildings, to improve the thermal efficiency and reduce wastage.*

It is important that the school can understand the consequence of any necessary alterations and the potential for simple reductions as well as more intrusive measures such as the installation of new systems or upgrade of building fabric. The successful bidder will be expected to present the findings from the review for consideration by the school to agree on the final solutions for each site, before the final report is published.

The assessment criteria for each proposed "project" shall include the following:

a) ***Assessment of planning requirements.*** *A desk-based assessment of the likely planning issues that may be faced in implementing the project for reasons such as but not limited to those associated with local archology, ecology, geology and cultural/historical significance.*

b) ***Disruption to service.*** *The consultant should make clear for each option any impact and disruption to service relating to the installation of a new heating system and options to improve the thermal efficiency of the building – taking into consideration the school term times. Possible options to mitigate disruption should be suggested.*

c) ***Register of main elements surveyed (e.g. systems / equipment / fabric etc).*** *Provide a table which includes details of the item (e.g. description, location, manufacturer/model, serial number, approx. date of installation etc) and an appraisal of the present condition and remaining life expectancy.*

d) ***Detailed summary and rating for the reliability of the system****. The reliable operation of the school is imperative and thus the chosen system must be reliable in terms of both* ***consistency of the source to deliver the energy supply*** *and in its ability to* ***not break down and be resilient in operation****.*

e) ***Detailed summary and rating of the complexity of the system.*** *The system should not be too conceptionally complex that regular maintenance and repair work cannot be carried out by the school facilities management. High complexity may also indicate the system has a lot of moving parts which could mean a lack of reliability which we are keen to avoid.*

f) ***Projected expectation for the availability of replacement parts****. Consideration of factors which may lead to parts not being available in the future for reasons such as but not limited to: likelihood of company bankruptcy due to its economic state or size - custom parts would no longer be available, use of materials no longer being available or becoming too expensive.*

g) ***Time period required to complete the project****.*

h) ***The total net cost to complete the project outlining the expected ROI period.*** *The consultant will need to quantify the costs involved in delivering the project and highlight what funding options, if any, exist to offset project costs. Detail cost savings/losses per year, over the lifetime of the equipment, compared to current equipment or modern equivalents, and provide estimates of the expected return on investment period.*

i) ***Impact on energy costs over 1 to 20 years.*** *Low running cost would be advantageous to support future development and self-sufficiency of the sites.*

j) ***Planned maintenance / Inspection requirements*** *for the new technologies e.g. what are the frequency of inspections and who needs to undertake these?*

k) ***The projected energy usage and tCO_2e over 1 to 20 years.*** *Important headline figure for climate emergency. A key metric will be the ratio between energy/tCO_2e savings and project costs per CO_2e in short and long term.*

l) ***Forecasting of future energy demands and CO_2e savings with evidence supporting projections through to the zero carbon target of the school.***

3.2 First Phase Deliverables

For each building surveyed, the consultant should produce a short note summarising the existing building condition and the suite of proposed intervention measures, with associated energy savings, carbon savings, and capital costs.

3.3 Second Phase – Shortlisting

Following the completion of the technical survey and submissions in the first phase, the consultant should arrange a joint meeting to discuss the findings and agree the final list of fully integrated solutions before the final report is published.

3.4 Second Phase Deliverables

The required deliverables are a draft and final Decarbonisation Plan (in word format) and should include:

1) *An executive summary, introductions, findings, main conclusions, and recommendations.*
2) *Where appropriate, maps, plans and illustrations should be included.*
3) *A fully costed plan and suggested timeline for delivering each site (in financial years). This should be largely based on details from the condition surveys and coincide with the suggested replacement dates for existing heating systems (gas boilers)*
4) *CO_2 projections showing the decrease in the school's total carbon footprint with milestones for the introduction of each technology. This should also account for the anticipated changes to the carbon intensity of the UK electricity and gas grids. All values used to calculate final values must be provided and cited in appendices.*
5) *Persons/organisations consulted and documents.*
6) *A fully costed options appraisal in order to realistically get all included buildings as close to net zero as possible, providing a complete list of:*

   a) *Energy efficient heating alternatives and comparisons to a conventional gas boiler system.*
   b) *Retrofitting options to improve the thermal efficiency of buildings to considered.*

7) *The appraisals carried out in points 2 and 3 should provide details covering the following criteria:*

   a) *Time period required to complete each project,*
   b) *Disruption to service assessments.*
   c) *Register of all installed items surveyed (e.g. systems / equipment / fabric etc). Provide a table which includes details of the item (e.g. description, location, manufacturer/model, serial number, approx. date of installation etc) and an appraisal of the present condition and remaining life expectancy.*
   d) *Appraisal of the current planned maintenance / inspection regime*
   e) *Assessment of planning requirements,*
   f) *Detailed summary and rating for the reliability of the system,*
   g) *Detailed summary and rating of the complexity of the system,*
   h) *Projected tCO_2e LT, CAPEX cost and LT running Cost.*
   i) *Life expectancy of the system,*
   j) *Projected expectation for the availability of replacement parts,*
   k) *Time period required to complete the project,*

- ***l)*** *The total capex (including i.e. planning, project management etc) and running (including i.e. O&M, utility costs factoring in anticipated changes to the market) costs to complete the project outlining the expected ROI period,*
- ***m)*** *The projected energy and tCO2e saved over 1 to 20 years,*
- ***n)*** *The projected monthly and Half Hourly energy usage / generation,*
- ***o)*** *Planned maintenance / inspection requirements of the new technologies,*
- ***p)*** *Operation and Maintenance Costs over 1 to 20 years,*
- ***q)*** *Forecasting of future energy demands with evidence supporting projections.*
- ***r)*** *All values and methods used to calculate final projections must be provided and cited in appendices.*

8) *Provide recommendations arising from the options appraisals based of the criteria set out in point 6, helping the school to understand how to prioritise their tasks, depending on available funding, appetite for significant change, planned maintenance interventions, ambition for the speed of decarbonisation.*

4 Funding & Finance

4.1 Funding & Finance Overview

On the back of targets set by the government in relation to climate change and emissions reduction, there are now a wide number of options available to schools regards obtaining funding as well as unlocking investment to support their journey towards net zero.

Funding Schemes

Various government funding schemes, such as the Capital Improvement Funding (CIF) scheme which have been put in place following government's commitment to reach net zero by 2030. Alongside government backed funding schemes, there, various independent and charitable organisations have established schemes with the aim of supporting schools to reach net zero, through offering free services such as procurement support, or through direct funding.

Green Energy Procurement

Any procurement decisions you make will have an impact on the school's sustainable development. Making careful decisions which assess issues such as initial costs, quality, durability, running costs, management and disposal have the potential to significantly reduce the school's CO_2 emissions.

Offsetting

Offsetting is a way of paying for others to reduce emissions or absorb CO_2 to compensate for your own emissions. A common example of this is planting trees to absorb carbon in the atmosphere. This can be achieved through a government certified offset scheme. Carbon offsetting is ideal for neutralising unavoidable emissions the school may produce.

4.2 Example Funding Schemes

Charitable Funding -Let's Go Zero

Let's Go Zero is a not-for-profit scheme which was founded by a number of charities which aims to provide schools with the motivation and expertise to create a successful pathway towards net zero. As of summer last year, more than 350 schools in total had signed to the scheme, pledging to reach net zero by 2030, with over 30 of those being independent schools.

Independent Organisational Funding – NetZero Buildings

NetZero buildings are an independent organisation who are able to fully fund the build, or alternatively schools can use some capital as well as part fund the building through various funding schemes. They offer a range of ESFA compliant funding packages, which unlike others allow schools to spread the payments over a longer period; as much as 20 years – ideal for those with a limited income.

Local Energy Accelerator (London)

The Local Energy Accelerator (London) allows access to funding for heat decarbonisation schemes for all education institutes.

5 Wider Sustainability Issues & Education

5.1 Integrating Sustainability into the School Values and Curriculum

Sustainability Champion

The school should look to appoint an individual the role of sustainability champion. The idea of the sustainability champion is to provide a designated individual who has the capability to take on various responsibilities related to the school's progression towards net zero carbon. This may include helping to create a programme of education surrounding sustainability and monitoring energy consumption on site.

Engaging Industry

The school should look to engage with industry professionals in order to enrich the programme of education geared towards sustainability/climate change.

For example, Buro Happold have been involved in numerous outreach schemes with schools, helping them to engage children in activities where they have the opportunity to learn about current opportunities and constraints relating to climate change and sustainability in the field of engineering. Our latest engagement was with independent school, Manchester Academy where one of our sustainability consultants delivered a lecture to the pupils on how we approach climate change issues in the field of sustainability engineering.

Curriculum

Changes to the School Curriculum

Following COP26, imbedding of sustainability into the school curriculum is quickly going to become a standard requirement, with measures surrounding the requirement to implement sustainability into the school curriculum already having been put together in a draft 'sustainability & climate change strategy' which is due for final publication in April 2022.

Empowering the Next Generation

The strive towards net zero should involve everyone, children included, and schools should be actively taking measures and setting up activities that include the children in learning about climate change and sustainability, but also empower them to want to make positive changes that contribute not only to the school's journey but also the UK, and the world as a whole.

Renewable Resources

Many children do not know which resources are renewable and which aren't. By teaching about what can and cannot be reused, and how to minimise use of non-renewable resources, will provide children with a mindfulness towards resource use in the classroom, that can also be transferred to life outside of school.

Recycling

By engaging children in hands on activities, where they can learn about the trash they throw away and ways to cut down on this, or ways they could make use of it for other purposes.

As well as appointing an adult in the school as a 'sustainability champion', perhaps a child in every class could be appointed the role of 'recycling champion', someone who can remind their classmates the ways in which they can recycle classroom waste. By giving responsibility to children, this will help to engage them in the school's journey and empower them to do their own part in taking accountability for their waste.

Energy Saving

By teaching children about the different uses of energy in their daily lives, and perhaps engaging them in activities where they conduct an audit of their daily energy usage, this will help them to develop a mindfulness towards their energy use both in and outside of school.

Appendix A – Energy Survey Template

BURO HAPPOLD

School Decarbonisation Survey Template

Project	School Decarbonisation Survey Template
Subject	Building xx
Project no	xxx
Date	xxx

Revision	Description	Issued by	Date	Approved (signature)
00	Sample	xx	xx	xx

1 Introduction

1.1 Overview

Xxx have been commissioned by **xxx** to produce a Building Energy Decarbonisation Plan for selected buildings within their campus. The Plan aims to provide technical advice and recommendations on building decarbonisation options for each building.
The options presented in this Plan aim to support the school's ambition to decarbonise their estate and to bring them towards carbon neutrality.

The study involves the assessment of xx buildings across the campus. This report refers specifically to **building xx.**

1.2 The Site

Summary of the building including:

- Address
- Site location (map)
- Principal elevation photograph
- Age
- Typical accommodation
- Any listed or protected status
- Overview of architecture, i.e. wall construction, glazing
- Details of any extensions or refurbishment work
- Particular access requirements
- Summary of utility connections

1.3 Survey Details

Summary of the building survey including:

- Date of survey
- Staff who assisted with the survey
- Weather at time of survey
- Purpose of survey and elements in scope
- Areas of the building which were surveyed and details of any areas which could not be accessed
- Health and safety summary

1.4 Documents Reviewed

Summary of documents reviews prior to survey such as:

- General arrangement layouts
- Asbestos surveys
- ECP/DEC
- Energy consumption/meter data

2 Targeted Condition Survey

2.1 Building Fabric

Table consisting description of building elements and condition, **generic example as follows**:

Element	Description / construction form	Age	Anticipated Remaining Life	Condition
Pitched Roof	Welsh slate coverings to the front sections with both traditional timber rafter configuration and steel and cut timber rafters. Standing seam sheet covering to the rear extended section. Warm roof construction to all parts. Various minor areas of deterioration and maintenance repairs required.	15 years (new section) 211 years (old section)	60 years (structure) 30 years (coverings) 50 years (structure) 10 years (coverings)	4*
Flat Roof	Assumed asphalt covered with precast concrete slab surfacing to the two front terrace/balconies.	circa 25 years	10 years	4
External Walls	Approx 300mm thick fair-faced blockwork and rendered blockwork cavity wall construction to the rear of the new section with reconstituted to the front elevation. Approx 300mm thick Sandstone ashlar to the front elevation of the old section and random rubble facing stone to the rear.	15 years (new section) 211 years (old section)	60 years 40 years	3*
Windows	Single glazed predominantly sash windows. Total area: 50.3m².	211 years	3 years	2*
	Single glazed steel framed crittall windows. Total area: 2.88m².	50 years	5 years	3*
	Double glazed prefinished aluminium casement windows, approx. 54Nr. Total area: 64.01m².	Circa 15 years	20 years	5
	Double glazed prefinished aluminium framed curtain walling. Total area: 54.5m².	Circa 15 years	20 years	5
	Double glazed prefinished 'Velux' type rooflights. Total area: 113.3m².	Circa 15 years	12 years	5
Doors	Various Types: Double glazed uPVC framed. Total area: 10.64m². Prefinished aluminium framed fully glazed doorsets. Total area: 11.04m².	Mixed Age 15 years 15 years	10 years 20 years	4
Doors	Painted solid timber panelled doorset. Total area: 2.21m².	50 years +	20 years	4*
Floor Structure	Solid stone/concrete to the ground floor and suspended timber to the upper floors to the old section. Solid concrete to the ground floor and suspended concrete floors to the upper floors to the new section.	48 years	40-60 years	5

2.2 Building Engineering Systems

Table consisting description of building elements and condition, **generic example as follows**:

Element	Type / Manufacturer	Age	Condition
Boiler	2Nr. 80kW Ideal Imax gas fired condensing boilers – providing 75°C LTHW at time of survey	Circa 15 years	1
Heating Distribution pumps	2 no. in-line pumps, variable speed drives not functioning	Circa 15 years	2
Radiators	Pressed steel twin panel radiators with thermostatic valves. No zone controls within the building	Circa 15 years	4
DHW calorifier/storage	Isolated electric showers noted within the office WC facilities Electric DHW storage heaters within WC/kitchenette cores providing all local DHW	Electric Showers & Instantaneous Hot Water Heaters < 5 years	5 5
AHU/Fans	Extract fans to some plant rooms and WC accommodation. Some may not be operational. Generally switched with lights or running 24/7 with no speed control	Circa 15 years	3
Lighting	Communal areas; Fluorescent strip and bulkhead fittings. Switched control only	Circa 15 years	2
	Classrooms; Fluorescent recessed fittings within suspended ceilings Switched control only	Circa 15 years	2
Electrical Incomer	Original 400V Three Phase Supply. Assumed newly installed smart meter is direct replacement.	Circa 15 years	4

Condition Key

Code	Definition
1	Life expired. Expected replacement within 1 year
2	Poor condition. Expected replacement within 2-3 years
3	Average condition. Expected replacement within 4-5 years
4	Good condition. Expected replacement within 6-10 years
5	Excellent condition. Expected replacement within 11-25 years / No anticipated works required

**Always subject to ongoing maintenance repairs to preserve and maintain the element's condition as various defects observed to this element.*
*** Further information on system / installation should be ascertained to verify and update report content.*

3 Considerations for Building Fabric Improvements

3.1 Thermal Efficiency Considerations

This section would include a descriptive overview of retrofit options proposed for the building relating to the building fabric, i.e.:

- Roof insulation and opportunities to improve
- Wall build-ups and opportunities to improve, i.e. internal insulation, cavity wall insulation, etc.
- Glazing types and opportunities to improve, i.e. secondary glazing, window replacement, etc.
- Door types and opportunities to improve, i.e. draught proofing
- Ground facing floors and opportunities to insulate if possible

3.2 Energy Efficiency Consideration

This section would include a descriptive overview of retrofit options proposed for the building relating to the energy efficiency and related carbon emissions of the building services, i.e.:

- Opportunities to decarbonise heat, i.e. heat pumps in lieu of gas fired boilers. This should highlight constraints such as space constraints and risks such as potential requirement to replace radiators or upgrade electrical infrastructure
- Opportunities to decarbonise domestic hot water generation, i.e. heat pumps in lieu of calorifiers
- Lighting installations and opportunities to increase efficiency, i.e. LED installation and lighting controls improvement
- Controls and opportunities to increase the system efficiencies, i.e. implementation of smart controls to allow optimisation of central plan, or variable speed drives on pumps and fans
- Opportunities for heat recovery within the ventilation system
- Opportunities for on-site renewable energy generation, i.e. solar PV or solar thermal

4 Summary of potential decarbonisation strategies

Table presenting strategies considered for decarbonisation and whether they are proposed to be taken forward, **generic example as follows**:

Strategy	Opportunity	Risk	Conclusion
Double glazing and draught stripping of sash windows	Reduce noise, heat loss and condensation Improve internal comfort	Overheating in summer can be an issue; will require more intrusive operation by staff	Proposed for energy efficiency and comfort benefits
LED lighting and controls	Cost effective; Easy to install, minimal maintenance	Installation requires installation of LED drivers and attention to lighting design	Proposed due to energy saving
Variable speed pumps	Allow the pumps to ramp down under part load, reducing energy consumption	Low risk	Proposed due to low cost and risk
Simplified BMS controls	BMS system within plantroom to allow automation of on/off and flow temps, visibility via internet	Low risk	Proposed due to low cost and risk
Replace boiler with Air Source Heat pump	Decarbonisation of space heating	Lower heat supply compared to the gas boiler will require radiator replacement and increased electrical load may require	Proposed due significant carbon savings which can be realised. High temperature units are also a possibility to remove

		upgrading electrical incomer. External location needs to be found for heat pump	requirement for radiator replacement.
Increase size of radiators to accommodate lower flow temperatures	Enables installation of low temperature ASHP system	Expensive and may require hydraulic balancing of the existing heating system	Proposed in tandem with low temperature ASHP
PV	Renewable electricity generation on south facing standing seam roof to reduce carbon emissions and operational costs	Roof condition is thought to be low risk. Maintenance costs can be high in the longer term	Proposed due to appropriate south facing roof area available

5 Energy & Carbon Savings

Tables representing kWh energy savings for each strategy, along with key assumptions used in the calculations:

Strategy	Energy source	Pre-project		Post Project		Savings	
		Annual consumption (kWh)	Annual emissions (tCO_2/yr)	Annual consumption (kWh)	Annual emissions (tCO_2/yr)	Energy saving (kWh)	CO_2 emissions (tCO_2/yr)
Secondary glazing of sash windows	Gas						
LED lighting and controls	Electricity						
Variable speed pumps	Electricity						
BMS controls	Electricity						
	Gas						
Replace boiler with ASHP	Electricity						
	Gas						
PV	Electricity						

Total cumulative savings for building:

	Existing	Post Project
Electrical consumption (MWh/yr)		
Gas consumption (MWh/yr)		
CO_2 emissions (tCO_2/yr)		

6 Outline Budget / CAPEX Costing

Element	Location	Budget Cost (£)
Construction Costs		
Secondary glazing of sash windows	Old building	
LED lighting and controls	Throughout	
Variable speed pumps	Boiler room	
BMS controls	Boiler room	
Replace boiler with ASHP	Boiler room	
Radiator replacement	Throughout	
PV	South facing roof	
Construction cost sub-total		
Main contractor mark-up & client contingency		
Contractor Prelims	20%	
Contractors Overheads & Profit	10%	
Contractors Design Contingency	10%	
Client Contingency	10%	
Contractor mark-up & contingency sub-total		
Total Budget Cost		

Note that all information set out within this audit template will be required to provide a fully informed business cases for Board approval.

Example of information to be appended to the report:

- **General Arrangement Drawings** - Snapshot of the building layout
- **Photo Schedule** - Photos taken during the survey of key building elements, with description of each

Appendix B - Example Decarbonisation Pathways

Independent School Decarbonisation Strategy

School A – Boarding School in a Rural Setting

Existing building services

School A* is an independent boarding school located in a rural area. It has centralised teaching campus featuring buildings of various ages that have been developed around a listed main school building. Away from the teaching campus the school has a number of boarding houses and staff residences, as well a sports building with 25m swimming pool. High energy consuming support services include catering facilities and laundry services.

Heating is generally provided by localised boiler systems served by the school's LPG network with some outlying buildings served by gas boilers. A centralised BMS system controls the majority of the heating plant, but some smaller systems are standalone. There is limited submetering of both power and LPG.

The varying age of the estate means that fabric performance varies widely and upgrades have been historically limited due to the listed status in some buildings.

Other building services (fans, pumps, lighting) are of variable energy performance depending on age. Many buildings are using fluorescent lighting. Sanitaryware is often old and is associated with high water consumption.

*Image is representative of school type

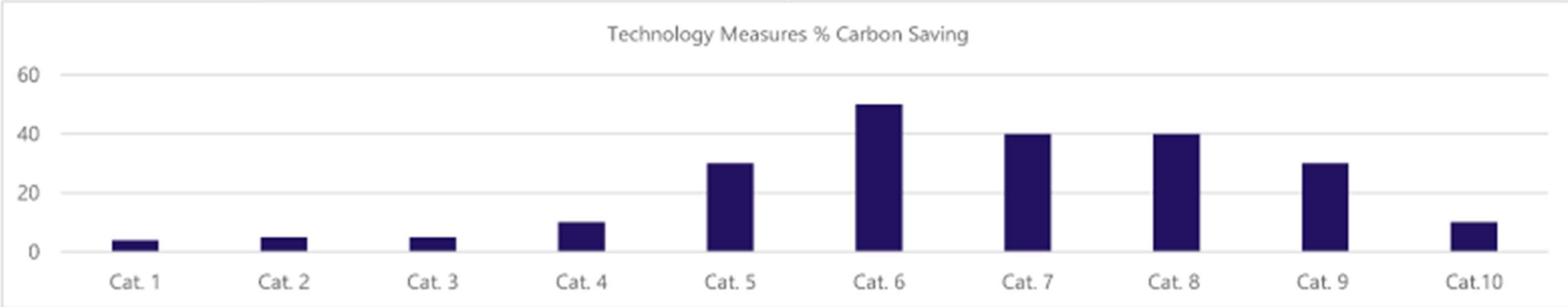
Decarbonisation strategy

The challenges with decarbonising a large and varied portfolio of buildings often comes with prioritisation of works particularly considering the limited access available during term time. A proposed heat decarbonisation strategy is as follows:

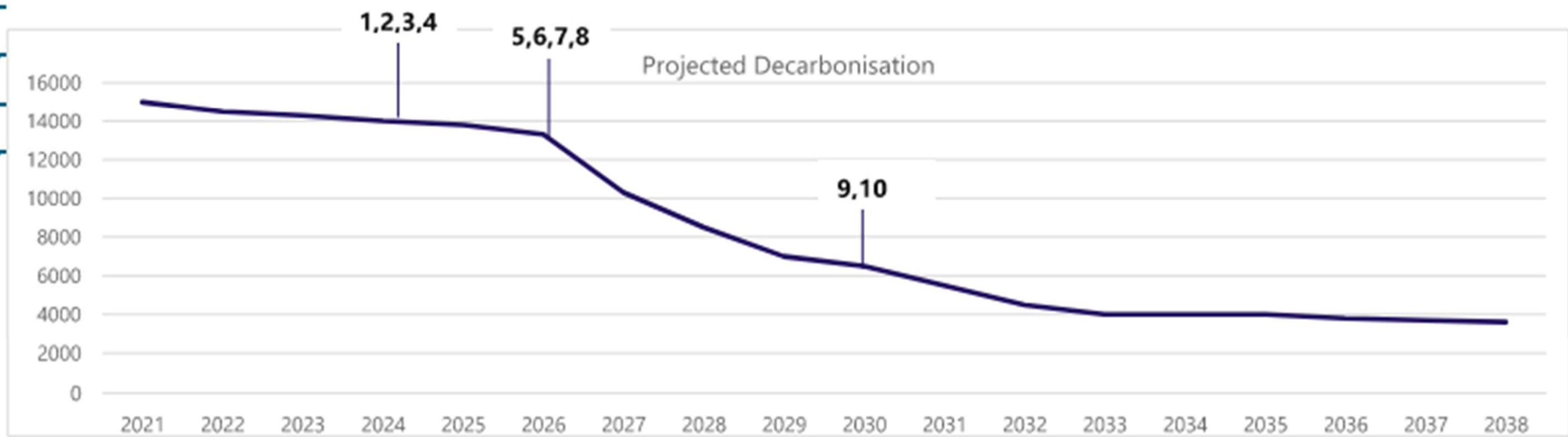
- Operational energy review including user satisfaction survey to identify 'problem' buildings/areas which could be affecting their core functionality as teaching, living or recreational spaces. BMS audit and introduction of sub metering strategy
- A phased programme of fabric improvement based on building typology. Seek specialist advice with respect to listed buildings.
- Upgrades to MEP systems including variable speed controls, LED lighting, opportunities for heat recovery. Become heat-pump ready.
- Electrical infrastructure upgrades to reduce reliance on LPG
- Replacement of LPG boilers with heat pumps for decentralised buildings, including upgrades of radiators
- Phased implementation of Heat Pump led heat network around centralised campus.
- Intrusive measures (e.g. fabric improvements and lighting upgrades) are delivered in tranches to allow continued operation of the school.

Category	Decarbonisation measure		Year
1	Operational Energy Review		2024
2	BMS Audit		2024
3	Monitoring and targeting sub-metered energy consumption		2024
4	Lighting Upgrades (Tranche 1)		2024
5	Double / Secondary Glazing Upgrades		2026
6	Ground Source Heat Pump & replace radiators		2026
7	Zonal Control valves for space heating		2026
8	Variable Speed Drives		2026
9	Heat Recovery Ventilation		2030
10	Lighting Upgrades (Tranche 2)		2030

Top Measures as per ARCHITYPE



Decarbonisation of Proposed Development



City Centre Day School Decarbonisation Strategy

School B – City Centre Day School

Existing building services

School B* is an independent day school located within a city centre. It has a main school building built in the early 1900s with modern extensions to provide additional teaching space. The school buildings surround a central quadrangle which provides outside space away from the adjacent main road. Sports facilities are shared with another school and located off-site.

The main building is heated by a single pipe radiator system served from gas boilers which are approaching the end of their service life. A separate, modern two pipe radiator system serves the extended areas from condensing gas fired boilers. One of the extension buildings has issues with traffic noise and poor air quality.

The school has limited space for air source heat pumps.

*Image is representative of school type

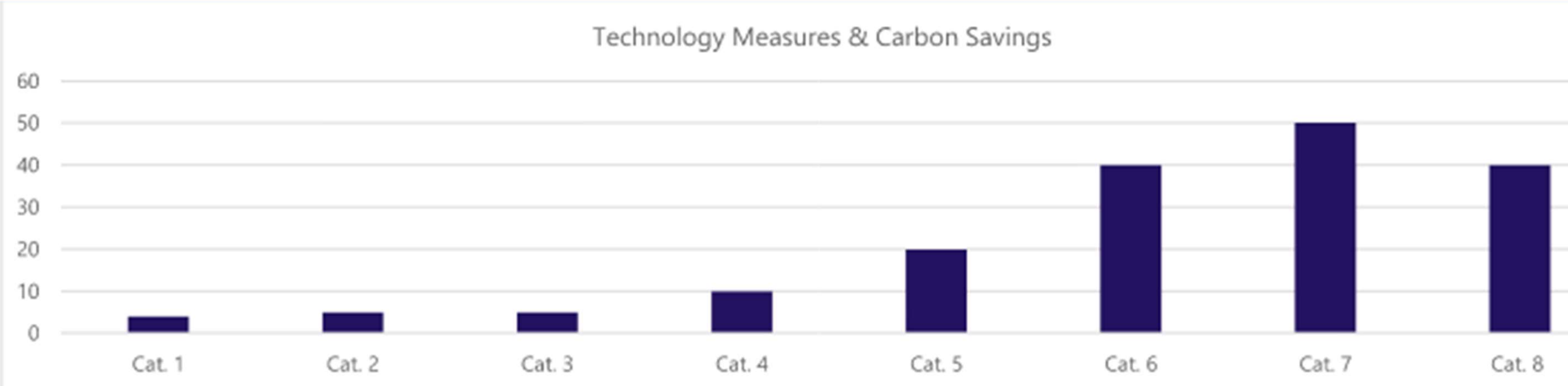
Decarbonisation strategy

The challenges with decarbonising schools in urban settings often relate to spatial constraints and, in some instances, the limited capacity in utility infrastructure . A proposed heat decarbonisation strategy is as follows:

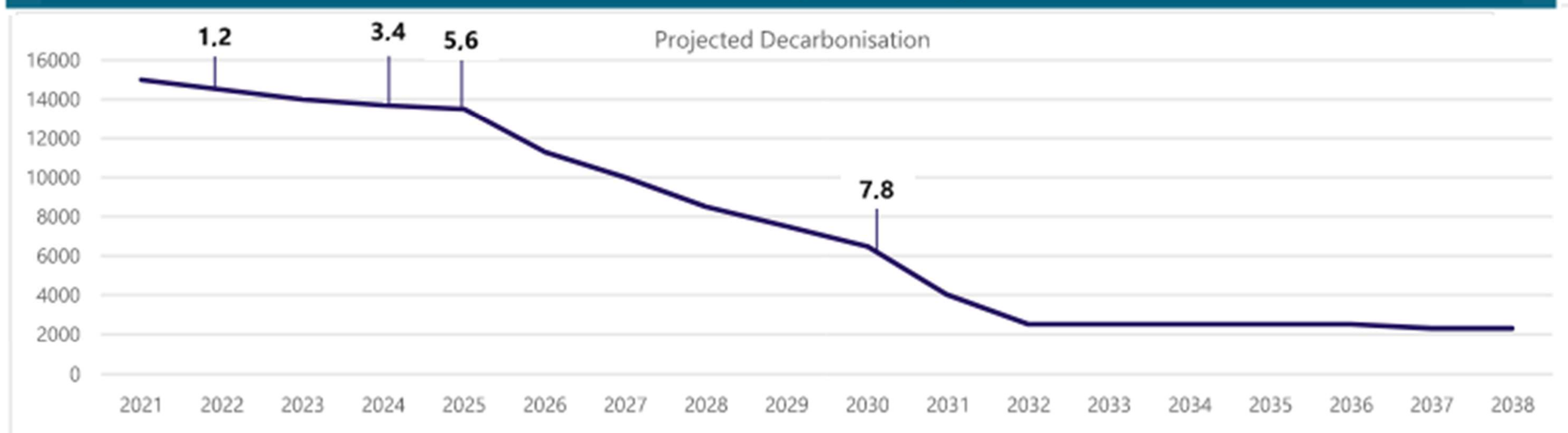
- Operational energy review including user satisfaction survey. BMS audit and introduction of sub metering strategy
- Introduction of secondary glazing in main building.
- Upgrades to MEP systems including variable speed controls, LED lighting, opportunities for heat recovery. Become heat-pump ready.
- Introduction of mechanical vent with heat recovery in the extension building (also reducing noise and improving air quality).
- Replace radiator system in main building with "heat pump ready" installation.. Introduce thermostatic and zone control
- In the long term replacement of the boilers with heat pumps

Category	Decarbonisation measure		Year
1	Operational Energy Review		2022
2	BMS Audit		2022
3	Monitoring and targeting sub-metered energy consumption		2024
4	Lighting upgrades		2024
5	Secondary/double glazing in main building		2025
6	Introduce MVHR in extension buildings		2025
7	Replace gas boiler with electric		2030
8	Replace radiator system in main building		2030

Top Measures as per ARCHITYPE



Decarbonisation of Proposed Development



Ben Jones

Buro Happold Limited
2nd Floor, Eastgate
2 Castle Street, Castlefield
Manchester
M3 4LZ
UK

T: +44 (0)161 233 5000
Email: benjamin.jones@burohappold.com