Glasgow Women's Library

Net-Zero Handbook

**Dress for the Weather,
John Gilbert Architects
and Lùths Services**

Our aim is to make Glasgow Women's Library Net Zero by 2030.

*definition of net zero as per RIBA 2030 Climate Challenge for building operational emmissions.

Introduction

Glasgow Women's Library recognises that that the impact of human activity on global warming has created a climate emergency, and believes that individuals, organisations, agencies and institutions must have a clear focus on environmental issues to redress negative impacts.

GWL has always worked with an awareness of its environmental responsibilities and instils these values and working practices throughout its Board, staff and volunteer team. GWL is committed to minimising waste, working towards maximum energy efficiency, re-using and recycling resources, using Fair Trade and environmentally friendly supplies, and actively championing cycling and green projects as members of the Green Arts Initiative.

This handbook collates work prepared by the design team: Dress for the Weather, John Gilbert Architects and Lùths Services into a format that has been developed as a more public-facing approach to the works and process involved in achieving operational 'net-zero'.

A methodology for the process is outlined across this handbook as well as a technical methodology for the energy modelling. This handbook outlines specific works and targets based on modelling. Specific works, design advice and testing throughout the process will determine the actual, eventual performance of the building.

GWL continues to shape organisational thinking and approaches to climate justice, carbon reduction and our role in caring for our environment, and has been turning to feminist leadership and solutions to look to the future and imagine a radically different world. GWL's dedicated cross-organisational Green Creative Cluster maintains a sharp focus in this area, and has been at the heart of developing this document - this handbook will act as a guide over the next nine years to achieving the goal of being operationally net zero.

About the Library

Glasgow Women's Library is a unique, internationally renowned, multi-award winning organisation: the UK's sole Accredited Museum dedicated to women's lives, histories and achievements, and a designated 'Recognised Collection of National Significance.'

As well as housing a lending library, museum and archive, GWL delivers innovative, inclusive programmes of public events across Scotland, from film screenings to guided heritage walks, with dedicated core projects supporting Adult Literacy and Numeracy learners, Women of Colour, and Volunteer Development.

A well-used, welcoming and accessible organisation, GWL is used and loved by people from around the world and around the corner, centring equality and human rights in its change-making work within communities across Scotland, and thriving with the support of, and 'ownership' by, the diverse communities it serves.

^ Main library space

^ Building Exterior

The Building

The library is located on Landressy Street in Bridgeton, Glasgow. The building was originally constructed as a Carnegie library in 1903 and is B-Listed with the following list description:

J R Rhind, 1903-6, as public library; low reading room to left (N) now occupied by post office. Edwardian baroque, stone-cleaned yellow ashlar, banded at ground; parapets conceal roofs. Front curved on plan, to line of street. 2-storey main range with pedimented outer pavilions, each with entrance, Ionic Order at 1st floor with Venetial window arrangement, figurative sculpture in tympanum; intermediate bays arcaded at 1st floor with Ionic pilasters; 3 tall round-headed lights to former reading room, sculptured detailing and framed roundel central at parapet. Good interior, retaining much original woodwork. Top-lit low rear range.

Glasgow Womens' Library took over the building in 2013 and completed a refurbishment in 2015, with Collective Architecture as the architects.

The refurbishment included the introduction of a new mezzanine level within the events space, a climate controlled archive and a new accessible lift.

^ Events space, photo by Keith Hunter

^ Archive

Defining 'Net Zero'

Scottish Government Target
In February 2021 the Scottish Government published a draft of the 'Heat in Buildings Strategy', which is a route-map on how to achieve Net Zero Emissions in Scotland's buildings by 2045.

It also designated the energy efficiency of buildings as a national infrastructure priority.

Net Zero
The term 'net zero' essentially refers to a carbon neutral process I.e. the amount of carbon produced in a process and the amount of carbon then offset as part of that same process should equal zero.

This works differently in different processes and contexts; and there is currently no universally agreed upon definition, or target, in an architectural sense.

Defining a Target
For this handbook we have adopted the RIBA 2030 Climate Challenge* targets and timescales. This is a voluntary initiative to encourage the architectural profession to take a leading role in carbon reduction.

The targets outlined within the Climate Challenge have been prepared in consultation with the UK construction industry; and align with the future legislative horizon.

It is also worth noting that there is no agreed upon standard for how emissions are offset. Ideally emissions are offset using on-site renewable technology; but this is not always possible and is recognized in the targets.

Lastly, the target being used is designed specifically for new build projects. At this time there is no agreed target for refurbishment projects.

*RIBA, Royal Institute of Brisitih Architects

Carbon and Energy in Buildings
There are a number of stages in a built project where energy is used and carbon is created. The term 'Whole Life Carbon' is used to define this.

Whole Life Carbon can de divided into four stages:
- product manufacture
- delivery to site and building construction
- the energy used in operating a building
- end of building life, including disposal

This can be distilled further into embodied carbon and operational energy; with these terms the most common for quantifying the impact of the building:

Embodied Energy relates to the amount of carbon produced in the construction of a building. It is measured in kgCO2/m2; the mass of carbon created in the production of materials in relation to the size of the building.

Operational Energy relates to the amount of energy used in the day to day occupation of a building.

Operational Energy Target
This handbook focuses on operational energy. This is primarily because the building already exists and as such the majority of the embodied carbon associated with the project has already been emitted. That said, the embodied carbon costs of new works should ideally be recorded and considered in the context of the operational performance.

Operational energy is calculated in kWh/m2/y (the energy used each year in relation to size of building).

We will focus on this metric as the means for both demonstrating the impact of the works to be undertaken, as well as how the building compares to operational targets.

As noted, there is no defined operational energy target for existing buildings, and as such we are proposing to use the RIBA 2030 Climate Challenge target of *less than 55 kWh/m2/y*.

Target:

< 55 kWh/m2/y

Operational Energy

(energy used by building, per year, in relation to size of building)

*** target for new builds adopted in lieu of target for existing buildings**

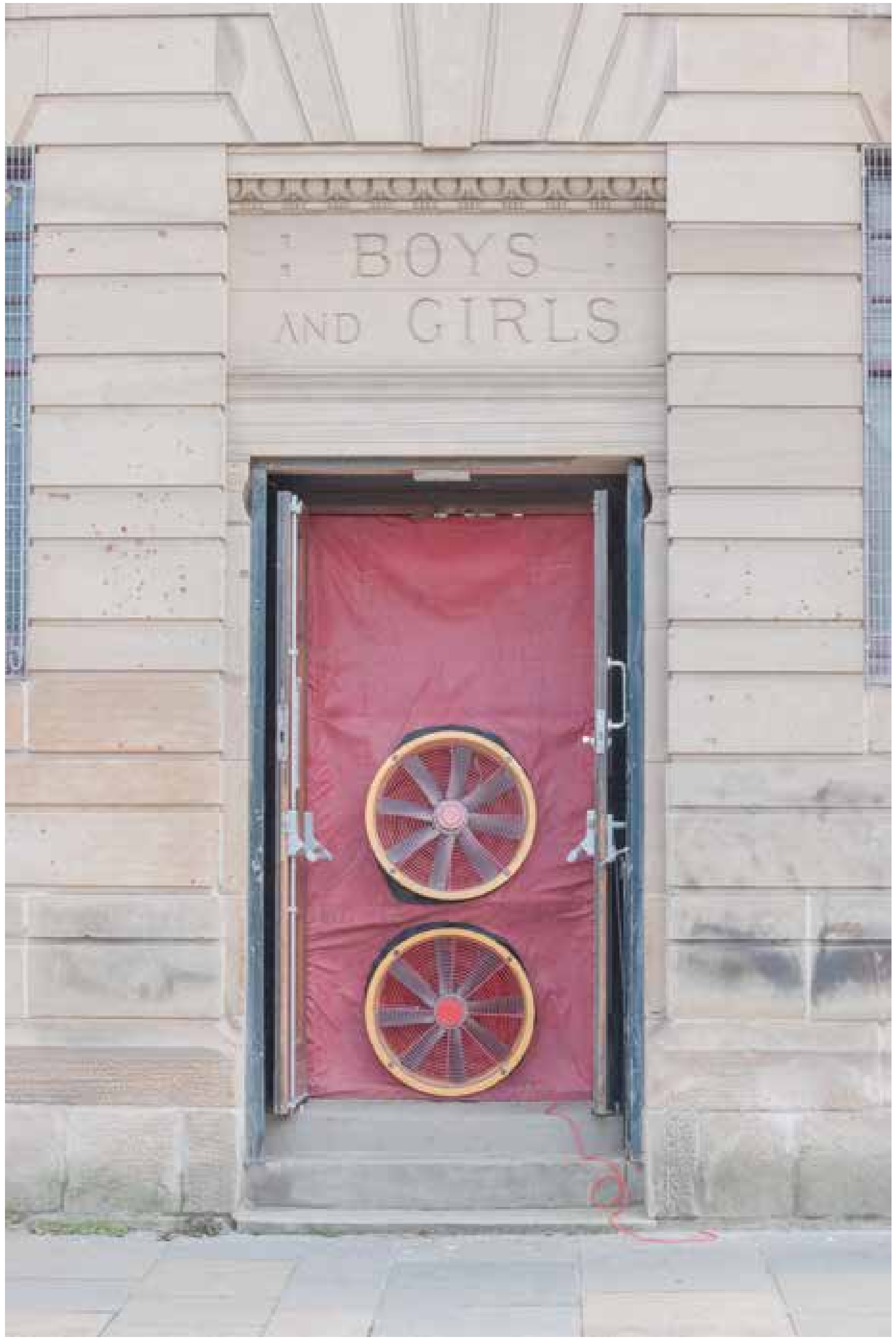
Section One:
Building Appraisal

Building Surveys

A Retrofit Assessment was carried out based on the surveys conducted in the building during April and May 2021.

The Retrofit Assessment is based on the surveys conducted by Dress for the Weather, John Gilbert Architect, Lùth's Services and Thermal Image UK, which were conducted to collate detailed information for a robust retrofit design:

- Visual Inspection
- Air Tightness Testing
- Thermographic Survey
- Existing Services Assessment



^ Side entrance during air tightness testing

Visual Inspection
The visual inspection conducted confirmed that the condition of the main building is fair with evidence of recent works to improve the overall condition of original elements.

The full details of the visual inspection are included within the 'Works' section of this handbook but generally stone, roofing, windows and internal finishes are in a good condition.

Specific recommendations for remedial works to be undertaken prior to the main energy improvement works are also outlined in the works section.

Air Tightness Testing
Air pressure tests were conducted by Thermal Image UK, in May 2021. A blower door fan unit was placed in one of the front entrance doors, as shown on the right. This involved fitting an adjustable aluminium frame with cloth cover, into which were set the fans.

The size of the building was also measured and environmental conditions were noted.

A smoke pen test was conducted during the airtightness test to identify the location of the main areas of leakage.

The test concluded that the current air permeability is 7.8 m3/ hr/m2 ; which indicates that the air leakage affecting the building is not significant for a building of this age and kind.

Thermographic Survey
A thermographic survey was conducted during the airtightness test, by John Gilbert Architects, which helped to identify defects, areas of concentrated air leakage and consequent heat loss.

The full findings of the thermographic images are included within the 'Works' section but the images show concentrated heat loss mainly in the external walls.

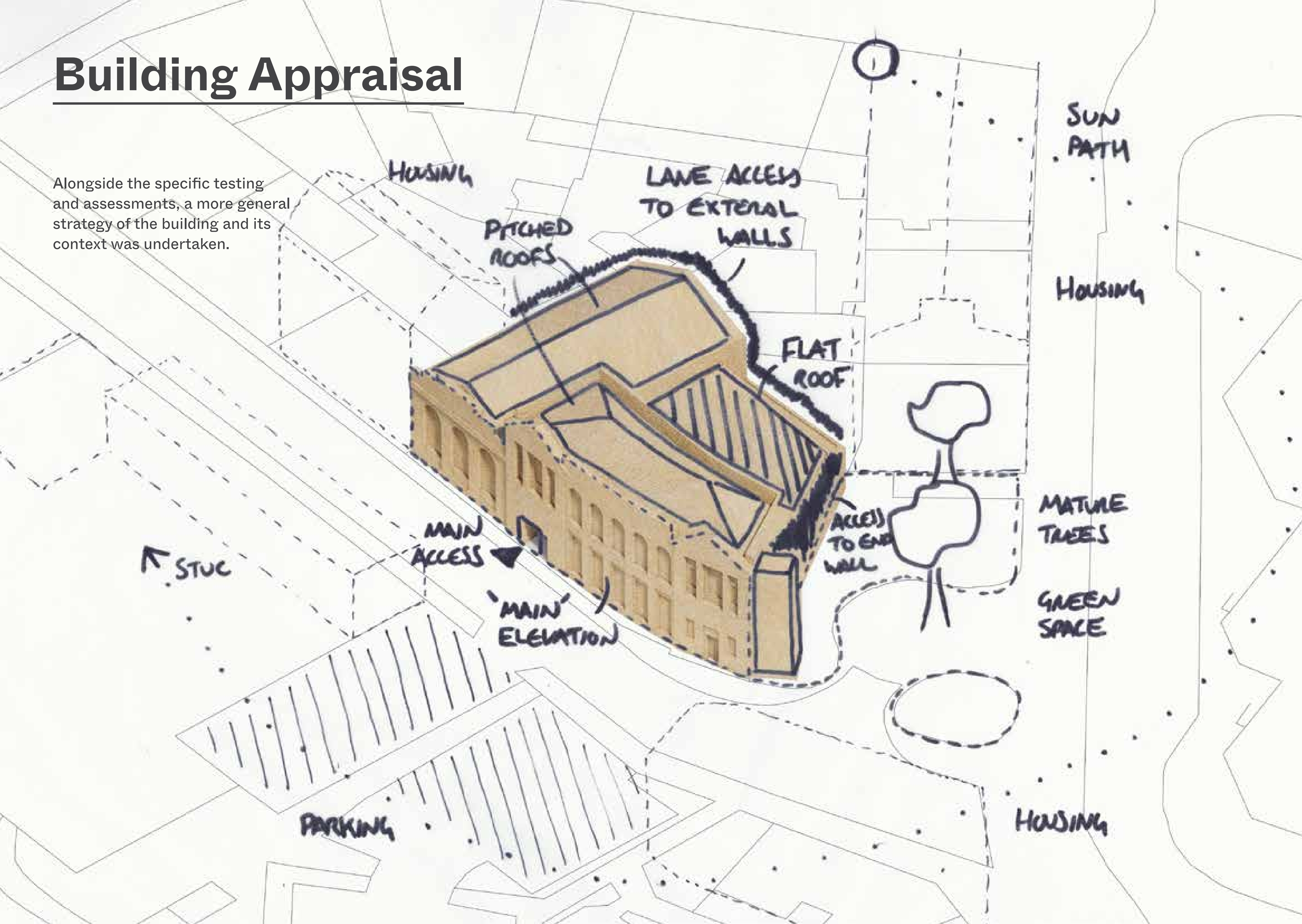
Both the air tightness test report and thermographic images from the survey are appended to this handbook.

Existing Services and Installations Inspections
Luths Services Ltd carried out a survey and report on the condition of the existing Services Installations at Glasgow Women's Library. The survey was limited to a visual inspection of the Mechanical and Electrical services installations to the property.

The findings of this survey are included in the 'Works' section of this handbook.

Building Appraisal

Alongside the specific testing and assessments, a more general strategy of the building and its context was undertaken.



Strategy

Fabric First Strategy
There are different types of work that can be undertaken to buildings to improve their performance; and these can be categorised in various ways, depending on the demands of the project.

We have categorised works as follows:
- Fabric Improvements
- Operational Plan
- Services
- Renewables
- Continued Improvements

This follows the principal of 'Fabric First'. This is the common definition of undertaking works which look to firstly reduce the demand of the building heating by reducing heat loss before making changes to upgrade the heating system and include renewables.

Conservation
In addition to this Fabric First strategy, the works will also take into account the heritage of the building, and have been reviewed by a Conservation Architect.

Fabric Works
This would include works to improve the thermal efficiency of the walls, floors, roofs and windows and doors.

This is done through adding insulation, upgrading products and improving air tightness.

Operations
These recommendations are generally about improving the day to day servicing and running of the building - making sure as little energy as possible is wasted by controlling the buildings as well as possible.

This element also relates to the different programmes and events taking place in the building, although these specific activities are not specifically quantified in this handbook.

Services
While much of the building services can be retained, we would propose strategic upgrades to elements here - heating, ventilation and electrical. These would improve efficiency.

Renewables
On-site renewables can generate all or some of the energy demands of a building. This can include solar panels or heat pumps as a means for generating heat and electricity on site.

Continued Improvements
Continued Improvements relates to the idea that although, by the end of the process, the building will have reached net zero, there is more that can be done.

As heating systems are replaced new technology will be considered, as long term remedial works and improvements are undertaken then more opportunites for fabric improvements may become available.

Step by Step
There are different reasons why retrofit works cannot always be installed 'in one go'. The main issues are disruptions and financial reasons which might limit the retrofit works, this is why a 'step-by-step' approach is generally adopted.

In this case, our 'step-by-step' approach proposes to implement the works in different phases. These can be installed over a period of years and should be planned alongside the current building maintenance programme.

Running concurrently with this would be the operational aspects of the building.

Having a comprehensive holistic plan from the start will ensure that the right decisions are made regarding sequencing, priorities and materials.

Fabric First Approach:

*Start with key works to improve fabric; exploit further 'invasive' improvements as parts of longer term maintenance regime

1. Fabric

2. Operations

3. Services

4. Renewables

5. Further Works

Methodology + Assessment

Reasonably Practical Works
The building surveys and appraisals have developed alongside the Fabric First strategy to identify a number of opportunities for intervening in the building in order to improve the performance.

This ties in to the strategy of 'explore everything' and essentially creates a list of works we can apply to the project to gauge the impact.

In this case, as we are aiming for an operational energy as close to zero as possible.

The works we have outlined are what we would judge to be reasonably practical.

The criteria we have applied for 'reasonably practical' works in this case are insulation methods and services upgrades that disturb the existing building fabric as little as possible, and works that are likely to receive funding.

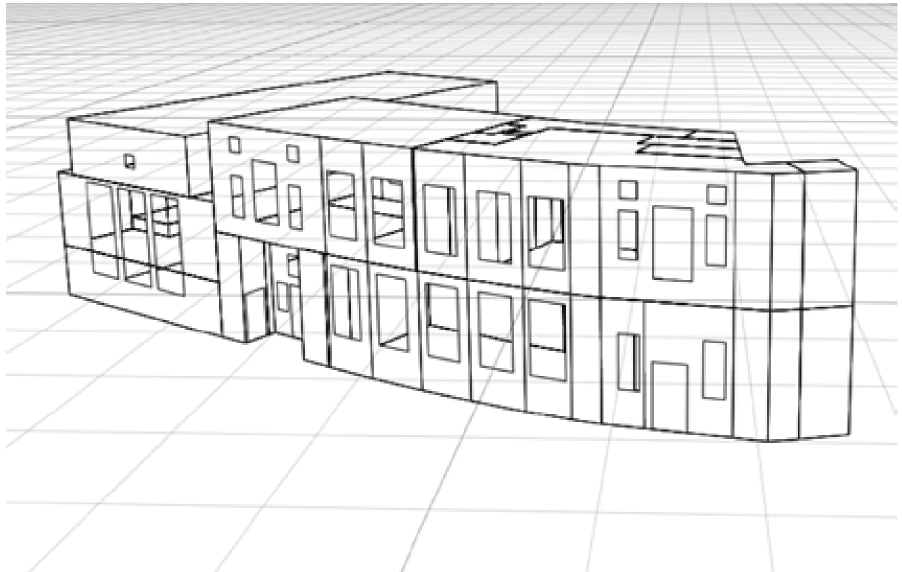
In order to quantify these works, and their impact, we have used energy modelling software.

Energy Modelling
The proposed energy efficiency measures were assessed by Lùths Services using IESve dynamic energy modelling software. The model allows us to understand the performance of the existing building and the impact of the proposed energy measures.

This comprises a notional building model with specific building and material characteristics represented. We prepare a base model with information 'as existing'. From there, we have modelled multiple scenarios relating to the improvement works in order to simulate the future building performance.

The results are compared against the RIBA Climate Change targets and follows the 'Low and Zero Emissions Heating Systems' strategy set by the Scottish Government.

These works have been outlined in detail in the following section.



^ Image from energy modelling software

Section Two: Works

Works

This section outlines the specific works we reccommend in order to achieve Net Zero Operational Energy.

We have split this section into the following categories:
- as existing / remedial
- fabric improvements
- operational plan *
- services
- renewables
- continued improvements *

* these sections are not directly accounted for in the quantified energy modelling, and final predicted energy use figure, but will provide further improvements to the building when undertaken.

0. As Existing / Remedial Works

Recommendations for maintenance work from building surveys, and current building energy performance.

As Existing:
Current Condition

The building currently comprises a solid masonry wall construction with timber floors and timber roof constructions. The external walls are sandstone finish to the front elevation with rendered areas to the sides and rear. There is also exposed brickwork to the rear of the building.

The current air tightness of the building has been recorded as <u>7.8 m3/ hr/m2.</u>

The existing condition includes various, recent improvement and alteration works undertaken up to June 2021. Including:

- heating system upgrade as part of 2015 refurbishment
- services upgrade as part of 2015 refurbsihment
- secondary glazing
- LED lighting

<u>Building Survey: Visual Inspection</u>

The visual inspection confirmed that the condition of the main building is fair with evidence of recent works to improve the overall condition of original elements. This includes stone repairs, roofing repairs and overhaul of historic windows. Internally finishes have been consolidated and appear to be in good condition.

During our inspection we have noted some areas of concern which should be investigated in tandem with energy efficiency works, and others which should be investigated and resolved to prevent further deterioration or issues in the future.

These areas are as follows:

- roof treatments vary across the building.

- generally where there is historically significant, traditional materials (slate, lead etc.) have been used, with bituminous materials used elsewhere and with parapet gutters lined with felt rather than lead. This has resulted in some complex details between different materials although generally appear to be sound in most areas.

- the rear, single storey area of flat roofing appears to be in the process of being repaired. However, falls in the roof do not appear to be sufficient and there is evidence of water pooling across the whole roof which could lead to deterioration and potential significant water damage in the future. There are also areas where new felt appears to be lifting / have not been fitted correctly around the structure which could allow water to flow beneath felt rather than over it towards the gutters.

- also at the rear, single storey area of flat roofing, there is a section of missing guttering from the neighbouring roof which should be replaced. There is an area of ongoing dampness / water ingress to the front elevation in the reading room. Inspection from the roof shows an area of pooling water and gutters appear to not have enough of a fall to reach the internal down-pipe. Further inspection here is required to determine if internal downpipes are blocked or damaged, or whether water has been able to penetrate through bituminous surface. It is recommended that lead over parapet is extended down to cover the stone to rear of parapet to form a more robust detail.

- across the first floor ceilings there are areas of cracking plaster and paintwork although they do appear to be superficial in nature. These should be monitored to ensure that cracks are not deepening which could be a sign of structural movement. Cracking in upstairs Community Room appears to be at the curve in building form and extends down wall. Recommended that high level inspection of plaster is undertaken to ensure it is sound and not at risk of falling.

- within the roof void timbers

appear to be in sound condition and there is evidence of some previous joist splicing. We also confirmed that the loft hasn't been insulated.

- the basement area has significant areas of dampness with signs of mould growth across some walls. Many walls have been painted (multiple layers) with a non breathable paint which has resulted in moisture becoming trapped in the wall. In many areas this is now peeling off and exposing areas of saturated stone. It is recommended that all exposed areas of paintwork be removed. If existing services are to be replaced in the future then the opportunity should be taken to remove all remaining areas of paint. If repainting is required then breathable paints should be used.

- generally inspection of all gutters and downpipes is required as there is evidence of debris and minor plant growth in multiple locations which could cause issues if not removed. There is evidence of new plant growth on the front elevation, at the right hand side at the connection between the stone and the new lift. This should be removed to prevent additional growth, and to prevent growth from more invasive species.

- during the site visit, the client confirmed that there are overheating issues in the community/ staff area in the first floor and in the main library space in the ground floor. The client also confirmed that the opening of windows for cross-ventilation purposes is not possible in these rooms due to the positioning of the new secondary glazing.

Building Survey: Air Tightness Testing

Air pressure tests were conducted by Thermal Image UK, in May 2021. A blower door fan unit was placed in one of the front entrance doors, as shown on the right. This involved fitting an adjustable aluminium frame with cloth cover, into which were set the fans.

The size of the building was also measured and environmental conditions were noted.

A smoke pen test was conducted during the airtightness test to identify the location of the main areas of leakage.

The test concluded that the current air permeability is 7.8 m3/ hr/m2 ; which indicates that the air leakage affecting the building is not significant for a building of this age and kind.

Building Survey: Thermographic Survey

A thermographic survey was conducted during the airtightness test, by John Gilbert Architects, which helped to identify defects, areas of concentrated air leakage and consequent heat loss.

The thermographic images show concentrated heat loss mainly in the external walls. The images also show cold air circulating within the internal cavity behind the internal lining which reduces the internal wall surface temperature incrementing heat loss through the walls and reduces thermal comfort and the overall energy performance of the building. Cold air leakage is also visible around windows.

In the Community Room, Thermal bypass (cold air circulating within the walls) was noted in the uninsulated walls and around windows. There is some air leakage shown at the base to wall junction and at corners, however, the most significant issue is the cold air circulating behind the internal lining, which reduces the internal surface temperature to 12*C, increasing the risk of mould growth and heat losses.

Building Survey: Existing Services and Installations Inspections

Luths Services Ltd carried out a survey and report on the condition of the existing Services Installations at Glasgow Women's Library. The survey was limited to a visual inspection of the Mechanical and Electrical services installations to the property. Access was available to all areas of the building, drawings of the existing Services Installations were not available at the time of the survey, but architectural drawings of the property were provided. For further details, please refer to the Services and Installation Report in the Annexes.

The existing installation works were surveyed and identified as following:

- Gas Installation

There is one main gas supply entering the property from the basement plant room. This supply is a 2" (80mm) gas pipe and has the correct gas train / metering installed.

- Water supply installation

There is one mains water entering the property from the -1F plant-room. This supply is a 35mm MDPE pipe and has the correct incoming installation configuration, with the stop cock.

- Heating System

The primary heat source for the library and staff office is an air handling unit ("AHU"). This is supplied from a post coil heater from the gas boiler in basement. The remaining spaces are heated by Radiators. The Main GF Hall/ Event space has mostly fan convectors, the rest of the building are mostly column radiators. The Archive rooms are climate controlled with mini split AC units and MVHR. The plant room supplies the low temperature hot water ("LTHW") heating circuits for the radiators 2 x natural gas boilers via an 50mm low loss header arrangement. The sealed system has an 300L expansion vessel (BOSS) and pressurisation unit (BOSS). The main circulation is by modern twin head pump (GRUNDFOSS MAGNA 3). The central heating boilers are 2 x recently installed HAMWORTHY WM99 98kW natural gas condensing boilers with fan assisted flues. The building is currently thought to require 136kW of space heating (subject to detailed design), so the building may be able to operate on 1 boiler for most of the year. The archive room also has 2x air conditioning ("AC") 'split' units (with inside and outside units – hence split). The system has 4 x wall mounted ducts (2 per archive room). These appear to be ~10-15 years old, however, and possibly due replacement or major service in next 5 years. These are 'reverse cycle' units and thus can provide heating as well as cooling. They are thought to be using an R410a refrigeration gas.

- Domestic hot water ("DHW") is serviced from local point use (PU) electrical storage units with ~10L storage capacity each. Legionnaires will be mitigated by maintaining the stored volume to under 15L. They are pressurised units so require annual checks. The use of these type of PU heaters is recommended for a building like this.

Remedial Works:

Required Maintenance

We have based our calculations on an optimum building model, meaning that certain maintenance works should be untertaken prior to commencement of the main strategy.

These works are:

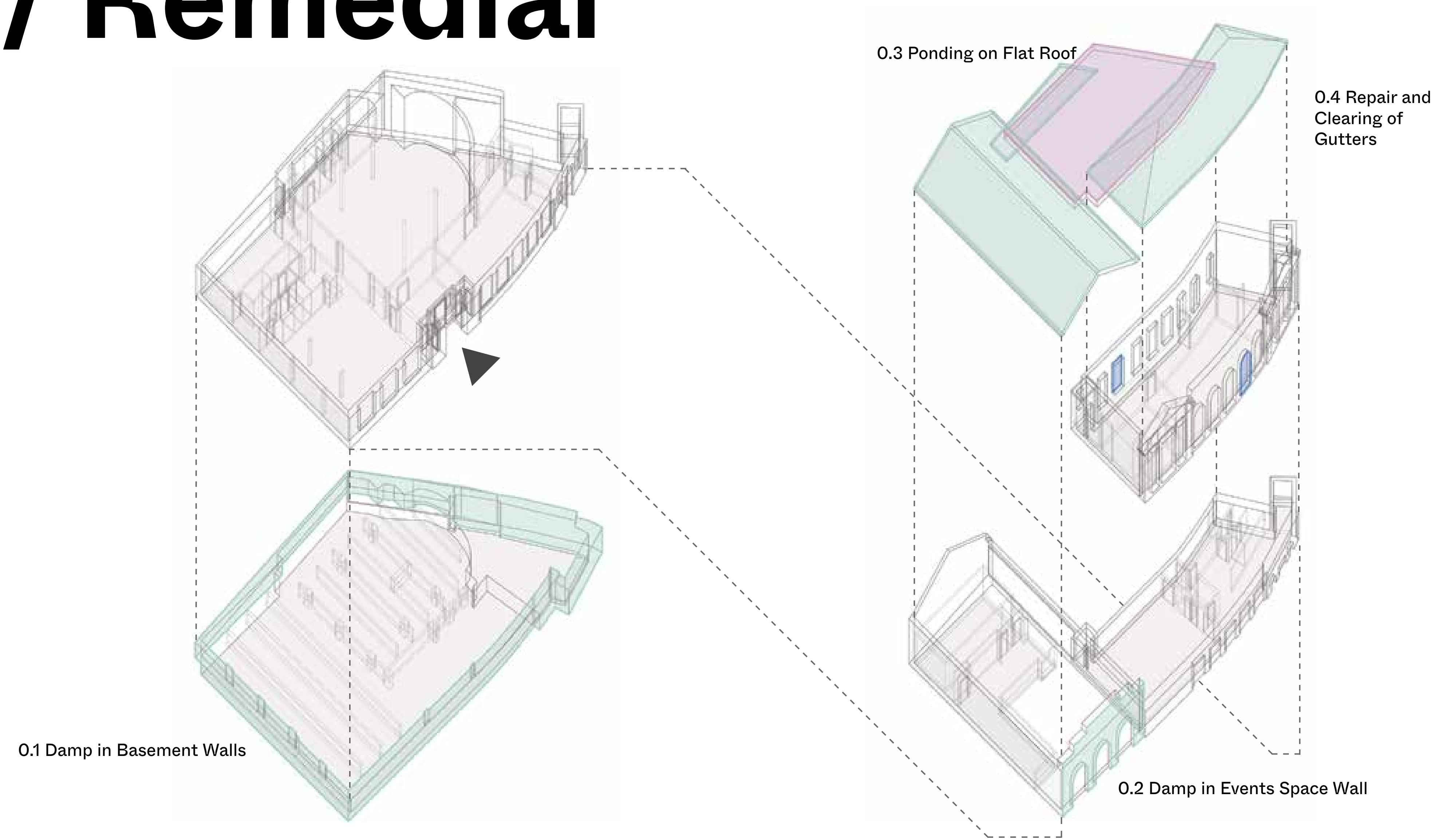
0.1 The basement area has significant areas of dampness with signs of mould growth across some walls. Many walls have been painted (multiple layers) with a non breathable paint which has resulted in moisture becoming trapped in the wall. In many areas this is now peeling off and exposing areas of saturated stone.

0.2 There is an area of ongoing dampness / water ingress to the front elevation in the Community Room. Further inspection is required here to determine cause prior to instructing repair.

0.3 Ensure no ponding occuring on flat roof, possible requirement to increase fall of newly finished flat roof.

0.4 At the rear, single storey area of flat roofing, there is a section of missing guttering from the neighbouring roof which should be replaced. Generally clear and maintain gutters.

As Existing / Remedial



As Existing Summary

Primary Energy
106.7 kWh/m2/y

Carbon Total
29.6 tCO2/y

Once remedial works are undertaken this is the estimated energy use and equivalent carbon emissions for the building ‘as existing’.

1. Fabric Improvements

Improving the floors, walls, roofs, windows and doors in order to reduce the amount of heat lost through these surfaces.

Airtightness is included in this section as a by-product.

Fabric First:

1.1 External Wall Insulation

This first phase intends to reduce the overall energy demand with fabric improvements, airtightness and correct ventilation as far as possible given the age of the building. Maintenance works should be conducted prior the installation of any energy efficiency works.

As noted during the surveys, there was a significant loss of heat through the external walls. And, as noted in the building appraisal, 3 of the 4no. elevations are not 'primary' or heritage elevations.

As such, the most practical starting point is to introduce external wall insulation to the side and rear elevations. This will have the added benefit of improving air tightness on these facades.

We have included a specificaiton for the external wall insulation and recommend this is installed as per the schematic diagram within this section.

External Wall Insulation Specification
PROPOSED U VALUE = 0.22 to 0.50W/m2 or better

- External wall Insulation to be installed to rear and side elevations, as per schematic drawing.
- External Wall Insulation System to be Wetherby Systems with 110mm Stone Wool 4S Silicone EWI system. Supply and install EWI Insulated timber frame system with silicone render finish to all exposed wall areas in accordance with Manufacturer's specification. Considered notice to be given to specification for system ventilation and fire break.
- Silicone render finishing and colours as per JGA's proposed elevations.
- Survey to existing walls and pre-treatments as specified by Wetherby Systems.
    - Manufacturer: Wetherby Building Systems Ltd.
    - Insulation type: WBS Stone Wool Insulation Boards
        - Dimensions: 1200 × 600, thickness 110mm.
        - Lamba value (I): 0.036 W/m2K
        - Fixings must be thermal bridge-free or reduced
        - Insulation Fixing & Fixing Pattern: see Wetherby Systems' specification.
        - Fire Fixing: as per Wetherby Systems spec.
        - Beads/ trims/ profiles/ rails / as per Wetherby Systems spec.
        - Minimum Compressive Strength: 120 KN/m2.
        - Thermal Conductivity: 0.036 Wm2/K.
        - Performance in Relation to Fire: Class A1 (BS EN 13501-1:2002). Non-combustible.
        - Environmental: CFC / HCFC Free, Zero ODP, GWP Less Than 5. U-value calculations and interstitial condensation conducted by EWI system manufacturer/ supplier.
        - Movement Joint Ref: WBS MJ6 Movement Joint as per Weatherby's specification.

Fabric First:

1.2 Internal Wall Insulation

We note that due to the heritage and architectural interest in the front facade, external wall insulation is not a viable option. But due to the performance of the external walls in the survey we do recommend insulation to this wall. We therefore propose to use internal wall insulation to the front, street facade but using an injecting process to install behind the internal wall features.

We propose EPS beads insulation infill to be installed to the existing cavity (behind lath and plaster). Using EnergyStore Super Bead insulation, or similar, stripping off of existing lath and plaster is not required.

To comply with current Fire and Building Regulations. Maintenance works and moisture levels within the fabric will need to be confirmed prior the commencement of the works.

To be installed together with airtightness measures. Proposed work to ensure a maximum wall U value of 0.8 W/m2K.

Internal Wall Insulation Specification (to street elevation only)
PROPOSED U VALUE = 0.80W/m2 or better
Existing plaster is Airtightness layer.

Install Bead EPS bead insulation to the front elevation, filling the 60mm internal cavity, behind existing lath and plaster.

Insulation material: EPS beads cavity fill.

Manufacturer & Product Reference: EPS Superbead, supplied by Energy Store. Specialist Installer to be approved professional, in accordance with the BBA Surveillance Scheme.

Thermal conductivity: 0.033 (W/m.K)

Fabric First:

1.3 Insulate Under Ground Floor

Another good opportunity for fabric improvements is the basement area underneath the main lending space. It may also be possible to insulate under the events space but we were unable to determine whether reasonable access was available here to install the insulation. As such our calculations only take into account the ground floor insulation shown in the schematic diagram.

We recommend the ground floor insulation to be 150mm to 200 mineral wool/ wood fibre insulation to be installed from below, in the under-flow space, which can be accessed from the basement.

To be installed together with airtightness measures. Proposed work to ensure a maximum roof U value of 0.15 W/m2K.

Ground Floor Insulation Specification

Air barrier over existing floor is Airtightness layer. U value to be 0.30 W/m2K or better

• Suspended ground floor insulation as per JGA's schematic drawing.
• Contractor to confirm if there is space beneath existing suspended timber floors. Leave existing floors
in place and access solum space from basement level. Ensure that there is adequate solum ventilation
• All redundant services beneath floor to be removed.
• Install 150 mineral wool between existing floor joists, fully fill all gaps, lambda 0.032 W/mK
• Install 100 mm mineral wool to underside of infilled joists
• Install vapour permeable membrane, Vapour resistance 0.08 MNs/g, ensure this is carefully sealed at
all laps and to all connections with adjacent masonry.
• Affix 25×50mm battens through membrane and mineral wool to retain all elements.
• Install airtightness and vapour control layer directly (eg 'Intello' by Pro Clima) over existing boards,
ensure membrane is fully sealed within plaster at all connections
to adjacent masonry walls and taped and sealed at all laps. Variable diffusion resistance/ airtightness membrane; sd value humidity variable 0.25 - 25m, vapour permeance humidity variable 0.13 - 13 u-sperm, airtightness 0.004 cfm/ ft2.

Fabric First:

1.4 Insulate Roof above Community Room

During the building surveys it became apparent that the current roof space above the community room is not surrently insulated.

We recommend the introduction of loft Insulation to this area: 350mm mineral wool insulation to be fitted between and above existing timber structure.

To be installed together with airtightness measures.

Proposed work to ensure a maximum roof U value of 0.20 to 0.30 W/m2K.
Proposed work to ensure a maximum roof U value of 0.20 to 0.30 W/m2K.

Ceiling Insulation/ Community Room Specification
Ceiling plaster is Airtightness layer. U value to be 0.30 W/m2K or better.
• Create safe access and conditions to all areas of loft
• Remove redundant services
• Ensure all holes / cracks in existing ceiling lath + plaster are filled (ceiling plaster will be airtightness
layer to ceiling)
• Install mineral wool insulation, lambda value 0.032 W/m2K to a depth of 250mm (1×150mm between
joists + 100mm above). First layer between existing joists, second layer cross-ways and third layer cross-ways again to minimise risk of contiguous air gaps - it is important to ensure that there are NO gaps at all between insulation and between insulation and adjoining joists / walls etc.
• Ensure insulation is tight up against rafter roll
• Install breather membrane loosely over insulation to prevent 'wind-washing' which reduces efficiency
of insulation and reduces risks from migrating fibres. Vapour resistance 0.08 MNs/g, acc to EN ISO
12572.
• Area for service access to be agreed. Assume 6 sq.m for now. In this area, install and brace 45×175 timbers cross-ways over existing joists, infill with insulation and again crossways above to be flush with adjacent insulation. Install deck over using 150×25mm boards with 5mm gaps between (not plywood etc - this can increase condensation risk), install 50×50mm edge batten and allow for 900mm handrail and balustrade all around
• Allow for wiring to 4no fixed lamp holders to be installed at high level onto rafters, with switch by loft hatch (within attic, not accessible from close).
• Cables to lighting to be run within conduits using suitable grommets to maintain airtightness if and when replaced.

Fabric First:

1.5 Control over Windows in Community Room

During the site visit it was noted that there are overheating issues in the community/ staff area in the first floor and in the main library space in the ground floor.

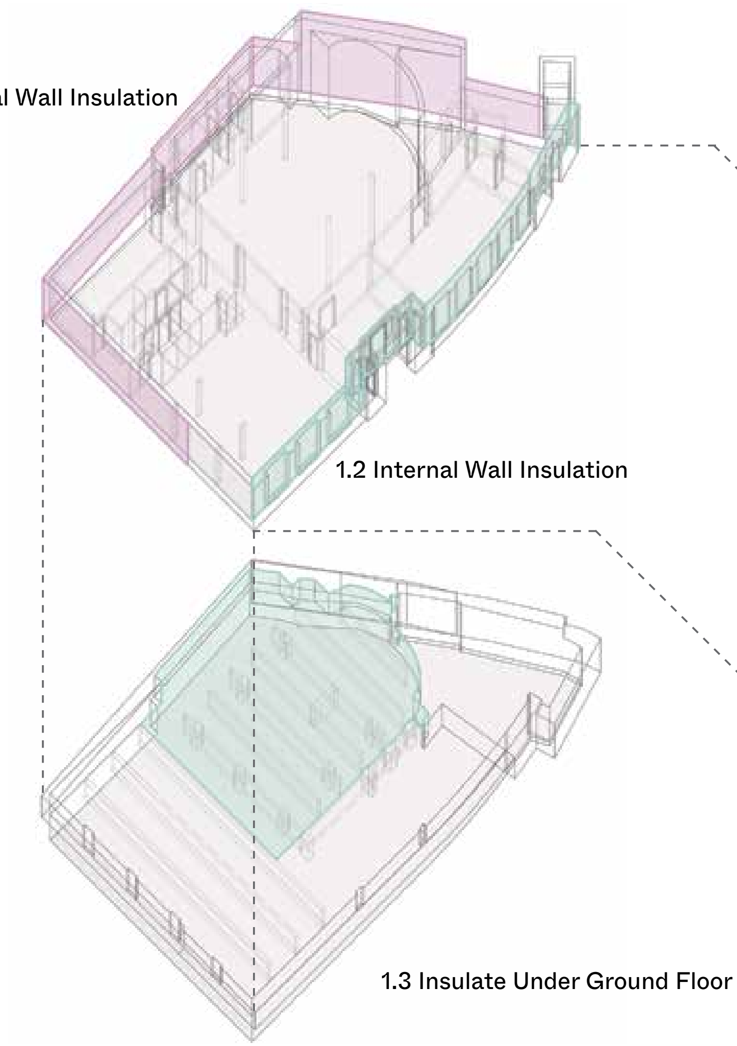
The client also confirmed that the opening of windows for ventilation purposes is not possible in these rooms due to the positioning of the new secondary glazing.

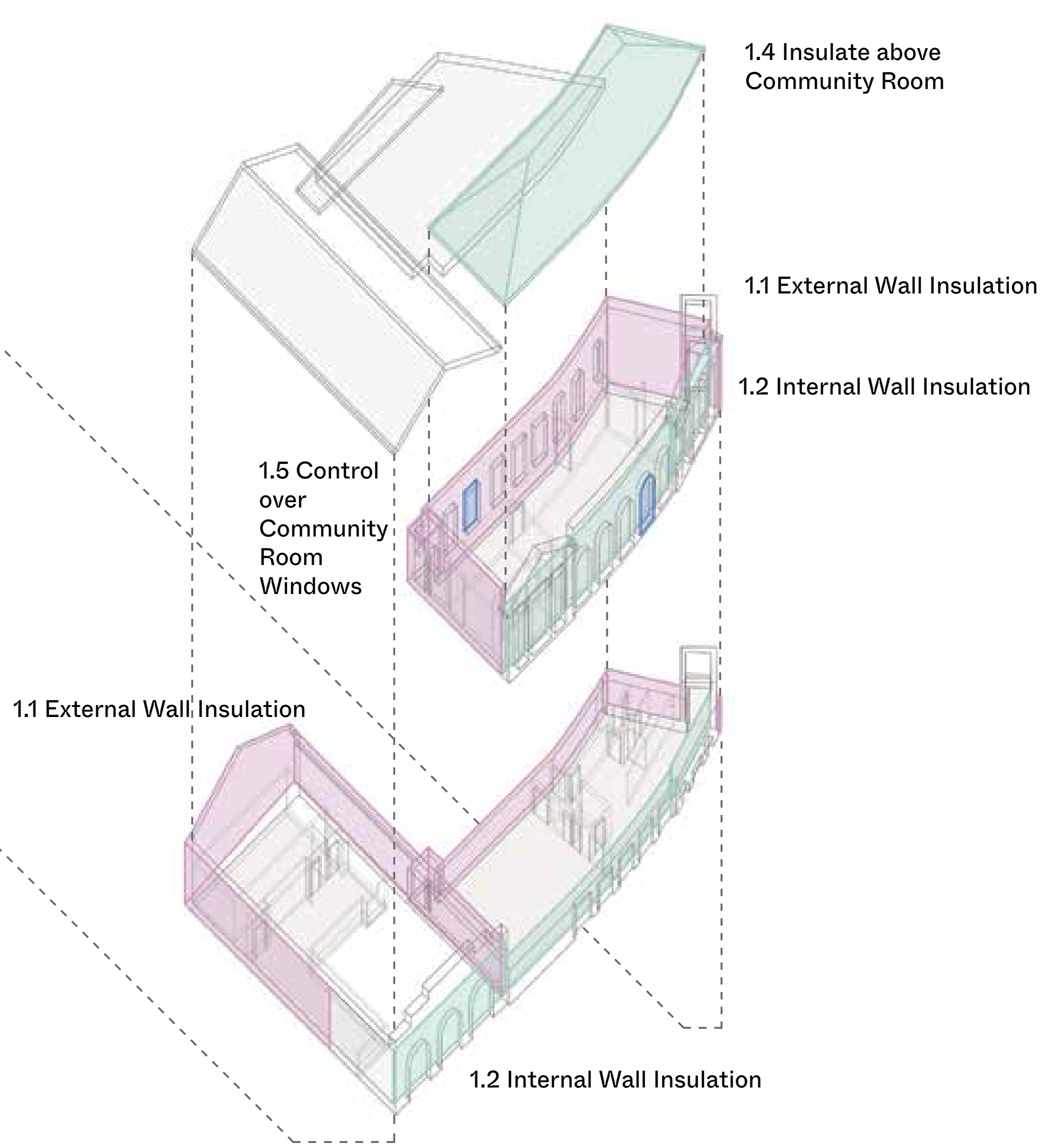
Ventilation strategy: the community space appears to have little auxiliary ventilation. The windows are openable but have been sealed with secondary glazing which has to be removed first. In time this will degrade the seals around the secondary glazing reducing their insulating properties.

The reconfiguration of the ventilation strategy with a continuous extract ventilation system (with demand control) from the loft and a detail design check is recommended as part of these works. This should also include CO_2 monitor(s) in the room spaces to monitor and alarm for ventilation conditions.

The overheating on the ground floor library space should be considered within the Operational Plan and Services upgrade strategy.

Fabric Improvements





Fabric Improvements Summary

Primary Energy 75.1 kWh/m2/y

Carbon Total 20.8 tCO2/y

Works:

+External Wall Insulation

+Internal Wall Insulation

+Ground Floor Insulation

+Loft Insulation

+Cross Ventilation

2. Operational Plan

Improving the operating of the building heating and ventilation systems in order to reduce demand.

These activities should run in conjunction with the programe of ‘capital works’.

Operational Plan:

2.1 Building Activities and Control

This aspect of the handbook is very much an on-going activity and should be developed as the other capital works are installed.

The primary aspect to this is ensuring knowledge of the buildings systems and the ability to Program Services (2.1) is retained and shared.

The overal services strategy calls for the retention of the current heating system as a back up system behind the renewable system, and as such a degree of complexity will be added to the overall building.

Proper control over these systems as these works progress will therefore be essential.

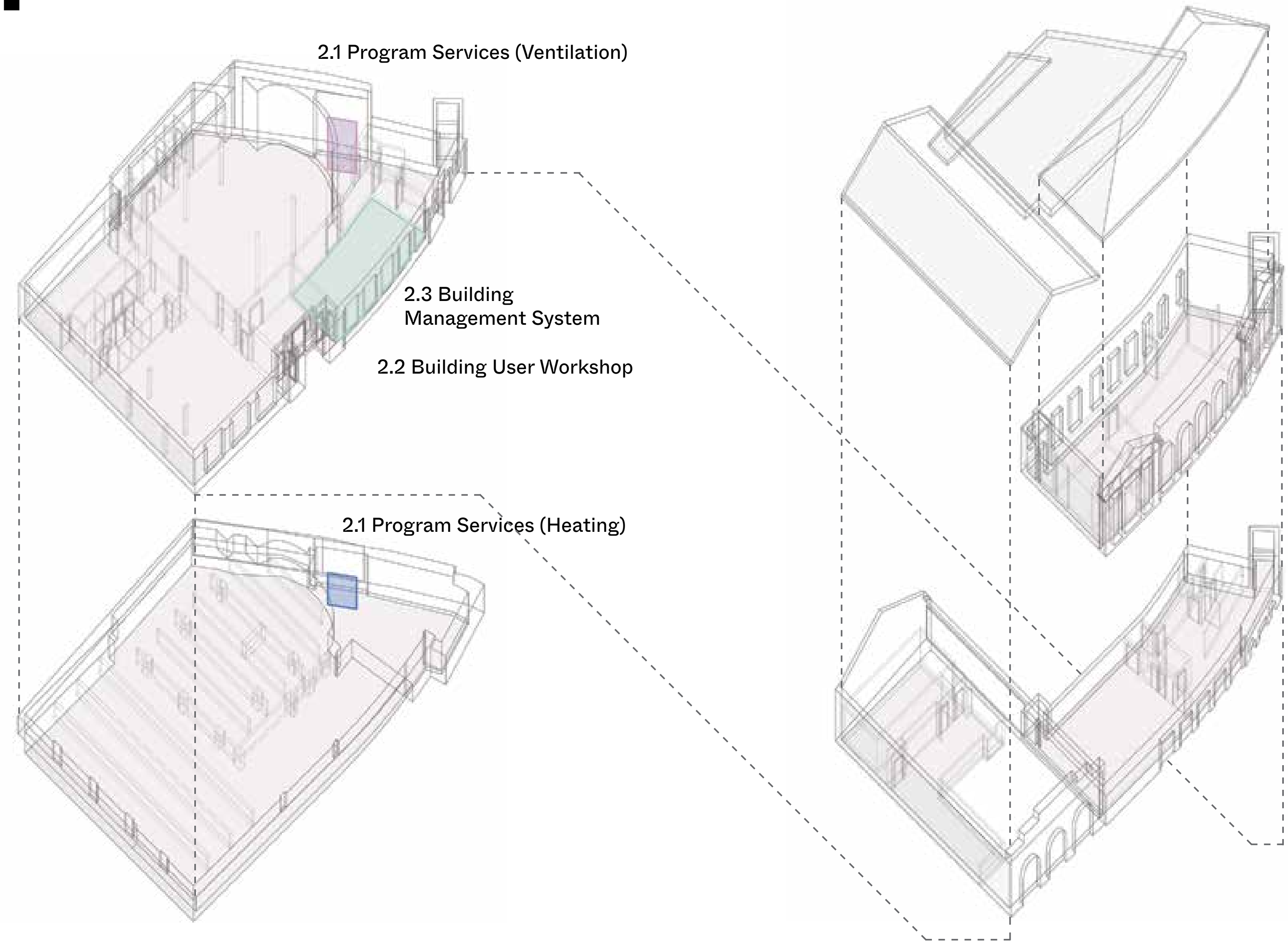
Alongside this we recommend Glasgow Women's Library start to record and plan the overall activity and use of the building as a means for better adapting heating and ventilation to activity.

A more efficient control over the internal climate will assist in reducing inefficiencies in the operating times and intensities of the services.

Communication of the building control required is also valuable across the organisation, a common tool for this is to conduct Building User Workshops (2.2) with colleagues. This does not need to be overly technical but can assist in creating a shared vision and responsibility for the space.

In addition to these service control and user pattern elements, we note the Glasgow Women's Library are undertaking a carbon appraisal process for each of their activity programmes and events, and making improvements in relation to waste. This all feeds in to the growing Building Management System (2.3).

Operational Plan



3. Services

Upgrading and improving the existing building heating, ventilation and lighting to optimise efficiency and reduce demand.

Services:

3.1 Improve Existing Services

These phases are intended to improve the existing active systems and reduce the existing energy use with improved controls, lowering set points for heating sources etc. A list of Mechanical Recommendations to improve the existing heating and hot water systems was prepared by Luths and includes the following measures:

3.1 Improve System controls
The Community room has several radiators with missing TRVs. Also the room temp controller for this appears to be in the Kitchen next door. A closer look at this issue may help control some of the overheat issues in that space. The ground floor event space has 4 fan convectors and 1 K2 radiator which appears to be under heated for the space, but this requires further review.

3.2 Upgrade Air Handling Unit
The system is thought to be set up on a Constant Air Volume. The current unit is thought to have a thermal wheel with 50-60% efficiency however we could not find any plant information on the day. It may be upgraded in the future to a higher efficient unit with Variable Air Volumes and ‘demand’ controls (CO2 and occupancy sensors as well as time schedules) that could adjust to number of people in the spaces. We could not see any fire dampers on the visit.

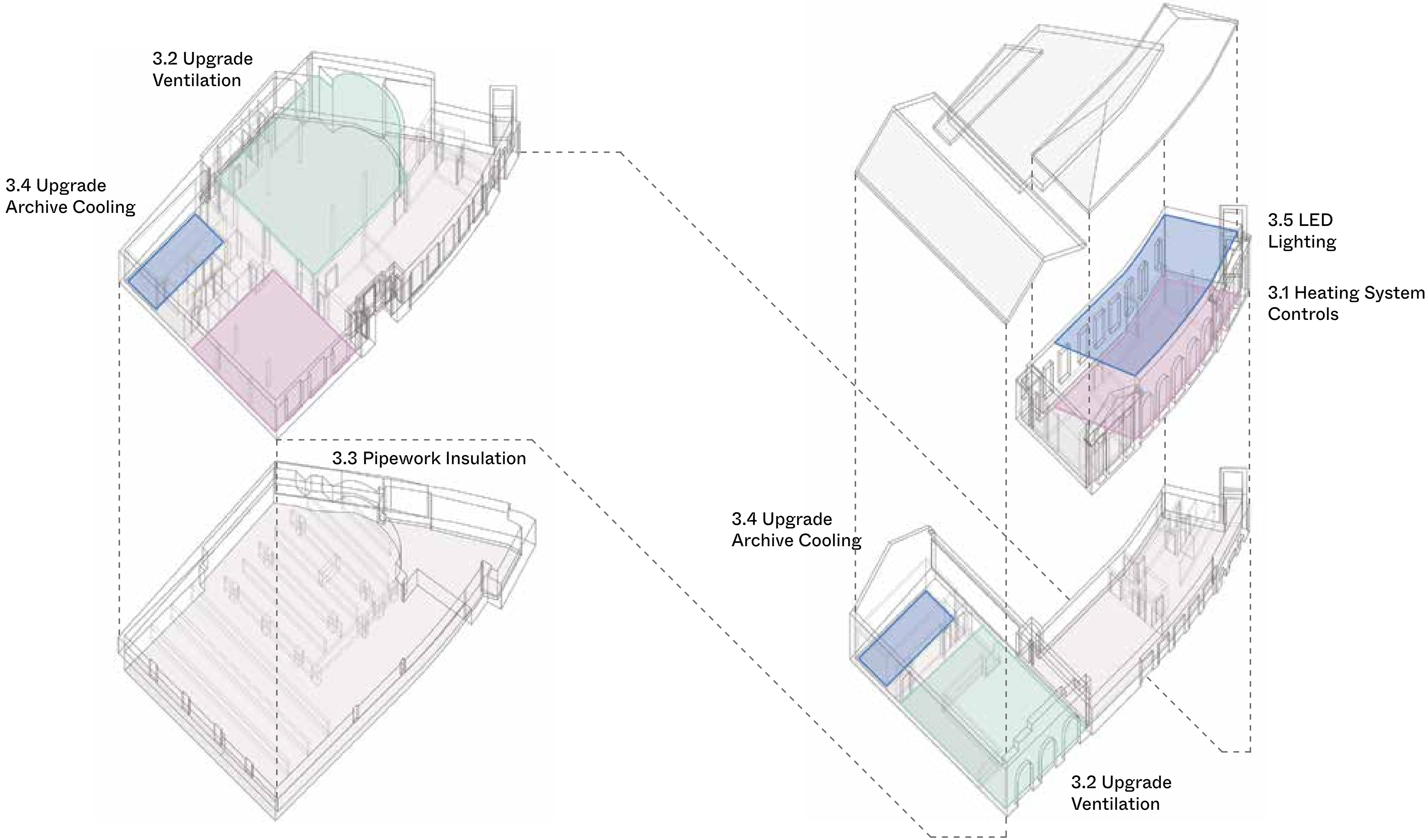
3.3 Additional Pipe Insulation
Pipe work is currently sized for high flow temperatures (65°C)- it may be a full design review would allow potential low temp heat sources to be connected at a future date (e.g. heat pump).

3.4 Upgrade Archive Cooling
Mitsubishi AC located in the Archive rooms: the AC are R410a refrigerant units. The AC age suggests replacement in next 5- 10 years- potentially with an F-gas with a lower global warming potential as R410a is to be phased out in next few years, but maybe with a more flammable nature that may require additional fire regulation assessments. The current units do not have drains for condensing water running off the bottom of the units so there is a risk of this water landing on the outside wall.

3.5 LED Lighting
The lighting in the Community Room is not thought to meet requirements of SLL and can be replaced with modern energy efficient LEDS. The current controls in most areas could be more energy efficient (e.g. such as PIR detector and daylight dimming).

It is recommended to get a lighting design done and replacement of lighting in key areas.

Services


3.2 Upgrade Ventilation
3.4 Upgrade Archive Cooling
3.3 Pipework Insulation
3.5 LED Lighting
3.1 Heating System Controls
3.4 Upgrade Archive Cooling
3.2 Upgrade Ventilation

Operations and Services Summary

Primary Energy
70.7 kWh/m2/y *

Carbon Total
19.6 tCO2/y

***as a guide RIBA 2025 target is < 70 kWh/m2/y**

These works, although not contributing significantly to the primary energy use, remove notable inefficiencies from the building before introducing renewables.

4.
Renewables

Adding on-site renewables to offset demand from the building systems.

Renewables:

4.1 Air Source Heat Pump

The Renewables phase proposes to offset the remainder of the energy consumption with as much onsite heat generation from photovoltaic panels, battery storage modules and an air source heat pump.

The existing gas boilers would be retained with use phased out over time to just providing top up on the very coldest days or hopefully just emergency backup if needed.

The Air Source Heat Pump (ASHP) would feed in to the existing wet heating system directly.

Air Source Heat Pump System Specification

• New space heating system provided by ASHP system, feeding existing wet radiators. The new ASHP system will supply space heating to the Main Library, the Entrance Hall, the Staff Office (GF), the Community Room and Kitchen (1F).

• Existing Pipe work is currently sized for high flow temperatures (65°C), A design review should be undertaken to provide pipework that would allow low temp heat sources to be connected to the new ASHP system.

• ASHP system: Ecodan CAHV Monobloc Air Source Heat Pump System.

• Radiators: replace existing radiators located in the office and Community Room with new low temperature radiators, all but one to be fitted with TRVs.

Renewables:

4.2 Solar Thermal and Commercial Battery Storage

A new Photovoltaic system is also recommended and should be connected directly to the ASHP system.

The battery storage system is then connected to the grid, and charged by the heat pump, with off-peak tariffs.

System controls are provided by both the battery storage and the ASHP systems.

Solar Thermal Water Heating System Specification

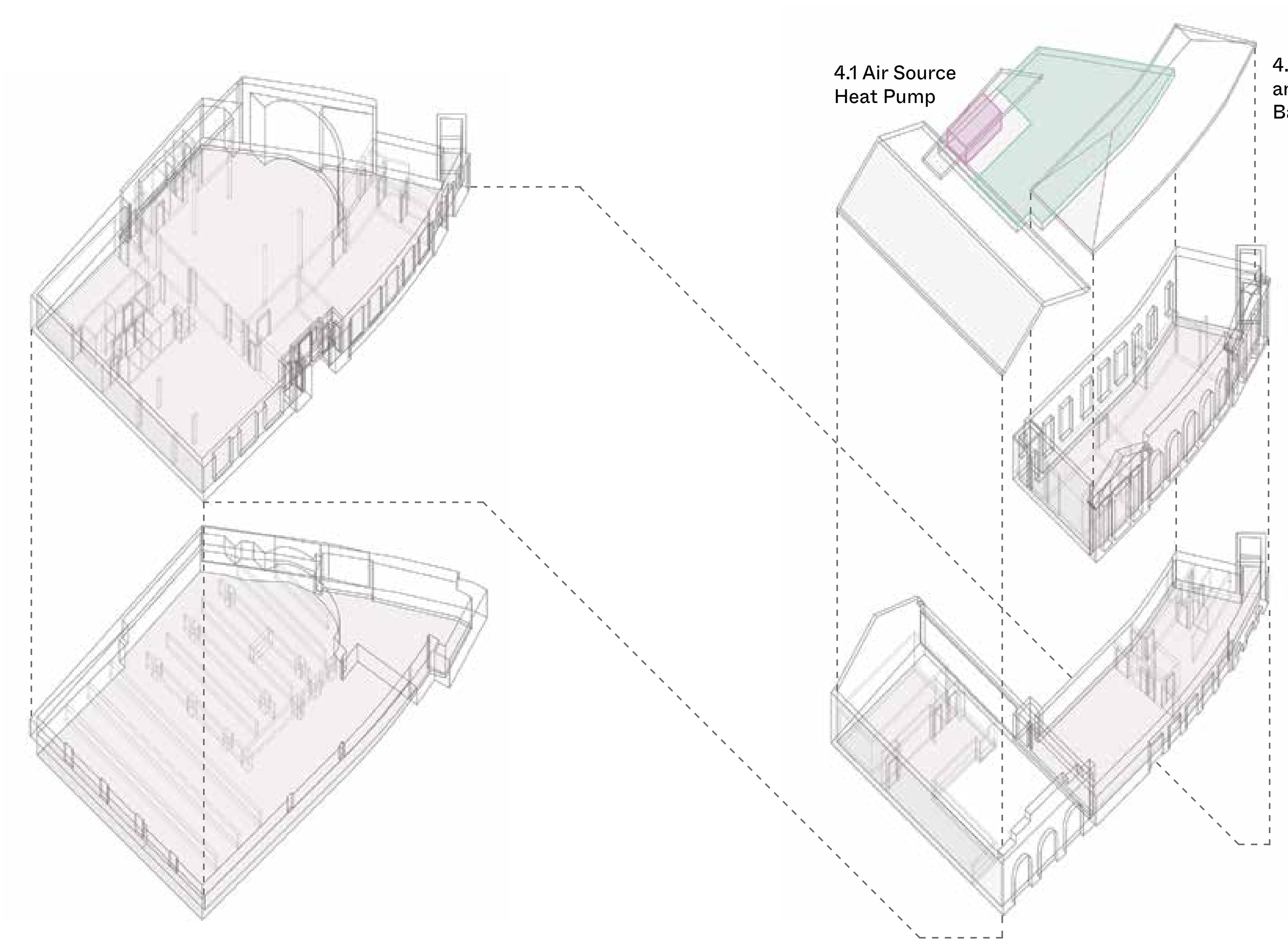
- Manufacturer: JA Solar
- Photovoltaic Panel: 340W MBB Half-Cell Module Mono JAM60S10 320-340/MR
- Supplier: Solarsense
- Number of photovoltaic panels: 33 (to be confirmed by Mechanical Engineer)
- Installed capacity: 8.08 kWP (to be confirmed by Mechanical Engineer)
- Structure: rail system fixed to flat, to be specified by Structural Engineer.
- Design and installation: as per Solarsense specification.

- As per MCS (Micro-generation Certification Scheme) Installation Guide. Standards:
- Photovoltaic modules: To BS EN 61215 or BS EN 61646.
- Junction boxes and switchgear assemblies: To BS EN 61439-1 and -2.
- Surge protection devices: To BS EN 50539-11.

Commercial Battery Storage Specification

- Battery storage integrated with the commercial solar panel system, to store cheaper energy form the grid during low cost periods and discharge during peak times.
- Manufacturer: Tesvolt TS 25, Commercial Battery Storage
- Supplier: Solarsense
- Modular Energy: 4.8 kWh
- TS 25 (2 modules)
- 1300×600×600mm

Renewables


4.1 Air Source
Heat Pump
4.2 Solar Thermal
and Commercial
Battery Storage

Renewables Summary

Primary Energy 32.4 kWh/m2/y *

Carbon Total 1.2 tCO2/y

***Compliance with RIBA 2030 target of < 55 kWh/m2/y**

Although not reaching actual zero, the renewables works take the project well within the threshold of a net zero building, operationally.

Projections:

Primary Energy

106.7 KWh/m2/y

↓

32.4 KWh/m2/y

Carbon Emissions

29.6 tCO_2/y

↓

1.2 tCO_2/y

* The above projections meets the RIBA 2030 Net Zero threshold

Methodology Summary for Energy Modelling

The proposed energy efficiency measures were assessed using IESve energy modelling software. The energy modelling studies confirmed the operational energy consumption for each proposed retrofit phase and confirmed that the final space and water heating demand for phase 3 can be provided by zero emissions alternatives.

The energy demand for heating and primary energy was calculated taking into account building fabric heat losses, ventilation heat losses, hot water demands, system losses and thermal response. A thermal demand was modelled for the building based on internal heat settings and local outside temperature data for a year. The chart shown below confirms the following calculation findings:

Overall, the proposed measures are predicted to reduce the existing yearly energy consumption from 106.7 kWh/m2 to 75.1 kWh/m2 in Phase 1, to 70.7 kWh/m2 in Phase 2 and to 32.4 kWh/m2 in Phase 3. This confirms that the final primary energy consumption for Phase 3 meets the RIBA 2030 Climate Challenge target of 60kWh/m2.yr. The energy model also confirmed that the final energy demand for Phase 3 can be provided by zero emissions alternatives.
The proposed fabric improvements reduce the yearly CO_2 emissions consumptions from 29.6tCO_2 to 20.8tCO_2 in Phase 1, to 19.6tCO_2 in Phase 2 and to 1.2tCO_2 in Phase 3.

Notes: (1) the existing building fabric build-ups and systems were based on the information gathered during the non-intrusive survey and assumptions, (2) fuel tariffs, meter systems and system components are based on IES modelling results. (3) existing fuel costs to be confirmed by the client.

Summary

The works outlined in this document are predicted to result in a primary operational energy use of 32.4 kWh/m2/y with carbon emissions of 1.2 tCO2/y. These projections meet the RIBA 2030 Net Zero Threshold.

5. Further Works

Additional activities deemed ‘disruptive’ that could be undertaken as part of long term maintenance to make further improvements.

Further Works:

5.1 Opportunities for Further Improvements

We have included this further works section primarily as advice on opportunities that may arise during specific circumstances.

On-going repairs and maintenance to the building may create opportunities to make additional fabric or services improvements to the building.

Similarly the detailed investigation of the recommended works may present further, or different, opportunities to reduce energy use in the building.

The building, and this process, are fluid things, and should be consistently appraised.

In addition, within the works timeframe, we anticipate that there will be technological advances and a changing context to energy usage. This may also influence the renwable elements and create different opportunities for carbon savings.

Section Three: Testing and Monitoring

Monitoring

Building
Future, and ideally continued, testing of the building during the process will help to identify progress and ultimately the performance of the building on completion of the works identified.

Accreditation
As the works are carried out, there is the opportunity to align with specific accreditation schemes and public registers. For example Energy Performance Certification or PAS 2060.

Use
Alongside the testing and monitoring of the building there is the opportunity to continue to explore carbon reduction in the use of the building. As the building systems are upgraded, the opportunity to monitor the operation of these systems is improved.

Monitoring:

Record Annual Energy Use and Aggregate over years.

Undertake intermittent testing and reviews.

Record of Works / Testing Undertaken

Record of Works / Testing Undertaken

Record of Works / Testing Undertaken

Appendix

The following information has been provided to Glasgow Women's Library as separate documents:

Air Tightness Test Results

Thermographic Images

Services Inspection Report

IES Modelling Data

Architect's Specification

Cost Report on Works