Granton Square Activity Hub
Project Booklet

Advanced Sustainable Design Project, 2023

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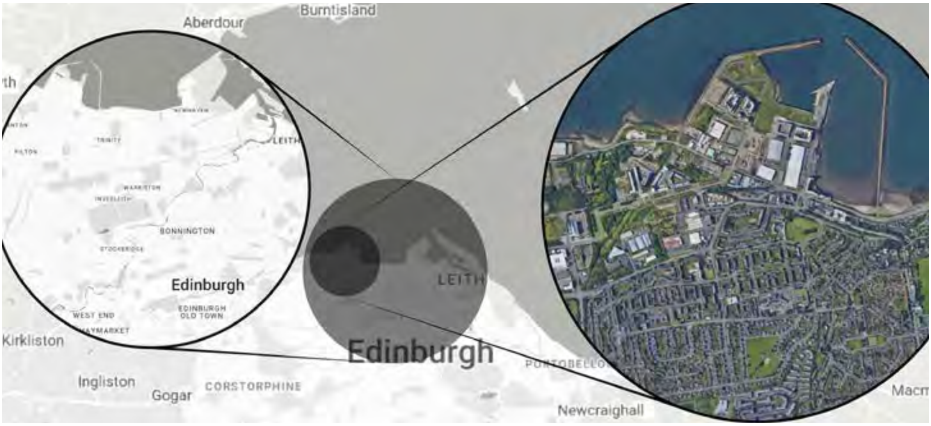
01 THE PLACE

Granton, Edinburgh

Granton is a district in northern Edinburgh. Historically, it has been a hub for industry; one of the busiest ports in the city, a centre for exporting coal, making stone for urban development, car manufacturing, and importing materials.



The following proposal contributes to *Edinburgh 2030*, specifically the *Granton Waterfront Regeneration*. Some of the key objectives include sustainable economic growth, community wealth-building, 20-minute neighbourhoods, greener corridors and travel, and pioneering a climate-conscious place to live. Most importantly, the proposal aims to create a sense of community pride and character.

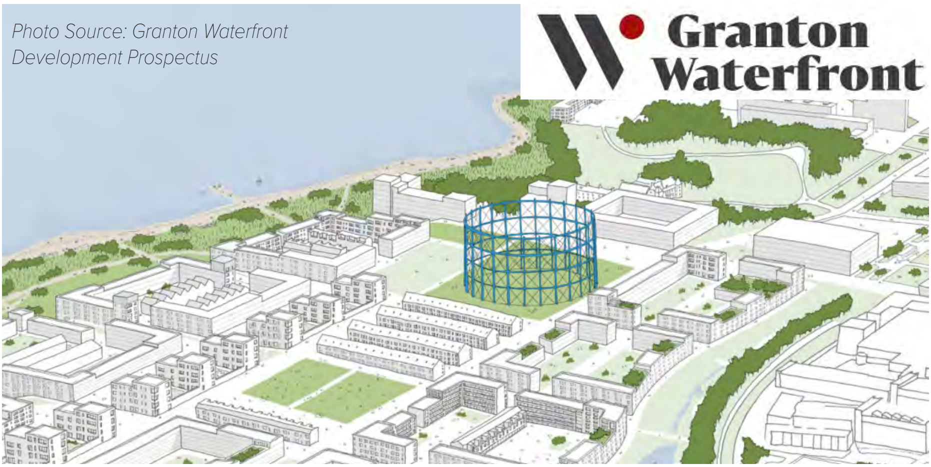


Photo Source: Granton Waterfront Development Prospectus

The City of Edinburgh Council has invested £250 million in the surrounding areas. Specifically, there is a £16.4 million successful bid for restoration of the area around Granton Harbour. The following proposal could consist of part of the future plans for this funding in connections with other projects and initiatives.

02 CHALLENGES

Services & Access

To create a truly sustainable neighbourhood, it is vital that residents--both current and future--are flourishing. This means providing essential resources that allows them to thrive. Some of these services include childcare, outdoor leisure and gathering space, public libraries, food pantries, after-school programs, civic engagement, and opportunities to strengthen community involvement. In Granton, many of the services needed for a successful and sustainable community are non-existent or outdated.

For example, the Royston Wardieburn Community Centre is located south of the waterfront near the public primary school. While it provides spaces for and hosts occasional community events, both the services and infrastructure are lacking the necessities for growth and long-term sustainability. Moreover, there is little youth and young-adult engagement.

In addition, there is no outdoor or indoor casual meeting spaces, and the building lacks attractiveness and vibrancy that many modern community centres have. In addition, little information is advertised. Without a website, the organisation relies on its Facebook page to promote events.

Royston Wardieburn Community Centre Classroom (upper left)
Gymnasium (upper right)
View from Wardieburn Road (bottom)

The map above shows many of the community services and demonstrates how spread out they are. Not shown is the lack of safe connections between them. Creating a town centre would allow residents to access their needs in one area.

Inadequate accessibility and links to everyday services create a series of disjointed neighbourboods and areas.

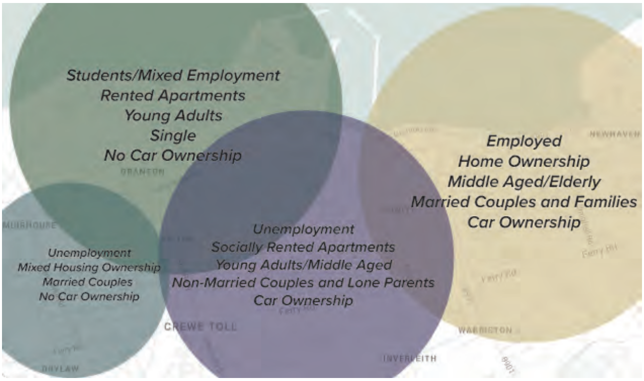
Residential blocks are composed of similar (often identical) design and typology with little-to-no connection to each other, resulting in a divide and absence of interactions. Moreover, there is little incentive for residents to visit what could be a beautiful waterfront.

02 CHALLENGES

Disjointed & Uncelebrated Character

Employment status, housing typology, age, and relationship status were studied geographically. Observing overlaps based on these characteristics suggests four areas that share boundaries across the categories. This data was used to identify areas of both opportunity and need to determine where connections and solutions would best serve the community.

These divides contribute to a lack of community pride and neighbourhood character by discouraging interaction between the areas. Granton has a rich history and diverse population filled with culture and personality that goes uncelebrated. The waterfront and harbour is now warehouses and their resulting waste. Several historic landmarks still stand; yet many remain unaccessible.



Unusable open space results in an overall lack of outdoor leisure areas. Aside from pockets of roundabouts nestled in the residential neighbourhoods, there is little greenery in the area. While areas like Pilton Park and Cresent park provide some communal outdoor green space, links, variety, and quantity is lacking.

There is tremendous potential to add more of these areas that are accessible to residents throughout the community. The map above highlights a sample spaces fit for regeneration.

The purpose of community redevelopment is to provide and improve connections that benefit the diverse population, within the larger city of Edinburgh and as a tight-knit radius. Creating links and opportunities for all is vital for a successful community where all members can thrive. The neighbourhood is missing a town centre that would promote small businesses, engagement, relationships, public transportation, community character, and resource sharing, which are vital for sustainable communities.

03 PROJECT AIMS

Goals & Strategies

There are three primary goals the project addresses to support current conditions and foster future prosperity. Each work to achieve longterm environmental, social, and economic sustainability.

Celebrate Culture, People, & Diversity

PLACE- AND PEOPLE-LED

- Understand the existing systems
- Enhance and expand from those
- Celebrate history and culture
- Involve locals with the design process
- Collaborate with local organisations
- Using data from surveys and maps

TOWN CENTRE

- Bustling hub of activity
- Concentrating services and resources
- Accessible basic needs
- Commercial and networking opportunities
- Sense and celebration of place

Efficient & Productive Infrastructure

FUTURE PROOFING

- Define short- and long-term visions
- Adaptability and flexibility
- Meet current and future needs
- Include biodiversity
- Consideration of future use and con-ditions

SHORT DISTANCES

- Complete and sufficient town centre
- Links between neighbourhoods
- Improving accessibility
- Densification & mixed-use
- Enabling a low-carbon lifestyle

ECO INFRASTRUCTURE

- Minimise energy demand
- Conscious design, materials, and construction
- High performing public buildings
- Connected neighbourhoods
- Environmental justice

Residents' Success & Prosperity

FORM RELATIONSHIPS

- Emphasises similarities from all walks of life
- Relationships of similar or different interests
- Celebrate passions, cultures, & interests
- Enables education of diversity

PROMOTE HEALTH

- Exercise classes and gym facilities
- Sporting events and competitions
- Safe and inviting outdoor space
- Increase time spent outdoors
- Community and collective involvement
- Team mentality

EDUCATE & ENTERTAIN

- Multi-purpose classrooms
- Share hobbies and ideas
- Networking and start-up opportunities
- Hybrid working environment
- Community and bond-forming events

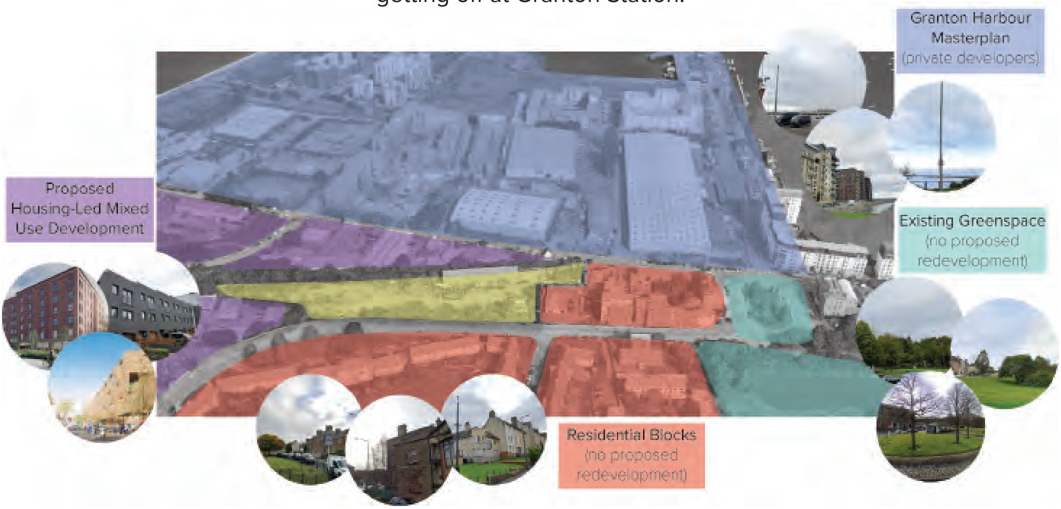
04 SITE SELECTION

Current Conditions

The current site is a recycling centre and scrap yard for discarded car parts that contrasts from the surrounding townhouses, green spaces, and regeneration.

The site is level and sits at 10m above sea-level. A 5-meter retaining wall runs along the southern portion of the site, which will be conducive to protecting occupants against strong south-west winds.

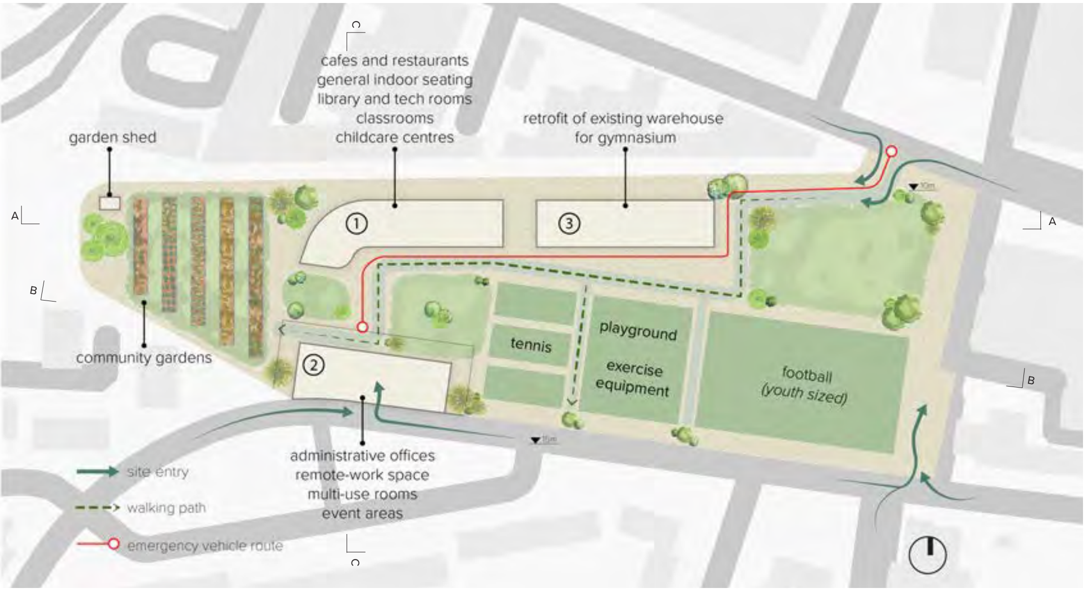
There is a plethora of redevelopment in close proximity. This will aid in the efforts to create a town centre and hub of activity for both residents traveling via shuttle, bike, bus, or foot, as well as visitors getting off at Granton Station.



By transforming the site into an vibrant space, it will provide links with other resources and services to promote density and intelligent land use. Moreover, its proximity to existing green spaces and bike routes offers a potential to extend and enhance existing networks.

05 SITE DESIGN

Holistic Sustainability



The main entry point to the site is on the north side along W Harbour Road. Visitors enter off the sidewalk and onto a surface made of recycled concrete tiles incorporated with rain water collection. They can walk through the grassy area filled with benches and trees, or continue around to reach the gymnasium and spots fields.

Visitors reach another green space surrounded by the new buildings. On the right, the building will host services like classrooms, childcare, the library, tech spaces, cafes, and small-business pop-up shops.

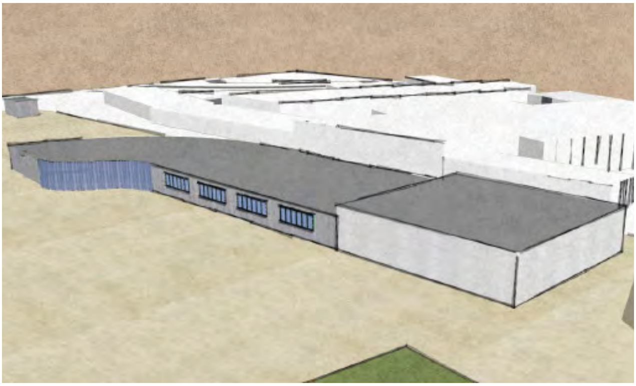
Across the green space, the 2-story building contains administrative offices, bookable remote-work offices, multi-use flexible spaces, and a large event hall. W. Granton Street-level access will also be available through the double-height space or wrap-around balcony.

The last stop on the site are the gardens, where fresh produce will be grown and led by the community.

06 THE BUILDINGS

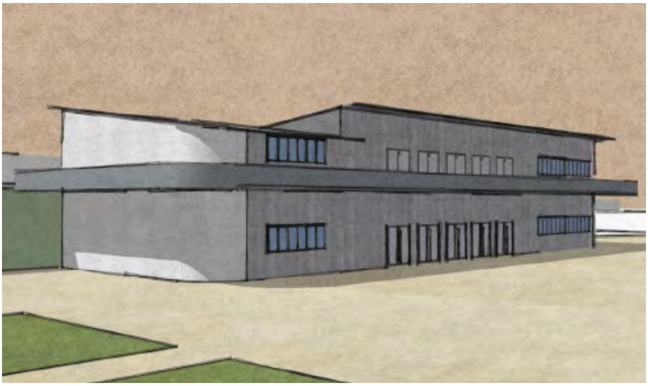
Retrofit & New Construction

BUILDING 1: SERVICES



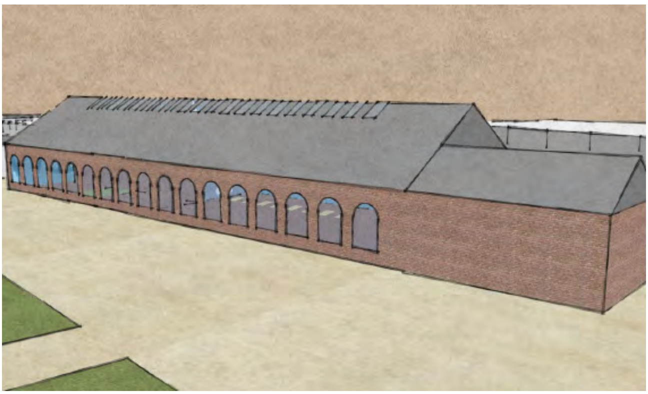
Building 1 houses services that residents will use on a regular basis. It is a single story with a clerestory on the library. The roof is left flat for solar panels, as well as potential usable rooftop space. The curved form helps to shape the site while optimising southern glazing exposure.

BUILDING 2: SPACES



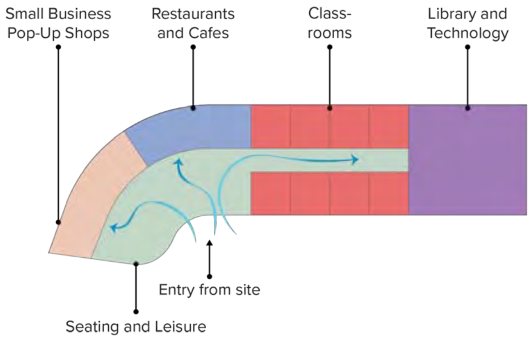
Building 2 provides space for flexible uses that can be reserved for community events, remote work offices, and administrative offices. It also acts as a southern entry point, where visitors enter from the upper level. A wrap-around deck provides shaded and unshaded areas, as well as an entrance for outdoor use when the building is closed.

WAREHOUSE RETROFIT: GYMNASIUM

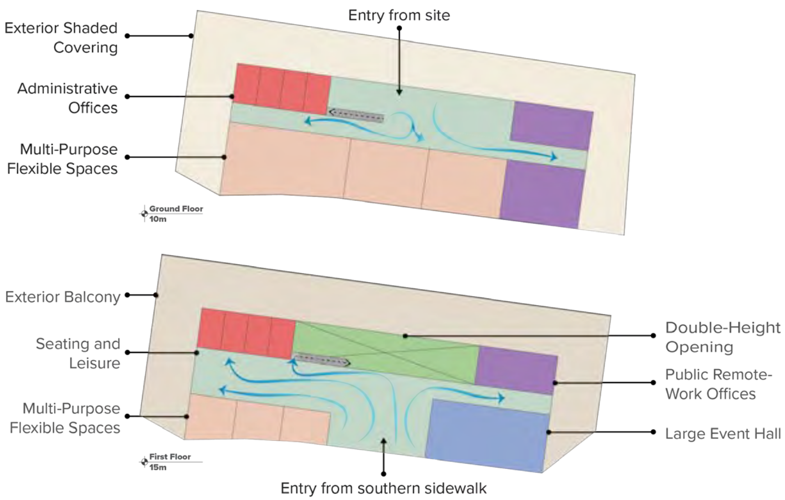


The existing structure is retrofitted into a gymnasium facility. Construction techniques are out of the scope of this project, but reusing an existing structure and fitting it to meet sustainability performance requirements mitigates the most embodied carbon intensive materials. Moreover, the structure has significant historic relevance and provides a sense of place for Granton.

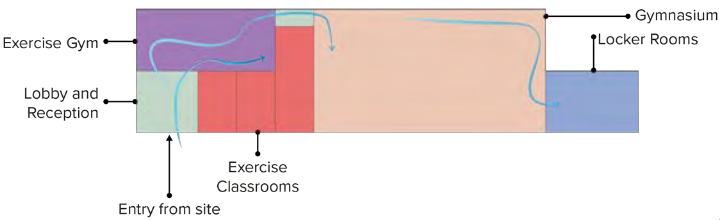
Building 1: Services

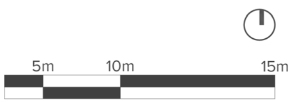


Building 2: Spaces



Building 3: Health & Wellness





07 ENERGY MODELING

Purpose & Goals

Using building simulation software, the three buildings were optimised based on several parameters including window-to-wall ratio, shading devices, U-values, mechanical systems, solar heat gain coefficient, air tightness, mechanical equipment efficiency, and amount of solar panels.

Before embarking on optimisation, qualitative and quantitative goals were set.

QUALITATIVE GOALS	
Performance High performing for UK Less focus on comfort Rooftop Solar PVs	**Temperature by Space** Flexible reception & halls Close-to-outdoors Controledl educational spaces
Comfort Conditions Wide ranges User control Closer to the outdoors	**Lighting by Space** Dark reception & halls Medium cafe Brighter educational spaces
Form Long E-W orientation Shaded outdoors spaces Limit western exposure	**Lighting** Controlled natural lighting Occupancy sensors Efficient fixtures

The qualitative goals contribute to creating a high performance building by UK standards, and solar PVs can overall lower the energy demand. Comfort levels are set close to exterior conditions in spaces where occupants pass through quickly. Other areas are kept flexible to be able to adapt to future climate conditions, space use, and individual preference. The lighting is also specified by space use, so they are well designed for each of the given tasks. Optimising daylighting, incorporating occupancy sensors, and ensuring efficient fixtures lower the lighting energy demand.

PERFORMANCE GOALS	
EUI (kWh/m2/yr)	30-90
CO2e (kg/m2/yr)	under 50

While the goal is to ultimately design a net-zero building, the project's buildings aim to be high performing by UK standards and use electric mechanical equipment. Scotland's energy grid is powered 99% by renewables, mostly coming from off-shore wind. Using on-site renewables in the form of rooftop solar PV panels and using Scotland's increasingly sustainable electricity grid, the building can have its energy demands powered by renewable sources.

07 ENERGY MODELING

Methodology

Baseline Case

FORM | **WWR** | **ENVELOPE** | **SCHEDULES** | **PVS**

The baseline case is first defined.

run initial tests and record results

EUI · Comfort · CO2e · Heating

The outputs studied are EUI, average percent dry bulb comfort achieved, CO_2 emissions, and total heating load, which are measured at each test to chose the best design option.

Passive Improvements

II. WWR

Test 1:	Test 2:
North = 0.4	North = 0.4
South= 0.4	South= 0.4
East = 0.2	East = 0
West = 0.2	West = 0

II. SHADING

Test 1:	Test 2:	Test 3:
N = 0.5 H	N = 0.5 H	N = 0.5 H
S = 0	S = 0.5 H	S = 0.5 H
E = 0	E = 0	E = 0.5 H
W = 0	W = 0	W = 0.5 H

III. U-VALUES

Test 1:	Test 2:
Walls = 0.24	Walls = 0.15
Floor = 0.16	Floor = 0.15
Roof = 0.15	Roof = 0.15
Glazing = 1.0	Glazing = 0.8

The second test alters window-to-wall ratio. Increasing these values could enhance natural ventilation, or increase unwanted heat gain from radiation. It will also show the impact of glazing on different facade orientations. The third test adds overhangs on each orientation. The fourth test increases insulation by reducing U-values. The first reduces UK Building Code Standards by 10%, and the second follows Passive Haus Standards.

Mechanical Improvements

IV. HVAC SYSTEM TYPE

Passive Chilled Beams	Packaged Terminal AC	Radiant Floor
Water-Cooled Chilling	Air-Cooled DX	Water-Cooled Chilling
COP = 5.5	Package Terminal AC	COP = 5.5
Efficiency = 0.9	**HHW Loop**	Efficiency = 0.9
HHW Loop	Heat Pump	**HHW Loop**
Heat Pump	COP = 5.5	Heat Pump
COP = 5.5		COP = 5.5
Cooling Tower		Cooling Tower
Efficiency = 0.95		Efficiency = 0.95

After looking at passive measures, the simulation then tests different HVAC systems to determine which option is best suited for the climate. Specifications are shown on the left. They systems were chosen based factors like popularity and efficiency.

V. EUI REDUCTION

v. Glazing	vii. HVAC Efficiency
Solar Heat Gain Coefficient = 0.15	Water-Cooled Chiller COP = 7
vi. Air Tightness	viii. Renewables
Crack Infiltration = 0.1 L/s-m2	PV Roof Coverage = 75%

After making initial passive improvements to the baseline and choosing a HVAC system, efforts are taken to further reduce the EUI.

Building 1

FINAL DESIGN		PERFORMANCE	
Window/Wall	0.4 on N and S	EUI (kWh/m2/yr)	49
Shading	0.5 horizontal overhang on South	Peak Heating Load (kW)	53
U-Values	Passive House Standards	CO2 Emissions (CO2e/m2-yr)	25
HVAC System	Passive Chilled Beams	Av. % Comfortable, Dry-Bulb	74

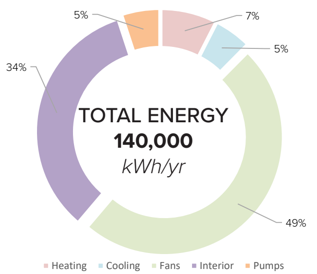
Building 2

FINAL DESIGN		PERFORMANCE	
Window/Wall	0.4 on N and S; 0.2 on E and W	EUI (kWh/m2/yr)	33
Shading	0.5 horizontal overhang on South	Peak Heating Load (kW)	59
U-Values	Passive House Standards	CO2 Emissions (CO2e/m2-yr)	17
HVAC System	Passive Chilled Beams	Av. % Comfortable, Dry-Bulb	65

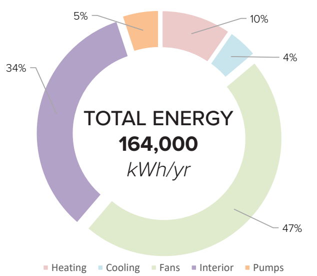
Warehouse

FINAL DESIGN		PERFORMANCE	
Window/Wall	0.4 on N and S	EUI (kWh/m2/yr)	91
Shading	0.5 horizontal overhang on South	Peak Heating Load (kW)	84
U-Values	Passive House Standards	CO2 Emissions (CO2e/m2-yr)	47
HVAC System	Passive Chilled Beams	Av. % Comfortable, Dry-Bulb	100

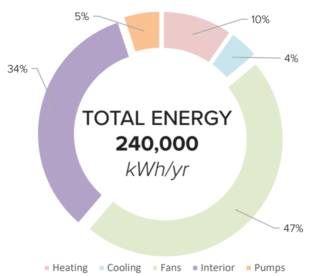
Based on the results from the simulation, final design decisions were made and are summarised in the tables above. Passive House U-values, passive chilled beams, and southern horizontal shading were used on all three buildings due to their energy savings and passive heating strategies. Building 1 and the warehouse uses 0.4 window-to-wall ratio on the north and south facades due to their long orientation and to block from morning and evening glare. Building 2 includes eastern and western glazing as well to provide natural light for the spaces abutting the retaining wall. The annual operational energy use for each building is summarized by demand in the pie charts below.



BUILDING 1



BUILDING 2

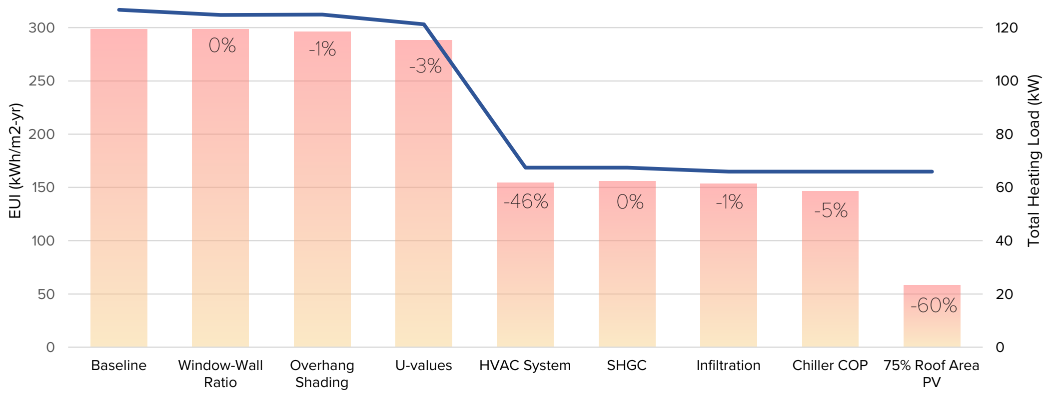


GYMNASIUM

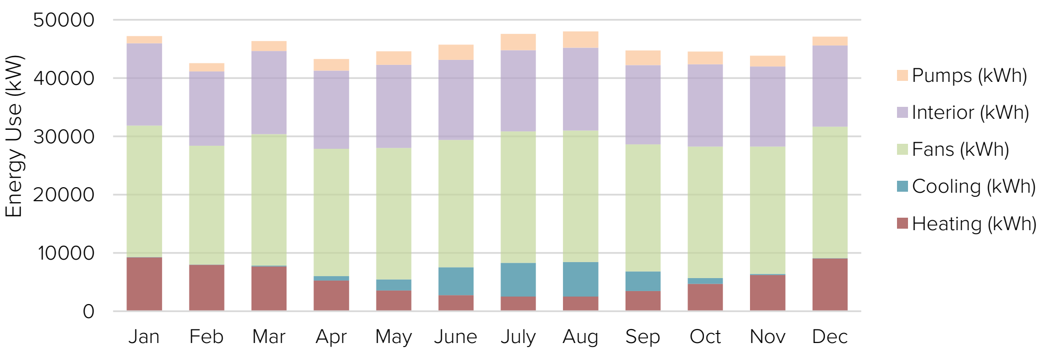
07 ENERGY MODELING

Results (cont.)

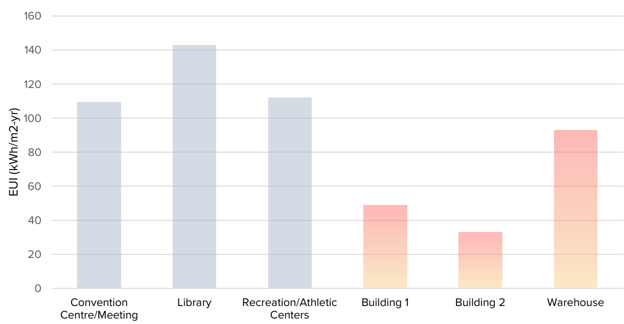
The graph below charts average EUI (bars) and total heating load (line) across the three buildings to see how each iteration improved the performance. The greatest impact came from using passive chilled beams with heat pumps and increasing rooftop solar PVs. Some of the iterations results in little-to-no improvement, but the changes were made based on design intent, like window-to-wall ratio and shading.



The graph below shows the total annual energy for all three buildings; an estimate of the project's total operational energy (total = 540,000 kWh). The highest demand come from heating and cooling.



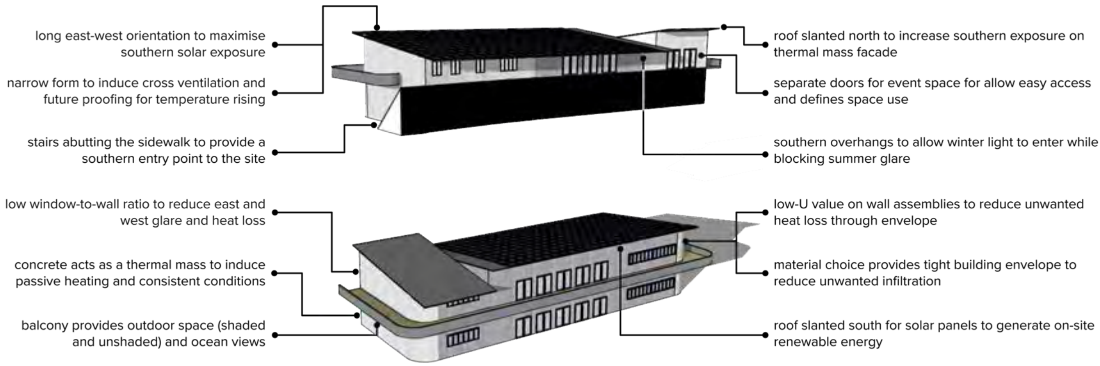
EnergyStar estimates the median EUI for public services to be between 90-150 kWh/m2/yr. The range pertains to the different programmes and their demands. The graph to the right compares the simulation results to EnergyStar's reported median. The project's buildings greatly out perform the typical values, between 25-75%.



08 BUILDING 2

Passive Design

After obtaining the results from the simulation to optimise passive techniques, a closer investigation was done for building 2. One of the primary focuses of the project was ensuring the buildings are well designed, so that their socially sustainable benefits are not outweighed by the environmental impacts of the new construction. Passive design was prioritised to work with the climate and reduce energy demand. The diagram below summarises the strategies used.



Using materials manufactured in Scotland provides many benefits. Not only does it support local businesses and a sustainable economy; it reduces emissions associated with transportation. Moreover, using vernacular materials ensures the materials work within the environment by providing passive gains like serving as thermal masses, reflecting or absorbing light, and carbon sequestration.

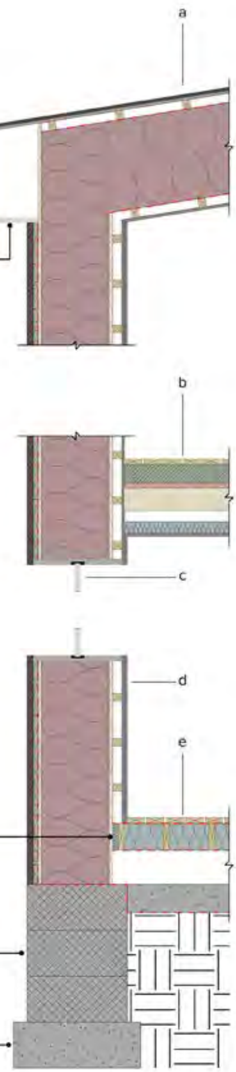
The chosen facade materials are a mix of western red cedar cladding and light-coloured concrete (shown above). Cedar was chosen due to is local accessibility, low maintenance, and small carbon footprint. In addition, its gray aging is commonly found on beach houses, celebrating the place and Granton's waterfront. The light coloured concrete with a stucco render was chosen due to its thermal mass capabilities, durability, and light-reflecting properties. High recycled content with fly ash and slag is specified to reduce embodied carbon further.

09 MATERIAL SELECTION

Wall Assembly

The photo below describes the wall, roof and floor constructions. Not only was low embodied carbon a criteria in material selection; performance, passive heating, tight envelope construction, and high insulation values were also considered.

The walls and floors can be modularly fabricated to reduce on-site waste, mitigate disruptions to the neighbourhood during construction, lower cost, and result in quicker erection. Modular and prefabricated assemblies also contribute to a tightly-sealed building envelope. This results in a less leaks and unwanted infiltration that reduce heating and cooling demands by keeping the internal conditioning constant.



Thermal performance and insulation were also a high priority when composing the wall and floor assemblies to reduce unwanted heat loss and gain through conduction.

The specified assemblies have the following U-values (W/(m^{2}K):

- Ground floor: 0.19
- Roof: 0.16
- Exterior Wall: 0.17
- Windows: 0.8

a. Roof
10 mm metal Roof
12 mm plywood
25x50 mm battened vented cavity
breather membrane
400 mm timber frame with mineral wool insulation
airtight membrane
25x50 mm battened vented cavity
15 mm plasterboard

b. Upper Floor
25 mm timber floor
85 mm base screed
20 mm sound insulation
100 mm timber floor slab
180 mm ventilation & utility void
50 mm mineral wool insulation
15 mm plaster

c. Glazing
triple pane
argon filling
low-E coating

d. Exterior wall
22-28mm rain screen
25x50 mm cement and battens
breather membrane
15 mm OSB
300 mm timber frame with mineral wool insulation
15 mm OSB
25x50 mm battened vented cavity
2 x 12mm plasterboard

e. Ground Floor
25 mm timber floor
vapour barrier
160mm timber joists with mineral wool insulation
polypropylene netting to support insulation
breather membrane
150 mm ventilation & utility void
150 mm concrete slab

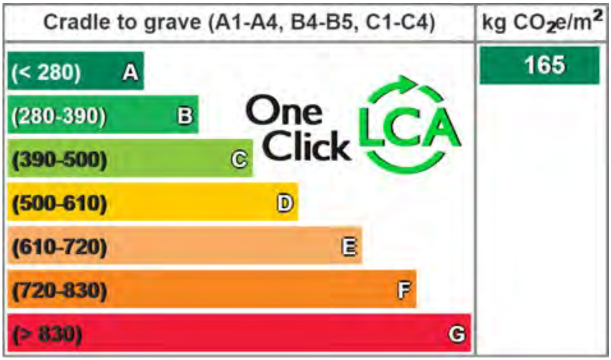
09 MATERIAL SELECTION

LCA

Embodied carbon is tracked through a lifetime carbon analysis (LCA). It measures the total embodied carbon of the building by obtaining the quantity of each material used and their individual embodied carbon, and summing the total impact. They can be used in the design stage to compare broad material choice, as well as which manufacturer is best fit for the project. Data bases of existing projects can benchmark by building type to create industry standards and measure performance.

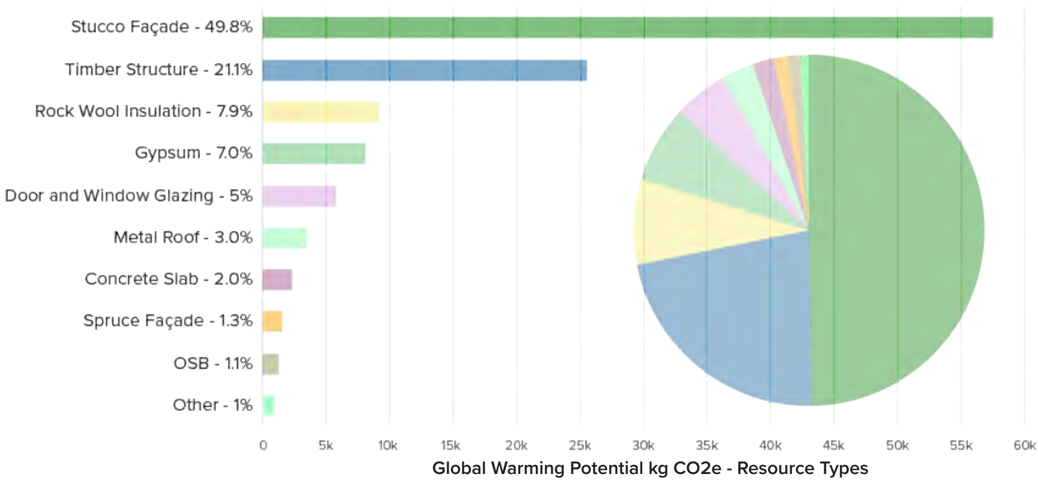
The United Nations Global Alliance for Building and Construction rating system benchmarks projects, so they can be compared on a uniform scale.

Based on the *2021 Global Status Report for Buildings and Construction,* Building 2 receives the highest A-rating.



Part of the LCA was measuring the impact of each material to see where the most effective improvements can be made. The concrete and stucco façade have the largest impact. Using innovative concrete that uses recycled materials is a possible improvement. However, its thermal mass properties have potential for operational carbon reduction

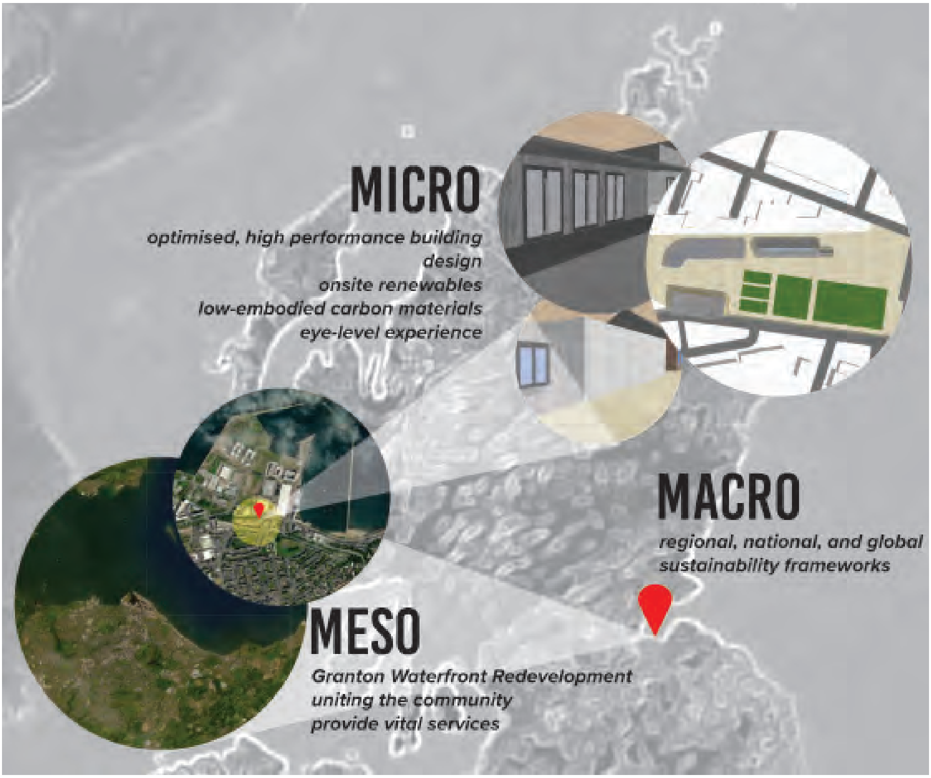
It is followed by the timber structure. The structural system usually accounts for the majority of the building's embodied carbon. If a concrete or steel structure was used instead, it would likely outweigh the stucco façade's contribution. Gypsum and insulation also account for a large portion. This is to due with the large quantity used, being a component of the exterior walls and floors.



10 HOLISTIC APPROACH

Macro, Meso, Micro Scale

The project contributes to the broader goals of *Granton Waterfront Restoration* and sustainable development aims of Edinburgh. The proposal laid out in this report is not a master plan, but rather a component in series of interventions created to serve the community at a micro scale.



The project addresses sustainability at three scale:

- **MACRO** (global, national, and regional levels): working towards organisational and governmental goals and frameworks.
- **MESCO** (community and neighbourhoods): Grandon Waterfront Development; community services; improving open space.
- **MICRO** (building level and human experience): building materials, construction, and performance; human experience on the site