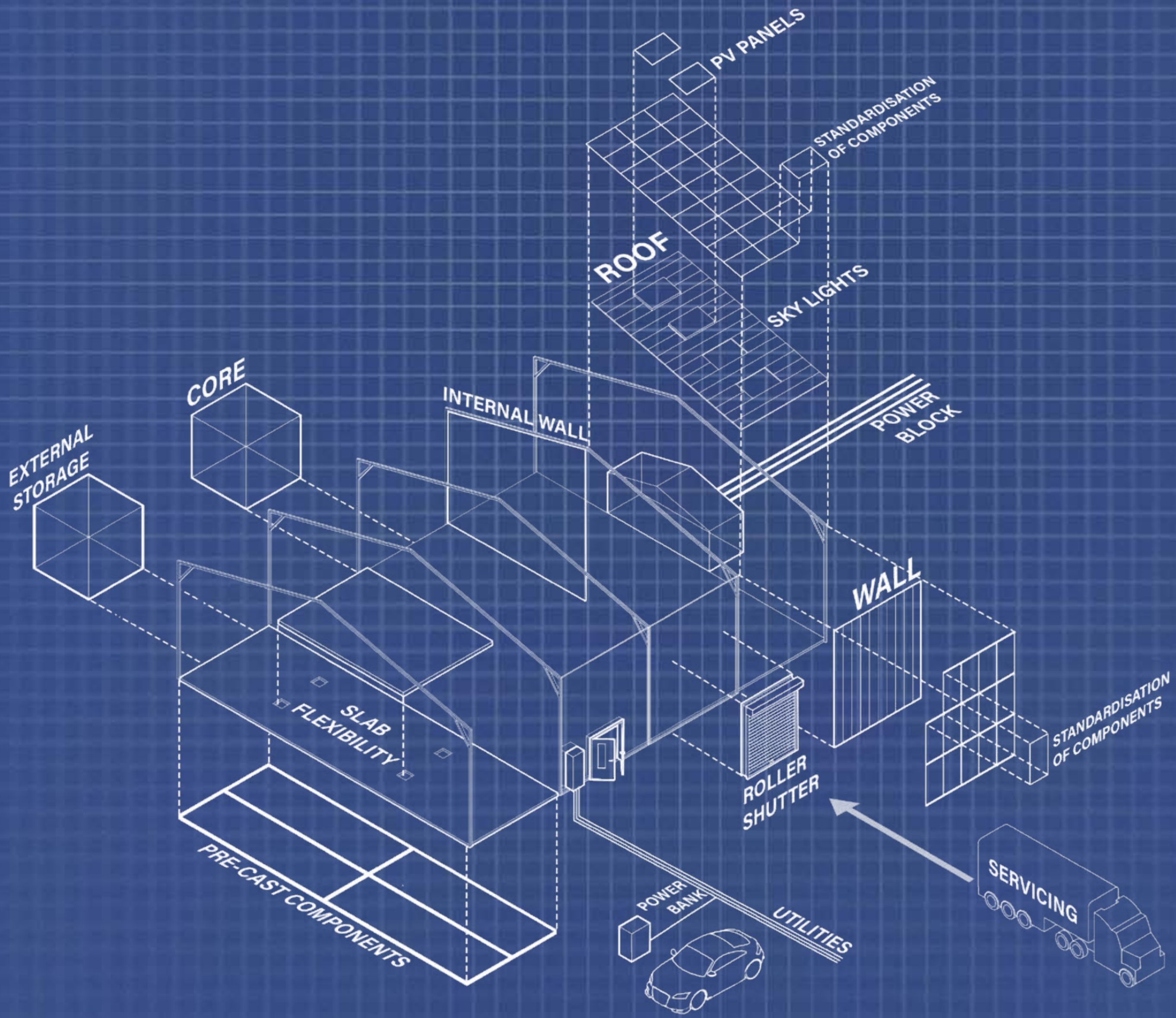
PORTAL

SCOTLAND'S INDUSTRIAL FUTURE



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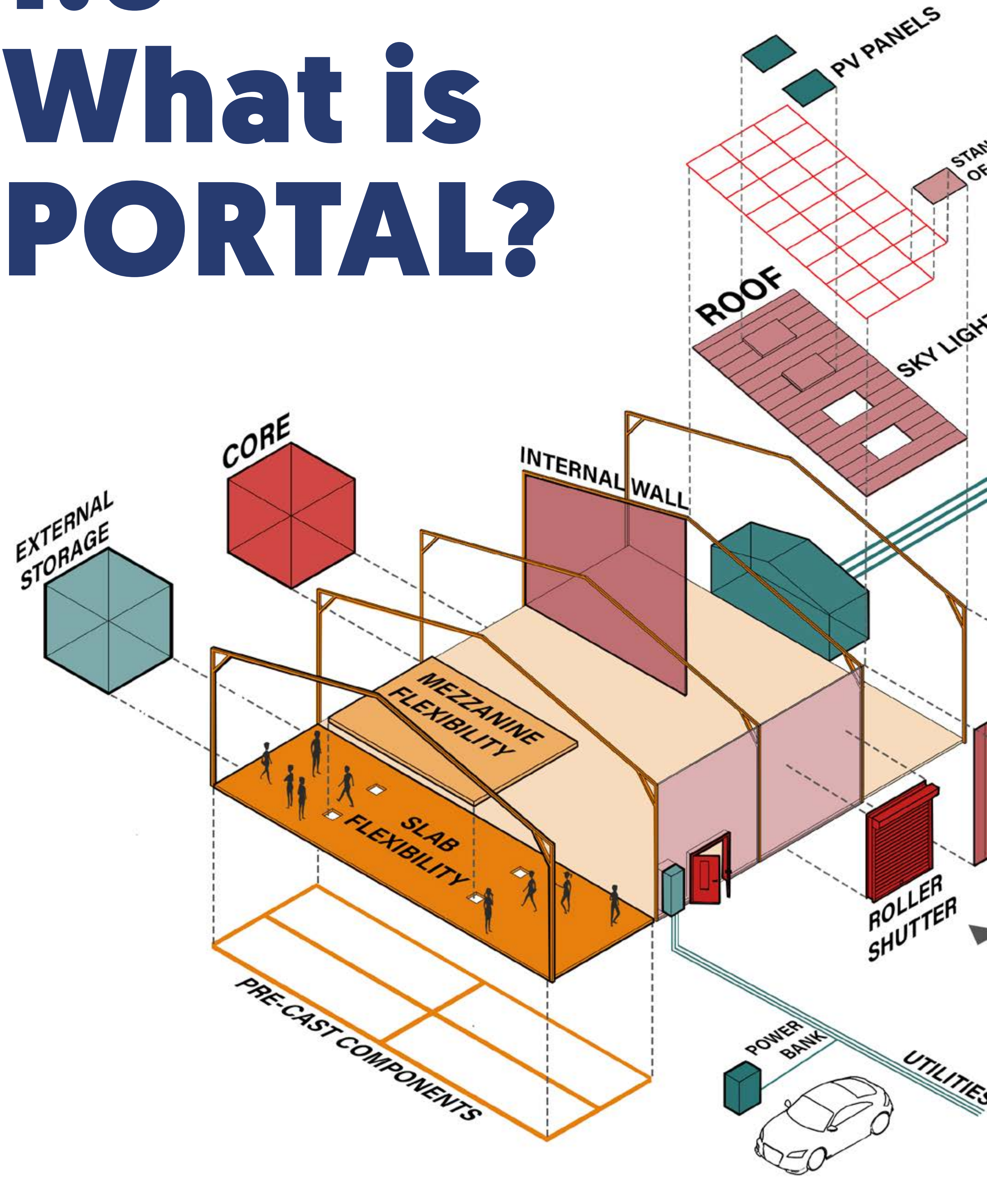
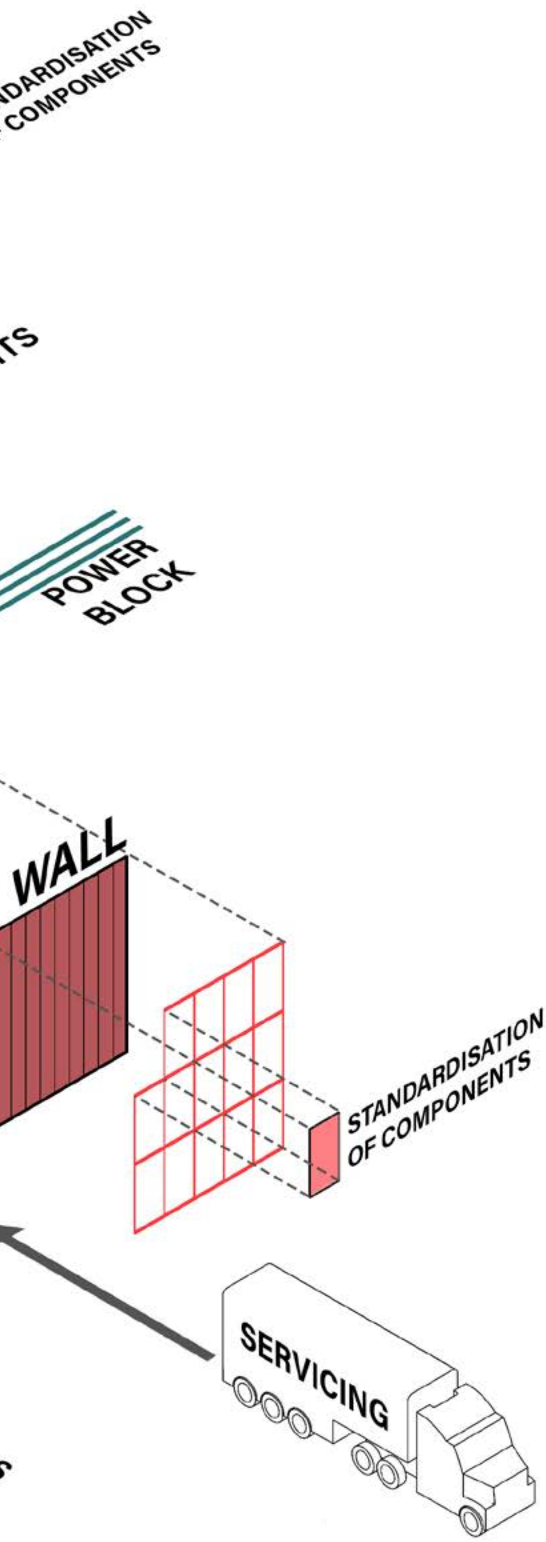
1.0 What is PORTAL?





The Context for PORTAL

The majority of industrial building stock in Scotland is now over 50 years old, no longer fit for purpose and reaching the end of its shelf-life.

At the same time Scotland, within a wider UK and global setting, is under pressure to re-think its construction industry to meet the global challenge of climate change and the Government objectives set-out in policies such as “Making Things Last” - the Scottish Government policy for a “circular economy strategy to build a strong economy, protect our resources and support the environment”

What is PORTAL?

It is within this context that Scottish Enterprise, Zero Waste Scotland, Construction Scotland Innovation Centre and their partners launch PORTAL, as a new-way of thinking about how we deliver quality industrial space and premises in Scotland.

PORTAL is an approach to building. Not a building solution. It is a product based on improving the value of our buildings while also taking positive steps towards meeting the challenges of the Circular Economy.

The PORTAL product is built around a methodology and toolkit that offers a staged approach to designing industrial buildings. We believe the approach has built in sufficient flexibility to offer value to both Public and Private sector investors.

The main user-audience is intended to be the Scottish SME market.

PORTAL is founded on:

- Delivering Circular Economy principles
- Redefining the concept of Value.
- Promoting the growth and development of Scottish economy and manufacturing.

A Staged Approach

The study recognises from the outset, that a target audience of Public and Private sector investors have wide ranging and differing objectives and business models.

For this reason the product is based on a simple 3- stage approach, promoted throughout the study, ranging from an “entry level” approach that can deliver immediate value while still embracing some key Circular Economy principles, all the way to a more committed approach that really focuses on long term values and more radical change.

Who Will Build PORTAL?

In the fullness of time, we believe all buildings should be delivered to LEVEL 3 and beyond.

However, we recognise that in the short term, the ability to commit to Level 3, or even Level 2, will be greatly tied to current commercial models and market conditions. We realise that, even where there is a will to embrace long term benefits and Circular Economy design principles, these need to be supported by the right policies and incentives and driven by the correct legislative infrastructure.

For this reason, we are not trying to position PORTAL as the single solution to every problem, but rather to stimulate and encourage a progressive evolution in our attitude towards design and building, focused on generating value.

Stage 1 – Lean Design
/ Be Efficient:

Ensure that the current market product is leaner and more efficient. As a minimum this step should reduce waste and the initial capital expenditure.

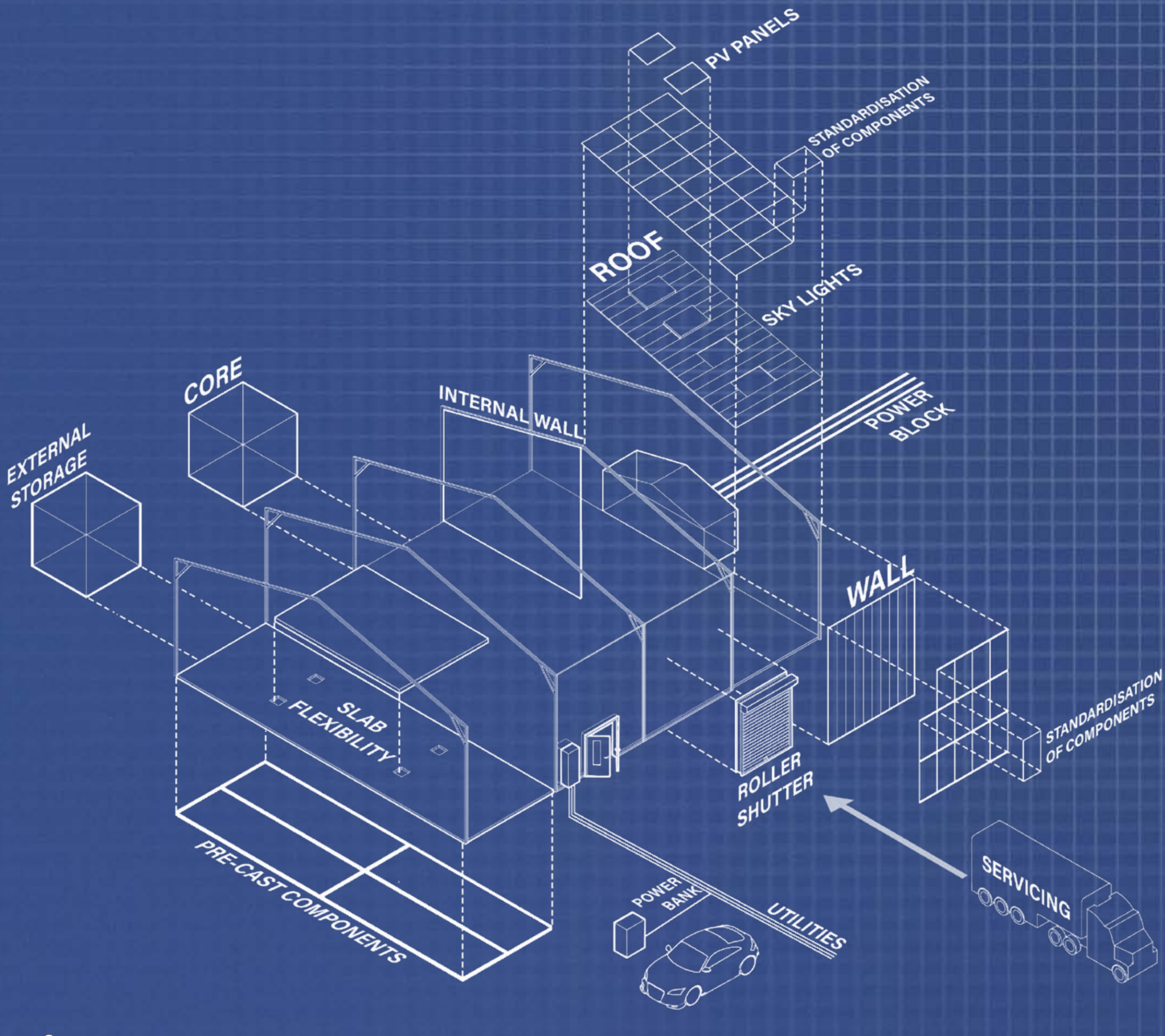
Stage 2 - Improved
/ Be Adaptable & Flexible:

The second stage is to trade savings generated in the first stage and re-invest them in the building. This will create a more adaptable building that will offer greater value for the same capital expenditure.

Stage 3 - Upgraded
/ Be Resilient:

The final stage is to look at a different investment model to create a product with an increased level of infrastructure and capacity. This product will be more flexible and adaptable for the market, and have a built-in resilience that will ensure a greater residual value.

2.0 Rethinking Value



Defining Value

Historically, and somewhat mistakenly, we tend to think of Value as Cost.

As such, the building industry is largely dominated by financial models that focus almost entirely on reducing capital expenditure.

While we recognise, and agree, that managing capital expenditure is of critical importance to any project, we also must recognise that reducing cost is not a guarantee of quality and will therefore impact Value.

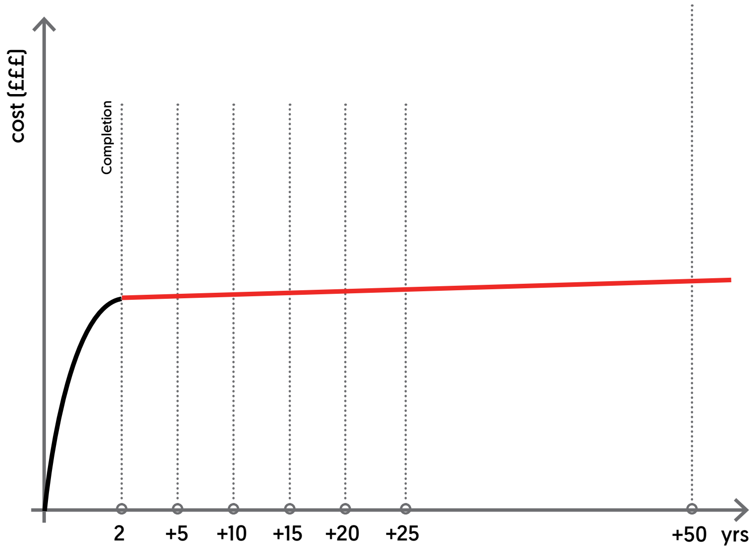
Redefining the Value Criteria: Cost, Quality, Time

If Value is a relationship between Cost and Quality, we must clearly define our value criteria to allow us to assess proposals objectively.

Within a circular economy, Value cannot be the 'cheapest way to build'. We want to avoid reiterating concepts that are widely and better explained in existing literature, and simply state that if we deliver a building around Circular Economy principles, we would need greater capital expenditure on day one in order to generate greater value over time.

Time is of course the third key variable in defining Value. One of the key factors influencing the approach to cost, will be 'cost ownership'. A key challenge to increased front-end expenditure is related to who holds the long-term interest in the building and its management, that allows the investor time to reap the rewards for their investment.

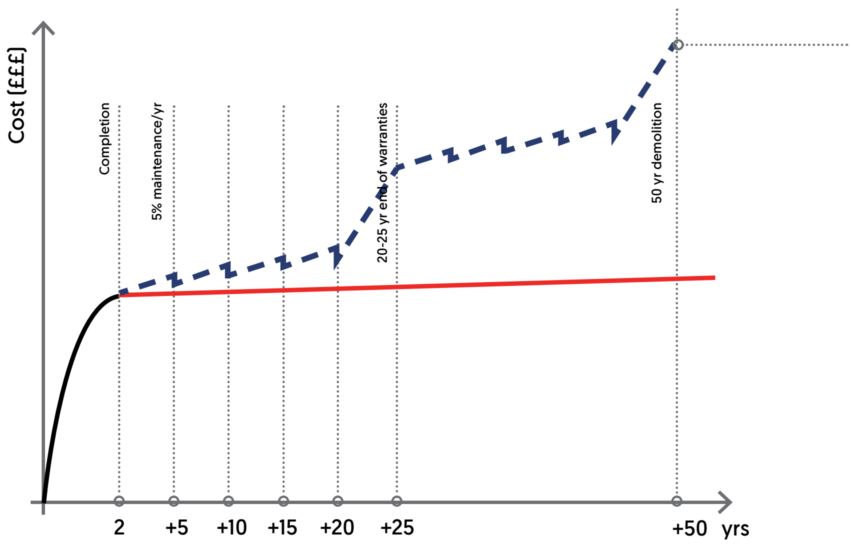
Cost & Trading Value



The diagrams on this page are a conceptual illustration of the Cost associated with a building over its lifespan.

Image 1 – Typical Cost model. Developer Cost (capital expenditure) and Tenant Cost (Maintenance).

- **Developer Capital Expenditure**
- **Tenant Running Costs**



Real cost to Landlord / Developer

Image 2 – Life-span costs. If we assume a 50 year life-span for a building, there is a lot more cost associated to take into consideration. End of lease costs and repairs, end of life replacement (M&E and envelope) and end of life costs (demolition).

- **Developer Capital Expenditure**
- **Lifecycle Costs (Landlord maintenance cost)**
- **Tenant Running Costs**

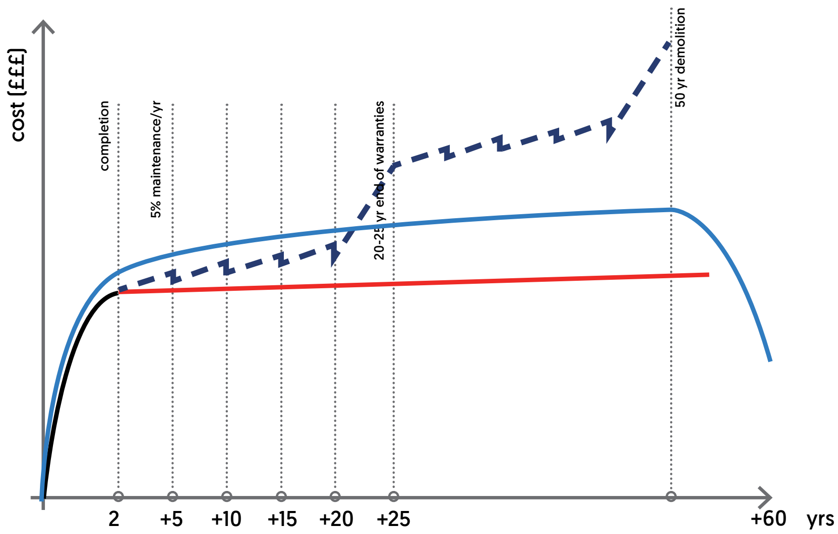


Image 3 – Trading value. Objective is to deliver a building that costs less over time and importantly retains greater value at the end (i.e. not be demolished, but re-purposed or de-constructed for re-use).

- **Developer Capital Expenditure**
- **Lifecycle Costs (Landlord maintenance cost)**
- **Tenant Running Costs**
- **PORTAL Cost Model**

Our approach to Value

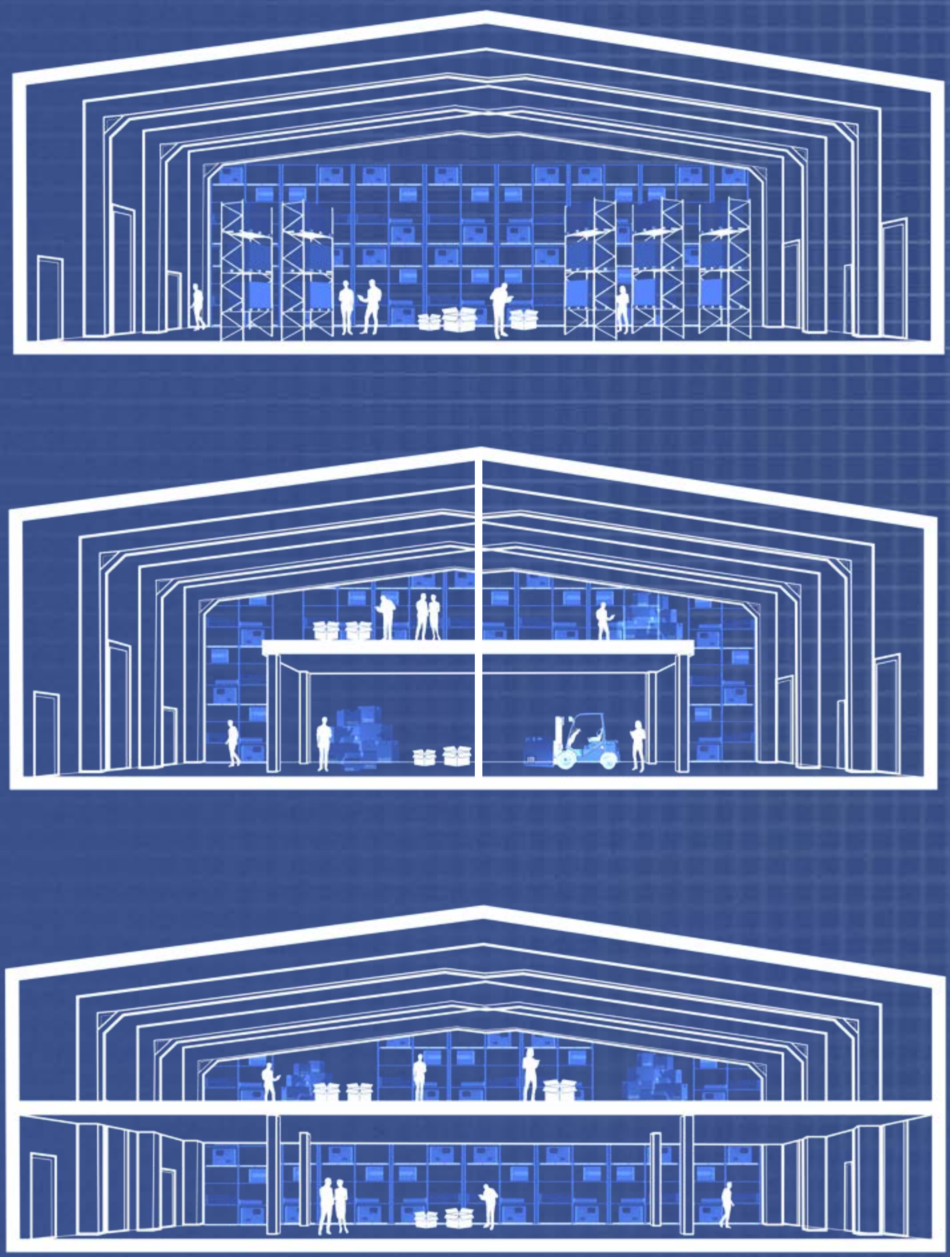
We believe that if we are to positively encourage investors to adopt Circular Economy principles, we need to demonstrate how we can build a higher quality product, balanced with cost and other commercial factors, to achieve greater value.

PORTAL aims to find this balance. It proposes an approach that demonstrates the opportunity to save on capital expenditure and proposes opportunities and ways to re-invest this in return for a higher quality product, hence greater value.

Our typical 3-stage approach aims to achieve Value at every stage:

- **Stage 1 – Lean design / Be Efficient:**
  Find opportunities to reduce capital expenditure
- **Stage 2 - Improved / Be Adaptable & Flexible:**
  Re-invest the savings to deliver a better product for the same cost
- **Stage 3 - Upgraded / Be Resilient:**
  Targeted capital investment to achieve long-term value/ benefits

3.0 The Right Product



An approach to building not just a building solution.

PORTAL sets out to define a set of principles to allow the development of buildings that are:

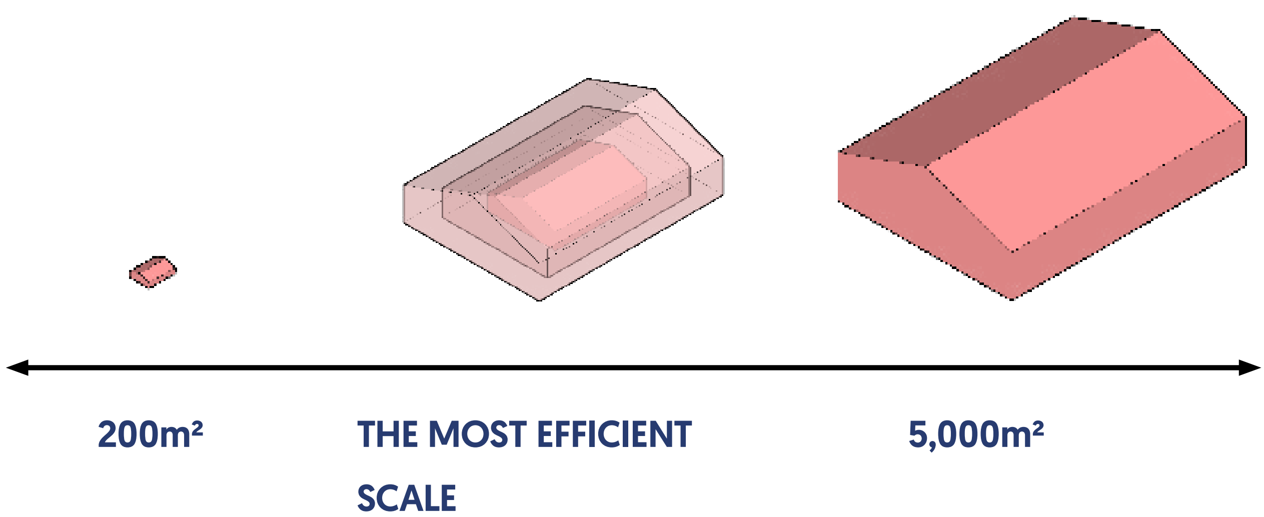
- Efficient In Form
- Offer flexible / easily adaptable volumes
- Rational in the approach to building services and energy as well as proposing new Landlord / owner driven approaches
- Setting out a methodology aimed at reducing and eliminating waste of building materials
- Future proofing the value of the asset, through the ability to re-purpose and expand the premises

3.1
Right Scale of Product

The PORTAL product is largely aimed at SMEs, the majority of which are up and coming enterprises. The premises need to facilitate initial business incubation and second stage growth. These SMEs are looking for an entry level unit size below the rates threshold, broadly equating to a size below 200m². This area represents a key module size from which to build on.

A 200m² standalone unit at one end all the way up to thousands of square meters at the other end are likely to be one off / bespoke briefs for very specific users.

To provide standard designs at each end of this spectrum is inefficient and impractical especially if we ignore the fact that site and client specific requirements will vary from project to project. PORTAL is based on the principle that there is an efficient range of building area and volume that can be brought to the market that offers the right level of flexibility to the end user and value to the developer.



3.2
A Change in Mindset

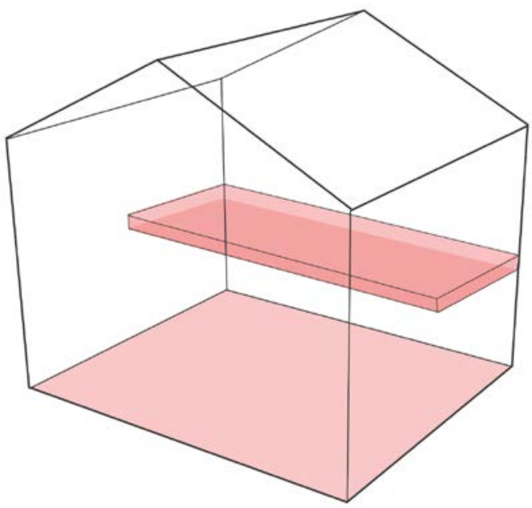
As part of the conversation on Rethinking-Value, we need to consider how this affects the scale and type of product.

Identifying the right building solution is only a first step. How a building is managed over the course of its life has a significant impact on the Circular Economy credentials of the design.

We should not focus on the cheapest build solution. We should focus on efficient buildings with long term value. To achieve this we need to rethink how we design, procure and manage the assets.

Efficiency and flexibility of buildings needs to be demonstrated to investors so that this is reflected in investment yield profile.

If the building is better suited to occupiers on a long term basis then this will lead to more rental security, lower vacancies and therefore more secure financial return.



Higher investment value will provide justification for a higher initial build cost or at least close the gap.

Developers & End-user – An inefficient relationship
Where the developer and the end-user are one this inefficiency is mitigated as there is longer term interest in the cost ownership issue. Where the two roles are separate however is where we see inefficiency creep in.

It is not within this scope of this document to address and propose solutions for many of these challenges, but we believe it is necessary to start the conversation.

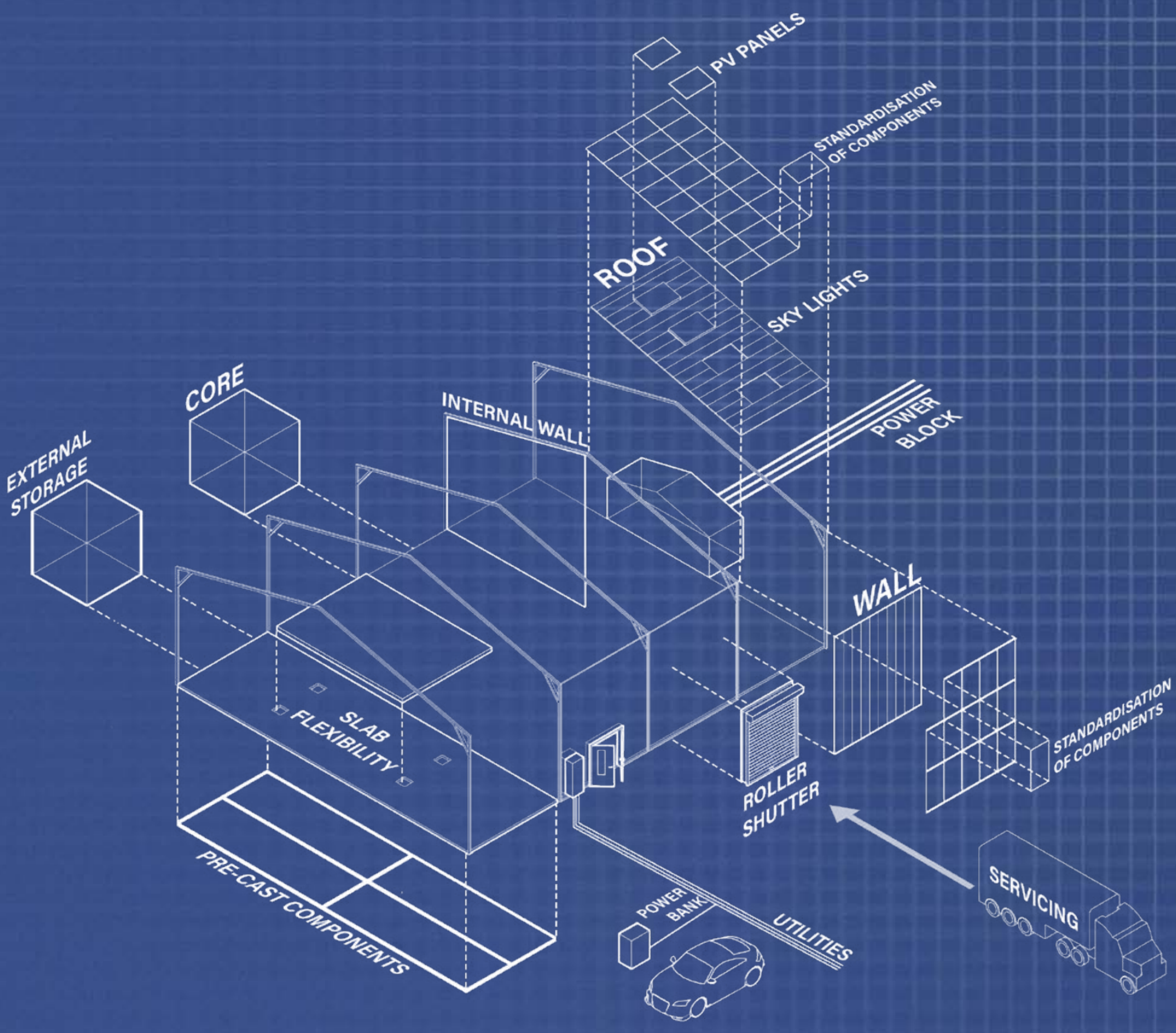
This study opens the discussion to those building elements that are directly related to the building itself:

- Volumetric Approach: Impact on development costs and rental value
- Increased Landlord works/reduce tenant interventions: quality control/waste reduction/ income generator
- Shared Ancillary facilities: efficient/waste reduction/income generator
- Landlord as services provider: efficiency and revenue streams
- Increased residual value of a building

Some of the areas of procurement and management that could benefit from further investigation, but are not covered in this study are:

- Building/asset management roles
- Rental models
- Material and product leasing models
- Statutory Efficiency (Planning, BW and Utilities)

4.0 How To Use PORTAL



An elemental approach

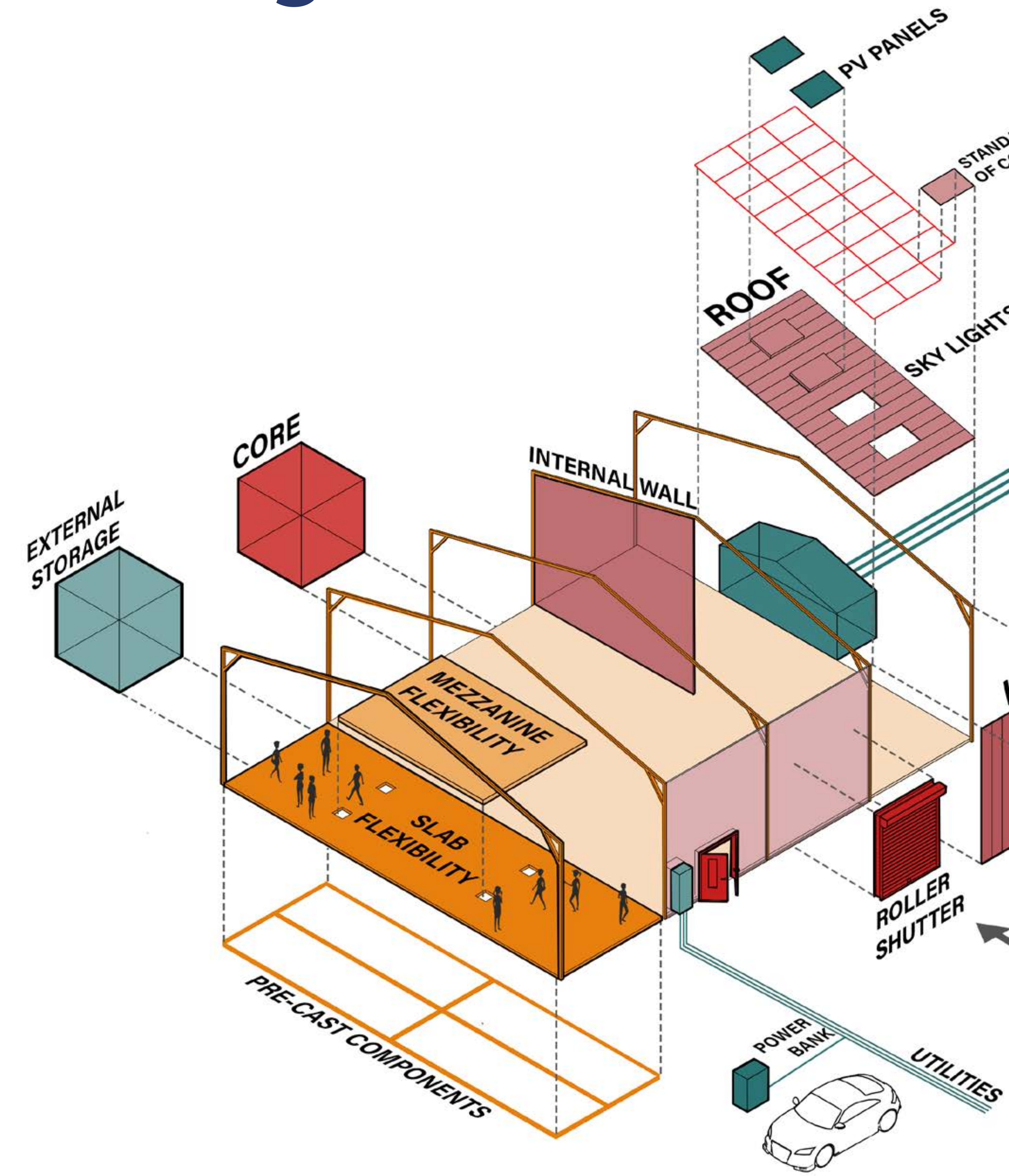
PORTAL is based on the principle that there is an efficient range of building area and volume.

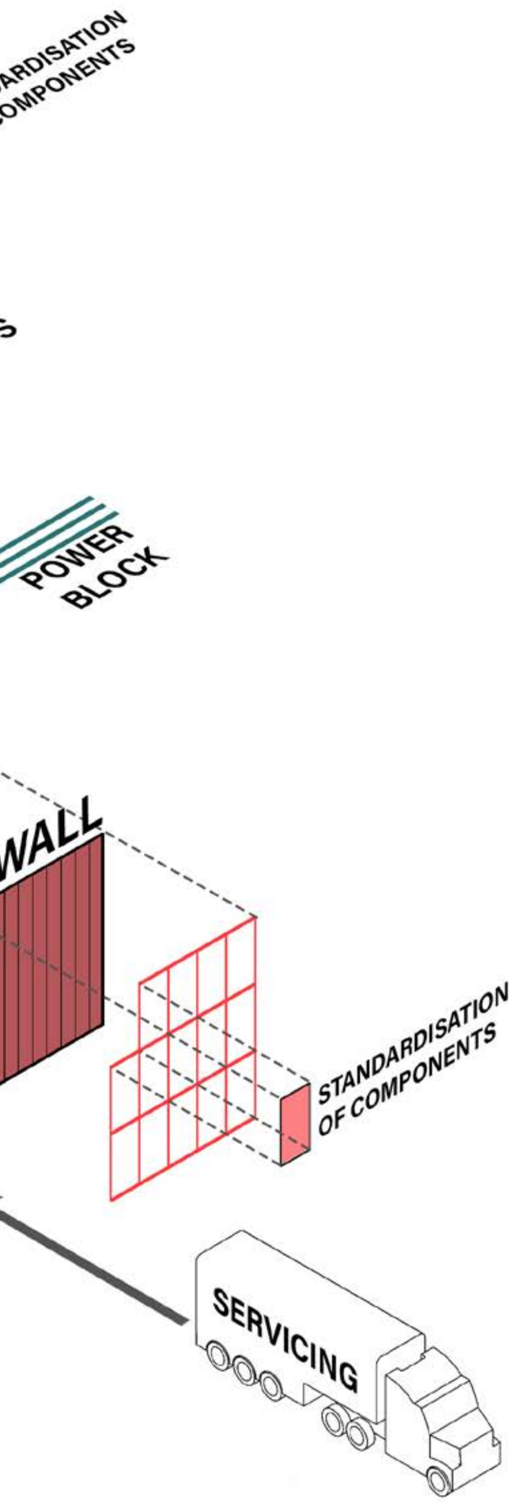
The methodology for PORTAL is to break a typical building down into its key elemental parts.

Each element is then broken down into a series of components / modules tied together within an efficiency range dictated by standard sheet sizes.

The result is not one or two defined building solutions but rather a set of rules and principles that can be used to deliver the appropriate solution to suit site and client specific requirements that will arise for each project.

4.0 A Design Toolkit





Structure

Flexible & adaptable

Structure is the most durable part of a building, "designed" to last at least 100 years. The structure of a building should be designed so it can be adapted and re-purposed throughout its lifespan. It is important that the right level of investment is made to ensure the long-term flexibility of the structure is achieved. Structure should be "over designed" and robust, not "lean" or inflexible.

Services

Energy efficient balanced buildings & future adaptability

PORTAL proposes a reduction in the level of servicing and adopts a warm air heating strategy that encourages a low carbon future. PORTAL also suggests an alternative servicing approach where the Landlord acts as the energy provider which generates revenue and keeps long term utility costs low.

Envelope

Sustainable supply chain & recycling

The guiding principle for designing the envelope for PORTAL is based on designing a solution that is efficient, standardises products and creates a modular set of components that makes the most efficient use of structure, minimising waste. PORTAL's envelope strategy embeds circular economy principles and proposes a credible solution that could be delivered using a local supply chain and existing technologies.

Cost

Re-define the cost cycle and value

PORTAL positively encourages investors to adopt Circular Economy principles, demonstrating how we can build a higher quality product, balanced with cost and other commercial factors, to achieve greater value. PORTAL aims to find this balance. It proposes an approach that demonstrates the opportunity to save on capital cost and proposes opportunities and ways to re-invest this in return for a higher quality product, hence greater value.

4.1
Form and Layout

An Efficient Product

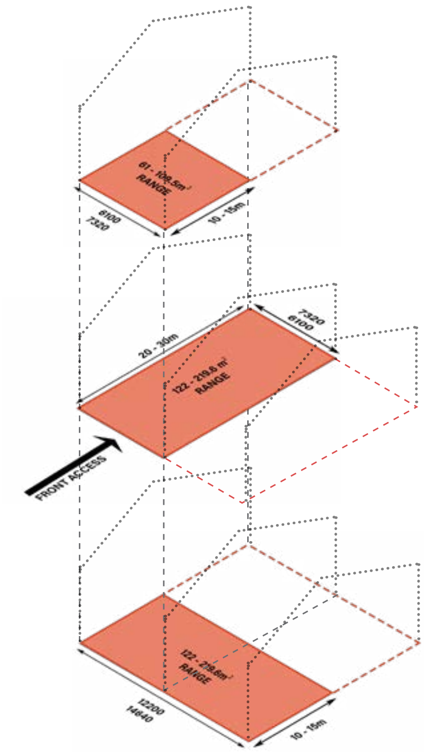
For the SME target market there are a number of different site layouts. Layouts are largely dictated by site, access, orientation and desired unit mix. At the site appraisal phase we should look to achieve the most efficient form on the site and layout.

Form

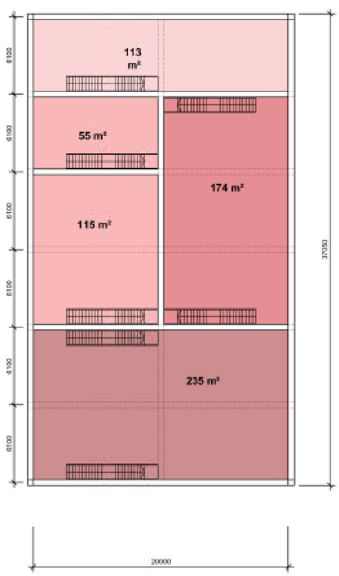
Too often we see unit layouts dictated by a simplistic interpretation of market / agency requirements, driven by the important requirement to let/ sell space. We compromise heavily at an early stage on efficiency of form.

Unit Size Flexibility

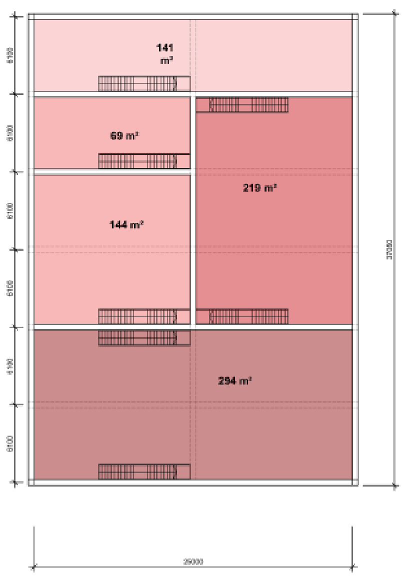
Using a range of PORTAL spacing and spans a number of unit sizes can be created under the one building envelope.



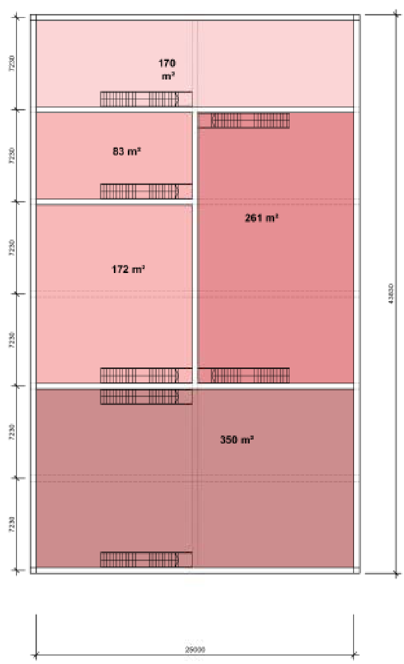
Unit mix example floorplans



Total Unit Area = 723 m²
(7782 sq.ft.)



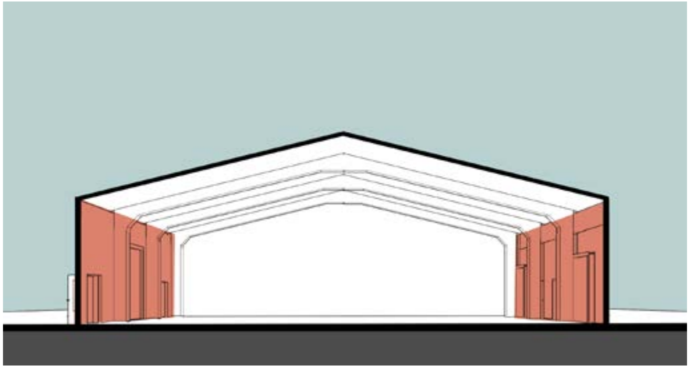
Total Unit Area = 904 m²
(9730 sq.ft.)

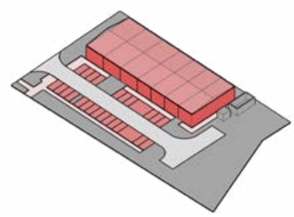


Total Unit Area = 1073 m²
(11549 sq.ft.)

Stage 1
Lean design / be efficient

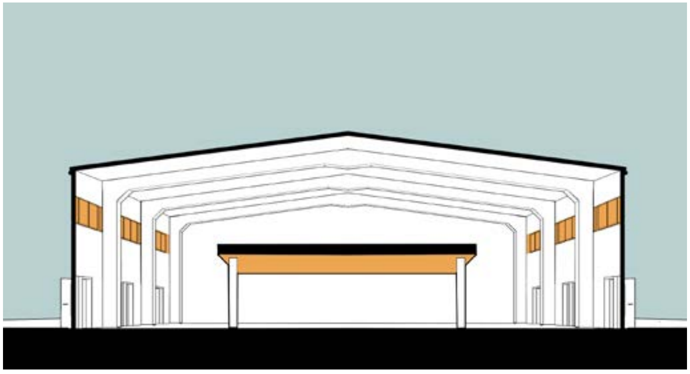
1. Balanced span and grid to generate single volume with good / varied subdivision capacity.

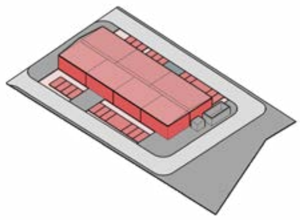




Stage 2
Improved / adaptable & flexible

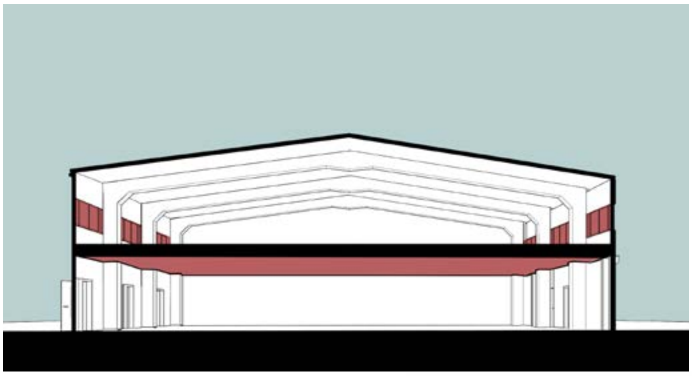
1. Efficient roof pitch to maximise / improve volume.
2. Volume should have ability to deliver mezzanine.
3. Improve site infrastructure to leave ability to future proof.

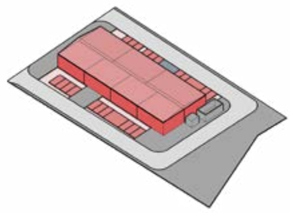




Stage 3
Upgraded / be resilient

1. Maximise potential volume and floorplate
2. Invest in residual value of buildings.





4.2 Foundations and Slab

Approach

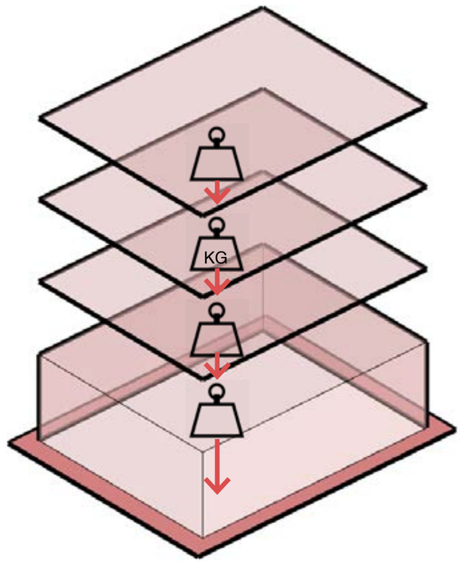
High Quality. Durable. Flexible

Industrial buildings are typically designed as single storey volumes with a high loading capacity in the structural slab / foundations.

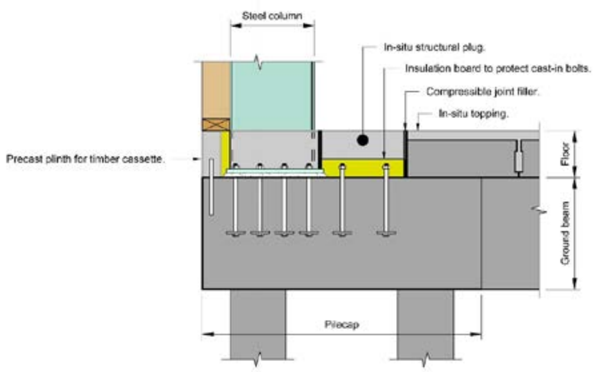
When designing slab / foundations for future flexibility we should consider the likely loadings of current and future requirements. To mitigate the need for any costly remedial works to the slab / foundations provision could be made for additional loads from internal partitions or mezzanine levels by means of slab thickening or by designing in additional capacity within piles, pad foundations or ground beams. To maintain an efficient frame any mezzanine structure should be independent of the main with a provision for point load distribution within the slab / foundations.

As change of use alters the requirement for below slab drainage, sufficient pop-ups could be installed to facilitate subdivision and pipe diameters/falls designed accordingly.

For the ground floor slab / foundations, the minimum specification should be able to accommodate the number of potential additional floors within the existing volume.



Designing for future slab flexibility



PORTAL column and future flexibility cast-in items within pile cap

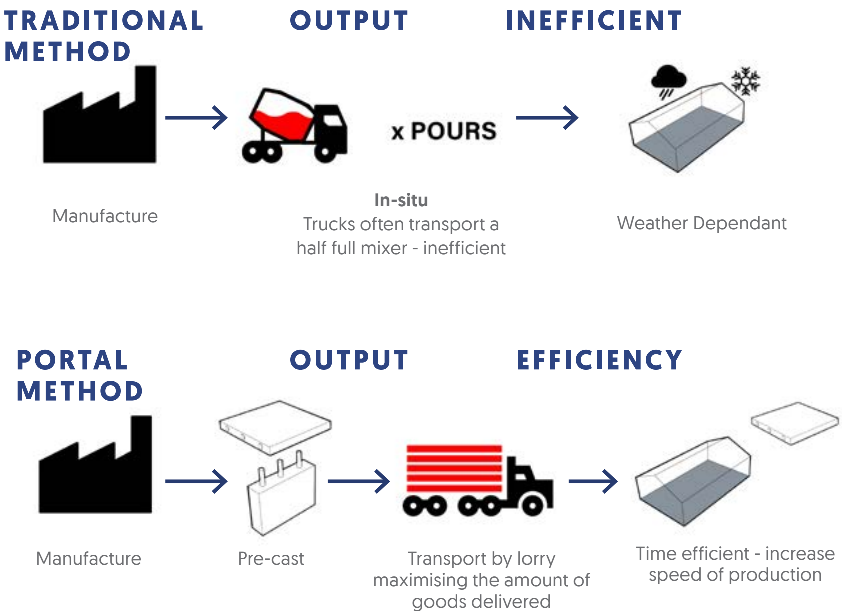
Stage 1

Lean design / be efficient

Promote the use of offsite slabs elements to:

1. Reduce waste
2. Programme efficiency
3. Quality and improved tolerances

Pre-cast "off the shelf" ground beams could then span between pile caps to support a pre-cast concrete floor system.



Stage 2

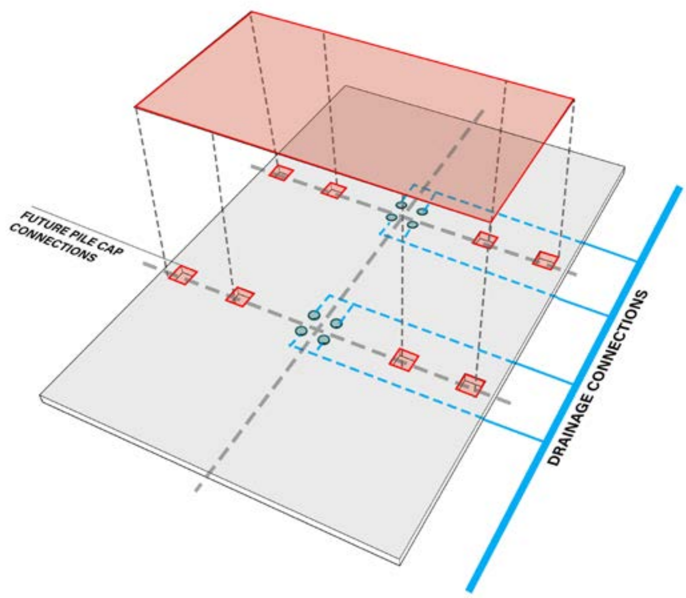
Improved / adaptable & flexible

"Over-design" slab capacity to allow for future repurposing of building. As industrial buildings tend to have very high loading capacity already this should not be a huge design & cost burden.

Stage 3

Upgraded / be resilient

Careful detailing of the slab will improve the ability/ease of retrofitting. We have considered 'plug-in' details to bring in secondary steelwork for additional columns/point load transfer. We also recommend installing drainage runs and pop-ups.



4.3
Frame

The Approach & Concept

Traditionally we think of structural efficiency as the 'leanest' structure we can design. However, structure is also the most durable part of a building, "designed" to last at least 100 years (compared to a typical 20-25 year life span of envelope and services). So arguably, the most efficient structure is the one that is the most FLEXIBLE + ADAPTABLE.

Form

The task is to enclose a regular rectangular space into an efficient volume. The most efficient analytical form is rarely the most efficient in terms of volume, buildability, adaptability or cost.

The use of portal frames for industrial buildings is widespread and accounts for 50% of steel construction in the UK. Their prevalence has fostered a desire to automate the design, fabrication and construction process.

PORTAL Frame Optimisation

What is structurally efficient may not be cost efficient for the overall build. Roof pitch, portal frame spacing, portal frame span and eaves height are the main variables that govern a frame's efficiency.

Roof Pitch

Studies have shown that as pitch increases the structural efficiency of the rafter increases, however; a steeper pitch means increased envelope and volume. The additional cost in the cladding would quickly outweigh the saving in steelwork. Then there is the likelihood that the cladding will be fully replaced at least once over the lifetime of the frame. As pitch increases, so does thrust from the rafters. The weight reduction is quickly offset by larger column sections required to control movement as the rafters are pushed outwards.

Portal Frame Spacing

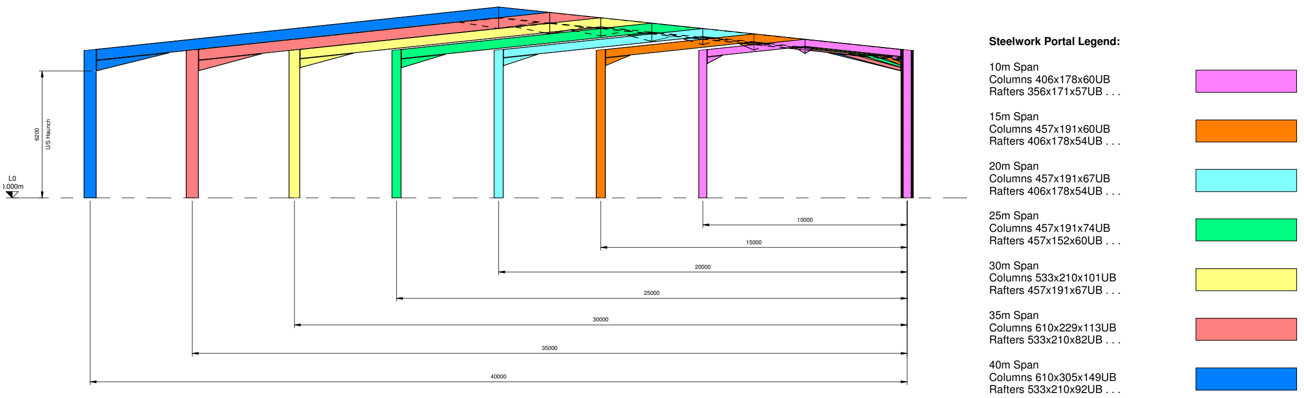
Portal frame spacings are primarily dictated by the structure spanning between portals; typically, secondary steel or cold rolled. Both provide restraint to main steel members reducing section sizes. Increasing frame spacing has implications for the design of other structural elements. To provide flexibility in the specification of secondary elevation structure/ panels, an optimum portal spacing would be between 6-8m.

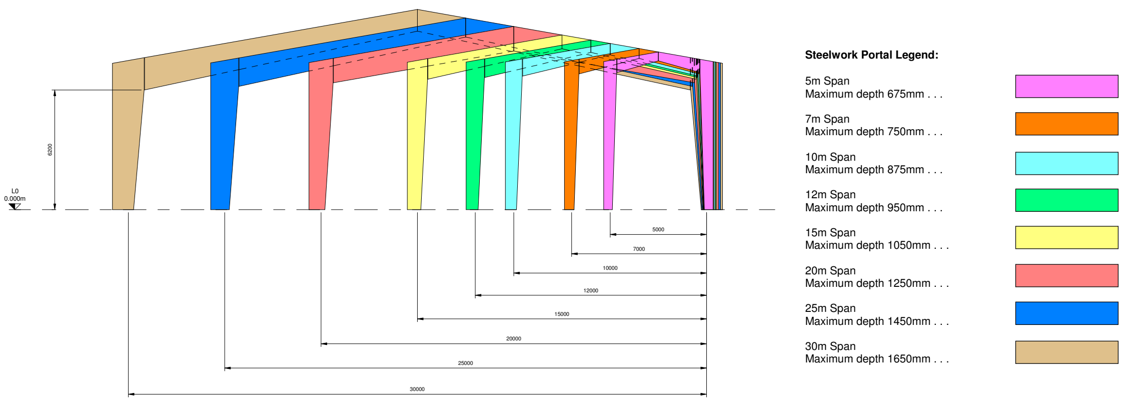
Height To Eaves

Height to eaves is dictated by intended use with consideration of future adaptability. Increasing frame height increases the surface area subjected to wind loads and reduces frame efficiency.

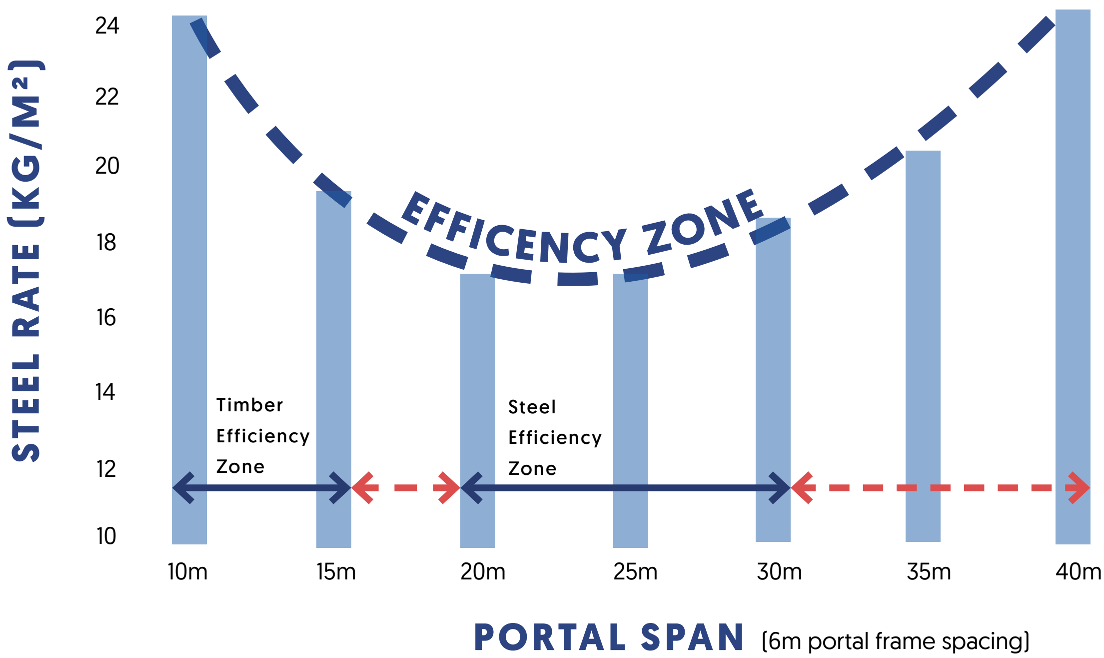
In order to decide on the optimum dimensions for each of the variables there is a need to first look at efficient volumes as dictated by the end user and future flexibility.

Structural Span Study





Structural Efficiency Graph

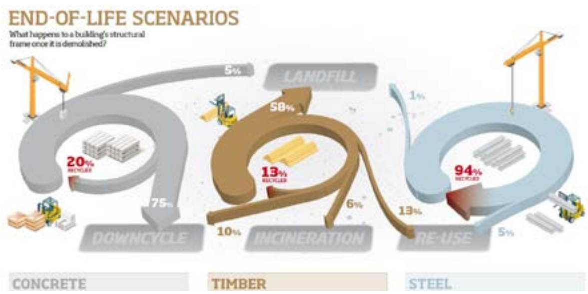


4.3 Frame

Structural Material Choice

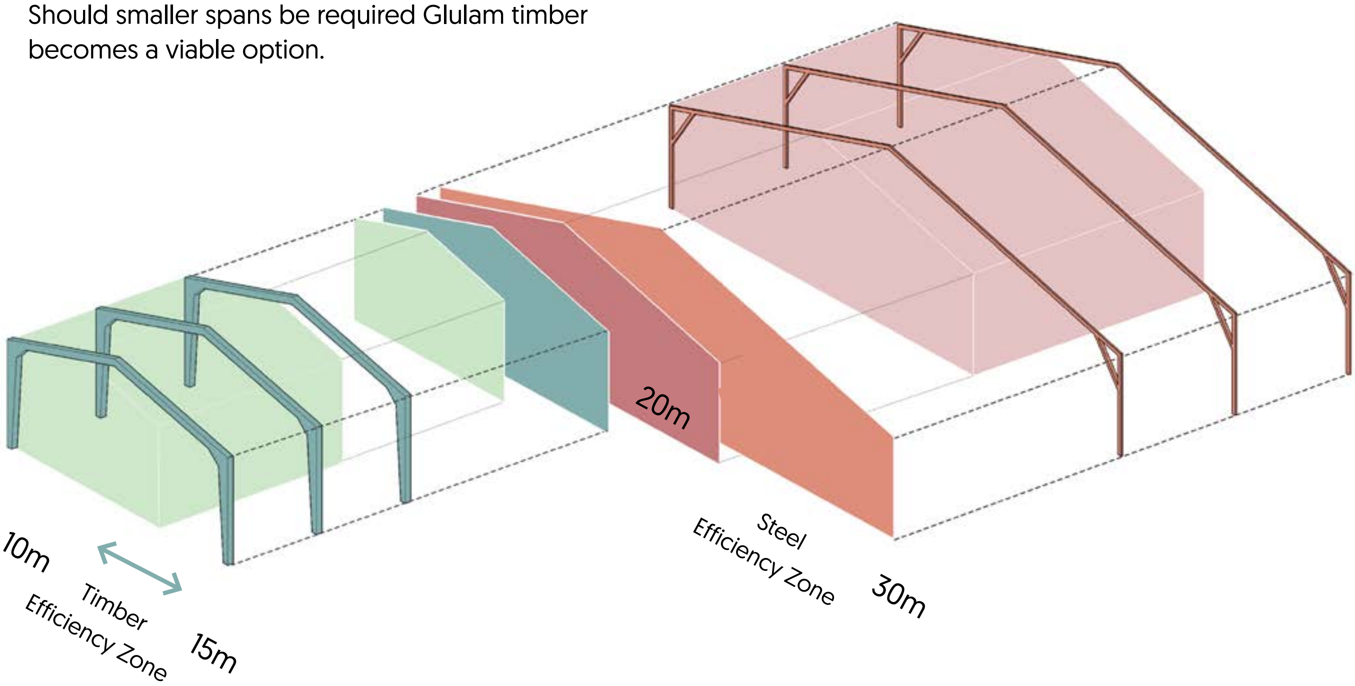
Both timber and steel are considered appropriate building materials, the selection of which is dictated by Portal span efficiencies. It is believed that steel's extended design life, adaptability and suitability for reuse negates any negative impact from the embodied carbon in steel production and recycling. Current building practices and material availability makes steel the more efficient option in terms of procurement and construction time.

Although Scottish Glulam timber is not grown locally it still utilises a Scottish workforce. Up scaling and increased demand may make timber a more suitable option for the future.



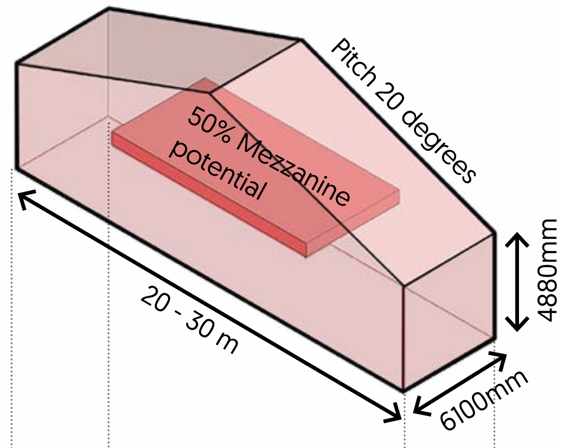
Span

Span efficiency is dependent on materials used for construction. Portal frame construction is predominantly steel. Studies have shown that there are optimum spans where steel would be the most efficient structure. These range between 20-30m. Should smaller spans be required Glulam timber becomes a viable option.



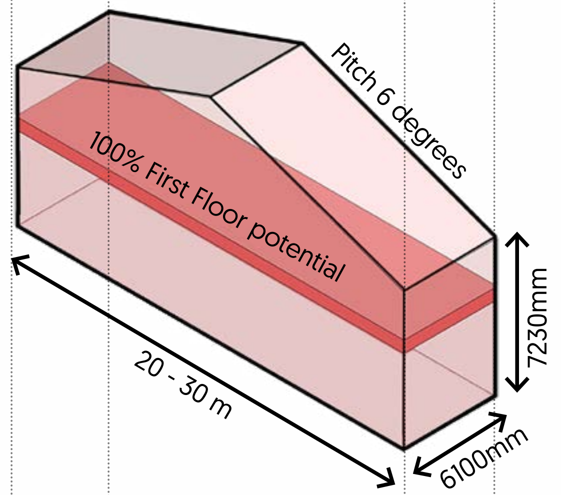
Stage 1
Lean design / be efficient

1. Balanced span and grid to generate single volume with good / varied subdivision capacity.
2. Volume should have ability to deliver mezzanine.



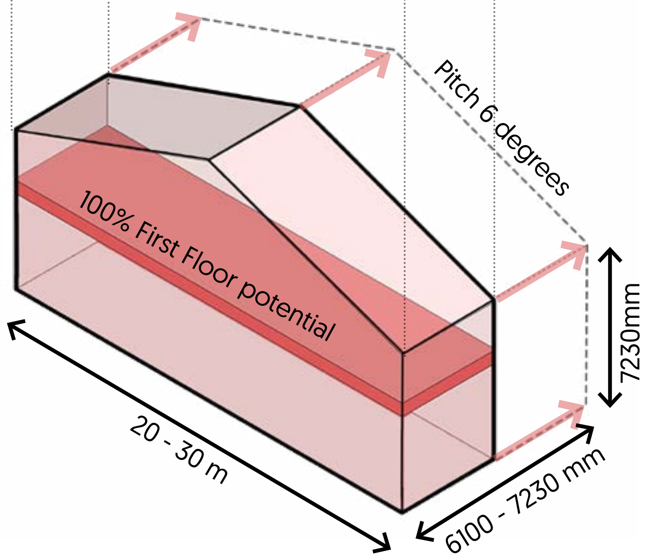
Stage 2
Improved / adaptable & flexible

1. Efficient roof pitch to maximise / improve volume.
2. Volume should have ability to deliver full first floor.



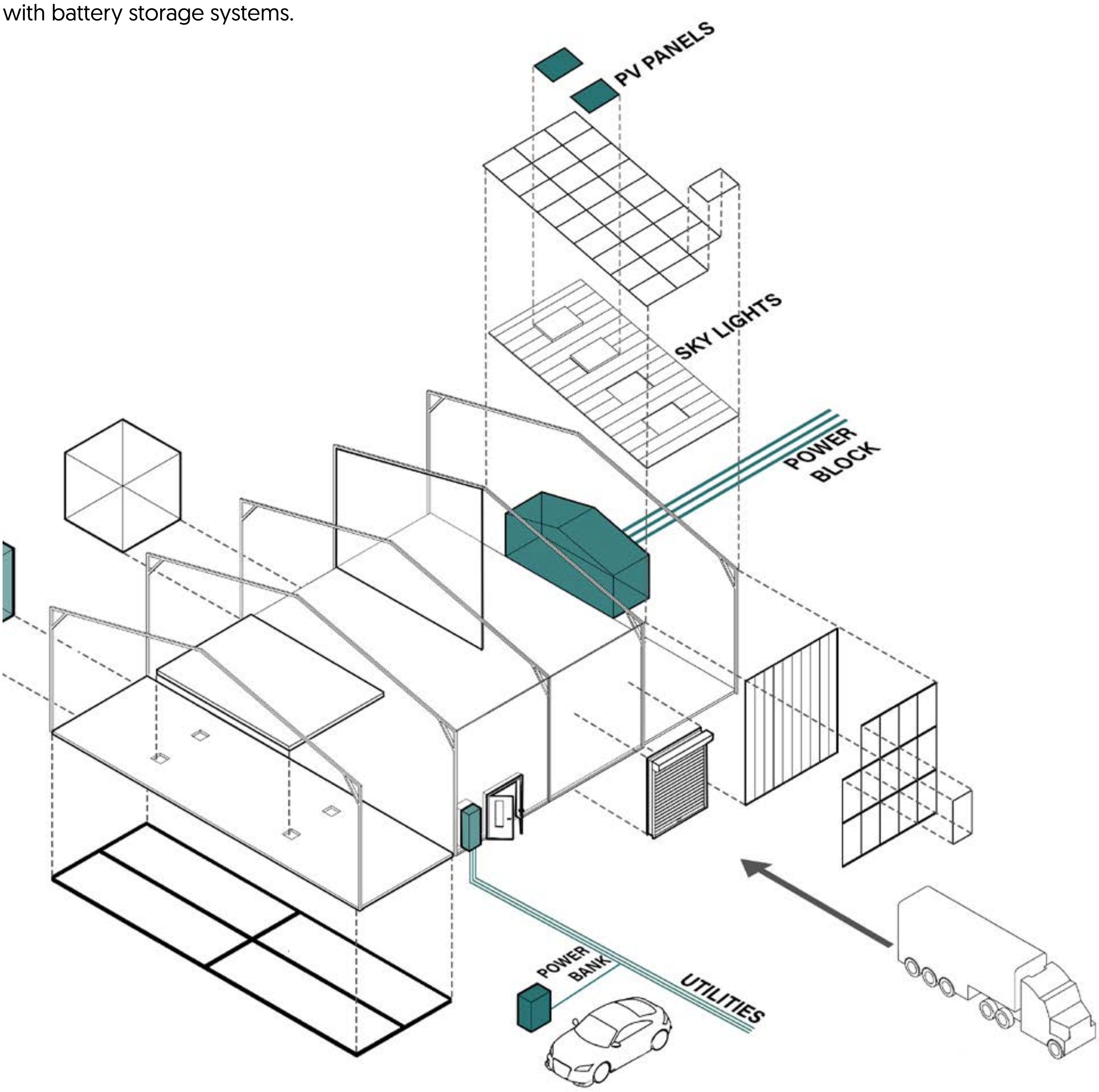
Stage 3
Upgraded / be resilient

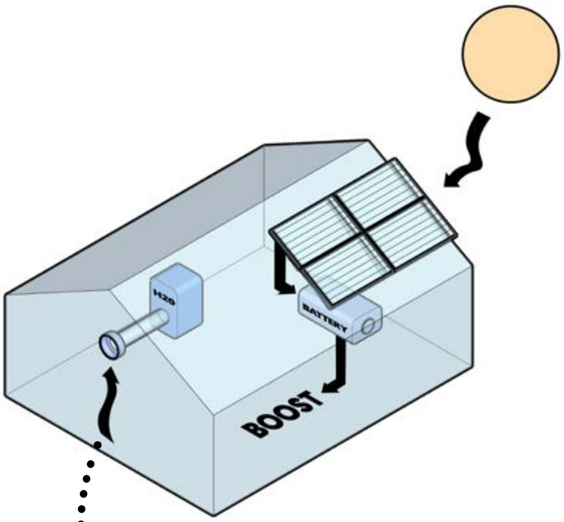
1. Increase portal span spacing to generate wider unit configurations.
2. Invest in residual value of buildings.



4.4 Services

PORTAL outlines a new approach to the design of an industrial unit within the context of the Scottish climate. Throughout this study the aim has been to form an environmental philosophy and strategy which responds to a low carbon future in line with the Scottish Government's national energy strategy. We have demonstrated means of self-sufficiency through the application of solar technology coupled with battery storage systems.



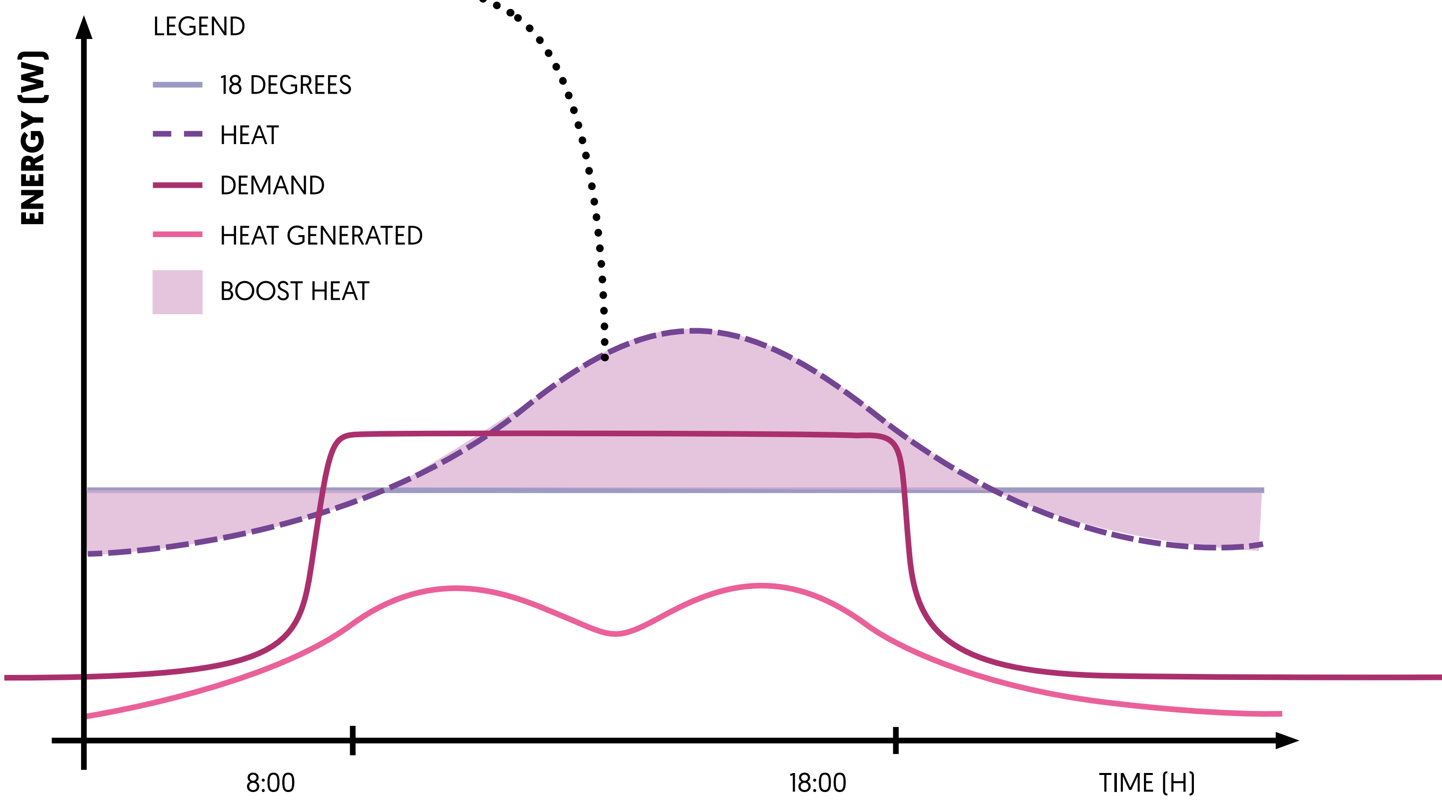


The Approach & Concept

The traditional approach to heating via means of warm air has been translated for the low carbon future. Using air source heat pumps and heat recovery devices powered by the clean solar-battery arrangement electrifies the heating process, removing local emissions and reliance on fossil fuels.

Improving the fabric and passive arrangements of the industrial unit is a fundamental first principle required to keep thermal and lighting demands as low as feasibly possible. Performance parameters have been outlined for consideration, however all buildings should be analysed on their own merits as some may respond better to passive solar heating or lighting than others.

The exchange of energy between other users demonstrates how the buildings of the future can in themselves become energy companies. Although legislation is still catching up in some aspects of this, great opportunity exists for local generation, use and sale of low carbon energy.

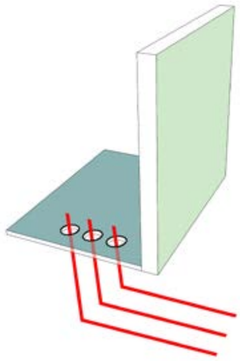


Stage 1

Lean design / be efficient:

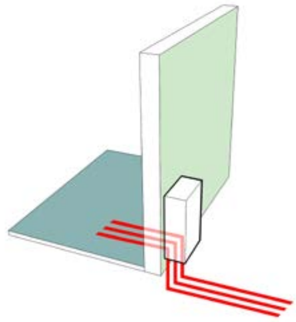
In the design of a shell unit we typically provide a connection to a single point within the unit for power, water and telecommunications. This is to ensure that we can start the fit-out as soon as possible without the typical delays associated with utilities. Once the first tenant has been established then the next unit is enabled with utility connections. This would be a progressive approach to minimise vacant fit-outs.

Traditional Servicing Entry Strategy



Services running underground and breaking through floorplate

PORTAL Servicing Entry Strategy

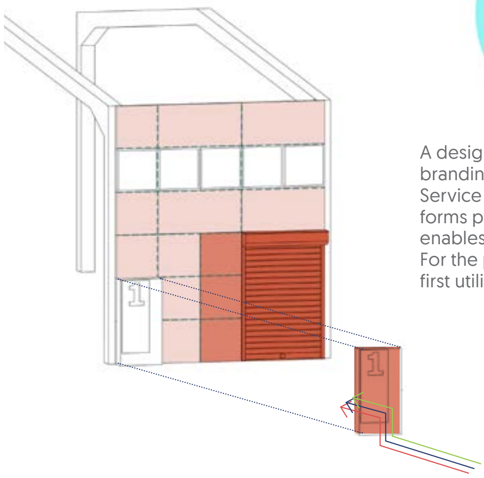


Services running through external utility box instead of breaking through floorplate

Stage 2

Improved / be adaptable & flexible:

The second stage is to trade savings generated in the first stage and re-invest them in the building. This will create a more adaptable building that will offer greater value for the same capital expenditure. In a fit-out situation which is typically agent driven we have a fully fitted space while utilities and the building services solutions would be established on day 1.



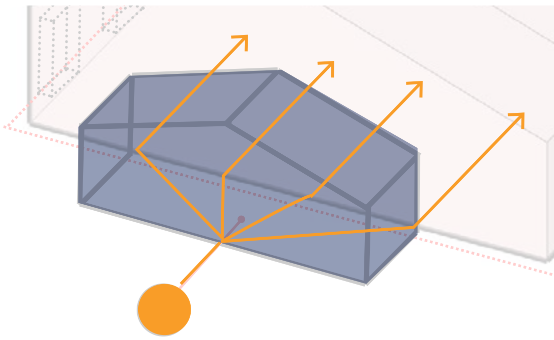
A design upgrade becomes a branding opportunity. Utility Service Entry Cubicle which forms part of the elevation which enables all utility connections. For the purposes of shell unit the first utilities are established.

Stage 3

Upgraded / be resilient:

We are suggesting an alternative approach for the PORTAL Model which is the Landlord acting as the energy provider which has potential to generate revenue and keep long term utility costs low. As part of the initial phase of works we would construct and install an energy centre connected to the utility network. This means that the Landlord has complete control over the fit-out programme and will be able to deliver services to units of varying size.

Landlord has complete control over the fit-out programme and will be able to deliver services to units of varying size.

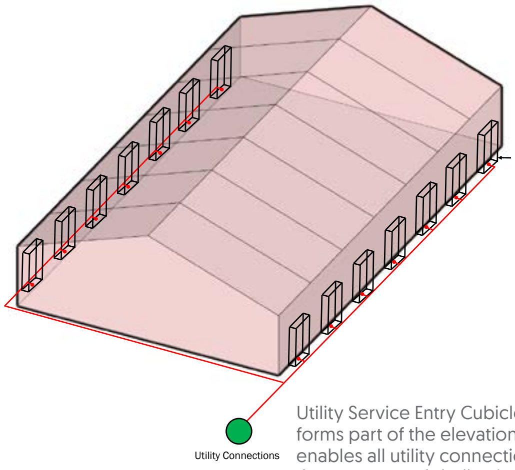


Advantages

- First tenant is enabled with utilities which expedites the fit-out process
- Ducting is fitted from the soft strip to enable future utility installation
- Waste is minimised as the services can be fitted to suit the unit size
- Equipment warranties and guarantees commence at point of fit-out
- Dilapidations assessments are easy as the cost for a potential fit-out would typically take the form of a contribution cost
- There is better scope for FRI leases as the plant would be new. This could limit the liability of the Landlord and reduces the sinking fund value

Disadvantages

- If there are two simultaneous tenants one would be delayed due to utility connections



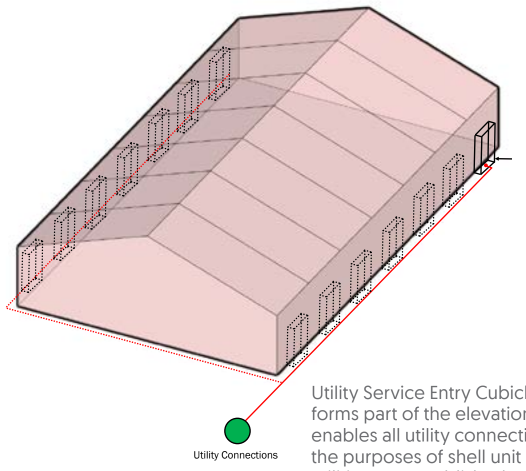
Utility Service Entry Cubicle which forms part of the elevation which enables all utility connections. For the purposes of shell unit the first utilities are established.

Advantages

- The space is ready for occupation.

Disadvantages

- Warranties commence as soon as handover is achieved. If the space is not occupied for a period of time then the warranty may run out prior to occupancy
- The fitted out space is not suitable in size or design solution to suit the tenant which leads to abortive base build spend and increases the cost of the tenant
- Dilapidations become more challenging as the modification to base build needs to be assessed at the end of the lease



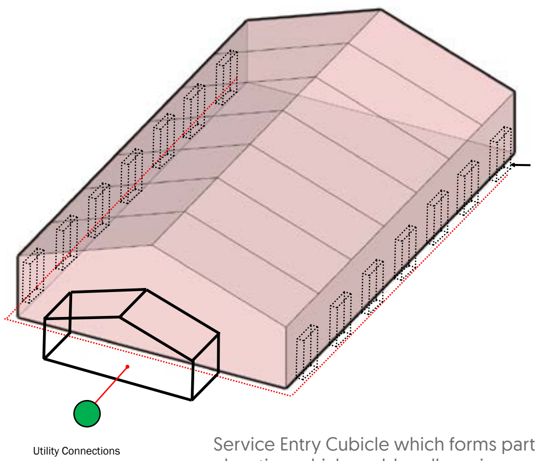
Utility Service Entry Cubicle which forms part of the elevation which enables all utility connections. For the purposes of shell unit the first utilities are established.

Advantages

- The space is ready for fit-out
- Long term revenue generation
- Low Carbon potentially Zero Carbon development
- Lower energy costs
- Zero Waste Solution

Disadvantages

- Higher Capital Costs
- Managed metering



Service Entry Cubicle which forms part of the elevation which enables all service connections. All connections will be taken from the energy centre at the appropriate time to suit the fit-out requirements.

The Energy Centre

The energy centre would contain the following elements:

- Main Switchboard with integrated tenant smart meters
- CT Meter for utility metering to the Landlord's supply
- Tesla Powerpack for energy storage so the Landlord is in control of taking grid power at an off-peak period acting as a top up
- Photovoltaic Inverter – This is to connect PV panels on the roof which generate electricity
- Telecom cable ducting
- AHU with integral heat recovery
- Hot Water Cylinder for heating boost
- Air Source Heat Pump generating low carbon heating and cooling within the AHU

Advantages

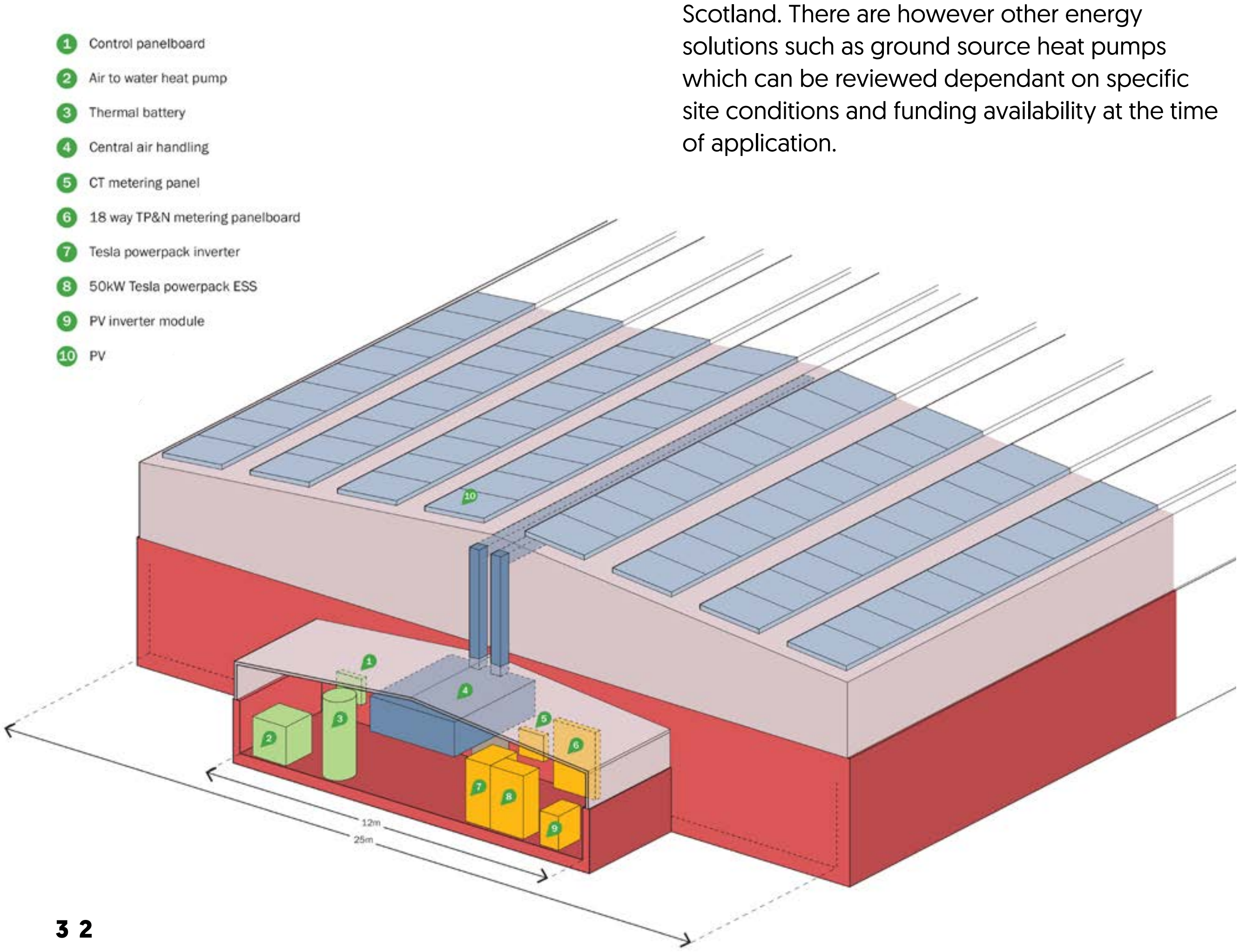
- The space is ready for fit-out
- Long term revenue generation
- Low Carbon potentially Zero Carbon development
- Lower energy costs
- Zero Waste Solution

Disadvantages

- Higher Capital Costs
- Managed metering

Alternative energy solutions

- This solution provided does not rely on grant funding and is capable of working anywhere in Scotland. There are however other energy solutions such as ground source heat pumps which can be reviewed dependant on specific site conditions and funding availability at the time of application.



Electrical price inflation

When we start to consider electricity prices and associated inflation, we find significant challenges for smaller electrical consumers; for example the average price business consumers pay in Scotland is 20.42p/kwh . When we apply this to our prototypical unit we find that the energy costs would be £6,680.00 for a 915sqm building. When we apply the most recent retail price index (RPI) of 2.4% this value increases to £11,016.00 in 25yrs time.

PORTAL energy solution

The Capital outlay for around 450 sqm of PV would be around £67,500.00 and by storing the unused energy in an ESS we can make use of all the electricity generated and put the funds towards a reduction in energy costs for the tenants. This also allows us to trade in off peak tariffs in the winter when the solar PV is not capable of delivering all our energy. Typically, an off-peak tariff would be in the region of 10p/kwh which is half that of the average price. The solution is based on one multi-unit building as a representative size; however, the energy centre is modular and can increase / flex to suit any site size.

The combined cost of both the solar PV and ESS is £107,500.00. The expected pay back period is 7 years with a positive profit of £384,581 generated by year 25.

The figures illustrated above do not include annual maintenance costs, however they clearly illustrate that the inclusion of PV and Battery storage is capable of providing quick returns on investment. The values provided above do not include any government incentives however there are a number of low carbon energy grants available, that if applied for, can potentially provide a shorter payback period.

4.5
Cost and Value

Materials & specification is a topic that requires to be expanded on in the context of value and cost.

While with form / layout, structure and services, it is easier to construct an argument to demonstrate the benefits of increased capital expenditure in return for increased value, it is harder to offer similar justification when trying to encourage increased capital expenditure in the building envelope.

Making the case for 'Circular Economy' cladding solutions.

The Matrix on this page sets out some of the traditional selection criteria we consider in specification (in blue). Performance criteria are important, but in an industrial setting, cost is a particularly critical driver. This makes masonry, built-up and composite cladding solutions the typical go-to options. Other products such as timber cassettes or CLT (cross laminated timber) are almost immediately eliminated on cost. However, if we were to expand this to include more Circular Economy criteria (in green), we believe we would soon see a shift it the overall scoring of less commonly adopted solutions.

It is unlikely that until there is a policy, legislative and financial regime (tax and/or incentives) that enforces and encourages these criteria, we will see a significant shift away from traditional products, unless the developer's own brief and motivations can support the cap-ex increase.

This is not an attempt to completely ostracise products currently available on the market where there are already many products and manufacturers that offer solutions which would fair well under circular economy criteria. However, it does stand to reason that as our industry is accepting it is inefficient and wasteful, that many other products are born of energy intensive and wasteful processes with poor recycling potential and we should be moving away from them.

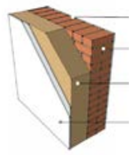
The Material Bank

A first incentive towards a change in attitude is the concept of BUILDING AS A MATERIAL BANK. This is founded on a simple principle of recycling materials. With raw products becoming increasingly more expensive, the idea is to ensure everything can be used and re-used multiple times. Therefore, if we think of building products as 'one iteration' in a material's circular life, we can see how they will retain a value and therefore be an asset for the building owner. As such we should be focusing on specifying materials and products that can be re-used or re-cycled.

Designing for Deconstruction, not Demolition

The above principle is not new. In recent years, demolition contractors are 'pioneering' waste management, downcycling and recycling. However, they are also governed by cost and opportunity and real recycling value mainly exists for metals, with mineral and timber products at best being down-cycled and many products like plastics and gypsum mainly destined for landfill. This alone is a complex subject and it is not within the scope of this study to explore it. However, where it is relevant is in connection with material choices, specification and how we put our buildings together. We should be giving careful consideration to how we assemble components, being careful to generate a methodology for dis-assembly.

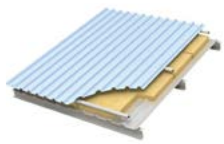
MASONRY



- **£80-£120**

(single skin facing block)

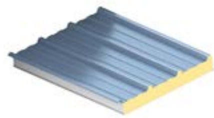
BUILT-UP



- **£60-£100**

(Twin ThermR wall system)

COMPOSITE CLADDING



- **£120-£150**

(Eurobond Rainspan)

- **£250-£350**

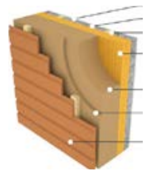
High end composite cladding (Kingspan Benchmark panel system)

TIMBER CASSETTE

- **£180-£250**

(Advice from Timber Market)

CLT



Price Varies

Depending on European market

Criteria	Weight	Masonry	Built-up	Composite	Timber Cassette	CLT
Traditional Criteria						
Cost (labour / material)	5					
Structural Grid	4					
Flexibility of Openings	2					
Second Structure	4					
Thermal Performance	2					
Air Tightness / U value	4					
Fire Integrity	3					
Ease of Construction	3					
Circular Economy Criteria						
Speed of Construction	3					
Designing for Deconstruction	4					
Built as Designed	4					
Marketability	3					
Manufacturing / Offsite	3					
Maintenance / Replacement	4					
Adaptability / Reuse	5					
Market Availability / Capability	3.5					
Provenance / Supply chain	5					
Recyclability	2					
Embodied Energy	3					
BIM credentials	3					

Note: the criteria and weightings in the matrix are for illustrative purposes only. They have been developed by the project team for the purpose of discussion and to illustrate a concept. Future detailed development of cladding and envelope solutions would be an opportunity to refine and properly test this approach.

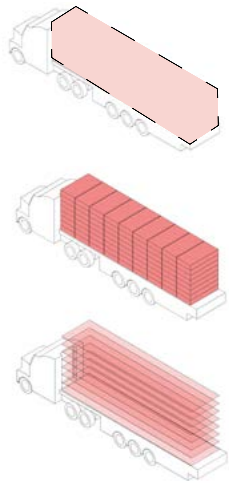
4.6 Envelope Modular Design

Regardless of the conversation on material choices and specification, PORTAL proposes an approach to envelope design that is already achievable with current products and technologies.

For efficiency PORTAL has set a standard grid on its buildings of 6.1 meters (see section 4.8 for rationale). We recognise however that it may not always be possible to adopt this envelope solution for a number of reasons, eg. budget restrictions or site restrictions and we further recognise that as materials and technologies develop, more robust and efficient solutions may become available that are more cost efficient and better aligned with the challenges of a Circular Economy.

The diagrams on this page illustrate the principle of creating a suite of modules and components using very few standard products. This example is further developed in the next section, but the key principles are to:

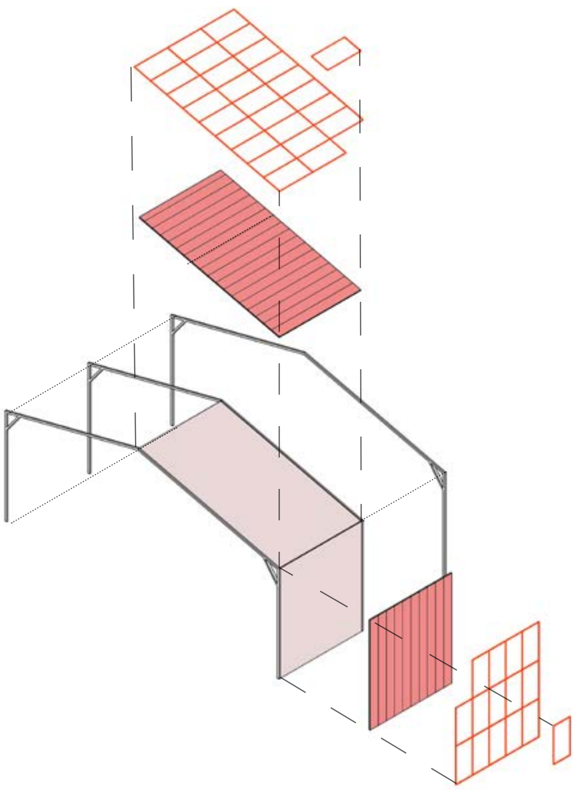
- Use standard size components as base modules
- Design for off-site manufacturing and efficient deliveries
- Standardise details and interfaces
- Increase quality
- Design for disassembly and re-use.
- Achieve minimal / zero waste
- Integrate secondary components



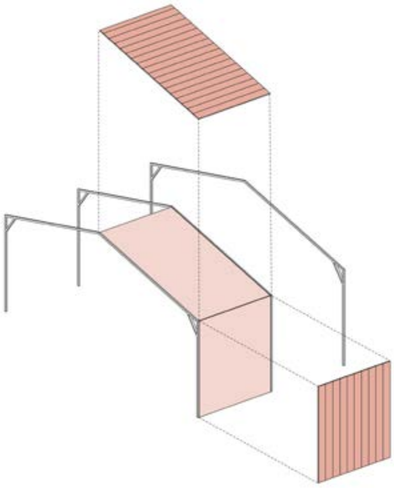
Maximum truck dimensions

Width: 2.55m
Length: 12m
Height: 3m

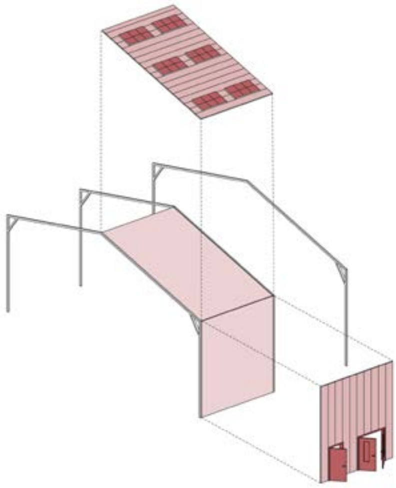
Maximum load
8 x 9 sheets



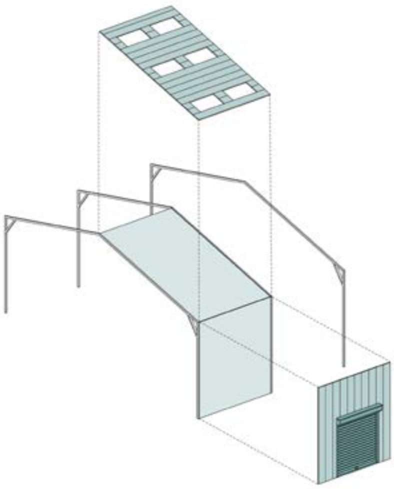
Blank roof and wall



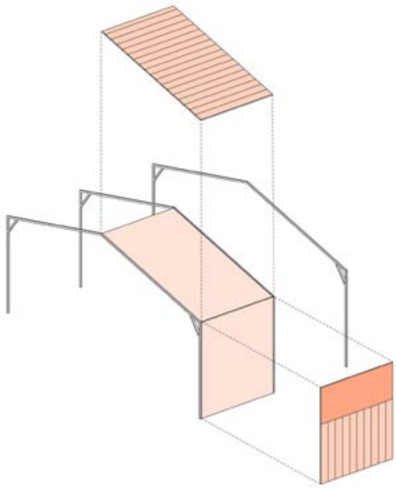
Door Thresholds



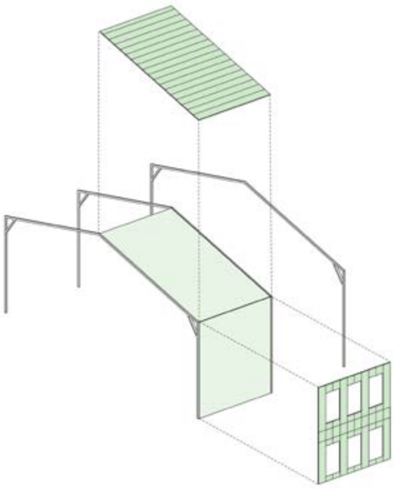
Roller Shutter



Clear storey



Commercial flexibility

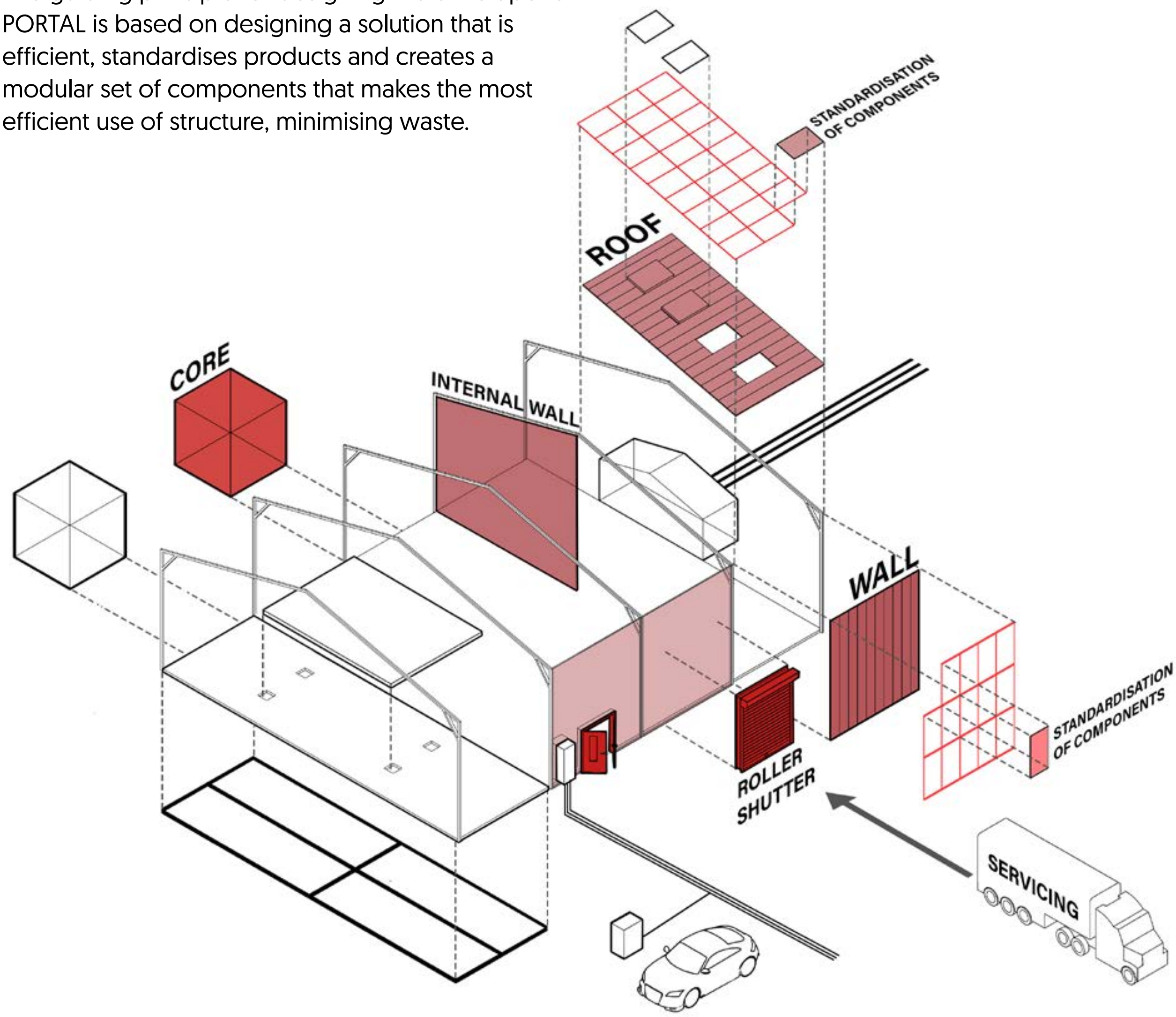


> **"At its core, a circular economy aims to design out waste. Waste does not exist: products are designed and optimised for a cycle of disassembly and reuse."**
>
> **World Economic Forum**

4.7 Approach to Envelope

Approach

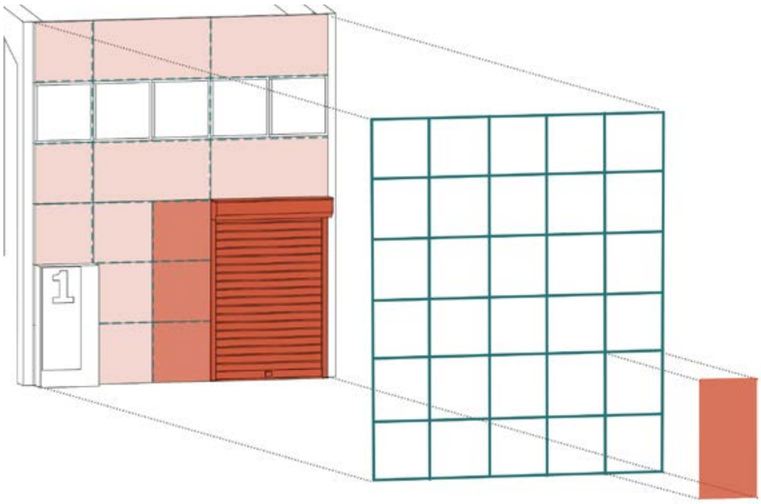
The guiding principle for designing the envelope for PORTAL is based on designing a solution that is efficient, standardises products and creates a modular set of components that makes the most efficient use of structure, minimising waste.



Stage 1

Lean design / be efficient

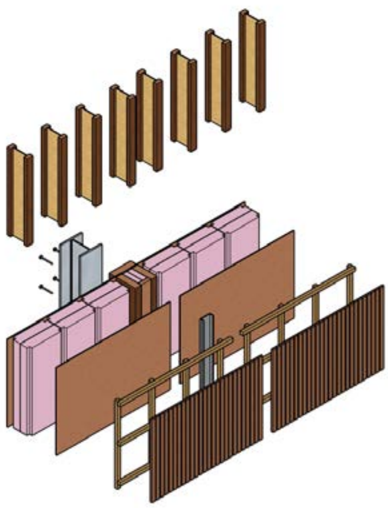
1. Standardise components to encourage efficiency.
2. Programme efficiency quality and improved tolerances.



Stage 2

Improved / adaptable & flexible

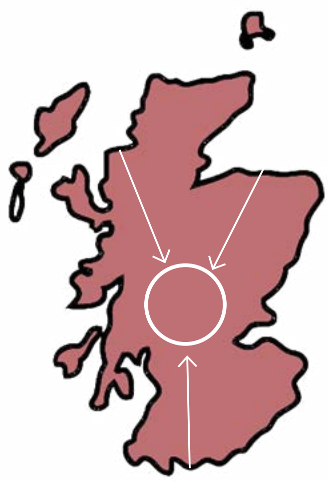
1. Design for deconstruction.
2. Increase Circular Economy principles
3. Build in value of material
4. Building as a material bank.



Stage 3

Upgraded / be resilient

1. A Scottish product
2. Local supply chain
3. Local economy



4.8
A Scottish Product

As part of the PORTAL study it was important to lay the foundations for the Stage 3 approach to cladding to table a credible solution that could be delivered using a local supply chain and existing technologies.

The Scottish market has an abundance of timber products and a well-established timber-cassette and offsite manufacturing industry. While the bulk of this product is focused on the residential market, it forms a solid base for developing new products and solutions in a competitive environment.

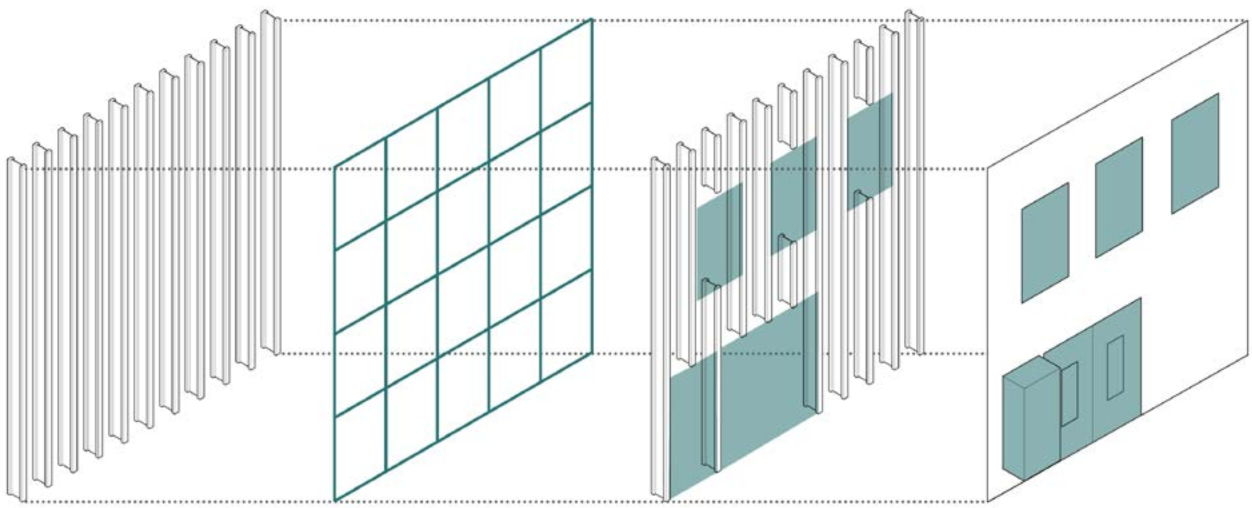
The images on this page illustrate the initial development of a modular envelope solution based around timber products.

The key module is a 1220x2440mm plywood sheet. This basic module informs Grid spacing and Eaves height, but still allows a degree of flexibility and scope to meet the requirements of a brief. (1220 + (2x 2440)) = a PORTAL spacing of 6100mm. Integrated with engineered joists we have developed initial cassettes/modules that could be manufactured off-site, which helps minimise waste, are efficient and easily transported and installed.

Having developed a base module, we then started exploring how to integrate secondary framing elements (still using the engineered timber) and other componentry such as doors and glazing.

Critical to the success of the solution will be the careful detailing. As part of the study we have started looking at key interfaces with structure to assess buildability as well as compartmentation details.

This solution helps grow the Circular Economy profile of the building by delivering on a number of key criteria discussed in the previous section.
Just as importantly, the modular infrastructure allows for future adaptability, making it easy to create additional openings for windows and doors while depth of construction can also allow increasing insulation levels. This kind of flexibility, together with the structural and volume flexibility described in previous pages, would make it relatively simple and efficient to re-purpose a building and give the owner a product of greater value.



Engineered Timber Joists.
Supplier Location - Scotland
Spacing 600mm

Sheathing Sheets
Supplier Location - Scotland
Standard 1220 x 2440 sheet size

Openings work within Joist spacing and Sheet Size grid

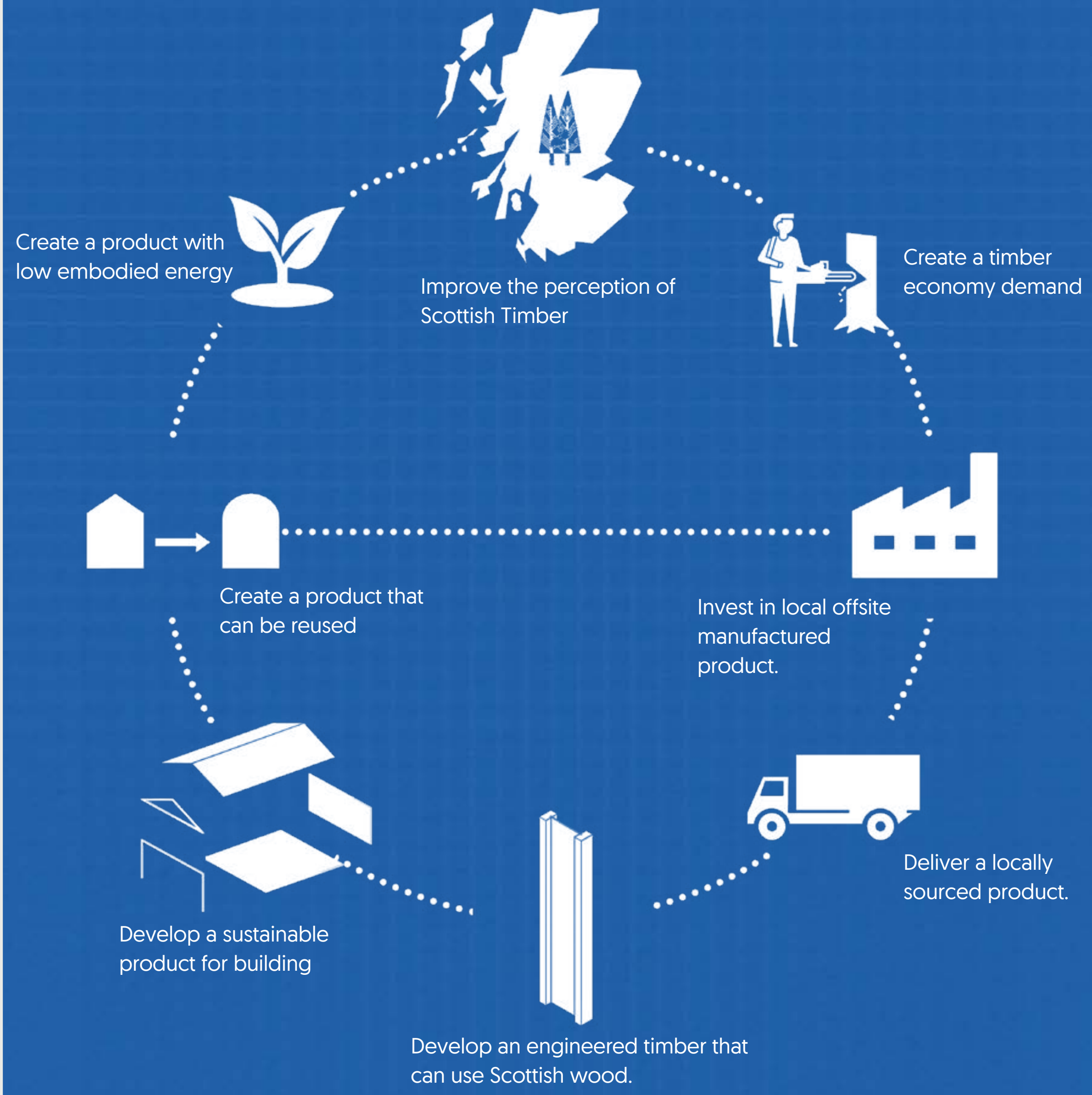
Additional componentry designed to be de-constructed from envelope solution.

Scottish Timber

Though an abundant product, Scottish Timber is not always seen as the best raw material, especially with regards to developing Engineered timber solutions. This is partly true and partly tied to perception issues. Central to the study however is the belief that by creating a demand in the market for more engineered timber products, this will help stimulate research and development to maximise the potential of this natural resource and increase its value.

We further recognise that as materials and technologies develop, more robust and efficient solutions may become available that are more cost efficient and better aligned with the challenges of a Circular Economy.

The diagrams on this page, illustrate the principle of creating a suite of modules and components using very few standard products. This example is further developed in the next section, but the key principles are to:



4.9
Site Infrastructure and Opportunities

Efficiency

The first premise of PORTAL is to strive for efficiency. With this stage comes the challenge to avoid building what is not required.

One of the 'wasteful' factors we observed in multi-tenancy industrial complexes, is the duplication of small-scale infrastructure requirements, such as welfare facilities, storage etc.

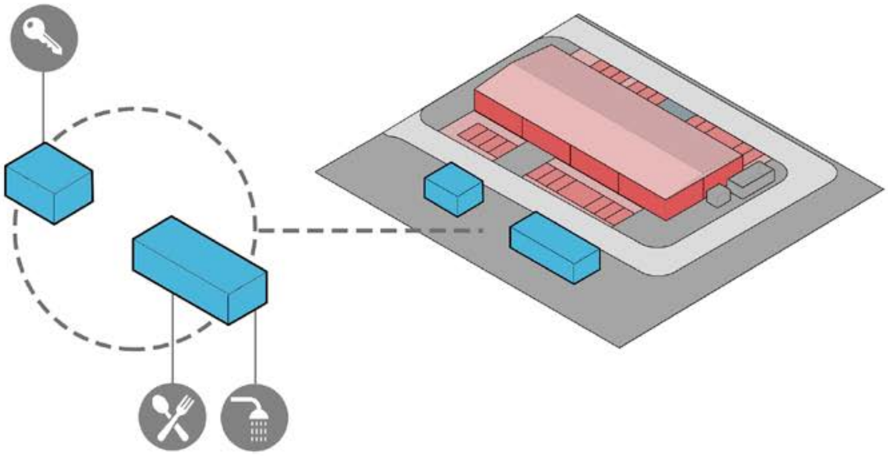
As part of the bespoke assessment of each site and brief, we would encourage thinking about how certain facilities can be provided more efficiently as a cluster, rather than replicated within individual units. For example:

- Welfare block with showers and changing facilities. Potentially kitchens
- Secure cycle parking facilities
- Storage block
- Waste and Recycling core
- Maintenance Equipment: create a shared 'library' of equipment such as cleaning products, tools, etc.

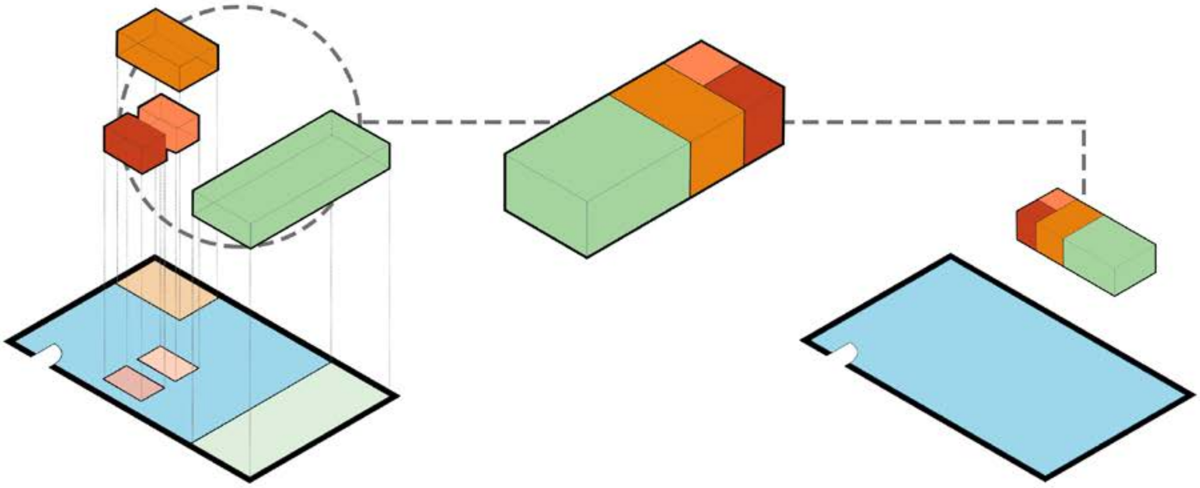
Where is the Value?

The strategy is largely aimed at delivering a more efficient and less wasteful approach to 'ancillary' requirements. Clearly some of the suggestions above present some management challenges, but as often remarked in this study, we need to think differently about solutions and re-assess our value criteria.

It can however be argued, that by extracting low-value functions from within the units, we ensure the 'high-value' space is used for the commercial purposes. As such we have more lettable space and arguably, the shared site infrastructure is an added-value that can be rentalised.



Ancillary elements such as storage, staff welfare and communal kitchen facilities could be taken out of the shell build. The space can be provided as additional services and monetised through a Landlord service charge.



This strategy means that the floorplate is optimised for use - removing all ancillary space within the shell building.

4.10 The Role of Big Data in PORTAL

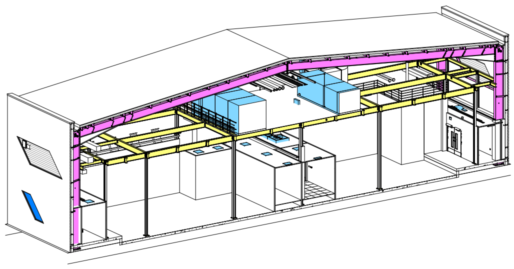
BIM

BIM (Building Information Modelling) is a 3D model-based process that gives architecture, engineering, and construction professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure.

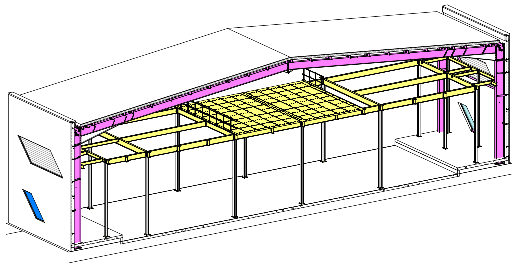
Though already well developed as a software, the building industry as a whole is yet to come to fully exploit the potential of this tool.

As a design tool there are many key benefits BIM can bring to the design process. Some of the benefits include:

- Working in a 3D/Virtual environment
- Improved collaboration and coordination between design disciplines
- Efficient work streams
- Resolution of Design conflicts and clashes



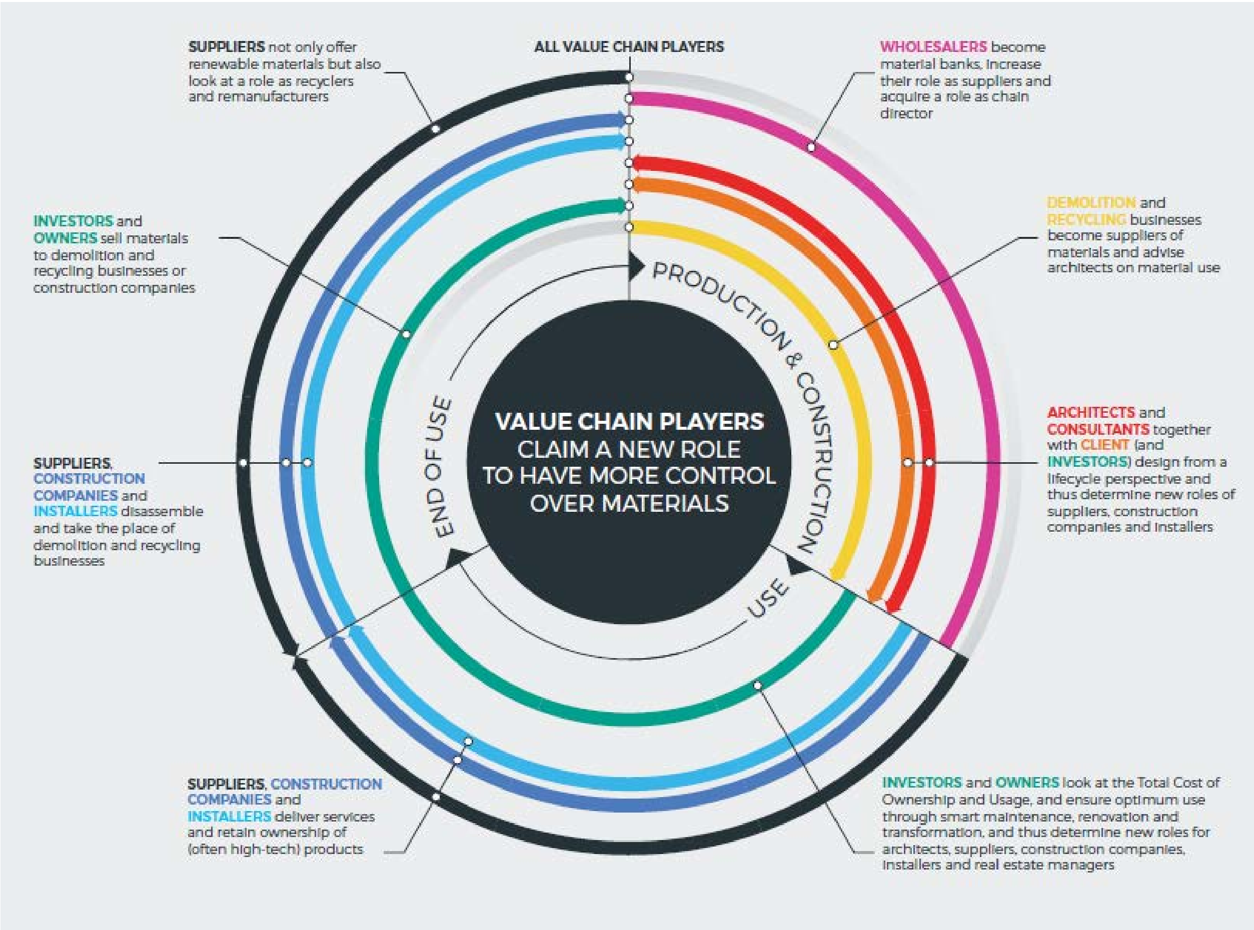
However, BIM isn't just 3D design. It's also a process for creating and managing Data. It is within this context that we believe BIM can bring the greatest value to the circular economy. Through BIM we have the ability to embed and store all of a building's details. For each element we will be able to create a MATERIAL PASSPORT. This will record for example, the supply and chain of custody of our timbers, or the assembly methods and detail or the maintenance history of our equipment.



The ability to manage and control a building to this degree will create real Circular Economy opportunities.

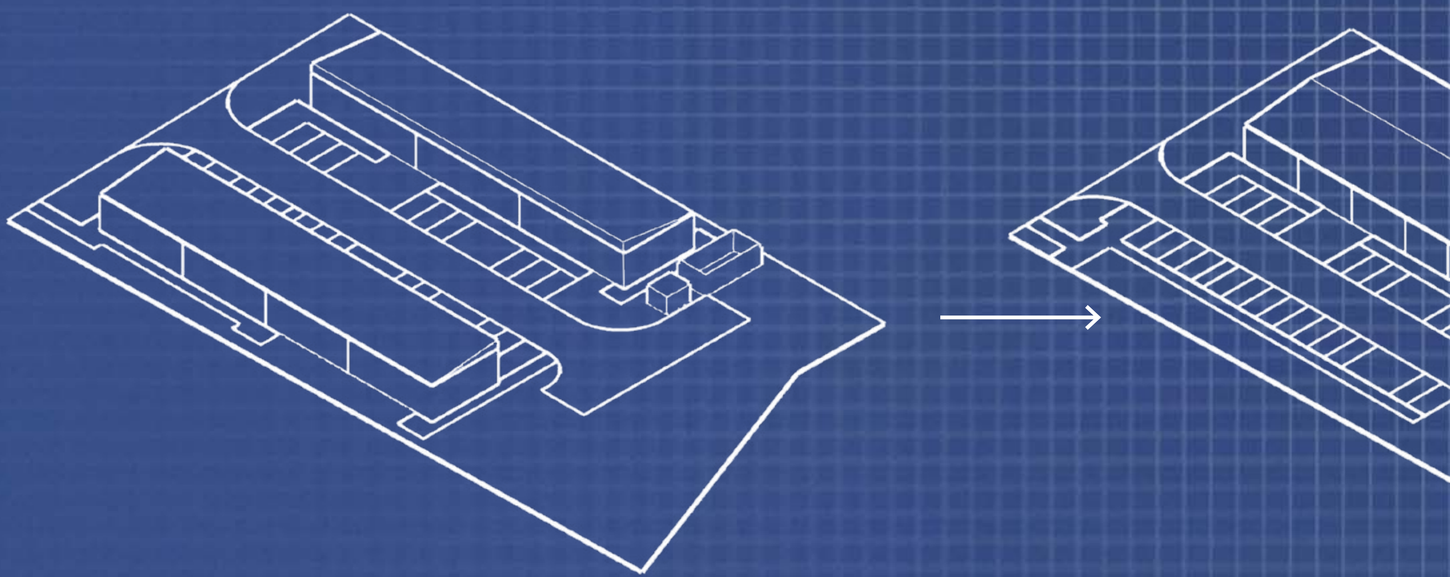
Building New Roles

With the use of the technology still in its infancy, it is clear that the skill-set required to manage this data is not fully developed as of yet. In the next few years, within each segment of the building industry we expect to see the development of new roles and responsibilities. These professionals will be critical in the ability to successfully implement, deliver and manage circular economy buildings.



Source: A future-proof built environment, putting circular business models into practice, page 23, Circle Economy & ABN AMBRO

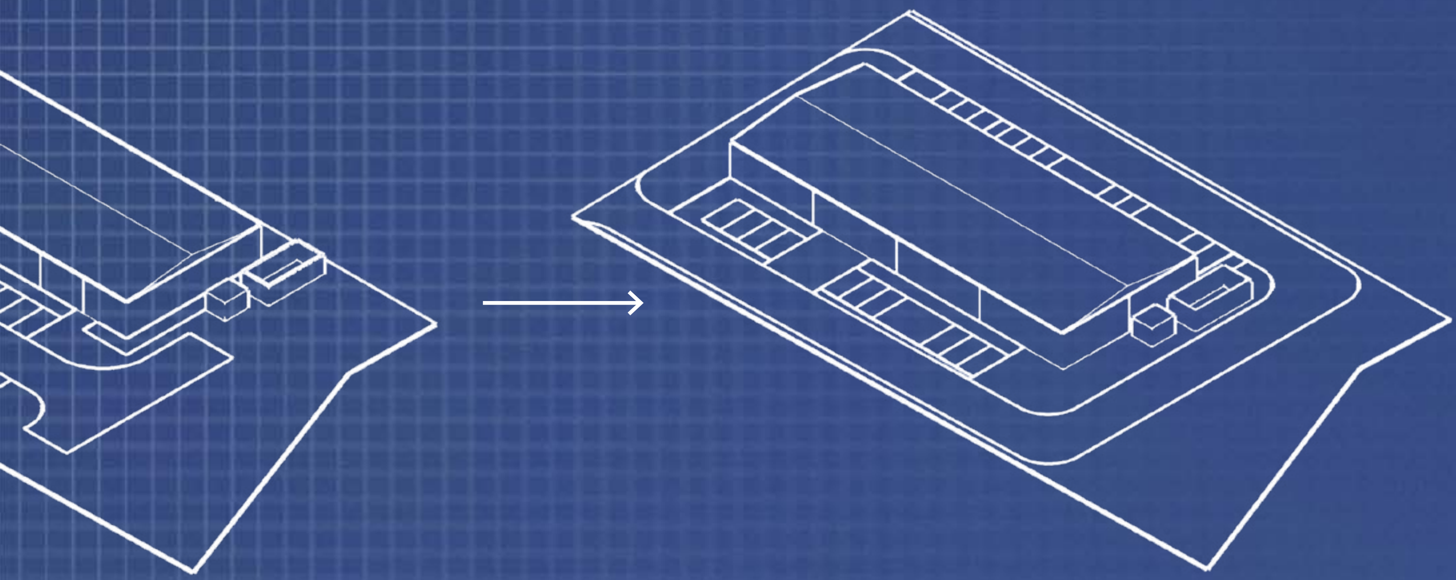
5.0 A Case Study



Queensway Case Study.

To demonstrate the potential for PORTAL, we have carried out an initial case study.

The approach was to take a recently completed project and review and rethink the product applying some of the PORTAL principles.

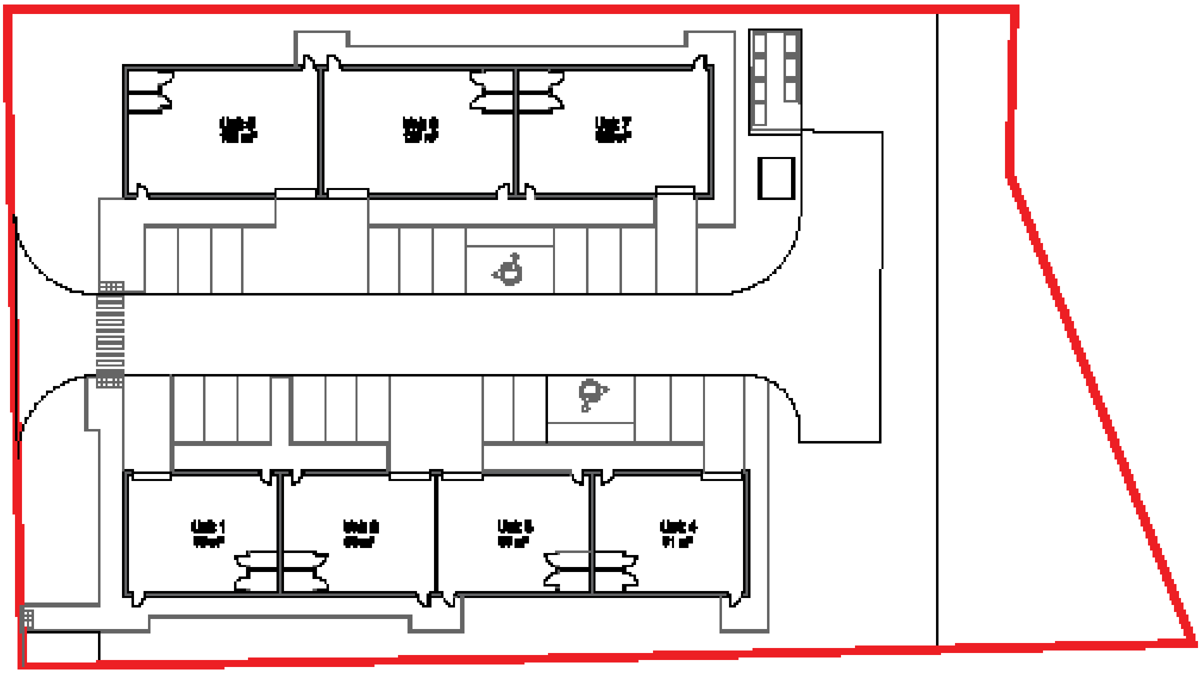


Why the Queensway?

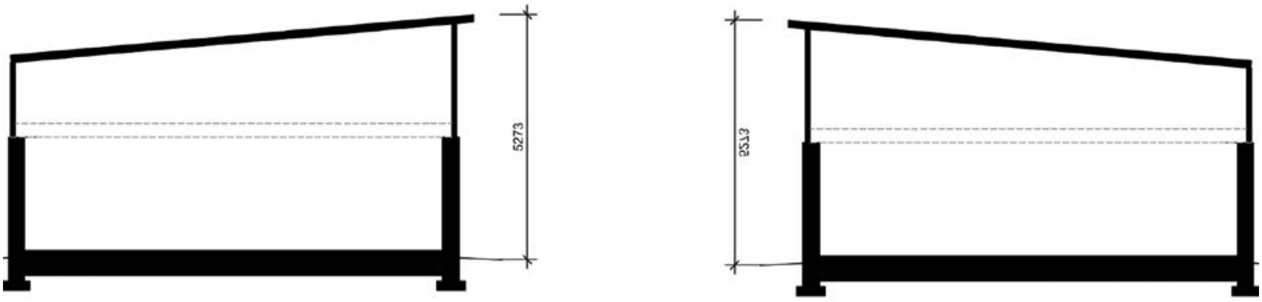
The study focused on recently completed industrial units in Fife. This product was selected as it is fairly representative of typical small scale industrial development aimed at the SME market. Furthermore it was developed by Fife Council who are one of the key Stakeholder's in the PORTAL project and who together with other local authorities and regional enterprise agencies are potentially the developers behind a first phase of delivery of PORTAL buildings.

Queensway Key Data

GIA:	8374 sq.ft
Site area:	c. 0.93 acres
Number of units:	7 units (range 90m² - 123m²)
Notional rent value:	£5.75 per sq.ft
Maintenance costs:	5% of rent/annum
Cost/sqft:	£174
Cap-ex:	£1.5M
50 year lifespan cost:	£3.5M (£40K/annum)



Diagrammatic site plan drawing of Queensway, Fife.



Diagrammatic sectional drawing of Queensway, Fife.

Photograph of Queensway, authors own.

5.1 The Queensway Study

Queensway in context

It is important to understand the position of the Queensway units in the context of other industrial units coming to the market.

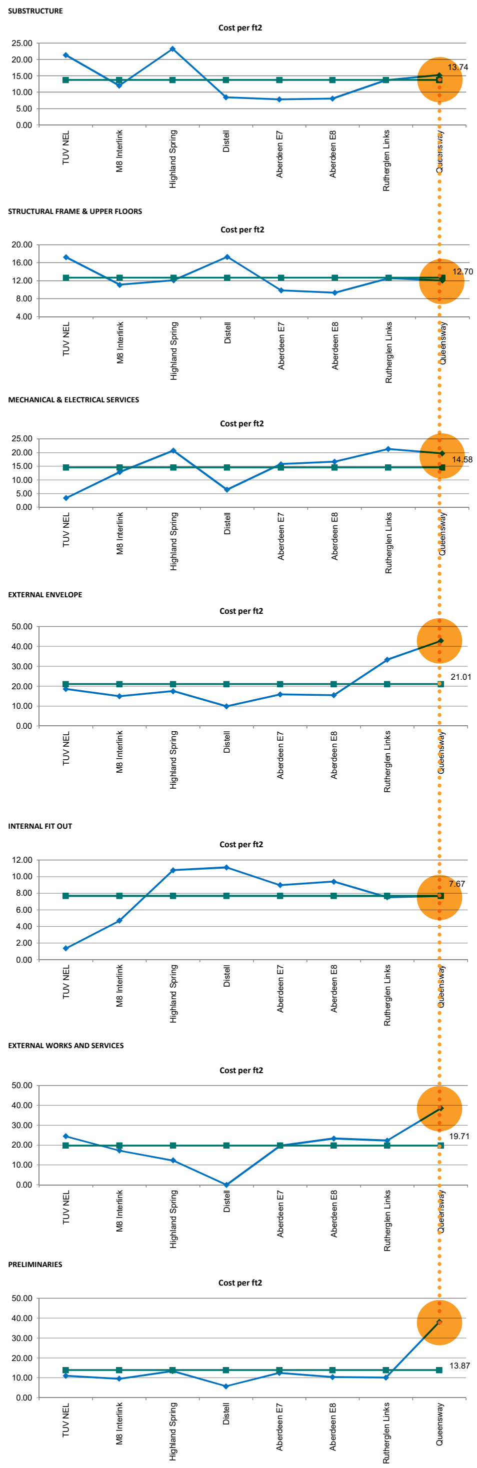
As part of the study we completed a benchmarking study to compare different scale and types of buildings (including the Queensway). An elemental breakdown shows how the cost/sq.ft in many instances Queensway sits higher than many other buildings observed.

This is largely due to fundamental differences in scale (smaller buildings will be less efficient), unknown user requirements (multiple users over single occupier) and the speculative nature of the fit-out (vs bespoke and clear requirements of known end-users).

However, the Queensway does represent a recently completed building aimed at the SME market that PORTAL seeks to support. It is an appropriate base point.

We further recognise that as the Queensway units have been delivered through Local Authority investments, it will have been procured based on a financial model that would be at odds with some private sector drivers.

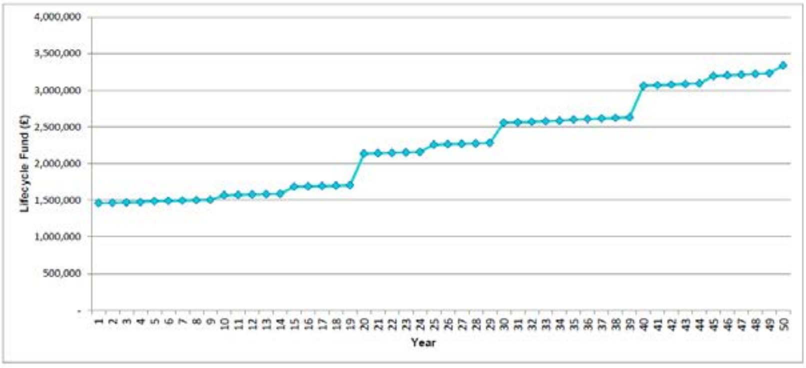
As such, the findings and propositions of this case study need to be understood in the context of the above and appropriately caveated.



Key building elements graphs cost per ft2 comparisons. Queensway highlighted in yellow, green line shows average rate.

Cost Review

50 Year Spend Profile



Understanding the real cost of the building

The above graph attempts to illustrate the 'life-span' cost of the building to the Landlord.

This is based on information provided by the Landlord and assumes a typical/current Landlord relationship. Key assumptions are:

- 5% of rent/annum set aside as a sinking fund
- 5-yearly cost spikes to manage end-of-lease and incoming tenants
- End-of-life replacement costs (10 and 25 year)
- Demolitions costs at 50 years

A combination of these factors adds a further £2M to the Landlords costs. This is on avg £40/annum.

If we think of this as the 'real cost' of the building, the Queensway product costs £417/sq.ft.

From Queensway to PORTAL – methodology

The study sets out to demonstrate how we could take this typical product and transform into a higher value and more efficient building that also starts integrating Circular economy principles.

As we wanted to demonstrate how immediate value/savings can be achieved, we've been careful to ensure that the core brief for the building remains the same.

As such the study mainly looks to implement Stage 1 and 2 principles with a focus on Form, Layout and Structure.

We have excluded most Stage 3 principles, particularly in relation to cladding and services as these would change the nature of the basic brief entirely making it difficult to draw a fair comparison.

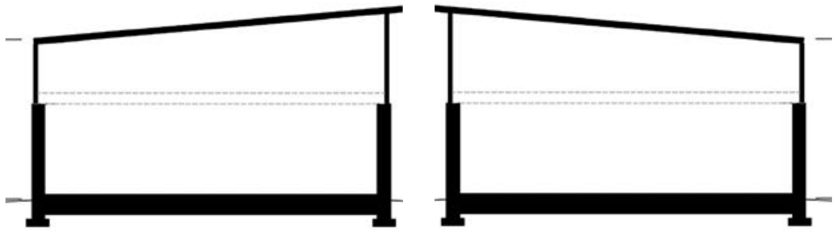
Throughout the study we have kept some constant factors:

- GIA
- Site area
- No. of Units
- Cladding materials

Stage 1

Lean design / Be Efficient

Queensway Existing



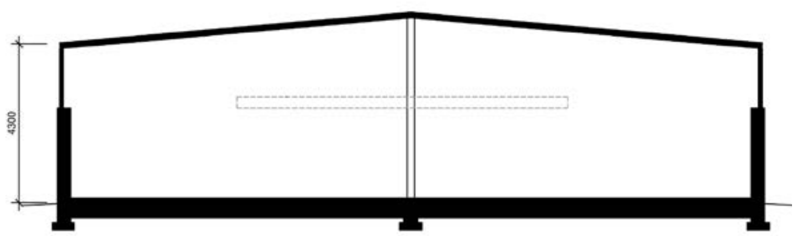
Queensway 2.0

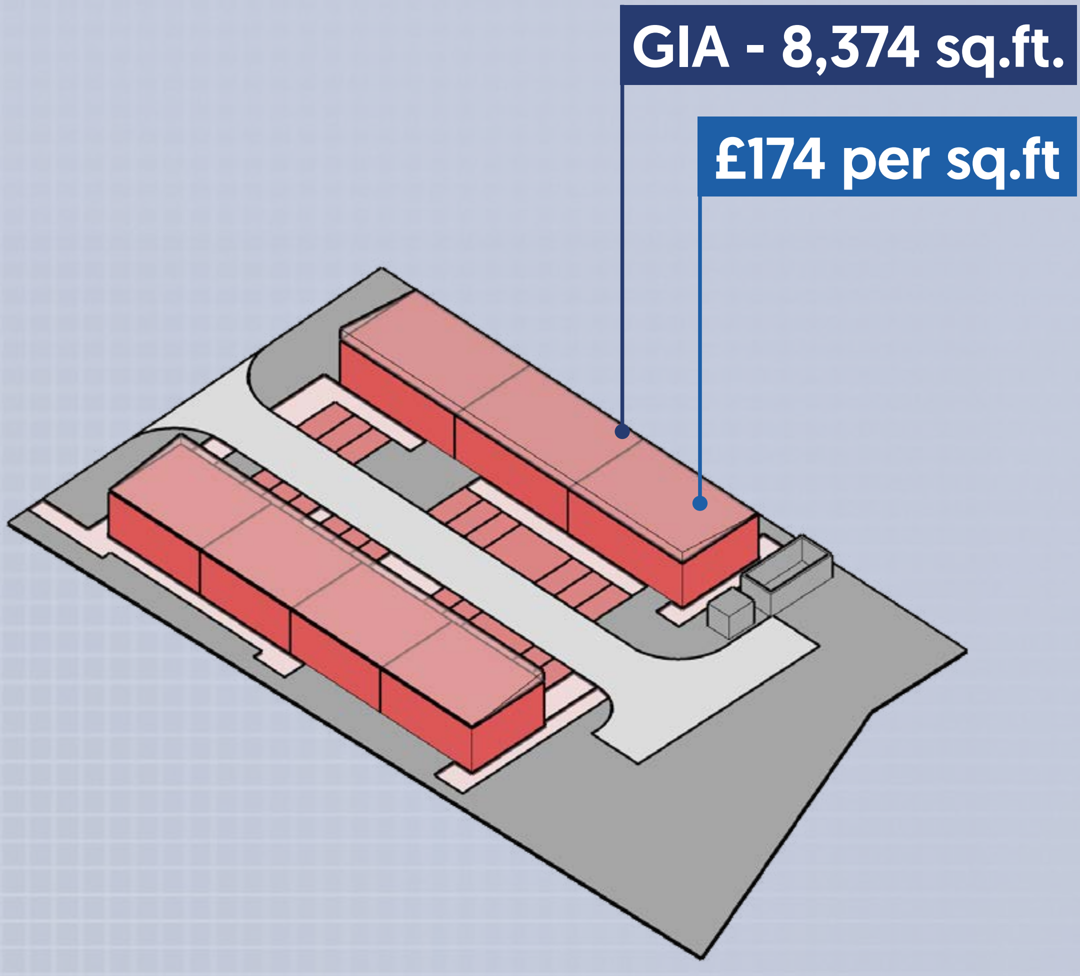
The first inefficiency we noted was in the unit layout.

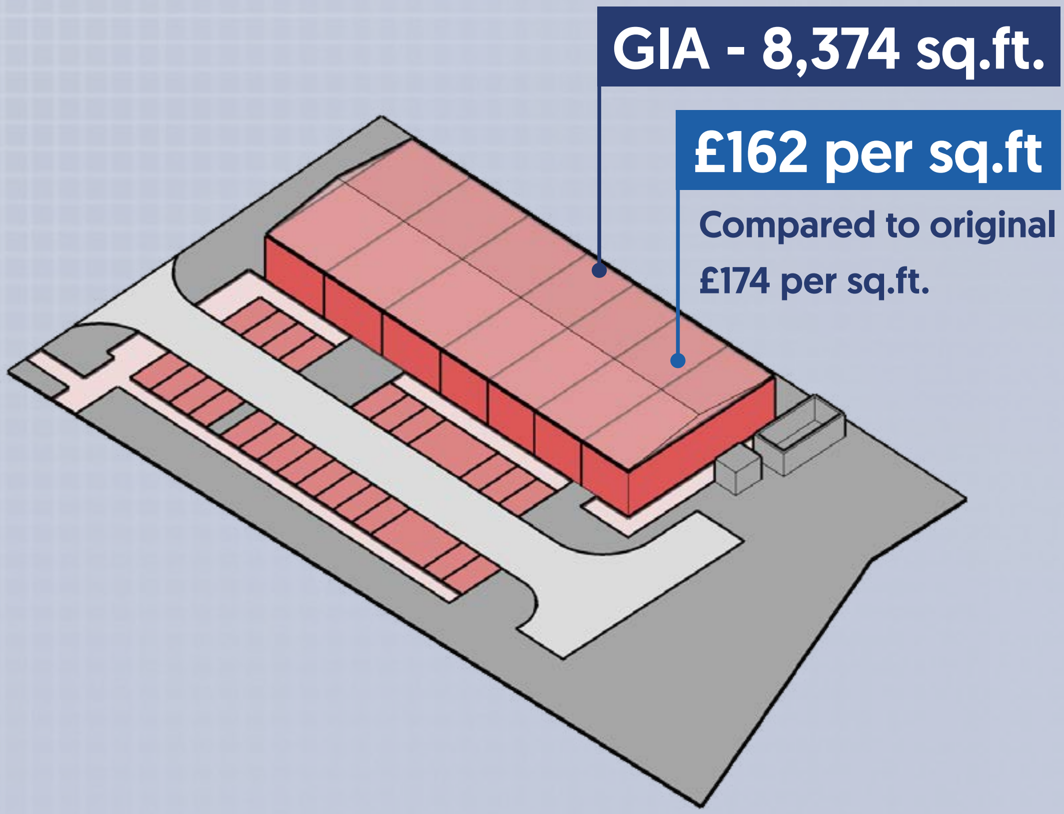
Queensway has 7 units over two buildings. This is inefficient in form and also a very inflexible floor plan offering limited variety to the market.

Our first approach is to bring the units together in one volume. This gives a 50% saving in overall envelope area and improves the unit flexibility and potential for combining areas.

c. 50% envelope reduction




GIA - 8,374 sq.ft.
£174 per sq.ft


GIA - 8,374 sq.ft.
£162 per sq.ft
Compared to original
£174 per sq.ft.

Stage 2

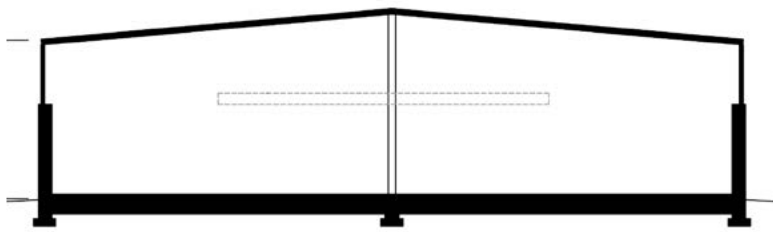
Improved / Be Adaptable & Flexible

Queensway 2.5

Having made the product more efficient, we looked to understand how we could trade the savings in favour of greater value.

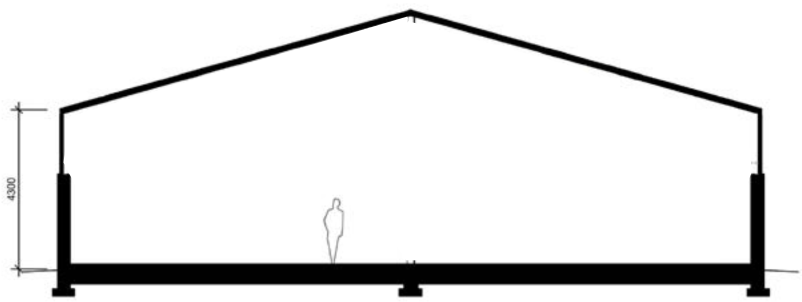
Infrastructure: to create a full loop road around the site (this is achievable within the site boundary), we also explore how changing the roof pitch could improve the internal volume.

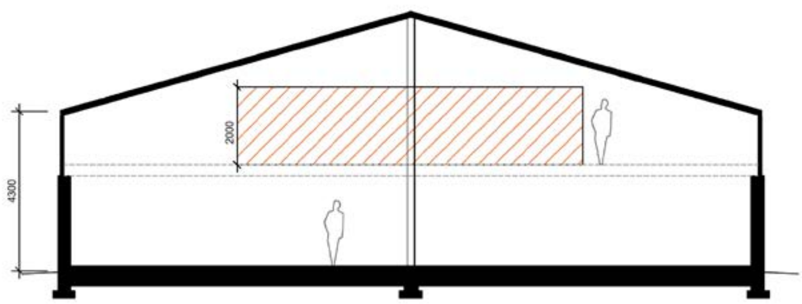
c. 50% envelope reduction



Queensway 3.0

This envelope gives you the ability to deliver a fully compliant floor / mezzanine. 50% coverage is an extra cost of £200K.

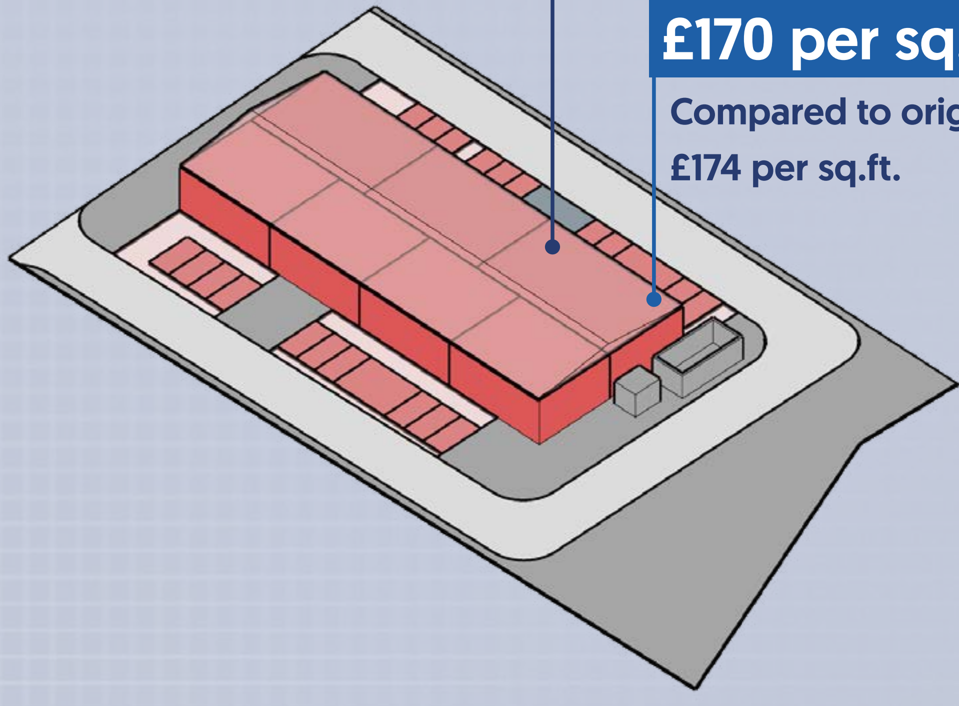




GIA - 8,374 sq.ft.

£170 per sq.ft

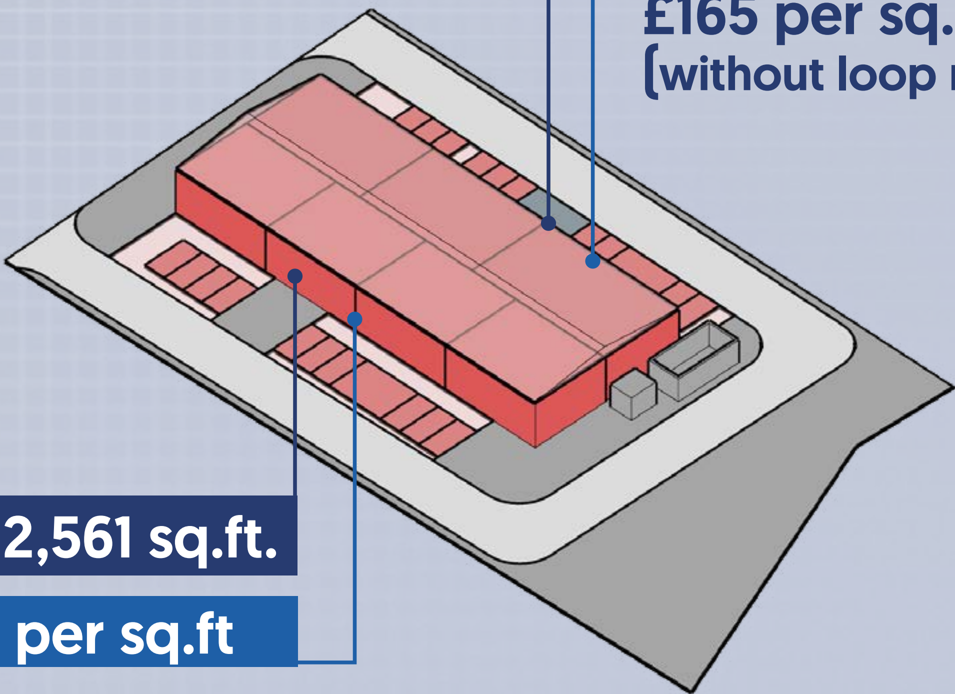
Compared to original
£174 per sq.ft.



GIA - 8,374 sq.ft.

£172 per sq.ft

£165 per sq.ft
(without loop road)



(150% area)

or GIA - 12,561 sq.ft.

for £131 per sq.ft

or £127 per sq.ft (without loop road)

Stage 3

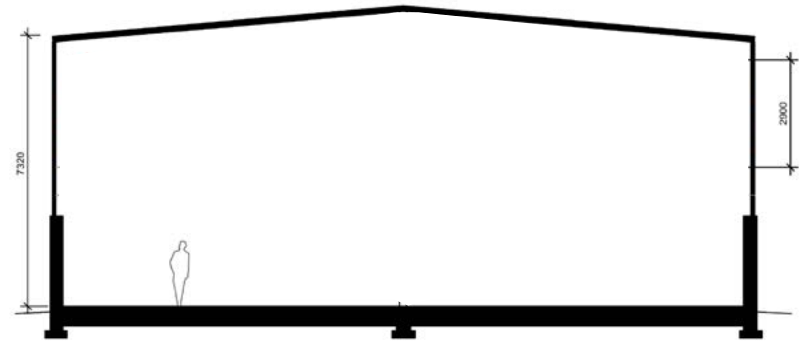
Upgraded / Be Resilient

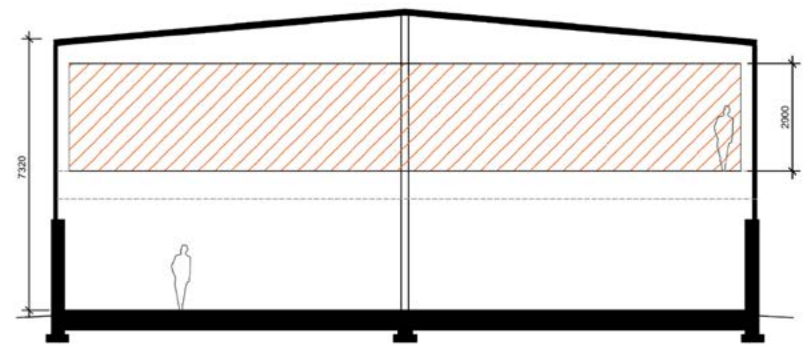
Queensway PORTAL

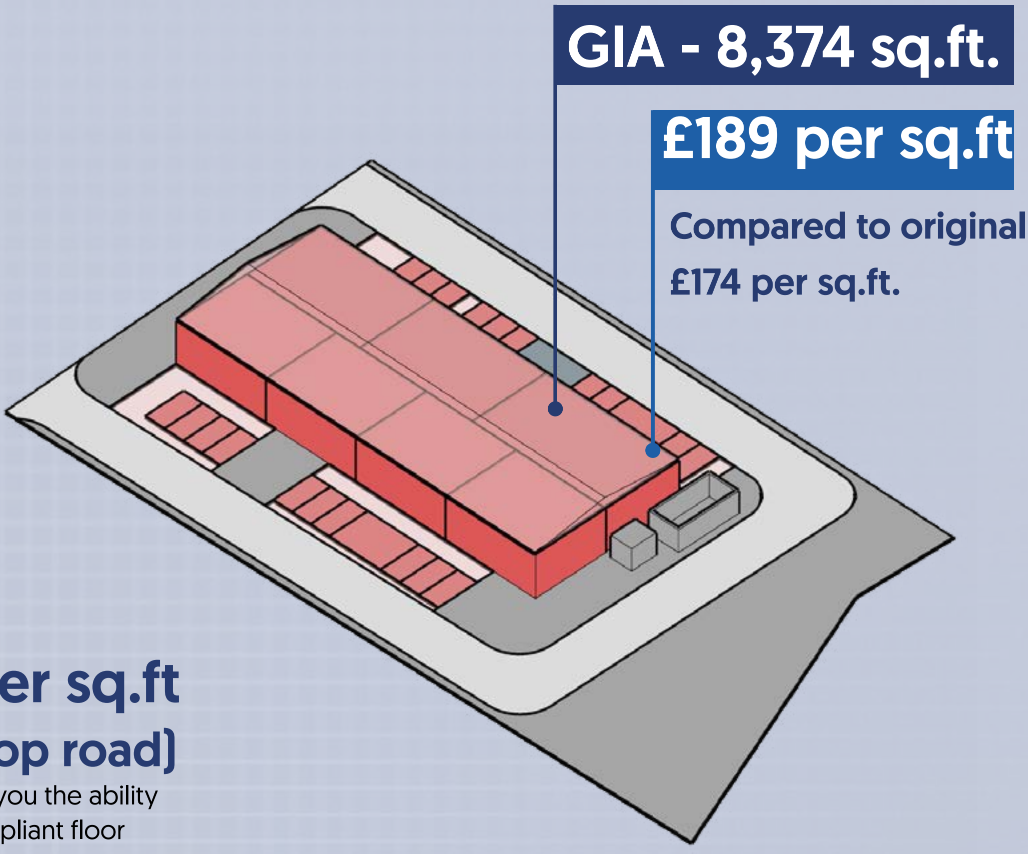
Having improved the product to make best use of the internal volume we explored options how to fully future proof the design through building in flexibility for a complete commercial plate to fit within the volume.

This envelope gives you the ability to deliver a fully compliant floor throughout. 100% coverage is an extra £375K.

c. 10% envelope reduction

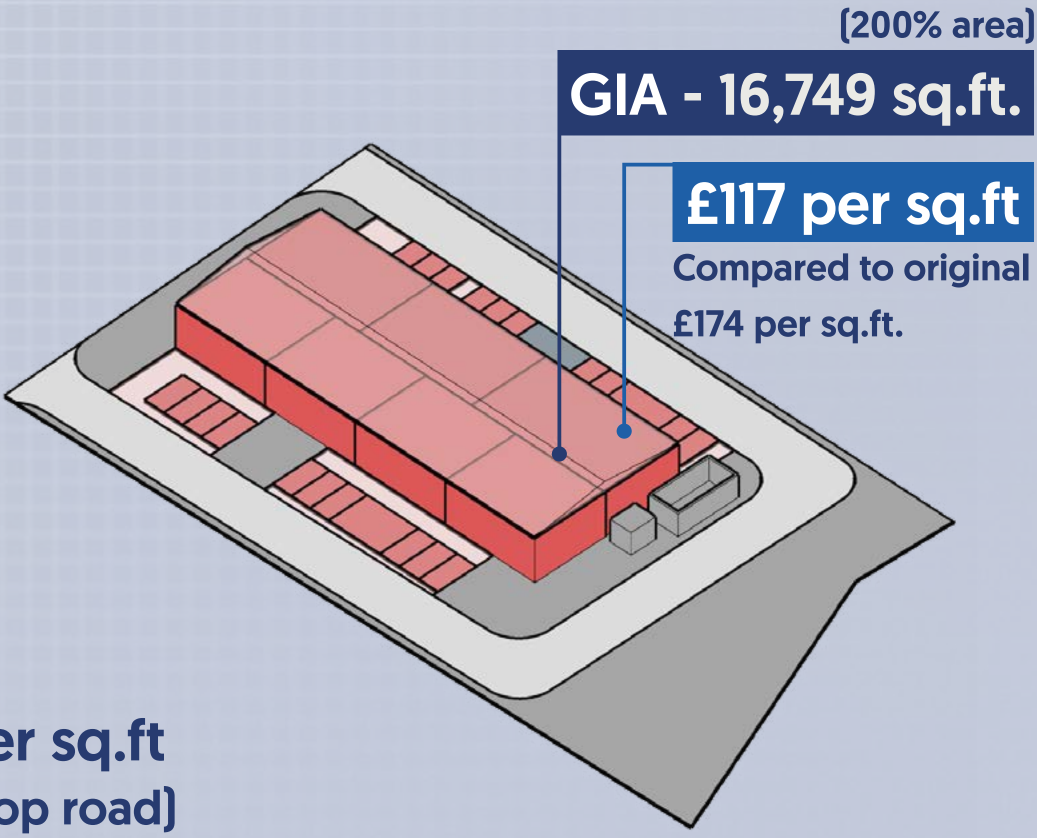






or £184 per sq.ft (without loop road)

This envelope gives you the ability to deliver a fully compliant floor throughout. 100% coverage is an extra £375K.



or £114 per sq.ft (without loop road)

5.5 Market Ready and Flexible Solutions

Challenging the basic brief – Market Ready vs Flexible solutions

While we can confidently argue that PORTAL offers a more flexible and valuable product, the reality is that Queensway PORTAL will be more expensive than the original Queensway buildings on basic £/sq.ft comparison.

What PORTAL achieves over and above the typical model is flexibility of area and volume. So the challenge is to find a solution to harness this flexibility while managing costs.

To try and capture this value we propose to challenge the initial brief. There is a significant inefficiency in the basic Queensway model. This is the inflexibility and wastefulness of building and fitting out speculative 'market-ready/walk-in' units.

The shell/base-build contains most of the potential for flexibility. If we compare the shell cost of the two solutions, we note they are actually very similar. This demonstrates that a developer "can buy" the potential flexibility for little additional investment. Where the costs start increasing is in the fit-out elements and through the addition of a mezzanine. However, we would argue that the fit-out' element also carries most of the inefficiency and waste as the exact needs of the Tenant are not known at time of construction. As such we should challenge the extent of fit-out required.

PORTAL proposes a key brief principle that requires a "Shell & Core" approach capable of "Just-in-time" delivery of units once a Tenant is known. This would allow the Landlord to capitalise on the flexibility and would be more efficient in the use of resources and building materials.

We recognise there is a balance to be struck between the programme and construction inefficiency of this 'customisation' approach, with the benefit of efficient design and waste reduction.

We further recognise that this approach is not a saving, but rather a deferring of costs and so it would require a review of how buildings are appraised, managed and procured. We have all along observed that to achieve a circular economy we must "Re-think Value" over time and this issue would be part of such a consideration.

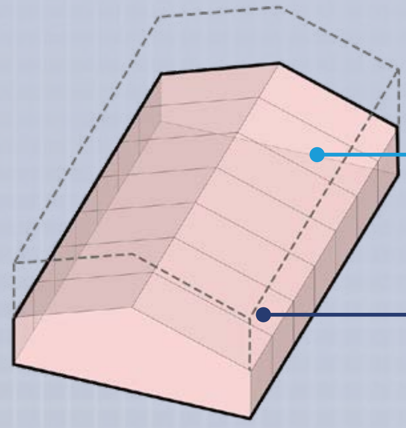
Despite these challenges, we believe that with the right combination of site infrastructure and services strategy each PORTAL brief can be developed to achieve this balance.

PORTAL as built on day one.

To try and find a balance, we have illustrated the following as a possible brief:

- Full Shell & Core construction
- Two units fitted-out and market ready
- Residual floor/volume left flexible for more bespoke requirements.

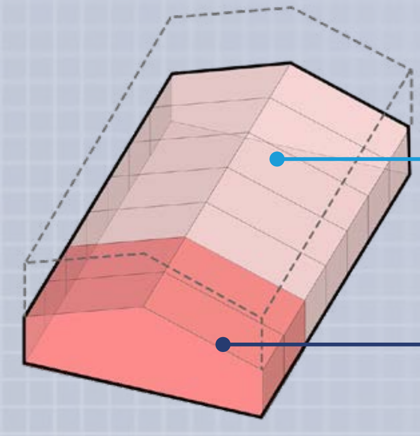
This building could be delivered for less than the original Queensway leaving c. £100K to invest in the necessary infrastructure to allow for 'just-in-time' delivery.



SHELL AND CORE

Queensway - £1.164 million
(£139 per sq.ft.)

PORTAL - £1.274 million
(£152 per sq.ft.)



UNIT FITOUT

Queensway - £42K per unit

PORTAL - £45K per unit

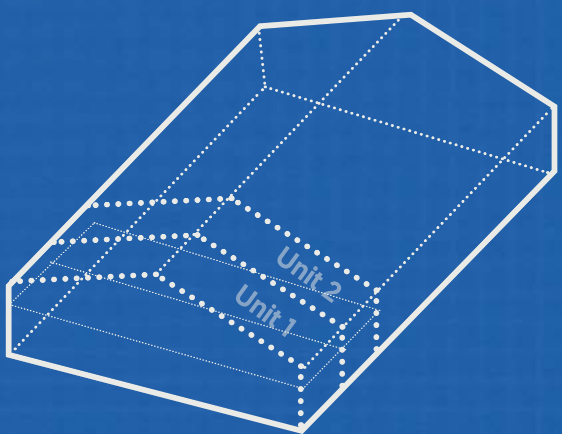
UNIT FITOUT INCLUDING MEZZANINE

Queensway - Not achievable

PORTAL - £54K per unit
(100% cover)

PORTAL

“as built on day one”



£1.362 M

(Shell plus ground floor fitout of 2 units)

£1.470 M

(Shell plus ground & mezzanine floor fitout of 2 units)

PORTAL

SCOTLAND'S INDUSTRIAL FUTURE

Stage 1 – Lean design / Be Efficient:

Ensure that the current market product is leaner and more efficient. As a minimum this step should allow a reduction in waste and initial capital expenditure.

Threesixty Architecture

PORTAL

SCOTLAND'S INDUSTRIAL FUTURE

Stage 2 - Improved
/ Be Adaptable:

The second stage is to trade savings generated in the first stage and re-invest them in the building. This will create a more adaptable building that will offer greater value for the same capital expenditure.

Threesixty Architecture

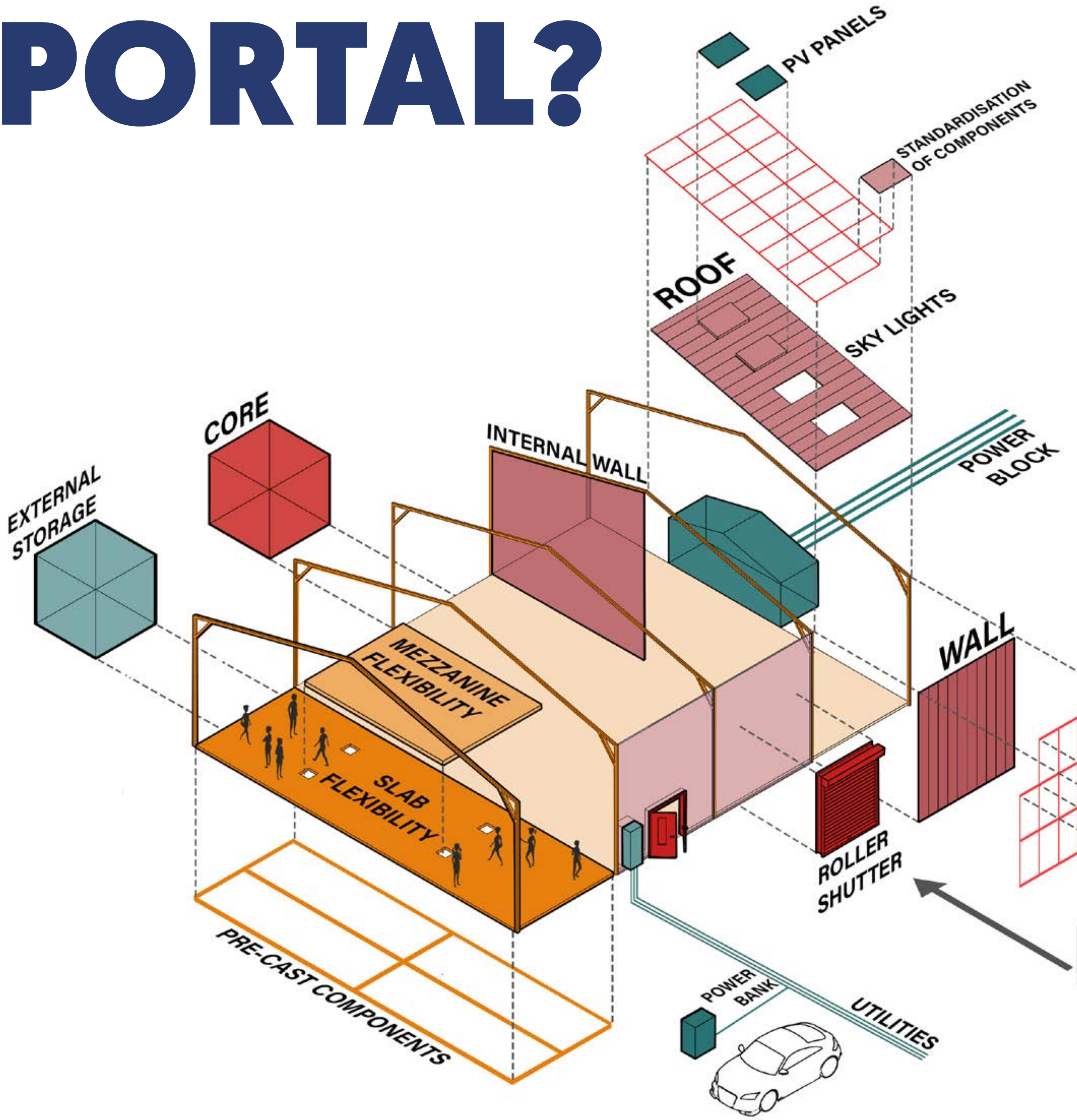
PORTAL

SCOTLAND'S INDUSTRIAL FUTURE

Stage 3 - Upgraded / Be Resilient:

The final stage is to look at a different investment model to create a product with an increased level of infrastructure and capacity. This product will be more flexible and adaptable for the market, and have a built-in resilience that will ensure a greater residual value.

6.0 How to use PORTAL?



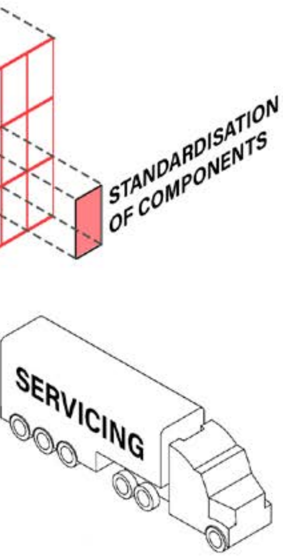
Getting the brief right.

As explained throughout, PORTAL is an approach to building, rather than a building solution.

In order to use the toolkit, it is important to ensure that anyone approaching a new build design, challenges their brief against each principle and opportunity. It will be important at the outset to establish:

- Value Criteria: Review commercial opportunities between initial capital investment against long term value.
- Flexibility & adaptability requirements.
- Quality of build and energy strategy.
- Procurement / leasing / management routes.

Formulating a strong brief and identifying these criteria will be essential to allow you to effectively develop your design and apply PORTAL approach in a way that brings value to your project.



While in the short term we recognise that there is a requirement for a transition period during which we are trying to encourage the industry to change mindset, some of the principles are immediately available to start delivering buildings that are better integrated into a Circular Economy and more environmentally sustainable:

- Structural and volumetric efficiency is immediately achievable as-well as designing in a commercially sensible level of flexibility.
- Through careful specification and quality of build we can successfully improve the carbon footprint of the building, especially in relation to creating energy efficient structures.

Furthermore, significant impact can be made through designing a site-specific utilities, services and energy strategy. The challenge of this approach will be in identifying suitable procurement and management vehicles to support this. However, we've demonstrated through the Energy Centre scenario, that there are already technological and commercially viable products to encourage developers to explore this aspect of their buildings.

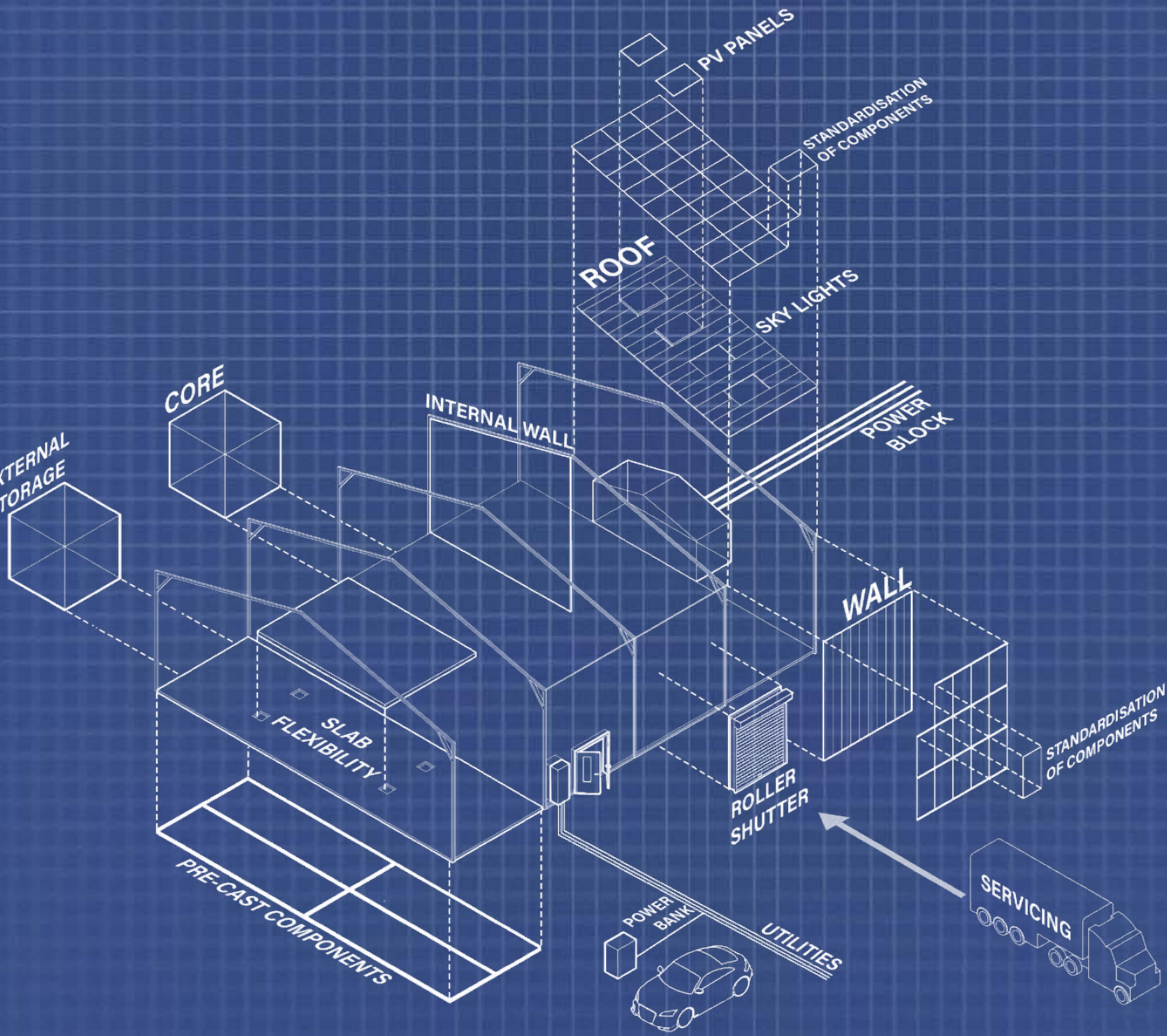
As the mindset shifts to focus on whole life value and the adoption of more sustainable practices, we will see other principle we have proposed become common practice.

We realise that the proposals for highly resilient envelopes, Circular Economy cladding solutions and the development and integration of a Scottish supply chain will become more viable as technology develops and legislation, policy and taxation pressures shift, making these decisions more commercially sustainable and necessary.

PORTAL demonstrates that through good and considered design it is already possible to make significant improvements to the quality and way in which we procure buildings. Thereafter PORTAL wants to motivate our industry to engage pro-actively through good design to meet the future challenges of our industry and demonstrates that by pushing the quality of design we can improve the buildings to everyone's benefit whilst also achieving better value for each project.

PORTAL

SCOTLAND'S INDUSTRIAL FUTURE



Threesixty Architecture