MINISTRY OF JUSTICE DECARBONISING SUB-STRUCTURES

Visualising Carbon in Platform Designs

April 2023

curtins AKERLOF

QUALITY INFORMATION

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REVISION HISTORY

Revision	Revision date	Details	Authorised	Name	Details
01	30/03/2023	Initial draft	JGH	John Handscomb	Partner

CONTENTS

We aim to take you on journey that sets out the high level principles for understanding platform principles. Throughout this report, we showcase how platform principles can be used to deliver Net Zero by 2050, offering a real world example for the Ministry of Justice (MoJ). We demonstrate how the MoJ's platform approach can allow the visualisation of carbon within discreet elements, in this case, sub-structures, and how this can be harnessed to implement practical changes that reduce carbon.

EXECUTIVE SUMMARY

The context

With the UK Government's legal commitment to a net zero future, departments have begun to review the sustainability profile of their requirements.

In parallel, broader systems thinking has risen in prominence, with both the Construction Playbook and TIP Roadmap to 2030 advocating a platform-based approach as a potential route to a greener, more socially equitable built environment.

The Ministry of Justice

Through its net zero strategy, the Ministry of Justice (MoJ) has committed to reducing the embodied and operational carbon of its future built assets. The MoJ has pioneered the adoption of platform principles, rationalising the design of its future portfolio to support faster, better and greener delivery.

The majority of effort to date has been centred towards the above-ground structure, with a particular focus upon optimising a standard houseblock design. Akerlof's 'Decarbonising Concrete' project (2022) demonstrated the potential for collaboration along the value chain to realise a 40% reduction in embodied carbon against industry baselines (ICE database) – equivalent to 21.8 million kgC02e in the construction of 4 new prisons for the Ministry of Justice.

This report extends these principles, exploring the opportunity for decarbonisation within the sub-structure works.

Decarbonising sub-structures

Using the 1,700-place prison at HMP Fosse Way as the basis for this research, the report focuses on the carbon content within the sub-structures and foundations, visually demonstrating the impact of each element to identify priority areas for embodied carbon reduction.

A comprehensive action plan and timeline is outlined, informing a route map for future carbon reduction as part of the MoJ's pathway towards net zero. This is recommended to include:

- Ground improvement techniques, to improve ground-bearing capacity and enable less carbon intensive foundation designs
- Investigation into alternative foundation and piling methods, to both reduce the quantum of work and impact
- Adoption of lower carbon concrete mixes, within the substructure design, external works, fencing foundations and aprons
- Development of policy around use of zero-emission plant during construction
- Collaboration with other government bodies (inc Arms Length Bodies) for shared research towards products such as:
  - Sustainable reinforcement
  - Lower carbon materials for security fencing
  - Lower carbon hard landscaping solutions, such as low temperature asphalt

THE MINISTRY OF JUSTICE'S PLATFORM JOURNEY

The Ministry of Justice (MoJ) has successfully made forward strides towards reducing both the embodied and operational carbon of its new-build projects by defining and applying a clear net zero strategy across a long-term pipeline of work.

This longer-term horizon, combined with the adoption of platform principles has allowed the MoJ to develop, benchmark and optimise standard designs, through a cycle of continuous improvement, driven by a data informed approach.

Construction strategy including platforms, MMC and net zero vision

Designers develop kit of part approach including T60 Houseblock

MoJ supports and embeds innovation that provides route to reduce carbon in above-ground structures by 40%

New prisons to be net zero in future - designs to eliminate 280,000tCO_2 and cut energy demand by half

MoJ, in conjunction with the MTC, commission report to provide route to future embodied carbon reduction in sub-structures

PETP LEGACY	10,000 ADDITIONAL PRISON PLACES PROGRAMME		3,000 ADDITIONAL PRISON PLACES PROGRAMME	EMERGENCY AND SHORT-TERM	CONVERSION
3,360	6,500	3,500	3,000	1,400 + 2,000 (SR21)	353
NEW PRISONS		EXPANSIONS	EXPANSIONS	TEMPORARY EXPANSIONS	NEW PRISON
NEW PRISON: FIVE WELLS; NEW PRISON: GLEN PARVA	NEW PRISON: FULL SUTTON; 3 NEW PRISONS	HOUSEBLOCKS AND REFURBS; WOMEN'S ESTATE; CAT D PHASE 1; CAT D PHASE 2	ACCELERATED HOUSEBLOCK DELIVERY PROGRAMME	COVID-19 CAPACITY; RAPID DEPLOYMENT CELLS PROJECTS	MORTON HALL CONVERSION

UNDERSTANDING
PLATFORM PRINCIPLES

A NEW PLATFORM APPROACH

Whilst the green agenda has shifted focus towards 'delivering better things', the construction industry continues to simultaneously wrestle with a need to 'deliver things better'.

The industry has repetitively been cited as inefficient and unproductive; too often focused upon bespoke outputs delivered in project silos. Further challenges exist with:

- Demographics: an ageing workforce (over a third of UK construction workers are over 50)
- Waste: with waste in defect remediation estimated to be between 10-20%
- Cost: with inflation and debt costs impacting pipelines and budgets allocated for capital allowances

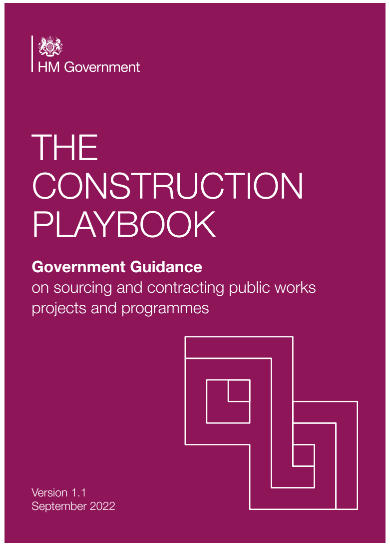
With an established case for change, the government announced its commitment to Modern Methods of Construction (MMC) in 2017 with the presumption in favour of offsite construction.

In December 2020 this was expanded upon within the Construction Playbook, setting out specific proposals relating to "A Platform approach to Design for Manufacture and Assembly (P-DfMA)".

Publication of the IPA's Transforming Infrastructure Performance (TIP) Roadmap to 2030 moved this further forward; outlining the vision and focus within government towards leveraging the use of platforms (standard, repeatable assets with interoperable components) to generate improved societal outcomes from its pipeline.

As the urgency to deliver net-zero has grown, so too has the prominence and profile of platforms and broader systems thinking as a potential enabler to a more sustainable industry and built environment.

Source: Infrastructure Projects Authority



Source: Cabinet Office

WHAT IS A PLATFORM?

The word 'platform' is used often in varying contexts: physical platforms, digital platforms, industry platforms, product platforms... etc.

Synonymous with themes of standardisation and repeatability, platforms typically feature:

- A set of common (low variety) core assets - typically components, processes, knowledge, people or relationships
- A complementary set of peripheral components that exhibit high variety
- Stable interfaces that act as a bridge between the common core asset and variable peripherals, permitting innovation in the core and peripherals.

By applying the principles of common components, processes, knowledge and relationships, platforms have been successfully applied in manufacturing to deliver mass customised products and solutions at a reduced cost, faster and with lower risk.

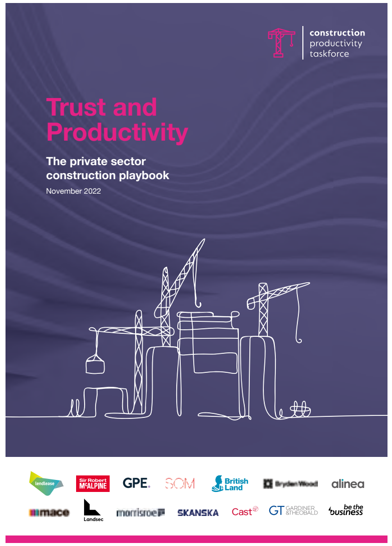
Seeking to offset issues such as low productivity, poor predictability and industry fragmentation, construction has regularly been encouraged to follow suit.

Both the Construction Playbook and the TIP Roadmap to 2030 reaffirm policy towards:

"procurement of construction projects based on product platforms comprising of standardised and interoperable components and assemblies".

The private sector has also begun follow a similar path, a trend recognised within the 'Private Sector Construction Playbook' and propelled by publication of supporting documents such as the Product Platform Rulebook.

Source: Construction Innovation Hub



Source: Construction Productivity Taskforce

SO MANY DIFFERENT TERMS...

With terminology rapidly evolving to reflect new innovations and ways of working, the interlink between platforms, MMC and offsite manufacture is not universally clear.

The graphic below illustrates this, with MMC as a broad umbrella term, used to describe contemporary innovations in construction, that include new technologies (such as digital tools and techniques), manufactured solutions and use of efficient processes to deliver better, more productive and sustainable outcomes.

Platforms are therefore a key part of MMC and an enabler to greater use of manufactured solutions

A platform-based approach is typically adopted to create a variety of products on a reduced cost base. By sharing components and processes across a platform, companies can develop distinct products and solutions efficiently, whilst maintaining economies of scale and scope.

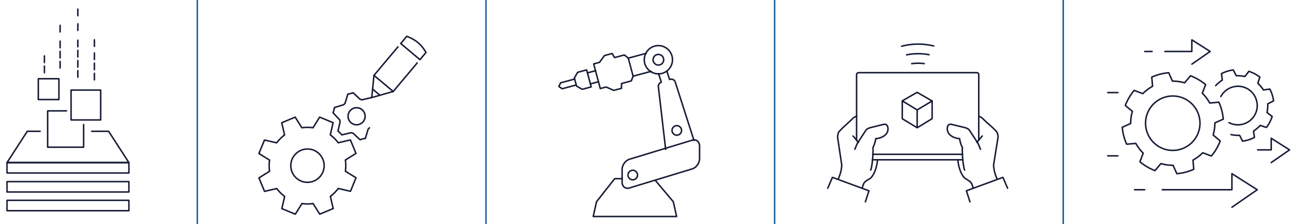
By shifting the horizon from individual projects to programmes, platforms offer the potential to leverage the re-use of knowledge, relationships and process to:

- Offset learning curves
- Mitigate repeat work and instead enable focussed effort of all parties towards areas that add real value
- Reduce complexity and instead enhanced predictability and certainty of time, cost and quality
- Facilitate feedback loops that support continuous improvement as opposed to repetitious reinvention

In reducing waste and facilitating continuous improvement, there is potential to leverage platforms not only to deliver societal benefits envisaged by TIP but also to propel the construction industry forward along its roadmap to net zero.

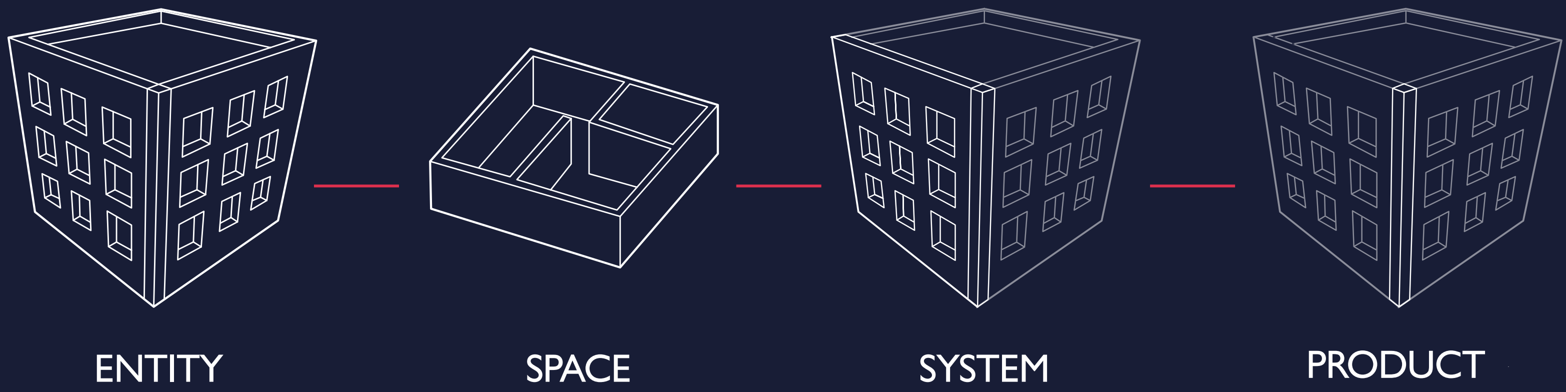
MODERN METHODS OF CONSTRUCTION

PLATFORM	DFMA	OFFSITE	DIGITAL	INDUSTRIALISATION
Standard, repeatable and interoperable solutions	Designed for manufacture and assembly	Manufactured offsite in a safer, more productive environment	Enabled through the application of data and digital technologies	Delivered by applying lean, repeatable processes



Source: Akerlof

PLATFORMS COME IN MANY FORMS BUT ARE, IN ESSENCE, ENABLERS FOR GREATER USE OF MANUFACTURED SOLUTIONS



Source: Akerlof

DELIVERING NET ZERO 2050 THROUGH PLATFORMS

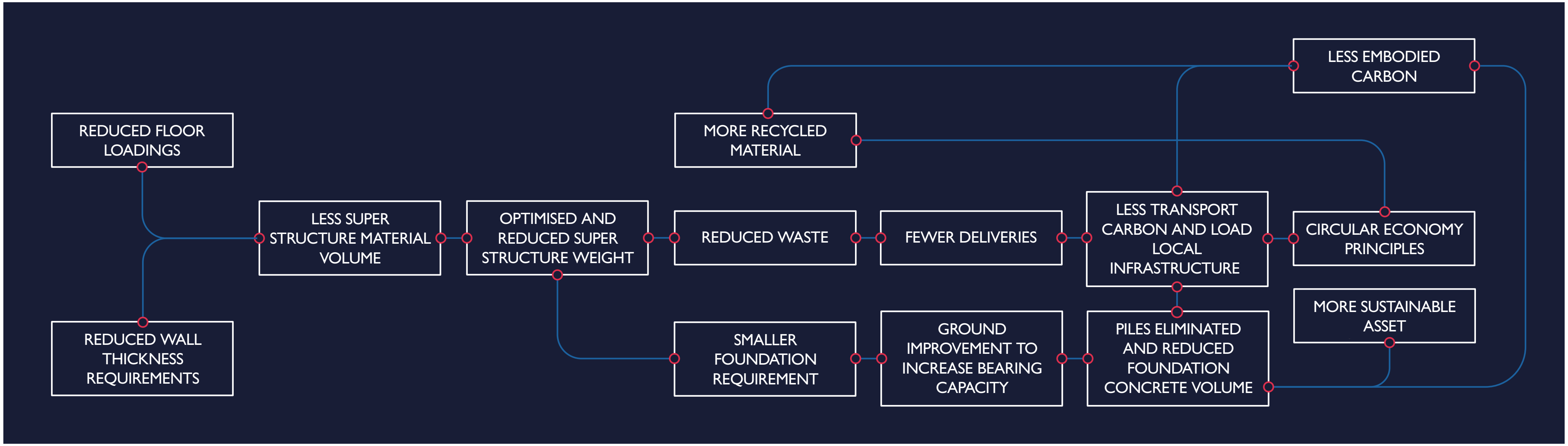
THE POTENTIAL FOR A GREENER APPROACH

By enabling manufactured solutions, platforms offer the potential to be greener, with a reduced carbon footprint and impact upon the environment. The creation of common 'kits of parts' alongside harmonised demand unlock high-volume manufacture of components, offering an opportunity for:

- Optimised design solutions: that minimise whole lifecycle carbon
- Greater resource efficiency: with optimised consumption of energy, water and raw materials in manufacturing
- Reduction in waste and quantities in construction
- Longer product lifecycles
- Better energy performance in use: with manufactured solutions closing the performance gap between design intent and asset in use
- Circular economy: via standard sizes, de-constructable building components and assemblies that can be dismantled and reused (ISO 2887)

Flexible solutions: that minimise the carbon impact of adaption for future needs

- Enhanced innovation: fostering greater innovation by enabling organisations to develop new solutions and services that build on existing technology and components
- Continuous improvement: that is measurable.



Source: Adapted from Bryden Wood - a project example of how platforms were applied to minimise environmental impact

WHERE PLATFORMS ARE BEING APPLIED

Seeking to grasp this opportunity, tangible initiatives applying platform principles have already begun to manifest, including:

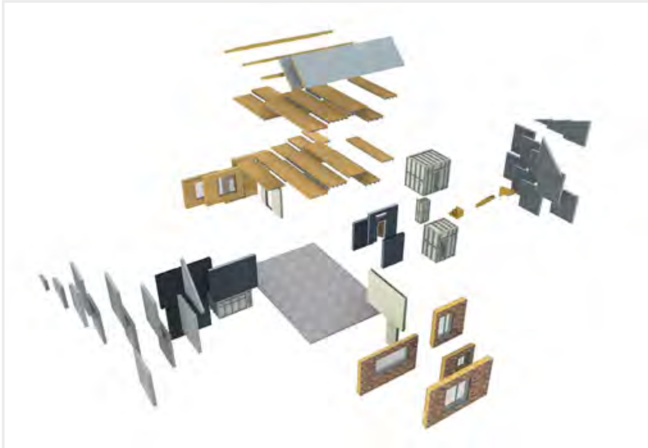
- R&D Investment: predominantly through the £172m 'Transforming Construction' programme, including development of digital and physical 'sandpit' demonstrators
- Growth in Construction Technology (ConTech): with an increased uptake in digital technology adoption, estimated at circa £1.3bn
- Specific platform-based programmes across individual Government departments including:
    - Department for Education: with the launch of their 'Alliance for Learning' programme, building upon their £4m investment in GenZero, a net zero primary school solution
    - Commissioned research into standard, digital kits of parts by Department for Levelling Up, Housing and Communities (DLUHC)
    - Department for Health & Social Care: defined commitment to platform principles across the New Hospital programme, estimated at circa £15bn

The Ministry of Justice's adoption of a platform design for its Four New Prisons programme is a leading example of this theme. Rising performance standards and far stronger focus towards net zero have only served to reinforce the shift towards manufactured solutions and the application of circular principles to support continuous improvement.

Source: Department for Education, Gen Zero

Source: Ministry of Justice, Decarbonising Precast Concrete

Source: Construction Innovation Hub, Sandpits

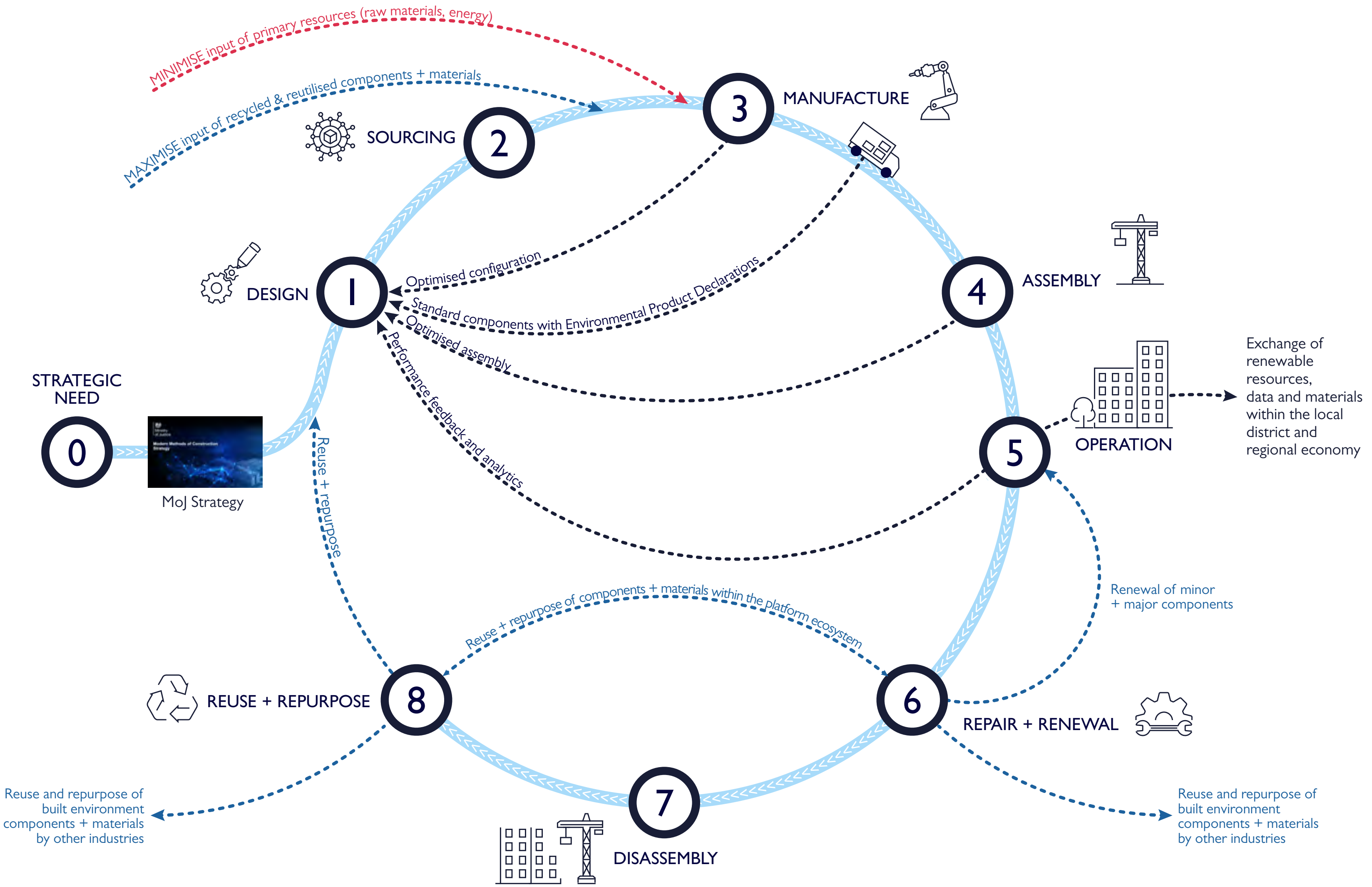


Source: DLUHC, Kit of parts

CIRCULAR 'PLATFORM' ECOSYSTEM

Linked to earlier comments, the Ministry of Justice have been able to realise many of the benefits of a 'circular ecosystem' by using a platform based approach. The visual below (adapted from Arup) highlight some of the practice steps undertaken by the Ministry. This review of the substructures is part of feedback, analysis and optimisation process.

1	Adoption of net zero electrical options for heating and water requirements Reduction in floor loadings Implementation of low carbon concrete
2	Requirement to locally source Principle of reducing building volume to reduce material demand
3	High pre-manufactured value of assets driven by platform approach to 'smart' precast building components and MEPH services
4	Offsite assemblies and sub-assemblies reduces workforce demand Adoption of low carbon plant and equipment on site
5	Platform and programme approach captures high quality data, which is then fed back into design standards
6	The requirement of a 120-year design life for structures and 60 years for facades results in low maintenance assets
7	Service assets are built so that internal areas can be reconfigured over the life time of the asset
8	When demolishing old assets the crushed concrete material is used on the new build and steel is recycled



Source: Adapted from Arup, circular economy

CARBON VISUALISATION WITHIN SUB-STRUCTURES

PROJECT SCOPE AND KEY FINDINGS

In looking to tackle carbon, the MoJ has focused to date on the highest impact areas of above-ground structures, facades and net zero energy of standard assets, with particular focus on the houseblock, due to its repeatable nature, across the estate.

Previous projects to reduce embodied carbon within both the structure and net zero in operation, utilised solutions embedded within the design principles. One of the next opportunities is to apply the same thinking to sub-structures and the site-wide infrastructure.

To focus in on the right areas, we have calculated the carbon in each element in order to visualise its impact and the areas that should be prioritised to make the most significant savings.

The following section reviews the data in different formats to inform the route map for future carbon reduction.

- Total embodied carbon within Substructures and infrastructure is kg CO_2e is 14,346,223.31 the equivalent of 7.35 houseblock structures (kgCO_2e [A1-A5] kgCO_2e 1,951,381)
- A1 - A3 [Product: Raw Material Supply, Transport, Manufacturing] overall is the most carbon intensive lifecycle stage for all substructure and groundworks making a proportion of 71.79%
- A5 [Construction: Construction Installation Process] is the second most carbon intensive stage making up 16.78%
- C2 - C3 [End of Life: Transport (2.03%), Waste Processing (8.29%)] make up the remaining majority 10.32%
- The top five most emitting resources are all concrete or steel related products.

We used the new 1,700-place prison at Glen Parva as our research project, undertaking calculations to establish the carbon content within the sub-structures and foundations of the built assets. This included below-ground drainage, hard landscaping, soft landscaping and security fencing across the following built assets.

- 7 houseblocks
- Casu
- Kitchen
- Workshops
- Entrance Resource Hub
- Central Service Hub
- Kitchen

Source: Lendlease, Glen Parva

CALCULATION PRINCIPLES

Taking quantities from HMP Glen Parva, we broke these down into both material and asset composite parts. We also looked at operational activities on site at an aggregated level, using relevant EPDs or trade data to provide an overview of cradle to practical completion [A1- A5] carbon impacts. Using industry data we measured cradle to grave [A1-C4] and beyond the building lifecycle [D]. Sources of carbon were identified and assigned with appropriate carbon factors to obtain kgCO_2e per unit of measure. This resulted in the carbon calculators using One Click LCA software.

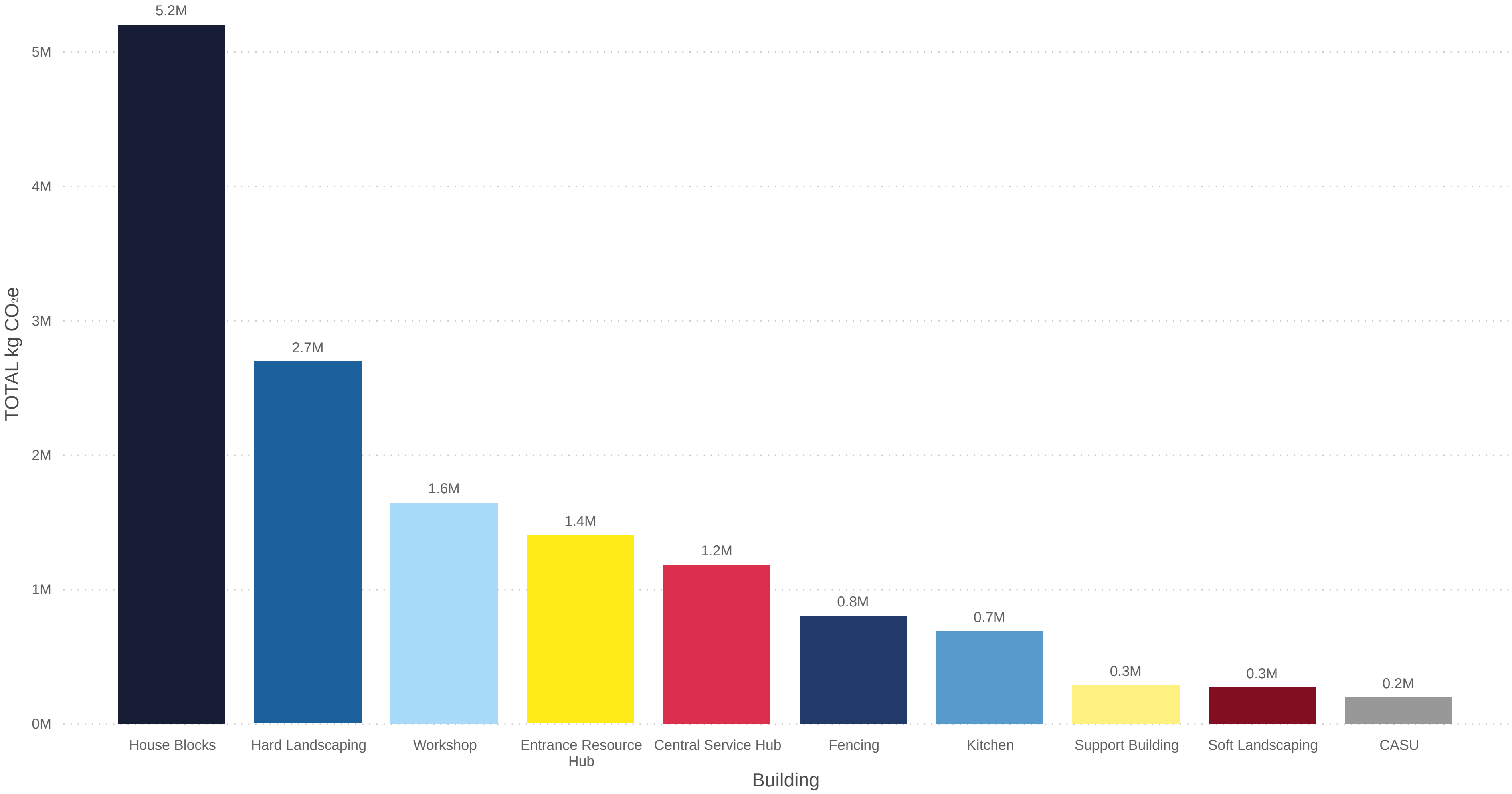
By working through the different benchmarks and sourcing Environmental Product Declarations (EPD) data, we developed a real world scenario, with a combination of carbon factors that most accurately reflected the supply chain and the materials deployed.

- Material quantity is based on Glenn Parva
- Assumed distance for transportation of the resource used is set to 5km for all materials to provide an 'average location approach'. We believe 5km to be representative due to the proportion of mineral products
- Where the exact specification of materials could not be obtained (for example recycled content), a national average has been used
- Where the exact material could not be used, a likewise material of the same grade or type has been substituted
- Site impacts are calculated through value of works undertaken (lifecycle stage A5)
- Electricity site usage could not be obtained and is therefore omitted from the calculation leaving lifecycle stage B6a blank (usage would have minimal affect)
- We have been unable to locate EPDs for security fencing and kerbs and so equivariant material data has been used
- Whilst every effort has been made to use accurate data, the report relies on a number of third party sources that have not being verified.

CALCULATOR	STANDARD	DESCRIPTION
CONCRETE CARBON CALCULATOR	PAS 2050:2011	A product carbon foot printing methodology developed by the British Standards Institute (BSI)
	BS EN 15804:2012	The European Standard developed to provide "Core Rules" for the environmental life cycle assessment and production of Environmental Product Declarations
	EN 16757	The product standard developed by the CEN Technical Committee responsible for concrete and provides a further specification of EN 15804 for concrete
BUILDING LEVEL CARBON CALCULATOR	EN 15978	The European Standard developed to provide overarching methodology for the environmental life cycle assessment of buildings. It follows the same principles and methodology as EN 15804 for construction products
	RICS Professional Statement on Whole Life Carbon Assessment for the Built Environment	An implementation of EN 15978 provided for the UK, giving relevant defaults, sources of data and proposing a recommended scope for assessment
	EN 16757	Provides guidance on the assessment of carbonation for concrete. This has also been considered as part of the review

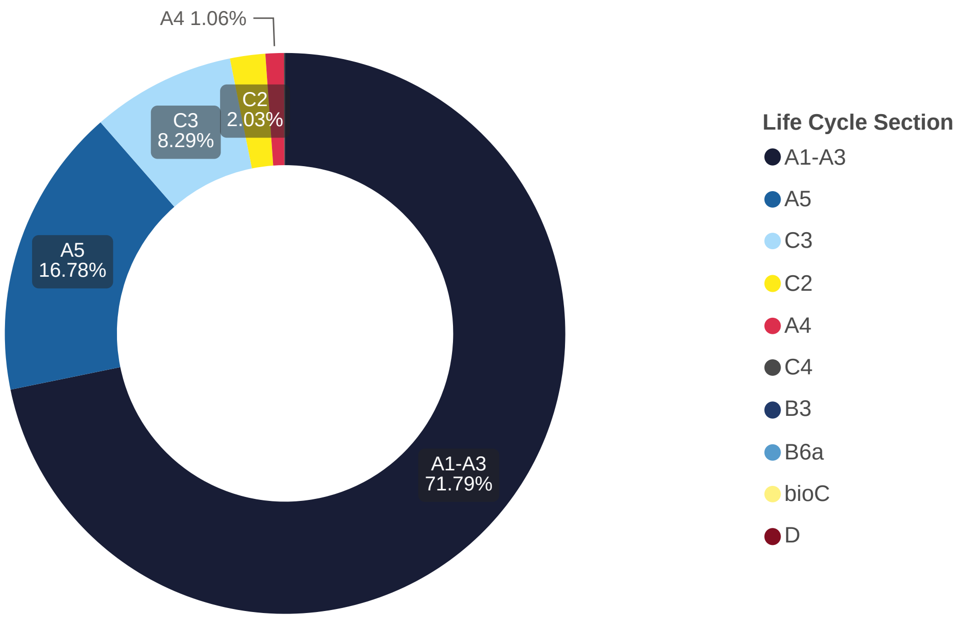
Total $kgCO_2e$ by building

- Comparison of building substructures and materials classified within hard landscaping, soft landscaping and fencing
- Houseblocks incudes all seven on the site.



Lifecycle stages for all projects

- The table shows the volume by life cycle stage and by asset type
- The bulk of carbon is within A1 - A3 and is dominated by concrete and steel products.



Building	Sum of TOTAL kg CO_2e
CASU	193,340.80
Central Service Hub	1,179,114.48
Entrance Resource Hub	1,400,918.43
Fencing	800,940.34
Hard Landscaping	2,691,943.84
House Blocks	5,197,896.51
Kitchen	685,998.02
Soft Landscaping	267,186.26
Support Building	285,566.89
Workshop	1,643,317.75
Total	**14,346,223.31**

14.35M
TOTAL kg CO_2e

14.43M
A1-A3 TOTAL kg CO_2e

212.67K
A4 TOTAL kg CO_2e

3.37M
A5 TOTAL kg CO_2e

0.00
B3 TOTAL kg CO_2e

0.00
B6a TOTAL kg CO_2e

-1.35M
bioC TOTAL kg CO_2e

408.81K
C2 TOTAL kg CO_2e

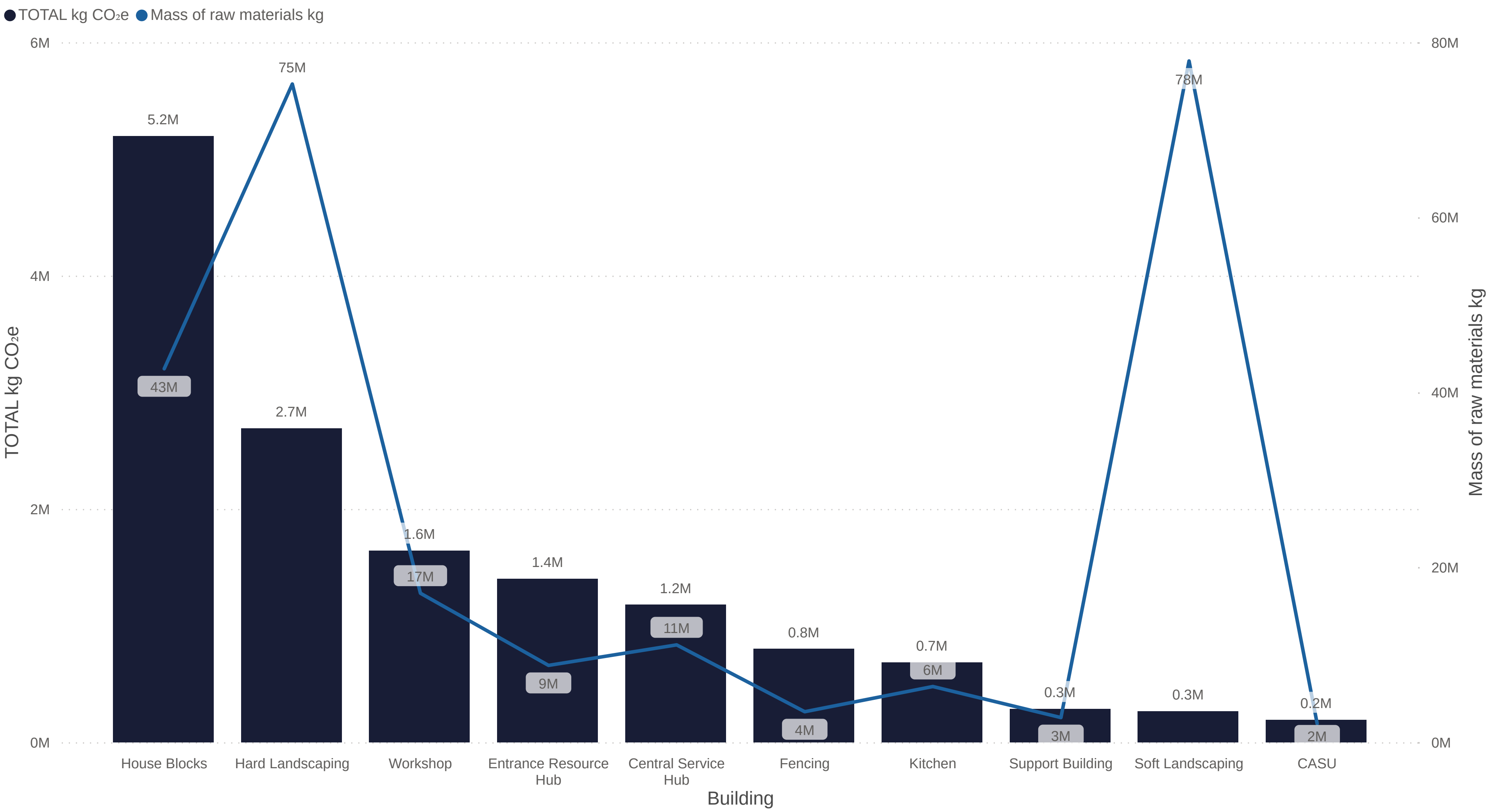
1.67M
C3 TOTAL kg CO_2e

12.47K
C4 TOTAL kg CO_2e

-4.40M
D TOTAL kg CO_2e

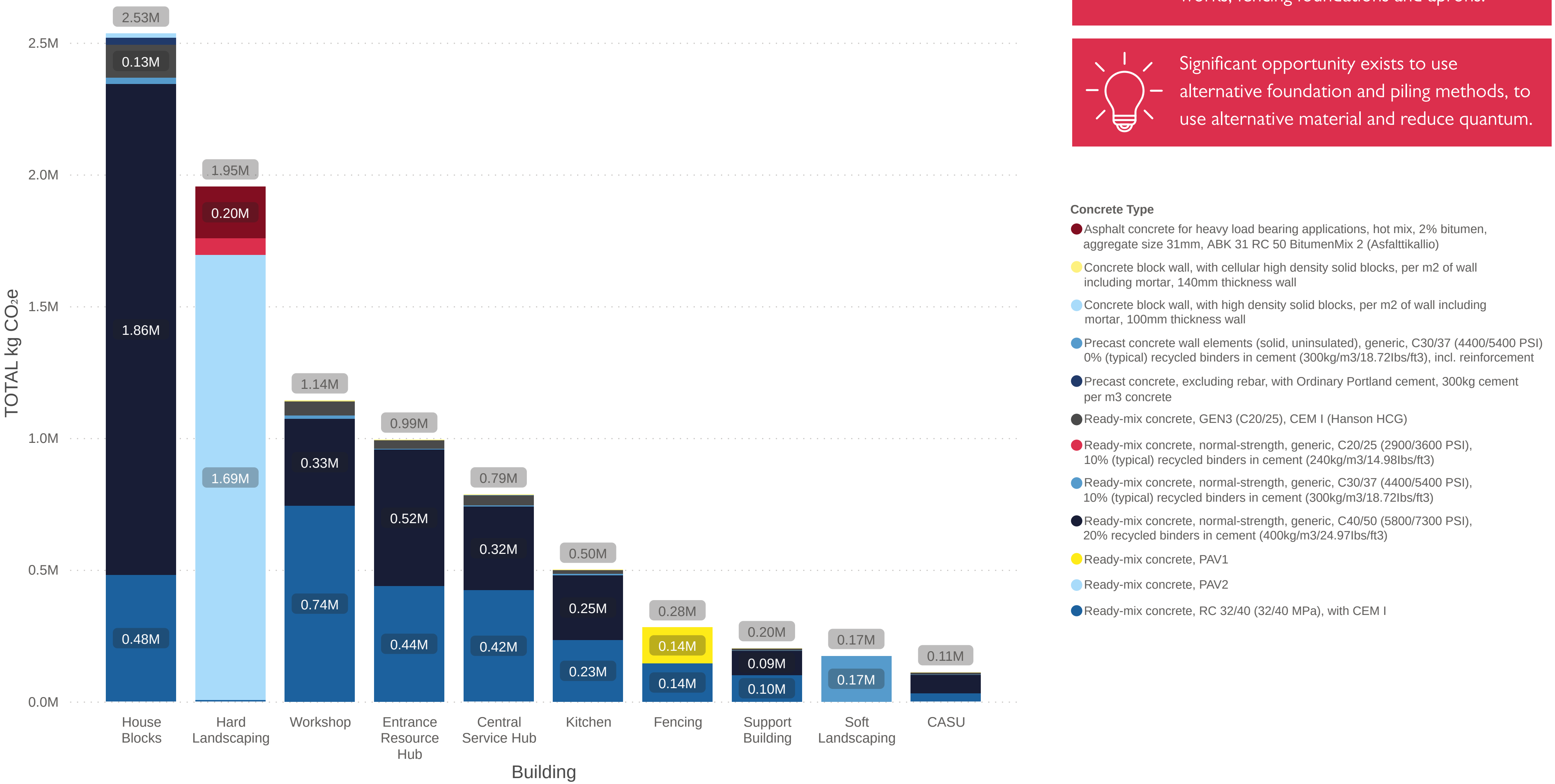
Total $kgCO_2e$ and mass of raw materials kg by building

- The table visualises the amount of carbon within the substructures of each asset, compared with the hard landscaping, fencing and soft landscaping
- The bars represent the volume of carbon compared to the line that represents the volume of material. One third of carbon is within the houseblock substructures, as expected. The lowest impact by volume is within the soft landscaping.



Total kgCO_2e concrete mix by building

- The table visualises the CO_2e by concrete mix type within each classification.

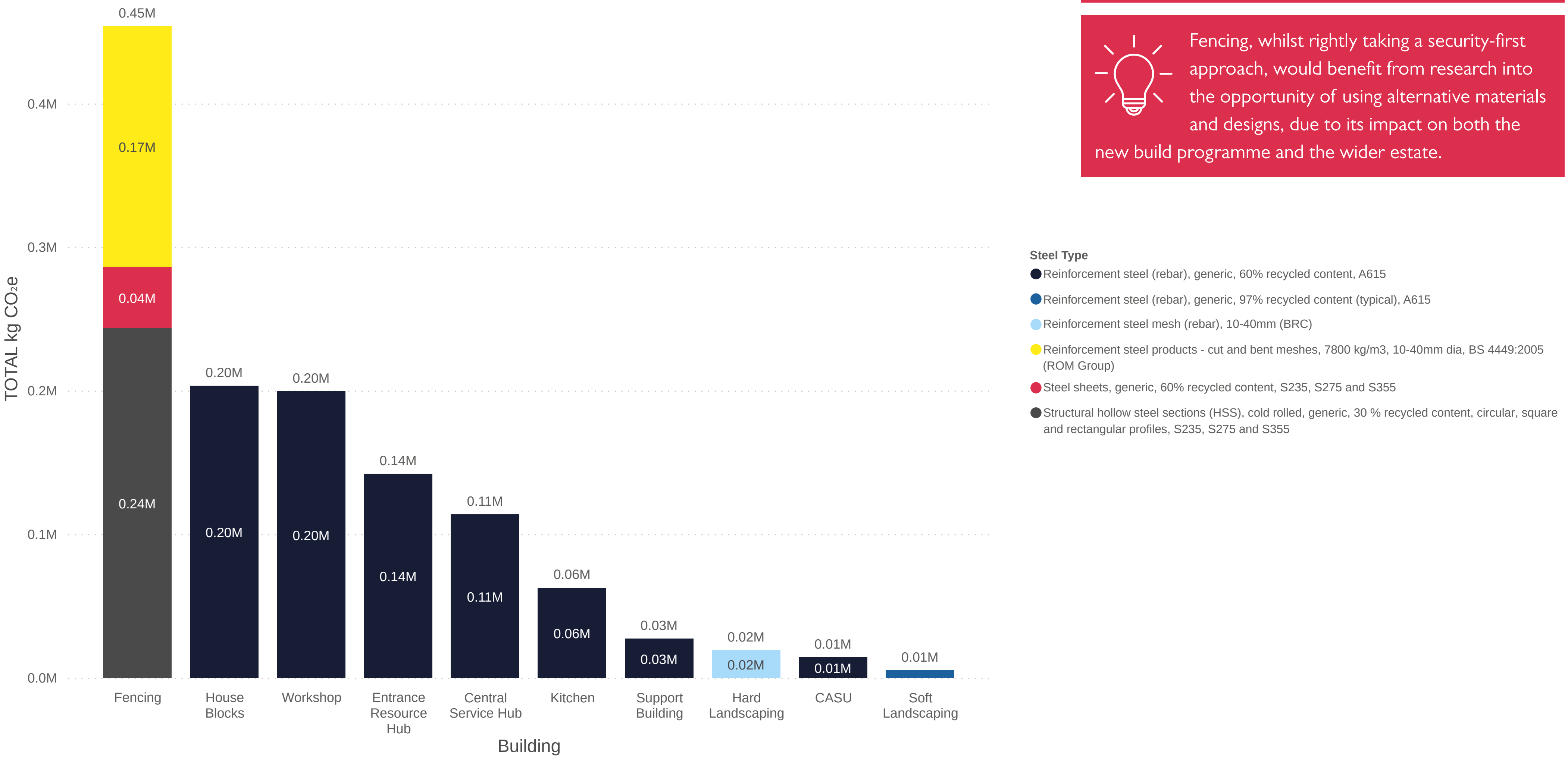


Significant opportunity exists to use reduced carbon concrete mixes both within the sub-structure design but also the external works, fencing foundations and aprons.

Significant opportunity exists to use alternative foundation and piling methods, to use alternative material and reduce quantum.

Total kgCO_2e steel type by building

- The table visualises the volume of steel within each classification.



Significant opportunity exists to ensure that the most sustainable reinforcement is used to minimise carbon impact.

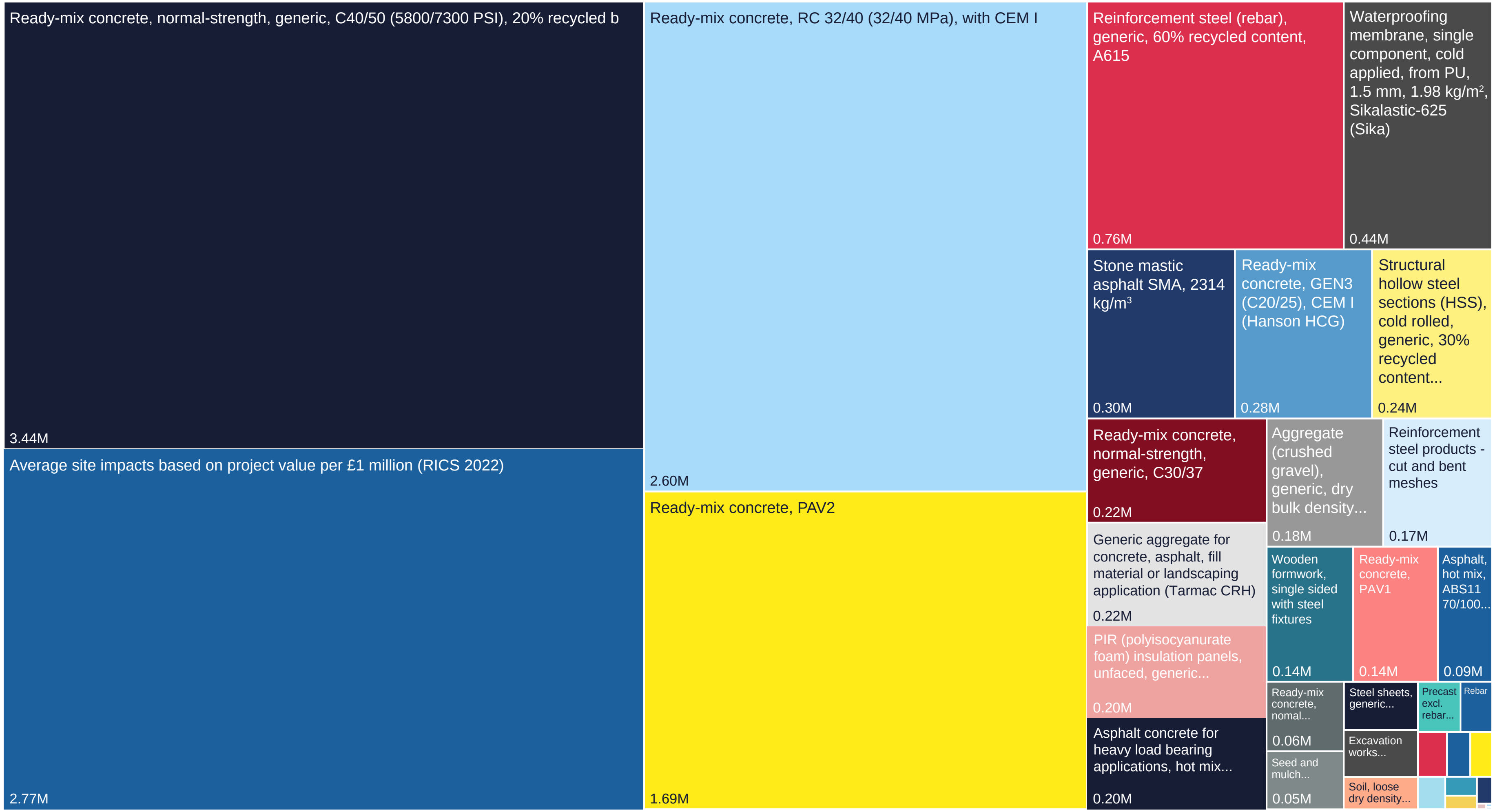
Fencing, whilst rightly taking a security-first approach, would benefit from research into the opportunity of using alternative materials and designs, due to its impact on both the new build programme and the wider estate.

Total $kgCO_2e$ by material type

- The table visualises the carbon impact of all materials and site impacts
- Different types of concrete dominate the carbon footprint.

Opportunity exists to implement policy around the use of zero-emissions plant and sustainability measures during construction.

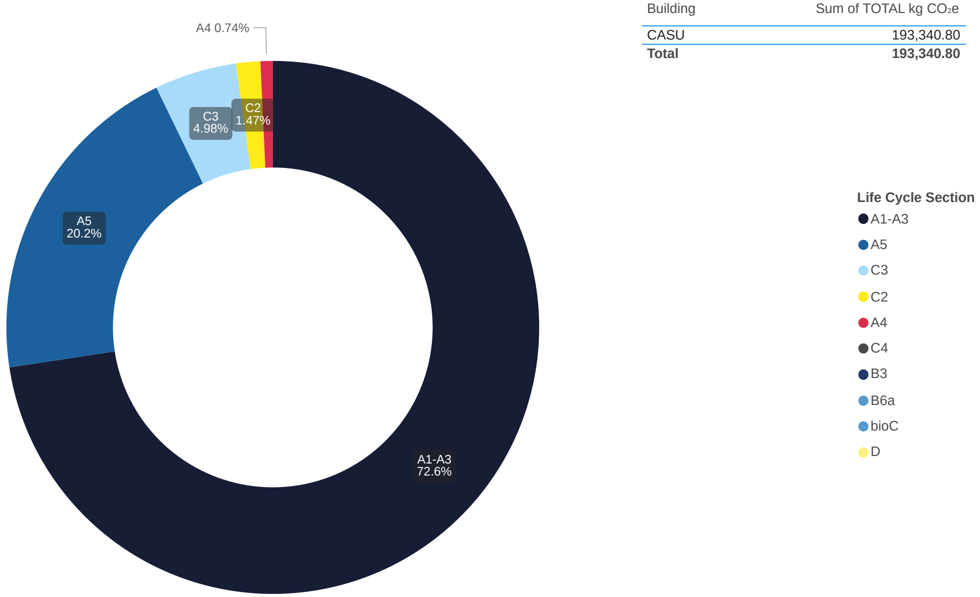
Use of reduced-carbon hard landscaping materials such as low temperature asphalt. Recognising that hard landscaping renewal is also required on across the wider estate.



LIFECYCLE BREAKDOWN BY BUILDING

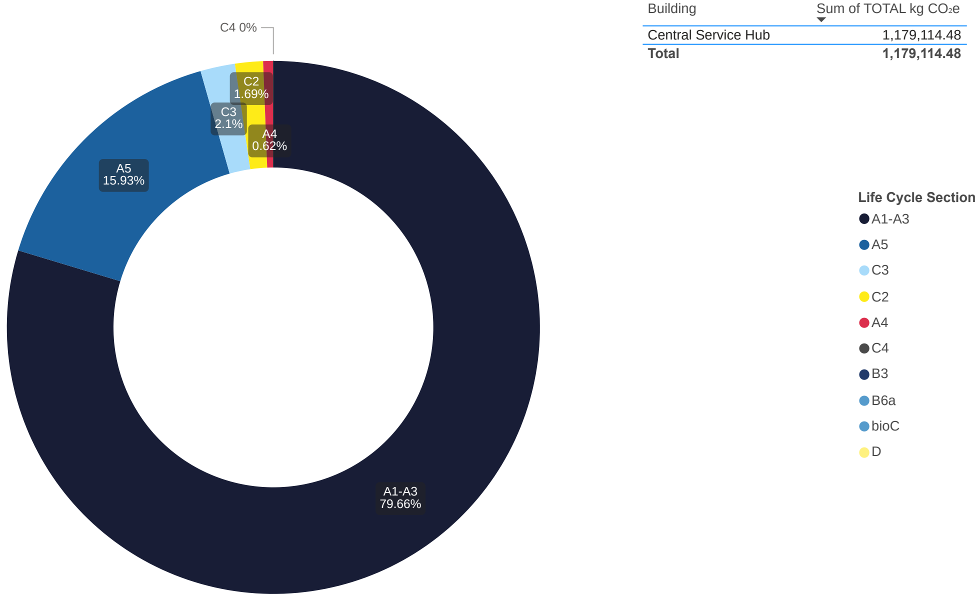
CASU

Building	Sum of TOTAL kg CO_2e
CASU	193,340.80
Total	**193,340.80**



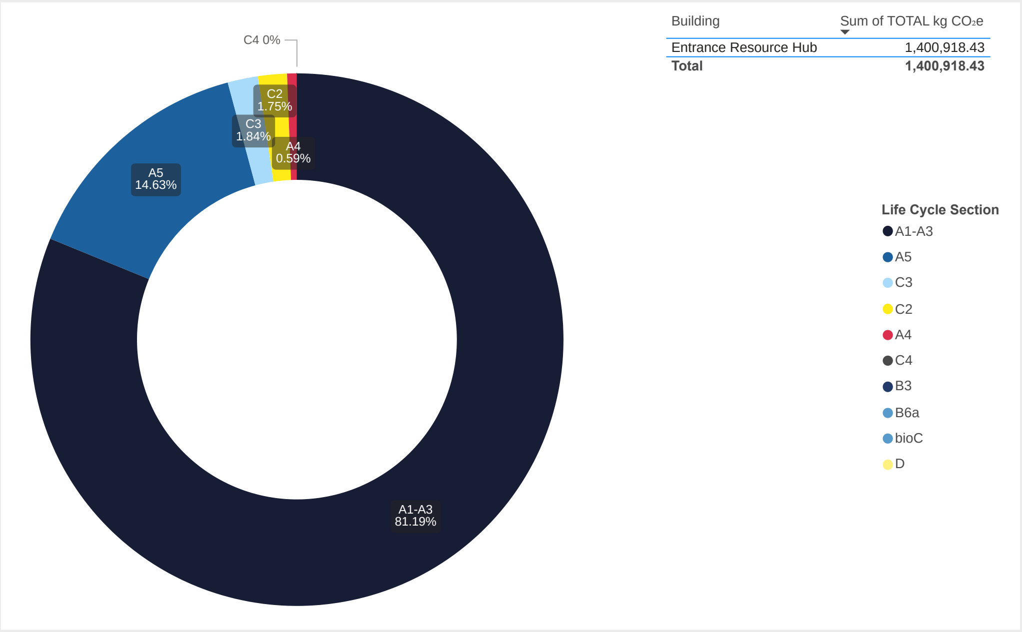
Central Service Hub

Building	Sum of TOTAL kg CO_2e
Central Service Hub	1,179,114.48
Total	**1,179,114.48**

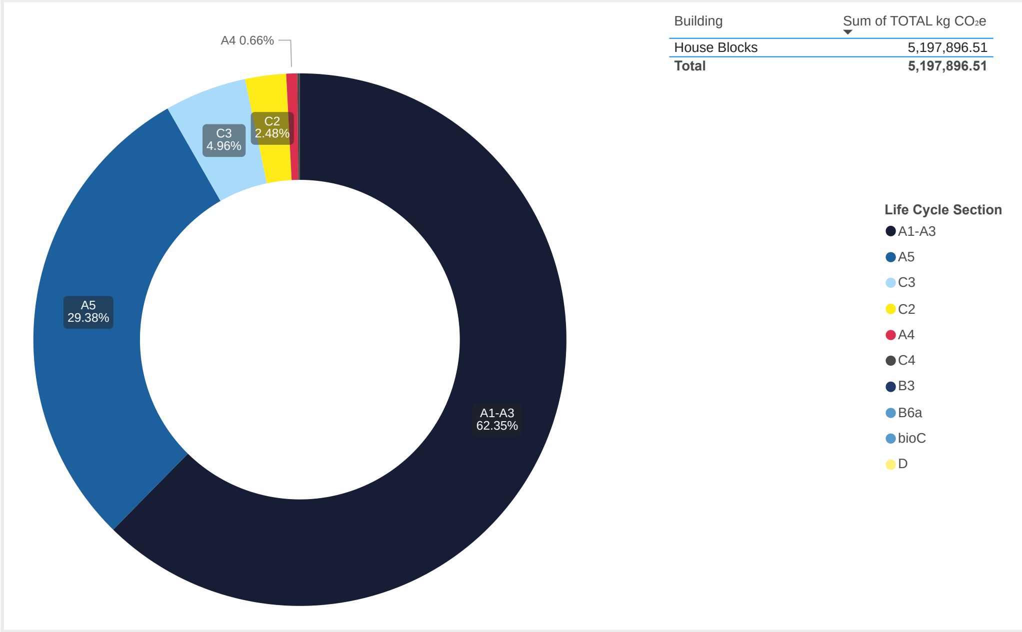


LIFECYCLE BREAKDOWN BY BUILDING

Entrance Resource Hub



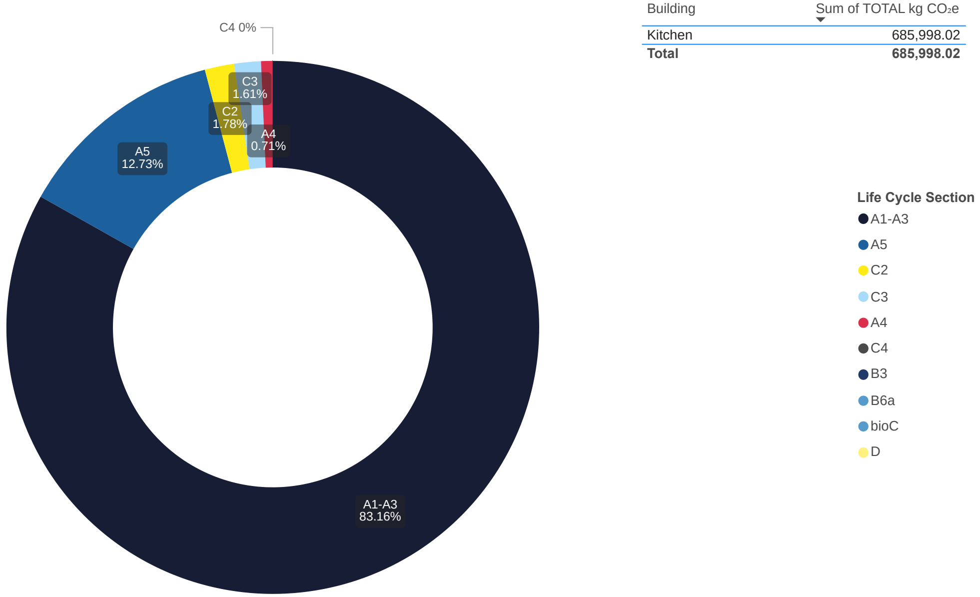
Houseblocks



LIFECYCLE BREAKDOWN BY BUILDING

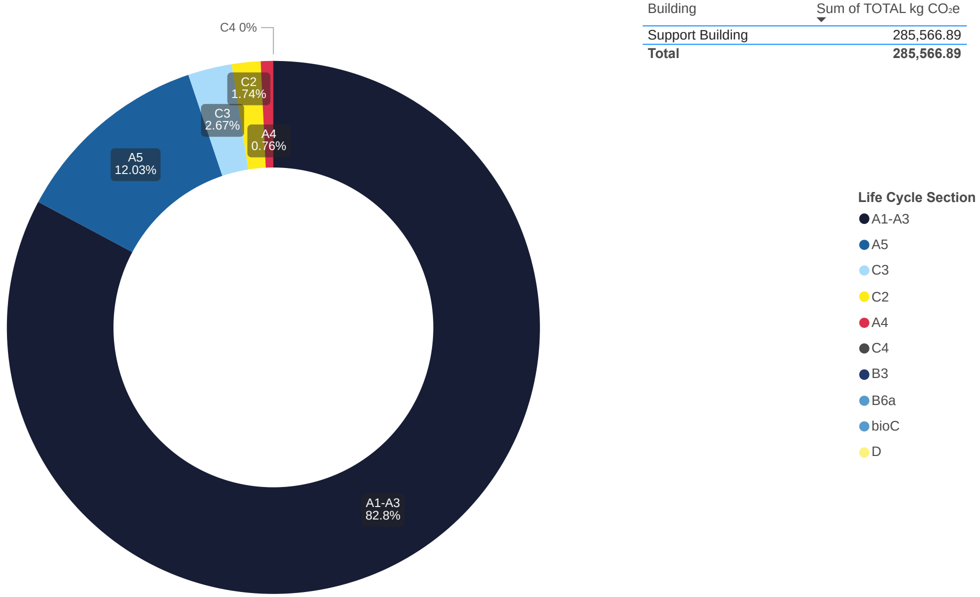
Kitchen

Building	Sum of TOTAL kg CO₂e
Kitchen	685,998.02
Total	**685,998.02**



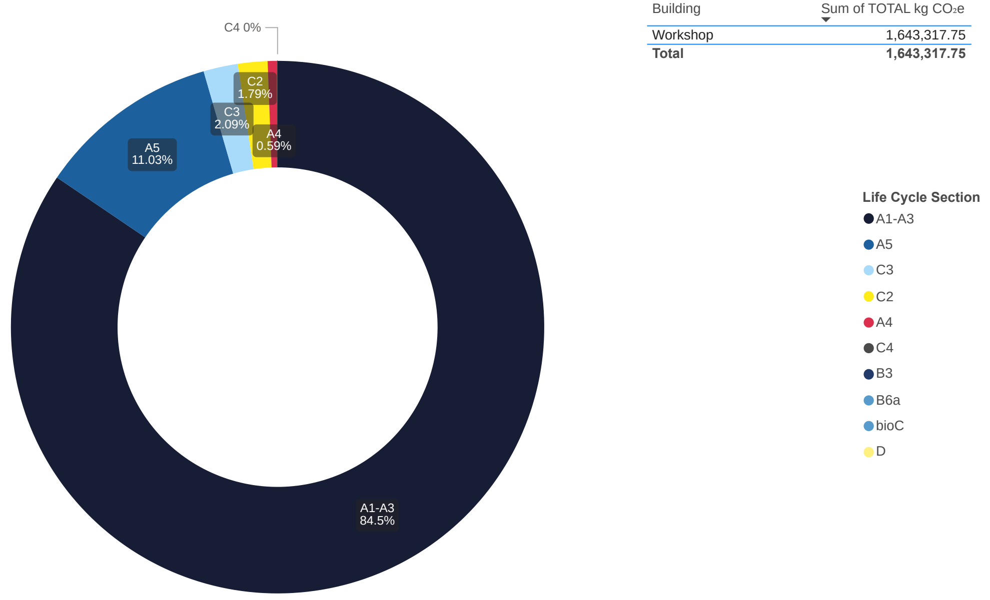
Support building

Building	Sum of TOTAL kg CO₂e
Support Building	285,566.89
Total	**285,566.89**



LIFECYCLE BREAKDOWN BY BUILDING

Workshop

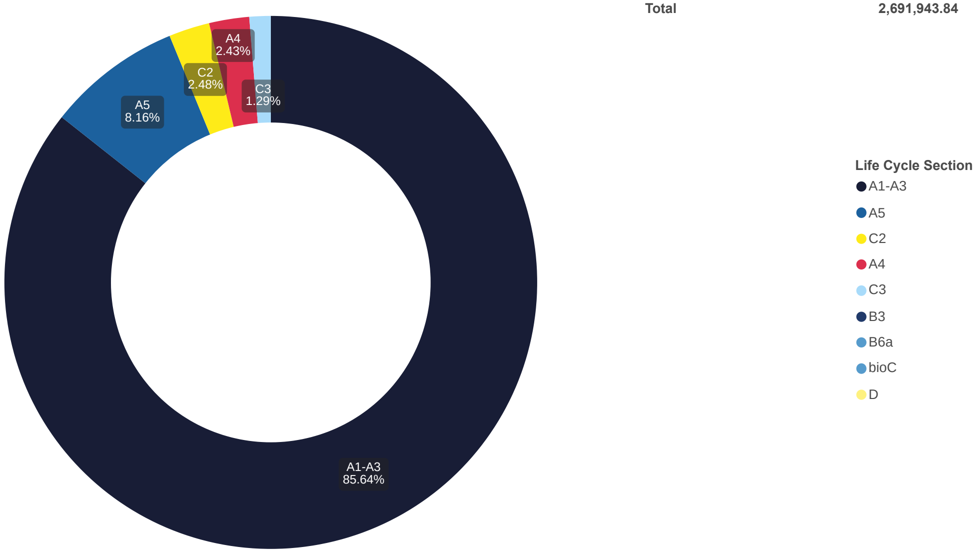


Building	Sum of TOTAL kg CO_2e
Workshop	1,643,317.75
Total	**1,643,317.75**

LIFECYCLE BREAKDOWN BY OTHER ASSET TYPES

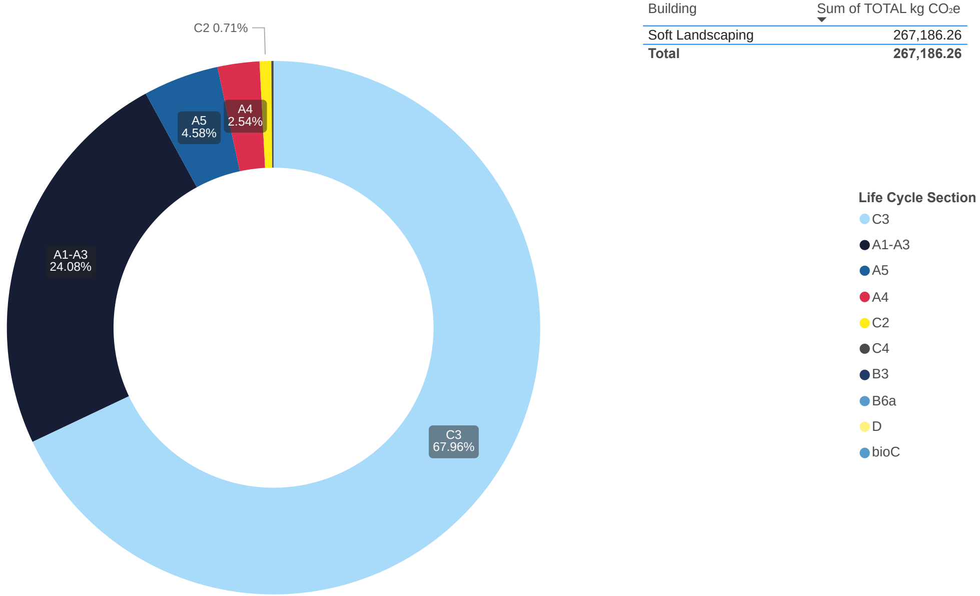
Hard landscaping

Building	Sum of TOTAL kg CO_2e
Hard Landscaping	2,691,943.84
Total	**2,691,943.84**



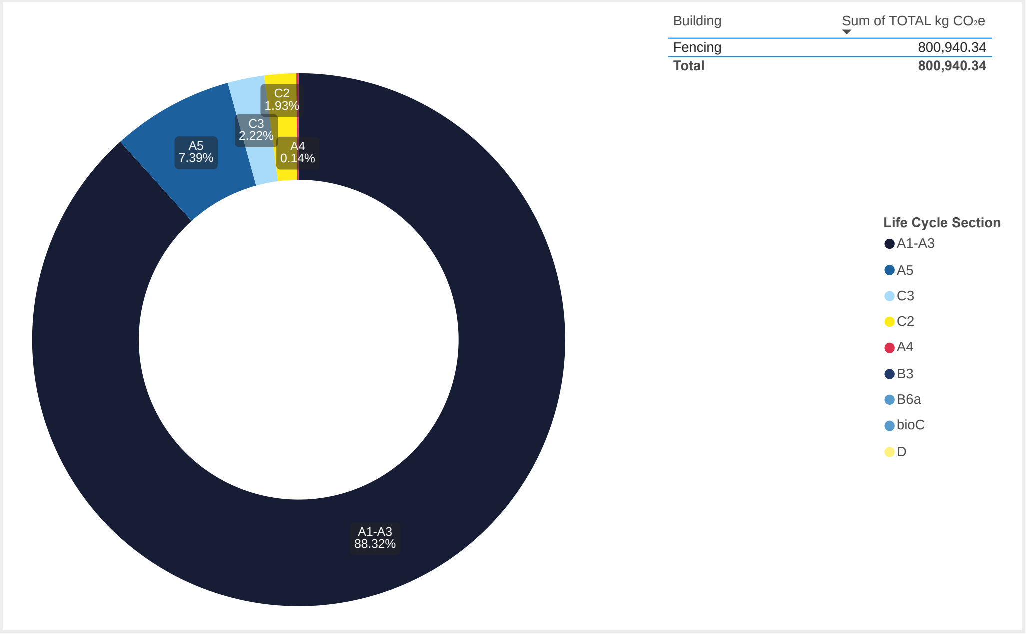
Soft landscaping

Building	Sum of TOTAL kg CO_2e
Soft Landscaping	267,186.26
Total	**267,186.26**



LIFECYCLE BREAKDOWN BY OTHER ASSET TYPES

Fencing



OPPORTUNITIES TO DELIVER REDUCED CARBON

REDUCING CARBON IN FOUNDATION DESIGN

Substructure design within prisons and, in particular, houseblocks, has traditionally specified the use of ground beams, pile caps and CFA piles. This is predominantly due to the weight of the buildings and ground conditions, which are often made ground.

However, following an extensive review, the Curtins engineering team has identified that opportunity exists within the way substructure design is thought about and delivered, which, if applied, could deliver significant carbon savings.

Ground improvement techniques have a lower carbon impact and, once the ground-bearing capacity is improved, can be combined with a wider range of less carbon intensive foundation designs.

Established methods include admixtures such as lime or cement stabilisation, wet and dry deep soil mixing, and soil stabilisation GGBs. This requires a mature supply chain to deliver ground improvement and, whilst every site isn't suitable, the majority would benefit from this approach.

When combined with alternative piling approaches, such as Vibro stone columns, overall savings could be in excess of 50%, when compared with traditional CFA piling.

Furthermore, we are seeing a number of new piling methods that both reduce carbon and allow the incorporation of heat recovery systems within the element. With the expectation that this technology will mature in the near future, these opportunities are recommended to be monitored and reviewed by the department.


Decarbonisation of Prisons

Foundations Solution Review - Calculations

Curtins Ref: 083232-CUR-00-XX-RP-Z-00001

Revision: P01

Issue Date: 03 March 2023

Security Classification: OFFICIAL

curtins

Source: Curtins, reducing carbon design process

DECARBONISING CONCRETE

Carbon-reduction thinking is becoming widely adopted within building structure design, however it is not always carried through within specifications relating to foundations, piling or in the extensive areas of hard landscaping such as kerbs, drainage, road and footpath construction. This may be relatively unique to the MoJ, in terms of their extensive use of concrete within security fencing foundations and defence measures.

Concrete is a unique material, in that the specifier can directly influence its constituent parts to ensure an optimum carbon footprint. Certain aspects can be adjusted to meet performance criteria, address design imperatives of resource and energy efficiency within a whole life context, and apply the principles of a circular economy.

Cement only makes up a small percentage of concrete mixes, however it is almost exclusively responsible for the CO_2 emissions associated with concrete production. By replacing a proportion of cement with alternative materials, the environmental impact of concrete production can be lowered.

Source: Institution of Civil Engineers (ICE)

REDUCING CARBON IN PRISON FENCING

The MoJ has, for many decades, applied a platform approach to its security fencing, resulting in highly-defined technical standards and standard details that are rightly security-focused. These bring standardisation both to the constructed security measures, as well as methods of operation and management across the entire estate.

The value of the existing solution cannot be under-estimated, however, due to the specialist nature of the components and supply chain, little work has been done regarding carbon calculation or reduction measures.

MoJ standards for fencing have never been looked at through the lens of carbon. The current design uses a significant amount of steel for posts, mesh and screening, as well as access gates and vehicle locks. It also requires a significant volume of concrete for foundations, patrol paths and anti-burrowing measures.

The opportunity exists to work with the supply chain, and potentially academic partners, to review the materials used and look at either modifying the specification to increase recycled content, within the components and materials for example, or the use of alternative materials.

Source: Binns Fencing

REDUCING CARBON IN HARD LANDSCAPING

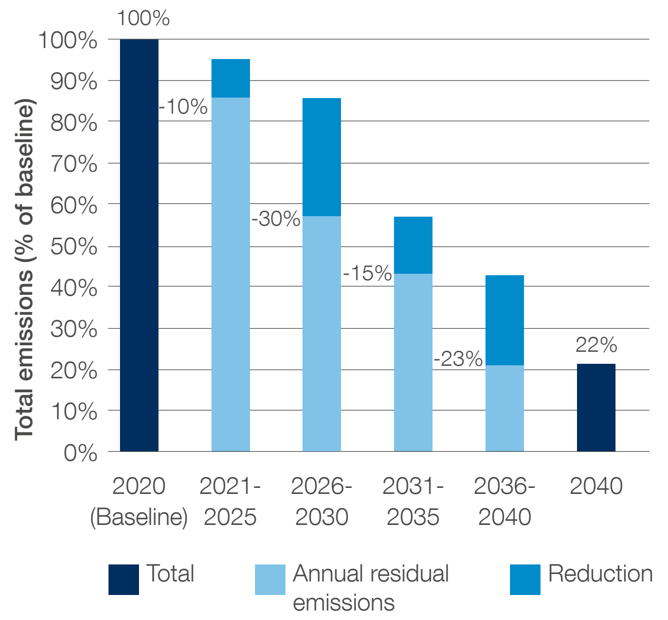
Lean on others

Advantages can be gained through cross-department collaboration. Whilst hard landscaping is not core to the MoJ's focus on design and innovation, it is a key area of development for National Highways. Using shared knowledge specifications can be re defined. In 'Net zero highways: our zero carbon roadmap for concrete, steel and asphalt', National Highways has a defined strategy for key materials. One good example and an opportunity for adoption would be low-temperature asphalt.

Low-temperature asphalt

Innovation in asphalt is moving quickly, with many new products entering the market. One such product is Warm Mix Asphalt (WMA) technology, which has the potential to reduce the embodied carbon of asphalt by up to 15 percent compared to conventional hot mixes. The principle behind the technology is that lower temperatures are used to manufacture the material, requiring less energy and therefore emitting less carbon.

By collaborating with National Highways to remain informed about advances, specifications can be regularly updated in line with material technologies to reduce emissions by 78% by 2040.



Current asphalt decarbonisation trajectory

Source: National Highways

ACTION PLAN

	SHORT 1-3 MONTHS		MEDIUM 6 MONTHS		LONG 1 YEAR PLUS	
REDUCING CARBON IN FOUNDATION DESIGN	Review construction and cost constraints	Identify suitable trial project	Design and implementation	Trial project	Lessons learnt	Implement as technical standard
DECARBONISING CONCRETE IN INFRASTRUCTURE	Review and update site infrastructure standards to include carbon reduction targets	Identify suitable trial project	Design and implementation of trials	Trial project	Review of innovation	Update technical standards in line with advancement
REDUCING CARBON IN PRISON FENCING	Work with manufactures to undertake accurate measurement	Work with manufactures to gain EPD for materials	Work with suppliers and acedemic institutions to look at alternative materials	Work with suppliers to look at increasing recycled content and circular economy principles	Trial projects	Update technical standards in line with advancement
	Update standards to require EPDs for materials		Establish what circular economy principles look like for fencing			
REDUCING CARBON IN HARD LANDSCAPING	Establish working relationship with Highways England	Knowledge exchange	Identify suitable trial project	Design and implementation of trials	Trial project Review of innovation	Update technical standards in line with advancement

Report prepared by

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