RAMBØLL

Bright ideas.
Sustainable change.

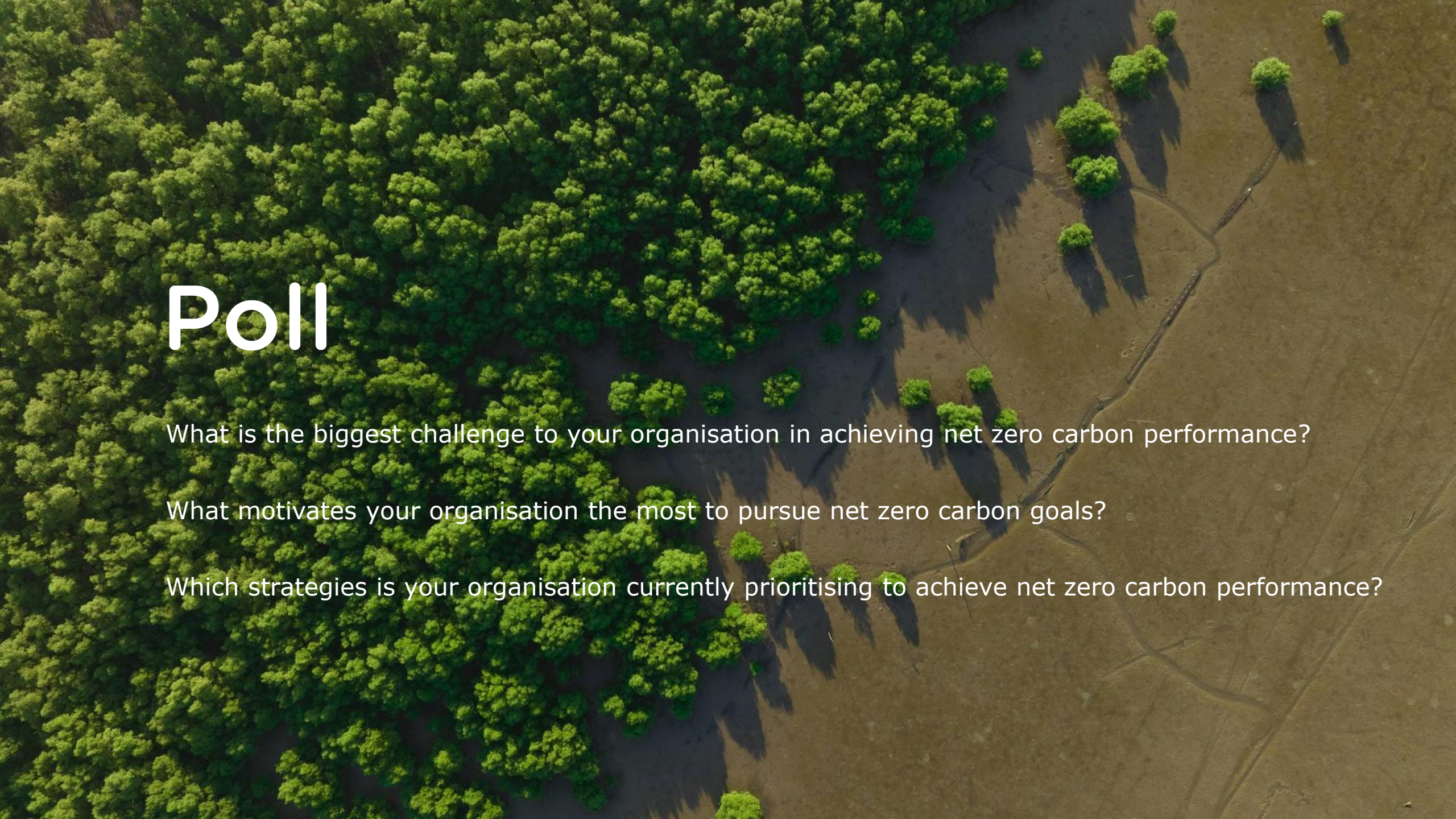
Food and Drink Federation Webinar

Net Zero Carbon for Buildings

20 November 2024

Agenda

1. Poll
2. Introduction
3. Net Zero Evolution
4. Modelling tools in support of the NZC Agenda
5. Example: Network Rail
6. Wrap up



Poll

What is the biggest challenge to your organisation in achieving net zero carbon performance?

What motivates your organisation the most to pursue net zero carbon goals?

Which strategies is your organisation currently prioritising to achieve net zero carbon performance?

Introduction

INTRODUCTION

Austen Bates, Sustainability Director - Buildings UK

James Thomson, Head of Digital Innovation-Building Services UK

RAMBØLL

Founded **1945** in Denmark.
Purpose driven for 70 years.

Owned by Rambøll Fonden.
Foundation owned.

Nordic sustainability and design led engineering.

Top 3 buildings designers in Europe.

Particularly strong presence in the Nordics, the UK, North America, Continental Europe, Middle East and Asia Pacific.

RAMBØLL

Global presence:

Offices:

300

in 33 countries

Employees / owners:

>18,000

RAMBØLL

UK presence:

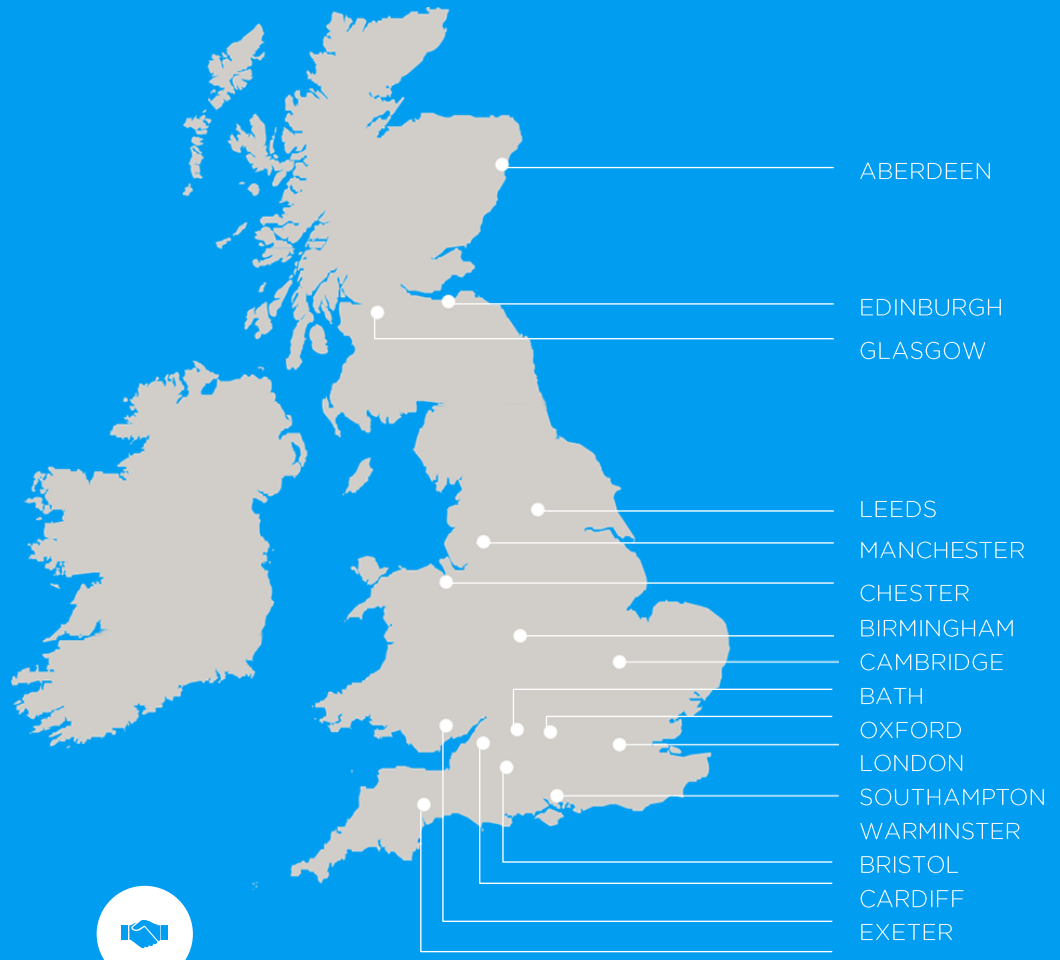
Offices:

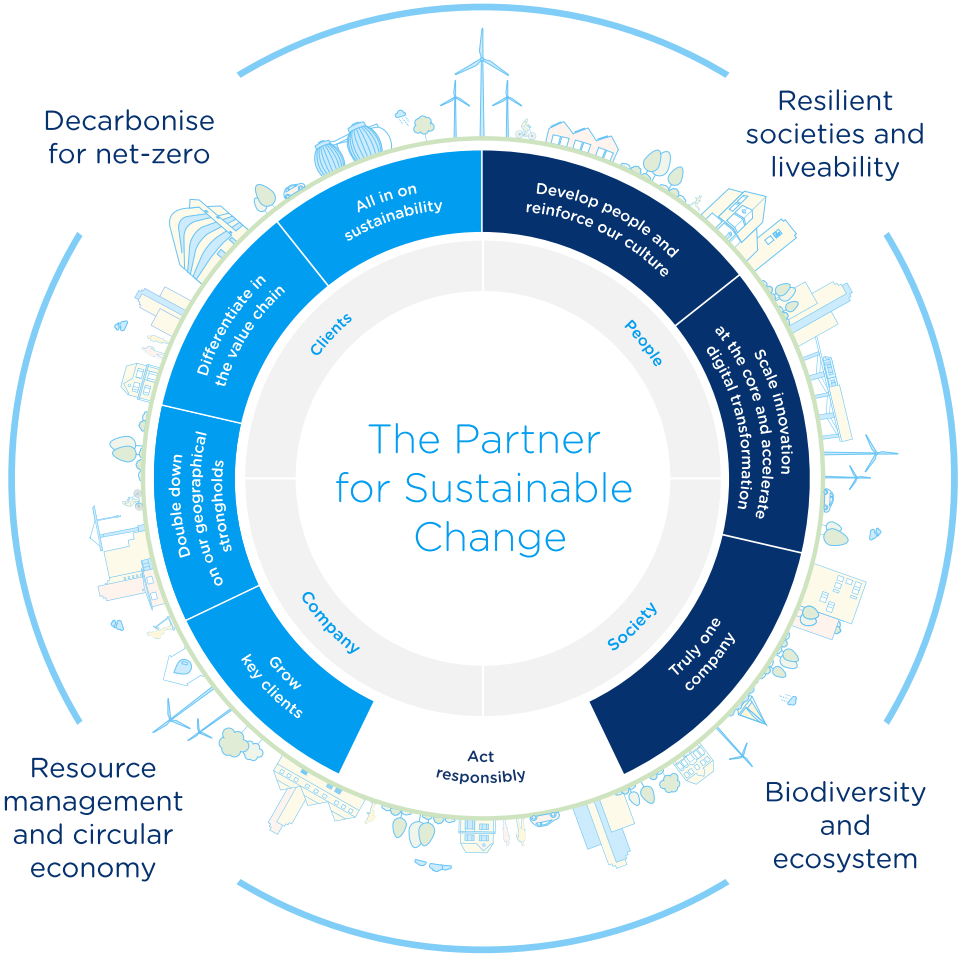
18

Employees:

c1,800

Our key markets:





Our ambition is to become a global leader within four unifying sustainability themes

Resource management and circular economy

Resource management for a transition to circular economy. Design for re-purposing and re-use of natural resources, building materials, lifetime extension, end-of-life and reuse of secondary materials

Resilient societies and liveability

Planning, designing, and retrofitting for resilient, healthy, safe, inclusive and socially coherent societies, cities and communities with attractive and accessible infrastructure and services, mobility, clean water and environment, and economic opportunities

Biodiversity and ecosystem

Protection of natural habitats and biodiversity, restoration of nature and ecosystems, bio-economy, biomaterials, and natural carbon sequestration in ecosystems

Decarbonising for Net Zero

Decarbonisation of the built environment in Buildings, Transport, Water and Energy-intensive industries via sustainable materials and reduced energy consumption

OUR ROLE IN BUILDING A SUSTAINABLE BUILT ENVIRONMENT

Understanding Market trends

Co-authoring world leading reports

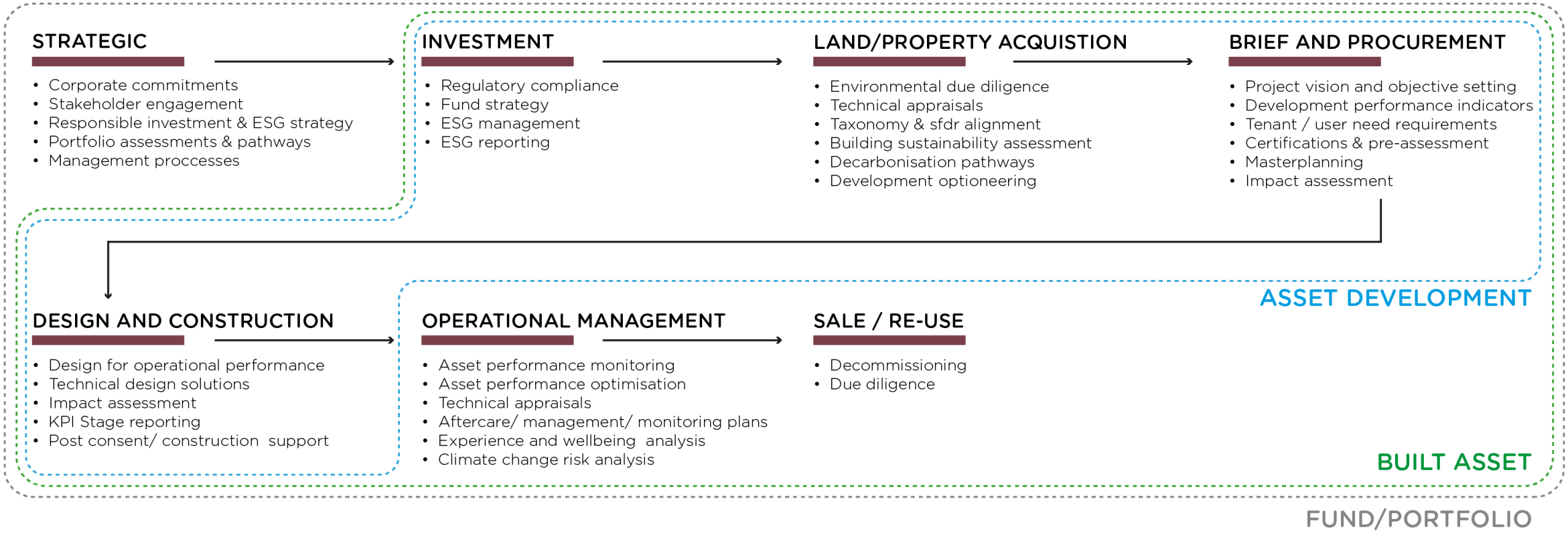
Partnering for industry change

Circular Setting Global Standards

Signatories of Leading Standards

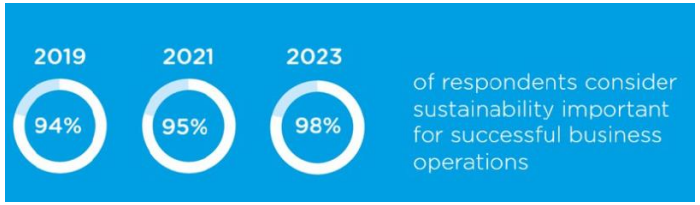
WORKING ACROSS THE ASSET LIFECYCLE

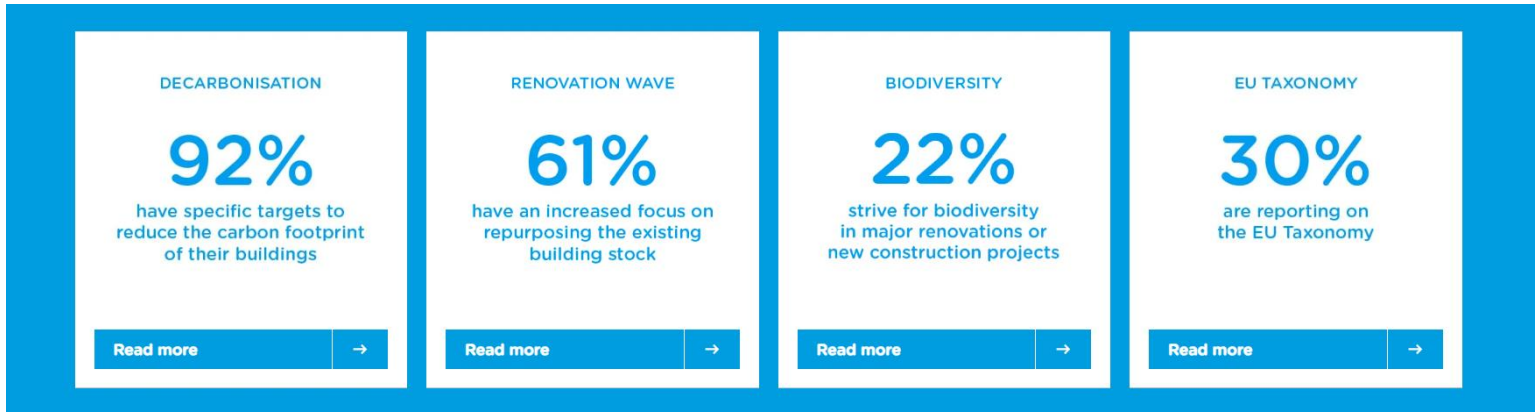
We guide our clients through every phase of the development lifecycle. From formulating and implementing portfolio ESG strategies to crafting tailored sustainability solutions at a building level, we are dedicated to enhancing performance at every stage.



The Rise and Rise of ESG...

The Rise and Rise of ESG





...A 30% increase from 2021

...A 24% increase from 2021

...A 220% increase from 2021

...2021 not considered

...62% thought 'circular economy' was the most important trend for the construction and real estate sector, compared with just 49% in 2021


Net Zero Evolution

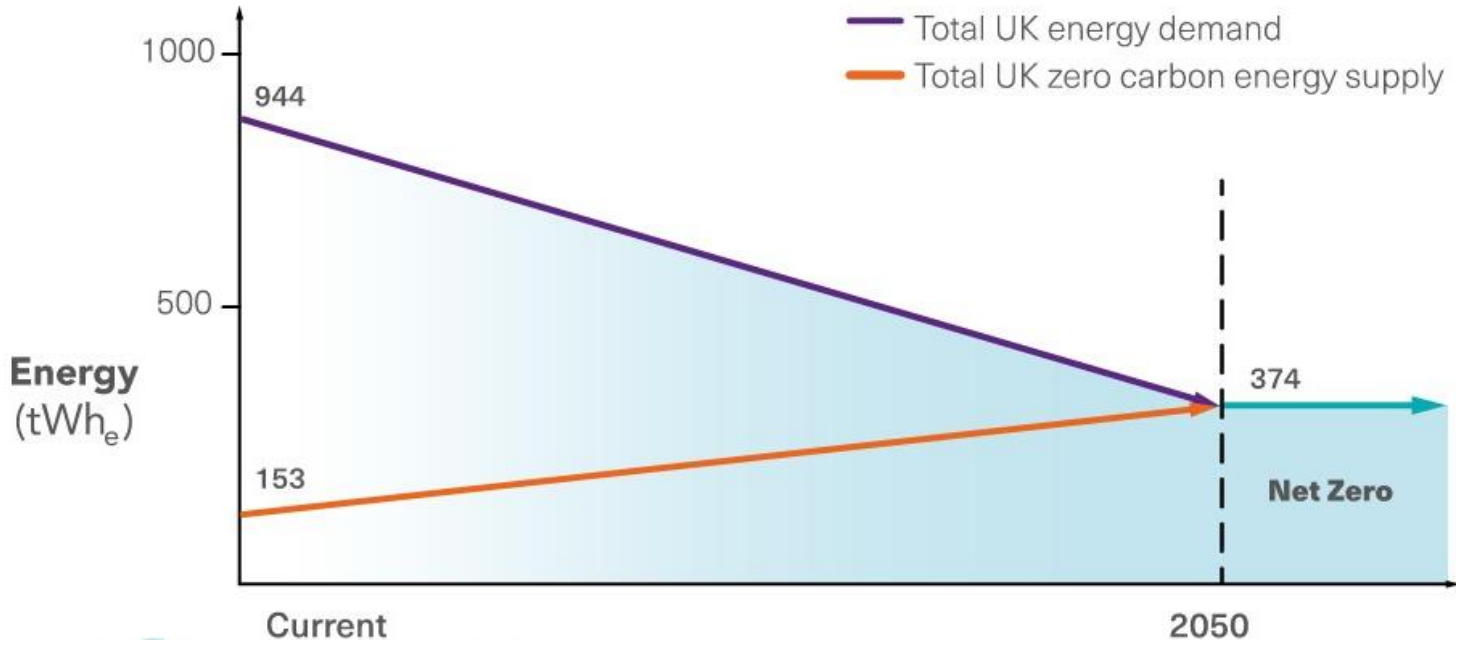
Electrification alone is not the answer

Electrical supplies will become harder to secure as more buildings switch away from fossil fuels.

But the Grid cannot and will not sustain the UK's built assets.

So energy reduction measures are essential to hit the UK's decarbonisation targets and avoid buildings becoming "Stranded Assets".

Figure 1: UK trajectory to a net zero economy



Source; UK Green Building Council

The Changing NZC Landscape

Carbon Risk Real Estate Monitor

LETI / RIBA Climate Challenge / UKGBC Paris Proof (Offices)

Future Homes & Building Standard

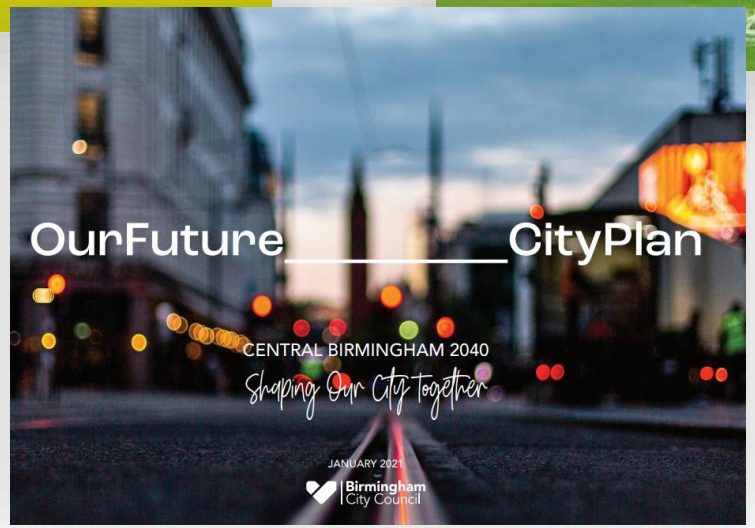
2017 — 2018 — 2020 — 2024 — 2025 — 2050

UKGBC Framework Definition

UK Net Zero Carbon Building Standard

UK Net Zero Target

How this is impacting local policies



The Evolving Policy Landscape

The understanding of Carbon in the market has matured:

- Client NZC 2030 targets now set
- Understanding Whole Life Carbon mainstreaming
- UK NZC Buildings Standard – Pilot Launch Oct 2024

UKNZC Buildings Standard – 13 Sectors

https://www.nzcbuildings.co.uk/pilotversion

- HOMES
- SPORT & LEISURE
- HOTELS
- OFFICES
- RETAIL
- COMMERCIAL RESIDENTIAL
- SCHOOLS
- CULTURE & ENTERTAINMENT
- STORAGE AND DISTRIBUTION
- HEALTHCARE
- SCIENCE & TECHNOLOGY
- DATACENTRES
- HIGHER EDUCATION

UKNZC Buildings Standard - Requirements

Report and meet limits:

- Upfront Carbon
- Operational Energy
- Fossil Fuel Free
- District Heating and Cooling Networks
- Refrigerants
- Heating Delivered

Report and meet targets:

- On-site Renewable Electricity Generation

Optional requirement:

- Offsetting and renewable electricity procurement

Reporting only:

- Life Cycle Embodied Carbon
- Operational Water Use
- Electricity Demand
- Heating and Cooling delivered to the building

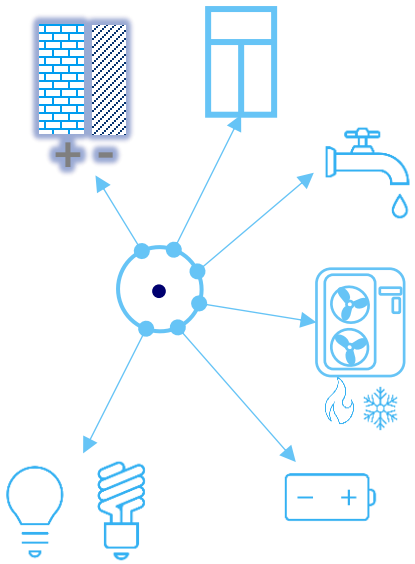
Tools

TOOLS FOR DELIVERY

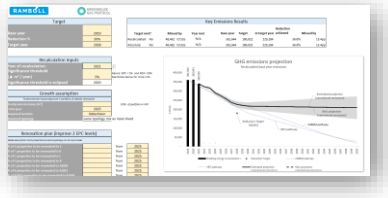
TOOLS

- Workshop
- Surveys
- Best Practice Precedence
- POE / User experience
- Climate change impact assessment
- Wellbeing / environment assessment
- Digital Simulation

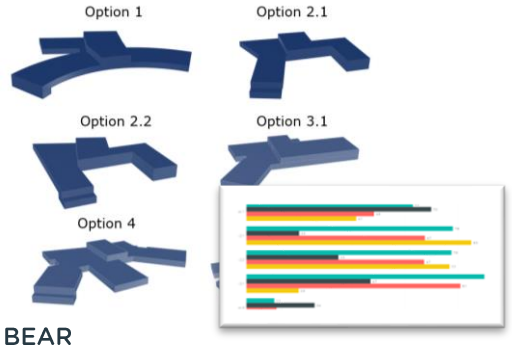
ASSESSMENT



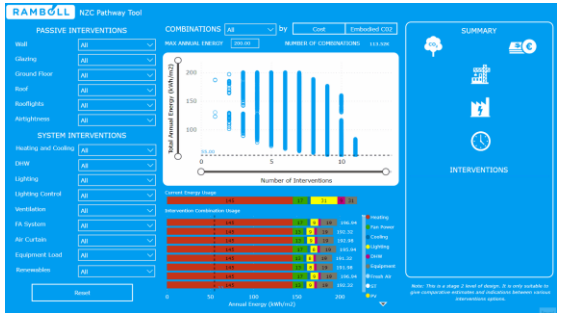
PERFORMANCE



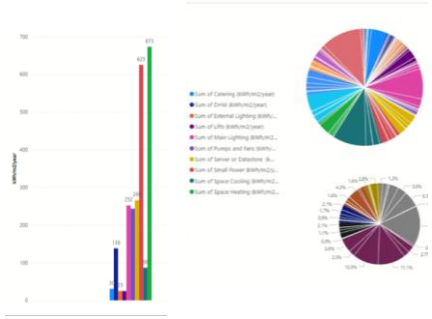
BUILDING DIGITAL TOOLS: OUR PROJECT TIMELINE



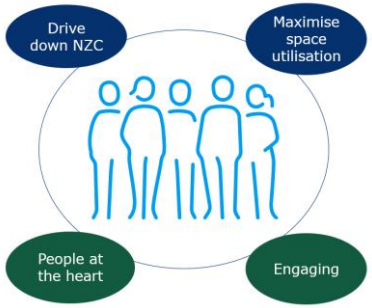
BEAR
A toolbox of early stage analyses built on Rhino and Grasshopper providing early stage comparisons of massing options.



Zebrafish
Zebrafish provides an exhaustive analysis of retro-fit options to decarbonise existing assets at all scales

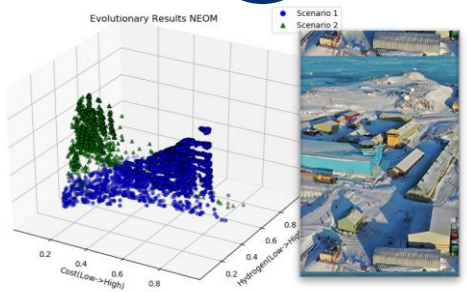


Operational Energy Database
A collation of operational energy results from Ramboll projects for mining for trends and insights before new project simulations

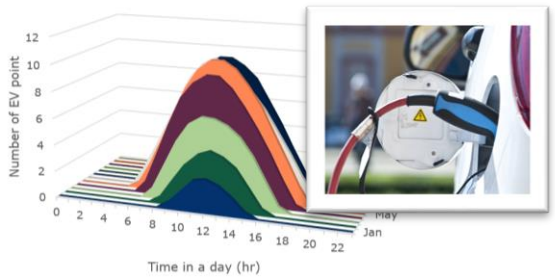


PEEPS
Human centred modelling for improved accuracy

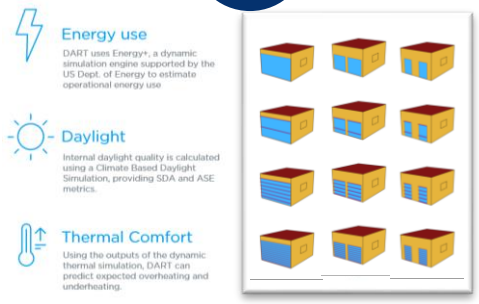
2017 — 2021 — 2024



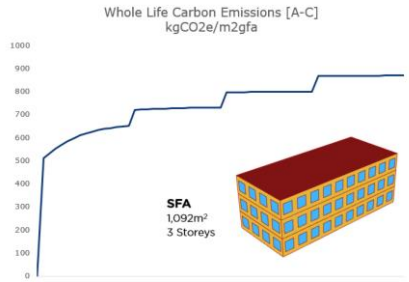
Evolutionary Energy Solver (EES)
A revolutionary rapid optimisation tool to perform supply and demand optimisation in accordance with CIBSE TM54



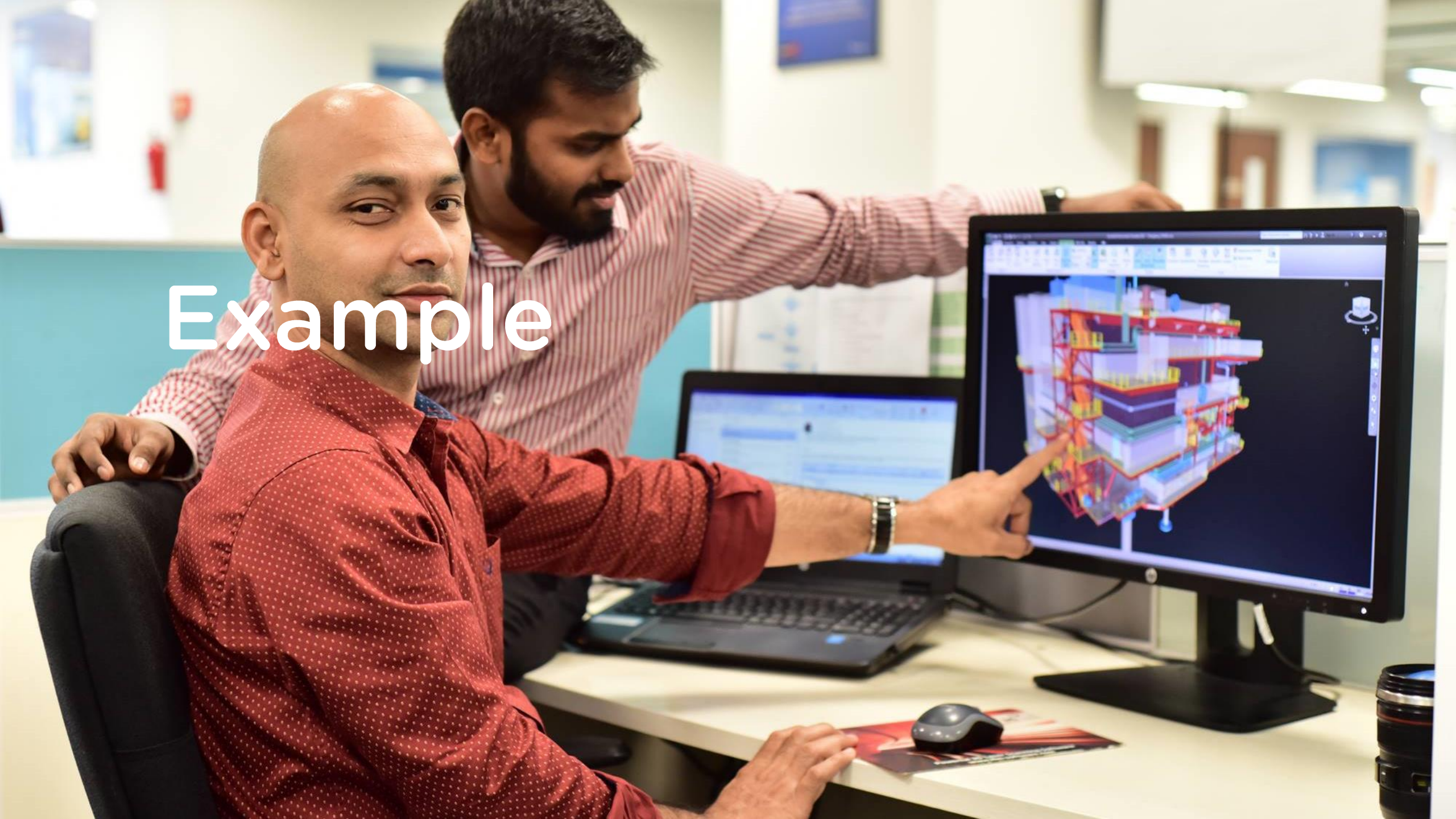
PV-CarBattery Optimiser
A tool to assess the potential for reducing a site's peak electric load and annual energy demand by integrating a solar and battery system



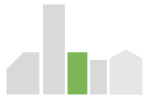
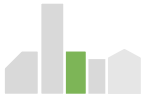
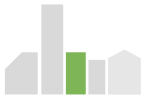
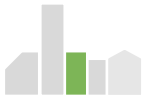
DART
Dart models can be used to assess multiple design options against holistic performance metrics without committing huge resources



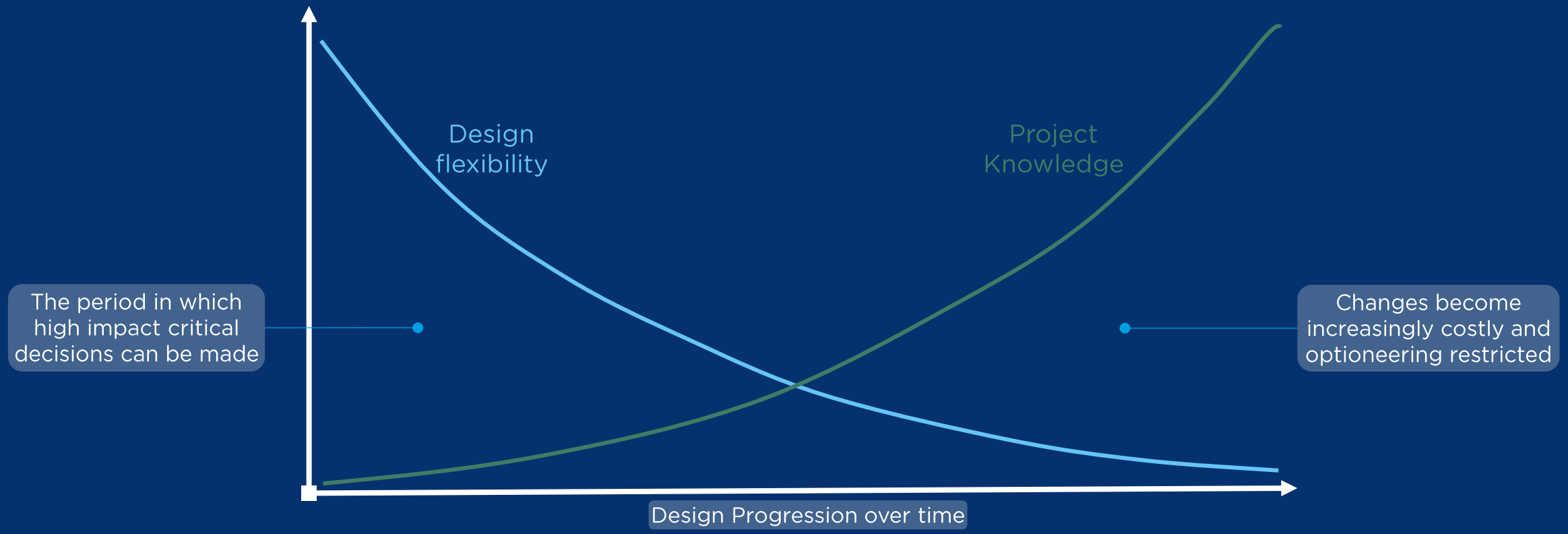
EarlyWLC
Whole building holistic carbon estimation to inform design


Example

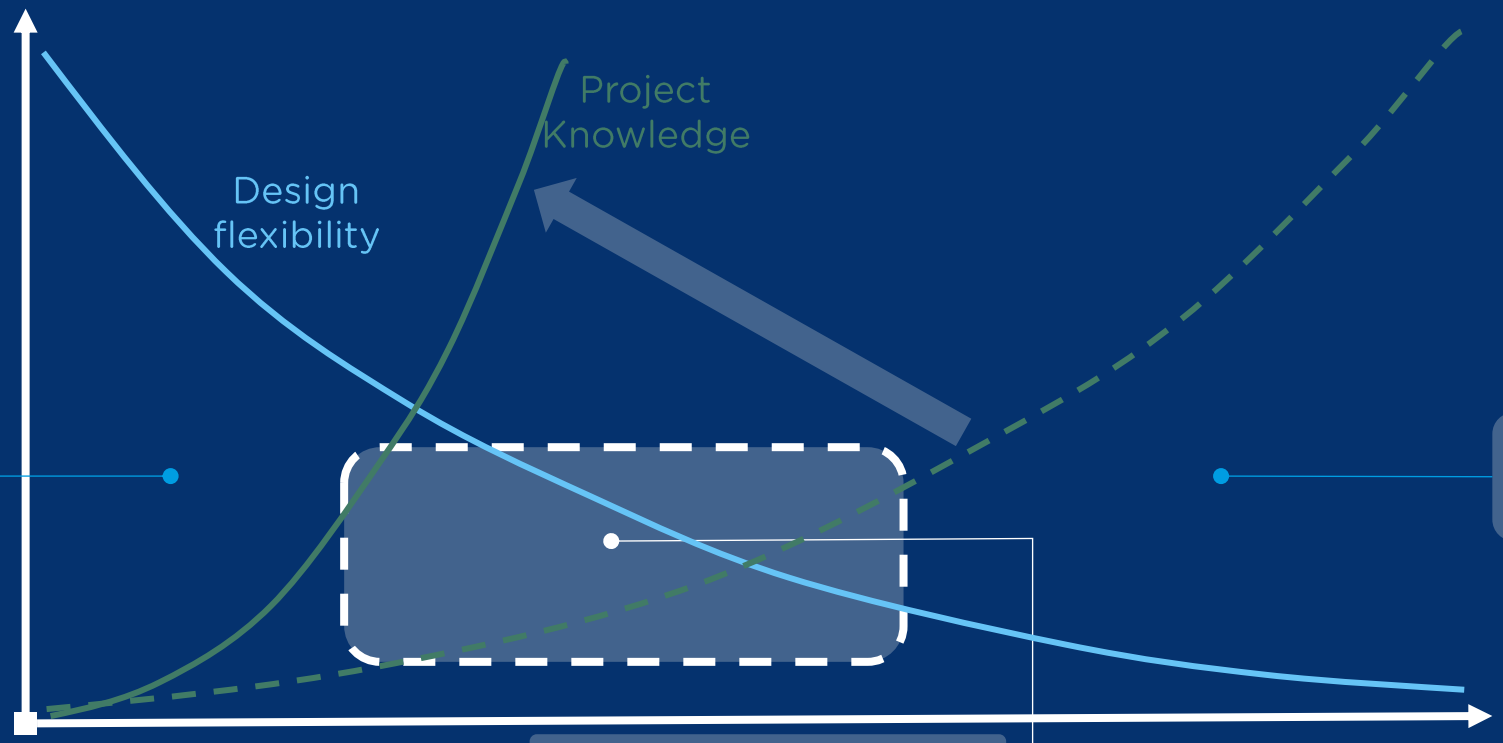
Early stage tools... which one?

	Scope		Purpose	Operational			Embodied			
KOALA	BUILDING		Parametric whole life carbon	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
Structural PANDA	BUILDING		Structural optioneering (cost + CO2)	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
DART	FLOOR		Sustainability optioneering	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
ZebraFish	BUILDING + PORTFOLIO		Decarbonisation optimisation	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
JellyFish	BUILDING		Sensitivity analysis on existing models	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
BEAR	BUILDING		Passive design analysis	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
MEP LCA	BUILDING		MEP Embodied carbon estimator	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP
FAÇADE PANDA	ROOM		Façade optioneering & analysis	Energy	Daylight+ Comfort	Peak loads	Facade	Sub structure	Super Structure	MEP

Why Early Stage?

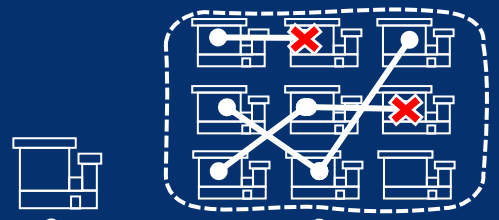


Why Early Stage?



Increase the knowledge available earlier to influence high impact decisions

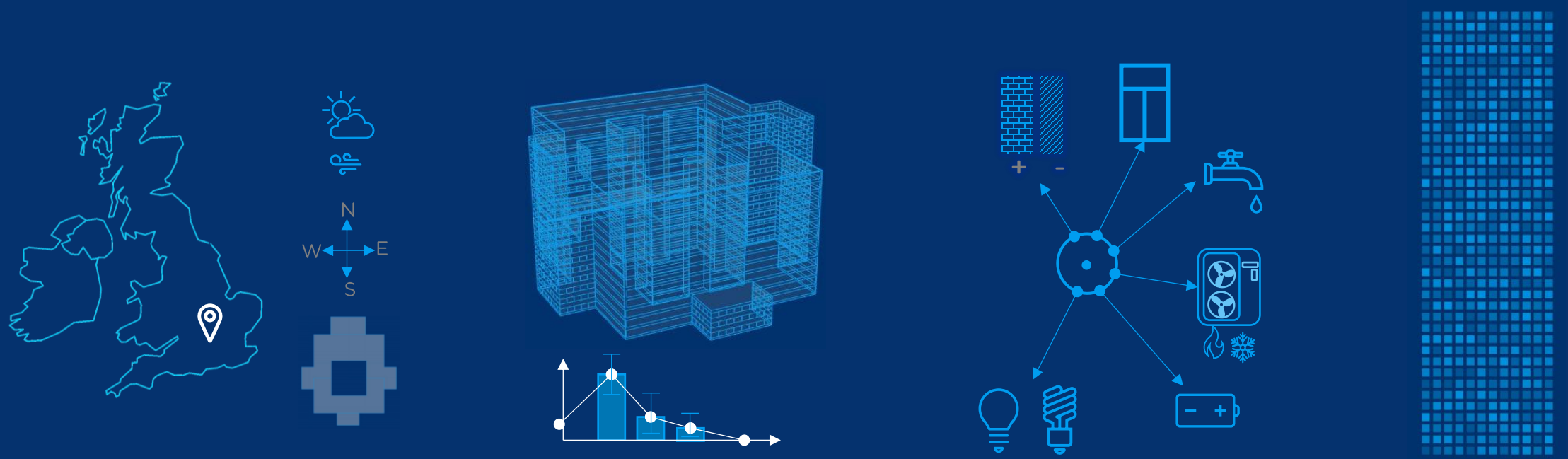
Reduce the need for changes at later stages of the design process



Allow for explorative modelling earlier in the design process

ZebraFish Workflow

(Zero, Energy, Buildings, Retrofit, Assessment, Fabric, Interventions & System Honing)



RAMBOLL NZC Pathway Tool

PASSIVE INTERVENTIONS

Wall	All
Glazing	All
Ground Floor	All
Roof	All
Rooflights	All
Airtightness	All

SYSTEM INTERVENTIONS

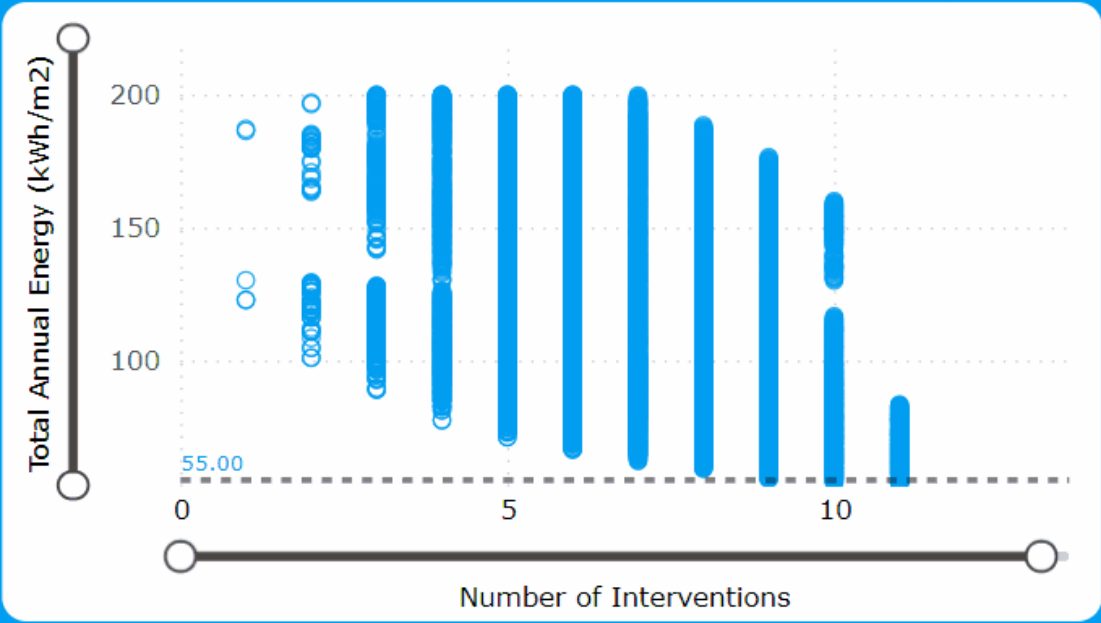
Heating and Cooling	All
DHW	All
Lighting	All
Lighting Control	All
Ventilation	All
FA System	All
Air Curtain	All
Equipment Load	All
Renewables	All

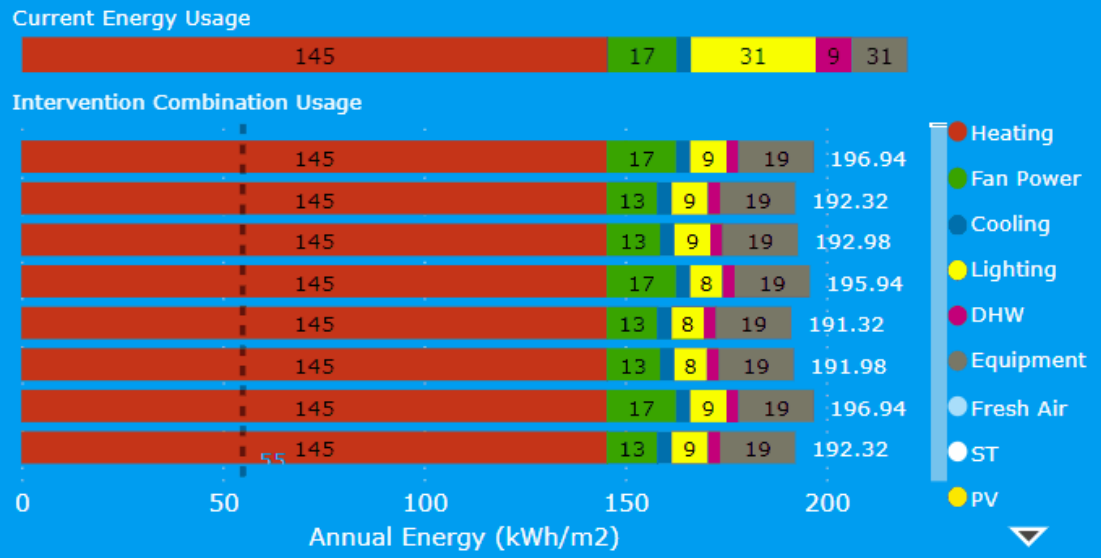
Reset

COMBINATIONS All by Cost | Embodied C02

MAX ANNUAL ENERGY 200.00

NUMBER OF COMBINATIONS 113.52K





SUMMARY

INTERVENTIONS

Note: This is a stage 2 level of design. It is only suitable to give comparative estimates and indications between various interventions options.

Network Rail Decarbonisation Tool

Project example

Sustainability

MDUs have an energy consumption

300% Kw/m²

Higher than average

Sustainability

EPC Currently only

10%

Of Stations are graded B or above

*Network Rail CP7 Buildings and Architecture policy document on Sustainability

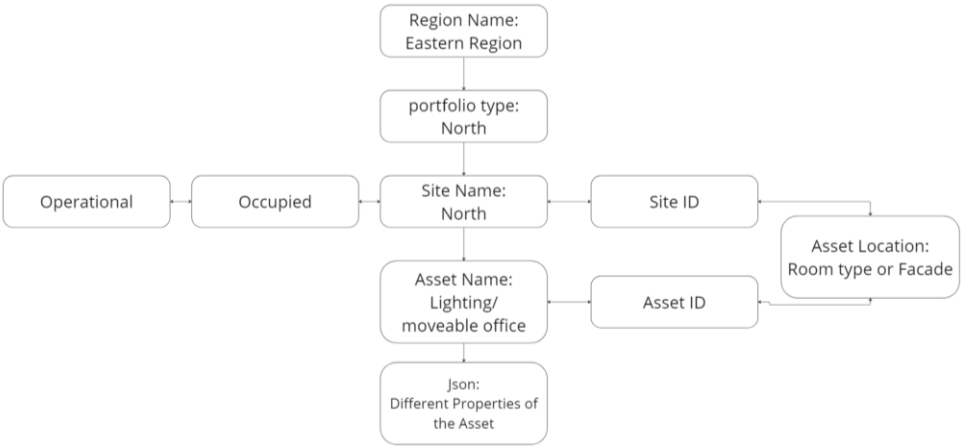
The Client Challenge

- Network Rail's Buildings and Architecture portfolio is one of the largest and most complex portfolio's of existing buildings in the UK
- Many buildings within this portfolio have extremely poor operational energy performance.
- Internal commitments to decarbonise stock in line with their own sustainability goals
- Regional Buildings managers need to prioritise budget and resources to retrofit stock to maximise improvements in operational performance but do not have a strong understanding of the current stock performance.
- Not all Regional Managers understand operation energy improvements

Understanding Network Rails Portfolio

Asset Management Database Analysis

Citadel database Structure:



Key data to extract:

1. How many functional zones (locations) in one block

2. Construction type for the external wall's properties of glazing?

3. HVAC systems present within the block

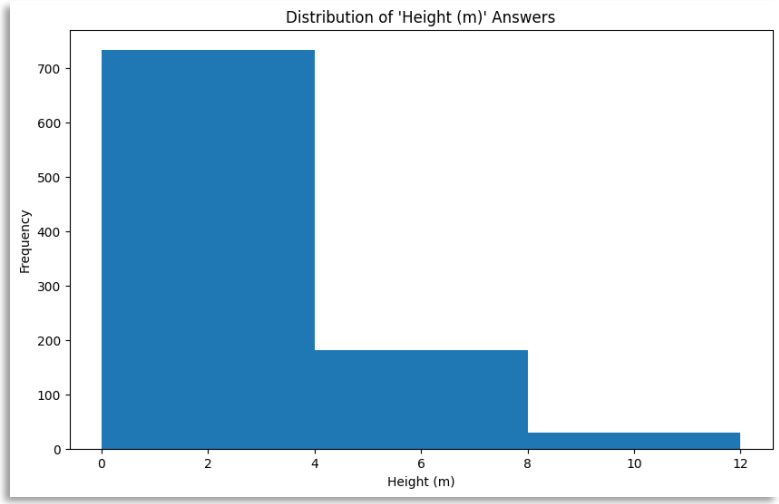
4. Geometrical size and shape of the building? (Height, Floor Area, Aspect Ratio, Glazing Area)

Understanding Network Rails portfolio

- Ramboll gain access to Network rails asset database "Citadel"
- Asset database contains raw information that could be analysed
- Data analysis undertaken by Ramboll to inform on Archetype Modelling

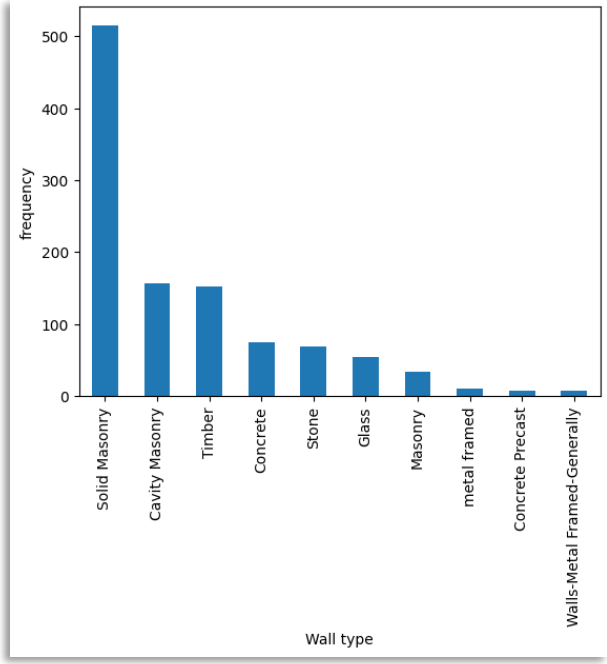
Data Exploration Method

With the key parameters identified Ramboll developed a data processing workflow to look at the dataset as a whole and aggregate the key data points to inform on the archetype modelling.

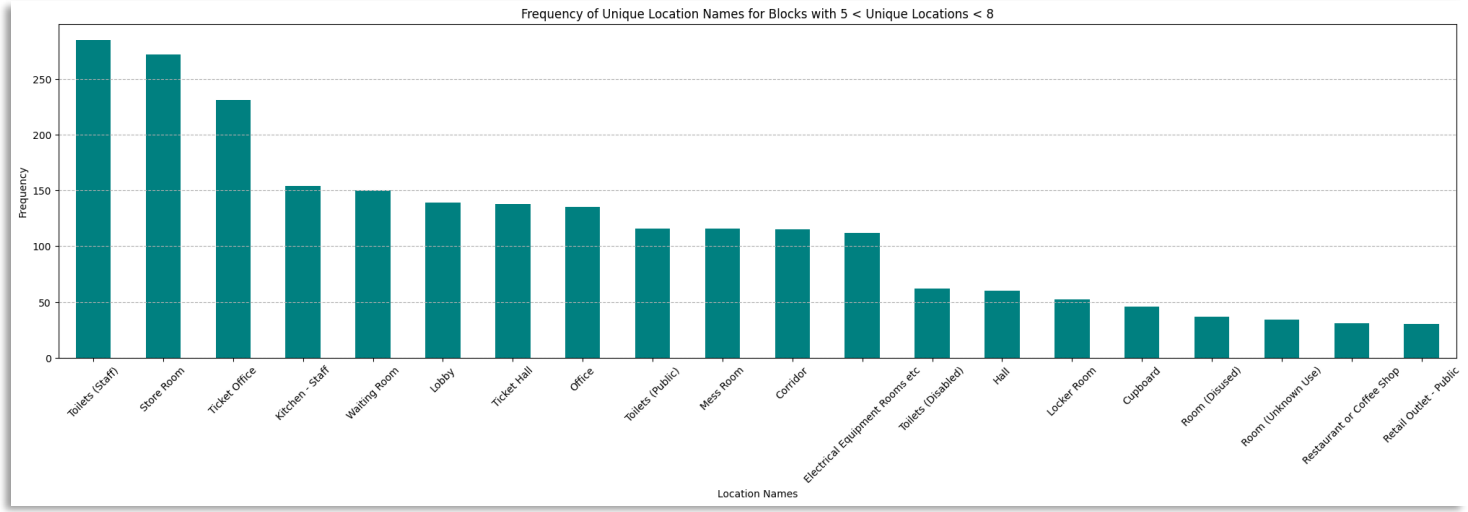



```
Basic Statistics for 'Height (m)':
count    943.000000
mean       3.339470
std        1.800265
min        0.000000
25%        2.400000
50%        3.100000
75%        3.860000
max       12.000000
Name: answer, dtype: float64
```

Example: Key geometric parameters



Example: Material build up



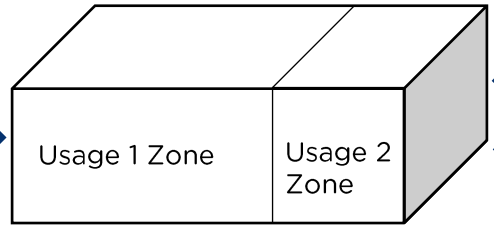
Example: Room usage summary

Define and simulate architypes

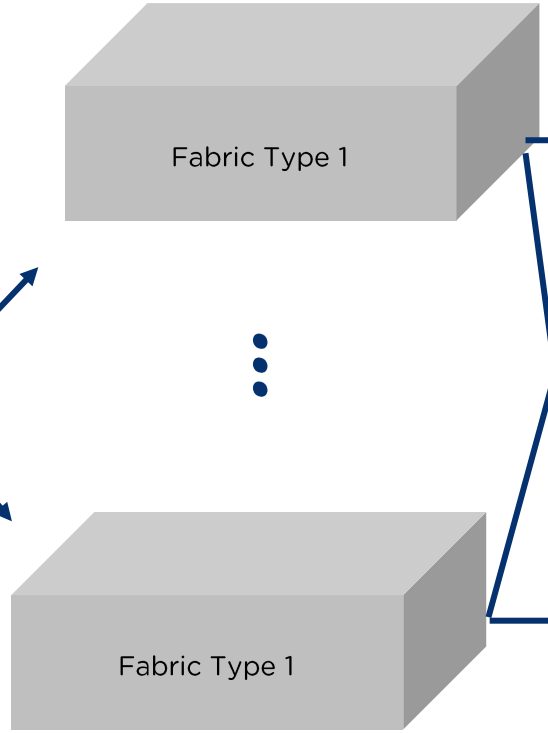
Modelling Methodology

Network Rail Asset Portfolio

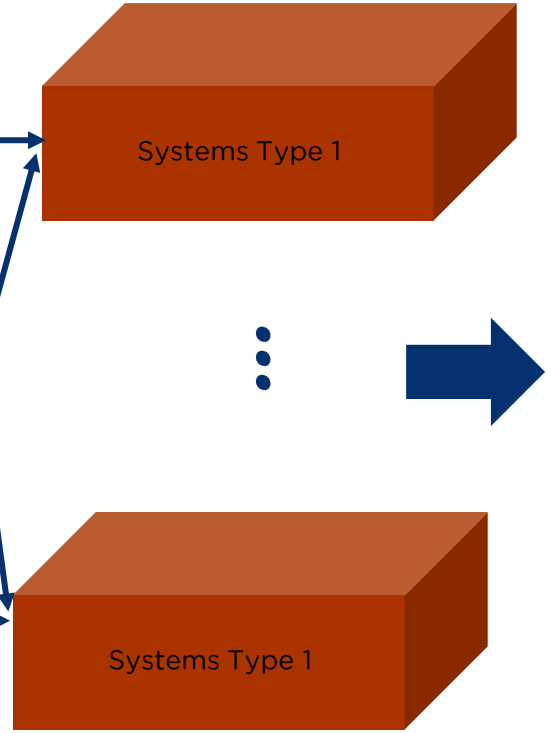
An archetype is defined as a building energy model representative of a number of assets which are present within the Network Rail portfolio.



Typical representative geometry
How the archetype is used/zoned



Upgrade Windows
Add insulation etc.

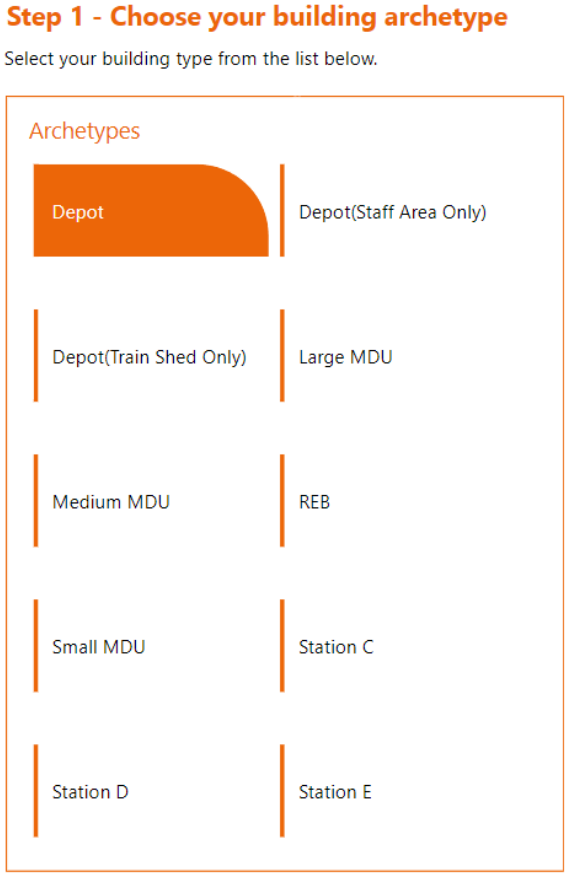


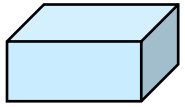
Change Heating System
improve lighting etc.

Results Database

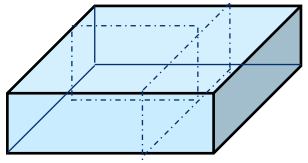
Modelling Methodology

10 Unique Buildings Architypes modelled using the 5 base geometries established in Phase 1.

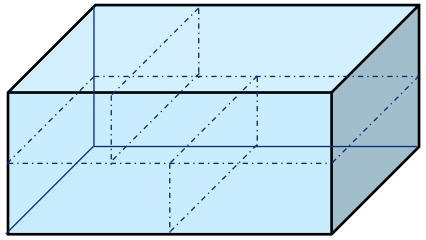




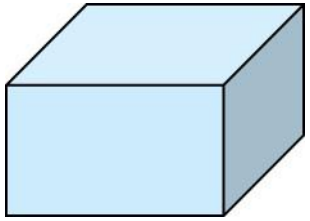
Small single zone box
e.g. REB or small MDU



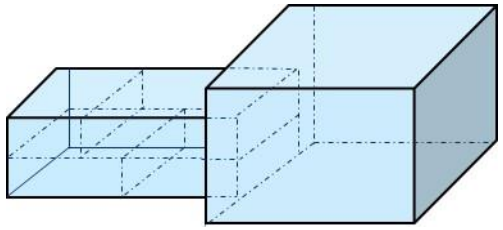
Medium sized, 1 storey, multi usage box
e.g. Medium MDU



Large sized, 2 storey, multi usage box
e.g. Large MDU or Depot Staff Area



Large sized, 2 storey, single usage box
e.g. Depot Train Shed



Large sized, 2 storey, single usage box & 2 storey, multi usage box combined
e.g. Depot

5 modelling geometries used to reflect the current proposed list of archetypes and base case scenarios.

Delivering a meaningful tool

BUILDING DECARBONISATION TOOL

Overview

Welcome to the Network Rail building decarbonisation tool.

This tool is to be used to give a high level indication of the operational energy decarbonisation strategy for existing rail assets. It should be used to support those reviewing their assets to understand what approaches could be taken and support their business case.

Note:
This is a Stage 1 level of design for a simplified representative model of each building archetype. It is only suitable to give comparative estimates and indications between various interventions options. Further engineering and design analysis should be undertaken to consider site and building specifics.

Version V1.0.0

Methodology

1. A desktop investigation was conducted on Network Rail's building asset portfolio, wherein the assets were catalogued into specific archetypes based on their size, functionality and usage.

2. Representative energy box models were developed for each archetype to assess the operational behaviours of the assets.

3. For each archetype, a broad range of the recorded existing building fabrics and system installations and potential improvement interventions were analysed. To consider regional weather impact, each archetype was also analysed with four weather files to represent the regions shown in Figure 1.

4. The analysis tested every possible combination of fabric types and system settings to create a detailed database of millions of potential decarbonisation permeations and the resultant impact on a building's operational energy.

5. This dashboard was developed to assist users to navigate through the database of results to facilitate decision-making for asset management and enhancement.

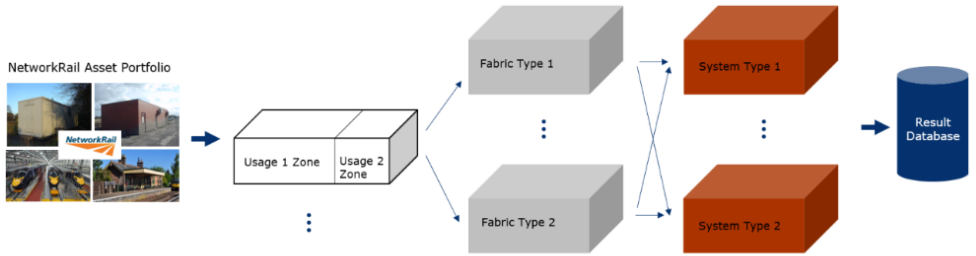


Figure 1: Methodology flowchart

Link to methodology document

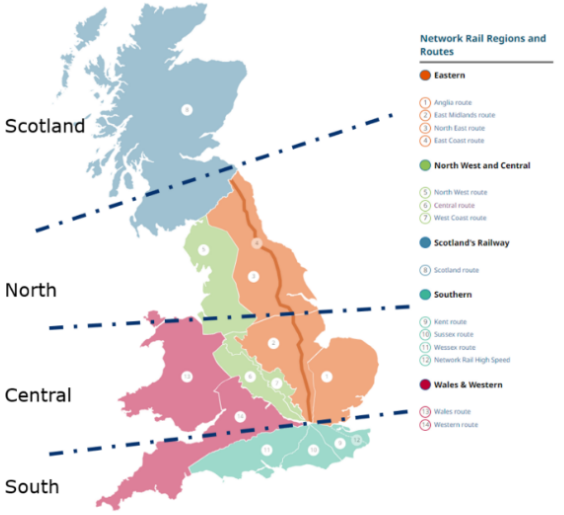


Figure 2: Regional split

How to Use

This dashboard is structured into three steps:

Step 1: Choose the archetype that best matches your building.
Step 2: Define current condition of your existing building.
Step 3: Discover ways to reduce your building's operational energy.

There are two ways possible ways of reviewing this data:

1. See the biggest impact you can make with the interventions possible.
2. See the impact of user defined interventions or combinations.

Go To Step 1 of 3

Archetype

An archetype is defined as a building energy model that represents a group of similar assets within the Network Rail portfolio.

Each archetype has been modelled as a representative box model, the size and usage zones of each has been defined by the most common / average data extracted from Network Rail's Citadel database.

You may be able to use the results of these archetypes for different buildings with similar size and usage profiles.

Step 1 - Choose your building archetype

Select your building type from the list below.

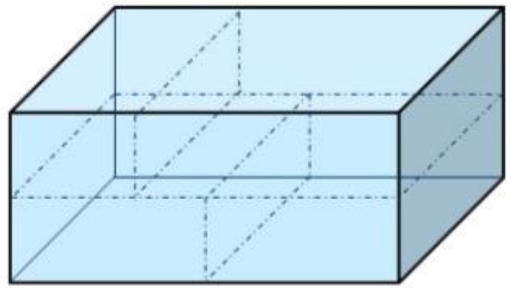
Archetypes

- Depot
- Depot(Staff Area Only)
- Depot(Train Shed Only)
- Large MDU
- Medium MDU
- REB
- Small MDU
- Station C
- Station D
- Station E

Description

A large building made of masonry or modular construction with basic facilities. This has been modelled as a 17.5x10m, two-storey building with 10% glazed area.
It has been assumed these buildings are used by four people during the day for office work and then used by 60 front line staff between shifts and during breaks over 24 hours. The facilities include toilets and showers, mess and kitchen area and some plant and storage spaces.

Analytical Model



Large MDU

Go to Step 2 of 3

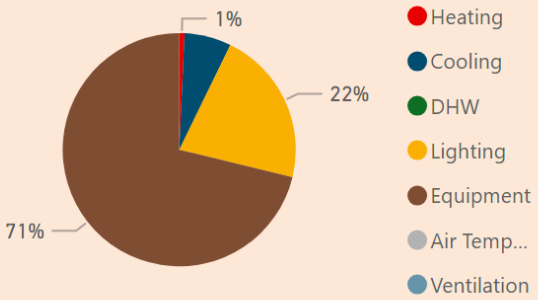
BUILDING DECARBONISATION TOOL

Existing Base Case

The existing base case is defined as a representation of an asset's current or assumed operational performance.

Existing Energy Use Breakdown (%)

An indication of the proportion of different energy uses in the existing building.



Building Archetype

REB

Description

A small buildings made of masonry or modular construction with basic facilities.
This has been modelled as a 8x3m, 2.8m tall box with minimal glazed area.
It has been assumed to be a predominantly unstaffed space housing temperature sensitive electronic equipment.

Step 2 - Define your existing building condition

Use the dropdowns on this page to define the existing building envelope condition and systems. After that, proceed to Step 3.

FABRIC

Wall	Basic Wall
Glazing	Single Glazing Windows
Ground Floor	Suspended Floor
Roof	Uninsulated Roof
Airtightness	Poor Airtightness

HVAC

Heating	DX Split
Cooling	DX Split

LIGHTING

Fittings	Fluorescent Fittings
Lighting Control	Automatic Lighting Control(...
Location	Central

Options Information

Choose from the list for more information about the options for that category: Wall

Options	Description
Insulated Wall	A wall with some insulation achieving a U-Value of ~0.4W/m2K
Standard Uninsulated Wall	A wall with no insulation achieving a U-Value of ~1.0 W/m2K. This is suitable for typical Cavity Masonry or Metal-Framed buildings.
Enhanced Insulated Wall	A wall with enhance insulation properties
Basic Wall	A wall achieving a U-Vaule of ~1.35W/m2K. This is suitable for solid brick walls with no insulation.

Clear Choices

Go to Step 3 of 3

Step 3 - Explore Top Combinations

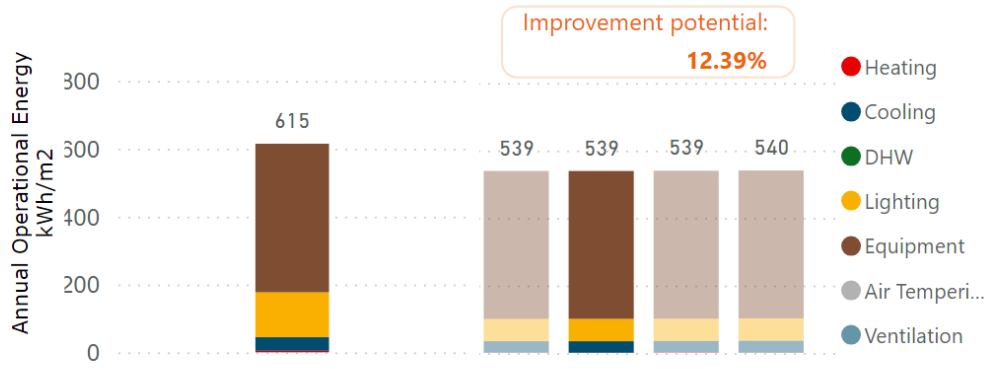
This page allows you to see what the best possible combinations are based off all your possible interventions. Use the dropdowns below to select what interventions are possible. The graph will highlight, of those choices, which combinations will have the biggest impact.

REB in the Central Region

	Existing Building Condition		Interventions
FABRIC			
Wall	Basic Wall	to	Multiple selections
Glazing	Single Glazing Windows	to	Enhanced Double Glazing Windows
Ground Floor	Suspended Floor	to	Multiple selections
Roof	Uninsulated Roof	to	Multiple selections
Airtightness	Poor Airtightness	to	Multiple selections
HVAC			
Heating	DX Split	to	High Efficiency DX Split
Cooling	DX Split	to	High Efficiency DX Split
LIGHTING			
Fittings	Fluorescent Fittings	to	All
Lighting Control	Automatic Lighting Control(Presence...	to	All

TOP OPTIONS

Select the bar you want to see more information about to see what intervention changes have been made and some things to consider (not exhaustive).



Changes

- Basic Wall to Standard Uninsulated Wall
- Single Glazing Windows to Enhanced Double Glazing Windows
- Uninsulated Roof to Enhanced Insulated Roof
- DX Split Unit Heating and Cooling to High Efficiency DX Split Unit Cooling, No Heating
- Fluorescent Fittings to All STD lux LED Fittings

Some things to consider...

Lighting

• Ensure the compatibility of the LED lighting fittings with the original system.

OUR TEAM WORK WITH

We work with in a variety of sectors and markets, supporting our clients on their decarbonisation journeys. Some examples include:

Wrap up

Poll Reflections

What is the biggest challenge to your organisation in achieving net zero carbon performance?

- Funding (lack of)
- Technology
- Regulatory hurdles
- Lack of expertise
- Other (please specify)

What motivates your organisation the most to pursue net zero carbon goals?

- Regulatory Compliance
- Cost Savings
- Corporate Social Responsibility
- Market Competitiveness
- Stakeholder Pressure

Which of the following strategies is your organisation currently prioritising to achieve net zero carbon performance?

- Energy efficiency improvements
- Switching to renewable energy sources
- Offsetting carbon emissions
- Investing in new technologies
- Enhancing supply chain sustainability

Q&A ?

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Sustainable change.