GGGI

ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy

3.4 Building Life Cycle Assessment (LCA)

Concept and Approaches

November 2024

ASEAN CENTRE FOR ENERGY ACE

EESL

HEAT

Supported by:

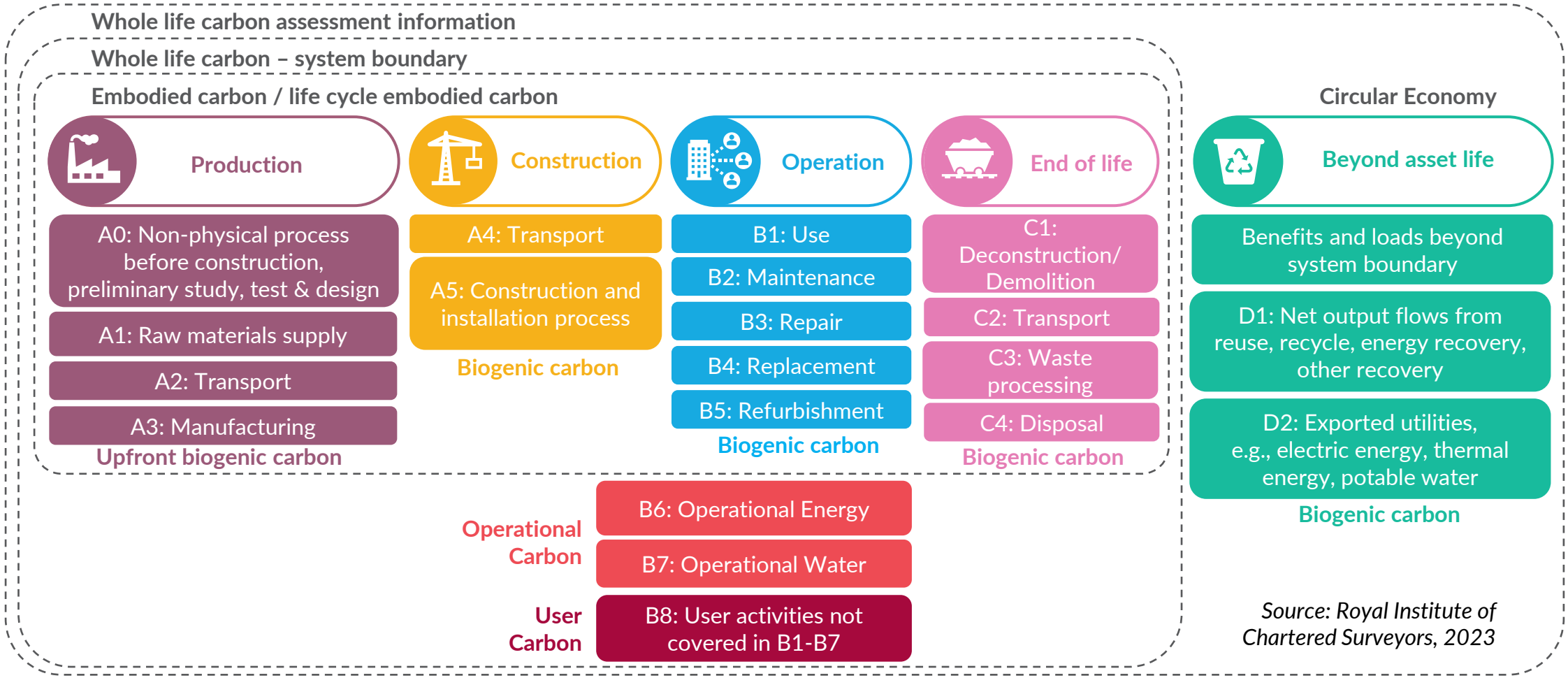
Federal Ministry for Economic Affairs and Climate Action

IKI INTERNATIONAL CLIMATE INITIATIVE

on the basis of a decision by the German Bundestag

WHOLE LIFE CARBON

Building life cycle stages



Source: Royal Institute of Chartered Surveyors, 2023

BUILDING LIFE CYCLE STAGES

Phases for embodied and operational carbon

Embodied carbon denotes carbon emissions associated with materials and construction processes throughout the whole life cycle of a building. This includes:[1]

- **Upfront carbon:** The emissions caused during the building material production and construction phases (A0–A5) of the building's life cycle before it is used. In contrast to other categories of emissions, these emissions have already been released into the atmosphere before the building is occupied or the infrastructure begins operation
- **Use stage embodied carbon:** Emissions associated with building materials and processes needed to maintain the building or infrastructure during use, such as for refurbishments (B1–B5). These are additional to operational carbon emitted due to heating, cooling and power etc.
- **End of life carbon:** The carbon emissions associated with deconstruction and demolition (C1), transportation from site (C2), waste processing (C3) and disposal (C4) phases of a building or infrastructure's life cycle which occur after its use

Operational carbon denotes the emissions associated with energy and water consumed (B6–B7) to operate the building over its life cycle[2]

[1] *Source: World Green Building Council, 2019*
[2] *Source: Royal Institute of Chartered Surveyors, 2023*

LIFE CYCLE ASSESSMENT

Scope of LCA

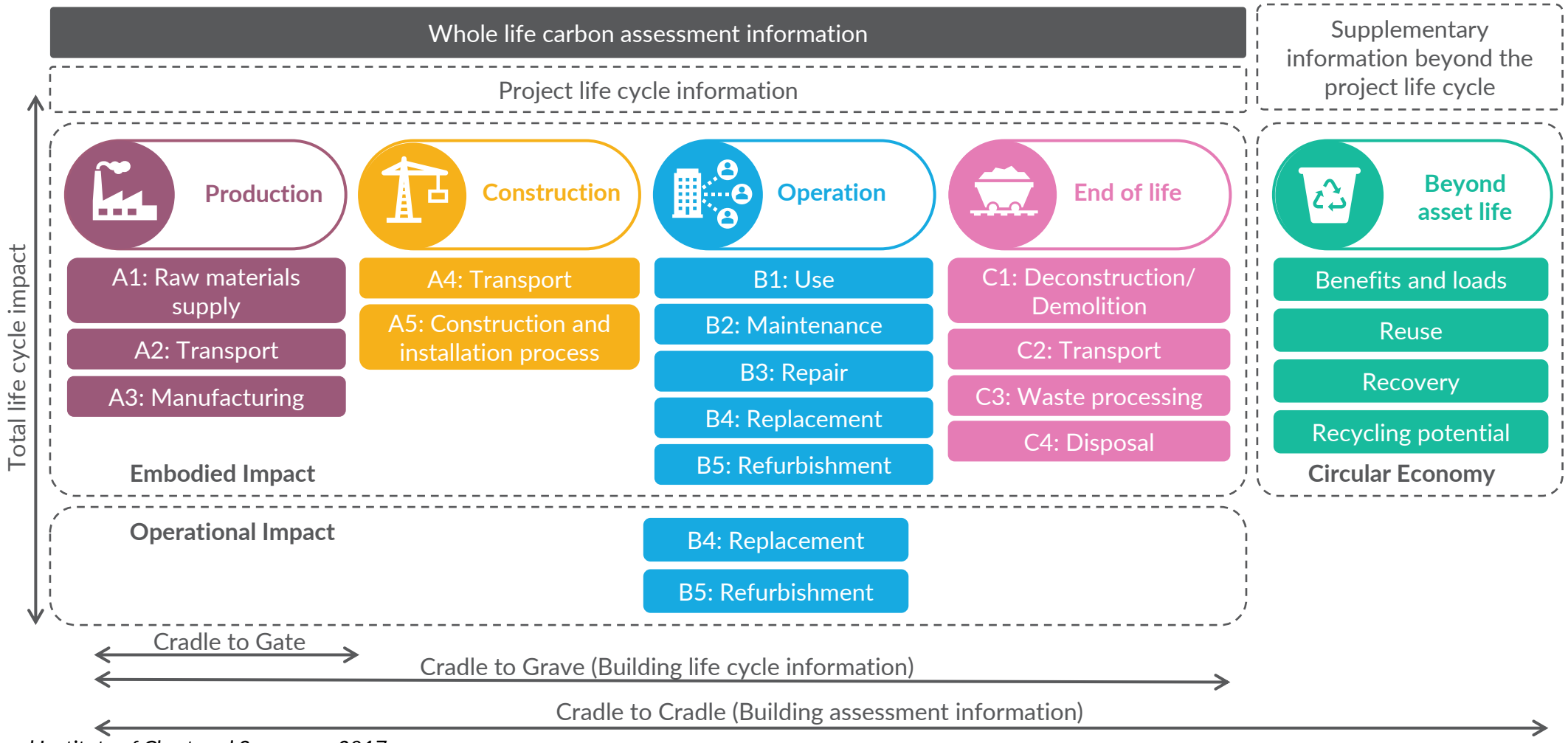
Life cycle assessment (LCA) is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to a building, infrastructure, product or material throughout its life cycle (ISO 14040: 2006)[1]

Based on the scope of the LCA or stages for which data is available, one can choose to leave in or take out building life cycle stages. Thus, LCA could be of the following types:[2]

- **Cradle-to-gate** considers all activities starting with the extraction of materials from the earth (the cradle), their transportation, refining, processing and fabrication activities until the material or product is ready to leave the factory gate (A0–A3)
- **Cradle-to-practical completion (handover)** includes the cradle-to-gate results to just before building occupation and use (A0–A5)
- **Cradle-to-grave** includes the cradle-to-practical handover results plus the GHG emissions associated with the use of the material or product (maintenance) and the end of life (disposal, reuse, recycling) (A0–C4)
- **Cradle-to-cradle** goes beyond cradle to grave and conforms more to the model of the circular economy. In a cradle-to-cradle model, products would be designed in a way so that at the end of their initial life they can be reused or recycled, and therefore avoid landfill

[1] *Source: World Green Building Council, 2019*
[2] *Source: Royal Institute of Chartered Surveyors, 2017*

LCA SCOPES



Source: Royal Institute of Chartered Surveyors, 2017

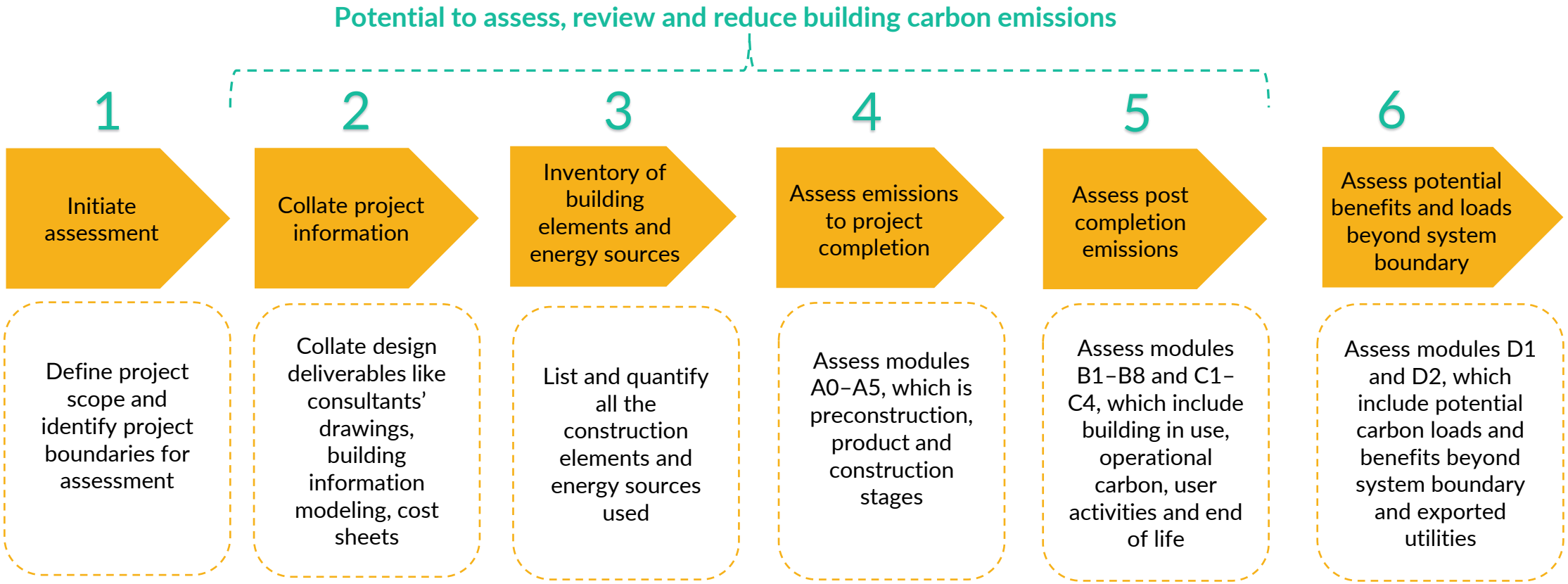
WHOLE LIFE CARBON ASSESSMENT

- **A whole life carbon assessment (WLCA)** is the calculation and reporting of the quantity of carbon impacts expected throughout all life cycle stages of a project and includes an assessment of the potential benefits and loads occurring beyond the system boundary.[1] **It is in effect a cradle-to-cradle LCA**
- All WLCAs follow a modular structure for carbon reporting, which breaks down the building life cycle into stages and modules
- A WLCA is intended to examine all carbon impacts from production of materials, construction, use and disposal of a built asset over its entire life cycle. This approach helps to mitigate the carbon at any stage of the life cycle

[1] *Source: Royal Institute of Chartered Surveyors, 2023*

WLCA METHODOLOGY

Steps for assessing WLCA

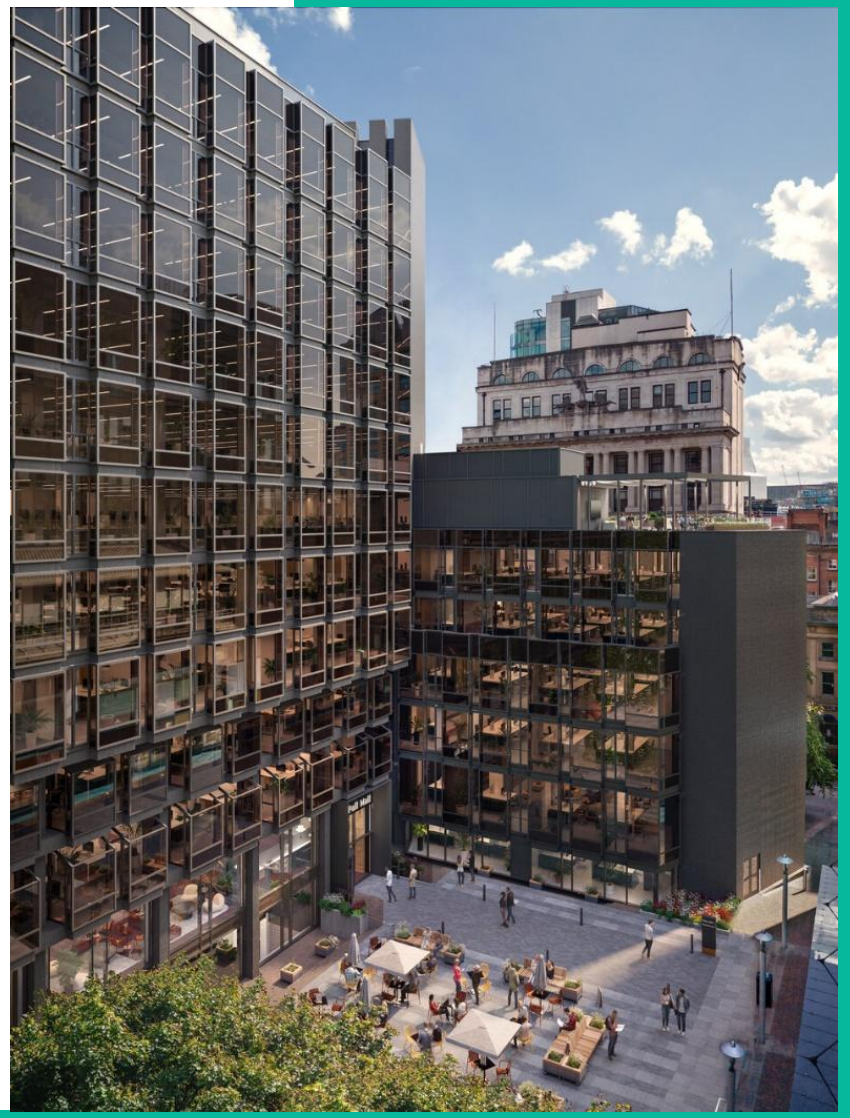


Source: Modified from Royal Institute of Chartered Surveyors, 2023

WLCA BUILDINGS

Retrofit case example: Pall Mall, Manchester, UK

- Pall Mall, built in 1969 and acquired by Bruntwood in 2021, is a property **of 85,000 sq. ft.** of office and hospitality spaces
- Whole life carbon was a driving factor for the decision to retain the building and undertake **a deep retrofit**
- **The WLCA revealed that deep retrofit is the most carbon-efficient solution** due to the proposed switch, away from gas heating to hybrid variable refrigerant flow, with an air source heat pump serving domestic hot water and air handling unit (AHU) coils



Source: Hollyman and Dodkin, 2024

WLCA BUILDINGS

Retrofit case example: Pall Mall, Manchester, UK (continued)

- The project, when completed in 2025, will achieve a **74% reduction in EUI** due to the deep retrofit
- The project will achieve a **higher energy performance rating (EPC), moving from G to A** (A+ being the highest; higher ratings being preferred by tenants)
- The project will achieve a **'very good' BREEAM rating with a 100% increase in rental value**

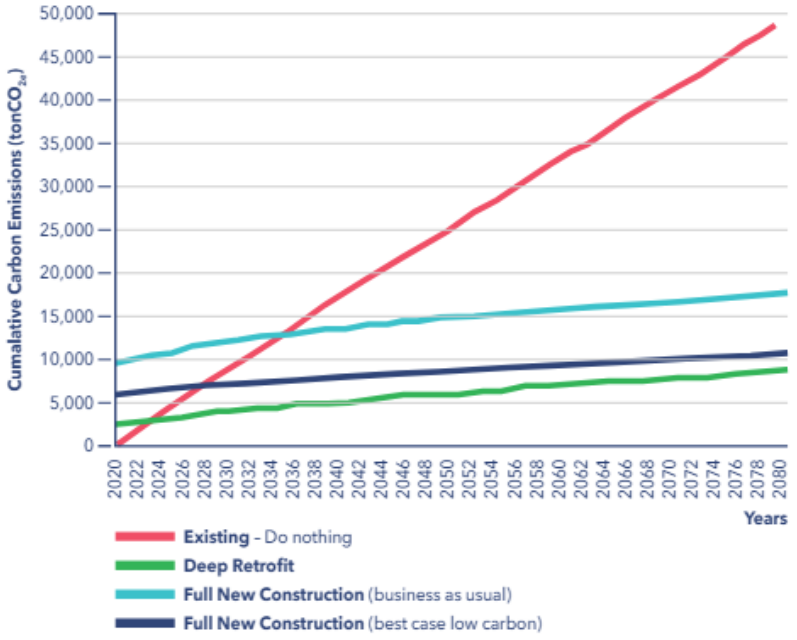


FIGURE 5:
Whole Life Carbon Timeline (in tons).

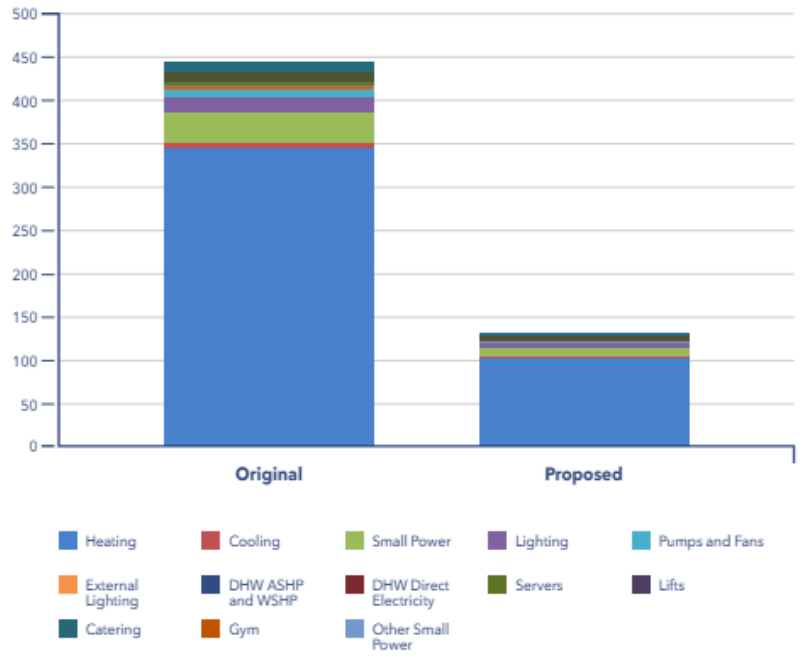


FIGURE 6:
Annual Energy Consumption of original and proposed building (kW/m²).

Source: Hollyman and Dodkin, 2024

WLCA BUILDINGS

Retrofit case example: Pall Mall, Manchester, UK (continued)

Other features of low carbon design:

- The fit out uses circular economy principles by **utilizing recycled and reclaimed furniture and materials for timber partitions and reclaimed raised access floors**
- The façade and glazing system designed reduces the need to cool the building

Bruntwood has **avoided 7,900 tons** of additional carbon by eliminating the need to rebuild (equivalent to around 16,000 flights from London to New York)

Source: Hollyman and Dodkin, 2024

Thank you!

For more information, visit us at https://ALCBT.GGGI.ORG or scan the QR code below

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Any person who believes they may be harmed by an IKI project or who wish to report corruption or the misuse of funds, can lodge a complaint to the IKI Independent Complaint Mechanism at IKI-complaints@z-u-g.org. The IKI complaint mechanism has a panel of independent experts who will investigate the complaint. In the course of the investigation, we will consult with the complainant so as to avoid unnecessary risks for the complainant. More information can be found at https://www.international-climate-initiative.com/en/about-iki/values-responsibility/independent-complaint-mechanism/.

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