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BIM-LCA Construction Project

Title: LCA FOR AN INDUSTRIAL BUILDING

ONE CLICK is a holistic initiative focused on analysing and minimizing environmental impacts throughout the life cycle of steel structures. The program emphasizes identifying critical stages within the life cycle of steel structures and evaluating their corresponding environmental effects.

Using a one-click LCA (Life Cycle Assessment) tool for an industrial building offers several advantages:

One-click LCA tools streamline the process of conducting life cycle assessments by automating calculations and simplifying data input. This efficiency saves time and resources compared to traditional manual LCA methods.

These tools provide a holistic view of the environmental impacts associated with the entire life cycle of the industrial building, including materials extraction, construction, operation, and end-of-life phases. This comprehensive analysis helps identify areas for improvement in sustainability.

With rapid calculation and output generation, one-click LCA tools enable quick decision-making by providing actionable insights into environmental hotspots and potential mitigation strategies.

The tools generate quantitative metrics such as carbon footprint, embodied energy, water consumption, and waste generation, allowing for precise comparisons and benchmarking against sustainability targets.

One-click LCA tools often integrate with Building Information Modeling (BIM) software and other design tools, enabling real-time sustainability assessments during the design and planning phases of the industrial building.

Many green building certification programs require life cycle assessments. One-click LCA tools simplify the process of gathering and analyzing data, facilitating the achievement of certifications such as LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method).

Clear and visually appealing LCA reports generated by these tools facilitate effective communication of sustainability performance to stakeholders, enhancing transparency and engagement in sustainable building practices.

In summary, utilizing a one-click LCA tool for an industrial building helps streamline the assessment process, provides comprehensive environmental insights, supports informed decision-making, and contributes to achieving sustainability goals and certifications.

1 – Aims

To perform a Life Cycle Assessment (LCA) of an industrial building using a one-click program, follow these steps:

Gather relevant data including building materials, energy consumption, water use, waste generation, and transportation impacts associated with the construction and operation of the industrial building.

Use the LCA software to input the collected data and build a life cycle model of the industrial building. This includes defining the life cycle stages (e.g., raw material extraction, manufacturing, construction, operation, end-of-life) and assigning environmental impacts to each stage.

Execute the LCA calculation within the software by initiating the one-click process. The software will automatically analyze the environmental impacts across the life cycle of the industrial building based on the input data and modelling parameters.

Review the LCA results generated by the software, which may include environmental impact indicators such as carbon footprint, energy consumption, water use, air emissions, and waste generation. Interpret the results to identify hotspots and areas for potential improvement.

Prepare a comprehensive report summarizing the LCA methodology, results, and recommendations. Communicate the findings to stakeholders, decision-makers, and project teams to raise awareness and facilitate informed sustainability decisions regarding the industrial building.

The objectives of this tutorial are as follows:

3 - Tutorial duration

The implementation described in this tutorial will be carried out through the ONE CLICK LCA software.

2 lesson hours are suitable for this training.

4 – Necessary teaching recourses

Computer room with PCs with internet access.

Required software: OPEN CLICK LCA

5 - Contents & tutorial

5.1 Tutorial

The primary objective of this tutorial is to compare three different analyses of a steel structure. The initial structure consists of non-recycled elements (foundations, beams, columns), while the second and third stages incorporate recycled materials. Below, you'll find descriptions of the recycled materials used in the analysis, along with a comparison between the second and third stages. The recycled materials considered include both infrastructure and superstructure components of the industrial building.

The objectives of this tutorial are as follows:

The Life Cycle Assessment (LCA) analysis for a steel structure comprises three distinct stages.

The initial stage involves evaluating the steel structure as it was initially designed.

The second stage:

Ready-mix concrete – 50% GGBS

Reinforcement steel (rebar)- 60% recycled

Steel sheets – 60% recycled

XPS insulation panels – 20 % recycled

Structural steel profiles – 60% recycled

Third stage

Ready-mix concrete – 30% fly ash concrete

Rebar – 90% recycled

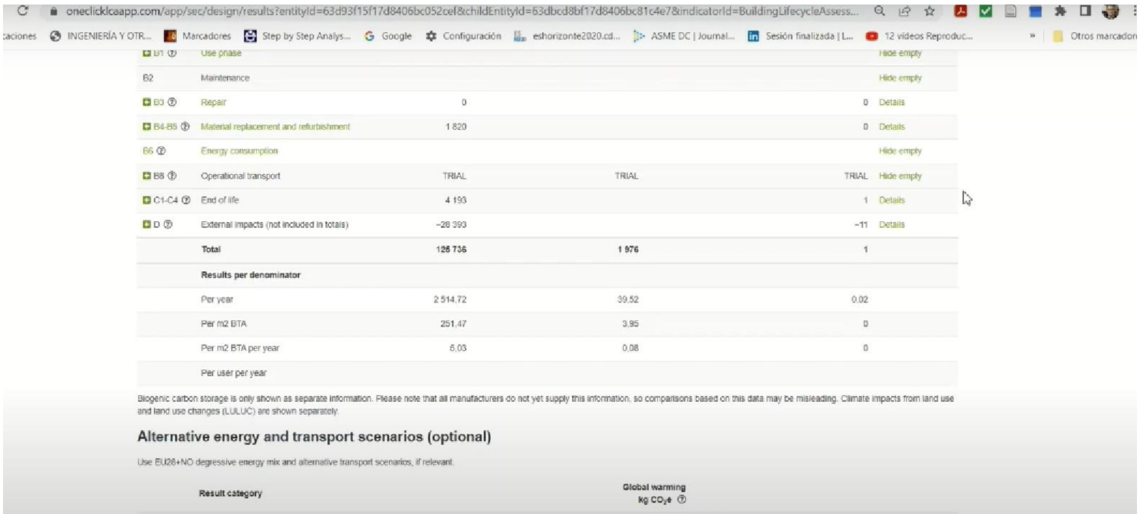
Steel sheets 90% recycled

XPS insulation – 40% recycled

Structural steel 0 90% recycled

5.1.1. OPEN CLICK LCA

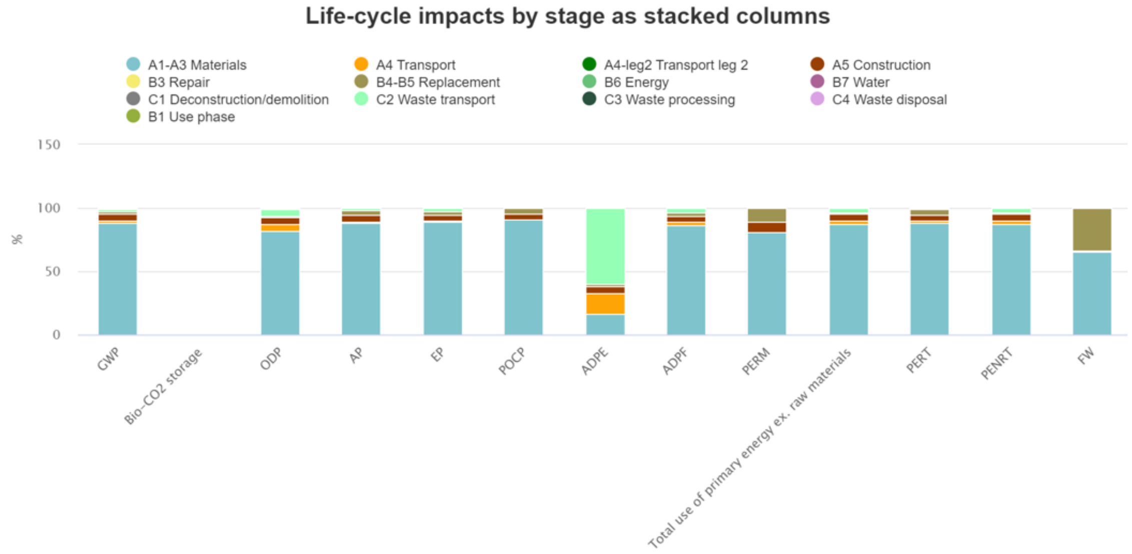
The program functions as a library where users can selectively choose and integrate the relevant data into their individual projects.



5.1.3.4 INTIAL STAGE

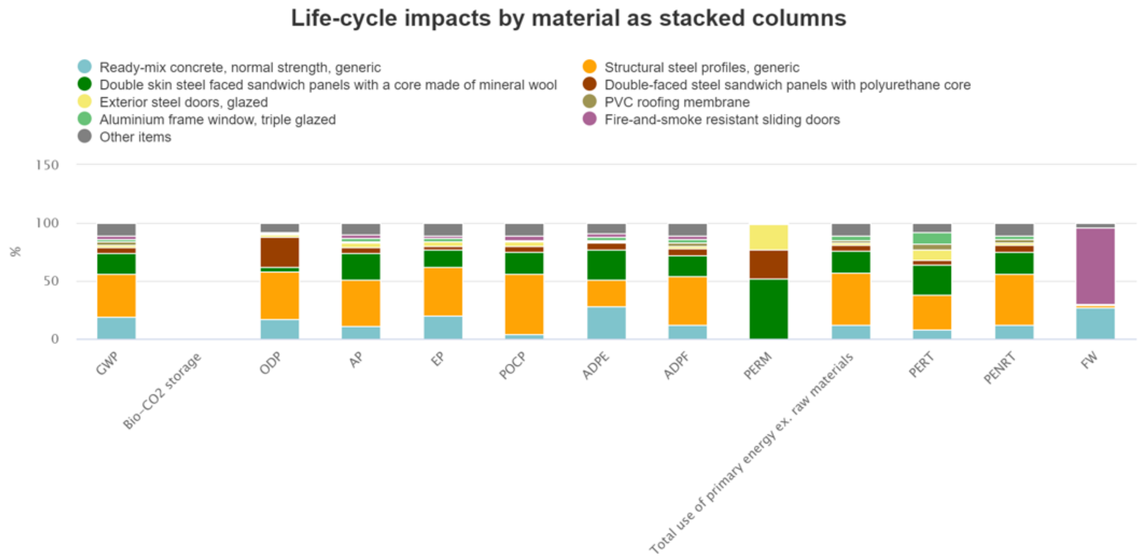
The first phase of the OPEN CLICK program involves visualizing life cycle impacts through stacked column charts, offering a concise and insightful portrayal of environmental effects throughout various stages in a product or system's life cycle.

LCA FOR AN INDUSTRIAL BUILDING



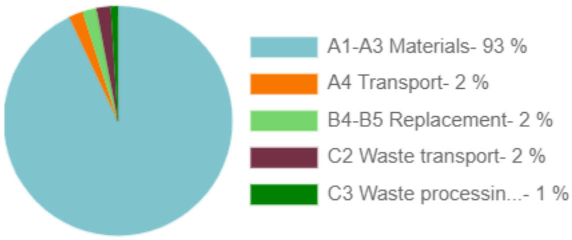
Life cycle impacts by stage as stacked column

The life cycle impacts by stage presented as stacked columns provide a detailed visual representation of the environmental impacts associated with each phase of the product or project life cycle. This graphical depiction allows for a comprehensive analysis, showcasing the relative contribution of different stages (such as raw material extraction, manufacturing, transportation, use, and end-of-life) to overall environmental impact.



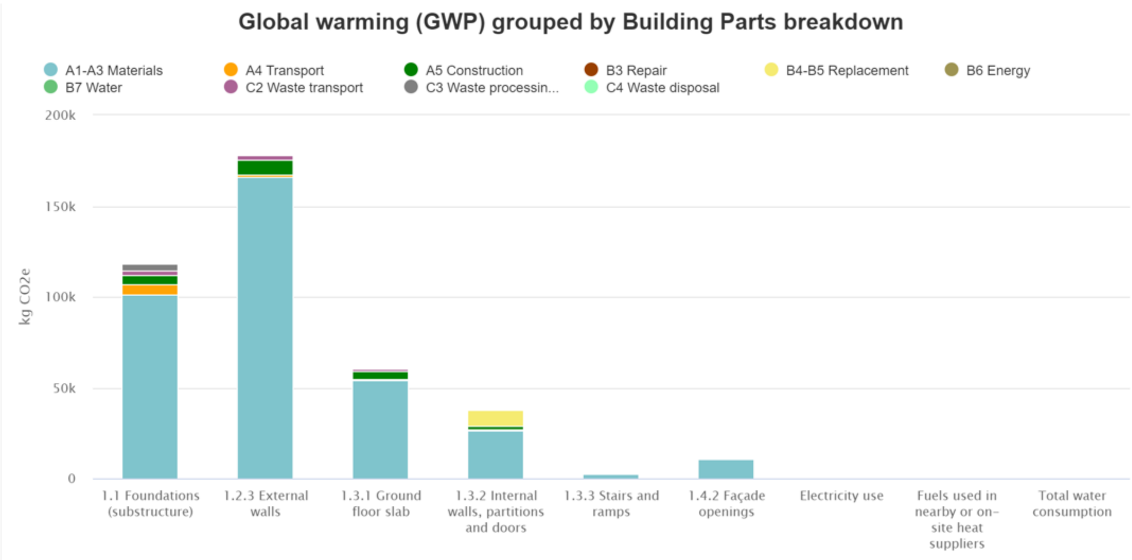
Global warming potential

Global warming potential (GWP) refers to the measure of the total impact a substance has on the Earth's climate over a specific time horizon, typically expressed in terms of carbon dioxide (CO_2) equivalents. GWP considers the ability of a substance to trap heat in the atmosphere relative to CO2, which has a GWP of 1. Higher GWP values indicate a greater warming effect on the climate, making it a crucial indicator for assessing the environmental impact of greenhouse gases and other contributors to climate change.



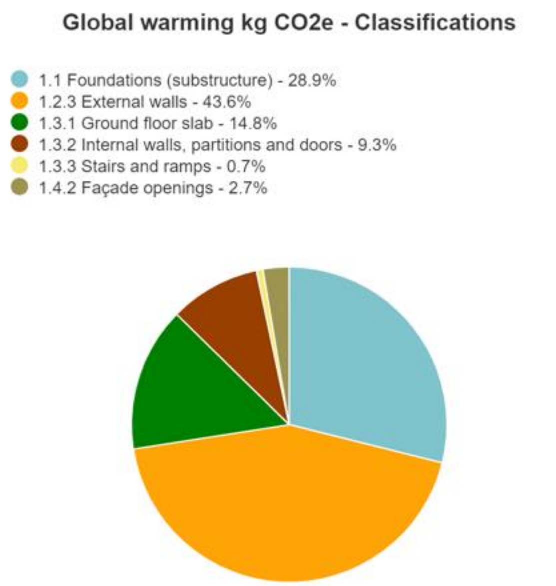
Global warming (GWP) grouped by building parts breakdown

Global warming potential (GWP) grouped by building parts breakdown refers to the analysis and categorization of greenhouse gas emissions associated with different components or systems within a building. This breakdown allows for a detailed assessment of the environmental impact attributed to specific building elements such as foundations, walls, roofs, HVAC systems, and finishes. By grouping GWP data according to building parts, it becomes possible to identify and prioritize areas for improvement in terms of reducing carbon emissions and mitigating climate change impacts throughout the building's life cycle. This approach facilitates a comprehensive understanding of the carbon footprint of building construction and operation, enabling informed decision-making towards more sustainable building practices.



Global warming kg CO2 – Classifications

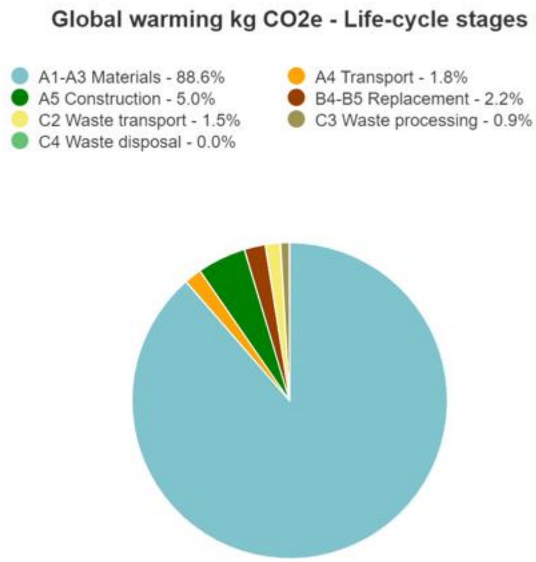
Global warming expressed in kilograms of carbon dioxide (kg CO2) involves categorizing emissions based on their contribution to climate change. This classification considers various sources of greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, each with its unique global warming potential (GWP). By quantifying emissions in kg CO_2 equivalents and classifying them according to their impact on global warming, this approach provides a structured framework for understanding and addressing different emission sources and their environmental consequences. Such classifications play a crucial role in developing strategies to mitigate climate change by identifying priority areas for emission reduction and promoting sustainable practices across various sectors and industries.



Global warming kg CO2e-Life-cycle stages

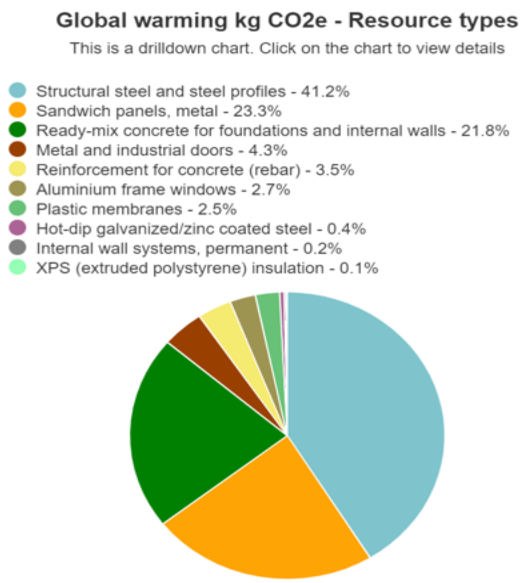
Global warming expressed in kilograms of carbon dioxide equivalent (kg CO_2e) across life-cycle stages involves assessing and quantifying greenhouse gas emissions associated with each phase of a product or project's life cycle. This comprehensive analysis considers emissions from raw material extraction, manufacturing, transportation, use, and end-of-life disposal or recycling. By evaluating emissions across life-cycle stages in kg CO_2e, this approach provides insights into the cumulative environmental impact of a product or project, enabling informed decision-making to minimize carbon footprints and promote sustainable practices throughout its life cycle. This methodology is integral to life cycle assessments (LCAs), helping identify opportunities for emission reduction and environmental improvement across various stages of production and consumption.

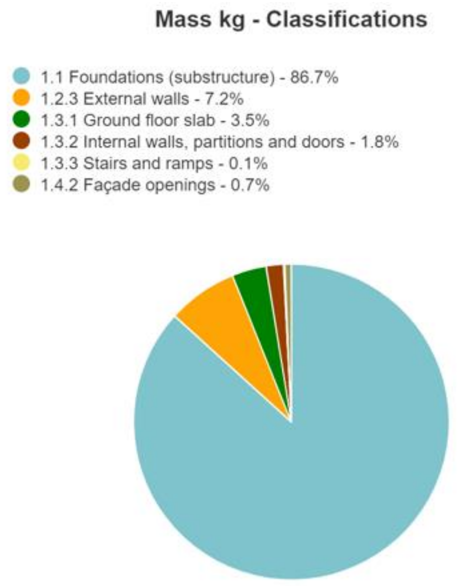
LCA FOR AN INDUSTRIAL BUILDING



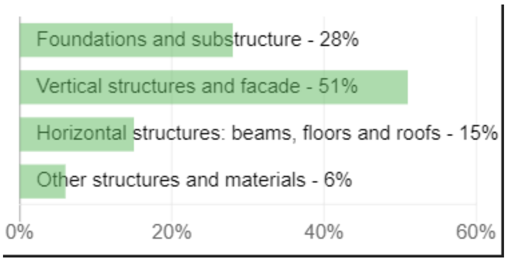
Global warming kg CO2e-Resource types

Global warming expressed in kilograms of carbon dioxide equivalent (kg CO2e) with respect to resource types involves evaluating and quantifying greenhouse gas emissions associated with different types of resources used in the production and consumption of goods or services. This analysis considers emissions across various resource categories, such as energy sources (fossil fuels, renewable energy), materials (metals, plastics, concrete), and water usage. By examining emissions in kg CO2e attributed to resource types, this approach offers insights into the environmental impact of resource extraction, processing, and utilization throughout supply chains. This methodology aids in identifying resource-intensive activities and promoting sustainable resource management practices to mitigate climate change and reduce overall carbon emissions associated with resource consumption.



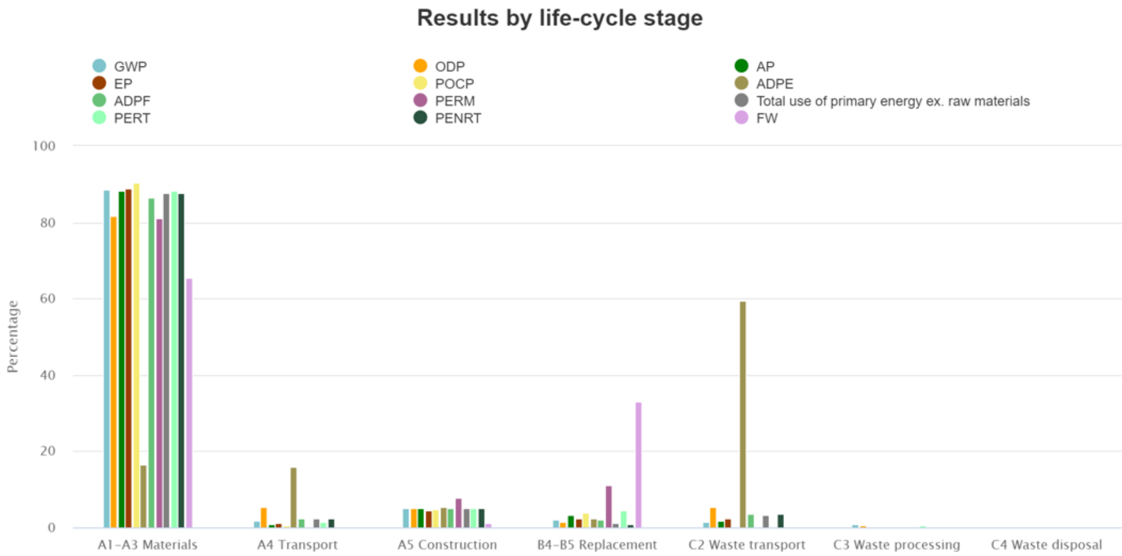


A comparison chart detailing infrastructure and superstructure elements are presented below, that allows for a visual analysis of key differences and similarities between these two critical components of a construction project.



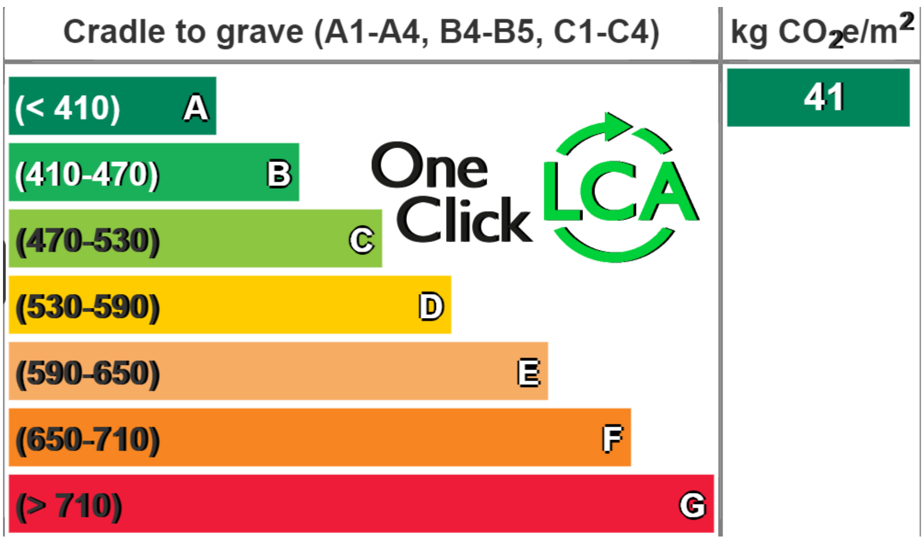
Results by life-cycle stage

The comparison chart provides a detailed analysis of key aspects related to infrastructure and superstructure components in construction projects. It evaluates various factors including the types of materials used, methods of transportation for these materials to and from the construction site, techniques employed during construction, considerations for replacement or renovation over time, approaches to waste transportation for both demolition debris and renovation waste, methods of waste processing such as sorting and recycling, and finally, strategies for waste disposal including options like landfilling or recycling facilities. By examining these elements, stakeholders can better understand the distinct characteristics and environmental implications associated with infrastructure (e.g., roads, bridges) versus superstructure (e.g., buildings, towers) components within the broader context of construction and development projects. This comparative analysis informs decision-making processes aimed at optimizing sustainability and efficiency throughout the project lifecycle.



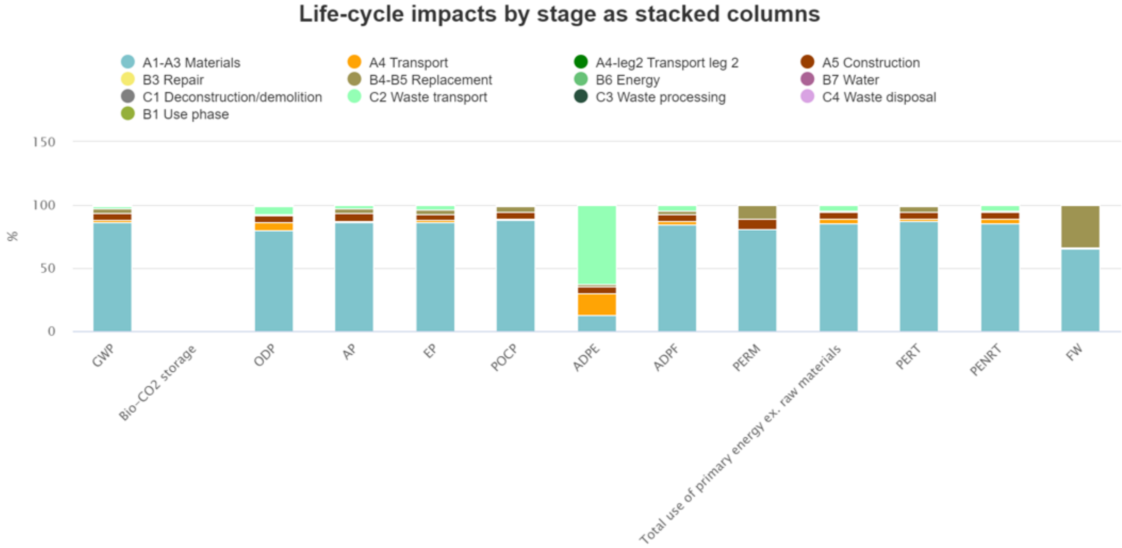
Romania all building types excl. MEP - 2023 Q3

In the third quarter of 2023, Romania experienced growth and development across various building types, excluding mechanical, electrical, and plumbing (MEP) systems. This encompassed a range of construction projects spanning residential, commercial, industrial, and institutional sectors, contributing to the country's urban landscape and economic advancement.

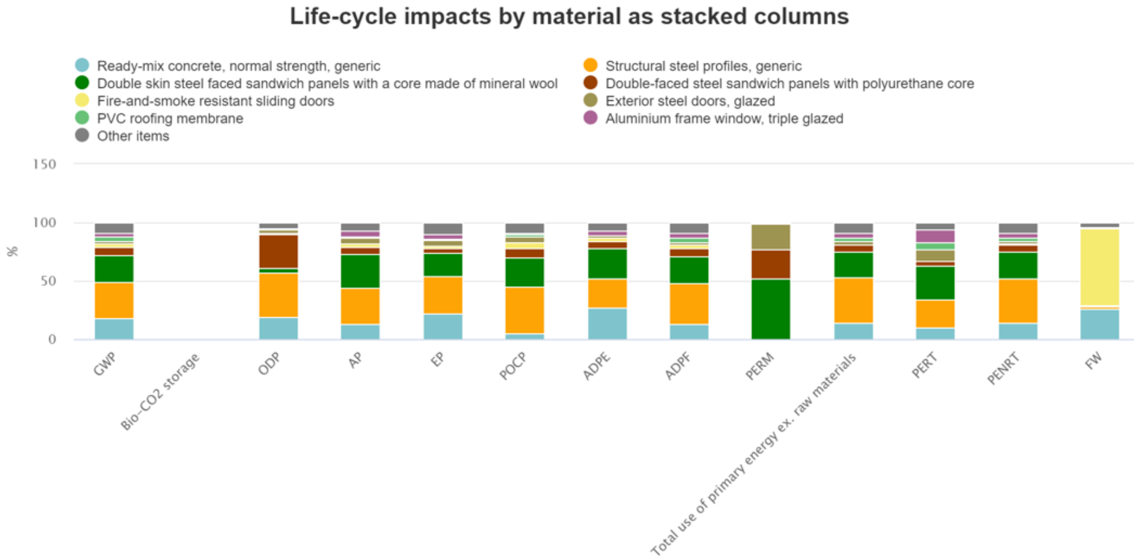


5.1.4 SECOND STAGE

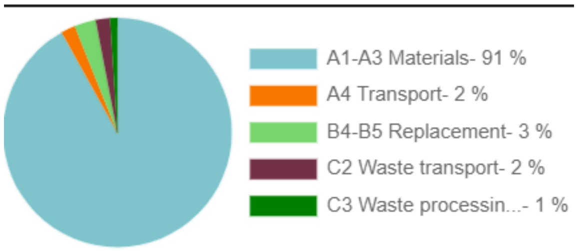
Life cycle impacts by stage as stacked columns



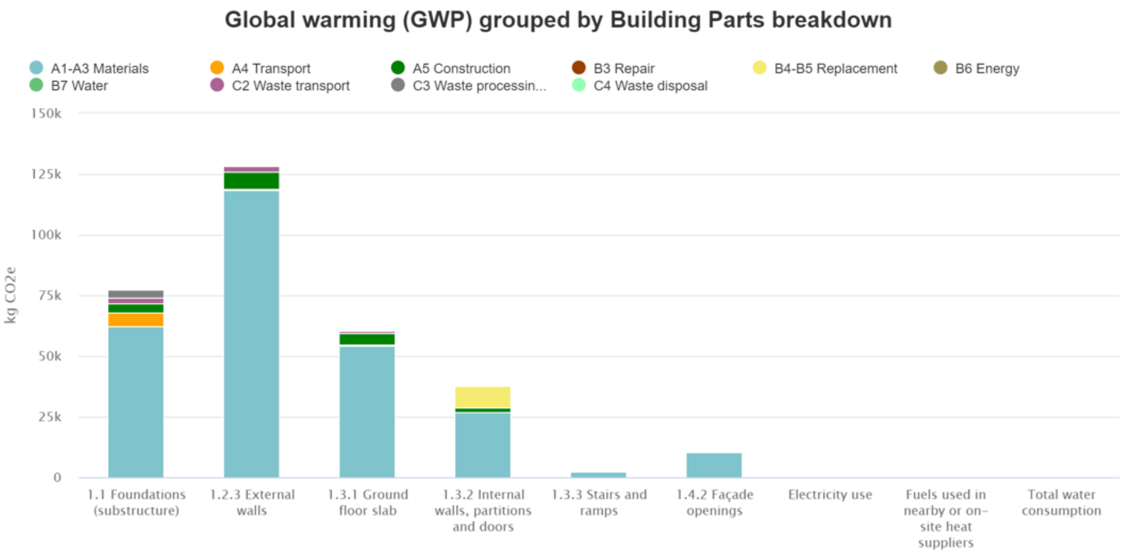
Life cycle impacts by material as stacked columns



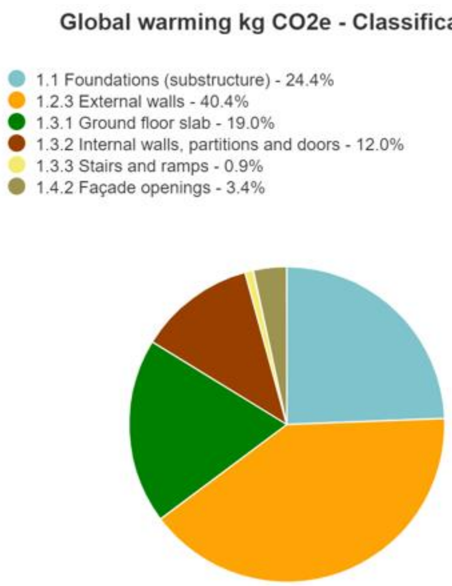
Global warming potential



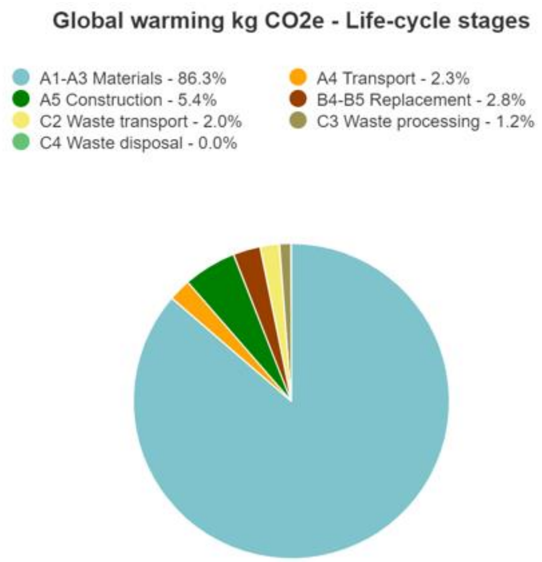
Global warming (GWP) grouped by Building Parts breakdown



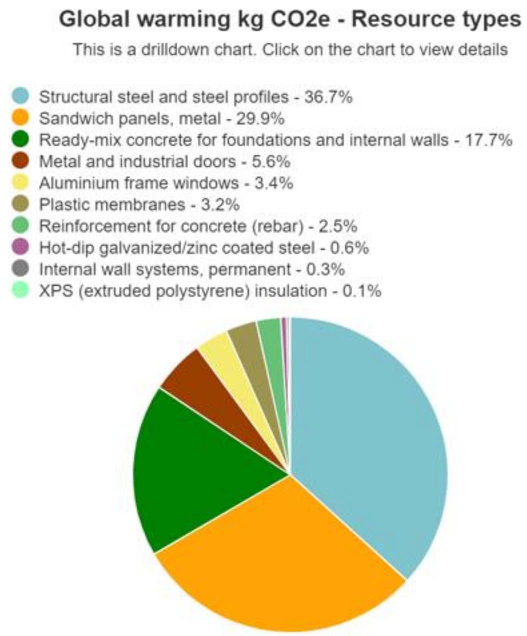
Global warming kg CO2e-Classifications



Global warming kg CO2e- Life cycle stages

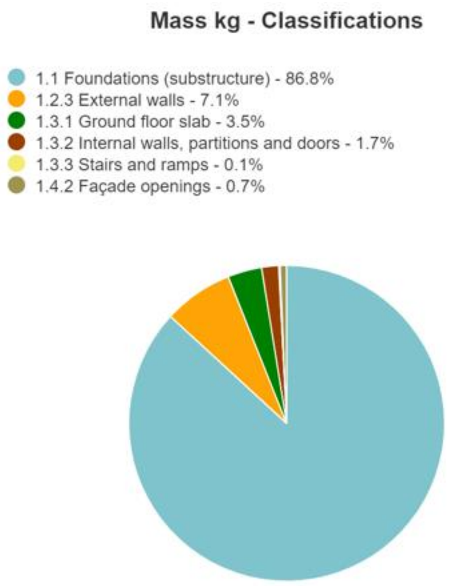


Global warming kg CO2e-Resource types

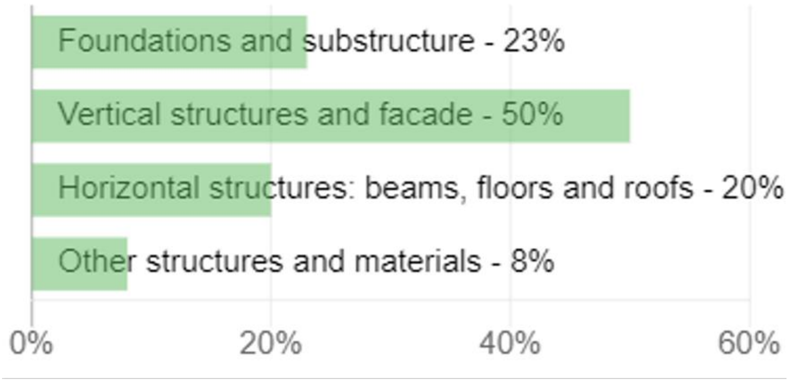


Mass kg - Classifications

Materials use by mass source

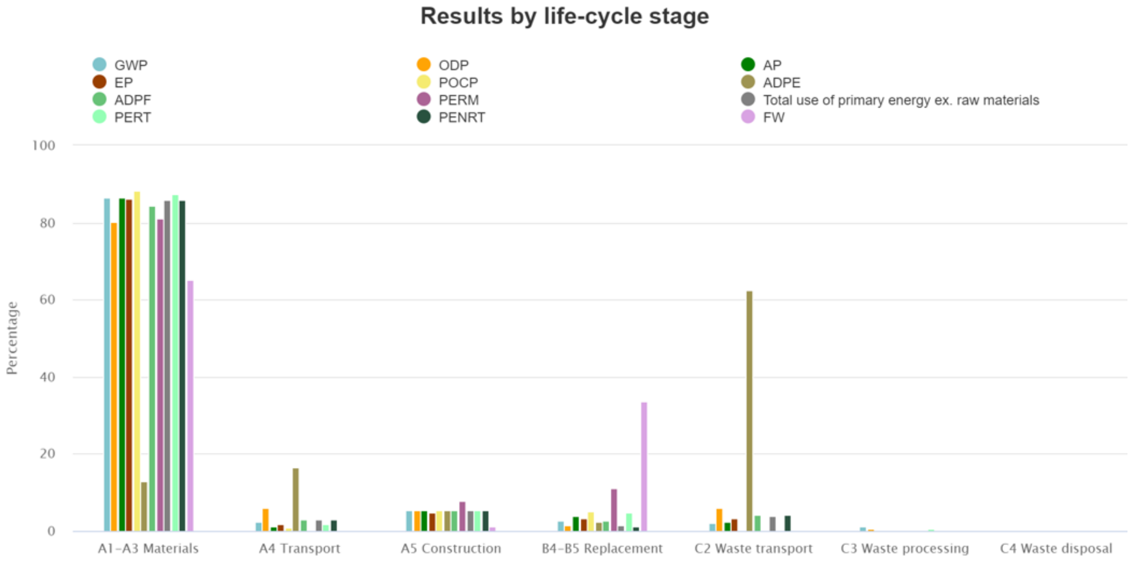


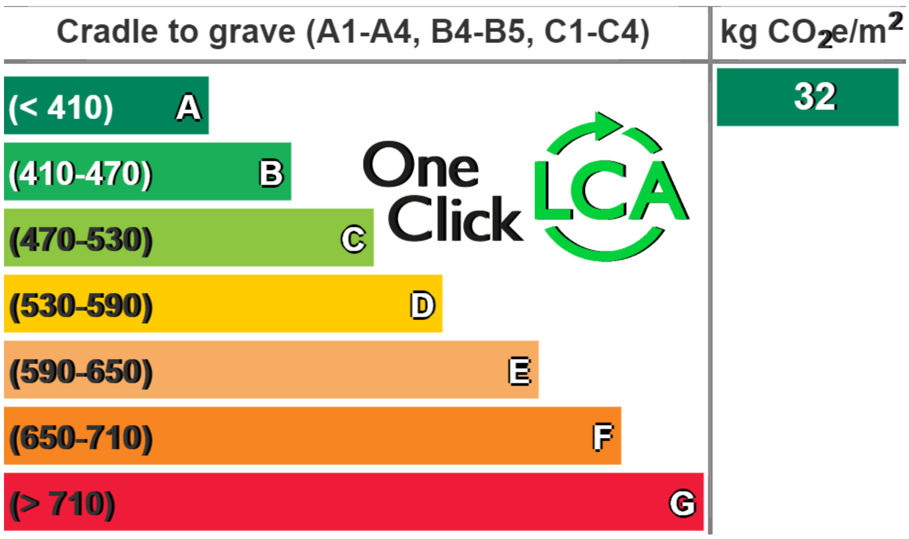
Materials use by mass source



Results by life cycle stage

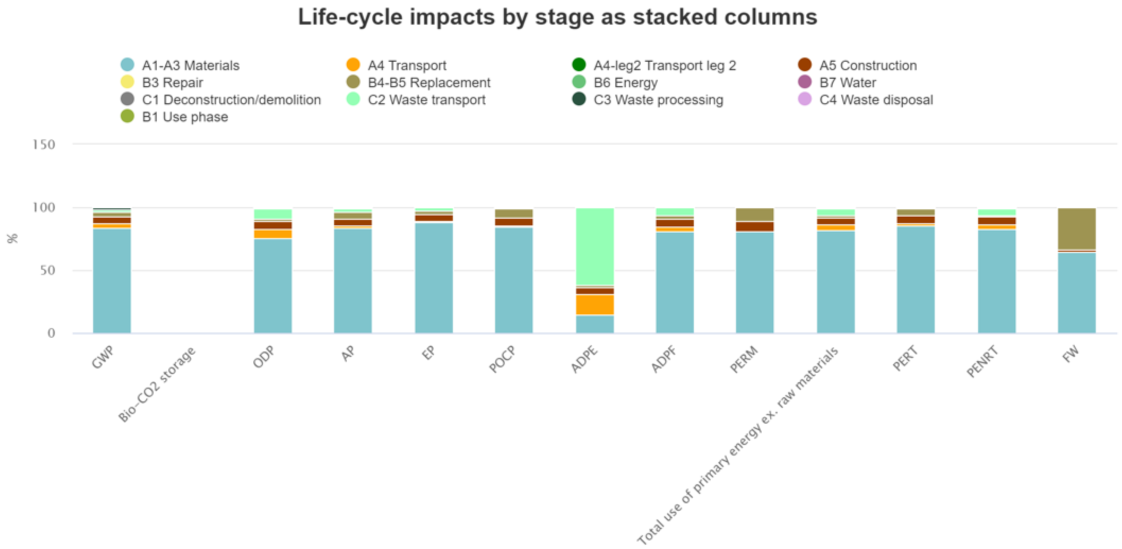
LCA FOR AN INDUSTRIAL BUILDING



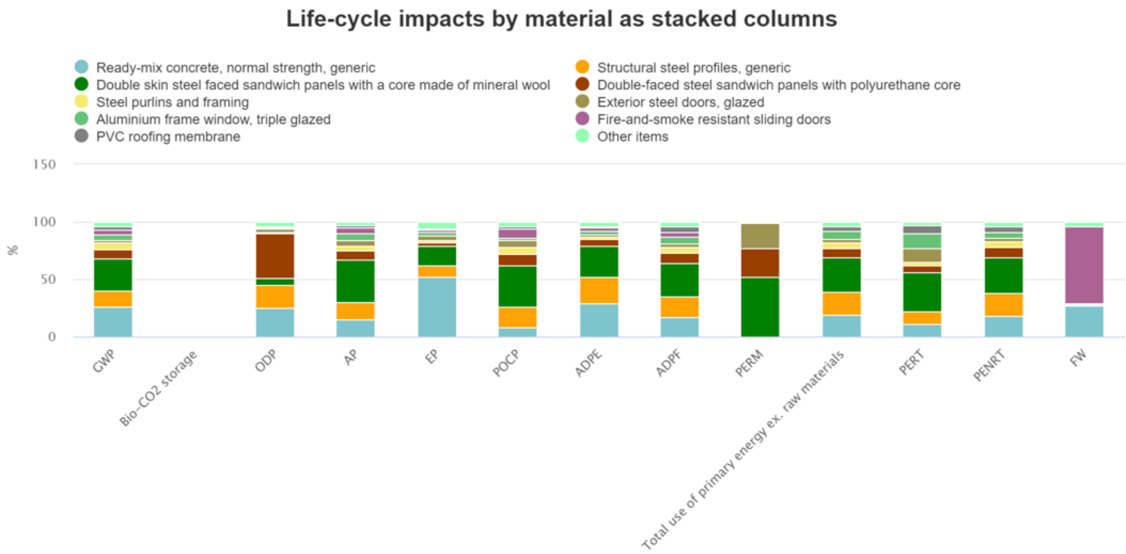


5.1.5 THIRD STAGE

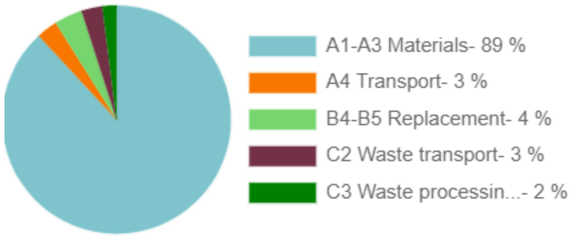
Life-cycle impacts by stage as stacked columns



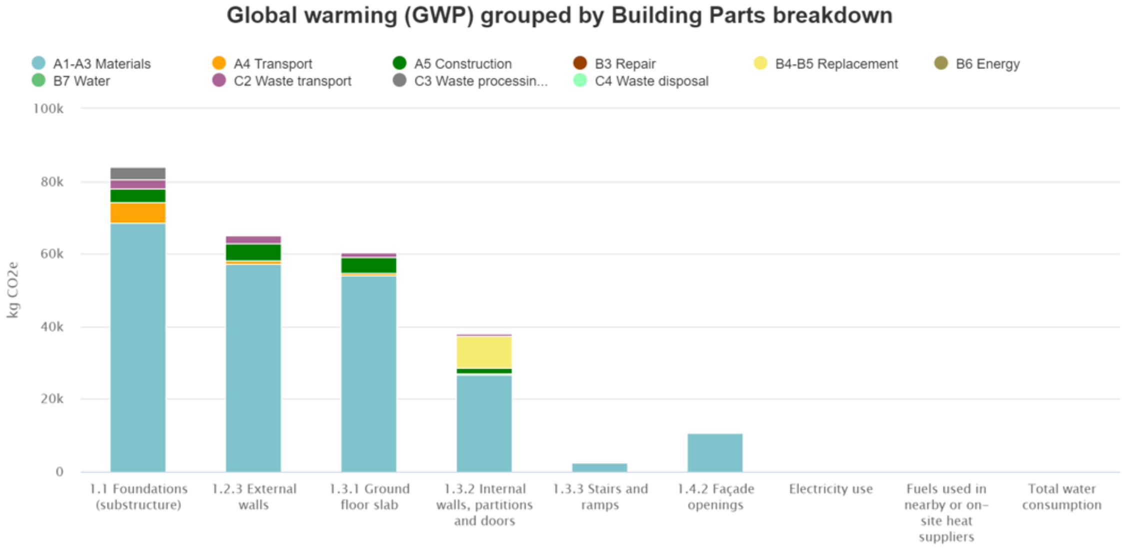
Life-cycle impacts by material as stacked columns



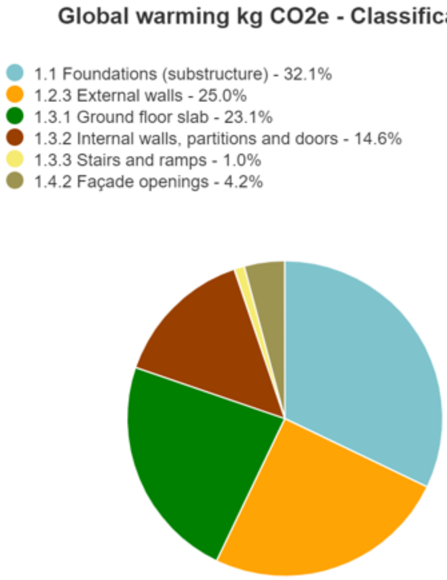
Global warming potential



Global warming (GWP) grouped by Building Parts breakdown

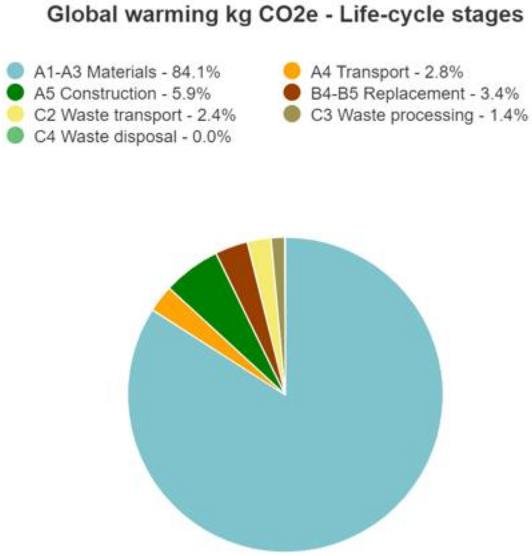


Global warming kg CO2 - Classifications

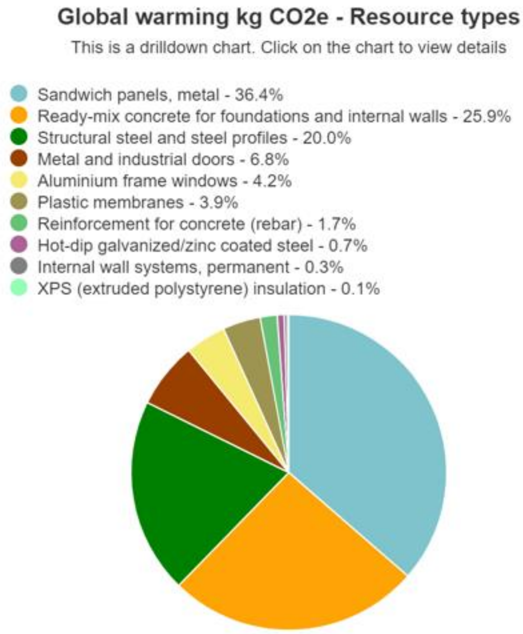


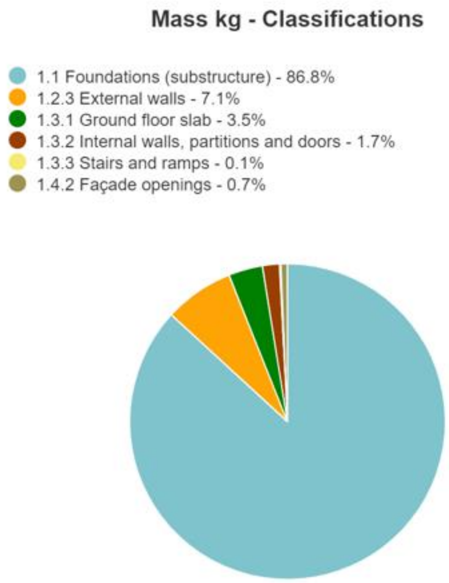
Global warming kg CO2e-Life cycle stages

LCA FOR AN INDUSTRIAL BUILDING

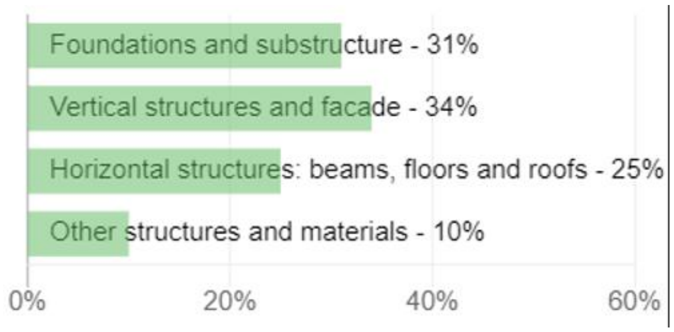


Global warming kg CO2e-Resource types

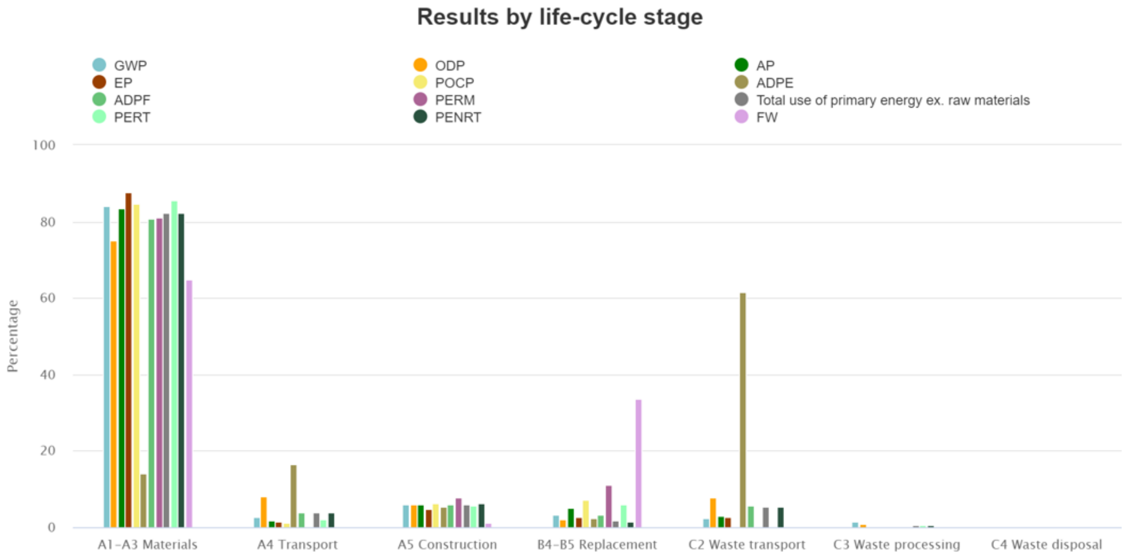




Mass kg Classification

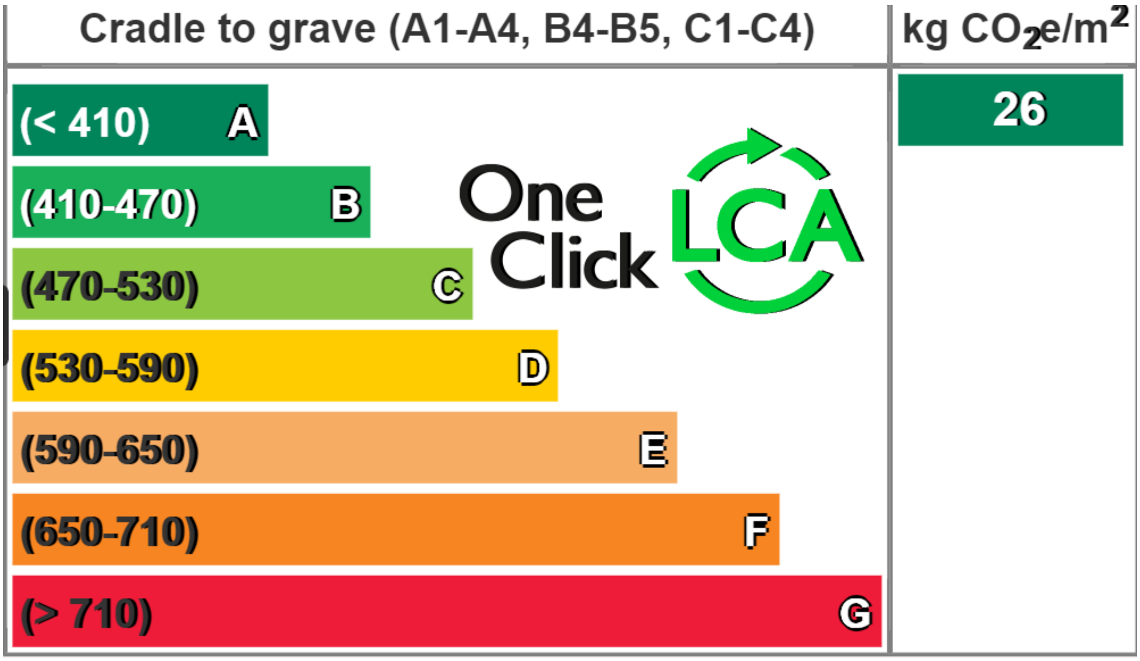


Results by life-cycle stage



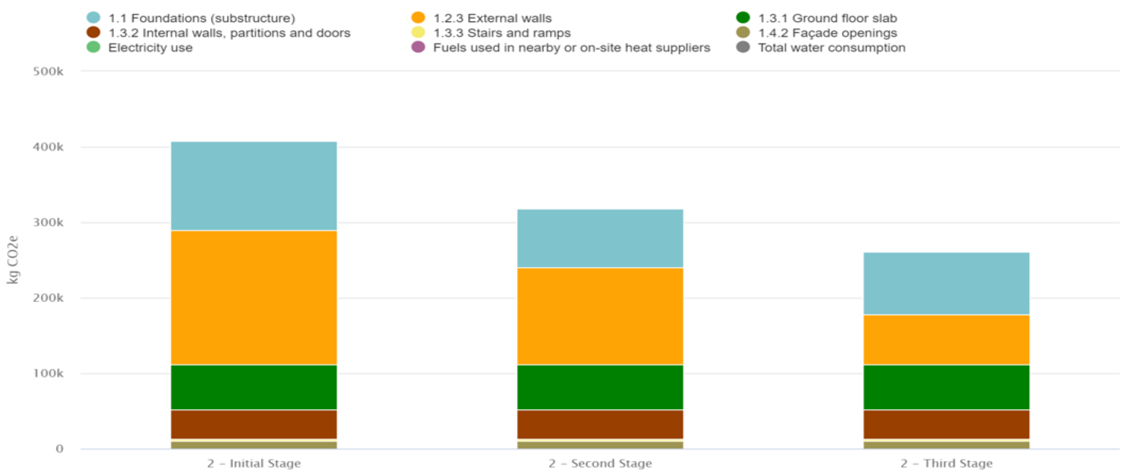
LCA FOR AN INDUSTRIAL BUILDING

Cradle to grave (A1-A4,B40=-B5,C1-C4)



5.1.6 COMPARISON OF THE 3 STAGES ANALYZED IN ONE-CLICK LCA

A comparison of the three stages focuses on evaluating and contrasting key aspects such as waste management practices and greenhouse gas emissions (GWP) across each stage. This analysis aims to identify differences, similarities, and trends in how waste is managed and its corresponding environmental impact in terms of GWP. By examining these factors, we gain insights into the progression, evolution, and effectiveness of waste management strategies over time or under different conditions within the context of environmental sustainability.



The chart below includes the following results obtained: GWP - Global Warming Potential: A measure of the total impact a substance has on the Earth's climate over a specific time horizon, typically expressed in terms of carbon dioxide (CO2) equivalents.

DDP - Delivered Duty Paid: An international trade term indicating that the seller is responsible for all costs associated with delivering goods to a specified location, including customs duties and taxes.

AP - Acidification Potential: The capacity of a substance to increase acidity in the environment, often associated with emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx).

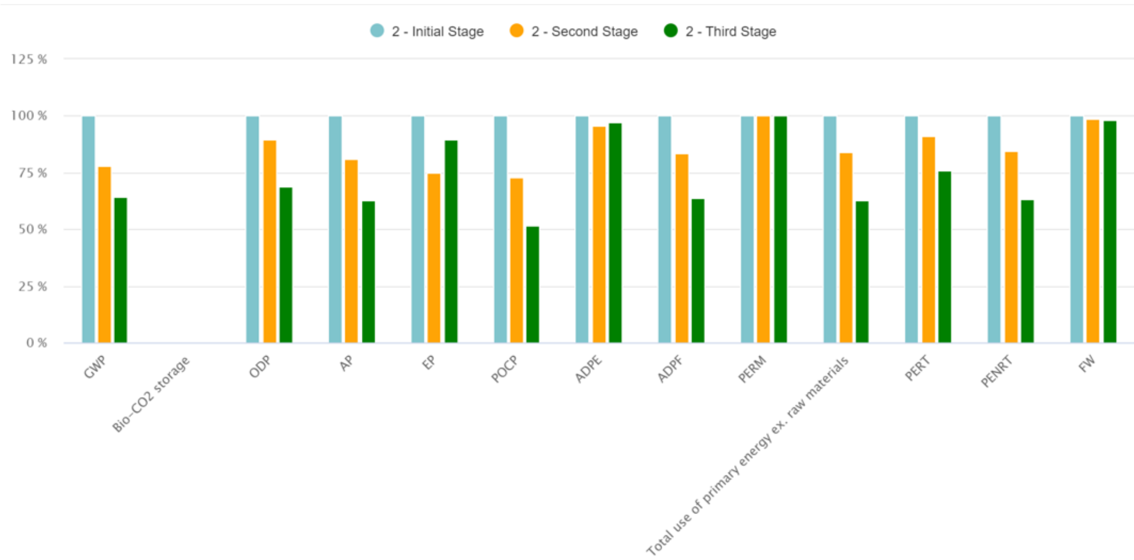
EP - Eutrophication Potential: The ability of a substance to promote excessive growth of algae and aquatic plants in water bodies, leading to oxygen depletion and ecological imbalances.

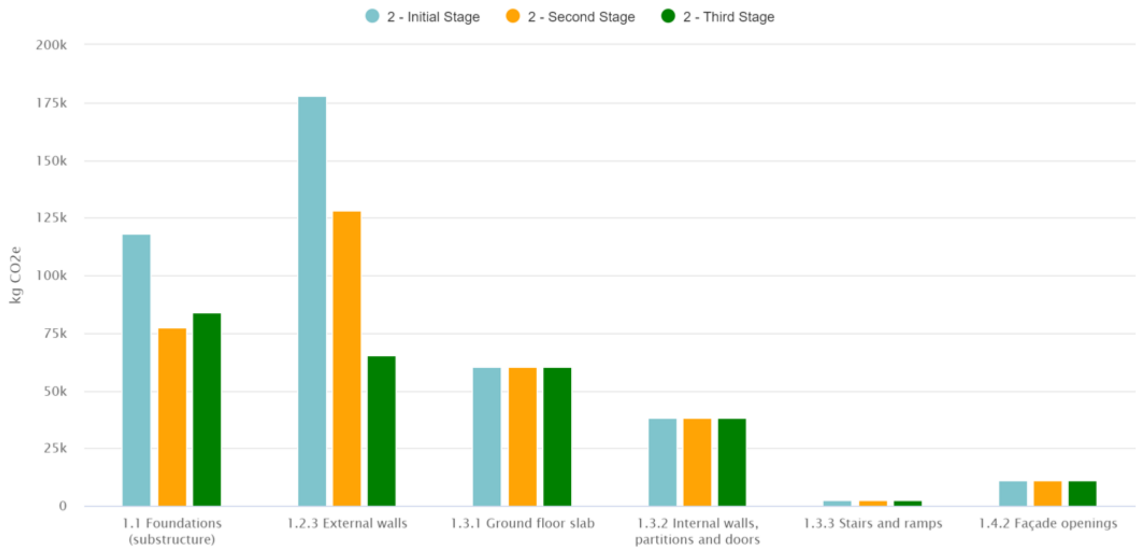
POCP - Photochemical Ozone Creation Potential: The potential of a substance to contribute to the formation of ground-level ozone (smog) through chemical reactions in the atmosphere.

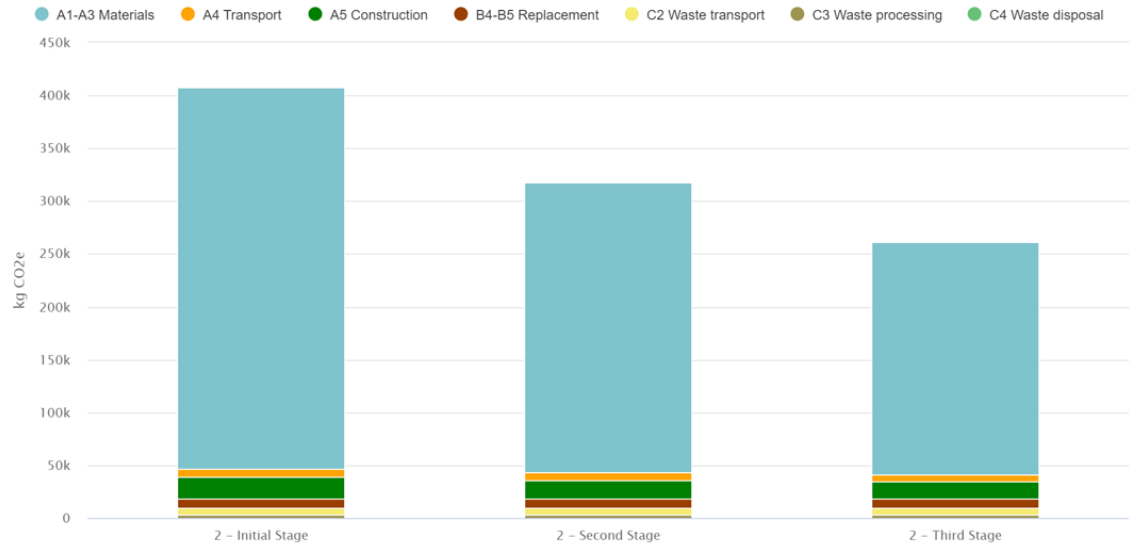
PERM - Primary Energy Resource Mix: The composition of primary energy sources (e.g., fossil fuels, renewables) used to produce energy in a given region or context.

PER - Primary Energy Requirement: The total amount of primary energy (including both direct and indirect energy) required to produce, process, and use a product or service.

PENRT - Primary Energy Non Renewable Total

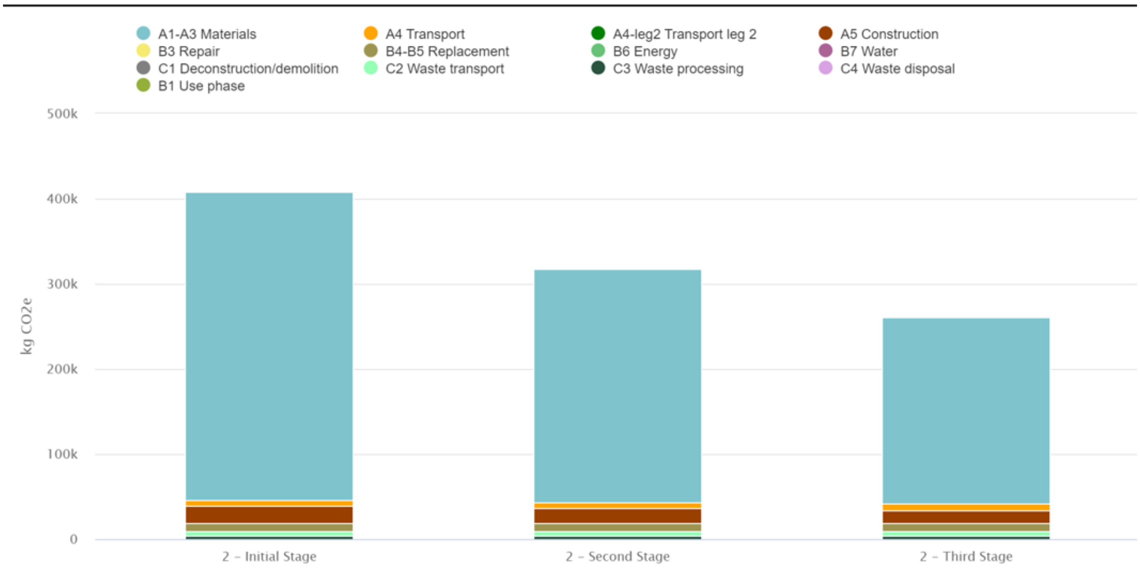






The chart below illustrates that CO2 consumption is significantly higher in the initial case (without the use of material recycling). Additionally, a more positive outcome is evident in the third stage, where a greater amount of recycled elements were incorporated into the analysis.

Increasing the utilization of recycled materials in construction leads to improved long-term performance and sustainability of the structure. By incorporating higher percentages of recycled content, such as reclaimed metals, concrete aggregates, or plastic composites, the building's environmental footprint can be minimized while enhancing durability and resource efficiency throughout its lifespan. This strategic approach aligns with sustainable practices and contributes positively to reducing overall environmental impact associated with construction activities.



It is essential to consider using recycled elements and structures to mitigate global warming, as this approach can have a significant long-term impact on reducing environmental harm and promoting sustainability. Incorporating recycled materials into construction practices can contribute positively to efforts aimed at combating climate change and minimizing resource depletion over time.

References

[1] LCA for construction & manufacturing, https://oneclicklca.com/

6 - Deliverables

To assess the effectiveness of the application, students will be required to input their own projects into the ONE CLICK LCA program and conduct a thorough evaluation.

7- What we have learned

To establish a comprehensive framework encompassing three distinct stages of recycling for a steel structure.

To extract and analyse graphical representations generated by the OPEN CLICK LCA program.