BDP.
Quadrangle

# Embodied Carbon in High Performance Walls

June 2022

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## 1.0 INTRODUCTION

This carbon emissions study was prepared by BDP Quadrangle to understand the environmental impacts of potential high performance exterior wall assemblies.

### 1.1 Summary

BDP Quadrangle has committed, under the Sustainability Strategy Decarbonization Roadmap, to a 40% reduction in embodied carbon for all projects completed in the office by 2030. The building envelope will be a critical part of this reduction as it accounts for roughly 30% of the embodied carbon in a multi-unit residential building. Any opportunity to reduce carbon emissions within the building envelope must consider both the impacts to the operational and embodied carbon, especially when considering high performing alternatives. Using a ratio of thermal performance (RSI) and global warming potential (GWP) we can begin to evaluate the overall carbon intensity of each wall assembly. The lower the ratio, the lower its carbon impact.

This report investigates the relative impact of six high-performance wall assemblies. Each of these wall assemblies were developed as potential solutions to achieve a high thermal resistance for a project targeting the Zero Carbon Building Standard through the Canadian Green Building Council (CaBGC).

### 1.2 Methodology

OneClick LCA was used to access Environmental Product Declarations (EPDs) to find the GWP of each assembly. GWP values are expressed in units of carbon dioxide mass equivalent (kg CO2e, in which all GHGs are converted to the impact of CO2).

### 1.2 Findings

The results varied significantly from a high of 217 kg c02e/$m^2$ to a low of 84 kg c02e/$m^2$ . In the study each material within the assembly was calculated separately so high-emission materials could be identified.

In the Toronto Multi-unit Residential sector, pre-finished aluminum cladding is the most common. For this reason, the study used this as a baseline cladding for the relevant assemblies. As indicated by the analysis on page 11, this cladding is the highest emitting cladding material of the EPDs compared. The assumption that this cladding is a industry standard should be challenged.

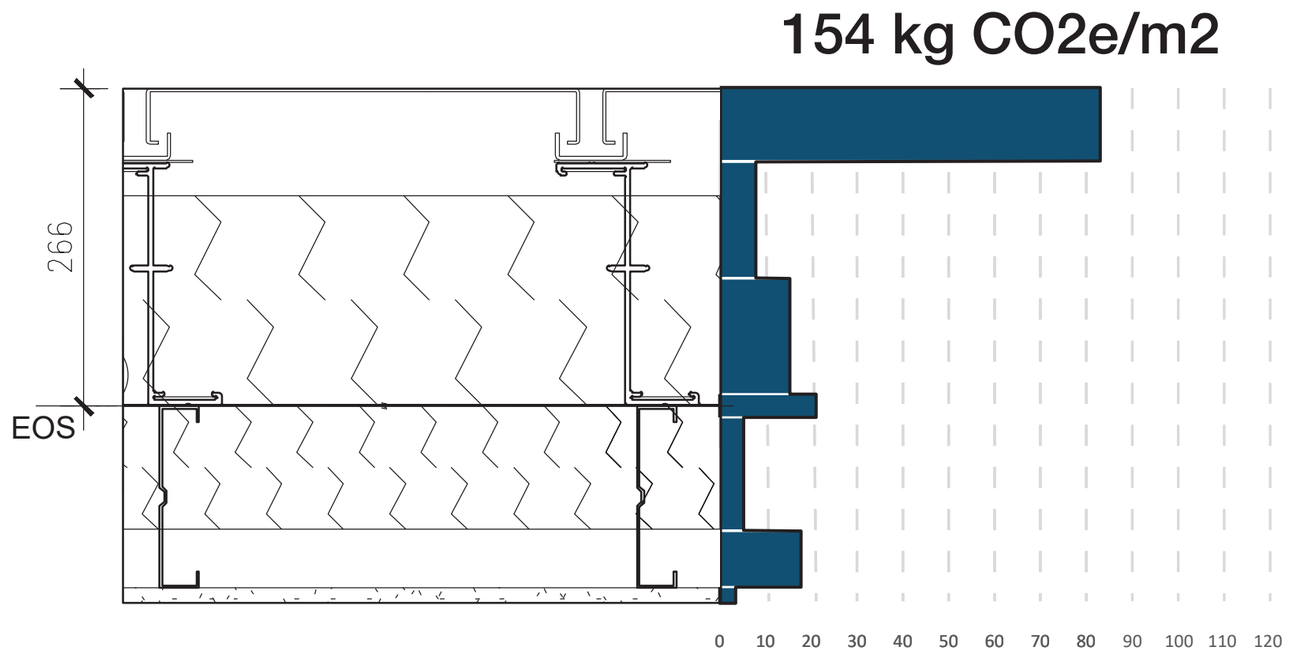
Page 9 and 10 show a comparison of these systems both with the baseline cladding and with a lower GWP alternative. By substituting the aluminium panel for a lower emission material the *GWP : RSI* ratio is greatly reduced for all assemblies except the precast concrete types. With this change the *Built-up Wall System* becomes the assembly with the lowest ratio at 11:1.

## 2.0 WALL ASSEMBLIES

### 2.1 Large Format Prefabricated Panel

| | |
|---|---|
| 3mm | Prefinished aluminium panel system c/w panel frame and wall clips |
| 25mm | Air space |
| 203mm | Greengirts (8”) @ 600mm OC |
| 175mm | Semi-rigid mineral wool insulation (RSI + 5.25) |
| 1mm | GALV steel sheet |
| 100mm | Semi-rigid mineral wool insulation (RSI = 3.0) |
| 152mm | GLAV structural steel studs @ 400mm OC) |
| 13mm | GWB |

Thickness = 431mm
Nominal RSI = 8.25 (R = 46.8)

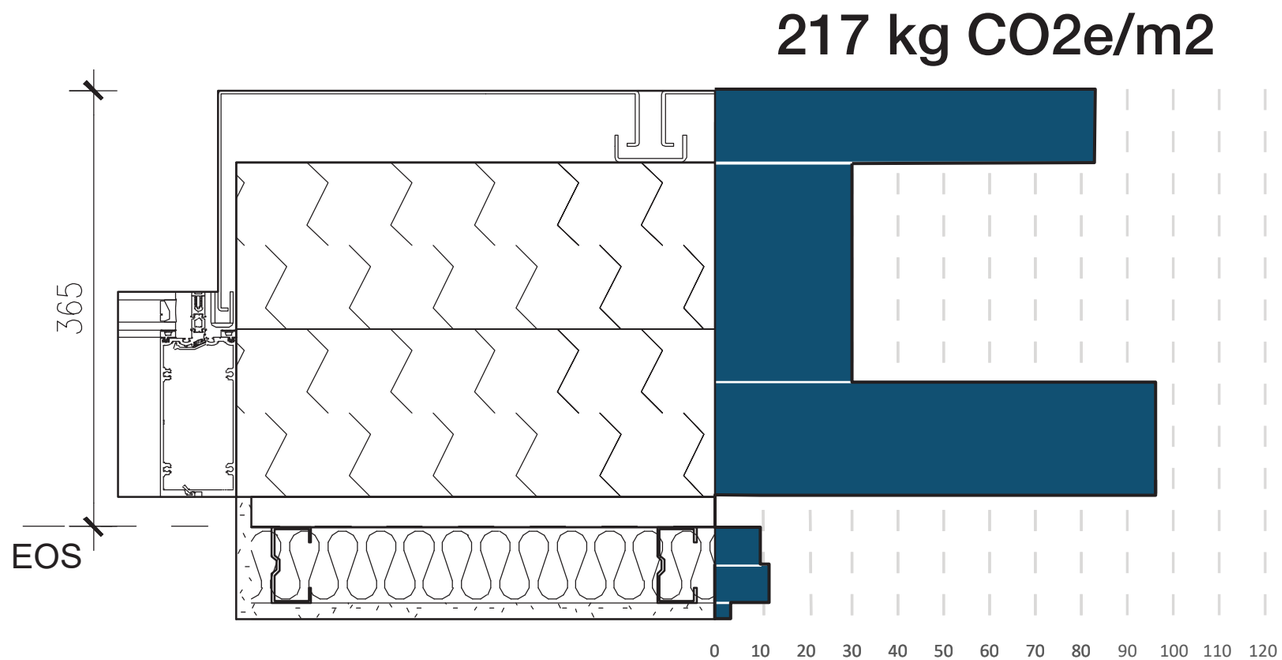



| | |
|---|---|
| TOTAL GWP (kg CO2e) per m2 | 154 |
| Effective RSI = | 3.34 |
| GWP : RSI | 46.2 : 1 |

## 2.2 High Performance Curtainwall System

| | |
|---|---|
| 3mm | Prefinished aluminium panel system c/w panel frame and wall clips |
| 280mm | Semi-rigid Mineral wool issulation (RSI = 8.25) |
| 203mm | Curtain wall system (203mm mullion) |
| 3mm | GALV steel backpan (not included in carbon calc.) |
| 64mm | Fiberglass batt insulation (RSI = 1.5) |
| 64mm | GALV structural steel studs @ 400mm ON |
| 13mm | GWB |

Thickness = 442mm
Nominal RSI = 9.75 (R = 55)

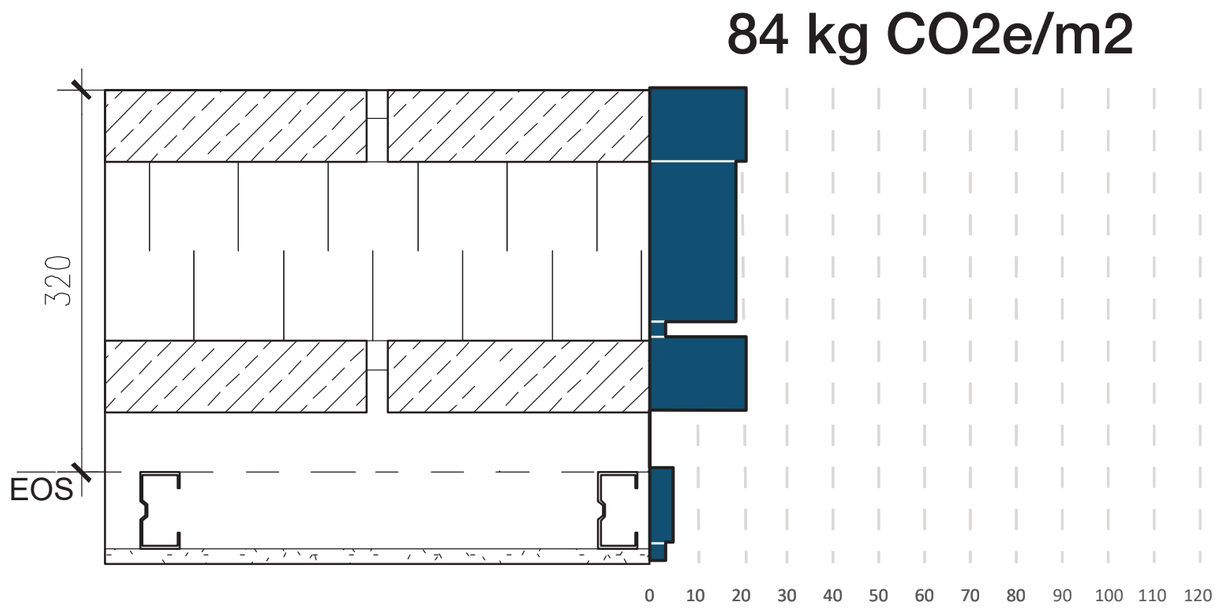



| | |
|---|---|
| TOTAL GWP (kg CO2e) per m2 | 217 |
| Effective RSI = | 6.16 |
| GWP : RSI | 35.2 : 1 |

## 2.3 Modular Precast System - Phenolic

| | |
|---|---|
| 60mm | Architectural precast concrete panel |
| 150mm | K20 Phenolic insulation (RSI = 8.8) |
| - | GRFP ties between wythes |
| 60mm | Architectural precast concrete panel |
| 50mm | Air space |
| 64mm | GLAV structural steel studs @ 400mm OC |
| 13mm | GWB |

Thickness = 397mm
Nominal RSI = 8.8 (R = 49.8)

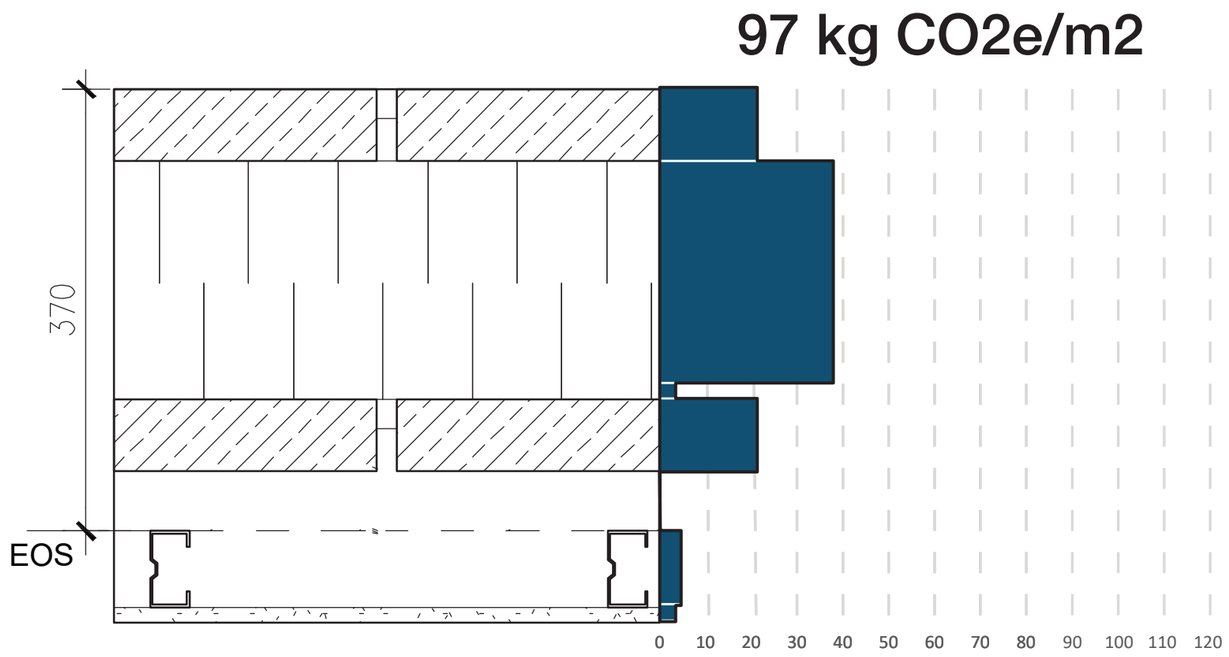



| TOTAL GWP (kg CO2e) per m2 | 84 |
|---|---|
| Effective RSI = | 6.69 |
| GWP : RSI | 12.6 : 1 |

## 2.4 Modular Precast System - Polyiso

| | |
|---|---|
| 60mm | Architectural precast concrete panel |
| 200mm | Polyiso insulation (RSI = 8.9) |
| - | GRFP ties between wythes |
| 60mm | Architectural precast concrete panel |
| 50mm | Air space |
| 64mm | GLAV structural steel studs @ 400mm OC |
| 13mm | GWB |

Thickness = 477mm
Nominal RSI = 8.9 (R = 51)

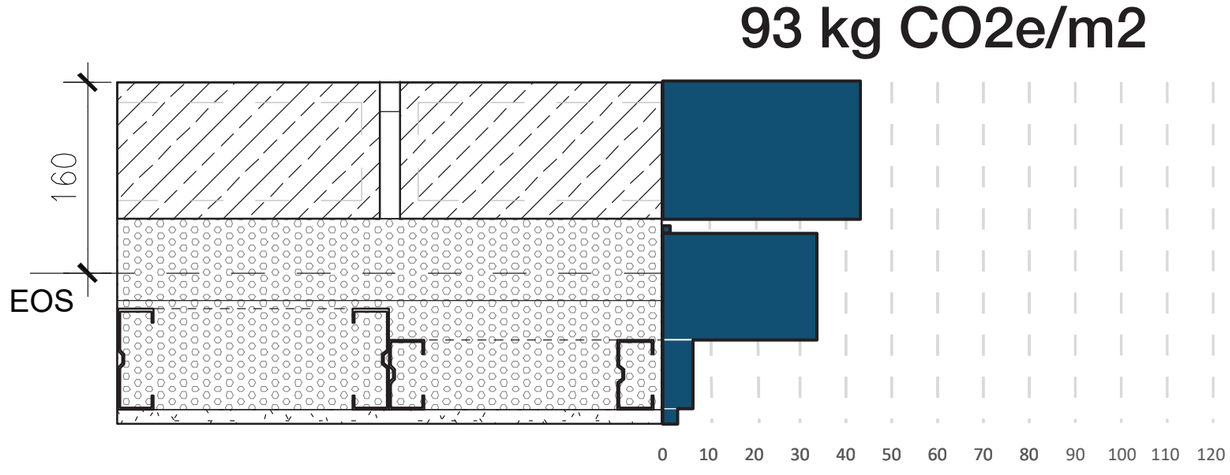



| TOTAL GWP (kg CO2e) per m2 | 97 |
|---|---|
| Effective RSI = | 6.69 |
| GWP : RSI | 14.6 : 1 |

## 2.5 Architectural Precast Concrete at Steel Stud Backup

| | |
|---|---|
| 125mm | Architectural precast concrete panel, two-stage joint seal |
| 175mm | 75+100mm closed cell polyurethane spray foam (RSI = 7.04) |
| - | 92mm or 64mm steel studs @ 400mm OC |
| - | (partially embeded into spray foam) |
| - | (92mm steel studs around window wall) |
| 13mm | GWB |

Thickness = 286mm
Nominal RSI = 7.04 (R = 40)



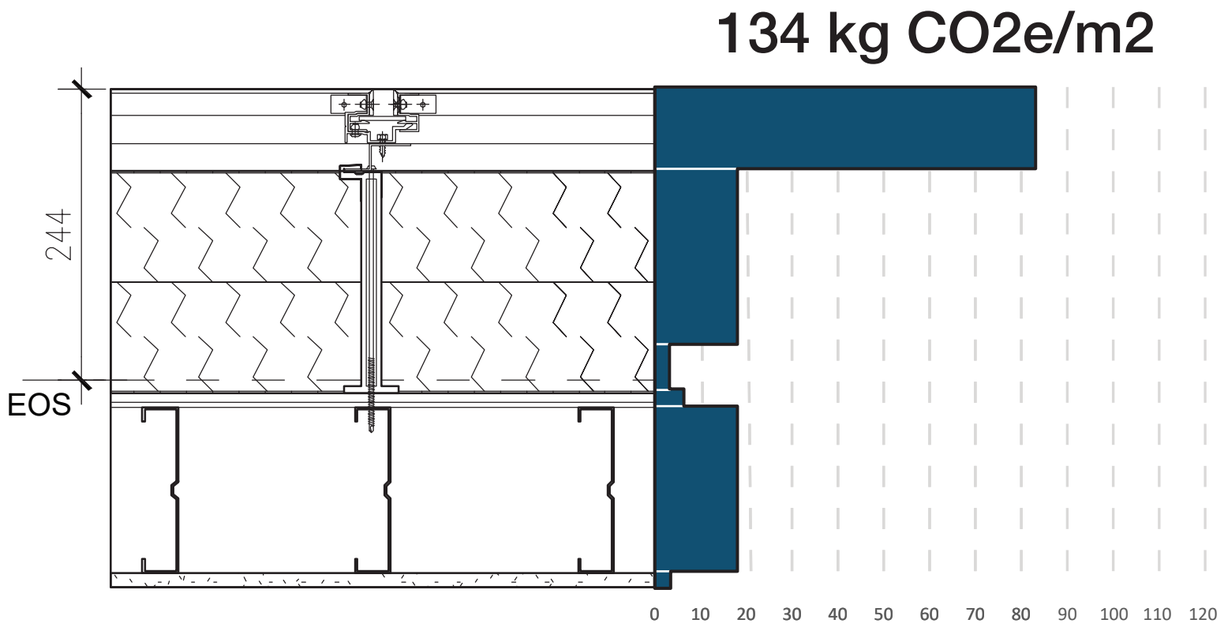

| | |
|---|---|
| TOTAL GWP (kg CO2e) per m2 | 93 |
| Effective RSI = | 5.46 |
| GWP : RSI | 17 : 1 |

## 2.6 Aluminium Architectural Cladding, Steel Stud Backup

| | |
|---|---|
| 3mm | Prefinished aluminium panel system c/w panel frame and wall clips |
| 25mm | Vertical GALV Z-girts or horizontal hat-track (as required) |
| 203mm | Fiberglass thermal spacer clips |
| 100mm | Semi-rigid mineral wool insulation (RSI = 3.0) |
| 100mm | Semi-rigid mineral wool insulation (RSI = 3.0) |
| 13mm | Exterior sheathing |
| 152mm | GALV structural steel studs @ 400mm OC |
| 13mm | GWB |

Thickness = 417mm

Nominal RSI = 6.0 (R = 34.0)

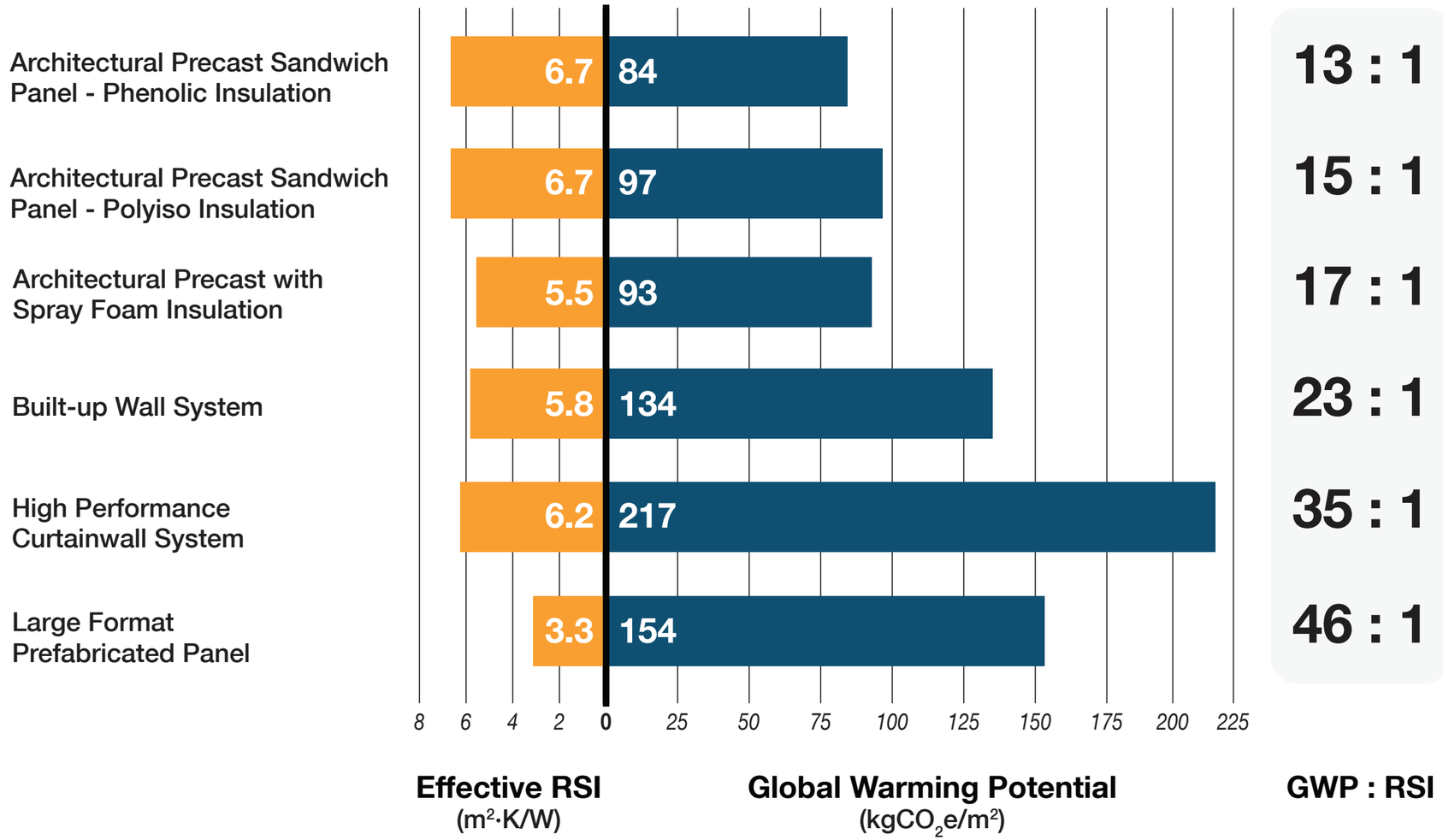



| | |
|---|---|
| **TOTAL GWP (kg CO2e) per m2** | **134** |
| **Effective RSI =** | **5.81** |
| **GWP : RSI** | **23 : 1** |

## 3.0 COMPARATIVE ANALYSIS

### 3.1 Systems Comparison - with Baseline Cladding

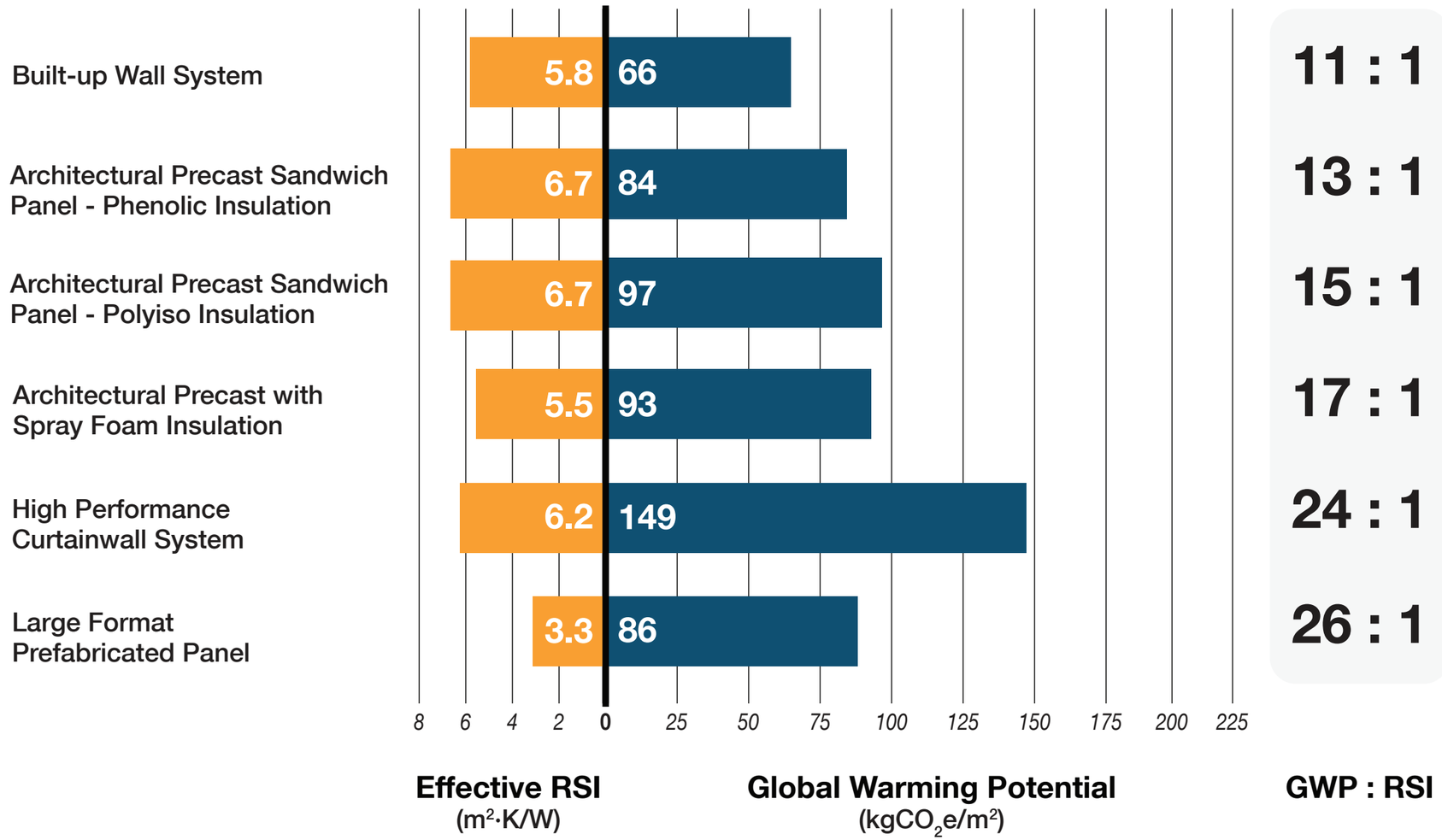
Using a ratio of thermal performance (RSI) and global warming potential (GWP) we can begin to evaluate the overall carbon intensity of each wall assembly. The lower the ratio, the lower its carbon impact. The ratio range varies significantly from 13:1 to 46:1.




Systems Comparison - Including Baseline Cladding

## 3.2 Systems Comparison - with Prefinished Steel Panel Cladding

By substituting the aluminium panel for a lower emission material the *GWP : RSI* ratio is greatly reduced for all assemblies except the precast concrete types. With this change the *Built-up Wall System* becomes the assembly with the lowest ratio at 11:1.



## 3.3 Material Carbon Emission of Cladding Only

Any of these cladding materials can be substituted for the pre-finished aluminum cladding. They range significantly in value from 16 kg c02e/$m^2$ to 83 kg c02e/$m^2$ which can make a significant different to a cladding system.