



Embodied Carbon in High Performance Walls

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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 CO₂e/m² to a low of 84 kg CO₂e/m². In the study each material within the assembly was calculated separately so high-emission materials could be identified. These findings are project specific and should not be relied upon by any third party.

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. Aluminum panel cladding is one of the highest embodied carbon materials for envelope design. 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.

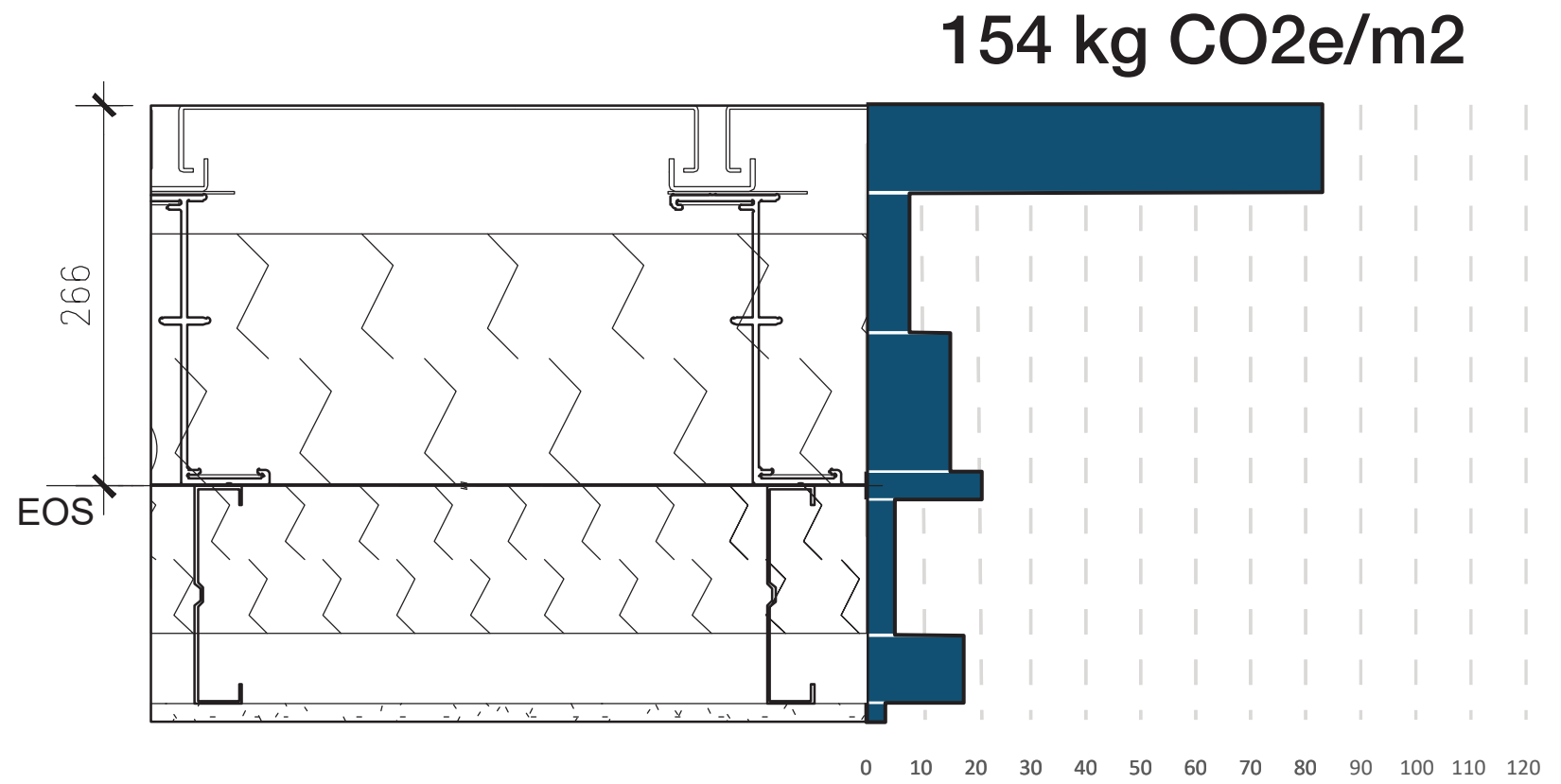
2.0 WALL ASSEMBLIES

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)

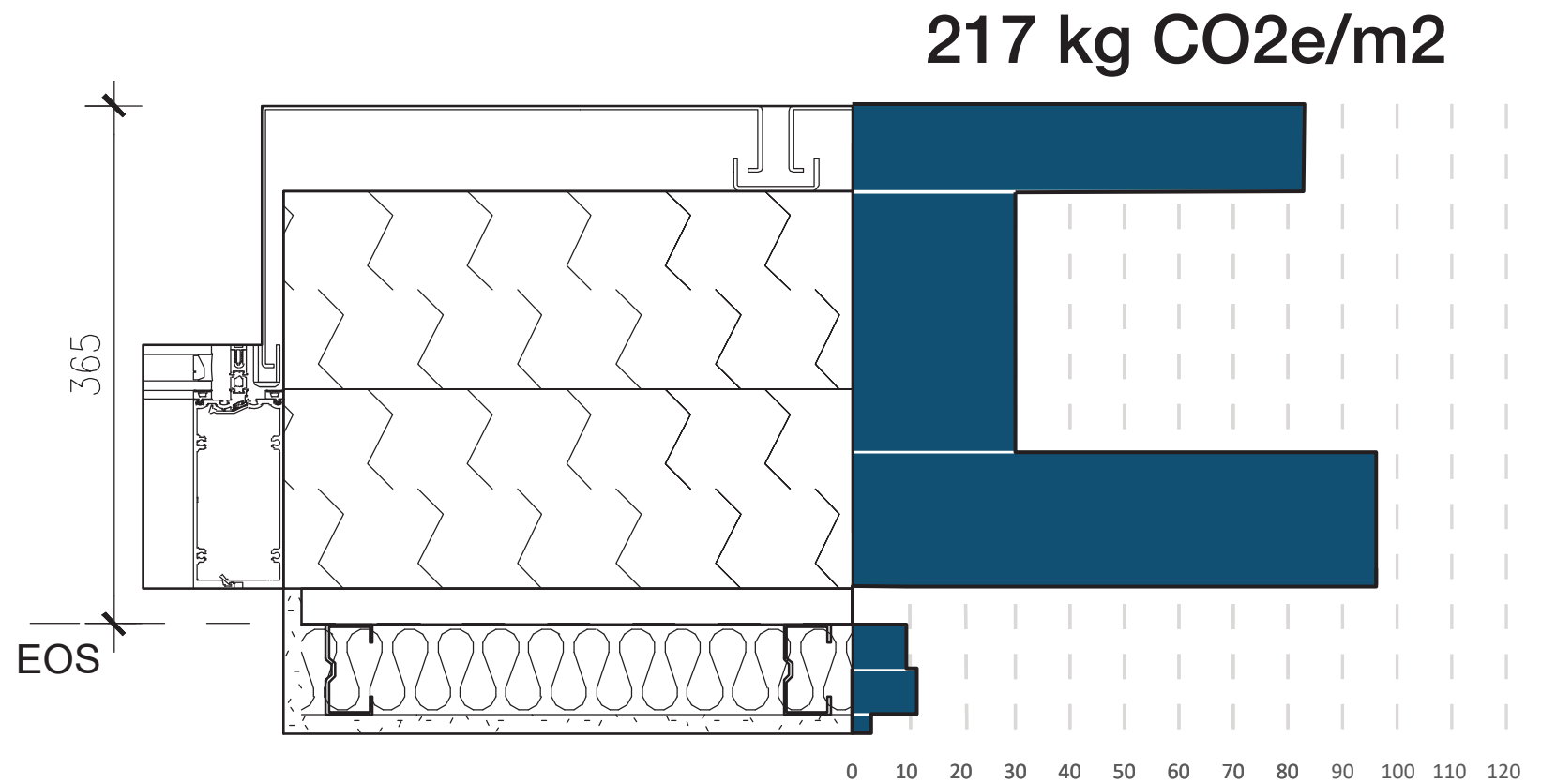


TOTAL GWP (kg CO2e) per m2	154
Effective RSI =	3.34
GWP : RSI	46.2 : 1

2.2 High Performance Curtainwall System

- 3mm Prefinished aluminium panel system c/w panel frame and wall clips
- 280mm Semi-rigid Mineral wool insulation (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)



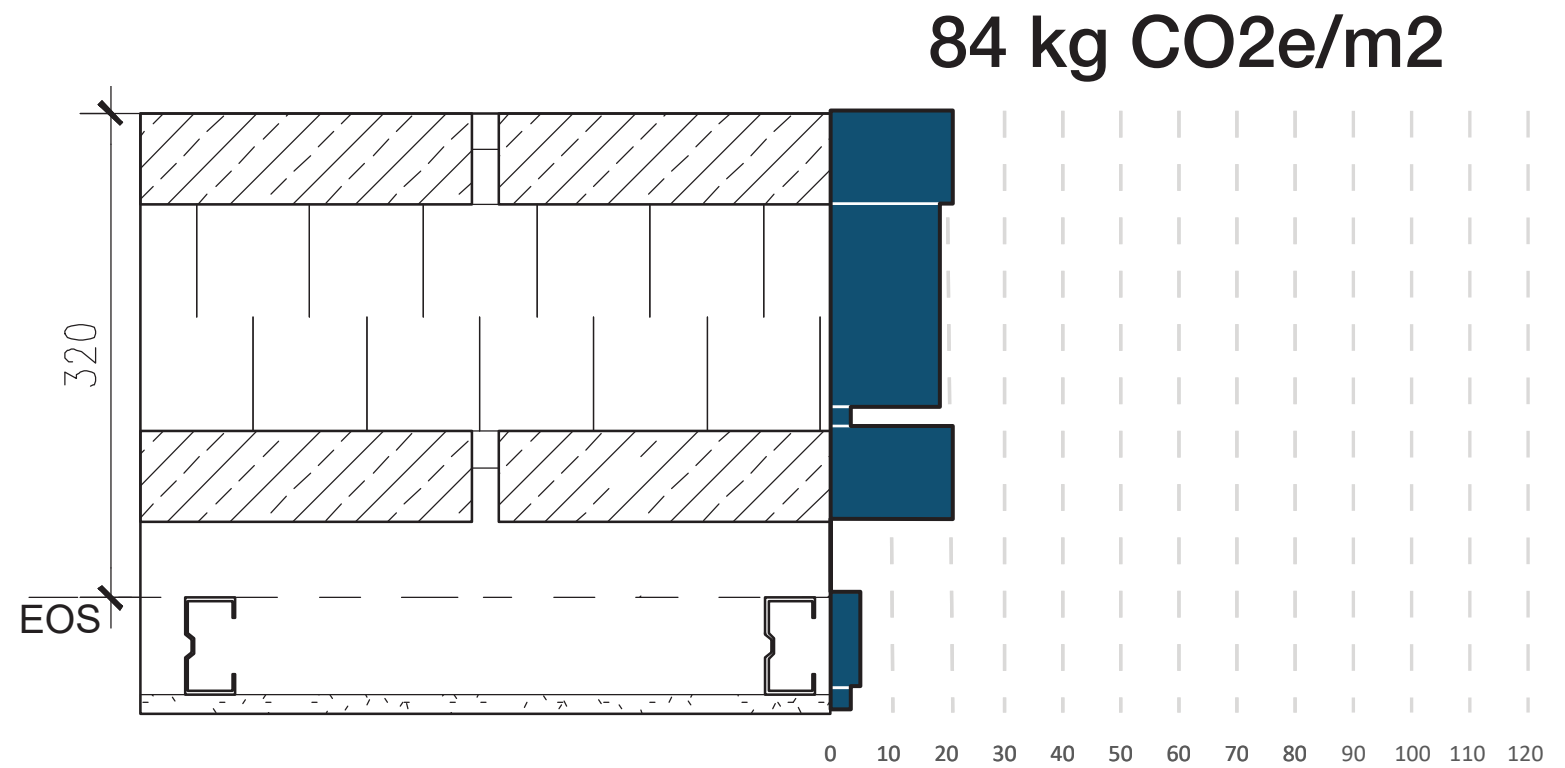
TOTAL GWP (kg CO2e) per m2	217
Effective RSI =	6.16
GWP : RSI	35.2 : 1

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)

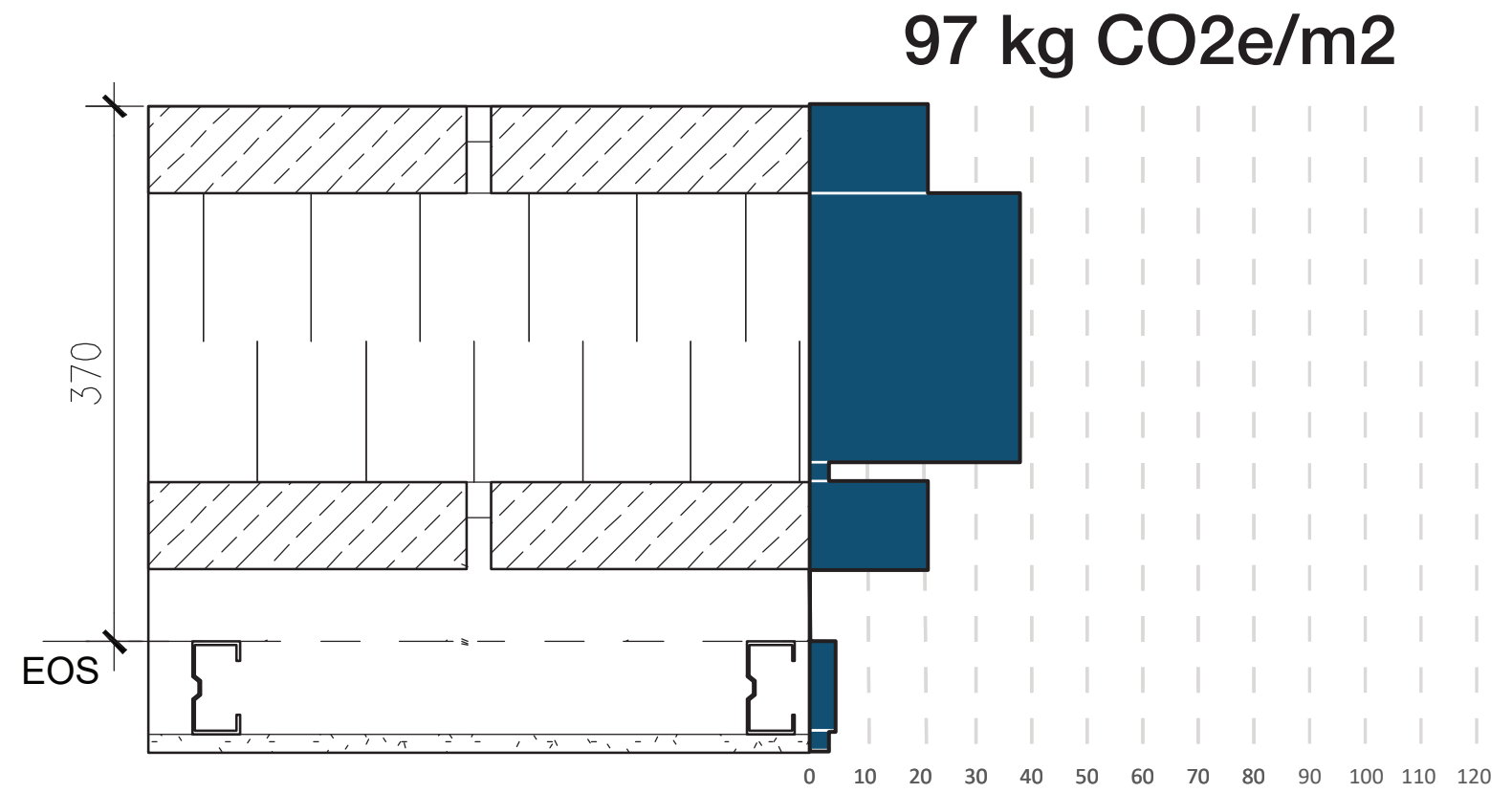


TOTAL GWP (kg CO₂e) per m²	84
Effective RSI =	6.69
GWP : RSI	12.6 : 1

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)



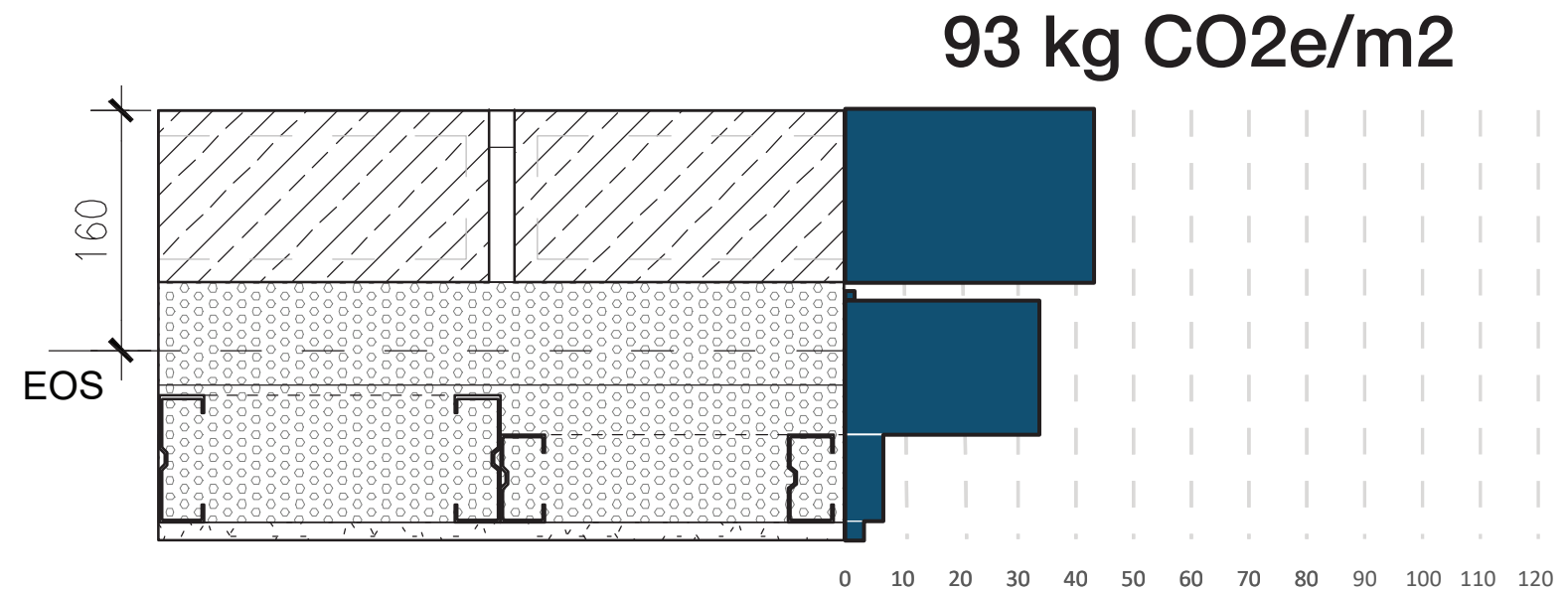
TOTAL GWP (kg CO₂e) per m²	97
Effective RSI =	6.69
GWP : RSI	14.6 : 1

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 embedded into spray foam)
- (92mm steel studs around window wall)
- 13mm GWB

Thickness = 286mm

Nominal RSI = 7.04 (R = 40)



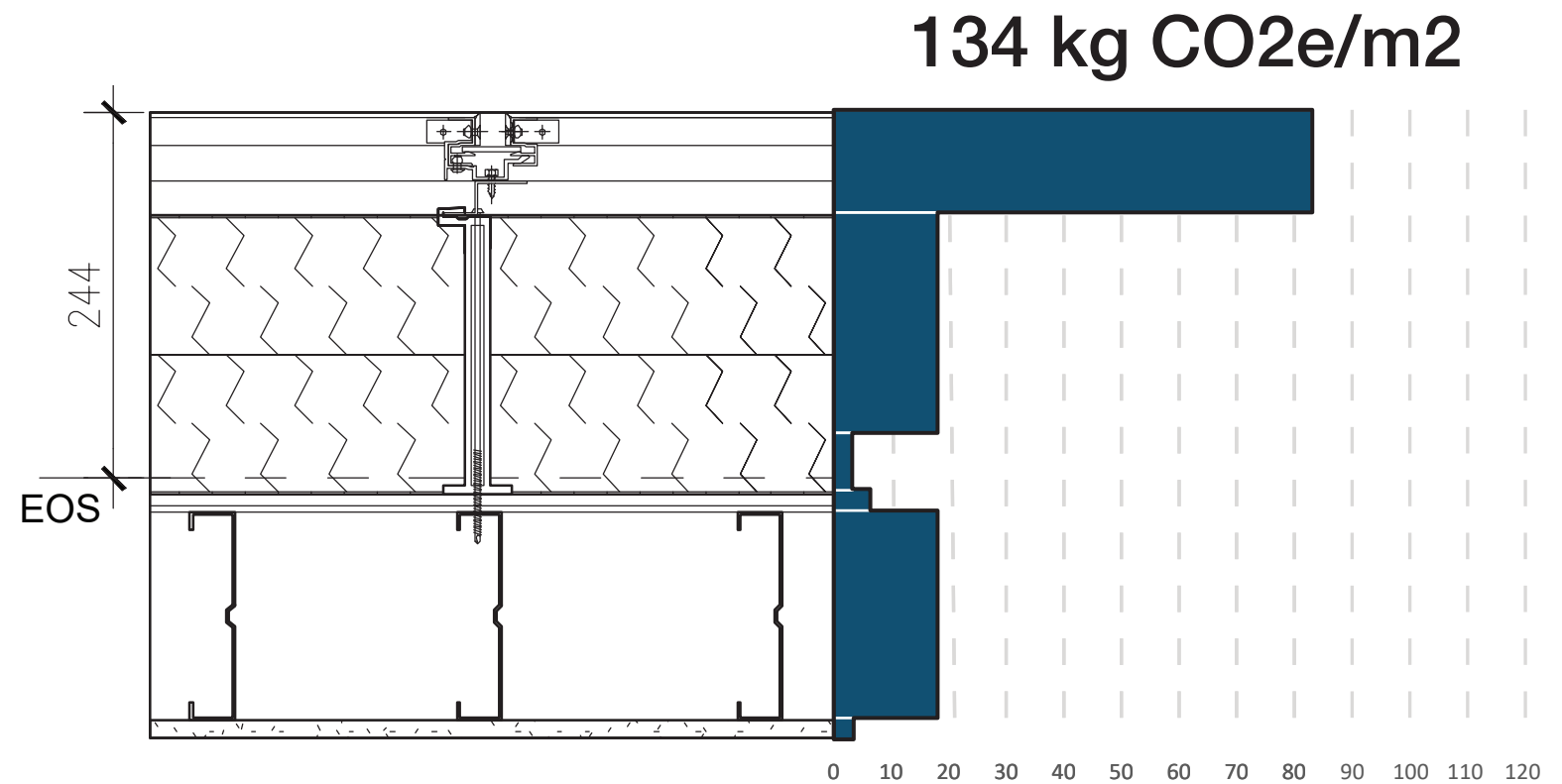
TOTAL GWP (kg CO₂e) per m²	93
Effective RSI =	5.46
GWP : RSI	17 : 1

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)

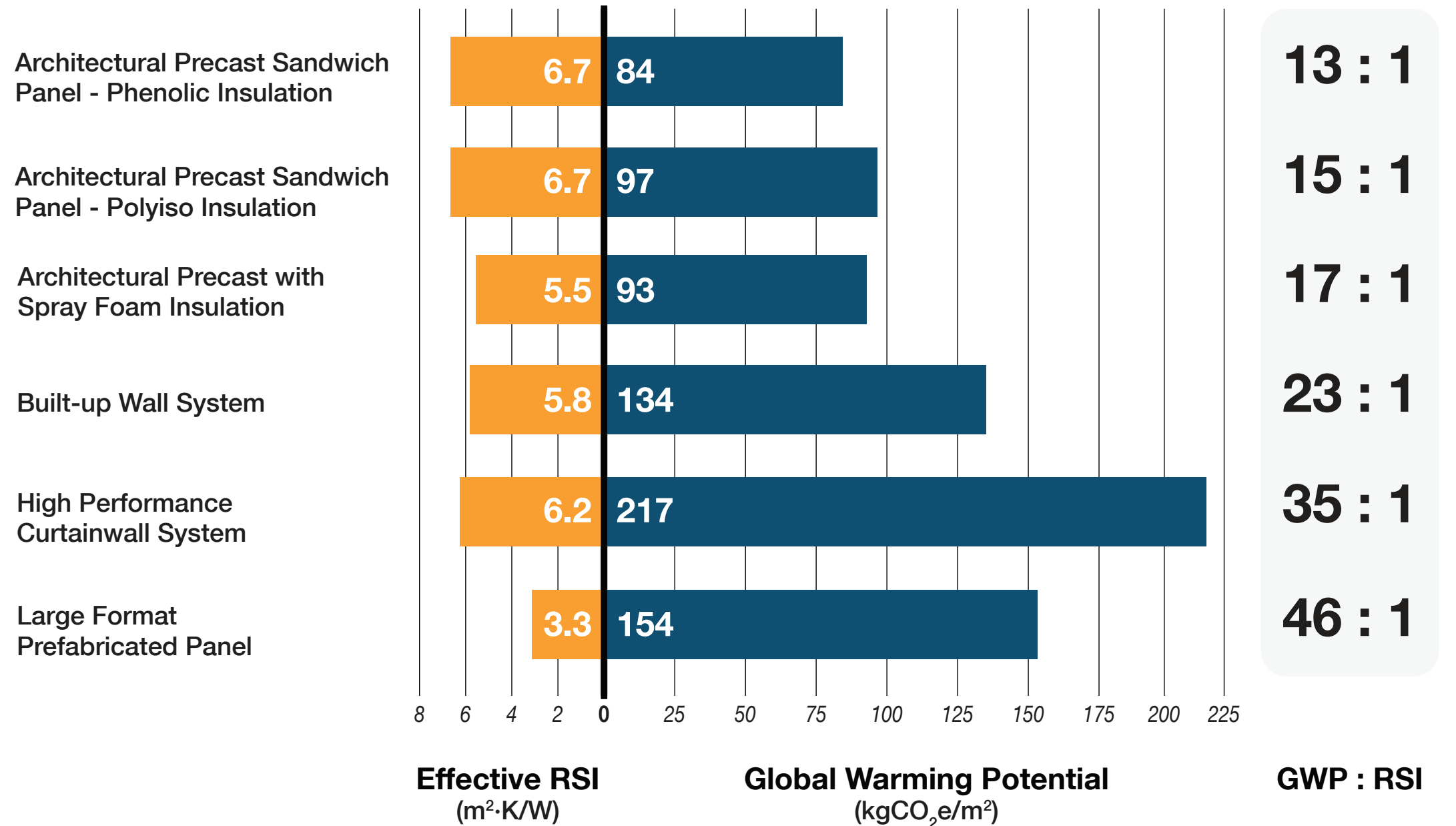


TOTAL GWP (kg CO₂e) per m²	134
Effective RSI =	5.81
GWP : RSI	23 : 1

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.



3.2 Systems Comparison - with low carbon rainscreen cladding

By substituting the aluminium panel for a lower embodied carbon 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.

