Green Public Procurement in Construction

Driving public purchase towards truly green construction products and materials

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Green public procurement in construction

Driving public purchase towards truly green construction products and materials

Project name
Green public procurement in construction
Driving public purchase towards truly green construction products and materials

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The authors would like to express their gratitude to the city of Zürich for the support in identifying the most suitable building and sharing information on the bill of quantity for the Allmend School building.

Contents

Executive Summary

Public procurement is a substantial component of the EU economy with around **19% of the EU's public procurement GHG emissions, equivalent to 78 megatons (Mt), linked to public construction activities**. A few highly carbon-intensive materials are the main driver for these emissions, primarily concrete and steel, of which EU public procurement uses around 156 Mm3 and 15.6 Mt of respectively.

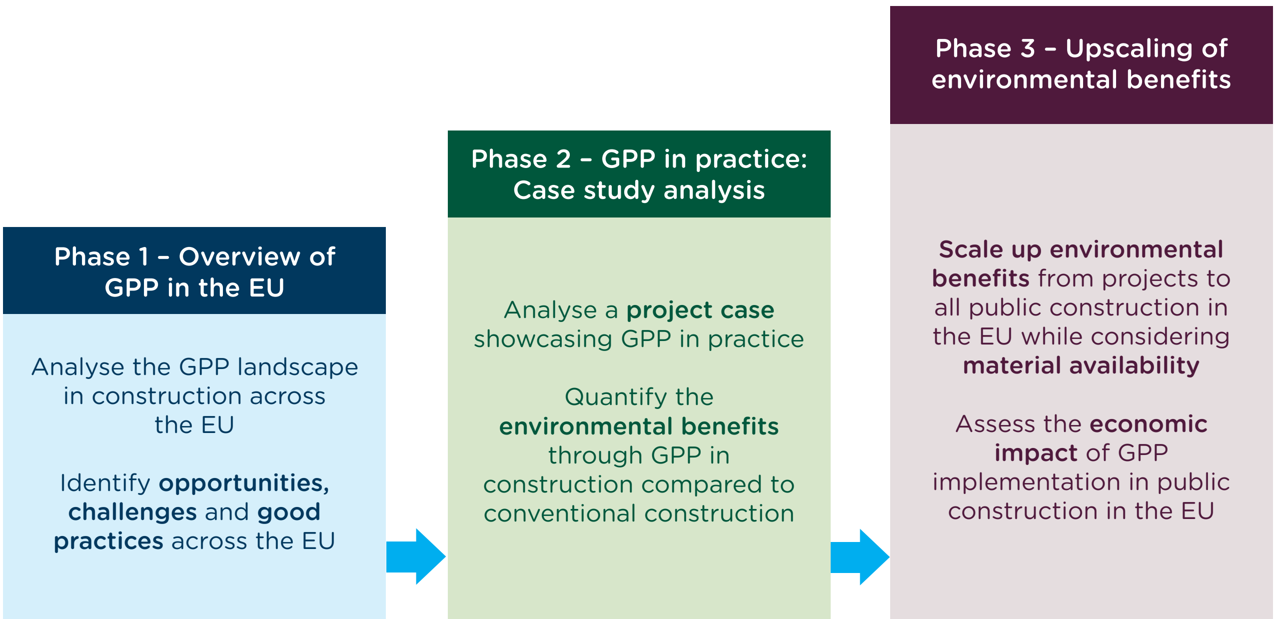
Green Public Procurement (GPP) promotes the sustainability of public procurement decisions. The existence of GPP criteria for the carbon intensity of construction projects and materials used in them can substantially support the decarbonisation of public procurement and create lead markets for low-carbon material alternatives.

Currently, the European policy landscape for construction is characterised by **voluntary GPP guidelines** issued by the European Commission and **varying national and local commitments** to GPP implementation across Member States. On general public procurement, the EU has defined basic principles on sustainability considerations during public procurement procedures in the Public Procurement Directive of 2014. However, it is up to contracting authorities to decide to what extent sustainability is included in assessments when awarding contracts. As a result, on the Member State level, the implementation of GPP has been subject to a **fragmented approach**, resulting in inconsistent standards, product coverage, and enforcement, leading to a diverse array of practices within the EU.

Methodology

This report is built on a three-staged study. As illustrated in Figure 0-1, an overview of current approaches to GPP across the EU in the first phase creates a **thorough picture of the status quo**. To underline the potential of GPP in the implementation of public construction projects, the second phase **analyses three scenarios for the construction of a school building** in Zürich, Switzerland, the Allmend School. The third phase **assesses the impacts of introducing GPP criteria for the entire EU in terms of emission reduction, material availability and economic impacts**. The study focuses on concrete and steel as widely used construction materials and drivers for embodied emissions of construction projects.

Figure 0-1 Project phases of the study's methodological approach



Current GPP frameworks across the EU lack ambition and specificity for decarbonising construction, particularly at the level of materials

The **voluntary EU criteria for GPP** in the construction of office buildings provide a starting point for authorities in Member States to apply GPP with low development efforts needed but **lack a comprehensive perspective with quantified targets for materials and buildings**. The revision of the EU criteria should introduce elements on key construction materials on which public procurers can make requirements from the earliest stage and lead the way towards sustainable and particularly low-carbon public construction for office buildings and potentially broader use types of common public procurement projects. In addition, the legal instruments of the ESPR and CPR provide strong frameworks to define general mandatory product-level environmental performance requirements for construction materials.

On Member State level, **national GPP frameworks for construction are mainly limited to high-level guidelines** rather than specific criteria with threshold levels – if the topic is covered at all. While relevant topics to climate change mitigation, such as embodied carbon and circularity, are touched upon across these Member States, frameworks **frequently lack threshold values or overall clarity on how to apply GPP criteria**. Instead, frameworks provide too much room for interpretation when used to evaluate public contracts on their climate impact. As a result, even when national GPP criteria align with the EU GPP criteria within the construction context to a large extent, the absence of dedicated strategies for the sector perpetuates business-as-usual practices, hindering transformative change towards decarbonisation.

This lack of specificity in GPP criteria for construction **leads to ineffective and fragmented implementation within and across Member States**. This holds up for threshold values on carbon-intensive materials as a consequence of lacking product-level requirements.

Thus, to harmonise GPP implementation in construction across the EU, the development of a **streamlined, mandatory approach to GPP in construction is required**. Through such an approach, fragmentation and complexity can be reduced. This is especially relevant for monitoring methods on GPP implementation in public construction, as it allows for comparability between Member States. As part of such an approach, product-specific criteria can contribute to the reduction of embodied carbon emissions in carbon-intensive materials to foster innovation towards low-carbon alternatives in the industry.

Taking material availability and economic impact into consideration, the implementation of consistent and ambitious GPP criteria in construction for the whole EU is possible and impactful

The potential and impacts of establishing GPP criteria are underpinned by three EU scenarios, shown in Table 0-1 for concrete and steel. The values in these scenarios are based on a case study of the Allmend School in Zürich (see Box 0-1). The city of Zürich has one of most comprehensive and advanced GPP requirements in Europe, which are demonstrated to be realistic in current construction. Thus, the as-built data of the Allmend School capture a currently feasible yet effective level of GPP. Going beyond, an ambitious scenario looks at top-performing sustainable materials to define a prospective ambition level for GPP. The values shown in Table 0-1 represent averages of the concrete and steel material quantities used in the Allmend School and their carbon intensities.

Table 0-1 Carbon intensities for concrete and steel for the three scenarios

EU Scenario	Corresponding Allmend School Scenario	Concrete		Steel	
		$kgCO_2e/m^3$	%	$kgCO_2e/kg$	%
Business as usual	Business as usual	195.42	100%	1.09	100%
Basic PP criteria	As-built	148.32	76%	0.72	66%
Ambitious PP criteria	Ambitious	133.49	68%	0.43	40%

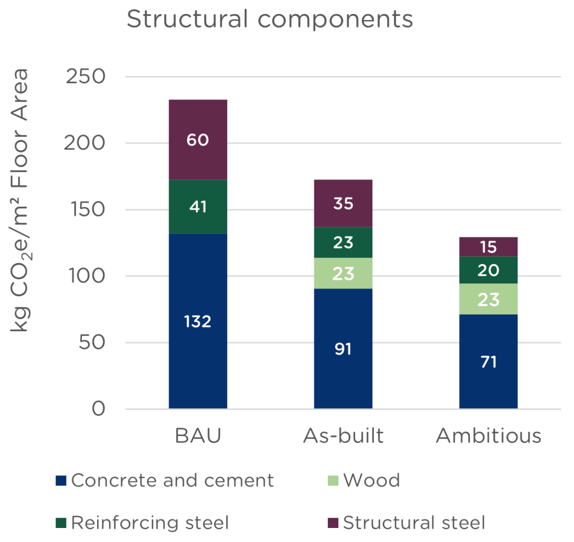
Box 0-1 Results of a GPP case study in Zürich, Switzerland

The case study of the Allmend School highlights the opportunities to reduce the environmental impacts of construction

The Schulanlage Allmend in Zürich is a new educational facility. As stipulated in the city's GPP framework, the active reduction of embodied emissions is mandated through the use of lower carbon cement[1] in most concretes, while circularity is promoted through requirements for recycled aggregates in concrete. Further, the building relies on material efficient design and the use of timber for large parts of its structural components.

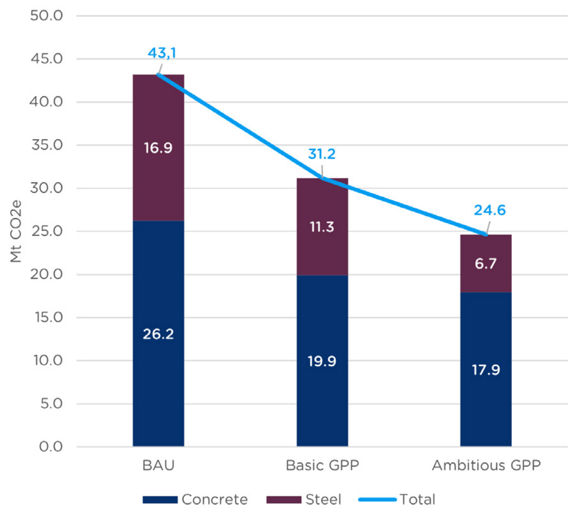
As shown in Figure 0-2, the **comparison of three scenarios reveals important GHG emission reduction potentials** from setting GPP requirements on embodied emissions. Compared to a business-as-usual (BAU) scenario, the design and materials chosen by the city of Zürich **resulted in 26% lower embodied carbon emissions from its structural materials**. The BAU scenario leads to embodied carbon emissions of 233 kgCO_2e/m², while the as-built version of the Allmend School creates 172 kgCO_2e/m² for these elements. A **further increase in GPP ambition with currently available low-carbon materials can even reduce the upfront carbon footprint by 45% compared to the BAU case**. The further reduced cement clinker quantities in concrete and maximum recycled content levels in steel achieve this additional reduction, which can bring embodied emissions to 129 kgCO_2e/m² for structural components. More detailed analysis shows that concrete components, steel components and the design choice of using timber each contribute to these reductions, with concrete and steel being the strongest reduction drivers.

Figure 0-2 Comparison of scenario results for structural components at building level



Introducing GPP criteria at the **basic level reduces GHG emissions linked to the two materials by 28%**, while **ambitious criteria lead to a reduction of 43%**. In absolute emissions, this translates to annual emission savings of 11.9 Mt CO_2e in the basic scenario and 18.5 Mt CO_2e in the ambitious one. Figure 0-3 illustrates these effects. In relation to the total estimation of GHG emissions linked to **publicly procured construction in the EU, this represents a reduction of at least 15% or almost a quarter (24%) in the ambitious scenario**. The potential to reduced embodied emissions from public procurement are therefore relevant and warrant the introduction of harmonised criteria to accelerate the transition of industries and satisfy the exemplary role of public buyers.

Figure 0-3 Comparison of GHG emissions from public procurement of construction in the three scenarios at EU-level



[1] CEM III/B

A **basic level of low-carbon material criteria can be introduced with existing materials and supply chains**. Supplementary cementitious materials, from different sources have comparable physical characteristics and are available to replace clinker in cement and concrete mixtures. For steel, the use of higher shares of secondary, recycled steel and low-carbon production routes have the potential to scale up and supply sufficient materials. The carbon intensities achieved on concrete and steel in the Allmend School in Zürich represent an immediately feasible level of reduction compared to the current average emission intensities of these materials.

The use of low-carbon versions of concrete and steel only marginally raises construction costs. Applying GPP criteria at the basic level would lead to **a total reduction of 11.9 Mt CO_2e per year, while generating an additional cost of only 410 million EUR** (a 1.6% increase). The abatement cost would therefore be only 34.46 EUR/tCO_2e, much below the current CO_2 costs of the EU ETS, which fluctuate around 70 EUR/tCO_2e, while awarding large amounts of free allocation. Applying the **ambitious GPP criteria in 2030 would lead to a reduction of 18.5 Mt CO_2e per year.** The additional costs of this increased level of GPP would be **1.48 billion EUR** (a 5.9% increase), translating to abatement costs of 80.04 EUR/tCO_2e. Further convergence of the cost impacts can be expected as a result of the EU ETS and the wider availability of renewable energy sources. This suggests that GPP implementation in construction is possible without significantly raising the costs, especially on a mid to long-term timeline.

Table 0-2 Green premium and additional public expenditure per scenario across the EU

Scenario	Concrete		Steel		Total increase in public procurement spending	
	Green premium (%)	PP spending (in billion EUR)	Green premium (%)	PP spending (in billion EUR)	In %	In billion EUR
Business as usual	0	15.41	0	9.58	0	0
Basic scenario	2.00	15.72	1.00	9.68	1.62	0.41
Ambitious scenario	6.25	16.37	5.40	10.10	5.92	1.48

Requiring deeper decarbonisation levels of public construction as captured in the **ambitious GPP scenario will be possible in a mid-term timeframe**. Material availability does not represent a barrier to the two criteria levels and innovation and the expected increase in production of low-carbon construction materials ensures a sufficient supply for the ambitious scenario in the near future. Thus, in 2030 or latest in 2032, the increase in ambition should be effective.

A proposed GPP approach could therefore **start with applying the basic level** of GPP criteria which would **mandate reductions of 24% for concrete components and 34% for steel components** used in public procurement projects compared to the national building average as a baseline or compared to a reference design for the specific project. In a second step, the ambitious level can then be introduced in 2030 to mandate reductions of 32% for concrete and 60% for steel.

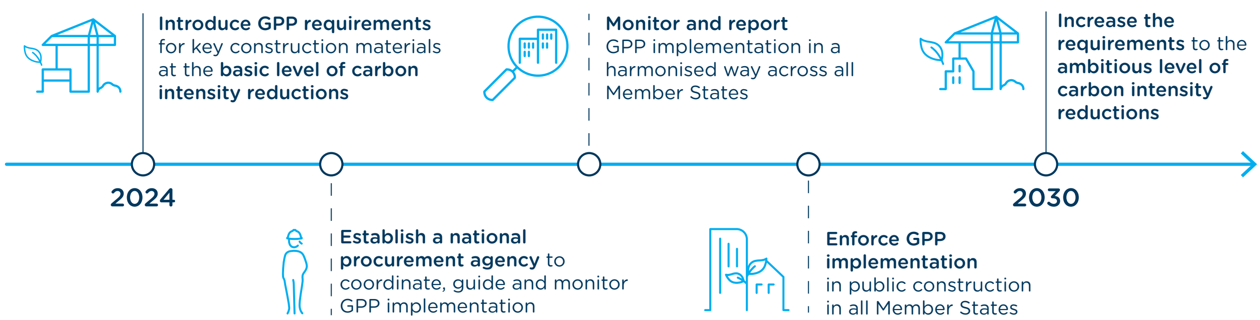
Recommendations

It is both feasible and important to stimulate decarbonisation in the construction sector through GPP. To guide the development of an effective and ambitious GPP framework for the construction sector across the EU, in this chapter recommendations are identified based on the findings of this study.

1. At the EU level, **revise the Public Procurement Directive** to legally mandate public procurers to **define and enforce GPP criteria.**
2. At the EU level, **leverage the EU GPP criteria** as an opportunity to complement the building-level perspective with **product-level criteria at the basic level** and a **future increase to the ambitious level**. The revisions of ESPR and CPR support this process, which is further complemented by building-level reporting and reduction of embodied emissions in the EPBD.
3. At the EU level, **harmonise monitoring and reporting** methods to gain a comprehensive overview of current practices on GPP implementation within and across Member States.
4. At the Member State level, **support GPP implementation by raising awareness and developing skills** among public procurers through a national procurement agency that coordinates the implementation of GPP.

Taking these recommendations into consideration, a roadmap to GPP implementation in public construction contracts is visualised in Figure 0-4. This roadmap outlines the steps identified as essential to integrate GPP practices, ensuring that environmental criteria are systematically embedded into the procurement processes for public construction projects across the EU.

Figure 0-4 Roadmap to GPP implementation in public construction




LÆS TIL

1. Introduction

Public procurement (PP) is a substantial component of the EU economy. A recent study by the Stockholm Environment Institute quantifies that **PP across products and services represents 15% of the EU's GDP**[2]. In terms of climate impact, it is estimated that PP accounts for at least 11% of the EU's emissions. Of these, around **19% of the EU's PP GHG emissions**, equivalent to **78 megatons (Mt), are linked to public construction activities**[3].

Zooming in on the most carbon-intensive materials used in the EU's construction sector, namely steel and cement, roughly **15.6 Mt of steel** and **47 Mt of cement** were used through public procurement practices in the EU's construction sector, in 2019. These numbers correspond to **11% of total steel consumption** and **31% of total cement use** in the EU[4]. This highlights the significance of public procurement as a tool to drive decarbonisation in the EU's construction sector.

PP can support decarbonisation by implementing **Green Public Procurement** (GPP), which can be used to significantly **advance** sustainability and **decarbonisation** in the construction of buildings and infrastructure. It does so by setting criteria for public contracts that encompass technical, financial, and environmental considerations.

Currently, the European policy landscape is characterised by **voluntary GPP guidelines** issued by the European Commission and **varying national and local commitments** to GPP implementation across Member States. As of now, the EU GPP guideline on 'Office Building Design, Construction and Management' is under revision. On the Member State level, the implementation of GPP has been subject to a **fragmented approach**, resulting in inconsistent standards, product coverage, and enforcement, leading to a diverse array of practices within the EU.

As such, this evidence-based report aims to illustrate the environmental savings and feasibility of adopting mandatory GPP criteria for construction products at EU level by analysing current practices and identifying recommendations to improve GPP as a tool through which to support the decarbonisation of the construction sector. The study findings guide the development of an effective and ambitious GPP framework for the construction sector across the EU, based on the demonstrated benefits and possibilities observed in a specific project implemented by the city of Zürich. The study has been prepared by Ramboll for the Environmental Coalition on Standards (ECOS), in support of their work to improve GPP implementation in the EU's construction sector.

To achieve this, the report is **outlined as follows**: Chapter 2 provides an overview of the Methodology and Scope of the report, highlighting the approach followed in this study. Chapter 3 provides an overview of the GPP landscape in the EU, with a specific focus on the construction sector. Chapter 4 shows an example of GPP in practice, through a case study on a Swiss school. Then, in chapter 5, the potential of ambitious GPP criteria of reducing environmental impacts will be introduced. Finally, in chapter 6, final remarks and recommendations to reap the potential of GPP in construction in the EU are identified.

[2] Nilsson Lewis, A., Kaaret, K., Torres Morales, E., Piirsalu, E., Axelsson, K. (2023). Green Public Procurement: a key to decarbonizing construction and road transport in the EU. Stockholm Environment Institute. Available at: https://doi.org/10.51414/sei2023.007

[3] Mähönen, M. et al. (2023) Public Procurement for Climate Neutrality – a transformative policy instrument? Report. Ecologic Institute. Available at: https://www.ecologic.eu/19385 (Accessed: 7 August 2024).

[4] Wyns, T., Kalimo, H. and Khandekar, G. (2024) Public procurement of cement and steel for construction - Assessing the potential of lead markets for green steel and cement in the EU. Brussels School of Governance. Available at: https://www.brussels-school.be/output/events/roundtable-event-public-procurement-steel-and-cement-construction-creating-lead (Accessed: 24 July 2024).

2. Methodology and scope

In this chapter, the designed methodological approach and overall project scope will be further highlighted. This will provide a comprehensive understanding of the framework employed and the objectives pursued through this study.

2.1 Project phases

As illustrated in Figure 2-1, the methodological approach can be divided in three phases. These phases enable the study to achieve its objective of enhancing the GPP framework in the EU by examining current practices and providing recommendations to improve GPP as a tool to support the decarbonisation of public construction. This section provides details on the three phases.

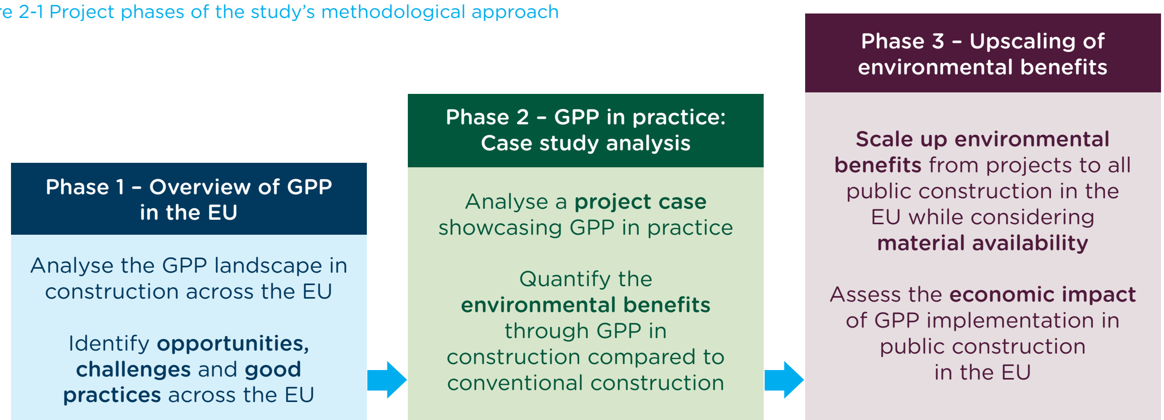
Phase 1 – Overview of GPP in the EU

In the first phase of the study, the GPP landscape in the EU's construction sector is analysed to gain a comprehensive understanding on the level of GPP implementation across Member States. The GPP landscape is examined through high-level and in-depth analyses. Both analyses are conducted through desk research and consultation of national partners of ECOS, allowing for the comparison between GPP implementation in public construction between Member States. The high-level analysis, covering all EU Member States, explores national GPP strategies and targets, referencing voluntary EU GPP criteria, resulting in an overview of the EU's GPP landscape, focused on construction. For this high-level analysis, desk research is conducted on national level only, through relevant strategies and policy frameworks. The in-depth analysis goes beyond this initial analysis, and focused on six Member States—Belgium, Finland, Germany, Italy, the Netherlands, and Sweden. These cases are selected due to their diverse GPP approaches and governance structures. In the in-depth analysis, national, subnational, and local practices of GPP are subject to further examination, to improve the understanding on how GPP is implemented at different levels within these Member States. The overall findings during this phase are found in Table 3-1, while the corresponding Country Fiches are provided in Appendix 1.

Phase 2 – GPP in practice: Case study analysis

In the second phase, a case where GPP is implemented in practice is analysed further. By examining a specific case, the potential of GPP in reducing the climate impact of construction can be further explored. This is done through a scenario analysis and quantification of environmental impact resulting from the application of GPP criteria. Important criteria for the selection of the case study are the explicit reduction of embodied emissions through GPP requirements, while also ensuring broader sustainability criteria such as resource efficiency

Figure 2-1 Project phases of the study's methodological approach



and energy performance are included. As a practical criterion, access to the project documentation and a bill of quantity of main materials was necessary to ensure a basis for accurate calculations. With only few GPP frameworks defining embodied carbon requirements and those being recent ones, the options proved to be limited.

Yet, the city of Zürich has built several projects in recent years while defining sustainability criteria for materials and building performance. The Allmend School development[5] therefore constitutes a fitting case study which carries lessons and insights for other stakeholders. Three scenarios for this building are described based on the bill of quantities obtained from the city: an as-built one complemented by a business-as-usual (BAU) and an ambitious but possible scenario. To ease access to data and calculations, EPDs and generic or average environmental product data was taken from German databases, mainly OneClickLCA. While absolute embodied emission levels may differ between data sources, the relative reductions which are the main result of this work are robust estimations for other locations in Europe as material production in the sectors covered is largely comparable. Further details and the results of this case study analysis can be found in Chapter 4, with additional information collected in Appendix 2.

Phase 3 – Upscaling of environmental benefits

Lastly, in phase 3, the findings done during the previous phases are combined and scaled up with additional literature review and discussion with experts in Ramboll to assess the overall environmental benefits gained if all public construction projects were to implement GPP in their procurement processes. The upscaling of environmental benefits is considered against EU-wide material availability of low-carbon construction materials, highly relevant to review the potential to scale up. Additionally, the economic impact of GPP implementation on construction costs is analysed. This phase expands on the quantification and scenario analysis in phase 2. The findings done during this phase are found in Chapter 5.

These three different phases then allow for the identification of policy recommendations which can be implemented to overcome current barriers and harness existing potential when it comes to GPP implementation in the EU's public construction projects. This is further highlighted in Chapter 6.

2.2 Study scope

The focus of this study is placed on the procurement of the carbon intensive and widely used construction materials concrete and steel and the GPP criteria that exist for these materials. When quantifying product volumes, emissions savings and cost impacts, the final products are assessed wherever possible. For the product concrete, cement is the main emission driver, which is why some data points and policies focus on this material and are considered as such in the report.

The analysis of current GPP frameworks focuses on circularity and embodied carbon from building construction and these materials. For the quantification of reduction potentials in the Allmend School as well as the EU public procurement landscape, priority was placed on the global warming potential (GWP) from embodied carbon emissions. This term comprises non-carbon greenhouse gas (GHG) emissions and is expressed in $kgCO_2e$. Besides this, the sustainability of a construction project and material choices therein are determined by other parameters, from resource consumption, land use and water impacts, as well as toxicity to ecosystems and humans. These parameters are not quantified in this report.

Within embodied carbon emissions, upfront emissions (LCA stages A1-A3) as the largest driver were calculated and compared. This provides insights into emissions that can be directly influenced by procurers today. In the context of a focus on concrete and steel, which are primarily used in structural elements, the use-phase emissions can be expected as negligible. Thus, graphs and values in Chapters 4 and 5 have to be understood as A1-A3 results.

In terms of geographical scope, the study focuses on the EU-27 only, specifically focusing on GPP implementation in public construction and renovation of buildings and built infrastructure. In these countries, both current and announced GPP practices are considered while creating an overall understanding on GPP implementation across the EU. Given its relevance in GPP requirements for embodied carbon, circularity and material efficient construction, a case study from a non-EU, but highly comparable economic and regulatory context, Switzerland, was selected. Under free-trade agreements, product standards are mutually recognised. Given Switzerland's proximity and close integration with surrounding EU Member States, its innovative procurement practices are considered to be applicable and adaptable within the context of the EU.

[5] More information on the project can be found on the city's website (in German): https://www.stadt-zuerich.ch/hbd/de/index/hochbau/bauten/bauten-realisiert/schulanlage-allmend.html

3. GPP in construction across EU: Complexity through fragmentation

The Green Public Procurement (GPP) landscape in public construction across the EU is mapped based on two analyses, namely a high-level and in-depth analysis on EU Member States. Based on the findings of these two analyses, this chapter describes the status quo of GPP in construction in the EU. The findings of the in-depth analysis can be found per country in Appendix 1.

3.1 General application of Green Public Procurement (GPP) across sectors in the EU

Throughout the EU, GPP implementation practices vary in scope and approach, yet a framework on the EU level is in place. The European Commission[6] defines green public procurement (GPP) as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured".

Currently, GPP is strongly recommended but not mandated by the EU, as per Directive 2014/24/EU of the European Parliament and of the Council[7]. While environmental considerations in public procurement are supported, implementing GPP remains voluntary for the Member States. However, following the Ecodesign for Sustainable Products Regulation (ESPR)[8] and Construction Products Regulation (CPR)[9], the European Commission has the authority to set mandatory minimum sustainability requirements for public procurement of construction products. This can enable the integration of specific green public procurement criteria into procurement processes.

To support public authorities to integrate environmental considerations into their procurement processes, the EU began developing voluntary GPP criteria in 2013. Covering product groups such as office IT equipment, food and transportation, these criteria aim to reduce environmental impact through energy efficiency, sustainable resource use, and waste minimization. Although not mandatory, they enable Member States and local authorities to adapt GPP criteria to fit their needs and contexts. Voluntary criteria for office building construction have been available since 2016 and are currently under revision to align with the latest ecological standards and technologies.

Despite these efforts on the EU level, Member States interpret GPP's scope rather differently, resulting in varying approaches to implementation and legal framing. As of 2024, 23 EU Member States have established a national, overarching strategy on GPP in place. However, although these overarching strategies are in place and GPP may even be compulsory in a Member State, this does not necessarily mean that all types of purchasing projects are covered.

[6] European Commission. 2008. 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Public Procurement for a Better Environment {SEC(2008) 2124} {SEC(2008) 2125} {SEC(2008) 2126}'. Retrieved 3 June 2024 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008DC0400).

[7] European Parliament and Council of the European Union (2024) Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC (Text with EEA relevance)Text with EEA relevance. Available at: http://data.europa.eu/eli/dir/2014/24/2024-01-01/eng (Accessed: 29 July 2024).

[8] European Parliament and Council of the European Union (2024) Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC. Available at: http://data.europa.eu/eli/reg/2024/1781/oj/eng (Accessed: 29 July 2024).

[9] European Parliament and Council of the European Union (2021) Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (Text with EEA relevance). Available at: http://data.europa.eu/eli/reg/2011/305/2021-07-16/eng (Accessed: 29 July 2024).

The mandatory status for GPP is usually established per product group, such as ‘copying and graphic paper’, ‘office IT equipment’ and ‘food’.

For the product group ‘office building design, construction, and management,’ embodied emissions and material selection receives less attention than operational energy use. A building-level perspective is included that requires the comparison of whole-life carbon (WLC) emissions to a reference building (criteria B10.1) either based on a full LCA[10] or based on an aggregation of EPDs for the main products used[11]. For concrete and masonry products, a criterion for minimum recycled content is also defined (B10.2). However, such a criterion does not exist for other carbon intensive materials (e.g. steel) and is placed as an alternative to the building-level calculation, which takes precedence. Thus, in their current format the voluntary EU guidelines miss a coordinated and effective approach. Either the GPP criteria are limited to concrete elements and their recycled content, or missing quantitative targets for WLC emissions. This leaves gaps in the sustainability impacts which can be realised. The extent to which EU Member States require GPP criteria in construction projects and the approaches used will be presented in more depth in the following sections.

3.2 GPP is weakly implemented in the construction sector, lacking ambition and consistency

Implementation of GPP in public construction projects is rarely mandatory and lacks enforcement

The implementation of GPP criteria for construction is highly fragmented and inconsistent across the European Union. As shown in Table 3-1 (Column 1), 17 Member States have developed national GPP criteria for construction to varying extents, while no GPP criteria for construction are in place for the remaining 10 countries. Out of the 17 Member States which do have GPP criteria for construction, only 11 match the voluntary EU GPP criteria to a great extent, considering the scope and type of requirements defined. This comparison already points to a highly fragmented and inconsistent treatment of construction projects in sustainable procurement across the European Union. Beyond this, the voluntary EU GPP criteria as well as most national frameworks lack specific quantifications for thresholds on embodied or WLC emissions. Circularity of materials is limited to concrete elements and in alternative to the lifecycle assessment approach.

GPP criteria are most commonly not mandatory to implement in public construction projects. This remains the case despite the European Commission’s authority, as outlined in Section 3.1, to establish mandatory minimum environmental sustainability requirements for the public procurement of construction products. As shown in Column 2 of Table 3-1, 10 Member States mandate some form of GPP in construction contracts; however, gaps persist in achieving comprehensive coverage or practical enforcement among purchasing authorities in all these countries. In fact, a mandatory status does not necessarily apply to all publicly procured buildings but might only pertain to a specific building portfolio.

For instance, in Germany, sustainable building assessments are only mandatory for buildings that fall under federal jurisdiction. This differs from a country such as Italy, where all public bodies under the code of public contracts are required to apply GPP.

Next to the lack of mandatory nature of GPP in construction, enforcement of implementation is a key challenge as well. None of the Member States which made GPP implementation mandatory for construction specify how there will be followed up on this. For Latvia, for instance, GPP has only recently become mandatory for construction. With no clear approach for enforcement, GPP implementation in construction is expected to happen slowly over time. In general, a lack of enforcement of mandatory implementation results in only limited implementation of GPP in public contracts. For instance, in Germany, in 2021 only 13% of all public contracts included sustainability in their award criteria, and only 37% of public contracts in Malta (in 2014), as can also be seen in Table 3 1. Another example is Italy, where GPP for construction is mandatory since 2017, but also still considered to be in an experimental phase. As a result, GPP implementation for construction is not enforced but rather encouraged by raising awareness and sharing best practices among public procurers. While the anti-corruption authority overseeing GPP implementation has the agency to appeal when GPP implementation is lacking, this has not been applied in practice[12]. After low rates of contracts using GPP criteria for several years, only in 2024 has the monitored rate increased to a solid 83% of contracts (in 2023). This correlates with high spending under the EU Recovery and Resilience Facility connected with stricter reporting requirements, showing the opportunity for widescale application when enforced and monitored effectively.

[10] Defined in criteria B10.1 comprehensive.
[11] Defined in criteria B10.1 core.
[12] Nilsson Lewis, A. et al. (2023) Accelerating green public procurement for decarbonization of the construction and road transport sectors in the EU. Stockholm Environment Institute. Available at: https://doi.org/10.51414/sei2023.007.

Table 3 1 Overview of GPP approaches for construction across the EU

	Framework for GPP in construction			GPP in construction on embodied carbon		GPP in construction on circularity	
	Is national GPP for construction based on the voluntary EU GPP criteria?	Is GPP implementation in construction mandatory and enforced?	GPP implementation is monitored for public construction?	Threshold values on building level?	Threshold values on carbon-intensive materials?	Threshold values on building level?	Threshold values on carbon-intensive materials?
EU-level							
Austria							
Belgium							
Bulgaria							
Cyprus							
Czechia							
Germany	*		13% of public contracts (2021)				
Denmark	*			*		*	
Estonia							
Finland			32% of public contracts (2022)				
France	*			*		*	
Greece							
Croatia							
Hungary							
Ireland			52% of public contracts (2021) **				
Italy			83% of public contracts (2023) **				
Lithuania							
Luxembourg							
Latvia							
Malta			37% of public contracts (2021)				
Netherlands			69% of public contracts (2023) **		*		*
Poland							
Portugal							
Romania							
Slovenia							
Slovakia							
Spain							
Sweden							

* While this category is not addressed through GPP criteria, the category is covered by general legislation.
** Implementation is only partially / indirectly monitored, through e.g. surveys, questionnaires, sampling.

Legend - Framework GPP for construction

(green)	Fully developed GPP criteria, mandatory and enforced*, monitored
(yellow)	Partially developed GPP criteria, not mandatory and/or partially enforced*, partially monitored
(orange)	No developed GPP criteria, no enforcement, no monitoring

*Note that mandatory logically comes before enforced

Legend - GPP critera in construction

(green)	GPP criteria are set as **requirements** through **threshold values**
(yellow)	GPP criteria are set as **optional award criteria** or equivalent, **no threshold values**
(orange)	No GPP criteria for construction

GPP implementation in construction is inadequately monitored

The lack of enforcement is strongly connected to the inadequate monitoring of GPP implementation, resulting in a scarcity of data on GPP practices in the construction sector across EU Member States. As indicated in Column 3 in Table 3-1, only 6 Member States monitor their GPP implementation in the construction sector regularly. Of those 6 Member States, only half monitor GPP in all public construction projects for which GPP is mandatory, with the others monitoring implementation indirectly through, for instance, surveys or questionnaires. Generally, such monitoring focuses solely on whether GPP is applied, for which the inclusion of one criterion is usually sufficient[13], not on the amount of GHG emissions avoided through GPP application. The only case in which such an estimate is made is the Netherlands, where 29.8 kt CO_2e GHG emissions were avoided through GPP in civil and hydraulic engineering projects, and 19.7 kt CO_2e GHG emissions were avoided through GPP in public projects on office buildings in 2019-2020.

Even though monitoring only provides an indication of GPP implementation in public construction contracts in six Member States, the implementation rates shown in Column 3 of Table 3-1 reveal that there is major room for improvement. Only in the case of Ireland, Italy, and the Netherlands, are GPP criteria applied to the majority of public construction contracts. The implementation of GPP in construction is generally monitored through agencies which support the implementation of GPP among public procurers as well (e.g., Sweden and Finland).

These findings underline that GPP does not live up to its potential as a tool to promote sustainability and decarbonisation in public construction projects. Shortcomings can be observed in all countries, and harmonisation across Member States on monitoring methods could improve data availability and comparability between Member States to gain an improved understanding of GPP in public construction across the EU.

3.3 GPP criteria on carbon-intensive materials are rare, lack ambition and specificity

Sustainability in construction, particularly building construction, can take the form of different priorities. In this assessment, the focus is placed on the sustainable use of carbon-intensive materials such as cement and steel. For these, two categories of criteria are relevant: (1) reduced embodied carbon emissions to limit global warming and (2) circular use of materials to reduce resource consumption. The coverage and ambition for these two areas are summarised in the following sections, based on Table 3-1.

Few countries define quantified criteria for embodied carbon emissions

Criteria for low embodied carbon building or materials are far from common across the EU. Only 13 Member States have any criteria for these emissions. Yet, as shown in Column 4 in Table 3-1, only 2 Member States (Finland and Germany) set specific targets reducing embodied carbon on building-level[14]. Moreover, the German GPP framework is only mandatory at federal level and in a few federal states, while Finland only encourages the use of the criteria which define the threshold. Even the voluntary EU GPP criteria as they are currently in place do not define quantified requirements but rather encourage evaluation of climate impact through an LCA. In contrast, Germany's BNB Sustainable Building Assessment set a maximum threshold of 66 kg CO_2e/m^2 per year for federally procured building construction, with two more ambitious performance classes to obtain higher scores. In Finland, the voluntary GPP criteria in construction states that structures and fillings are to be designed in a way that 10% of their weight consists of low carbon recycled or renewable materials.

When embodied carbon reduction is addressed, this is usually through the integration of a lifecycle assessment (LCA) in procurement processes. In total, 11 Member States allow for embodied carbon reduction in such manner. While this does not set specific targets for reducing embodied carbon on product-level, these assessments do allow procurers to evaluate the climate impact more easily. For this, the provision of freely available tools is important, to allow for consistent and transparent evaluation of project proposals. An example of such is a tool is Dubocalc, available in the Netherlands, which allows for the assessment and quantification of the environmental impact of construction projects.

When it comes to product-level criteria on carbon-intensive materials, such as concrete and steel, specific targets are rarely set. Only in a few Member States are requirements set on product-level for concrete elements.

[13] In contrast, the voluntary EU GPP criteria differentiate between core criteria which are designed to be applied jointly and comprehensive criteria which can be selected to go beyond the baseline ambition.

[14] In addition, Denmark, France and the Netherlands have legal requirements to limit embodied carbon emissions below a defined threshold. This applies to all residential and office buildings, including public procured ones, but does not constitute specific GPP criteria.

For instance, in Ireland, public procurement requires a minimum of 30% clinker replacement for concrete products, the use of Environmental Product Declarations (EPDs), and eliminates the use of carbon-intensive CEM-I cement for all public and government works, effective from September 2024. In the Netherlands, maximum thresholds on the environmental costs of concrete elements set quantified requirements which include embodied carbon and circularity. These costs include a fixed cost value per kg of CO_2e but also other environmental impacts such as marine and freshwater toxicity. Next to this, Finland and Sweden also allow for and recommend the reduction of embodied carbon by selecting concrete with a lower climate impact.

Criteria for circularity show similarly important gaps

When circularity is addressed, Member States primarily do so on the project-level, setting recycling requirements on all non-hazardous demolition waste products at once. Six Member States (Spain, Portugal, Ireland, Malta, Italy, and Latvia) define minimum re-use, recycling and recovery rates for waste generated during demolition as part of their GPP requirements. The ambition level for this varies across Member States, with Italy requiring 70% (in terms of weight) of materials to be prepared for re-use, recycling and recovery, while Malta, Latvia and Ireland require 55% to be prepared. The latter is equal to the minimum requirement set in the EU voluntary GPP criteria of 2016. Other Member States do not set any mandatory requirements, but 9 Member States do encourage recycling practices, by requesting a demolition plan (e.g., Finland) or other documentation requirements (e.g. Sweden).

While Member States have made first efforts to improve circularity through GPP criteria on individual carbon-intensive materials, this is far from becoming the norm. Recycling demolition waste in aggregates of carbon-intensive materials is encouraged in 9 Member States, but only 3 of these countries set minimum requirements on steel and/or concrete for this. At the national level, Italy, Malta and the Netherlands (see above) have established specific requirements for recycled content in concrete[15] (Italy (5%), Malta (15%)) and steel (only Italy (up to 75%)). On the regional level, in Flanders (Belgium), a policy plan is drafted to achieve 70% circularity of non-stony materials by 2030. Additionally, 50% of the recovered materials should remain in the building sector. On the local level, Berlin (Germany) implemented a procurement regulation as well, setting a minimum quota for recycled content in concrete in line with the upper limits of German industry standards[16]. While these efforts show that such criteria can be defined, a detailed look into the recovery requirements reveals low levels of ambition when it comes to specific requirements on carbon-intensive materials.

The specific insights from the six in-depth case studies (see Appendix 1) therefore also underlines the fragmented and uncoordinated approach. For embodied emissions and circularity can vastly different – and lacking – requirements be observed.

3.4 Mandatory GPP frameworks and harmonised monitoring efforts are required for effective implementation

Summing up, voluntary EU criteria for GPP in the construction of office buildings provide a starting point for authorities in Member States to apply GPP with low development efforts needed, but lack a comprehensive perspective with quantified targets for materials and buildings. While concrete elements have targets for recycled content, this is not the case for other materials. The primary approach of lifecycle assessments on the other hand is not linked to quantified targets. Nonetheless, the use of these criteria would still close important gaps in Member States' GPP frameworks with no action so far. The revision of the EU criteria should furthermore introduce elements on key construction materials on which public procurers can make requirements from the earliest stage and lead the way towards sustainable and particularly low-carbon public construction for office buildings and potentially broader use types of common public procurement projects. In addition, the legal instruments of the ESPR and CPR provide strong frameworks to define general mandatory product-level environmental performance requirements for construction materials.

[15] Italy's and Malta's requirements on recycled concrete can be found here (Italy) and here (Malta). The requirements on concrete are the Netherlands here.

[16] See https://www.berlin.de/nachhaltige-beschaffung/recht/ for Berlin's ordonnance. The current standard allows 25-45% of aggregate volume for concretes up to strength class C30/37.

On Member State level, national GPP frameworks for construction are mainly limited to high-level guidelines rather than specific criteria with threshold levels – if the topic is covered at all. While relevant topics to climate change mitigation, such as embodied carbon and circularity, are touched upon across these Member States, frameworks frequently lack threshold values or overall clarity on how to apply GPP criteria. Instead, frameworks provide too much room for interpretation when used to evaluate public contracts on their climate impact. As a result, even when national GPP criteria align with the EU GPP criteria within the construction context to a large extent, the absence of dedicated strategies for the sector perpetuates business-as-usual practices, hindering transformative change towards decarbonisation.

This lack of specificity in GPP criteria for construction leads to ineffective and fragmented implementation within Member States. This holds up for threshold values on carbon-intensive materials as a consequence of lacking product-level requirements. However, on the building level, there is also room for improvement. In Germany, for instance, a sustainable building assessment system is performed to integrate GPP criteria into construction projects of different building types, which only occurs to a small extent. Projects are evaluated across various sustainability themes, including embodied carbon emissions, and have to meet a minimum score. Yet, applying the framework is only required for the federal government as well as a few of the federal states that chose to adopt it. Additionally, the exact scores can vary between themes, so a strict requirement per theme, such as embodied carbon and circularity, cannot be deduced. Meanwhile, in the Netherlands and Sweden, the (voluntary) GPP frameworks in place on GPP criteria allow for ambition levels to be selected out of suggested criteria and ambition levels depending on what public procurers see fit, fragmenting GPP implementation even further.

Thus, to harmonise GPP implementation in construction across the EU, the development of a streamlined, mandatory approach to GPP in construction is required. Through such an approach, fragmentation and complexity can be reduced. This is especially relevant for monitoring methods on GPP implementation in public construction, as it allows for comparability between Member States. As part of such an approach, product-specific criteria can contribute to the reduction of embodied carbon reduction in carbon-intensive materials to foster innovation towards low-carbon alternatives in the industry.

3.5 Mandatory GPP implementation needs to be complemented by capacity- and knowledge building among public procurers

In addition to specific criteria and monitoring, there is also a widespread need to raise awareness and skills by providing training and freely accessible tools to public procurers to ensure the successful implementation of GPP in construction. To support public procurers in adopting GPP in their procurement practices, it is key that the established GPP strategy is accompanied by adequate tools and training provisions to raise awareness and skills among public procurers. To coordinate this on the national level, a supporting GPP expertise centre (e.g., PIANOo in the Netherlands, the Swedish Procurement Agency (SPA) in Sweden) has proven to be beneficial in supporting local GPP implementation in construction, as they can identify needs and wants in their local public procurement landscape. Both PIANOo and SPA are tasked with following up on the national GPP strategy, both supporting and evaluating the implementation of GPP across public authorities through training, capacity building, knowledge-sharing and monitoring.

Improved knowledge on successful GPP implementation across Member States is also needed, as it would allow for increased knowledge-sharing on best practices and successful GPP implementation. Currently, examples of and data on buildings constructed through GPP are hard to combine, limiting lessons learned to individual systems. Additionally, while awards for sustainable public buildings exist, information on the requirements, challenges and opportunities remains limited. Chapter 4 of this report illustrates the possibilities of reducing environmental impacts through a case study on a (Swiss) school building of the city of Zürich, where a mandatory GPP framework has been successfully implemented for two decades. This represents an initial step towards sharing good practices and the resulting sustainability effects. Wherever other examples exist across Europe, their results and experiences should be shared more widely and across borders.

In short, only through an enforced, mandatory framework, coupled with tools (e.g. on lifecycle costing), awareness-building, a dedicated procurement agency and harmonised monitoring mechanisms can GPP implementation in public construction be brought to a higher level. For this, harmonisation in monitoring methods and specific criteria for both products and buildings are essential to guide Member States towards more GPP in their public construction. Further details on the findings of the in-depth analysis can be found in Appendix 1, where these are presented on the country level.

4. GPP in practice: A case study of the Allmend School in Zurich

This chapter complements the review of GPP policy frameworks with a case study of a procured and finalised building in which GPP was applied, influencing the design and material selection. The building which is presented and analysed in detail in the following is the newly constructed Allmend School in Zürich.

Examining the effects of GPP for construction materials in a case study based on a real-life building allows for a practical demonstration of how sustainable purchasing decisions can influence environmental outcomes, particularly the embodied carbon performance of the design and structural materials being used. This also helps stakeholders to better understand the challenges and opportunities associated with implementing GPP policies, providing a concrete foundation for promoting sustainable practices in the construction industry.

4.1 Zürich's Allmend School as a case study for GPP construction

The Schulanlage Allmend in Zürich is a new educational facility designed to accommodate around 250 children across two kindergarten classes, nine primary school classes, and three special education classes[17]. It was constructed between 2020 and 2023 and has a total floor area of 6520 m².

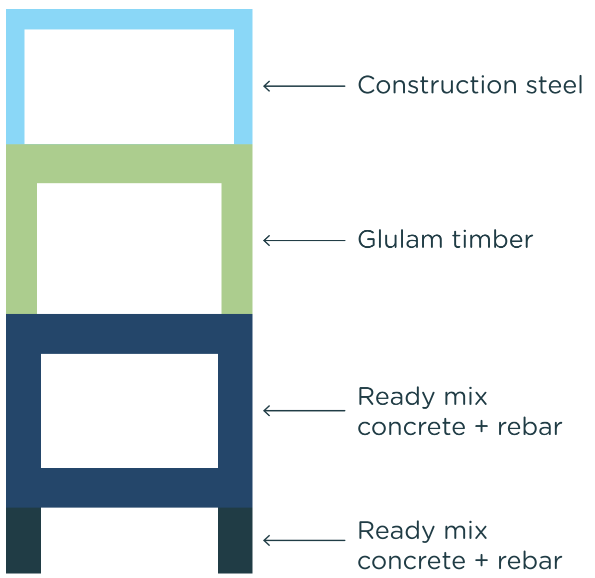
The building was built under Zürich's GPP criteria for building construction, which emphasise the use of low-carbon cement and recycled concrete as part of their commitment to sustainable development and the 2000-Watt Society. Specifically, Zurich has mandated the use of recycled aggregates in concrete for 20 years to reduce material consumption and related land-use impacts from gravel extraction.

The city also encourages the replacement of higher shares of cements clinker, which is the most carbon-intensive component of cement, with supplementary cementitious materials (SCMs) like fly ash and ground granulated blast furnace slag. Since 2013 Zurich has prioritised the use of CEM III/B cement, which contains a substantial proportion of these types of SCMs.

The building features a narrow, three-story design constructed primarily using wood. The school received the Minergie-A-ECO certification, highlighting its energy efficiency in combination with the low-embodied carbon material selection.

A concrete foundation and ground structure is topped with glulam timber materials in the superstructure and structural steel in the top floor. Figure 4-1 and Table 4-1 illustrate the building profile and the bill of quantities obtained from the city of Zurich.

Figure 4-1 Illustration of building structure with different primary materials



[17] More information on the project can be found on the city's website (in German): https://www.stadt-zuerich.ch/hbd/de/index/hochbau/bauten/bauten-realisiert/schulanlage-allmend.html

Table 4-1 Bill of quantities for the Allmend School building

Material category	Specific material used	Quantity	Unit
Concrete and cement			
Concrete	Structural concrete RC-C (proportion of concrete granules 50%), cement grade CEM III/B, dosage 290 kg/m³	2880	m³
	Structural concrete primary gravel, cement grade CEM II/B, dosage 300 kg/m3	5	m³
	Lean concrete RC-M (proportion of mixed demolition 100%), cement grade CEM III/B, dosage 200 kg/m³	150	m³
Micropile grouting	CEM I	150000	Kg
Steel			
Reinforcing steel	Steel B500B (ca. 120 kg/m³ concrete)	360000	Kg
Structural steel	S235	170000	Kg
Wood			
Wood	Glulam spruce/fir glulam	418	m³
	Glulam ash glulam	9	m³
	Laminated veneer lumber FSH	235	m³
	OSB (oriented structural board)	34	m³
	Steel parts excl. fastener S355	8570	kg

This overview illustrates that the Allmend School combines the selection of low-carbon alternatives for common carbon-intensive materials such as concrete (with CEM III/B cement as binder) and design choices for a material-efficient structure with a high timber share. As mentioned, Zürich's GPP framework sets requirements for the recycled aggregate content and promotes the use of carbon-optimised concrete based on CEM III/B cement. The 2000-Watt Society initiative defines additional threshold values for project-level embodied carbon values which influence the design choice for integrating lighter, timber-based structures.

4.2 Three scenarios allow the comparison of GPP impacts on embodied carbon emissions

To illustrate the benefits of reduced embodied carbon emissions three scenarios are defined and calculated:

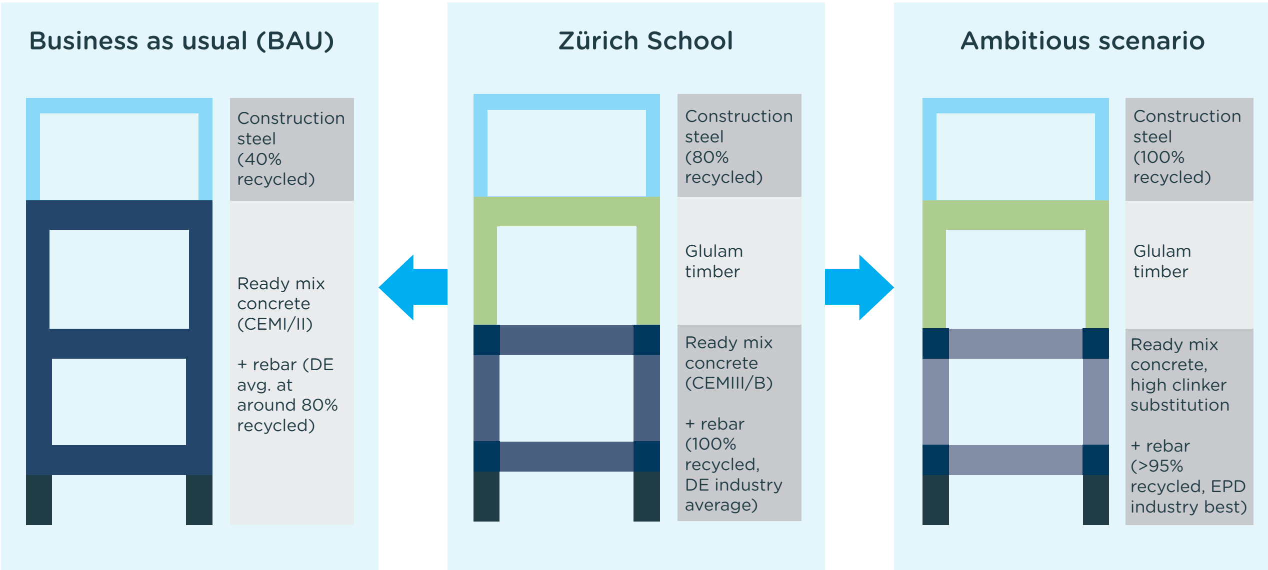
- First, to compare Zürich's approach to a building built without GPP requirements, a **business-as-usual (BAU) scenario** is created. For this scenario, German average environmental product declarations (EPDs) are used for the construction materials[18]. In addition, the building design is adapted to reflect a conventional reinforced concrete structure rather than timber in the sub-surface storeys. Following common experiences on the replacement ratios, 1 m³ of timber is substituted by 0.92 m³ of ready-mix concrete and 105 kg of rebar.
- Second, the GPP **scenario as implemented by the city of Zürich** is calculated. This follows the bill of quantities and materials specified by the city. To quantify embodied carbon emissions, German EPDs are used to ensure comparability across all three scenarios.
- As a third scenario, an **ambitious level of product-level GPP criteria** is introduced based on existing but more innovative materials and processes. This includes a higher recycling content in steel products, and low-carbon concrete from highly clinker efficient cement. As basis for this concrete specification, Vinci's Exergy concrete was used as a reference, where calcined clay and metakaolin act as additional clinker substitutes in addition to ground blast furnace slag and fly ash[19]. Vinci defines concrete categories up to ultra-low carbon concrete. However, as this type of concrete cannot be used for all exposure classes and construction processes, a combination of very-low-carbon and ultra-low-carbon is used in this scenario. No further design changes are made in comparison to the second scenario.

[18] German environmental data was used for ease of access, as generic and specific data is available for a wide range of products. Differences to Swiss data and the impacts calculated using these may occur in absolute values but relative proportions between materials, components and scenarios are robust across geographies.

[19] For more information, see: https://exegy-solutions.com/en/accueil/

Figure 4-2 below illustrates the key differences between the three scenarios. Further information on the data sources and scenario calculations can be found in Appendix 2.

Figure 4 2 Key differences between scenarios for the case study comparison



4.3 Substantial reductions are possible across all materials and assessment levels

Compared to the BAU scenario without any GPP, Zürich's school building resulted in 26% lower embodied carbon emissions from its structural materials. The BAU scenario leads to embodied carbon emissions of 233 kgCO_2e/m², while the as-built version of the Allmend School creates 172 kgCO_2e/m² for these elements. The focus on structural components involves the building components for which specific data is available and therefore provides the most robust quantification.

A further increase in GPP ambition with currently available low-carbon materials can even reduce the upfront carbon footprint by 45% compared to the BAU case. The further reduced cement clinker quantities in concrete and maximum recycled content levels in steel achieve this additional reduction, which can bring embodied emissions to 129 kgCO_2e/m² for structural components. Figure 4-3 illustrates the comparison between the three scenarios.

Figure 4-3 Comparison of scenario results for structural components

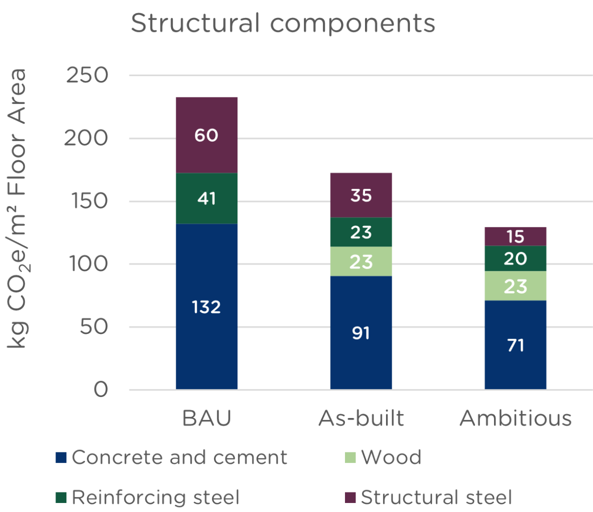


Figure 4-4 Comparison of scenario results for concrete components

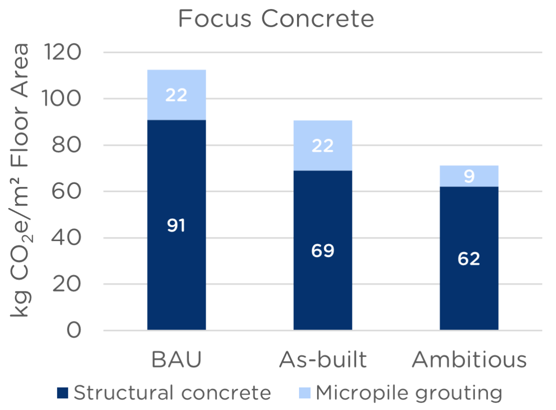
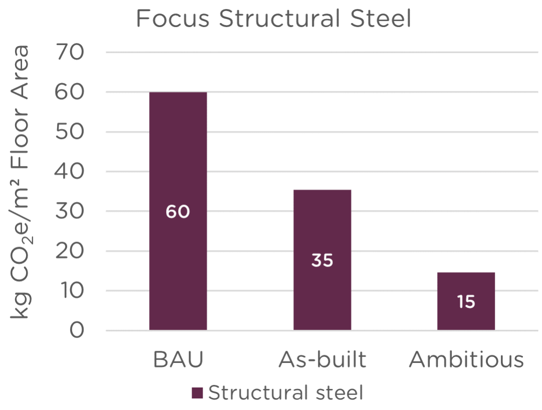


Figure 4-5 Comparison of scenario results for structural steel



Selected materials for both concrete and steel, as well as design choices contribute to the reductions. The largest driver of embodied emissions is **concrete**. As illustrated in Figure 4-4, the use of CEM III/B cement for the majority of concrete compared to current averages reduces the carbon footprint by 19%. The further substitution of clinker in cement mixtures reflected in the ambitious scenario, including the use of CEM III for micropile grouting would achieve a reduction of 37% compared to BAU levels. Similarly, Figure 4-5 illustrates that the recycled content of **structural steel** leads to important emission reductions. While substantial shares of recycled content are common in construction steel, the use of specific materials with higher recycled shares shows strong climate benefits. In comparison to the generic data point for structural steel profiles in the BAU scenario with 40% recycled content, the increase to 80% as used in the Allmend School reduces embodied emissions by 41%. In the ambitious scenario, when using 100% recycled steel, the reduction can even be 76% compared to the BAU. Lastly, the **design choices** of using wood materials for structural purposes in the above-ground storeys contributes to the reductions. Compared to the assumed reinforced concrete structure in the BAU scenario, the use of timber reduces embodied emissions by 12%. This quantification excludes the biogenic carbon stored in timber products. No change in the ambitious scenario was calculated. Therefore, the results are the same as for the as-built one. The effect of design choices is illustrated in Figure 4-6.

When considering the whole building, the emission reduction remains important. Using common ratios for non-structural building components, insulation and technical systems, a whole building calculation was performed. Non-structural elements were grouped in the other category and no changes were modelled between the three scenarios for these components. As shown in Figure 4-7, the reductions achieved by the Allmend School compared to a BAU case amount to 17%, while an even more ambitious set of GPP criteria could achieve 30% lower upfront embodied emissions than the BAU one.

Figure 4-6 Comparison of scenario results for design choices

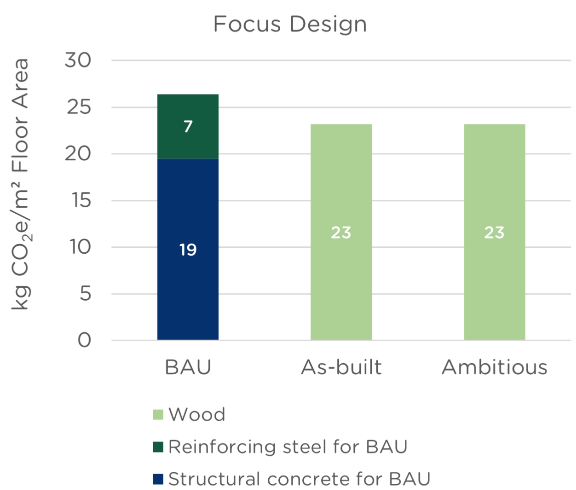
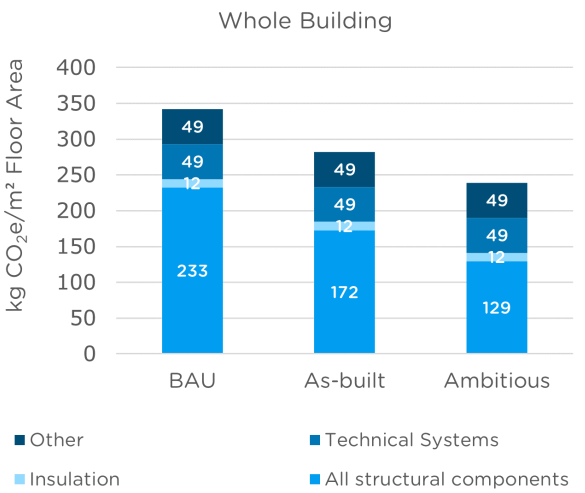


Figure 4-7 Comparison of scenario results at whole building level



4.4 Sustainable construction can be promoted through GPP

The case study of the Allmend School highlights the opportunities to reduce the environmental impacts of construction. As quantified above, the selection of low-carbon options for concrete and steel combined with material efficient design and the partial substitution of carbon-intensive reinforced concrete in the structure lead to substantial savings in embodied emissions. The GPP criteria of the city of Zürich create a framework that strongly promotes the use of such materials.

Beyond embodied carbon, requirements also exist for the recycled content in concrete aggregates, which limits resource consumption. Importantly, the prominent feature of material efficient design as an underlying principle reduces both the embodied emissions and the need for virgin materials. This improves the options for procuring the sustainable concrete and steel alternatives as lower quantities are needed in a situation of stronger supply challenges than with conventional materials or no GPP requirements.

The background discussions also underline that the existence of criteria alone is not sufficient. Exchanges with city officials in Zürich coordinating public construction projects such as the Allmend School repeatedly point to the importance of creating awareness throughout the public administrations and in the relations with suppliers and contractors. A continuous process of developing and improving a mutual understanding of priorities, feasibility and other impacts such changing process on construction sites is necessary to create a strong basis for the technical requirements in GPP criteria.

Allmend School in Zürich. Photographer: Matthias Vollmer, Zürich.

5. Potential for reducing the environmental impacts of construction through ambitious GPP criteria

This chapter builds on the findings of the case study scenarios to explore the impact and feasibility of GPP criteria across the EU. In addition to the data generated in the case study analysis, the assessment refers to recent publications on GPP in the EU, which it aims to complement.

Specific attention is placed on the carbon footprint performance of concrete and steel as key construction materials. As reflected in the existing landscape of GPP criteria for construction, the sustainability of a construction project and material choices therein comprises several parameters, from the carbon footprint to resource consumption, land use impacts and toxicity. Different ways to reduce environmental impacts exist and there can be synergies and trade-offs between these. Material efficiency – including challenging the underlying need for construction – have to be placed highest in the assessment. However, a need for new construction will remain and therefore the choice of materials is critical; yet substantial gaps in existing GPP frameworks exist while a reduction potential has been identified in the case study analysis. Therefore, the assessment in this chapter is focused on the carbon intensity of concrete and steel.

5.1 GHG emissions from public construction can be reduced substantially

Different levels for GPP criteria can be derived from the three scenarios presented and calculated in the previous chapter. While the absolute values can be subject to variation depending on the data source and local product landscape, the relative reduction across the three scenarios provides a fairly robust indication for a high-level perspective.

- The business-as-usual (BAU) scenario captures current average construction practices in Europe.
- A scenario of basic GPP criteria based on the material specification used for the Zürich Allmend school, ready to be implemented.
- A scenario of ambitious GPP criteria based on the material selection with most advanced carbon intensity levels.

The material quantities used in the three scenarios for the Allmend School in Zürich and their carbon intensities were combined to obtain averages for the two key materials concrete and steel. Table 5-1 below illustrates these average intensities in absolute and relative terms.

Values for current practices vary across other publications on the topic and depending on the specific scope of products considered.

Table 5-1 Carbon intensities for concrete and steel for the three scenarios

Scenario	Concrete		Steel	
	$kgCO_2e/m^3$	%	$kgCO_2e/kg$	%
Business as usual	195.42	100%	1.09	100%
Basic PP criteria	148.32	76%	0.72	66%
Ambitious PP criteria	133.49	68%	0.43	40%

For **steel**, recent publications looking at steel production in general are quantified at 1.7 $kgCO_2e$/kg steel[20] or 1.81 $kgCO_2e$/kg[21], which are higher than the baseline results of the BAU scenario. Contrarily to this, German average EPDs for rebar steel and structural steel indicate carbon intensities of 0.61 $kgCO_2e$/kg steel[22] and 1.13 $kgCO_2e$/kg[23] respectively. In addition, studies focusing on steel used in construction concluded on 0.81 $kgCO2_e$/kg[24], which is considerably lower than the scenario results. This divergence can be explained with the use of specific steel types. Steel used in construction, particularly rebar steel has high shares of recycled content from electric arc furnace (EAF) routes. Flat steel and steel sheets, however, still have higher contents of virgin steel from mainstream integrated routes using blast furnace and basic oxygen furnace installations. Both rebar and flat structural steel are used in the Allmend School. Therefore, a BAU value in the middle of the range can be expected.

For **concrete**, the use of average EPDs for German ready-mix concrete ensures a robust baseline value. The EPD balances CEM I and CEM II cements and has a clinker substitution rate of ca. 12% for fly ash, with further substitution from e.g. blast furnace slag not explicitly stated[25]. Also, many publications focus on the carbon intensity of cement, with results between 0.6 kgCO2e/kg cement[26] and 0.815 $kgCO_2e$/kg[27]. Based on EU ETS data, the JRC describes carbon intensities from EU cement plants as ranging from below 0.5 $kgCO_2e$/kg to above 0.8 $kgCO_2e$/kg[28]. With a cement content of 300kg/m^3, the results from the BAU calculations translate to a carbon intensity of 0.65 $kgCO_2e$/kg cement, considering that the carbon footprint of water, sand and aggregates is minor in comparison to the cement content. This value is also within the expected range.

The basic and the ambitious scenarios can be contextualised by the requirements of the EU Taxonomy for steel and cement production[29]. For cement, an emissions intensity of 0.469 tCO_2e/t of cement lies between the basic and ambitious scenarios when breaking down the concrete values to cement with the cement content of the concrete used at 300 kg/m^3. For steel, the EU Taxonomy threshold for EAF steel is defined at 0.209 tCO_2e/t[30] indicating that further reductions for fully recycled steel can be envisaged and both basic and ambitious levels in Table 5-1 are realistic.

Combining the three levels of carbon intensity with the total material volumes of cement and steel used in public procurement can give important information on the GHG savings potential from a widespread implementation of GPP criteria at the basic and ambitious level. The recent Wyns et al. (2024) study[31] quantifies these volumes for the EU at 47 Mt of cement[32] and 15.6 Mt of steel being used in PP each year. This represents 31% and 11% respectively of the total use of these materials in the EU economy.

[20] Carbone4, IN Europe, (2024). Buy European and Sustainable Act: accelerating the low-carbon transition in the European Union. Available at: https://www.carbone4.com/en/publication-buy-european-and-sustainable-act

[21] Koolen, D. and Vidovic, D. (2022). Greenhouse gas intensities of the EU steel industry and its trading partners. EUR 31112 EN. Publications Office of the European Union. Luxembourg. ISBN 978-92-76-53417-4. Available at: doi:10.2760/170198. JRC129297

[22] https://www.oekobaudat.de/OEKOBAU.DAT/datasetdetail/process.xhtml?uuid=8565038f-5c21-48d7-94cb-958498ba9dd3&version=20.23.050

[23] https://www.oekobaudat.de/OEKOBAU.DAT/resource/sources/f56f48ce-b3a6-499a-9692-12c221aeab5e/Baustaehle_Offene_Walzprofile_und_Grobbleche_10656.pdf?version=00.02.000

[24] Wyns, T., Kalimo, H. and Khandekar, G. (2024) Public procurement of cement and steel for construction - Assessing the potential of lead markets for green steel and cement in the EU. Brussels School of Governance. Available at: https://www.brussels-school.be/output/events/roundtable-event-public-procurement-steel-and-cement-construction-creating-lead.

[25] Informationszentrum Beton, (2023). Umweltproduktdeklaration. Beton der Druckfestigkeitsklasse C30/37. Available at: https://www.beton.org/fileadmin/beton-org/media/Dokumente/PDF/Wissen/Beton-Bautechnik/Nachhaltigkeit/2023-10-20-EPD-C30-37.pdf.

[26] Carbone4, IN Europe, (2024). Buy European and Sustainable Act: accelerating the low-carbon transition in the European Union. Available at: https://www.carbone4.com/en/publication-buy-european-and-sustainable-act

[27] Wyns, T., Kalimo, H. and Khandekar, G. (2024) Public procurement of cement and steel for construction - Assessing the potential of lead markets for green steel and cement in the EU. Brussels School of Governance. Available at: https://www.brussels-school.be/output/events/roundtable-event-public-procurement-steel-and-cement-construction-creating-lead.

[28] Marmier, A. (2023). Decarbonisation options for the cement industry. Publications Office of the European Union. Luxembourg. Available at: doi:10.2760/174037. JRC131246

[29] There are no criteria for concrete around a substantial contribution to climate change mitigation. Detailed information can be found in the EU Taxonomy Compass: https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass

[30] For carbon steel in EAF production routes as carbon steel is the most commonly steel type used in construction purposes.

[31] Wyns, T., Kalimo, H. and Khandekar, G. (2024) Public procurement of cement and steel for construction - Assessing the potential of lead markets for green steel and cement in the EU. Brussels School of Governance. Available at: https://www.brussels-school.be/output/events/roundtable-event-public-procurement-steel-and-cement-construction-creating-lead.

[32] This translates to 134.28 Mm3 of concrete

Introducing GPP criteria at the basic level reduces GHG emissions linked to the two materials by 28%, while ambitious criteria lead to a reduction of 43%. In absolute emissions, this translates to annual emission savings of 11.9 Mt CO_2e in the basic scenario and 18.5 Mt CO_2e in the ambitious one. This is equivalent to the annual CO_2e of, respectively, 2.9 and 4.4 million internal combustion engine passenger vehicles. Figure 5-1 and Table 5-2 below illustrate these effects. In relation to the total estimation of GHG emissions linked to publicly procured construction in the EU, this represents a reduction of at least 15%.

Additional reductions can be achieved from design choices for material efficiency and low-carbon material alternatives. As demonstrated by the Allmend School, the use of timber and steel structures instead of reinforced concrete can reduce material demand and thus the connected GHG emissions. The re-use of elements (e.g. steel beams or wall elements) also results in substantially lower emissions. According to academic and applied publications, careful design to construct material efficient buildings can reduce the use of concrete by 10-40% and steel by 12-24%[33][34]. The modelled scenario for the Allmend School thus even lies on the conversative end of the reduction range.

The potential to reduce embodied emissions from public procurement are therefore relevant and warrant the introduction of harmonised criteria to accelerate the transition of industries and satisfy the exemplary role of public buyers. The following two chapters will consider the dependencies of such this approach on the availability of low-carbon materials and the impact on construction costs.

Figure 5-1 Comparison of GHG emissions from public procurement of construction in the three scenarios at EU-level

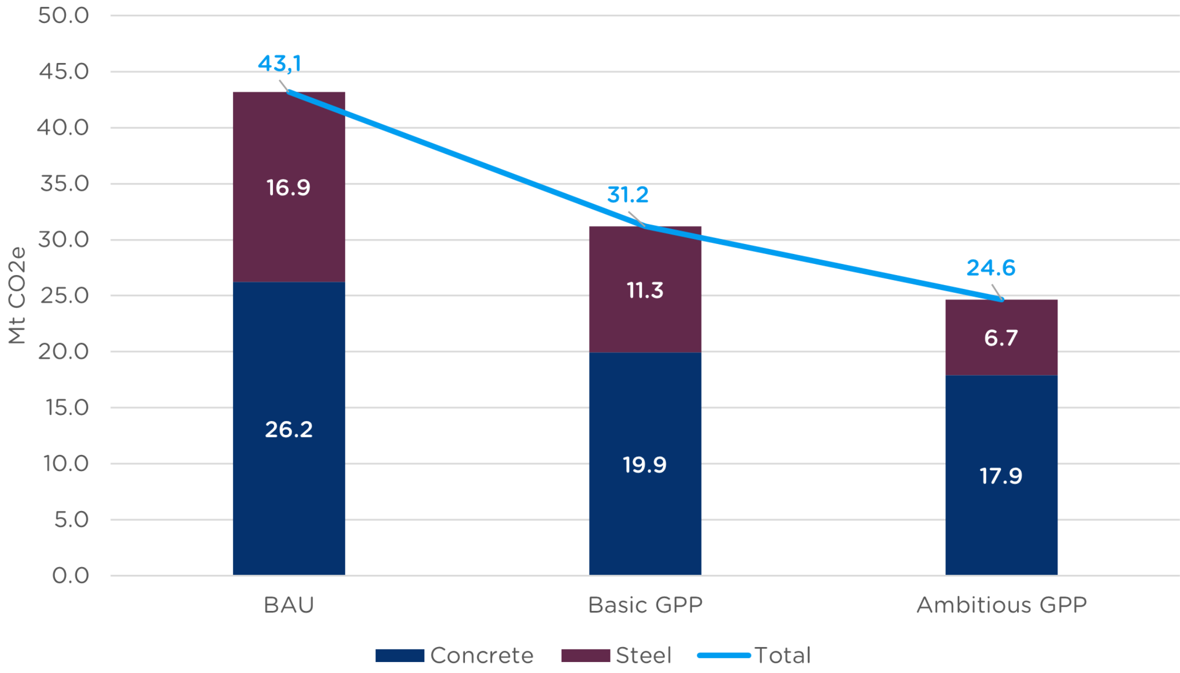


Table 5-2 Absolute and relative GHG emissions in the three GPP scenarios

Scenario	GHG emissions (Mt CO_2e)			Reductions	
	Concrete	Steel	Total	Mt CO_2e	%
BAU	26.2	16.9	43.1	0	0
Basic criteria	19.9	11.3	31.2	-11.9	-28%
Ambitious criteria	17.9	6.7	24.6	-18.5	-43%

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[33] Karlsson, I., Rootzén, J., Johnsson, F., & Erlandsson, M. (2021). Achieving net-zero carbon emissions in construction supply chains – A multidimensional analysis of residential building systems. Developments in the Built Environment, 8, 100059. https://doi.org/10.1016/J.DIBE.2021.100059

[34] Material Economics. (2019). Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry. Available at: https://materialeconomics.com/sites/default/files/2024-06/material-economics-industrial-transformation-2050.pdf

5.2 Low-carbon materials are available to match GPP criteria

Considering targets or limits on the carbon intensity of concrete and steel requires the availability of low-carbon materials for procurement.

At the scale of individual projects, materials can already today be selected in line with the scenario of basic GPP criteria as demonstrated by the case study described in Chapter 4. However, the introduction of effective GPP requirements across the EU would increase the demand for concrete and steel with substantially lower carbon intensities than current average products.

Production routes and technologies for this reduction in carbon intensity have been expanding and further innovations are being demonstrated in multiple areas. While it is not the scope or objective to perform a detailed technology review, a short overview of opportunities and remaining challenges helps to reduce concerns about the feasibility of widespread and effective GPP criteria for concrete and steel as key construction materials. Table 5-3 captures the main challenges and highlights that opportunities to overcome those challenges exist. **This enables the availability of sufficient volumes of low-carbon materials to meet the ambitious criteria level in the mid-term future**.

Table 5-3 Challenges and opportunities for the material availability of low-carbon steel and concrete

Product	Carbon intensive production steps	Challenges for widespread availability of low-carbon materials	Opportunities for increasing the availability of low-carbon materials
Steel	Primary steel production through integrated BF-BOF route	Sufficient availability of secondary steel based on scrap, produced in EAF route to substitute primary steel from BF-BOF routes	EAF steel has a substantially lower carbon intensity, in line with the ambitious criteria level described in Table 5-1. Currently, in the EU BF-BOF steel accounts for 77 Mt, while 59 Mt are produced in EAF routes[35]. In construction uses the EAF share is higher. At the same time, the EU is a net exporter of scrap (13.8 Mt) that are available to increase the amount of secondary steel[36]. Together, this means that a strong basis for EAF production and use is in place and can be expanded. Improved waste recovery and processing can increase this amount even further. Assessments foresee that EU primary steel production could be reduced by 80% in 2050[37]. In addition, the transition of production routes for primary steel is increasing the availability of low-carbon steels. Steel produced based on direct reduced iron (DRI) is emerging in the EU[38]. When combined with the increased availability of renewable hydrogen, this technology reduces the carbon intensity well below ambitious criteria[39]. According to other forecasts, green hydrogen-based steelmaking (H2-DRI-EAF) becomes cost-competitive with traditional methods at a hydrogen price EUR 3.6/kg when a carbon price of EUR 70/tCO_2 is in place[40]. This reflects recent EU carbon pricing, while H2 prices are expected to be around EUR 5/kg. The cost-effective production can thus be expected in the 2030s[41]. Together, these processes ensure materials available for GPP. For ambitious criteria, a stronger focus is placed on primary steel production, while basic GPP criteria mainly require optimised use of secondary steel, which will reduce in carbon intensity as electricity becomes increasingly renewable across the EU.

[35] Eurofer, (2023). European Steel in Figures 2023. Available at: https://www.eurofer.eu/assets/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2023/FINAL_EUROFER_Steel-in-Figures_2023.pdf

[36] European Parliament, Directorate-General for Parliamentary Research Services. (2021) Carbon-free steel production: cost reduction options and usage of existing gas infrastructure. LU: Publications Office. Available at: https://data.europa.eu/doi/10.2861/01969.

[37] Material Economics, (2018). The Circular Economy - A Powerful Force for Climate Mitigation. Available at: https://circulareconomy.europa.eu/platform/sites/default/files/the-circular-economy-a-powerful-force-for-climate-mitigation.pdf

[38] See Eurofer mapping: https://www.eurofer.eu/issues/climate-and-energy/maps-of-key-low-carbon-steel-projects

[39] Keßler, L. and Lovisolo, M. (2023) Hydrogen DRI for Steel in a Resource-Constrained Europe: How Much Renewable Electricity is Needed to Decarbonise the Sector with Green Hydrogen. Brussels, Belgium: Bellona. Available at: https://bellona.org/news/energy-systems/2023-07-hydrogen-dri-for-steel-in-a-resource-constrained-europe-how-much-renewable-electricity-is-needed-to-decarbonise-the-sector-with-green-hydrogen.

[40] Hasanbeigi, A.; Zuo, B.; Kim, D.; Springer, C.; Jackson, A.; Heo, Esther H. (2024). Green Steel Economics. Available at: https://static1.squarespace.com/static/5877e86f9de4bb8bce72105c/t/669f95f0998c325bfaa6eb1c/1721734643151/factsheet_03_EU_240721.pdf

[41] Agora Industry (not yet published). Der Gebäudesektor als Leitmarkt klimafreundlicher Grundstoffe: Reduktion und Regulierung von Embodied-Carbon-Emissionen in Deutschland

Product	Carbon intensive production steps	Challenges for widespread availability of low-carbon materials	Opportunities for increasing the availability of low-carbon materials
Concrete	Cement clinker production	Availability of materials able to substitute cement clinker in concrete[42] Emission-intensive production from energy use and process emissions	In addition to fly ash and blast furnace slag as clinker substituting materials, amongst others using limestone and calcined clay in the place of burned clinker to reduce carbon intensive clinker contents in cement and concrete have been developed by different initiatives and companies[43]. These achieve clinker replacement rates of 50-70% with more widely available materials and result in carbon intensity reduction of concrete in line with the ambitious criteria described in Table 5-1. Wider commercialisation of these technologies and materials can contribute to cutting clinker demand and emissions[44]. Reducing quantities of fly ash and blast furnace slag can also be substituted by recycled concrete and mortars, which could create total amounts equivalent to 20-70% of total cement quantities produced in key EU countries[45] and where the possibility of electrification is currently being developed in synergy with EAF steel processes[46]. Using such supplementary cementitious materials reduces the need for clinker in cement, while improving product characteristics such as durability. In addition, alternative binders in concrete mixtures provide alternatives to SCMs. Further, alternative fuels and energy efficiency measures lower the emissions and energy use of the remaining production processes. Together, they offer a synergistic effect, leading to greater overall emission reductions. For the remaining emissions, including process emissions, most scenarios for the decarbonisation of cement production rely on the use of carbon capture and storage (CCS) as process emissions and fuel requirements prevent the decarbonisation through renewable fuels. Both EU Commission and the cement industry project a rapid increase of CCS from 2030 onwards[47]. Pilot installations of CCS in cement plants already exist. However, uncertainties remain on the exact scale of CCS in Europe over the coming years as the technology has not reached commercial levels yet and require efforts on CO_2 infrastructure and suitable storage sites. Despite this, the increasing carbon costs mean that CCS is expected to appear more and more widely in cement production and support both the basic and ambitious criteria.

Standards and norms are an important barrier to realising the full possibilities from these material innovations. Standards for construction materials and particularly cement and concrete are most often based on conventional material formulas relying on Portland cement. The focus lies on strength and consistency from times where sustainability was of much lower priority. The ubiquitous use of these standards, while mostly an accomplishment in common practices, creates barriers for innovative and low-carbon alternatives to gain regulatory approval, limiting their market adoption. To address sustainability challenges, these standards and their development processes must find ways to account for innovative solutions that limit the environmental impact of materials.

[42] The main materials currently used to substitute clinker in concrete are fly ash and ground granulated blast-furnace slag (GGBFS). These materials are primarily industrial by-products; fly ash is derived from coal combustion in power plants, GGBFS from the coal-fired steel manufacturing process. Their availability is limited due to a decline in coal usage for energy, resulting in less fly ash, and changes in industrial processes that reduce the production of GGBFS.

[43] See for an overview: https://alliancelccc.com/wp-content/uploads/2023/10/Factsheet-on-SCMs-in-making-low-carbon-cement-and-concrete-a-reality-October-2023-final.pdf and specific examples: https://lc3.ch/; https://exegy-solutions.com/en/accueil/#solutions

[44] IPCC, (2022). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.

[45] Shah, I.H., Miller, S.A., Jiang, D. et al., (2022). Cement substitution with secondary materials can reduce annual global CO2 emissions by up to 1.3 gigatons. Nat Commun 13, 5758, https://doi.org/10.1038/s41467-022-33289-7.

[46] Dunant, C.F., Joseph, S., Prajapati, R. et al. (2024) Electric recycling of Portland cement at scale. Nature 629, 1055–1061. https://doi.org/10.1038/s41586-024-07338-8

[47] See EU Commission (2024) Commission Communication on industrial carbon management (COM/2024/62). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2024%3A62%3AFIN&qid=1707312980822; and Cembureau (2024) From Ambition to Deployment. Available at: https://cembureau.eu/media/ulxj5lyh/cembureau-net-zero-roadmap.pdf

5.3 Economic impacts of green construction criteria are positive or neutral at minimum

The incorporation of sustainable practices in public construction contracts through GPP is expected to be accompanied by short-term price increases, but only to a limited extent. This increase in costs for construction projects compared to when conventional construction materials are used is due to the limited material availability and lacking infrastructure.

The extent to which green public procurement in construction results in cost increases for materials and projects varies across different studies but is commonly estimated at low to marginal rates. For instance, Wyns et al. (2024)[48] note that the adoption of climate-friendly versions of cement and steel, defined as reducing greenhouse gas emissions by at least 80% compared to current best practices, is expected to have a minimal impact on financial expenditures. Total public procurement costs are anticipated to rise by only 0.2 to 0.5%, while construction-specific procurement costs may increase by 1 to 2.2%.

To inform the assessment of economic impacts from the **basic scenario**, a review published in an upcoming report by Agora Industry compares prices for available low-carbon concrete to conventional ones[49]. Prices are continuing to converge with low-carbon concrete now 2-3% more expensive than conventional one[50]. The impact on steel prices is found to be marginal, with secondary EAF routes starting to have lower production costs than primary BF-BOF routes[51]. However, transport costs can be expected to increase slightly as the required shares of secondary steel may not be available at the closest steel plants. This focus on material prices is reduced further when assessing the total upfront project costs, which only increase by 1% or less as a result of higher material costs. Other costs such as labour, financing and planning costs do not change significantly as a result of the requirements. This 1% increase is contrasted with embodied emission reductions of 17% as calculated for the Allmend School in Figure 4-7.

In the **ambitious scenario**, the economic impacts are more uncertain to estimate as the introduction of GPP at this level is assumed further in the future (see more details in Section 5.4). The projection of currently less widespread technologies as well as dependencies on prices for renewable energy sources and carbon emissions are the main causes for this uncertainty. Building on the findings of Agora Industry's transformation cost calculators[52] and findings presented in the aforementioned report[53], the costs of deep transformations are estimated considering a mix of solutions as discussed in Section 5.2 as well as the share of emission reductions considered in the ambitious GPP scenario (see Table 5-1). As a result, premiums in the range of 5.4 to 6.3% are estimated. This is aligned with an economic assessment by Future Cleantech Architects and Tech for Net Zero (2023)[54]. Their research expects public expense increases around 3 to 6% overall and 5-7% in carbon-intensive construction in order to reach net zero, which underlines that a net-zero transition for public construction is possible at manageable extra costs. For the project level, the higher material costs translate to an increase of 3-4%, for embodied emissions reductions of 30% as illustrated by the Allmend School case.

[48] Wyns, T., Kalimo, H. and Khandekar, G. (2024) Public procurement of cement and steel for construction - Assessing the potential of lead markets for green steel and cement in the EU. Brussels School of Governance. Available at: https://www.brussels-school.be/output/events/roundtable-event-public-procurement-steel-and-cement-construction-creating-lead.

[49] Agora Industry (not yet published). Der Gebäudesektor als Leitmarkt klimafreundlicher Grundstoffe: Reduktion und Regulierung von Embodied-Carbon-Emissionen in Deutschland

[50] Some concrete suppliers have general price lists for certain regions. A review of 2024 prices for Holcim concretes across Germany points to decreasing premiums in the range of 1.5 to 4%.

[51] Norsa, E. (2022) 'Italian EAF production costs drop below blast furnaces - EUROMETAL', Kallanish Steel, 1 November. Available at: https://eurometal.net/italian-eaf-production-costs-drop-below-blast-furnaces/ (Accessed: 8 August 2024).

[52] Agora Industry (2022). See https://www.agora-industry.org/data-tools/steel-transformation-cost-calculator for steel (primary) and https://www.agora-industry.org/data-tools/cement-transformation-cost-calculator for cement.

[53] Agora Industry (not yet published). Der Gebäudesektor als Leitmarkt klimafreundlicher Grundstoffe: Reduktion und Regulierung von Embodied-Carbon-Emissionen in Deutschland

[54] El-Helou, I. et al. (2023) How much does Green Public Procurement (GPP) cost in practice? - An Economic Assessment for Climate-Neutrality in Public Purchasing. Future Cleantech Architects and Tech for Net Zero. Available at: https://techfornetzero.org/en/impuls-4-green-public-procurement/.

Table 5-4 Green premium and additional public expenditure per scenario across the EU

Scenario	Concrete		Steel		Total increase in public procurement spending	
	Green premium (%)	PP spending (in billion EUR)	Green premium (%)	PP spending (in billion EUR)	In %	In billion EUR
Business as usual	0	15.41	0	9.58	0	0
Basic scenario	2.00	15.72	1.00	9.68	1.62	0.41
Ambitious scenario	6.25	16.37	5.40	10.10	5.92	1.48

Table 5-4 illustrates the green premiums and implications on public procurement spending. While these green premiums provide insights into the overall cost increases associated with GPP implementation, it should be stressed that green premiums are likely to vary between Member States, dependent on the proportion of concrete and steel costs in public construction projects. Further details on the calculations are provided in Appendix 3.

Putting these levels of increased spending in the context of expected GHG emission savings points to the abatement costs for GPP criteria. The basic scenario results in 34.46 EUR/tCO_2e, while this is estimated at 80.04 EUR/tCO_2e in the ambitious scenario. The findings are summarised in Table 5 5. It should be noted that these cost increases refer only to the costs for material procurement of concrete and steel. Other options for GHG emission reduction can effectively lower material and project costs. This can often be the case for material efficient designs, prioritisation of refurbishments, or the selection of local material alternatives (e.g. timber, straw, stone).

In practice, abatement costs comprise a range from low to high. Construction as a sector has a beneficial profile, with only few high-cost transition levers[55]. Most of these relate to material efficient design and carbon-optimised selection and sourcing of materials. The numbers indicated above and in Table 5-5 can only give an average of the abatement costs. Around this, the costs follow a curve from less costly ones to highly complex and costly ones. The use of secondary steel and available low-cement concretes is possible at very little additional costs, while the use of steel from hydrogen-fuelled production routes remains much more costly for the moment.

Despite these short-term potential cost increases, GPP implementation in construction stimulates decarbonisation in the construction sector by fostering innovation and industry advancement, ultimately leading to reduced overall costs. By creating a demand for sustainable building materials and practices, GPP enables the construction industry to develop itself to minimise its environmental impact[56]. This proactive approach not only promotes low-carbon construction methods but also enhances efficiency and resource management. Consequently, the initial investment in GPP translates into long-term savings by fostering innovation towards cost-effective, low-carbon solutions.

Table 5-5 GHG abatement costs per scenario on EU level

Scenario	GHG emission savings (MtCO_2e)	Carbon abatement costs (EUR/tCO_2e)		
		Concrete	Steel	Combined total
Basic scenario	**11.9**	48.92	17.12	34.46
Ambitious scenario	**18.5**	116.04	50.67	80.04

[55] World Economic Forum, (2021). Net-Zero Challenge. The supply chain opportunity. Available at: https://www.weforum.org/publications/net-zero-challenge-the-supply-chain-opportunity/

[56] Nilsson Lewis, A., Kaaret, K., Torres Morales, E., Piirsalu, E., Axelsson, K. (2023). Green Public Procurement: a key to decarbonizing construction and road transport in the EU. Stockholm Environment Institute. Available at: https://doi.org/10.51414/sei2023.007

At the latest by 2040, low-carbon construction materials will be available at prices similar to those of conventional materials, even exceeding these in terms of cost-effectiveness by 2050. This is explained by the increases in carbon prices across the EU. At the moment, the cement and steel industries do not pay for their emissions under the EU Emissions Trading System (ETS) due to free allocation rules[57]. Yet, with the introduction of CBAM and the transition to the next trading period in 2030, free allowance is expected to be phased out and carbon prices to rise in Europe due to stricter emissions caps alongside the increasing availability of renewable fuels, the relative costs start to shift. Specifically, low-carbon alternatives of carbon-intensive construction materials are expected to have similar prices as conventional materials by 2040, while the cost-effectiveness of these low-carbon alternatives is projected to exceed conventional materials by 2050[58]. Already today, without free allowances at a price of around 70 EUR/t CO_2, materials for the basic scenario would be the cost-effective choice.

5.4 Consistent and ambitious GPP criteria for key construction materials are possible

In sum, taking material availability and economic impact into consideration, the implementation of consistent and ambitious GPP criteria in construction is possible to support the decarbonisation of the construction sector across the EU Member States. The scenarios presented in Section 5.1 offer a basis for defining two steps of GPP criteria for specific carbon-intensive materials (e.g. steel, concrete).

A basic level of low-carbon material criteria can be introduced with existing materials and supply chains. The carbon intensities achieved on concrete and steel in the Allmend School in Zürich represent such an immediately feasible level of reduction compared to the current average emission intensities of these materials.

As pointed out in Section 5.3, the use of low-carbon versions of concrete and steel only marginally raises construction costs. This suggests that GPP implementation in construction is possible without significantly raising the costs, especially on a mid to long-term timeline.

Requiring deeper decarbonisation levels of public construction as captured in the ambitious GPP scenario will be possible in a mid-term timeframe. As indicated in Section 5.2, material availability does not represent a barrier to the two criteria levels and innovation and the expected increase in production of low-carbon construction materials ensures a sufficient supply for the ambitious scenario in the near future. Thus, in 2030 or latest in 2032, the increase in ambition should be effective.

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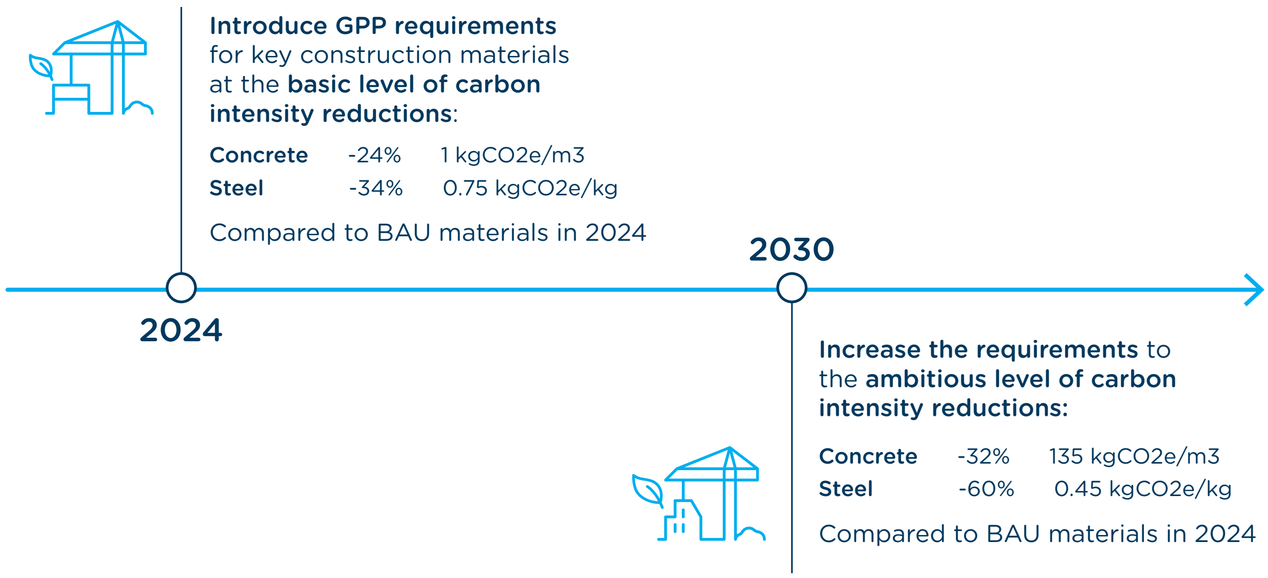
[57] Carbon Market Watch, (2023). The Emissions Aristocracy. Available at: https://carbonmarketwatch.org/publications/the-emissions-aristocracy/

[58] Agora Industry (not yet published). Der Gebäudesektor als Leitmarkt klimafreundlicher Grundstoffe: Reduktion und Regulierung von Embodied-Carbon-Emissionen in Deutschland

Figure 5-2 illustrates this timeline together with proposed reductions to the carbon intensities compared to a BAU scenario for the building using the latest average data on materials. For this approach to be implemented, the use of EPDs to support the selection of materials should to be part of the requirements for contractors. The request for EPDs to inform public construction procurement decisions has been in place in the GPP framework of California in the US[59] and is being introduced in Ireland in autumn 2024[60]. At the EU level, this approach ensures taking into account carbon intensities in local construction markets as reflected in average EPDs for the products used. At the same time, consistent ambition levels and monitoring structures can reduce the need to develop a full framework from scratch, where no GPP requirements for construction, especially on embodied carbon emissions have been in place so far.

In the first step, the basic level of GPP criteria would mandate reductions of 24% for concrete components and 34% for steel components used in public procurement projects compared to the national building average as a baseline or compared to a reference design for the specific project. On average, the carbon intensity of concrete per project would have to meet the maximum threshold of 150 $kgCO_2e/m^3$ and that of 0.75 $kgCO_2e/kg$ for steel. Together, this requires the efficient use of low-carbon materials available. In the ambitious level, these requirements are then increased. Support and coordination from the EU-level can strongly support this development through capacity building, knowledge exchange and financing of baseline values. Additionally, primarily at national level, the requirements should be complemented with skills development and tools for including these requirements in tender descriptions as well as assessment tools for the comparison of offers and project follow-up can make this an effective and relatively low-effort element to include in EU-wide GPP frameworks.

Figure 5-2 Timeline towards ambitious GPP criteria for key construction products



[59] https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act

[60] https://www.gov.ie/en/press-release/41f29-government-approves-public-procurement-guidance-to-promote-the-reduction-of-embodied-carbon-in-construction/

6. Conclusions and recommendations

Given the significant share of GHG emissions stemming from public construction, GPP is an essential tool for driving the construction sector's decarbonisation. Through this study, the current practices to Green Public Procurement (GPP) implementation in construction in the EU were analysed to improve GPP as a tool to support the decarbonisation of the construction sector.

However, as indicated by the study, GPP frameworks in construction are currently limited in terms of ambition level across the EU. Instead of setting specific criteria with threshold values, GPP frameworks for construction are underdeveloped or absent in most Member States, limiting the effectiveness in application.

Specifically, as detailed in Chapter 3, the absence of harmonised monitoring mechanisms, the lack of enforcement of a mandatory framework, and the unawareness regarding GPP implementation hinder the potential impact of GPP in public construction. This, despite the significant potential of GPP to reduce greenhouse gas emissions in public construction projects, as shown by the case study of the Allmend school in Zürich in Chapter 4. In comparison to a business-as-usual scenario, Zürich's GPP criteria led to a reduction in upfront embodied carbon emissions by 26% on structural components. Low-carbon concrete, high recycled content in steel and a design that substitutes structural concrete with timber. An ambitious scenario that assumes the use of existing but less widely available materials even achieves a 44% reduction. This highlights the need to prioritise low-carbon materials and induce innovation to expand innovative material compositions even further.

At the EU-level, basic GPP criteria can feasibly reduce GHG emissions stemming from steel and concrete by 28%, as shown in Chapter 5, while ambitious criteria lead to a total reduction of 43%. Material alternatives to comply with the carbon reduction ambitions are available for both the basic and the ambitious level, considering a stepwise introduction (see Figure 6 1). This approach to GPP for construction would result in very modest increases in public procurement volumes of 1.62% (410 million EUR) at the basic level and 5.92% (1.48 billion EUR) in the ambitious level. Compared with the important emissions reductions that can be achieved, this translates to emission abatement costs of 34.46 EUR/tCO_2e at the basic and 80.04 EUR/tCO_2e, which are well-below or just above the current carbon price in the EU ETS of around 70 EUR/tCO_2e.

As such, it is both feasible and important to stimulate decarbonisation in the construction sector through GPP. To guide the development of an effective and ambitious GPP framework for the construction sector across the EU, in this chapter recommendations are identified based on the findings of this study.

1. **At the EU level, revise the Public Procurement Directive to require public procurers to include GPP criteria**. By mandating GPP implementation, public authorities engaged in procurement processes will be obliged to consider GPP criteria for all procurement product groups. This EU-wide, cross-sectoral measure will help eliminate the fragmentation of the GPP landscape. This goes beyond the current EU legislation on public procurement, described in Section 3.1, which only encourages environmental criteria to be considered when awarding contracts. Extending the scope of Green Public Procurement (GPP) beyond legal obligations on environmental parameters ensures a holistic approach that also addresses social and economic sustainability (e.g. lifecycle cost assessments), promoting ethical labour practices, social equity, and long-term economic benefits alongside environmental gains.

2. At the EU level, leverage the EU GPP criteria together with the revisions of ESPR and CPR as an opportunity to complement the building-level perspective taken in the EPBD with product-level criteria. Currently, EU GPP criteria focus on the building level for which the EPBD is introducing lifecycle assessment requirements and threshold values. At the product-level, the Ecodesign for Sustainable Products Regulation (ESPR)[61] and the Construction Products Regulation (CPR)[62] enables the EU Commission to develop specific sustainability criteria for the highest polluting materials (cement, concrete, steel) based on key environmental indicators (embodied carbon, circularity). This provides an opportunity to integrate specific requirements for carbon-intensive materials into the EU GPP criteria for public buildings (i.e. not only office buildings), establishing achievable, but ambitious standards for GPP.

   The carbon intensity of key construction materials can be reduced and GPP criteria can promote the use of product variations for concrete and steel that create lower environmental impacts. The two levels of ambition defined in Chapter 5 are relevant starting points for the introduction of product-level criteria in relation to a business-as-usual scenario.

3. **At the EU level, harmonise monitoring and reporting methods to gain a comprehensive overview of current practices on GPP implementation within and across Member States**. The complexity resulting from varying governance structures and GPP strategies currently weakens the comparability of GPP implementation between Member States. Thus, as highlighted in Chapter 3, monitoring of GPP implementation among Member States is currently inadequate, with low data availability as a consequence. As such, it is recommended that an EU-level monitoring system with common metrics is provided, allowing Member States to share comparable data regularly. At a minimum, the share of contracts by volume for which GPP was applied should be reported, together with a transparent information on the type of criteria applied. More informative would be a common use of lifecycle assessments and the quantification of emissions per Euro spent. To successfully implement mandatory and standardised monitoring and reporting methods, collaboration with Member States is required to ensure feasibility and compliance, by identifying current obstacles and opportunities to further streamline monitoring and reporting on GPP. GPP monitoring should extend beyond merely assessing implementation to evaluating the actual GWP reductions achieved, and the specific GPP criteria set in public construction projects. This adds depth to the understanding on GPP implementation by delivering measurable environmental benefits that can be compared between projects and Member States.

4. **At the Member State level, support GPP implementation by raising awareness and developing skills among public procurers through a national procurement agency that coordinates the implementation of GPP**. By raising awareness, building capacity and providing necessary tools, a national procurement agency can meet the needs of local procuring entities and prepare them to successfully integrate environmental considerations in their procurement processes. While nine Member States have already set up such national procurement agencies, this is far from the norm. However, to elevate GPP implementation further, mandatory requirements alone are insufficient; public procurers must also receive appropriate support.

   Therefore, every Member State is recommended to establish a national procurement agency that can coordinate, guide, and monitor GPP implementation effectively. For instance, national procurement agencies can coordinate GPP implementation by following up with EU and national strategies and guidelines, to ensure that GPP is introduced and applied to local public procurers. To follow up on these overarching strategies and ambitions, national procurement agencies can raise awareness among public administrative bodies on the value and approach to GPP implementation in public contracts, provide tools (e.g. LCA assessment software) and provide training on how to use these. This enhances the capacity of public administrative bodies responsible for implementing GPP. Finally, national procurement agencies can also oversee monitoring practices by applying the agreed-upon monitoring mechanisms for all public contracts.

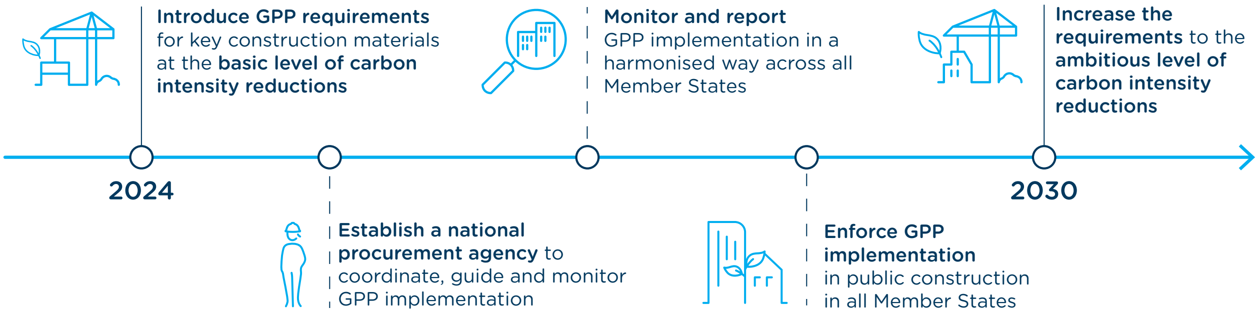
[61] European Parliament and Council of the European Union (2024) Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC. Available at: http://data.europa.eu/eli/reg/2024/1781/oj/eng (Accessed: 29 July 2024).

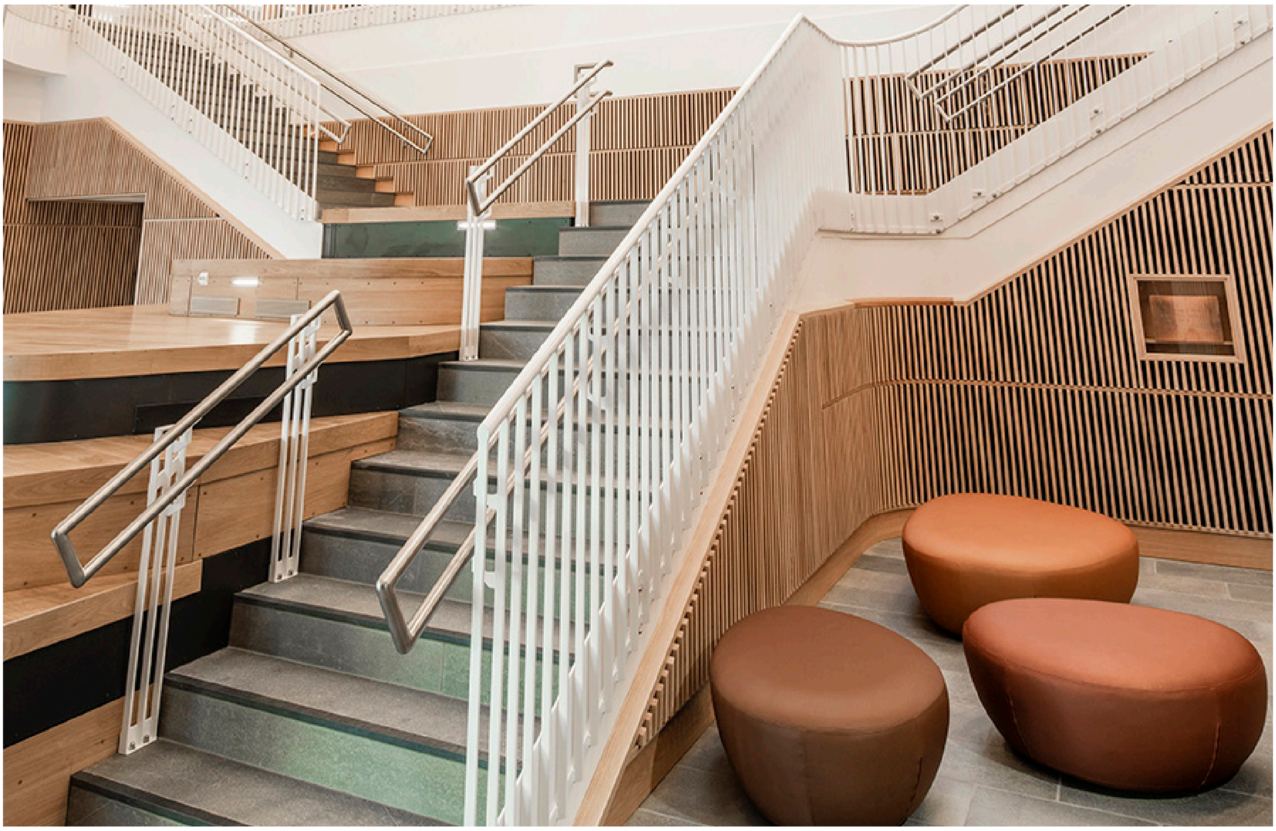
[62] European Parliament and Council of the European Union (2021) Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC (Text with EEA relevance). Available at: http://data.europa.eu/eli/reg/2011/305/2021-07-16/eng (Accessed: 29 July 2024).

Taking these recommendations into consideration, a roadmap to GPP implementation in public construction contracts is visualised in Figure 6-1. This roadmap outlines the steps identified as essential to integrate GPP practices, ensuring that environmental criteria are systematically embedded into the procurement processes for public construction projects across the EU.

While the extent to which all recommendations can be applied varies between Member States, the action points identified to further GPP implementation are essential to bring GPP implementation in public construction in the EU to a higher level. While these action points are highly relevant to reduce embodied emission, other sustainability parameters and actions should not be left out. Material efficient design and construction reduces material consumption and related emissions. Beyond that, prioritising renovation and redevelopment over new construction reduces GHG, as it conserves embodied carbon within existing structures and minimises the environmental impact of sourcing and manufacturing new materials.

Figure 6-1 Roadmap to GPP implementation in public construction





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Appendix 1.

In-depth country fiches

An in-depth analysis was conducted on six EU Member States: Belgium, Finland, Germany, Italy, the Netherlands, and Sweden. These countries were selected based on their diverse approaches to GPP implementation in construction and their representation of different governance structures, while also covering different approaches to GPP including the more ambitious frameworks across the EU. The in-depth analysis examined national, subnational, and local GPP practices, in reference to the voluntary EU GPP criteria on construction. In this Appendix, the findings of this analysis are shared in the country fiches below, in which all the studied cases are described in depth.

Belgium	
General GPP framework and implementation of GPP in construction	
National Framework and Implementation	In 2014 a strategy on sustainable public procurement for the federal departments was established on sustainable public procurement. This is done in reference to the voluntary GPP criteria on GPP by the European Commission. Through a **freely accessible national online tool** (https://guidedesachatsdurables.be/nl) on GPP implementation, innovative, social, ethical, and environmentally friendly procurement is supported with GPP criteria tailored to product groups.
Structure and Legal Format	The national strategy is translated into specific GPP criteria for various sectors, including **construction and buildings, to a limited extent**. Set GPP criteria for construction do not contain details on approaches to implementation and lack specific targets on building-level and carbon-intensive materials. GPP implementation is **not mandatory** on national, regional, and local levels.
Monitoring and tracked share of GPP	**No data is available on the share of GPP in construction**. At the national level, Belgium does report to DG ENV through the "Procurement Monitoring Report Template In view of the Member States' reporting process under the Directives 2014/23/EU, 2014/24/EU and 2014/25/EU".
GPP criteria on embodied carbon	
Building-level	**Embodied carbon is not addressed on building-level through GPP** on (sub)national level.
Material-level	**No GPP criteria** are developed **on embodied carbon** reduction of carbon-intensive materials.
GPP criteria on circularity	
Building-level	**Circularity is not addressed on building-level through GPP** on the (sub)national level. However, a construction project does score higher in the GRO tool (non-mandatory self-evaluation tool to measure sustainability of projects, https://www.gro-tool.be/) **if more than 75% of building elements and m aterials are re-used.**
Material-level	**No GPP criteria are developed on circularity of carbon-intensive materials**. However, outside of GPP, circularity of concrete/cement is encouraged. For instance, in Flanders (regional level), a policy plan is set up which aims to achieve 95% circularity of stony materials by 2030. 50% of the recovered materials should remain in the building sector.
Summary	In Belgium, **implementation of GPP in construction can be improved**. While tools and strategies are set up to support GPP implementation, missing threshold targets, voluntary GPP implementation and lack of monitoring data result in a fragmented GPP landscape for public construction projects, both on national and regional level.

Germany

General GPP framework and implementation of GPP in construction	
National Framework and Implementation	On the federal level there is a **national strategy on sustainability**, which refers to GPP. State-level public procurement is not covered by this strategy. Sustainability of projects is calculated using the **Sustainable Building Assessment System (BNB)**, through which buildings are assessed on various themes related to sustainability. Federal buildings are required to add up to a minimum number. As part of the Industrial Deep Decarbonisation Initiative (IDDI) the federal government pledged to review the levels of BNB to drive demand for low-carbon construction materials. Additionally, the involvement in IDDI supports efforts to define low-carbon cement and steel in an international context, but as the only participating EU country so far.
Structure and Legal Format	While not specifically, referring to the EU GPP criteria, the BNB assessment covers similar themes. Sustainability themes assessed through BNB include, among others, Life Cycle costs (LCC), Life Cycle Assessment (LCA), Circularity, energy efficiency, and CO2-shadow pricing. The **BNB Silver Standard** (65% of achievable points) **is mandatory for federal buildings**. The **federal** states of Berlin, NRW, and Brandenburg have also committed themselves to the BNB. Yet, the exact scores can vary between criteria, so a strict requirement on certain aspects, such as embodied carbon and circularity, cannot be deduced.
Monitoring and tracked share of GPP	Since 2020, **all public contractors have to submit data on various components** to the federal statistics office. Procurement characteristics monitored include, among other things, data on total number of contracts, geographic distribution, and **the consideration of sustainability criteria in procurement** procedures. Monitoring reports are produced at regular intervals. According to the procurement statistics, **12.7% of publicly procured buildings** (federal, state, municipal, and other) considered sustainability criteria when awarding contracts in 2021[63].
GPP criteria on embodied carbon	
Building-level	BNB requires for the CO2-shadow price to be included in the Life Cycle Costing (LCC).
Material-level	No GPP criteria are developed on embodied carbon reduction of carbon-intensive materials.
GPP criteria in construction on materials	
Building-level	**Life cycle assessment (LCA) is part of the BNB assessment. The level of reusability of building products** is assessed as part of BNB.
Material-level	**No GPP criteria are developed on circularity of carbon-intensive materials on the national level.** On the sub-national level (Berlin), has set a minimum quote for recycled concrete depending on the types of concrete (between 25% and 45% of aggregates) in line with industry standards.
Summary	In Germany, sustainable construction is covered by a **Sustainable Building Assessment System** (BNB), requiring federal buildings to achieve a minimum total score across various themes, among which, embodied carbon and circularity. However, **no specific GPP thresholds** exist on national level **to enhance the circularity or define material-specific embodied carbon requirements**. In addition, only three German Länder apply the same framework, while others have separate criteria or no requirements on construction. Therefore, a high degree of fragmentation remains when assessing the bulk of public procurement.

[63] https://www.bmwk.de/Redaktion/DE/Publikationen/Wirtschaft/bmwk-vergabestatistik-zweites-halbjahr-2021.pdf?__blob=publicationFile&v=6

Finland	
General GPP framework and implementation of GPP in construction	
National Framework and Implementation	**The Finnish national public procurement strategy** consists of 8 areas of development. This means that economic, social, and ecological sustainability must be taken into account in public procurement. it launched in 2020. Based on the strategy, criteria for low-carbon construction are set up which concern energy, materials, and innovations. In addition to these, the suitability of the providers and the costs are evaluated. The EU GPP criteria serve as a foundation for developing the national standards.
Structure and Legal Format	Construction, real estate, and maintenance are some of the product groups for which specific GPP criteria are set up. **None of the criteria for GPP are mandatory**. However, sustainable procurement is strongly encouraged for municipalities, while the strategy was issued as a decision in principle by the government, with which the Government commits to common goals.
Monitoring and tracked share of GPP	**KEINO**, the Competence centre for Sustainable and Innovative public procurement in Finland, **monitors sustainable public procurement implementation** every few years (2018, 2020, 2022). KEINO has mapped the procurement situation in Finland from three different perspectives, namely how procurement is managed in various public organizations in Finland, what the state and level of competence is in terms of procurement sustainability and innovation and how innovative and sustainable public procurement is in general. In public construction, **32% of contracts included GPP**. Of this 32%, 42% included targets surrounding reducing emissions, 56% included targets on circularity, 50% included targets on waste reduction and 48% included targets on the avoidance of harmful substances[64].
GPP criteria on embodied carbon	
Building-level	For the building design, the GPP criteria suggest including the **calculation of the carbon footprint of the building's massing options and main structure types**, as well as combining this information with the carbon footprint of energy consumption. The components of the life cycle carbon footprint are reported to the customer for the selection of the cost-optimal option. The calculation is made according to standard EN 15978 for the entire life cycle. Structures and fillings are designed in such a way that at least 10% of their weight consists of low carbon recycled or renewable materials.
Material-level	**No tangible targets or threshold values are set for carbon-intensive materials on national level**. However, in the city of Helsinki, low-carbon classification of concrete is applied to public street procurement, setting a threshold value of -15 % emissions compared to the industry average in 2022. The use of it in city's own building developments and zoning is promoted as well.
GPP criteria on circularity	
Building-level	As part of the design, **a demolition survey** of the parts of the building to be demolished can be requested, in which reusable and recyclable building parts are reported and the amount of generated waste is estimated according to the division of the waste list.
Material-level	For circularity, voluntary GPP criteria are developed to encourage circularity of concrete, brick, metal and steel, encouraging reuse and reduced waste. **No tangible targets or threshold values** are set for this.
Summary	**Finland's 2020 public procurement strategy** emphasises economic, social, and ecological sustainability, setting criteria for low-carbon construction that encompass energy, materials, and innovation, grounded in EU GPP guidelines. In public construction, **32% of contracts included GPP**, targeting emissions reduction (42%), circularity (56%), waste reduction (50%), and avoidance of harmful substances (48%). **Material-specific targets on embodied carbon are rare**, but in Helsinki a low-carbon concrete classification sets a 15% emissions reduction threshold. Circularity criteria encourage reuse and waste reduction for materials like concrete and metal, but **lack mandatory thresholds, limiting their enforceability**.

[64] https://www.hankintakeino.fi/sites/default/files/media/file/innovatiiviset_ja_kestavat_julkiset_hankinnat_2022.pdf

Italy	
General GPP framework and implementation of GPP in construction	
National Framework and Implementation	The **National Action Plan for GPP was updated in 2023**. At the regional and local levels, many regions, provinces, metropolitan cities, and municipalities have adopted a GPP action plan with guidelines, training, technical assistance, and dissemination.
Structure and Legal Format	GPP criteria are set through **environmental minimum criteria (CAM)**, which provide a framework for the implementation of the voluntary EU GPP criteria. These CAM are published in legislative decrees defining detailed criteria and verification methods for 20 sectors), among which, construction. GPP is **mandatory for all public bodies that operate under the code of public contracts** (e.g., central administration, governmental institutions, local public administrations, publicly owned companies, schools, and universities).
Monitoring and tracked share of GPP	All public contracts are monitored by the National Anti-Corruption Authority (ANAC), which is also (partly) monitoring GPP. Legambiente and Fondazione Ecosistemi coordinate civic monitoring through the Green Procurement Observatory (Osservatorio Appalti Verdi). This is done on voluntary basis through an annual questionnaire, through which regions, metropolitan cities, protected areas and public Health organisations are asked to self-evaluate their compliance. **The use of CAM in construction still has gaps in implementation**, including at the central government level, despite its mandatory status. However, as per the annual survey, there is an increase in compliance rates with CAM in public construction. In 2021, 37 % of public construction tenders (on city level) was compliant with CAM[65], while this number increased to 87 % of public construction tenders for all public administration bodies in 2023[66]. When CAM is not implemented, the Anti-corruption Authority can provide a reasoned opinion. Should the contracting authority disregard this, an appeal can be made to the administrative courts. However, there are no known cases or repercussions for failing to implement CAM.
GPP criteria on embodied carbon	
Building-level	**No requirements are set on embodied carbon reduction on building-level**. However, there is a rewarding criterion for adopting the building LCA.
Material-level	**Embodied carbon is not addressed through GPP for carbon-intensive materials.**
GPP criteria on circularity	
Building-level	At the building level, the designer must provide **at least 70% (in terms of weight) of building components which can be disassembled at the end of life** (recyclable or reusable). In addition, the designer must draw up the **plan for disassembly and selective demolition**.

[65] https://www.legambiente.it/wp-content/uploads/2021/11/Green-Public-Procurement_report2022.pdf

[66] https://www.appaltiverdi.net/i-primi-risultati-2024-del-monitoraggio-civico-dellosservatorio-appalti-verdi-2024/

Material-level	For concrete, GPP criteria are developed that address circularity. For instance, concrete made on-site, and precast concrete products, are required to consist of at least **5%** (in terms of weight) of the total concrete content of recycled, recovered, or by-product materials. Autoclaved aerated and vibro-compressed concrete products are required to have a recycled, recovered or by-product content of at least 7.5%. These requirements on recycled content are not considered to be ambitious, as, for instance, Finland and Berlin, Germany, set higher minimum requirements on recycled content (10% and 25-40% respectively). For concrete, GPP criteria are developed that address circularity. For instance, concrete made on-site, and precast concrete products, are required to consist of at least 5% (in terms of weight) of the total concrete content of **recycled, recovered, or by-product materials.** Autoclaved aerated and vibro-compressed concrete products are required to have a recycled, recovered or by-product content of at least 7.5%. These requirements on recycled content are not considered to be ambitious, as, for instance, Finland and Berlin, Germany, set higher minimum requirements on recycled content (10% and 25-40% respectively). **For steel, both structural and non-structural, a minimum recovered (recycled or by-product)** content is required. For structural steel, the minimum share is 75% for unalloyed electric furnace steel, while for non-structural steel this is 65%. For both structural and non-structural steel, 60% for alloyed electric furnace steel and 12% for steel from integral cycle content are required to be recovered.
Summary	Italy's updated National Action Plan for Green Public Procurement (GPP) mandates environmental minimum criteria (CAM) for all public bodies, but **implementation gaps remain**. The Anti-Corruption Authority monitors compliance but **lacks enforcement** actions. In terms of criteria, GPP criteria do not mandate embodied carbon reduction, focusing instead on Life Cycle Assessment (LCA) and requirements on circularity. While Italy set minimum requirements on recycled content, these are not considered to be ambitious, with higher minimum requirements set elsewhere in Europe (e.g. Berlin, Zurich).

The Netherlands

General GPP framework and implementation of GPP in construction	
National Framework and Implementation	On national level, guidelines on GPP are provided through a **sustainable procurement manifesto**. Public administration bodies can sign this manifesto, meaning they commit themselves to these criteria through their public procurement procedures. These entities are to draft an action plan, stating how they will implement sustainable public procurement in their public projects. Specific criteria on product groups are provided in the MVI criteria online tool, where there are in **total 800 different criteria, for 6 different product groups**. There are different levels of ambitions for different GPP criteria. GPP criteria are set following the voluntary EU GPP criteria.
Structure and Legal Format	For office buildings, there are 7 product groups, with demolition, new construction, and renovation as especially relevant. **GPP implementation is voluntary**, but some regional and local authorities commit themselves to the sustainable procurement manifesto.
Monitoring and tracked share of GPP	GPP implementation is **monitored by the RIVM,** the National Institute for Public Health and the Environment, which has been monitoring the effect of GPP on the environment, climate and social developments every 2 years. Implementation of GPP is **monitored for construction specifically**. In terms of overall share of GPP implementation in office buildings between 2019 and 2020, **69% of office building construction** through public procurement was rendered GPP. For civil and hydraulic engineering, public procurement fell under GPP in 90% of the cases[67]. In terms of avoided GHG emissions, 29.8 kton CO2-eq GHG emissions were avoided in Civil and Hydraulic engineering in 2019-2020. In office buildings, 19.7 kton CO2-eq GHG emissions were avoided through GPP in 2019-202069i.
GPP criteria on embodied carbon	
Building-level	In the Netherlands, the Environmental Performance of Buildings (EPB) is used to measure the environmental impact of the materials used in a building. Preparing an **EPB is mandatory** for every application for an environmental permit for newly built homes and new office buildings **larger than 100m²**. In an EPB calculation, the environmental impact of materials is calculated, expressed in shadow prices (environmental costs), and added up. The EPB result is a shadow price per m2 of floor surface area. The reference value for offices is € 0.90 per year per m2 of gross floor area (GFA).
Material-level	**Environmental cost indicators are set for several concrete elements** (concrete mortar, hollow-core slab, concrete retaining walls, stacking blocks) in new construction, civil constructions, and renovations. Threshold values are based on the Betonakkoord 2023 (Concrete agreement 2023)[68] which provides a framework for sustainable concrete procuring specifically
GPP criteria on circularity	
Building-level	Through GPP, a contractor might be requested to submit a **circular demolition plan** which focuses on reducing, re-using, recycling, and recovering materials from a building perspective.
Material-level	Circular demolition of concrete building elements is encouraged, but no specific threshold values are set through GPP except for the requirements set out in the Betonakkoord (Concrete agreement). Through this agreement specific requirements on circularity are set and included in the overall cost calculation of concrete. This also stipulates targets on circular demolition and recycling rates.

[67] https://www.rivm.nl/bibliotheek/rapporten/2023-0131.pdf

[68] https://www.betonakkoord.nl/wp-content/uploads/sites/43/2023/12/20231218-Plafondwaarden-MKI-Betonakkoord-september-2023-DEF.pdf

Summary	The Netherlands' framework for GPP is based on **a voluntary sustainable procurement manifesto** that public bodies commit to. Monitoring shows 69% of office building and 90% of civil engineering projects adhered to GPP between 2019 and 2020, but the **voluntary nature** of GPP **limits** widespread **impact**. Effectiveness of GPP criteria is hindered by the **lack of** mandatory enforcement and **specific thresholds for carbon-intensive** materials and buildings, especially with regards to **circularity**.

Sweden	
General GPP framework and implementation of GPP in construction	
National Framework and Implementation	In 2017, a **National Public Procurement Strategy** with seven goals was published. Two of the goals (**public procurement that drives innovation and promotes alternative solutions, and environmentally responsible public procurement**) can directly contribute to an environmental transition, especially in the road and construction sector.
Structure and Legal Format	GPP criteria are developed for construction and property, in line with the EU voluntary GPP criteria. This covers various aspects of construction, such as reconstruction, renovation, demolition, and more. **GPP implementation is not mandatory.**
Monitoring and tracked share of GPP	**The Swedish Procurement Agency** (SPA) follows up on the implementation of the National Public Procurement Strategy, issuing a bi-annual survey to all procuring agencies (government agencies, municipalities, regional authorities, and state-owned companies) to measure participation and understand current practices and challenges. **GPP is not monitored specifically for construction**. In 2022, 41% of public procurers identified to use of sustainable procurement to a high extent. Regional entities lead this average by 51%, while municipalities score lowest with 37%[69].
GPP criteria on embodied carbon	
Building-level	In terms of embodied carbon, the entire life cycle on building-level is addressed through a **life cycle assessment**. Through this, procurers can evaluate based on project's climate impact. The life cycle assessment follows EN 15 978 and EN 15 804. As of 2022, to obtain a building permit, developers are to submit a **climate declaration** on the GHG emissions emitted during the construction stage. While this climate declaration exists outside of the GPP framework, it does not set threshold values as of now, this is foreseen to be introduced in the future.
Material-level	To reduce embodied carbon, GPP promote the **selection of concrete in consideration of climate impact**. However, no threshold values are set on national level.
GPP criteria on circularity	
Building-level	For circularity, GPP requires **inventory management, sorting of waste, a waste management plan, and a demolition plan**. For this, contractors are required to document material and waste quantities. However, no threshold values are set on national level.
Material-level	On the national level, **circularity of concrete and steel is encouraged**, as there is the aim to increase the degree of reuse and recycling, as well as to reduce the amount of waste and contribute to an increased circularity of resources. However, no threshold values are set on national level.
Summary	GPP in Sweden, developed in line with EU voluntary guidelines, covers various construction activities but remain **non-mandatory**. The Swedish Procurement Agency (SPA) tracks implementation via bi-annual surveys across public agencies but does not specifically monitor GPP in construction. For both embodied carbon and circularity, **no threshold values are set on the national level**, reducing impact of the GPP criteria.

[69] https://www.upphandlingsmyndigheten.se/globalassets/dokument/publikationer/nationella-upphandlingsrapporten-2023.pdf

Appendix 2.

Scenarios for Allmend School Building

Table 6-1 Mapping of materials and data sources for GWP calculations

Material	GWP according to EPD	Unit	Description
Ready mix concrete (CEMI/II)	196	kgCO2e/m³	German average EPD ca. 12% replacement
Ready mix concrete (CEMIII)	149	kgCO2e/m³	One Click LCA Datapoint 70% cement replacement
Rebar (80 % recycled)	0.61	kgCO2e/kg	German average EPD
Rebar (100 % recycled)	0.42	kgCO2e/kg	One Click LCA Datapoint
Rebar (90-95% recycled)	0.37	kgCO2e/kg	Product specific EPD
Glue laminated timber (Glulam)	159.1	kgCO2e/m³	One Click LCA Datapoint
Laminated veneer lumber	264	kgCO2e/m³	Product specific EPD
Steel parts	1.51	kgCO2e/kg	One Click LCA Datapoint
Steel profiles, 40% recycled	2.3	kgCO2e/kg	One Click LCA Datapoint
Steel profiles, 80% recycled	1.36	kgCO2e/kg	One Click LCA Datapoint
Steel profiles, 100% recycled	0.56	kgCO2e/kg	Product specific EPD

Table 6-2 Scenario details based on bill of quantities

Bill of quantities				BAU scenario		
Material cateogry	Material	Qty	Unit	Material specification	GWP	Unit
Concrete	Structural concrete RC-C (proportion of concrete granules 50%), cement grade CEM III/B, dosage 290 kg/m3	2880	m3	Ready-mix concrete, German average, C30/37, density 2400 kg/m3 (InformationsZentrum Beton GmbH)	196	kgCo2/m3
	Concrete - additional for BAU scenario	648	m3	Ready-mix concrete, German average, C30/37, density 2400 kg/m3 (InformationsZentrum Beton GmbH)	196	kgCo2/m3
	Structural concrete primary gravel, cement grade CEM II/B, dosage 300 kg/m3	5	m3	Ready-mix concrete, German average, C35/45, density 2400 kg/m3 (InformationsZentrum Beton GmbH)	220	kgCo2/m3
	Lean concrete RC-M (proportion of mixed demolition 100%), cement grade CEM III/B, dosage 200 kg/m3	150	m3	Ready-mix concrete, German average, C25/30, density 2400 kg/m3 (InformationsZentrum Beton GmbH)	181	kgCo2/m3
Micropile grouting	CEM I	150000	kg	Portland cement, generic, CEM I	0.94	kgCO2/kg
Reinforcing steel	Steel B500B (ca. 120 kg/m3 concrete)	360000	kg	Reinforcement steel wire, EN15804+A2, ref. year 2022	0.61	kgCO2/kg
Reinforcing steel	Rebar - additional for BAU scenario	74000	kg	Reinforcement steel wire, EN15804+A2, ref. year 2022	0.61	kgCO2/kg
Structural steel	S235	170000	kg	Structural steel profiles, generic, 40% recycled content, I, H, U, L, and T sections, S235, S275 and S355	2.3	kgCO2/kg
Wood	Glulam spruce/fir glulam	418	m3			
	Glulam ash glulam	9	m3			
	Laminated veneer lumber BauBuche FSH	235	m3			
	OSB (oriented structural board) OSB	34	m3			
	Steel parts excl. fastener S355	8570	kg			

Zürich School - as built				Ambitious GPP scenario		
Material category	Material specification	GWP	Unit	Material specification	GWP	Unit
Concrete	Ready-mix concrete, normal strength, generic, C30/37 (4400/5400 PSI) with CEM III/B, 70% GGBS content in cement (300 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA)	149	kgCo2/m3	Theoretical – informed by Vinci Exergy concrete	134.1	kgCo2/m3
	Ready-mix concrete, normal strength, generic, C35/45 (5000/6500 PSI) with CEM II/B-V, 30% fly ash content (340 kg/m3; 21.2 lbs/ft3 total cement)	240.5	kgCo2/m3	Theoretical – informed by Vinci Exergy concrete	216.48	kgCo2/m3
	Ready-mix concrete, normal strength, generic, C25/30 (3600/4400 PSI) with CEM III/B, 75% GGBS content (280 kg/m3; 18.7 lbs/ft3 total cement) (One Click LCA)	132.2	kgCo2/m3	Theoretical – informed by Vinci Exergy concrete	118.98	kgCo2/m3
Micropile grouting	Portland cement, generic, CEM I	0.94	kgCO2/kg	Cement, CEM III 52.5, EN15804+A1, ref. year 2021	0.39	kgCO2/kg
Reinforcing steel	Reinforcement steel (rebar), generic, 100% recycled content, A615	0.42	kgCO2/kg	Reinforcement steel bars, 5-40mm, 7850 kg/m3, B500B, B500C, B500B/A (STAHL GERLAFINGEN AG - AFV BELTRAME GROUP)	0.37	kgCO2/kg
Reinforcing steel						
Structural steel	Structural steel profiles, generic, 80% recycled content, I, H, U, L, and T sections, S235, S275 and S355 (One Click LCA)	1.36	kgCO2/kg		0.56	kgCO2/kg
Wood	Glue laminated timber (Glulam), 544 kg/m3, 12% (± 3%) moisture content (One Click LCA)	159.1	kgCo2/m3	Glue laminated timber (Glulam), 544 kg/m3, 12% (± 3%) moisture content (One Click LCA)	159.1	kgCo2/m3
	Glue laminated timber (Glulam), 544 kg/m3, 12% (± 3%) moisture content (One Click LCA)	159.1	kgCo2/m3	Glue laminated timber (Glulam), 544 kg/m3, 12% (± 3%) moisture content (One Click LCA)	159.1	kgCo2/m3
	Laminated veneer lumber, 800 kg/m3 (Pollmeier Furnierwerkstoffe GmbH)	264	kgCo2/m3	Laminated veneer lumber, 800 kg/m3 (Pollmeier Furnierwerkstoffe GmbH)	264	kgCo2/m3
	Oriented strand board (OSB), 613 kg/m3, 3% moisture content (One Click LCA)	241.3	kgCo2/m3	Oriented strand board (OSB), 613 kg/m3, 3% moisture content (One Click LCA)	241.3	kgCo2/m3
	Steel sheets, generic, 80% recycled content, S235, S275 and S355 (One Click LCA)	1.51	kgCO2/kg	Steel sheets, generic, 80% recycled content, S235, S275 and S355 (One Click LCA)	1.51	kgCO2/kg

Appendix 3.

Economic impact quantification

Overview of green premium assumptions for concrete and steel

	Concrete			Steel		
	Measures	**Premium**	**Assumptions/ Sources**	**Measures**	**Premium**	**Assumptions/ Sources**
Without GPP	Current average concrete, clinker content of 75-80%	0		Current average construction steel combining rebar and structural steel	0	
Basic scenario	Clinker replacement at CEM III/B level, integrating calcine clay	2.00%	Price comparison of publicly available price lists for major EU concrete suppliers	Recycling content of 60-80%	1%	Comparison of past and projected production costs for secondary and primary steel, assumed increase in transportation costs
Ambitious scenario	Increased clinker replacement with widespread use of calcine clay and end-of-life binders, use of CCS in cement production	6.25%	85% of reductions achieved through clinker replacement, 15% through use of CCS in cement production in 2030 (Agora transformation cost calculator) EU ETS price increase and phase-out of free allocation	Recycling content of 90-100% Increasing use of steel from H2-DRI routes	5.40%	60% of reductions achieved through cost neutral increase in secondary steel, 40% from use of H2-DRI production routes for primary steel in 2030 (Agora transformation cost calculator) EU ETS price increase and phase-out of free allocation

Table 6-3 Assumptions on future prices for key determinants of the ambitious scenario

Item	Unit	2030 assumption
EU ETS allowance price	EUR per EUA	132
Hydrogen price	EUR per kg H2	5.24
CCS price (including transport and storage)	EUR per t CO2	170

Determination of public procurement volume and cost increase

Table 6-4 Cost assumptions

Material	Unit	Unit price (EUR)	Assumption/Sources
Concrete	m3	115	Estimated EU average based on price lists and practical expertise for medium to large projects, including public buildings
Steel	t	614.4	Weighted average from 90% rebar and 10% structural steel, source European Steel Prices March 2024

Table 6-5 Public procurement volumes for concrete and steel

	Concrete		Steel	
	Public procurement volume (Mm3)	Costs (EUR)	Public procurement volume (Mt)	Costs (EUR)
Without GPP	134	15,410,000,000	15.6	9,584,640,000
Basic scenario	134	15,718,200,000	15.6	9,680,486,400
Ambitious scenario	134	16,373,125,000	15.6	10,102,210,560

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