Comparative Study on the methodologies used or proposed in European countries to measure and evaluate CO_2 emission reductions in public works tenders

Final Report

July 2026

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COMPARATIVE STUDY ON THE METHODOLOGIES USED OR PROPOSED IN EUROPEAN COUNTRIES TO MEASURE AND EVALUATE CO_2E EMISSION REDUCTIONS IN PUBLIC WORKS TENDERS

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GLOSSARY

Item	Explanation
CO_2e assessment framework	**Overarching term,** comprising the systems, rules and tools used to reflect CO_2e emissions in the procurement of public works tenders. This normally relies on a methodology as well as tools and data. It can take the form of a legal requirement, certification, or remain at a commonly used calculation and assessment approach
Methodology	The **set of calculation rules and assumptions** that defines *what is measured* (system boundary, life-cycle modules, functional unit), *how it is measured* (calculation procedures, default data/EPDs, scenarios), and *how results are reported/verified*. A methodology can be codified in a **standard** or **guideline**.
Tool	A **software or spreadsheet implementation** of a methodology (or a bundle of methods) used to perform calculations and aggregate results for projects or tenders. Tools should explicitly state **which methodology/standard** they implement and any **deviations.**
Database	The **source of emission data** for construction materials and other processes to be used in CO_2e calculations. This often takes the form of national databases providing generic data, and accepted product-specific data from EPDs.
Law/Regulation	A **normative document** (e.g. national/EU law) specifying mandatory or recommended calculation rules possibly including tools and/or databases and often defining performance thresholds.
Scheme/Certification	A system that **assesses an organisation's or supplier's carbon management maturity** and can be used as a **selection/award** lever in procurement (e.g., award points for certification level). It is **not** a project-level calculation method.
Procurement integration	The **mechanism** that translates carbon information into **tender outcomes** (e.g., award formulae using CO_2e, benchmarks, shadow prices, minimum thresholds, variant bids, ECI). This should be described **separately** from the calculation methodology/tool.
Procurement criteria	The definition or a **requirement or scoring system** to determine the selected supplier. Usually as a set of criteria covering different aspects such as price, quality, CO_2e emissions, etc.
Procurement model	Different options to **organise the procurement of construction projects**, from design, implementation, detailed requirements, risk-sharing and incentives. Key models, also referred to as procurement types, include Design-Bid-Build, Design and Build, Alliance or Early Contractor Involvement.
Design-Bid-Build (DBB)	The **traditional and most commonly used** procurement model in public construction, structured **sequentially**: the public authority first contracts designers to produce the design and tender documents, then separately procures a contractor through competitive bidding (lowest price or price + technical criteria). Offers clear role separation and transparency, but **limits early contractor input** on constructability, innovation, and whole-life carbon performance.

Design & Build (D&B)	A procurement model in which a **single contractor holds single-point responsibility for both design and construction** under one contract. Fosters innovation, faster delivery, and **integrated risk management**, and enables contractor input on materials, methods, and **low-carbon solutions**. Often used for technically complex or innovative projects.
Early Contractor Involvement **(ECI)**	A procurement model that **engages the contractor early in project development**, before the design is finalised, to bring practical insights on materials, methods, and supply chain logistics into design optimisation, sustainability, and risk management. Typically structured as a **two-stage process** (collaborative design phase followed by delivery phase by the same contractor). Less common, but particularly effective for large-scale infrastructure projects.
Alliancing / Partnering	A **collaborative procurement model** where the public authority and contractor(s) form an **integrated team that jointly shares risks, rewards, and key decisions** against common objectives (cost, quality, sustainability). Requires high trust and robust governance; used mainly for complex projects.

EXECUTIVE SUMMARY

Under the binding 2030 and 2050 targets of the European Climate Law, the construction sector must deliver structural emission reductions over the coming decade. Meeting these objectives requires a transformation of the built environment, where the extraction, production and use of carbon-intensive materials such as cement, steel and aluminium account for a substantial share of total emissions. Policy ambition and stakeholder awareness have grown significantly in recent years, yet implementation in the contractual and procurement frameworks that govern public infrastructure and building works continues to lag behind stated objectives.

Public works procurement is among the most direct instruments available to close this gap. Across the EU, contracting authorities commission vast volumes of infrastructure and buildings each year, giving procurement substantial leverage over the sector's carbon trajectory. In parallel, the EU regulatory framework is evolving. The recast Energy Performance of Buildings Directive (EPBD) will require Whole Life Carbon assessments for new buildings above defined floor-area thresholds from 2028, with limit values tightening progressively to 2050, and the Commission's revision of the Public Procurement Directives, expected by mid-2026, is anticipated to address the treatment of environmental and carbon criteria across public works more broadly. For infrastructure, no equivalent EU-level carbon assessment requirement is yet in force in procurement. The EIA Directive captures climate impacts of major projects, but functions as a disclosure instrument rather than as a driver of low-carbon procurement.

Against this backdrop, this study, commissioned by FIEC, EIC and EuDA, provides a comparative analysis of CO_2e assessment methodologies used or proposed across Europe (with one international reference case) to measure and evaluate emission reductions in public works tenders, intended as a robust evidence base for advocacy towards EU institutions and Member States. The research covers ten CO_2e assessment frameworks, eight in infrastructure and two in buildings, examined through desk research, expert interviews and a stakeholder workshop held in April 2026.

The examined frameworks combine methodological, tool-based and regulatory elements in varying proportions. Maturity of the examined frameworks is uneven: a small number have been in use for over a decade, while most remain in early implementation or developmental phases, and individual components (methodology, tools, emission factor databases) often advance at different speeds within the same framework. There is gradual methodological convergence around life-cycle assessment, though differences in system boundaries persist between sectors: building frameworks more consistently include operational emissions (B-modules), while infrastructure frameworks remain anchored on upfront embodied carbon (A1–A5), the stages over which contractors have most direct influence. The principal remaining technical gap is in databases: national emission factor databases operate in parallel without a common or interoperable layer, undermining comparability across bids even where calculation methodologies are aligned.

The carbon outcomes of public procurement depend less on the existence of individual technical levers than on how those levers are combined with the procurement model and supported by client-side capacity. Design-Bid-Build (DBB) remains the dominant model for public works, particularly for smaller projects, but it inherently constrains the contractor to construction-phase and material decisions, because design parameters are fixed before tender. Design & Build (D&B), Early Contractor Involvement (ECI) and Alliancing progressively widen the share of design-stage abatement that contractors can access, with ECI and Alliancing offering the strongest mainstream levers for unlocking design-phase reductions. Across the examined frameworks, award scoring of carbon performance remains the exception rather than the rule: several mandate carbon calculation and set reduction targets or limit values, but only a minority translate calculated emissions into a weighted award criterion or a shadow price that can genuinely

move the ranking of bids, and where applied, award scoring is mostly concentrated in the design-tender phase rather than in construction.

Drawing on these findings, the following key messages are distilled for contracting authorities, EU institutions and Member States:

- **Design tender frameworks for the average contracting authority and the relevant sub-sector, rather than against best-in-class examples.** Scope, granularity and benchmarks should reflect the materially different emission profiles of, for example, materials-dominated works and equipment-intensive works such as dredging or foundations. The CO_2e weighting in the award decision should likewise be set within a defined range and calibrated to project scale, sub-sector and material intensity.
- **Match the assessment scope and award mechanism to the procurement model.** Contractors should be evaluated only on parameters they can actually influence. Under DBB this typically means a tight A1–A5 scope anchored by a client-built baseline of the prescribed design. Under D&B, requirements should be stated in functional and performance terms across an extended life-cycle scope, with fixed reference assumptions for service life and use-phase parameters, and carbon translated into the award decision through a weighted MEAT criterion or shadow pricing. Under ECI, the pre-construction phase should be used deliberately to embed carbon in joint design optimisation. Under Alliancing, carbon outcomes should be integrated into the shared gain/pain-share structure alongside cost and time.
- **Treat product-level and project-level carbon criteria as complementary.** While product-level requirements anchor performance on the highest-impact materials, project-level targets can unlock contractor-led optimisation across design, methods and materials. Contracting authorities are therefore recommended to approach both as complementary components, leaning on product-level criteria to anchor performance on the highest-impact materials, and shifting weight towards project-level criteria (in models where contractors have the room to optimise across design, methods and materials).
- **Close the remaining gaps in the layered methodology-data-tools architecture, with particular attention to the data layer.** A common LCA methodology and shared principles at EU level are largely in place through the European standards and, from 2028, the recast EPBD's Whole Life Carbon requirement for buildings. The principal remaining gap sits in the parallel national emission-factor databases, where an openly accessible interoperability layer is needed to deliver comparability across borders.
- **Co-develop frameworks with the sector, and ensure they are free, openly accessible, available in local languages, and formally recognised by contracting authorities.** Sector co-development underpins practical applicability and SME access. Free and recognised access underpins the level playing field and the cross-border bidding on which the single market depends.
- **Invest in capacity-building across the value chain, and phase the introduction of requirements realistically.** Client-side capacity is a frequently identified bottleneck and warrants coordinated training across procurement officers, designers and contractors. In parallel, frameworks should follow a phased trajectory from prescriptive product-level requirements towards performance-based and, where appropriate, regulatory criteria, so that ambition is not introduced faster than the sector can absorb.
- **Make tendered carbon commitments contractually binding.** Calculation requirements at the design stage and monitoring obligations during construction should be embedded in the contract itself. These should be paired with verification at completion and bonus/malus consequences proportionate to project scale, so that the carbon performance that determined the award is held to during delivery.

Looking ahead, the Commission's forthcoming revision of the Public Procurement Directives, expected by mid-2026, is the principal European-level instrument through which CO_2e assessment can be embedded in public works tenders at scale. Building on this opportunity, four policy priorities are identified for EU institutions and Member States:

- **Retain the Directive's neutrality on procurement model, but restructure the GPP toolkit around procurement-model-specific guidance for the construction sector,** rather than by asset type alone, so that scope, product- versus project-level criteria and award mechanisms are calibrated to the level of contractor influence under DBB, D&B, ECI and Alliancing.
- **Introduce a proportionate and phased pathway towards best practice of CO_2e assessment in the revised legislative framework for public works** Member States should be able to begin with prescriptive product-level requirements (such as minimum clinker substitution for cement and concrete) and move to project-level performance criteria as data infrastructure and capacity among contracting authorities and contractors mature.
- **Address the data-layer gap as a single-market issue.** Divergent results from parallel national databases for substantively the same products and processes weaken comparability across borders and complicate cross-border bidding even where calculation methodologies are aligned. The Commission should support, through existing instruments such as LIFE and the Technical Support Instrument, the development of an openly accessible interoperability layer between national databases with shared conventions for upstream emission factors, transport, electricity mix and end-of-life modelling.
- **Underpin frameworks with accessibility, formal recognition and coordinated capacity-building**, by maintaining EU-level reference resources such as the GPP helpdesk and multilingual toolkit, establishing mutual recognition of national tools that are aligned with commonly set methodological criteria, avoiding lock-in to any single proprietary platform, and supporting training and the development of standardised model tender documents across the Member States.

As the study has shown, the technical and procurement instruments needed to embed carbon performance into public works tenders already exist and are applied in several countries. What remains is to bring them together within a coherent, accessible and proportionate EU framework, one that turns the next regulatory cycle into a genuine driver of low-carbon construction rather than an additional layer of administrative burden.

1. INTRODUCTION

The European Climate Law enshrines the EU's commitment to climate neutrality by 2050, with a binding interim target of reducing net greenhouse gas (GHG) emissions by at least 55% below 1990 levels by 2030. Meeting these objectives demands a transformation across all sectors of the economy including in the built environment, where the extraction, production and use of carbon-intensive materials such as cement, steel and aluminium account for a substantial share of total emissions.

Policy ambition in this area has grown considerably in recent years, and awareness of the need to measure and reduce CO_2 equivalent (CO_2e) emissions across construction value chains is now widely shared. However, awareness has not translated into action to the same extent. Implementation in the specific processes and contractual frameworks that govern procurement of infrastructure and buildings construction continues to lag behind the stated objectives.

Public works procurement represents both a gap and an opportunity in this regard. Contracting authorities across the EU collectively commission vast volumes of infrastructure and building construction, giving public procurement substantial leverage over the sector's carbon trajectory. Some Member States and their infrastructure agencies have begun to require CO_2e calculations as part of tender and contract processes, but these initiatives vary considerably in scope, methodology and ambition and remain absent in large parts of the EU.

This report maps the landscape of existing and emerging frameworks for integrating CO_2e assessments into public works procurement. Drawing on a structured review of selected case studies from across the EU and beyond, it identifies the range of approaches in use, examines their differences and common features, and highlights examples of emerging good practice.

The findings and recommendations are intended to support the development of practical, robust and legally sound GHG assessment rules for public works tenders, and to contribute to the progressive harmonisation of these approaches across the EU.

1.1 Reducing CO_2e emissions in public construction works

Building public infrastructure and buildings is not only linked to a large volume of GHG emissions, but also a complex process. The early stages of needs assessment, feasibility studies, and conceptual design establish the fundamental parameters of a project: its function, scale, location, and broad technical approach. These decisions, taken by clients and their advisers, carry significant downstream consequences, as the choices made at this stage largely determine the types of materials and technologies that will be required throughout the rest of the process.

In the next step, the project moves into detailed design and planning, where architects, engineers and technical consultants translate the conceptual brief into precise specifications. At this stage, material choices, structural systems and construction methods are defined. These decisions determine not only cost and timeline, but also the carbon intensity of what will ultimately be built and the lifetime for which it is built. The procurement of works, whether through a single main contractor or a series of specialist packages, usually follows from these specifications and sets the contractual framework within which the physical work will be carried out.

The construction phase itself draws together a complex network of contractors, subcontractors and material suppliers. Raw materials are extracted and processed into manufactured products which are transported to site and assembled by the workforce. Throughout this phase, emissions arise from multiple sources simultaneously: the embodied carbon of materials manufacturing processes, fuel used in transport and logistics, and the operation of construction

machinery on site. The project reaches completion when the finished asset is handed over to the client, ready for use or operation.

Within this value chain, procurement models shape how emission-relevant decisions are distributed across actors and the timing at which contractors are involved. Traditional design-bid-build separates design from construction, limiting contractor influence over material choices and incentivising lowest upfront cost. More integrated models enable greater whole-life optimisation by involving contractors in design and aligning incentives across the value chain.

However, before emission-related decision-making is possible, a comprehensive understanding of the project's environmental impacts must first be established. When it comes to systematically assessing emissions in public construction projects, **Life Cycle Assessment (LCA)** is commonly applied as a framework to quantify environmental impacts across the entire project life cycle. The following box provides a detailed overview of LCA and its application in the construction sector:

Box 1. Life Cycle Assessment (LCA) in Public Construction Works

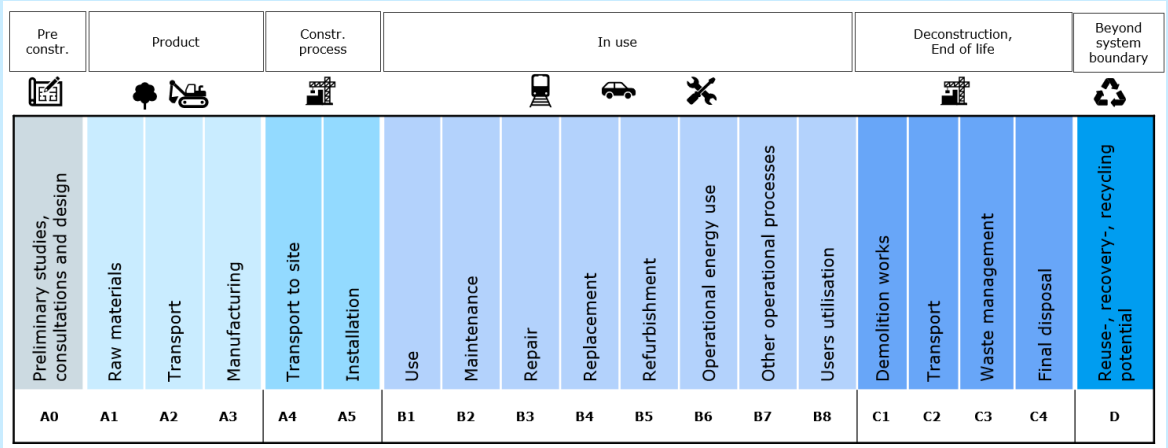
Life Cycle Assessment (LCA) is a systematic, standardised methodology used to evaluate the environmental impacts of a product, process, or service throughout its entire life-cycle, encompassing stages from raw material extraction to end-of-life disposal. In the context of public construction works, LCA offers a quantitative and scientifically grounded approach to identifying key sources of emissions and optimising resource efficiency, allowing for informed decisions regarding low-carbon procurement.

The methodological framework of LCA is internationally defined by ISO 14040, which establishes the general principles and structure of life-cycle studies, while greenhouse-gas accounting and verification can be supported by ISO 14064. In the European construction sector, more specific guidance is provided by EN 15804 for environmental product declarations of construction materials, EN 15978 for building-level environmental performance assessment, and EN 17472 for the sustainability assessment of civil engineering works. Together, these standards ensure that LCA studies in the construction sector are conducted using harmonised methodologies, consistent system boundaries, and comparable environmental indicators, enabling robust sustainability assessments of buildings and civil engineering projects.

For construction works, LCA typically covers the following life-cycle stages, as also shown in the Figure below:

- **Product stage (A1-A3):** extraction of raw materials and production of construction products (e.g., cement, steel, asphalt).
- **Construction stage (A4-A5):** transport of materials and on-site construction activities.
- **Use stage (B1-B8):** operation, maintenance, repair, refurbishment, and replacement.
- **End-of-life stage (C1-C4):** demolition, waste treatment, recycling, and disposal.
- **Benefits beyond the system boundary (D):** potential reuse or recycling benefits.

Figure 1-1. Life-cycle Stages[1]



1.2 The EU's policy framework for low-carbon public works

The 2014 EU Green Public Procurement (GPP) framework introduced voluntary criteria enabling public authorities to procure goods, services and works with a reduced environmental impact. It emphasised life-cycle costing and set minimum environmental performance thresholds, representing meaningful early progress in embedding sustainability considerations into public spending decisions. This was connected with a revision of the EU Public Procurement Directive (PPD), which allows quality criteria, including environmental performance, to influence the most economically advantageous tender.

However, its voluntary nature has resulted in uneven adoption[2]. In the construction sector specifically, the GPP criteria for buildings lack quantified targets for embodied carbon in materials[3], while for infrastructure projects ambiguity in criteria definitions and complexity in integrating GPP with sector-specific procurement models have left low-carbon incentives largely underutilised[4]. Uptake varies substantially across Member States, and fragmented implementation has limited the framework's overall effectiveness. The EU PPD also restricts the reference to specific products or brands, which prevents mentions of Environmental Product Declarations (EPDs) in the technical specifications of bidding processes.

Recognising these shortcomings, the European Commission has initiated a revision of the Public Procurement Directives, with a legislative proposal expected by mid-2026. The revision aims to mainstream non-price criteria, including sustainability, resilience and European preference, in procurement decisions, clarify the interplay between procurement rules and other areas of EU legislation, and extend sustainability requirements beyond the public sector to

[1] Le Den, X., Marton, C., Witteveen, E., Dettenborn, T. Towards Low-Carbon Transport Infrastructure in the Nordics – Comparative Study on Embodied Carbon Management for Road and Rail Infrastructure across the Nordic Countries, 2025, https://doi.org/10.5281/zenodo.14745475

[2] For more details, also see: SWD(2025)332

[3] Steinmann J., Le Den X., Witteveen E., Kovacs A., Pirttikoski K., (2024). Green public procurement in construction - Driving public purchase towards truly green construction products and materials. https://doi.org/10.5281/zenodo.14000359

[4] Le Den, X., Marton, C., Witteveen, E., Dettenborn, T. Towards Low-Carbon Transport Infrastructure in the Nordics – Comparative Study on Embodied Carbon Management for Road and Rail Infrastructure across the Nordic Countries, 2025, https://doi.org/10.5281/zenodo.14745475

incentivise private procurement. Life-cycle-based CO_2 performance standards are among the instruments under consideration as part of this shift.

Complementing the procurement reform, the proposed EU Industrial Accelerator Act (IAA)[5] targets the decarbonisation of energy-intensive industries that supply the construction sector. The Act is expected to establish criteria for clean, resilient and circular products, streamline permitting for decarbonisation investments, and introduce low-carbon product requirements for strategic materials including steel, cement and aluminium, the three material categories that dominate the embodied carbon of most construction projects.

As part of the bigger picture, it is worth noting that many infrastructure projects are subject to an Environmental Impact Assessment (EIA). The EU's EIA Directive requires that projects likely to have significant effects on the environment undergo a systematic assessment before development consent is granted. For major public infrastructure projects, this includes an obligation to identify, describe and assess direct and indirect impacts on climate, including greenhouse gas emissions. In principle, the EIA process therefore provides an early-stage mechanism for making the carbon consequences of large infrastructure projects visible to decision-makers and the public.

In practice, however, the treatment of GHG emissions within EIA procedures has remained inconsistent. The Directive does not prescribe a standardised methodology for quantifying emissions, and the depth of climate-related analysis varies considerably between Member States and between project types. Carbon assessments, where conducted, are often qualitative or partial, and the EIA process does not in itself generate requirements that feed into procurement or contractual obligations for contractors. As a result, the EIA currently functions more as a project-level disclosure instrument than as a driver of low-carbon procurement or design optimisation.

Building construction is subject to adopted rules which are being implemented in the Member States – not limited to public procurement. The recast Energy Performance of Buildings Directive (EPBD), adopted in 2024, introduces for the first time an EU-level requirement for Whole Life Cycle (WLC) carbon assessments for new buildings. From 2028, Member States will be required to ensure that new buildings above a defined floor area threshold are subject to a WLC assessment, quantifying greenhouse gas emissions across all life-cycle stages from material production through construction, operation and end of life. Member States will further be required to establish and progressively tighten limit values for WLC carbon performance, with a trajectory aimed at achieving climate-neutral buildings across the EU by 2050.

For public procurement, the EPBD's WLC requirement is directly relevant. Public building projects that fall within the scope of the Directive will need to demonstrate compliance with WLC carbon limits, creating a regulatory basis for embedding carbon assessment into the design and procurement process. The Directive aligns methodologically with existing European standards for building LCA, particularly DIN EN 15978, providing a framework that is in principle compatible with the shadow price and CO_2e assessment approaches discussed in this report. Together, the EPBD and the procurement directive revision represent a convergence of regulatory instruments that is likely to accelerate the integration of carbon performance into how public buildings are both designed and procured.

[5] For more details, please see: COM/2026/100 final

2. APPROACH AND SCOPE

2.1 Study approach

The objective of the study is to produce a comparative study of methodologies used or proposed across Europe to measure and evaluate CO_2e emission reductions in public works tenders, providing FIEC, EIC, and EuDA with a robust evidence base for advocacy towards EU institutions and Member States.

More specifically, the study will result in a mapping of existing CO_2e quantification methods from a public procurement perspective by:

- Analysing their similarities, differences, and legal implications for construction-sector bidders;
- Identifying best practices and proposing recommendations for a harmonised, effective EU-level framework for integrating CO_2e reduction capacity into public procurement award criteria.

Phase 1: Selection of relevant frameworks

The Inception phase of this study involved a systematic screening of various CO_2 frameworks. The evaluation was structured around a set of predefined criteria, designed to assess the suitability and effectiveness of the frameworks under consideration. For more details on this screening process, please see the Inception Note.

Phase 2: Information collection and analysis

During phase 2, data on selected CO_2e assessment frameworks was collected through desk research and expert interviews. This data collection allowed the study team to analyse the technical features, policy context, and implementation in public procurement.

Phase 3: Identification of best practices and recommendations

The third phase was designed to extract best practices from the analysis of methodologies and develop targeted recommendations for harmonised and effective CO_2e assessment in EU public works procurement.

As part of this phase, an initial set of best practices and recommendations was developed based on the findings of phases 1 and 2, and subsequently refined through the dedicated workshop held on **April 14th, 2026.** The workshop brought together industry stakeholders to validate and refine the preliminary findings and further develop the recommendations. The insights and discussions gathered during the session have been incorporated into the final best practices and recommendations presented in this study.

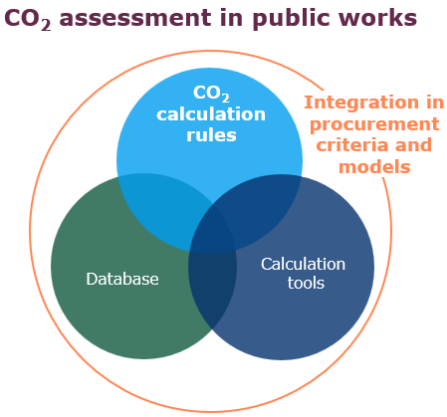
2.2 Study scope

The research scope for this project and final report focuses on the consideration of CO_2e assessment frameworks in public works tenders. These frameworks can be driven by calculation rules (also referred to as methodologies, calculation tools, legal requirements, or certification schemes). Together with a database of emission data, these elements enable (and sometimes mandate) the calculation of CO_2e emissions.

The research will further examine how the outcomes of these calculations are incorporated into procurement criteria, specifically focusing on the selection and evaluation of construction contractors.

The Figure below illustrates these elements of the scope.

Figure 2-1. Illustration of the elements of scope for this research



The scope covers methodologies applied in both the infrastructure and building sectors, including national LCA-based tools (e.g., InfraLCA, Klimatkalkyl, DuboCalc, RE2020), federation-proposed methods (e.g., SEVE-TP), and the benchmarking approach by Infrastructure NSW in New South Wales, Australia. In total, ten frameworks were selected for further study. Of these, eight cover infrastructure projects, while two cover buildings. The full list of frameworks can be found in the table below.

Table 2-1. Selected CO_2e frameworks for further study

Framework	Organisation	Country
Infrastructure (8 frameworks)		
FTIA: Low Carbon Assessment Method for Infrastructure	FTIA	FI
Trafikverket: Klimatkalkyl	Trafikverket	SE
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc	Rijkswaterstaat	NL
Infrastructure NSW: Decarbonising infrastructure delivery	Infrastructure NSW	AU
Vejdirektoratet: InfraLCA	Vejdirektoratet	DK
TII: Carbon Tool	TII	IE
Puertos del Estado: Carbon footprint in ports	Puertos del Estado	ES
FNTP: SEVE-TP	FNTP	FR
Buildings (2 frameworks)		
Bygningsreglementet BR18	Social- and Boligstyrelsen	DK
RE2020	Ministères transition écologique aménagement du territoire transports ville et logement	FR

2.3 Report outline

The outline of the report is as follows: *Chapter 3: Approaches to CO_2e calculations across frameworks* begins by classifying these frameworks according to their maturity, system boundaries, and alignment with methodological standards, before assessing the tools and datasets that support their implementation, including embedded databases and real-time monitoring requirements.

In *Chapter 4: Integration with public procurement*, the discussion then turns to the integration of these frameworks with procurement processes, examining the procurement models, award criteria, and mechanisms such as shadow carbon pricing that incentivise low-carbon construction.

Finally, *Chapter 5: Best practices and recommendations* identifies best practices and challenges that inform future policy and practice.

3. APPROACHES TO CO_2E CALCULATIONS ACROSS FRAMEWORKS

This chapter focuses on the underlying methodologies, tools and data sources used to quantify CO_2e emissions in the frameworks. This represents an important foundation for the definition of procurement criteria and selection of low-carbon offers.

The chapter first assesses the overall characteristics and maturity of the frameworks, before presenting the tools and implementation support to use the methodologies, and the monitoring and verification processes.

3.1 Characteristics and maturity of frameworks

Table 3-1 provides an overview of the type of framework, system boundaries and level of maturity across the studied cases.

Table 3-1. Overview of framework characteristics across the case studies

	Type of framework	System boundaries	Level of maturity
Infrastructure			
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	Methodological framework	A1–A5, B4	Widely implemented (mandatory)
Trafikverket: Klimatkalkyl (SE)	Tool with methodological framework	A1–A5, B2–B5	Widely implemented (mandatory)
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	Tool with methodological framework	A1–A5, B1–B7, C1–C4, D	Widely implemented (mandatory)
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	Methodological framework (with supporting tools)	A1–A5, B1–B5 (optional), C1–C4 (optional)	Early implementation
Vejdirektoratet: InfraLCA (DK)	Tool with methodological framework	A1–A5, B4, B6, C1–C4, D	Early implementation / under development
TII: Carbon Tool (IE)	Tool with methodological framework	A1–A5, B1-B7, C1–C4, D	Established (since 2018)
Puertos del Estado: Carbon footprint in ports (ES)	Methodological framework	GHG protocol scopes 1-3	Early implementation
FNTP: SEVE-TP (FR)	Tool with methodological framework	A1-A5, B1-B7 (optional), C1-C4 (optional)	Widely implemented (Early implementation in some cases)
Buildings			

Bygningsreglementet BR18 (DK)	Regulatory	A1–A5, B4, B6, C3–C4, D (optional)	In force (since 2023)
RE2020 (FR)	Regulatory	A1–A5, B1–B7, C1–C4, D (optional)	In force (since 2022)

Type of framework

The CO_2e calculation frameworks examined as part of the study fall into three primary categories, each serving distinct but often complementary roles in public construction works:

- **Methodological frameworks** establish the foundational rules for carbon accounting, delineating system boundaries, calculation methods, and reporting standards. These frameworks pertain to the overall strategy set up for carbon reduction across projects (of an organisation).
- **Tool-based frameworks,** such as software or spreadsheets, operationalise these methodologies by offering platforms for data entry, analysis, and reporting. Often complemented by embedded databases of emission factors, these tools facilitate practical implementation, enabling phased data collection and iterative refinement of carbon assessments.
- **Regulatory frameworks,** by contrast, impose legally mandated requirements, including minimum thresholds to ensure alignment with national decarbonisation targets. Their strength lies in enforcing compliance and ensuring that public projects adhere to broader climate goals.

The boundaries between these categories are not always clear-cut. In practice, many frameworks include different elements, like a defined methodological approach and a calculation tool pre-set to the defined calculation rules or serving regulatory purposes by defining a methodology and mandating data sources. For instance, InfraLCA in Denmark shows this interplay, where the LCA approach and standardised reporting are implemented through both a methodology and a tool.

Among the frameworks studied, those relevant to infrastructure typically prioritise voluntary, tool-centred approaches that are widely adopted across public bodies, even in the absence of legal mandates. Their pragmatic focus enables organisations to commit to carbon reduction targets independently.

In contrast, buildings frameworks are typically more standardised and regulation-driven, reflecting the European Union's emphasis on building energy performance and decarbonisation. Buildings projects, often tied to stricter procurement and compliance frameworks, differ from infrastructure projects, which tend to be more complex and longer in duration.

Maturity

The maturity of most CO_2e calculation frameworks remains limited, despite the growing adoption of carbon assessments in public construction projects. While some frameworks such as the Netherlands' DuboCalc and Sweden's Klimatkalkyl have been established for over a decade, the majority are still in the developmental or early implementation phases. This uneven progression is further complicated by the fact that individual components of a framework, such as methodological guides, tools, and emission factor databases, often advance at different rates. This can result in mismatches between expected and actual uptake of carbon assessment at project level.

Carbon assessment in infrastructure projects has often progressed through more collaborative, project-based approaches, rather than through regulations imposed by governments. In the buildings sector, more established legislative frameworks, primarily focused on building codes and energy efficiency, provide a structured foundation onto which whole-life carbon and material emission assessments can be integrated. However, this does not represent a universal baseline: in many countries, comprehensive carbon frameworks for buildings are still lacking and are only expected to become more widespread with the implementation of the Energy Performance of Buildings Directive over the coming years.

Level of granularity

The level of granularity in CO_2e calculation frameworks varies across the examined countries, reflecting differences in methodological rigour, data requirements, and integration into procurement processes.

Several frameworks, such as Infrastructure NSW's framework and the BR18 Climate Requirement in Denmark, demonstrate high granularity by integrating detailed methodologies, standardised tools, and mandatory reporting at each project stage. These frameworks utilise LCA modules, product-specific EPDs, and sector-specific calculators, ensuring precision in carbon footprint calculations.

Conversely, some frameworks, particularly those focused on infrastructure or port operations, rely more heavily on generic emission factors and coarse system boundaries, resulting in lower granularity. These gaps in coverage result in lower granularity of carbon assessments for specific infrastructure components due to lack of detailed, project-specific data integration.

System boundaries

The system boundaries of the examined frameworks reveal a gradual convergence towards LCA-based carbon assessment, though substantial differences persist between buildings and infrastructure sectors. Buildings frameworks, such as France's RE2020, more consistently incorporate operational emissions (modules B1–B7) in their carbon assessments. Infrastructure frameworks are also extending to accounting for operational emissions, but many continue to place emphasis on embodied carbon (modules A1–A5) to ensure consistency in measuring upstream emissions across raw materials, transport, manufacturing, and construction stages.

From a contractor's perspective, the emphasis on embodied carbon (modules A1–A5) especially holds relevance, as it directly influences procurement requirements, material selection, and construction practices. In contrast, the assessment of B and C modules (in-use and end-of-life emissions) is an important factor for design and life-cycle costing considerations, but usually areas where contractors have little influence on reductions through their actions.

Variations in system boundaries are evident across frameworks. Some, including Sweden's Klimatkalkyl and Ireland's TII Carbon Tool, incorporate operational emissions, while others restrict their scope to embodied carbon. Of the frameworks, only Puertos del Estado's Carbon footprint framework in Spain diverges by utilising the GHG Protocol scopes 1–3 instead of LCA, prioritising direct operational emissions over a comprehensive life-cycle analysis.

Across these frameworks, biogenic carbon and land-use change (LULUC) are currently usually omitted. An exception is found in Sweden, where deforestation and peatland drainage are included from 2026. A possible explanation for the exclusion of LULUC and biogenic carbon from

carbon assessments is that this is included in the environmental impact assessment from a project-level perspective during the early conceptualisation stages.

Functional unit

The functional unit serves as the foundational reference for CO_2e calculations across all frameworks, ensuring consistency and comparability in carbon assessments between projects, tenders, and design alternatives. It explicitly defines the scope of what is being measured: for instance, whether the assessment is conducted per infrastructure asset, per square metre of building, or per kilometre of road, and specifies the assessment period, typically ranging from 30 to 60 years (for infrastructure). The approach to defining the functional unit varies between infrastructure and buildings sectors.

In infrastructure frameworks, functional units are tailored to the project scope, allowing for custom functional units tailored to the specific scale and characteristics of the project. A practical illustration of this distinction can be seen in the TII Carbon Tool (Ireland), which employs project-specific functional units such as "one infrastructure asset" (defined in project-scope) or "one kilometre of motorway." This approach allows for tailored assessments that align with the unique requirements of each infrastructure project.

In contrast, building frameworks tend to adopt more standardised functional units prescribed by regulation. An example is the RE2020 framework in France, which standardises the functional unit as m^2, facilitating comparisons across building projects, designs, and ensuring alignment with regulatory requirements.

3.2 Support tools and implementation environment

The table below provides an overview of the tooling and implementation environment for each of the frameworks, by providing insights on project types affected, tool integration, and data sources used.

Table 3-2. Overview of tools and implementation environment across the frameworks

	Project types affected	Integrated with tool	Data sources
Infrastructure			
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	All FTIA and ELY Centre planning projects requiring project appraisal (roads, railways, streets, parks; generally above ~€2 million threshold).	No specific tool mandated but FTIA and ELY Centre projects utilise the Ihku calculation service (infrastructure cost calculation).	Emission data can be sourced from national databases for typical construction products in Finland, or from EPDs or equivalent climate reports for known products.
Trafikverket: Klimatkalkyl (SE)	National transport infrastructure projects (roads, railways, major civil works) as well as other transport projects over 50 million SEK (approx. €4.6 M).	Klimatkalkyl (tool) is integrated with the design and procurement process, with data structured by project phase: early stages use high-level quantities, while procurement and construction phases require detailed inputs.	Built-in database maintained by Trafikverket; primary data can replace default values; supplier-specific EPDs required for key materials.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	All infrastructure and civil engineering works of Rijkswaterstaat.	Yes, DuboCalc (tool) is integrated within the Sustainable Civil Engineering Approach (Aanpak Duurzaam GWW).	Contains an embedded database of emission factors. Contractors may supply primary LCA data but only if reviewed by a certified LCA expert.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	All state-led infrastructure projects exceeding specified financial thresholds (A$50 million or more for buildings projects, and A$100 million or more for linear infrastructure).	Yes, framework introduces Sector-specific tools and calculators, including the NABERS Embodied Carbon Calculator and Transport for NSW Carbon Tool.	Allows primary and provides secondary data, prioritising actual project-specific information as it becomes available. Contractors to provide as-built data at project completion.
Vejdirektoratet: InfraLCA (DK)	Used by Vejdirektoratet and Banedanmark for major road and rail infrastructure projects.	InfraLCA (tool) is used through all project phases. In early planning (phases 0–2), a basic CO_2 estimate is prepared using standardised reporting.	It includes predefined material/process datasets and supports importing EPD-based primary data.

	Project types affected	Integrated with tool	Data sources
TII: Carbon Tool (IE)	Used for national road, greenway, and light-rail projects.	It integrates with TII's design process in that each TII project "phase" has a corresponding section of the tool (Concept, Design, Statutory, Procurement, Construction, Closeout).	Primary supplier data is used where available during the project. Embedded carbon factor library available, based on UK government data.
Puertos del Estado: Carbon footprint in ports (ES)	Port infrastructure projects (dredging, quay walls, superstructure).	Does not come with a central database or tool.	Does not come with a central database or tool. Users can use publicly available databases for emission factors.
FNTP: SEVE-TP (FR)	Universal tool designed to quantify and compare the environmental impacts of infrastructure projects, including roads, greenways, and other public works, from material extraction to construction and maintenance.	SEVE-TP is primarily a tool to calculate and compare project-specific data to generate environmental reports. This is connected to a methodology of a partial LCA.	Provides a collective database (third-party verified by IDRRIM) common to all users, providing average environmental costs. Individual users can add own data provided they attach supporting documents such as EPD or FDES (Fiche de Déclaration Environnementale et Sanitaire).
Buildings			
Bygningsreglementet BR18 (DK)	Applies to all new buildings and major renovations in Denmark.	No tool. As long as the calculation method follows the referred standard and guidelines, any tool can be used	The database is based on generic data and a national initiative to create representative EPDs of the Danish industry. Specific product EPDs which are not included in the database can also be used
RE2020 (FR)	Applies to new residential and non-residential buildings.	No standardised calculation tool in place. Calculations are usually done by a specialist thermal and environmental engineering consultant.	The INIES database is used for calculations, which includes both primary and secondary data. Only data from this database and validated configurators, based on EN 15804, are accepted.

Project types affected

For both infrastructure and building frameworks, primary focus lies on new construction projects, rather than maintenance and refurbishment. Across the infrastructure frameworks reviewed, transport infrastructure construction remains the focal point, with varying thresholds and scopes. The Finnish FTIA, Irish TII Carbon Tool, and Dutch Rijkswaterstaat DuboCalc explicitly apply to national transport and civil engineering works, including roads, railways, and parks. For buildings, the Danish Bygningsreglementet BR18 and French RE2020 frameworks apply broadly, covering all new buildings in Denmark, and new residential/non-residential buildings in France, including offices and educational buildings. From 1 May 2026, RE2020 extends to new categories of buildings, including universities, hospitals, and airport terminals.

Some of the infrastructure bodies set monetary thresholds on which projects are to be included as well, with FTIA and Trafikverket imposing financial thresholds (€2 million and €4.6 million). Similarly, the Australian Infrastructure NSW and Danish Vejdirektoratet frameworks target state-led or major infrastructure projects, with Infrastructure NSW including buildings over A$50 million and linear infrastructure over A$100 million. The Spanish Puertos del Estado framework is more specialised, covering national road and greenway projects, and port infrastructure (e.g., dredging, quay walls).

Tool integration

Most infrastructure frameworks include a dedicated tool to standardise carbon calculations, such as Ireland's TII Carbon Tool and Denmark's InfraLCA. These tools, often Excel- or web-based, feature embedded databases of emission factors and are designed to streamline assessments. Finland's FTIA represents a hybrid approach, using the Ihku service for cost and emission estimation but permitting alternative compliant tools if they meet the required standards (e.g., EN 15643, EN 15804, EN 17472). Puertos del Estado lacks a centralised tool entirely.

However, the extent to which these tools are integrated into a wider methodology varies substantially. Trafikverket's Klimatkalkyl, Rijkswaterstaat's DuboCalc, Infrastructure NSW's sector-specific calculators, Vejdirektoratet's InfraLCA, and TII's Carbon Tool are all integrated into their respective methodologies, with data inputs structured by project phase. For example, Klimatkalkyl is used from early planning through construction, while DuboCalc is embedded in the Sustainable Civil Engineering Approach (Aanpak Duurzaam GWW).

Integrating tools into broader methodologies provides structure and granularity, but it can also create dependence on the methodology and limit flexibility for contractors. By contrast, independent or less tightly integrated calculators offer greater freedom for contractors to explore innovative design or material options, but may reduce the granularity, consistency, and comparability of data across projects. Ultimately, the choice between integrated and independent approaches involves balancing control and standardisation against flexibility and local innovation opportunities.

The assessed building regulations do not mandate a specific tool. France's RE2020 and Denmark's Bygningsreglementet BR18 adopt a framework-centric approach, requiring compliance with regulatory standards but allowing the use of any certified LCA software (e.g., One Click LCA, ELODIE). In Denmark, the policy development process included the creation of a free tool accepted for the calculations, but not mandated. Calculations are typically performed by consultants using validated methodologies.

This difference likely stems from the difference in approach between infrastructure and buildings sectors; whereas infrastructure bodies responsible for construction develop and integrate a tool as part of their approach to CO_2e assessment. Buildings, on the other hand, are

also to a large extent developed by private entities creating a market for competing solutions and differentiation in sustainability frameworks and capabilities.

Data sources

A shared characteristic among the infrastructure frameworks is their reliance on centralised databases of emission factors, typically maintained by national transport or environmental agencies. These databases provide default values for materials, construction activities, and transport, ensuring consistency in baseline calculations, and product-specific data in EPDs for detailed offers and as-built reporting. For instance, Ireland's TII Carbon Tool uses the UK Government GHG conversion factors and industry EPDs, while Finland's FTIA draws on the Finnish Environment Institute (SYKE) national database and EPDs for construction products. Sweden's Klimatkalkyl and the Netherlands' DuboCalc similarly maintain or utilise databases updated annually or compliant with EN standards, reflecting a broader trend towards centralisation. The Puertos del Estado in Spain is the only infrastructure framework without a database, but it does refer to available databases that can be used instead.

While the extent to which project-specific data is required varies substantially across frameworks, all require the use of EPDs to validate replacements of default values. For instance, Ireland's TII Carbon Tool enforces high dependence on project-specific data, mandating detailed contractor data (e.g., fuel use, component lists) during the project. In contrast, France's SEVE-TP, Denmark's InfraLCA and Finland's FTIA adopt more flexible approaches, allowing for variability in data submission while also relying on standardised emission factors and default assumptions. The same applies to the building frameworks, France's RE2020 and Denmark's Bygningsreglementet BR18, that focus primarily on regulatory compliance and calculations performed by specialist consultants using certified software and national databases, allowing for product-specific EPDs and data validated based on EN 15804.

3.3 Monitoring and verification of CO_2e data

The overview table below summarises key aspects associated with ensuring compliance with the frameworks, including their monitoring requirements, verification mechanisms, and enforcement strategies.

Table 3-3. Monitoring and verification table

	Monitoring	Verification	Enforcement mechanism
Infrastructure			
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	**Yes**. Standardised Excel sheets and reports are saved into the Velho information system. Real-time data collection for CO_2 emissions is required for contracts starting in 2025.	**Yes**. Data is checked by FTIA reviewers, but no third-party verification.	**Yes and no**. Not implemented yet, but sanctions and/or partial penalties under development. They are to be imposed if committed emission savings are not realised during project execution.

	Monitoring	Verification	Enforcement mechanism
Trafikverket: Klimatkalkyl (SE)	**Yes**. Climate declarations submitted by contractors are systematically tracked, detailing CO_2 levels and the effectiveness of emission reduction measures.	**Yes**. Supplier-specific emission factors are verified through third-party certified EPDs. Contractors must submit climate declarations before project completion.	**Yes**. Bonuses and penalties are applied to ensure compliance with climate performance requirements.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	**Yes**. Contractors submit DuboCalc calculation files and reports throughout the project, which are reviewed for accuracy and compliance.	**Yes**. Submitted data is subject to thorough review. Custom data must be verified by a recognised LCA expert.	**Yes**. The ECI score is contractual. Fines are imposed if the promised ECI is not achieved at handover.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	**Yes**. Embodied carbon is monitored at key milestones: Business Case, Planning/ Design / Procurement, and Project Completion.	**Yes**. Carbon data will be verified at practical completion as part of the data collation process and this process is still in development.	**No**. There are currently no central penalties or fines for non-reporting/non-compliance.
Vejdirektoratet: InfraLCA (DK)	**Yes**. Monitoring is facilitated by the alignment of material lists with cost lists provided by contractors.	**No**. No formal verification mechanism exists. Verification depends on tender-specific instructions.	**No**. No enforcement mechanisms as there are no legal requirements.
TII: Carbon Tool (IE)	**Yes**. Contractors provide monthly data on CO_2 performance, monitored against a contractually defined baseline.	**Yes**. No mandatory third-party verification, but TII does work with external consultants that conduct reviews.	**Yes and no**. With the framework under development, different mechanisms in place. Piloting occurs with fines.
Puertos del Estado: Carbon footprint in ports (ES)	**No**. No formal monitoring requirements exist. Some companies conduct internal carbon tracking.	**No**. No formal verification mechanism is in place. Early pilot efforts have not evolved into mandatory monitoring.	**No**. Implementation remains voluntary; no enforcement mechanisms are currently in place.
FNTP: SEVE-TP (FR)	**Yes**. Monitoring is facilitated by the SEVE-TP tool, which allows for verification of emission results during and after construction.	**Yes**. Input data from construction materials is independently verified if sourced from recognised databases.	**No**. No enforcement mechanisms are introduced as part of the SEVE-TP framework.

	Monitoring	Verification	Enforcement mechanism
Buildings			
Bygningsreglementet BR18 (DK)	**Yes**. While the law only requires a final as-built LCA at completion, LCA calculations are commonly continuously updated throughout design and construction phases.	**No**. No requirement for independent third-party check. Final LCA report is to be shared with municipality for overall compliance check, but no data verification.	**Yes**. Local building authorities conduct checks on a random selection of LCAs during the occupancy approval process.
RE2020 (FR)	**Yes**. LCA calculations are updated at key stages: building permit application and project completion.	**Yes**. A qualified, independent professional verifies the consistency of the project as built against design-stage documents.	**Yes**. Non-compliance with RE2020 results in prevention of legal occupancy and may trigger the contractors' liability.

Monitoring

Across the examined frameworks, monitoring of carbon emissions and embodied carbon is a central requirement, though the scope, frequency, and methodological approach vary significantly. Most frameworks mandate the systematic tracking of CO_2 emissions at key project milestones, such as during design, procurement, and project completion. For instance, Finland's Low Carbon Assessment Method for Infrastructure (FTIA) requires real-time data collection for contracts starting in 2025, while Sweden's Klimatkalkyl and the Netherlands' DuboCalc rely on contractors submitting detailed climate declarations or calculation files for review. Similarly, Denmark's InfraLCA and France's SEVE-TP tools facilitate monitoring by aligning material lists with cost data or using specialised software to verify emission results. However, some frameworks, such as Spain's Carbon footprint in ports, lack formal monitoring requirements, with only internal tracking conducted by individual companies.

The primary difference in terms of monitoring lies in the frequency of monitoring. Under frameworks like the TII Carbon tool (Ireland), DuboCalc (Rijkswaterstaat, Netherlands) and the Buildings Bygningsreglementet BR18 (Denmark), monitoring of progress occurs frequently/continuously throughout the design and construction phases. In contrast, frameworks such as Infrastructure NSW and RE2020 instead require monitoring at key milestones of the project (e.g., project completion).

Both continuous and milestone-based monitoring offer distinct advantages and drawbacks. Continuous monitoring, while resource-intensive, provides a granular view of a project's carbon performance. It allows for the identification of trends and patterns in emissions, which can inform decisions on material selection, design modifications, and construction methods on a more ad hoc basis. This level of detail is particularly beneficial in complex projects where the potential for emission reduction is high but requires constant oversight. For instance, the TII Carbon tool's monthly data collection enables contractors to adjust their practices in response to emerging data, fostering a culture of continuous improvement. On the other hand, milestone-based monitoring offers a more streamlined approach, reducing the administrative complexity associated with frequent data collection and reporting. This method is often preferred in projects with less complex carbon reduction targets or where the primary goal is to ensure compliance with regulatory

requirements at project completion. However, it may overlook interim inefficiencies or missed opportunities for early intervention, potentially leading to last-minute adjustments that are less effective or more costly.

The alignment of monitoring systems with existing project management frameworks shapes their practical application. Frameworks that integrate monitoring with cost tracking, such as Denmark's InfraLCA, streamline processes for contractors by utilising data already compiled for financial reporting. This alignment eliminates redundant data collection while ensuring consistency between material quantities and their associated emissions.

Ultimately, the selection between continuous and milestone-based monitoring should be determined by project-specific parameters such as scope, resource availability, and the granularity of data needed for carbon governance.

Verification

Verification mechanisms are broadly recognised as essential for ensuring the accuracy and reliability of carbon data across the frameworks, yet their implementation varies widely. Most frameworks incorporate some form of verification, ranging from internal reviews to third-party audits. For example, FTIA (Finland) and Trafikverket (Sweden) employ internal reviews and third-party certified EPDs to validate submitted data. Similarly, the DuboCalc (Netherlands) and RE2020 (France) frameworks require thorough reviews by recognised experts or independent professionals, ensuring compliance with methodological standards. However, several frameworks, such as Puertos del Estado (Spain) and InfraLCA (Denmark), lack formal verification mechanisms, relying instead on tender-specific instructions or internal company practices. In the case of Infrastructure NSW (Australia), the framework's verification procedure is still under development at this stage.

The key differentiator is the degree of independence and rigour in verification processes. Frameworks like Trafikverket (Sweden), RE2020 (France) and Rijkswaterstaat (Netherlands) leverage third-party certification and expert verification to enhance credibility. In contrast, Ireland's Carbon Tool and the FTIA primarily work with internal reviewing, with no mandatory third-party verification. This variability underscores differing levels of trust in contractor-reported data and the extent to which regulatory bodies prioritise robust validation.

The choice of verification method reflects the framework's maturity and the importance of accuracy, especially when emissions data influence awards, bonuses, or penalties. Frameworks that mandate third-party verification often do so to strengthen accountability and transparency, particularly in high-profile or high-risk projects where the stakes for accurate carbon reporting are higher. For example, the Netherlands' DuboCalc framework requires thorough verification by recognised LCA experts, ensuring that contractors adhere to rigorous methodological standards—especially since carbon is one of the award criteria in procurement decisions. By requiring thorough verification, these frameworks support credible data while encouraging contractors to maintain accurate reporting from the outset, as errors can affect project evaluations.

For frameworks still under development, stringent verification may be premature. At the early stage, the focus lies on working collaboratively with contractors to identify realistic targets and understand the practical limitations of monitoring and data collection. This approach allows frameworks to refine methodologies and build feasible reporting expectations before introducing formal verification requirements, ensuring that eventual verification processes are both rigorous and practical. The development stage of verification procedures, as seen in Infrastructure NSW (Australia), underscores this evolving nature of carbon governance. While the framework's verification process is still under development, its eventual implementation will likely draw from the lessons learned during this initial phase.

Enforcement mechanisms

Enforcement mechanisms are designed to ensure compliance with CO_2e reduction targets and are implemented through contractual obligations, penalties, or governance-based approaches.

At this point in time, enforcement mechanisms are under development in a minority of the infrastructure frameworks. Frameworks utilise financial incentives or penalties to ensure compliance with carbon performance requirements. For instance, FTIA (Finland) imposes sanctions or partial penalties if committed emission savings are not realised during project execution, while Trafikverket (Sweden) applies bonuses and penalties based on climate performance. Similarly, Rijkswaterstaat (Netherlands) enforces fines if the promised Environmental Cost Indicator (ECI) score is not achieved at handover, and under their Carbon tool, TII (Ireland) is also piloting penalty mechanisms in some of its projects.

However, the application of enforcement mechanisms remains limited, with most frameworks still lacking formalised measures. This generally reflects either a voluntary approach or an early stage of implementation. Infrastructure NSW (Australia) currently has no central penalties for non-compliance, while Vejdirektoratet (Denmark) and Puertos del Estado (Spain) have no legal requirements or enforcement measures in place.

In line with the findings on monitoring and verification, this pattern suggests that enforcement within infrastructure frameworks is still largely experimental and fragmented, with only a small number of authorities moving beyond pilot applications. The reliance on voluntary compliance or non-binding expectations may support early industry engagement and the development of their frameworks, but it also limits the ability of frameworks to guarantee delivery against stated carbon targets.

Where enforcement mechanisms do exist, they tend to be set up at project completion, rather than embedded throughout the project life-cycle. This approach can simplify the procedure by concentrating verification and compliance checks at a single point, reducing monitoring complexity during delivery. It may also provide flexibility for project teams, allowing adjustments and optimisations during execution without the pressure of continuous compliance assessments. However, it can also limit effectiveness. By focusing enforcement at the end of the project, there is less incentive to consistently manage and prioritise carbon performance during earlier stages. It may also delay the identification of underperformance, making corrective actions more difficult or costly to implement. A more systematic approach, linking enforcement to interim milestones, could strengthen performance tracking and reduce the risk of under-delivery.

Enforcement mechanisms are more common among the buildings frameworks. For instance, France's **RE2020** adopts a stringent stance by preventing legal occupancy for non-compliant buildings, thereby leveraging regulatory authority to drive compliance. The same applies to *Bygningsreglementet BR18* (DK), where compliance is considered during the occupancy approval process. This disparity highlights the role of legal frameworks and institutional capacity in shaping enforcement strategies.

4. INTEGRATION WITH PUBLIC PROCUREMENT

Using the CO_2e results calculated based on the specific methodologies, tender and award criteria can be defined to consider the carbon impacts in the bidder selection process. This chapter describes the different approaches used for this integration with the public procurement processes.

First, different models for public procurement are introduced as these shape the leverage that contractors have on CO_2e emissions in their bids. Second, the chapter analyses the integration in selection criteria for public works construction, before, thirdly, linking this to the effectiveness of driving low-carbon construction.

4.1 Procurement models in public construction works

Procurement models in public construction works define the organisational and contractual frameworks through which public authorities acquire construction services. These models determine how responsibilities, risks, and incentives are distributed among project stakeholders, particularly between design consultants and contractors. The choice of procurement model influences project delivery, cost efficiency, and the integration of carbon assessments.

The comparative analysis of the frameworks reviewed in this study indicates that, with a single exception, the carbon assessment methodologies examined are not developed with a specific procurement model in mind. As such, the frameworks can be applied across various procurement models, such as Design-Bid-Build, Design & Build, and, in most cases, Early Contractor Involvement and Alliancing arrangements. The sole framework set up in relation to a specific procurement model is the FNTP's SEVE-TP, which was developed within the commonly applied Design-Bid-Build context. Its application has nevertheless been extended to Design & Build contracts in practice.

Below is an overview of the most prevalent procurement models across the EU, their operational mechanisms, and their implications for public construction projects. The procurement model retains a decisive influence on the extent to which contractors can apply CO_2e frameworks to reduce emissions through their bids, as elaborated in the subsequent sections.

Design-Bid-Build (DBB)

The traditional Design-Bid-Build model remains a commonly used method in public construction across Europe and beyond. Its dominance stems from its straightforward and transparent structure, which aligns with traditional public procurement practices. Under this model, the public authority first engages design consultants (typically architects and engineers) to develop detailed project plans, specifications, and tender documents. Once the design is finalised, the authority procures contractors through a competitive bidding process, where the lowest price or a combination of price and technical criteria determines the winning bid.

This sequential approach ensures clear separation of roles: designers focus on technical feasibility and compliance, while contractors are responsible for executing the works as per the approved design. However, the DBB model presents limitations, particularly in addressing complex or innovative projects where early contractor input could enhance constructability and sustainability. The lack of early collaboration between designers and contractors often leads to fragmented risk management and suboptimal solutions, especially concerning carbon reduction and whole-life performance.

Design-Build (D&B)

While not as universally established as DBB, Design-Build (D&B) is also used, particularly for technically complex or innovative projects, as it integrates design and construction phases under a single contract. In this model, the public authority procures a single entity (a design-build contractor) responsible for both the design and construction of the project. This single-point responsibility fosters innovation, streamlines decision-making, and enhances constructability, as contractors can provide early input during the design phase.

The D&B model is often employed where speed, efficiency, and integrated risk management are priorities. By consolidating design and construction, it reduces the likelihood of design flaws and misalignments between plans and execution. Additionally, it enables contractors to leverage their expertise in materials, methods, and supply chain optimisation to propose low-carbon solutions.

Early Contractor Involvement (ECI)

The Early Contractor Involvement model is designed to engage contractors during the early stages of project development, often before detailed design is finalised. While less common, inclusion of contractors in the design phase allows for early identification of constructability issues, optimisation of designs for efficiency and sustainability, and proactive risk management. Under ECI, contractors are typically invited to participate in workshops, design reviews, and value engineering exercises. Their input can lead to more innovative, cost-effective, and environmentally sustainable solutions, as contractors bring practical insights into materials, construction methods, and supply chain logistics. ECI is often structured as a two-stage process: an initial collaborative phase to refine the project scope and design, followed by a delivery phase, typically undertaken by the same contractor subject to agreement on price, risk allocation, and programme. This model is particularly effective for large-scale infrastructure projects where early contractor engagement can drive significant improvements in project outcomes.

Despite its advantages, adoption remains limited due to several key challenges. Contractual complexity and ambiguous risk allocation create uncertainty between clients and contractors, deterring organisations from adopting ECI. Cultural barriers should also be acknowledged. Public procurement frameworks traditionally favour competition over collaboration, making it difficult to deviate from established processes. All in all, ECI requires greater client capability, time, and upfront investment during early project stages, which can limit its wider application. Together, these factors collectively contribute to the limited adoption of ECI despite its potential benefits.

Alliancing

The Alliancing or Partnering model represents a collaborative procurement approach, where public authorities and contractors form long-term, risk-sharing partnerships to deliver projects. In contrast to Early Contractor Involvement (ECI), which primarily facilitates early input from contractors without fundamentally altering traditional risk allocation, alliancing creates an integrated team where risks, rewards, and key decisions are collectively shared. In Alliancing, the authority and contractors agree to share both risks and rewards, aligning their interests to achieve common objectives, such as cost efficiency, quality, and sustainability. While not yet the standard in most European contexts, alliancing has gained traction in countries such as Finland and the Netherlands, particularly for complex projects.

Alliancing fosters a culture of collaboration, transparency, and mutual accountability. Contractors are incentivised to propose innovative solutions that reduce costs and environmental

impacts, while the authority benefits from shared expertise and reduced administrative burdens. However, the alliancing model requires a high degree of trust, clear governance structures, and robust legal frameworks to ensure fair risk distribution and conflict resolution. Its effectiveness depends on the ability of all parties to collaborate effectively, which can be challenging in traditional public procurement environments.

4.2 Use in procurement criteria

Figure 4-1. The integration of the frameworks with procurement

Framework	Methodology	Tool	Database	Procurement levers:			
				1. Variants / value engineering	2. Establishment of a **baseline** (with outcome-based incentive)	3. Shadow carbon pricing	4. Award scoring based on CO2 reduction
FTIA: Low Carbon Assessment Method for Infrastructure Construction (FI)	✓			✓		✓	
Trafikverket: Klimatkalkyl (SE)	✓	✓	✓	✓	✓	✓	
Rijkswaterstaat: DuboCalc (NL)	✓	✓	✓	✓	✓	✓	✓
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	✓	✓	✓	✓	✓	✓	
Vejdirektoratet: InfraLCA (DK)	✓	✓	✓	✓	✓	✓	
TII: Carbon Tool (IE)	✓	✓	✓	✓	✓		
Puertos del Estado: Carbon footprint in ports (ES)	✓				✓		
FNTP: SEVE-TP (FR)	✓	✓	✓	✓	✓		✓
Bæredygtighedsklassen (Sustainability Class) (DK)	✓		✓		✓		✓
RE2020 (FR)	✓		✓	✓	✓		✓

The integration of low-carbon construction frameworks into public procurement processes is currently in its early stages. The figure above highlights that most frameworks are experimenting with individual procurement levers, yet these do not constitute an all-encompassing strategy. This section will go over the four most prominent ways to integrate CO_2e assessment into procurement, namely (1) *variants / value engineering*, (2) *establishment of a baseline*, (3) *shadow pricing* and (4) *award scoring*.

Variants / value engineering

The frameworks examined demonstrate a shared commitment to value engineering as a means of reducing embodied carbon, but their approaches diverge between being design-led and contractor-led. The use of variants for value engineering means that alternative design or material solutions can be formally assessed and compared for their carbon impact before implementation. While most frameworks enable value engineering during the design phase, the role of contractors is often limited. Contractors are often only required to track and report emissions of supplied materials, reducing the number of opportunities for them to innovate in low-carbon construction methods.

However, frameworks like InfraLCA in Denmark and Klimatkalkyl in Sweden explicitly support value engineering during construction, empowering contractors to propose changes as the project progresses. Others, such as DuboCalc in the Netherlands and FTIA's low carbon assessment method in Finland, do not extend value engineering beyond the design phase.

The approaches used to allow for value engineering range from manual and iterative processes (e.g., Klimatkalkyl, InfraLCA) **to structured processes** (e.g., FTIA and DuboCalc). In the case of the frameworks of Puertos del Estado and BR18 Climate Requirements, no value engineering is possible.

Ideally, value engineering would integrate both design-led and contractor-led approaches. This would ensure that carbon considerations are embedded from the earliest design stages while simultaneously empowering contractors to propose and implement optimisations throughout the construction process. By bridging the gap between design optimisation and contractor-led implementation, these frameworks offer a promising model for reducing embodied carbon in infrastructure projects. Their success lies in creating an environment where value engineering is not just an academic exercise but a practical tool for driving systemic change in the construction sector.

An overview of value engineering across the frameworks can be found in the table below.

Table 4-1. Value engineering across the frameworks

	Grading	Explanation
Infrastructure		
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	✓	**Design-led value engineering:** Compares alternative designs early; no contractor-led value engineering during construction.
Trafikverket: Klimatkalkyl (SE)	✓	**Design- and contractor-led value engineering:** Enables variant comparison on design options, materials, and construction methods.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	✓	**Design-led value engineering:** Optimises designs pre-construction; no value engineering during construction.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	✓	**Design-led value engineering:** In business case and option selection, teams calculate and compare the total embodied CO_2 of design alternatives. During contract procurement and construction, compliance is enforced.
Vejdirektoratet: InfraLCA (DK)	✓	**Contractor-led value engineering**: Enables alternative variants during construction; contractors submit EPDs of products used for construction for evaluation.
TII: Carbon Tool (IE)	✓	**Design-led value engineering:** Encourages finding carbon-saving measures (e.g. using recycled materials, optimising structures) before final design.
Puertos del Estado: Carbon footprint in ports (ES)	✕	**No value engineering**: Value engineering between alternatives is not foreseen as part of the overall framework. In the example case (Port of Valencia), contractors are not allowed to suggest alternatives.
FNTP: SEVE-TP (FR)	✓	**Design- and Contractor-led value engineering:** Allows modelling of specific elements to compare base solutions and variants, and enables alternative products, e.g., with higher recycled content.

	Grading	Explanation
Buildings		
Bygningsreglementet BR18 (DK)	×	**No value engineering:** Contractors are encouraged to adopt carbon-saving measures to ensure that the baseline is met, but they cannot suggest alternatives.
RE2020 (FR)	✓	**Contractor-led value engineering:** Where a contractor proposes a variant, they are required to be able to justify the carbon impact of those changes.

Establishment of baselines

Baselines serve as the client-defined benchmark against which carbon performance is measured, evaluated, and reduced. The role of the client in setting this initial benchmark is central, as baselines built and shared upfront determine both the comparability of subsequent bids and the accessibility of the framework to contractors with varying levels of LCA capacity. The primary value of the benchmarks lies in establishing comparability across bids and ensuring that carbon reduction is not a subjective or fragmented effort but rather a standardised process that can be monitored.

Seven out of the ten examined frameworks have implemented some form of baseline, while the remaining three either lack formal baselines entirely or rely on port-specific or incentive-based approaches. The majority of frameworks establish baselines during the early design or planning phases.

All frameworks that establish baselines (whether at the project or product level) typically use generic data or emission factors to establish the baseline. How a baseline is set up is also linked to the applied procurement model: where the client controls the design (DBB), the baseline can be constructed from a finalised design, while in models where design is shared or contractor-led (D&B, ECI), baselines necessarily rely more on reference scenarios or generic data. An example is DuboCalc (Netherlands), which uses a standardised Environmental Cost Indicator (ECI) reference value derived from generic data to establish project-level baselines. Similarly, InfraLCA (Denmark) and Klimatkalkyl build project-specific baselines/reduction targets using standardised emission data. During the project, contractors typically have the possibility or are required to provide project-specific data in addition to this.

Where established, baselines are linked to incentive schemes in several cases, either through qualifying thresholds and financial rewards (e.g., DuboCalc, with a 25% ECI (environmental cost indicator) reduction requirement and incremental benefits upon further ECI reductions), disqualification or penalties for non-compliance/exceeding the baseline (e.g., TII Carbon Tool, where failure to meet the baseline triggers penalties or loss of incentives), or contractual obligations to meet reduction targets (e.g., RE2020's carbon budget per trade lot).

Both buildings frameworks define limit values by law during the design stage, which tenderers must adhere to. In the case of RE2020, tender documents include a carbon budget per trade lot, ensuring that contractors adhere to specified emission limits for different project components.

Across the infrastructure frameworks, customised baselines for individual projects are typically established, often based on project characteristics, available data, or early-stage

assessments. These baselines are dynamic, adaptable, and project-specific, allowing for tailored carbon reduction strategies. For instance, in the case of InfraLCA (Denmark), baselines evolve as more EPDs are required in tenders, allowing for continuous refinement as better data becomes available. While project-specific baselines allow for refinement, they also risk inconsistency and resource burdens.

Trafikverket's Klimatkalkyl has developed a hybrid baseline system with two components: both product- and project-specific targets. Specifically, it sets **fixed requirements** for products (steel, concrete, cement, asphalt) and vehicles, fuels, and working equipment. These fixed CO_2 requirements apply to all projects, regardless of size or type. These requirements function as minimum standards. Additionally, for larger development projects (≥150 MSEK, approx. €14 M), contractors must propose emission reduction targets based on a reference scenario using 2015 emissions data. Trafikverket sets the percentage reduction requirement, which can be adjusted based on project difficulty. Enforcement is stringent: contractors are required to meet these targets, with bonuses for exceeding them and penalties for non-compliance, ensuring that carbon performance is not a competitive factor but a contractual obligation.

In summary, the frameworks examined demonstrate that baselines can take many forms, from fixed legal requirements to project-specific benchmarks, each with distinct advantages and limitations. An overview of baselines establishment procedures across the frameworks can be found in the table below.

Table 4-2. Establishment of baselines across the frameworks

	Grading	Explanation
Infrastructure		
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	×	**No baseline established**: Incentive models for contractors have been developed but not yet piloted. Baseline to be established using general data from the CO_2 database, with contractors refining calculations using EPD data.
Trafikverket: Klimatkalkyl (SE)	✓	**Baseline on project- and product-level**: Fixed CO_2 requirements for products (steel, concrete, cement, asphalt, fuels) and project-specific reduction targets based on 2015 reference scenario for large projects (≥150 MSEK). These requirements are enforced through bonuses and penalties.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	✓	**Baseline on project-level:** ECI reference value serves as baseline within projects, derived from generic data, providing a standardised benchmark for award scoring.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	✓	**Baseline on project-level**: Provides baselines through benchmarks for early-stage estimation and carbon reduction targets. No fixed limits; each project sets its own reduction target.
Vejdirektoratet: InfraLCA (DK)	✓	**Baseline on project-level:** No fixed CO_2 limits; builds project-specific CO_2 baselines during early phases using EPD-based emission factors in InfraLCA.

	Grading	Explanation
TII: Carbon Tool (IE)	✓	**Baseline on project-level:** Baseline set up by client using non-project specific data ahead of project. Contractors report carbon using actual data during project.
Puertos del Estado: Carbon footprint in ports (ES)	✕	**No baseline established:** No baseline procedure in overarching framework; Port of Valencia uses mandatory CO_2 ranges in tenders, with disqualification or penalties for being outside these ranges (above or below).
FNTP: SEVE-TP (FR)	(✓)	**Baseline can be established on project level:** SEVE-TP does not provide an automatic baseline for all kind of projects. However, the generic database enables every project owner to implement their baseline solution in the tool.
Buildings		
Bygningsreglementet BR18 (DK)	✓	**Baseline on project-level:** Limit values are defined by law and specified during design stages. Tenderers have to respect these limit values. Contractors in practice have to at least be able to provide EPDs for materials and quantify construction site emissions to be considered for projects.
RE2020 (FR)	✓	**Baseline on project-level:** Limit values are defined by law and specified during design stages. Tenderers have to respect these limit values. The tender documents include a carbon budget to be respected per trade lot.

Shadow pricing of carbon

Shadow carbon pricing represents a mechanism for internalising the social cost of carbon emissions within infrastructure and building projects, yet its application remains limited across the frameworks. This limited adoption reflects a broader challenge in aligning economic decision-making with climate objectives, as the true cost of carbon emissions is often excluded from project appraisals and procurement processes. The effectiveness of shadow pricing as a procurement lever depends heavily on the price level set: where the rate is too conservative, the resulting differential between bids may remain too small to meaningfully reward lower-carbon offers.

Where shadow carbon pricing is applied, it does so in diverse forms—ranging from formal integration into Cost-Benefit Analysis (CBA) to indirect monetisation through procurement mechanisms. Frameworks such as FTIA (Finland), Infrastructure NSW (Australia), and InfraLCA (Denmark) treat shadow carbon pricing as a direct cost in CBAs, ensuring that carbon reduction is quantified and monetised within appraisals. In the case of Sweden, shadow carbon pricing is embedded in national transport planning instead.

However, in the Netherlands, DuboCalc applies shadow carbon pricing indirectly through the Most Economically Advantageous Tender (MEAT) mechanism, where carbon reductions are monetised and used to adjust tender scores or prices. While this does not involve explicit inclusion in CBA, it translates carbon performance into financial terms during procurement, incentivising contractors to prioritise low-carbon materials and methods.

As an alternative approach, the German Construction Association and KPMG have developed a proposal for shadow pricing emissions to include these external costs in the price comparison of proposals. This concept has not been applied in practice by contracting authorities yet. For this reason, instead of an in-depth assessment, the shadow price concept for Germany is presented in Box 2 below.

An overview of shadow carbon pricing across the frameworks can be found in the table below.

Table 4-3. Shadow carbon pricing across the frameworks

	Grading	Explanation
Infrastructure		
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	✓	**Shadow pricing as part of a CBA:** Shadow carbon costs are used in socio-economic project appraisals to evaluate viability. They are not yet integrated into the comparative price of contracts, though this is being piloted for 2026, for example. for asphalts.
Trafikverket: Klimatkalkyl (SE)	✓	**Shadow pricing as part of investment decisions**: Not part of procurement procedure but integrated into national transport planning via the ASEK 8.0 framework. This framework assigns monetary values to CO_2e emissions (1.72–6.28 SEK/kg CO_2e in 2024 monetary value, 2019–2045), reflecting the social cost of carbon in transport forecasts and project evaluations.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	✓	**Shadow pricing as part of procurement**: Yes, shadow price is set on the basis of these environmental costs, via the MEAT approach. While this is a fictional price, it results in a potential discount.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	✓	**Shadow pricing as part of a CBA**: The costs of emissions, and benefits of reduced emissions, must be included in CBA. In 2026, this carbon value is A$133 per tonne and will increase to A$350 per tonne by 2050.
Vejdirektoratet: InfraLCA (DK)	✓	**Shadow pricing as part of a CBA:** The Danish Road Directorate aims to select climate actions based on an expected CO_2 shadow price, defined as the socio-economic cost per tonne of CO_2 reduction. The Directorate has set a price of 200 DKK (approximately €27) / tonnes of CO_2 during 2026.
TII: Carbon Tool (IE)	✕	**No shadow pricing**: No shadow carbon price established as of now.
Puertos del Estado: Carbon footprint in ports (ES)	✕	**No shadow pricing**: No shadow carbon price established as of now.
FNTP: SEVE-TP (FR)	✕	**No shadow pricing**: No shadow carbon price established as of now.
Buildings		
Bygningsreglementet BR18 (DK)	✕	**No shadow pricing**: No shadow carbon price established as of now.

	Grading	Explanation
RE2020 (FR)	×	**No shadow pricing**: No shadow carbon price established as of now.

Box 2 German CO_2 Shadow Price Model in Procurement[6]

The proposed CO_2 shadow price model is a market-based instrument that monetises greenhouse gas emissions during tender evaluation, creating a direct financial incentive for contractors to compete not just on cost but also on carbon. The model suggests the following steps and elements.

Building the baseline

Before a tender is issued, the contracting authority prepares an LCA using standardised default data (in Germany, typically the ÖKOBAUDAT database) to establish the baseline greenhouse gas emission profile of the project. This baseline becomes the reference point against which bidders can differentiate themselves.

How bidders compete on carbon

Contractors are invited to optimise the emissions associated with their specific solution in their offer. Using product-specific EPDs, they quantify the CO_2e of their proposed materials, logistics and construction methods. Areas within the contractor's control, such as the carbon intensity of concrete, the use of low-emission machinery, or supply chain choices, become levers for competitive advantage.

The concept does not propose a specific methodology and system boundaries for the works and products to be included. For buildings, it refers to existing and widely applied German sustainability reporting rules (QNG). For infrastructure projects, common calculation frameworks do not exist. Certain methodologies have been developed and could be mandated by the client. However, this still constitutes a gap as comparisons between projects are challenging – and efforts for bidders to adjust calculations are high.

From Emissions to Evaluation Price

In their tender documents, the contracting authority specifies a shadow price per tonne of CO_2e. Each bidder's total CO_2e quantity is then multiplied by this rate to produce a monetised climate cost. The proposal does not suggest a specific carbon price, but refers to the German Federal Environment Agency, which recommends a rate of €237 per tonne of CO_2e.

This figure is added to the contractor's actual tender price to form the Evaluation Price:

$$\textit{Evaluation Price} = \textit{Tender Price} + (CO_2e\ \textit{Quantity} \times \textit{Shadow Price})$$

Ranking and Contract Award

Contract award is determined by the lowest Evaluation Price, not the lowest tender price. This is the key shift the model introduces. A contractor submitting a higher nominal bid can nonetheless win the contract if their emissions are sufficiently lower to offset the price difference. Carbon efficiency becomes a direct determinant of competitive ranking, embedded structurally in the selection process rather than treated as a qualitative add-on.

Contractual Accountability

The CO_2e values declared in the winning bid do not disappear after award. They become binding contractual obligations. Should the contractor fail to meet the agreed emission targets during execution, the contract may provide for penalty payments. The instrument thus closes the loop between procurement incentive and on-site performance.

Advantages and Limitations

The CO_2 shadow price model offers a structurally elegant way to integrate climate objectives into standard procurement practice without requiring a fundamental overhaul of existing award procedures. By translating

[6] For more information please see link

emissions into a monetary value that directly affects competitive ranking, it moves sustainability from a qualitative scoring criterion into the core evaluation logic. For contractors, this creates a genuine and calculable business case for investing in low-carbon materials, equipment and supply chains: the benefit of carbon reduction is directly visible in the evaluation price and therefore in the probability of winning work. The model also rewards innovation progressively: the greater the emissions reduction a contractor can credibly demonstrate through EPDs and verified data, the stronger their competitive position.

However, the model carries notable limitations and risks. Its effectiveness as an incentive is highly sensitive to the shadow price chosen: a rate set too low makes the carbon adjustment marginal relative to price differences between bids, effectively neutralising the intended competitive signal. Conversely, a very high rate risks distorting award outcomes in ways that may be difficult to justify legally or politically. The reliance on EPDs and LCA methodologies also places a significant administrative and technical burden on contractors, particularly smaller firms, who may lack the in-house expertise to prepare robust emissions calculations across the relevant life-cycle modules. Inconsistent or low-quality data submissions could undermine comparability between bids and expose the process to challenge. Finally, while contractual penalties provide a mechanism for enforcement, verifying actual on-site emissions against declared values remains practically complex, meaning the link between procurement incentive and real-world carbon performance is not always guaranteed.

Award scoring based on CO_2 reduction

Award scoring based on CO_2e reduction represents one of the most direct and impactful mechanisms for embedding low-carbon objectives into procurement decisions. By allowing designers and contractors to compete not only on price but also on carbon performance, award scoring transforms procurement from a purely financial exercise into a wider evaluation that also considers carbon impact.

The value of award scoring based on CO_2 reduction lies in its ability to create a level playing field where contractors are rewarded for proposing solutions that reduce embodied carbon, rather than simply meeting minimum regulatory requirements. Unlike frameworks that rely solely on baselines or other targets, CO_2-based award scoring explicitly prioritises carbon reduction as a core procurement deliverable. This allows for further embodied carbon reduction, with contractors positioned to identify and propose innovative low-carbon solutions that can further drive CO_2e reductions.

However, despite its potential, the adoption of CO_2-based award scoring remains limited and uneven across the examined frameworks. In the majority of examined frameworks, CO_2 is not part of the award scoring mechanism at this stage, meaning that procurement decisions are made solely on cost, with environmental and carbon considerations overlooked.

Yet, some frameworks, such as RE2020 (15% weighting) and the SEVE-TP framework (5-30% weighting depending on contracting authorities' decision), both in France, have begun to incorporate CO_2 as a weighted award criterion in tender scoring. Additionally, DuboCalc (Netherlands) and BR18 Climate Requirement (Denmark) have started adopting this, though primarily for design tenders rather than construction contracts.

An overview of award scoring mechanisms across the frameworks can be found in the table below.

Table 4-4. Award scoring across the frameworks

	Grading	Explanation
Infrastructure		
FTIA: Low Carbon Assessment Method for Infrastructure (FI)	×	**No award scoring:** While shadow carbon costs are used in socio-economic project appraisals to evaluate viability, they are not integrated into the comparative price of contracts.
Trafikverket: Klimatkalkyl (SE)	×	**No award scoring:** Considerations of carbon footprint/GWP are currently not included as award criteria in public procurement projects by Trafikverket. Instead, Trafikverket sets mandatory carbon reduction requirements.
Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)	✓	**Weighted award scoring**: The ECI (Environmental Cost Indicator) forms part of the award criteria, which translates into a fictitious discount within the Most Economically Advantageous Tender (MEAT) evaluation. However, the magnitude of this discount remains subject to debate and is influenced by the type and complexity of the project.
Infrastructure NSW: Decarbonising infrastructure delivery (AU)	×	**No award scoring:** Currently, carbon itself is not explicitly an award-scoring criterion in Infrastructure NSW tenders.
Vejdirektoratet: InfraLCA (DK)	×	**No award scoring:** No formal scoring criterion as of now.
TII: Carbon Tool (IE)	×	**No award scoring:** No formal scoring criterion as of now.
Puertos del Estado: Carbon footprint in ports (ES)	×	**No award scoring:** CO_2 is not currently part of award scoring in the framework. Some port authorities (Port of Valencia) have recently published tenders ("pliegos") where there is a weighting assigned to CO_2 in tender scoring, obliging bidders to demonstrate carbon performance as part of the award process.
FNTP: SEVE-TP (FR)	✓	**Weighted award scoring:** When used in tender requirements, the result of CO_2 calculations, potentially alongside other environmental criteria, is incorporated as a weighted award criterion within a points-based quality scoring system. The weighting assigned to this criterion can range from 5% to 30%, depending on the specific case.
Buildings		
Bygningsreglementet BR18 (DK)	✓	**Weighted award scoring:** This is optional for public buyers, but CO_2e targets and scoring of offers based on emission totals are increasingly embedded in tender specifications, often as award criteria alongside price. However, this is much more common for design tenders than for construction contractors.

	Grading	Explanation
RE2020 (FR)	✓	**Weighted award scoring:** Also in France, this is an optional add-on to the mandatory limit value. Public contracting authorities have begun weighting environmental performance criteria in bid scoring. Tenderers must submit technical statements identifying the carbon impact of their proposed materials, along with the EPD references they intend to use.

4.3 Driving low-carbon construction

The integration of low-carbon construction frameworks into public procurement has taken varying shapes across the examined frameworks, as further highlighted in the previous section. The most effective frameworks share a common set of enabling features that foster iterative refinement, incentivise alternative submissions, and provide standardised methodologies for comparison. These features not only facilitate the development of low-carbon solutions but also ensure that such solutions are practical, measurable, and aligned with real-world construction processes. This section now examines the key elements considered essential for advancing low-carbon construction:

Procurement models and low-carbon construction

In section 4.1, several procurement models were highlighted, encompassing both traditional and collaborative models. These models include the Design-Bid-Build model, where design and contractor procurement are distinctly separated, as well as Design & Build, which integrates both design and construction under a single contractual agreement. Additionally, more collaborative frameworks such as Early Contractor Involvement and Alliancing are highlighted, both of which allow contractors to contribute meaningfully to the final design.

The choice of procurement model has an impact on the ability of contractors to influence the design phases to further drive innovative procurement. The table below synthesises the key features of the four highlighted procurement models. The varying degrees of impact on low-carbon innovation demonstrate that the choice of procurement model is not merely a procedural decision but a strategic one that can significantly impact a project's sustainability, innovation potential, and long-term performance.

As such, to foster sustainable and innovative low-carbon construction, strategic consideration must be given to the selection of a procurement model. By prioritising models that enable contractor input early on, such as Early Contractor Involvement (ECI) and Alliance models, clients and stakeholders can further support low-carbon innovation by enhancing feasibility through collaborative problem-solving between the client, design and construction.

Table 4-5. Procurement models and their impact on low-carbon innovation in construction

Feature	Design-Bid-Build	Design&Build	ECI	Alliance model
Contractor ability to influence design	**Low**: Contractors are typically involved only after the design is complete.	**Medium:** Contractors are involved for technical optimisation of preliminary design.	**High**: Contractors are engaged from the early design stages.	**Very high**: Collaborative approach with shared responsibility for design and construction.
Ability to influence material selection	**Low**: Contractors are constrained by set requirements for products.	**Medium**: Contractors can influence material choices by choosing alternative structural solutions and technical systems that meet client's performance requirements.	**High**: Contractors can influence material choices early in the process.	**Very high**: Collaborative decision-making allows for optimal material selection.

Feature	Design-Bid-Build	Design&Build	ECI	Alliance model
Potential for low-carbon innovation	**Low**: Limited opportunities for innovation due to rigid design constraints.	**Medium**: Contractors can propose innovative low-carbon solutions that meet the client's performance requirements.	**High**: Early input enables innovative low-carbon solutions to be integrated into the design.	**Very high**: Collaborative environment fosters innovation and low-carbon solutions.

The role of industry collaboration in tool development

The relevance of industry collaboration extends beyond procurement models and into the development of carbon assessment tools. Frameworks such as the TII Carbon Tool (Ireland) and Infrastructure NSW's Decarbonising Infrastructure Delivery (Australia) exemplify how collaborative tool development enhances the practicality of construction practices. These tools are not merely instruments for emissions reporting; rather, they are co-created with contractors, suppliers, and industry experts to ensure alignment with operational realities. By involving the stakeholders that ought to work with these carbon assessment tools, they can be shaped in a way that allows for effective carbon assessment, rather than impose impractical requirements that are largely perceived as an additional administrative burden.

Enabling refinement through project-specific data and value engineering

Furthermore, enabling continuous improvement in low-carbon construction relies on the ability to refine and optimise projects iteratively during both design and construction. By enabling the development of project-specific baselines that contractors can refine using EPDs and by suggesting alternatives, projects can be further optimised given practical considerations unknown before the project was started. This process encourages the exploration of innovative construction methods and optimised logistics, often overlooked in initial designs, which can yield additional carbon savings during construction. By embedding this flexibility, these frameworks ensure carbon considerations are central throughout project delivery, incentivising contractors to propose solutions that are both compliant and innovative.

Beyond monitoring: The necessity of enforcement and procurement integration

While carbon monitoring and reporting are essential components of any low-carbon framework, they are insufficient on their own to drive meaningful reductions in GHG emissions. Without attaching incentives or penalties to GHG reduction, carbon reporting is often treated as a peripheral task, with contractors prioritising cost and technical compliance over environmental performance. This passive approach fails to create the urgency or accountability required to shift industry behaviour and actively drive low-carbon construction.

In contrast, frameworks that combine monitoring with enforceable baselines, incentives, or penalties have the ability to obtain greater engagement from contractors. By integrating carbon reduction into procurement levers, these frameworks ensure that contractors are not only measuring emissions but also actively working to reduce them. The enforcement of baselines, coupled with clear consequences for non-compliance, transforms carbon management from a voluntary exercise into a core deliverable, driving measurable GHG reductions in contractor proposals and execution.

Incentivising innovation: The power of award criteria

One of the primary strategies for rewarding contractors' efforts in delivering additional CO_2 reductions is the integration of CO_2 as a weighted award criterion within construction tender evaluations. Frameworks such as SEVE-TP (France) embed environmental performance as a key component of bid scoring (typically 5–30% of total points), directly incentivising contractors to propose low-carbon alternatives. This approach ensures that contractors' proposals are evaluated holistically, balancing cost, quality, and environmental impact. By making carbon performance a quantifiable and competitive factor, these frameworks align the financial interests of contractors with the environmental goals of public authorities. While award scoring is getting embedded in the design-tender phases of several examined frameworks, its application to construction remains limited.

Conclusion: A roadmap for systematic change

The evidence from European frameworks demonstrates that driving low-carbon construction requires more than just technical tools or voluntary measures that monitor CO_2e. It demands a combination of iterative refinement, industry collaboration, enforceable mandates, and procurement incentives. By enabling contractors to refine designs, submit alternative solutions, and utilise standardised methodologies, frameworks can unlock innovation in low-carbon construction. Taken together, these observations suggest that the impact of CO_2e assessment on procurement outcomes depends less on the existence of individual levers than on how they are combined, calibrated to the procurement model, and supported by client-side capacity, considerations that inform the recommendations developed in the following chapter.

5. BEST PRACTICES AND RECOMMENDATIONS

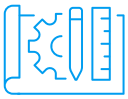
These targeted recommendations aim to support more harmonised and effective CO_2e assessment in EU public works procurement. The recommendations are structured in three parts. **Section 5.1** sets out general principles for contracting authorities that apply across procurement models, highlighting the cross-cutting findings of the study. **Section 5.2** acknowledges that the levers available to contractors differ markedly between procurement models and provides specific guidance on how low-carbon construction can be operationalised under each: DBB, D&B and ECI. **Section 5.3** connects the technical recommendations to policy updates and support from the EU and national levels revising and implementing the Public Procurement Directive. It does not introduce new substantive recommendations but rather reframes the operational guidance of the preceding parts as advocacy priorities for the EU level.

5.1 General recommendations across procurement models

The following recommendations apply across all procurement models. They are intended to strengthen the use of CO_2e assessments in public works tenders by making such assessments more common, standardised and actionable for all parties involved, namely contractors, contracting authorities and the wider supply chain. The recommendations reflect the cross-cutting findings of the study and are formulated so as to remain workable for the average public contracting authority, while also keeping reporting and bidding burdens proportionate for contractors.

Theme 1: Scoping the carbon assessment

The scope of a carbon assessment (e.g., what is measured, against what baseline, and at what level of granularity) determines what the assessment can credibly compare and what it can credibly drive. Scoping decisions at the tender stage shape the parameters on which contractors are evaluated, the comparability of bids, and the abatement the procurement process can ultimately access. The recommendations in this theme set out the principles that should govern these decisions.



Design tender frameworks for the actual capacity, type of public works and sub-sectoral context they will operate in.

Local contracting authorities carry out the bulk of public works tenders and typically have more limited in-house expertise and resources to operate complex carbon assessment frameworks. Therefore, tender frameworks should be designed around the capacity of an average contracting authority, not against a best-in-class example. They should equally reflect the specificities of the associated sub-sector and type of works, as well as proportionality with regard to project size, complexity and administrative capacity. Different sub-sectors of public works have materially different emission profiles, abatement options, and metrics. Some sub-sectors operate with intensity metrics and well-established performance levels (for example tCO_2e/m^2 in buildings, or per kilometre of motorway) while others work in absolute emissions and lack comparable benchmarks. In some types of works, emissions are dominated by materials and design choices, while in others, notably dredging and other equipment-intensive works, fuel and vessels can account for the overwhelming share of emissions. As such, public authorities designing carbon assessment frameworks, whether at EU level, in national guidance, or in sub-sectoral standards, should calibrate them to the operational reality and specificities of each sub-sector and type of works.

This logic of calibration to context extends to the weighting of CO_2 in the award decision itself. The weight CO_2 carries in the award scoring ultimately determines whether carbon performance can

meaningfully influence the tender outcome, and a single fixed weighting cannot reflect the variation in carbon intensity across types of works. Frameworks should therefore allow the CO_2 weighting to be set within a defined range. In France, for example, contracting authorities use the sector's **SEVE-TP tool** to score the carbon performance of bids, and decide themselves what weight to assign to the carbon criterion within a defined range of 5% to 30% of the total award score, calibrated to project scale, typology and material intensity. While the level of weighting is context-dependent and should be considered against the geography, sub-sector and type of works, it must be high enough to incentivise genuine competition on carbon performance and not only on price. If a binding CO_2 assessment requirement extends only to performing the calculation, without a corresponding obligation to integrate the result into the award logic through weighting, thresholds or equivalent mechanisms, there is a risk that carbon assessment is reduced to a compliance exercise only.

Define an assessment scope that is fair and comparable, limited to what contractors can actually influence within the context of the procurement model and the nature of the works.

Lifespan, intended use and other design choices fixed by the client should be held constant across bidders, since inconsistency between bids in the same tender makes the exercise unreliable. Trade-offs between materials or design alternatives often only become visible when use-phase (B) and end-of-life (C) stages are captured over a defined lifespan: a material that appears high-impact at A1–A3 may perform differently once durability, maintenance and recyclability are accounted for. The appropriate level of granularity depends both on the procurement model and on the scope of works assigned to the contractor. In models with limited contractor influence on design, fine-grained data adds reporting burden without driving better outcomes, whereas in collaborative models it becomes a genuine driver of low-carbon decisions. Likewise, emission profiles and dominant sources differ significantly between, for example, equipment-intensive infrastructure, heavy civil engineering or foundation works (where machinery and fuel use dominate) and building construction or turnkey/fit-out projects (where embodied carbon in materials dominates); system boundaries, level of detail and applicable benchmarks should reflect these differences. Framework designers and contracting authorities should therefore calibrate scope, granularity, system boundaries and life-cycle coverage to the influence contractors actually have under the chosen procurement model and type of works contracted. The usage of default values should be permitted where in-house LCA capacity is limited (e.g., in the case of smaller contractors), particularly in the case of early implementation of CO_2e frameworks, provided that transparency is maintained. This would ensure that scope requirements do not themselves become a barrier to participation. Ireland's **TII Carbon Tool**, for example, has the client establish a project baseline using generic carbon factors ahead of the tender, after which contractors report monthly using actual project data via standardised templates. Denmark's **InfraLCA** operates following a similar logic, with baselines built in early phases of the project on the basis of EPD-based emission factors and supplemented with generic/default datasets included in the tool. During construction, contractors submit contract-specific EPDs. At completion, a total climate account and a post-calculation are prepared, and data is collected across projects to inform future climate measures.

Maintain material and equipment neutrality through performance-based mechanisms.

Tenders should leave technical choices on equipment, fuels and specific materials to contractors unless strongly justified by the contracting authority or local legislative requirements (e.g., low emission zone requirements). Imposing particular approaches reduces competition, can lead to the exclusion of smaller players, and locks projects into options that are not necessarily optimal. Instead, focus should be on whole-project performance, leaving the choice

of how to drive low-carbon construction to the contractor. Public contracting authorities should therefore specify performance outcomes rather than prescribe means, and framework designers should ensure that assessment methods are themselves technology-neutral. Doing so widens the field of credible bidders and keeps the door open to innovation as low-carbon construction technologies evolve over time.

Carbon pricing mechanisms are a particularly well-suited approach towards material and equipment neutrality, as they put a price on emissions without prescribing how those emissions should be reduced. The **shadow price model developed by the German Construction Association and KPMG** provides a strong example of how carbon pricing can embed material-neutral incentives directly into the standard award logic. In this model, the contracting authority specifies a shadow price per tonne of CO_2e in the tender documents. The contract would be awarded on the lowest Evaluation Price, not the lowest tender price. This is the key shift the model introduces, as a higher-priced bid can win if its emissions are sufficiently lower to offset the price difference. That said, the impact of carbon pricing mechanisms depends on the level at which the shadow price is set: conservative values may not generate a large enough differential between bids to reward superior environmental performance. For this reason, they are best applied alongside complementary mechanisms that reward low-carbon performance through other routes.

One such complementary approach is Rijkswaterstaat's **"Aanpak Duurzaam GWW" DuboCalc framework**, which allows the client to set an Environmental Cost Indicator (ECI) based on generic LCA data. This indicator becomes the reference value in the tender specifications, serving as both an upper limit and the starting point for the ECI calculation. Interested bidders submit a project design optimised using DuboCalc, including their price quote together with the ECI value generated by the tool. The choice of materials and the combination of inputs used to meet the ECI performance target are left to the bidder, with a low ECI value translating into a higher potential (fictional) discount on the bid price. As a result, bidders have submitted proposals on recycled asphalt, low-carbon concrete and energy-efficient machinery.

Consider product-level and project-level carbon criteria as complementary.

Product-level criteria allow clients to set targeted requirements on the most carbon-intensive materials (typically steel, concrete, cement and asphalt) where reduction potential is well understood, standards do not constrain choices and the highest-impact decisions can be addressed directly. Project-level criteria can operate differently: rather than prescribing where reductions must come from, they set an overall carbon performance target and allow contractors to identify the most effective routes to meeting it, including through design choices, construction methods or material combinations the contracting authority may not have considered. The relative weight of the two depends primarily on the procurement model: product-level criteria do more work where the contractor cannot influence design (DBB), and project-level criteria become the principal lever where contractors can (D&B, ECI, alliancing). Contracting authorities are therefore recommended to approach both as complementary components, leaning on product-level criteria to anchor performance on the highest-impact materials, and shifting weight towards project-level criteria (in models where contractors have the room to optimise across design, methods and materials).

The most prominent example of this is Sweden's **Klimatkalkyl,** through which Trafikverket combines product- and project-level criteria as parallel mechanisms with different, complementary functions: fixed product-level requirements for steel, concrete, cement, asphalt and fuels apply as minimum standards across all projects, while a project-level reduction target against a reference scenario, with associated bonuses and penalties, drives optimisation above the product-level floor.

Theme 2: Methodology, tools and databases

Methodology, tools and databases are the technical components on which any carbon assessment framework rests. Differences in calculation methods, in the underlying emission factors, or in the tools used to compute results can produce divergent answers for what is substantively the same project, undermining the comparability on which procurement decisions depend. Methodological clarity is therefore a precondition for both the acceptance and the practical applicability of CO_2e assessment in procurement: without clear and consistent definitions, such approaches risk being perceived as unreliable or overly complex. The recommendations in this theme address how these technical components should be organised, and at what level, in order to support consistent and credible assessments across tenders.

Ensure transparent system boundaries and declared units.

Specify clearly which life-cycle stages, building elements, and declared units must be included in calculations. Inconsistent boundaries are a primary source of non-comparability between offers. Therefore, public contracting authorities at tender level should set out the life-cycle stages, declared units and reference periods that calculations must follow, and lock these for the duration of the procurement, so that offers can be compared on a like-for-like basis and bid-stage commitments cannot be reopened later on grounds of inconsistent boundaries. Frameworks embedded in regulations provide the greatest clarity in this respect: for instance, the **SEVE-TP** developed and used in France primarily focuses on the upfront embodied emissions (A1-A5) as these are directly linked to the contractor's work. In addition, expected emission hotspots can be defined to include further life-cycle stages by the contracting authority.

Pursue and complete a layered approach: common methodology at EU level, sector-validated databases, common tools per project.

A clear preference emerged for a three-level structure — at EU level, a common LCA methodology and general principles, including how to develop sector databases; at sector or national level, uniform databases validated by the sector and/or by public authorities; at project level, tools that share a common methodological backbone but reflect sectoral specifics. Elements of this structure are already in place at EU level through the European standards for construction LCA (EN 15804, EN 15978 and EN 17472) and, from 2028, through the recast EPBD's binding Whole Life Carbon requirement for new buildings.

The principal remaining gap is the absence of unified, validated emission databases. EU rules that promote the harmonisation of national databases would be helpful to facilitate seamless integration with recognised databases and EPD platforms. This is essential to enable automation, reduce administrative burden and support widespread adoption across the sector. National databases such as **INIES** (France, referenced by RE2020) and the **National Environmental Database** (Netherlands, referenced by DuboCalc) currently operate in parallel, and without a common or interoperable layer comparability across bids remains weak even where methodology is aligned. Closing this gap is a shared responsibility; the European Commission and standardisation bodies for the methodological layer, public authorities and sector federations for the validated databases, and tool developers under public oversight at project level[7].

[7] An example of this layered logic in practice is the EFFC/DFI Carbon Calculator. This calculator is a free, sector-maintained tool for foundation construction aligned with existing LCA standards recognised by EFRAG in their Voluntary Standard for SMEs (VSME) standard. It illustrates how project-level tools can sit on a common methodological backbone while reflecting sectoral specifics, allowing SMEs and larger firms to converge on a shared tool within a defined sector and compete on carbon performance rather than on calculation methodology.

Develop carbon assessment frameworks together with the sector while keeping a level playing field for all contractors.

Larger contractors typically have the resources to develop and maintain their own carbon assessment tools, drawing on in-house LCA expertise and proprietary datasets. SMEs rarely have this capacity, and requiring each bidder to bring its own tool effectively narrows the field of bidders who can credibly compete on quantitative carbon criteria. A sector-validated framework, developed with the sector and accepted by contracting authorities, reduces this asymmetry: SMEs gain access to a credible assessment instrument they could not build themselves, and contracting authorities can compare bids on a consistent basis. Public authorities should therefore invest in developing, validating and maintaining common sector tools and contracting authorities should adopt them as the reference for carbon assessment in tenders. Without this, SMEs will continue to face structural disadvantages in tenders with quantitative carbon criteria. Such is the case of Australia's Decarbonising Infrastructure Delivery framework: administered by **Infrastructure NSW**, the public infrastructure government agency, it was developed in close cooperation with NABERS and Transport for NSW (TfNSW) in order to consolidate and align on the underlying emission factors and assumptions to enable consistent measurement of embodied carbon across asset types. A similar collaborative experience can be found in Ireland, where the **TII Carbon Tool** is being implemented together with contractors to optimise the tool for future, widespread adoption. Drawing on user experience and lessons from pilot projects, TII encourages contractors to propose as many reduction opportunities as possible to further refine the tool and its emission factors.

Ensure frameworks are free to use, openly available, and formally recognised.

Where carbon assessment tools carry regulatory force or weight in tender evaluation, their value depends in large part on how widely they can be used. A framework with a tool and database that are costly to access, restricted in their user base, or recognised by only a subset of contracting authorities will, in practice, narrow the field of bidders who can credibly engage with it, particularly disadvantaging SMEs and firms operating across multiple countries. Frameworks should therefore be designed for broad accessibility from the outset: free to use, openly available to all bidders, available in local languages, and formally recognised by the contracting authorities that will rely on their outputs. The longer-term governance of such frameworks, including whether public authorities or independent bodies maintain them once requirements become binding, should likewise be anticipated when frameworks are designed, since fragmented or contested ownership tends to undermine the recognition on which their accessibility depends. As such, public authorities are recommended to build accessibility into frameworks from the outset, and the relevant public authorities (e.g., EU or national public bodies) should provide the formal recognition that turns a credible tool into one contracting authorities can confidently rely on. Without that recognition step, even well-designed tools tend to remain niche. France's **SEVE-TP** provides a valuable example in this regard: Free for all, the tool was developed using databases from INIES and ADEME by the French National Federation of Public Works (FNTP), and has formally been referenced by the French government in mid-2025 as an approved tool for public procurement environmental analysis, a recognition step that underpins its operational legitimacy with contracting authorities and confirms its strong uptake by over 15,000 users and 1,500 organisations. **Finland's FTIA** further exemplifies an interoperable yet open CO_2-calculation system, in which the methodology, calculation tools, and emission-factor databases are developed and maintained by different actors but aligned to work together in practice: Developed by the Finnish Transport Infrastructure Agency (FTIA), the low-carbon assessment method for infrastructure construction does not mandate the use of a specific calculation tool, thereby allowing flexibility in implementation. However, FTIA and ELY Centre projects commonly use the Ihku infrastructure cost calculation service, which calculates

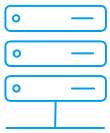
emissions by multiplying activity data (e.g. material volumes and transport distances) by standardised emission factors. These emission factors are maintained by the Finnish Environment Institute (SYKE) through its national database but can be replaced with project-specific data. For the estimation of working hours for site activities, data can be derived from multiple sources, including construction-element benchmarks within the Ihku system, contractor-provided data, or information from comparable projects.

Theme 3: Capacity, governance and pace

Even well-designed carbon assessment frameworks fail to deliver intended outcomes where the capacity to apply them is missing, where commitments made at tender are not held to during construction, or where requirements are introduced faster than the sector can absorb. The recommendations in this theme address the conditions under which the principles set out above can translate into actual abatement on public works projects, rather than remaining aspirational.

Invest in capacity-building across the entire value chain.

Successful application of low-carbon procurement requires public procurement officers, designers and contractors to share a common understanding of LCA methods, available procurement levers, and low-carbon alternatives. Training initiatives for public procurement officers should additionally cover the practical mechanics of evaluating carbon-related award criteria during the tender phase and verifying compliance during project execution. Client-side capacity is a frequently identified bottleneck and warrants particular attention: in DBB, where the client controls design, weak client-side carbon expertise is a common reason good carbon outcomes fail to materialise. Member States and the European Commission should therefore back a coordinated capacity-building effort across the value chain by rolling out training programmes for procurement officers and designers in contracting authorities and supporting sector federations and public bodies in providing accessible training, model tender documents, and shared access to tools for contractors. Without this investment, the methodological frameworks recommended above will continue to outpace the capacity to apply them, and the resulting carbon outcomes will fall well below what the frameworks could otherwise deliver. The French National Federation of Public Works (FNTP) pairs its **SEVE-TP tool** with short training sessions that allow public authorities and contractors to apply the framework without needing dedicated in-house LCA teams. Because FNTP's reach extends across the public works sector, the same training brings contracting authorities and bidders to a common operating level.



Align calculation precision and verification requirements across project stages.

Carbon assessment at bid evaluation (typically at design stage) and as-built monitoring during construction should be treated as distinct exercises with their own data and reporting requirements, but kept symmetrical so that on-site monitoring can credibly verify what was committed at the bid stage. Tender criteria cannot be more granular at the construction stage than design-phase calculations can support, regardless of on-site data collection capability. As such, validation should be proportionate to the uncertainty within the proposed design; anything beyond limited assurance is unlikely to be accurate until after final construction. A prerequisite for this alignment is that CO_2 requirements are not reserved solely for contractual clauses but are also reflected in the tender evaluation itself: requirements that bidders do not see scored at award stage are unlikely to be internalised or priced into their offers.

Alongside this methodological alignment, tendered carbon reduction commitments should be made contractually binding, specifying a baseline methodology, monitoring and reporting obligations

during construction, verification at completion where the procurement model and project scale justify it, and clear consequences for non-compliance. Bonus/malus mechanisms tied to verified outcomes (for example a bonus capped at a small percentage of the contract sum if verified emissions meet the tendered target, with a penalty if they exceed it) close the gap between tendered promises and actual delivery. Public contracting authorities should therefore set out, for each tender, two aligned sets of requirements (what bidders must calculate at the design stage to be evaluated, and what contractors must monitor and report during construction), and embed both, together with the bonus or penalty consequence, directly into the contract rather than treating them as soft commitments alongside it. Without this combination, design-stage commitments cannot be meaningfully held to during execution, and the carbon performance that determined the award risks dissolving in the gap between bid and as-built. Australia's **Infrastructure NSW framework** illustrates the methodological side, operating across three stages (business case, design and procurement, construction and completion) with a data hierarchy that progresses from secondary benchmarks at design stage to project-specific primary data at completion. Finland's **FTIA Low Carbon Assessment Method** illustrates the contractual side: for contracts starting in 2025 where a project appraisal was prepared during the design phase, real-time data collection on actual CO_2 emissions during execution is now required, paired with a partial penalty if the emission savings presented at tender are not realised.

Phase the introduction of low-carbon procurement progressively.

Where carbon assessment capacity in the sector is still developing, frameworks can begin with prescriptive requirements (for example, minimum clinker replacement ratios for concrete) that are workable without full LCA, and transition to performance-based targets as data maturity improves. A phased trajectory (prescriptive in the short term, performance-based in the medium term, with regulatory force where appropriate in the longer term) gives both contracting authorities and contractors time to build the capabilities the framework eventually requires. Public contracting authorities should therefore build a clear phasing trajectory into the framework from the outset, with explicit milestones for moving from prescriptive to performance-based to regulatory requirements, and calibrate the pace to the sector's actual data and capacity maturity. Without a phased trajectory of this kind, frameworks tend either to introduce requirements faster than the sector can absorb, excluding SMEs and contracting authorities that lack the capacity to comply, or to defer requirements indefinitely in deference to sector readiness, in which case the climate ambition the framework was meant to deliver does not materialise. France's **RE2020** puts this transitional approach into law: limit values apply to new construction projects from January 2022, and thresholds are set to tighten progressively through to 2031, with a higher allowance until 2028 for projects relying on a higher share of default LCA data.

5.2 Recommendations per procurement model

The recommendations below are organised by procurement model. Each model offers contractors a different scope for influencing design and materials, and the same procurement instruments operate differently under each. Where most of the carbon savings sit (the design phase) is the same regardless of model. What differs across models is the share of those savings the contractor can actually access. The recommendations below are presented for all procurement models, from DBB (narrowest contractor influence) to ECI / alliancing (widest). To avoid distortions while ensuring meaningful competition on carbon performance, contracting authorities should combine flexible weighting ranges with scoring relative to a project-specific reference baseline. This approach can be complemented by minimum performance thresholds for key materials or systems.

Recommendations for Design-Bid-Build (DBB)

In Design-Bid-Build (DBB), the client (or the client's designer) has fixed material types, design lifespan, and key system boundaries before the tender is issued. The contractor controls construction-phase emissions and material procurement within the prescribed design. DBB currently remains the dominant model for public works, particularly for smaller projects.

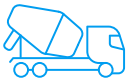
In DBB, evaluate contractors only on what they can influence: construction and materials within the fixed design.

In DBB, limiting the scope to what contractors can influence typically means restricting the assessment to upfront embodied carbon (modules A1–A5, covering raw material extraction, transport to site, manufacturing, and the construction process itself) and to the most carbon-intensive material elements within that scope. Lifespan, design choices, system boundaries and other client prescriptions should be set by the client and held constant across bidders. Keeping the scope tight is what makes the exercise tractable for an average contracting authority and ensures contractors are evaluated only on parameters they can move. This also avoids the situation in which bid-stage commitments depend on parameters fixed by the client (for example, design lifespan or operational energy assumptions) but for which the contractor would nonetheless carry verification responsibility during construction.

In DBB, anchor the tender with a client-built baseline of the prescribed design.

Because the client already has a completed design in DBB, they are well-placed to quantify a default emission level for the prescribed design. A baseline gives bidders a common reference point against which improvements can be proposed and lets contractors who cannot yet quantify their own emissions fall back on the default value. This is a DBB-specific advantage: under D&B or ECI, the design is not yet fixed and a meaningful baseline is harder to construct. Public contracting authorities running DBB tenders should therefore use their design-stage knowledge to construct and publish a project baseline upfront, allowing bidders to compete on credible reductions against a shared reference and providing a fallback default for SMEs that lack in-house LCA capacity. Without such a baseline, DBB tenders either rely on each bidder's own assumptions, which undermines comparability, or exclude SMEs that cannot generate their own emission profile. Under the **Swedish Klimatkalkyl framework**, larger development projects (≥150 MSEK) are required to reduce emissions in line with the Swedish Transport Administration's (STA) reduction targets. These reductions are compared against a reference scenario based on 2015 emissions data (i.e. how climate impact would have occurred using 2015 practices), calculated using the Klimatkalkyl tool. The percentage reduction requirement is decided by the STA based on a proposal from the contractor and can be adjusted according to the project's level of difficulty and technical requirements. If substantial changes occur during the project, a revised baseline may be calculated to adjust the reference point. Monitoring is conducted through the systematic tracking of climate declarations submitted by contractors, which detail CO_2 levels and the effectiveness of implemented emission-reduction measures compared to the 2015 baseline.

In DBB, focus on priority materials rather than every line item.



Clients can specify a small number of priority materials (e.g., carbon-intensive materials such as steel, concrete, cement, and asphalt) and measure bidders against those. In practice, only the most carbon-intensive elements have a materially significant impact on overall emissions, and these are the elements that tend to be assessed in any case. A deliberate focus on them keeps reporting burden manageable for both contracting authority and bidders. Public contracting authorities running DBB tenders should therefore identify, ahead of

the tender, the small set of carbon-intensive materials that will determine bid evaluation, specify them clearly in the tender documents, and measure bidders against those alone, leaving the remaining material lines outside the assessment unless their share of total emissions justifies inclusion. Without this discipline, DBB tenders either overreach into reporting requirements that average contracting authorities cannot administer, or default to such broad assessments that the carbon signal in bids becomes diluted across line items that do not move the total. Naturally, contractors remain responsible for ensuring that the materials they propose can be sourced, are practical and available in the quantities required. Sweden's **Klimatkalkyl** illustrates how a priority-materials list can be defined: across all projects, fixed product-level requirements apply specifically to steel, concrete, cement, asphalt and fuels (the materials that account for the bulk of public works emissions) rather than to all material lines.

Recommendations for Design & Build (D&B)

In D&B, the contractor is responsible for both design and construction, and can therefore influence material selection, design alternatives, and construction methods within the client's functional requirements. This broadens the scope for carbon optimisation compared to DBB.

In D&B, state requirements in functional and performance terms, not prescriptive design.

D&B unlocks contractor-led optimisation only if the client's requirements are stated in functional terms (what the asset must do) and in whole-project performance terms (the carbon target the design must meet) rather than in prescriptive design terms. Material and equipment neutrality matters even more under D&B than under DBB: prescribing specific solutions narrows the contractor's design freedom to the point where the gains from contractor-led optimisation cannot materialise. Public contracting authorities running D&B tenders should therefore specify what the asset must do (functional requirements) and the carbon performance the design must meet (a project-level carbon target), and leave the design choices, material selection and construction methods that get there to the contractor. Without this framing, contractors in D&B tenders cannot apply their design expertise to reduce emissions, and the carbon outcomes end up no better than under DBB despite the design influence D&B is meant to give the contractor. The Netherlands' **DuboCalc** framework operationalises this performance-target logic: tenders set a reference Environmental Cost Indicator value as the carbon target, and bids must demonstrate at least a 25% reduction against that reference to qualify, with the choice of how to deliver that reduction left entirely to the contractor. For contractors, this performance-based framing is what allows design-stage low-carbon innovation to be priced into the bid in a way that is recognised and rewarded by the client.

In D&B, expand the assessment beyond A1–A5 where contractor influence reaches use and end-of-life.

Because the contractor under D&B makes design choices that affect both construction and use phases, it is appropriate to extend the assessment scope beyond upfront embodied carbon to the use phase and end-of-life where the contractor's design genuinely shapes those outcomes. This expansion only produces comparable bids if the client fixes the reference service life and use-phase assumptions in the tender documents, as B-module emissions are calculated over a defined lifespan, and bidders left to assume their own service life can produce B totals that differ by a factor of two for the same maintenance regime. Public contracting authorities running D&B tenders should therefore align the modules included in the assessment with the modules the contractor's decisions actually affect: where the design controls structural efficiency,

durability, maintenance cycles, or end-of-life recoverability, the corresponding life-cycle stages should be in scope. Where the contractor has no influence on a given stage, that stage should sit outside the assessment. Contracting authorities should also fix the reference service life and other use-phase parameters so that bidders compete on design choices within those parameters rather than on differing assumptions about them. Without this alignment, bid-stage commitments fail to capture the full set of decisions on which contractors can compete. A contractor proposing a structurally efficient design that lowers maintenance and replacement burdens over the asset's lifespan would be evaluated against an A1–A5-only assessment that ignores those benefits, and the carbon advantage of the better design would not be visible at award.

In D&B, integrate carbon into the award decision through weighted criteria or shadow pricing.

D&B allows the award decision to weigh integrated design-and-build proposals against each other, so award criteria can target life-cycle-optimised solutions rather than narrow construction-phase scoring. CO_2 can be integrated either as a weighted award criterion under a Most Economically Advantageous Tender (MEAT) framework or, equivalently, through shadow pricing applied to tendered emissions. Whichever approach is chosen, the carbon weight or shadow price must be high enough to incentivise genuine competition on carbon performance, not only on price. Public contracting authorities running D&B tenders should therefore decide, ahead of the tender, which mechanism (weighted MEAT criterion or shadow price) will carry carbon into the award logic, and set the weighting or shadow price at a level where carbon performance can genuinely move the ranking. Carbon should function as a lever capable of changing which bid wins, not as a tie-breaker applied after price. Otherwise, carbon scoring exists in name only: contractors compete on price, the design-influence advantage of D&B goes unused, and the lower-emission proposals the model could surface never make it through the award process. France's **SEVE-TP** applies the weighted-criterion route in infrastructure works: the result of carbon calculations, alongside other environmental criteria, is incorporated as a weighted criterion within a points-based scoring system, with the weighting ranging from 5% to 30% depending on the specific case. The best-performing offer (lowest environmental impact) receives the maximum score, and the remaining offers are scored proportionally against that benchmark. The German **shadow-price model** takes an alternative route: the contracting authority sets a recommended price (€237/tCO_2e), and each bidder's monetised emissions are added to their tender price to form an 'evaluation price' on which the contract is awarded, allowing a higher-priced bid to win if its emissions are sufficiently lower.

Recommendations for Early Contractor Involvement (ECI) and Alliancing

ECI is a procurement and delivery approach: the contractor is engaged before the main construction works begin so that contractor expertise informs design decisions. ECI can be delivered through several contract structures (most commonly a two-stage open-book tender, but also through modified D&B, Framework Agreements or NEC arrangements). Because the bulk of carbon reductions sit in design decisions, ECI is the strongest mainstream lever for unlocking design-phase abatement. Alliancing is a contract structure: a multi-party agreement that integrates client and contractors into a single project team, with shared risk, shared reward, and joint decision-making. It suits large, complex projects where outcomes depend on genuine cooperation between client and several parties over long timescales. The two are not mutually exclusive: alliance contracts are themselves a way of formalising deep ECI-style collaboration, but most ECI in public works is delivered through lighter-touch contract structures. The applicability of both approaches varies considerably across Member States and depends on national legal frameworks, market maturity,

and project scale, so the recommendations below should be read as principles to apply where these approaches are available rather than as universally applicable guidance.

In ECI, bring contractor expertise into design decisions, with the client-side capability to use it.

The case for ECI in low-carbon procurement is that it brings the parties with low-carbon expertise (namely, the contractors and their supply chain) into the design phase, where most emission-relevant decisions are made. Frameworks that retain a strict separation between design and tender will, by nature, capture only a fraction of available abatement. For contractors, ECI is the model under which their material and method expertise can actually be brought in to improve carbon performance: under DBB this expertise is brought in only after the most consequential decisions have been made, and under D&B it is constrained by the client's functional requirements set in advance. ECI moves both of those constraints, but only if the contracting authority is set up to use them. ECI places substantial demands on the client's own capabilities, particularly around managing collaboration without compromising procurement fairness, and where these capabilities are absent, ECI risks operating as a relabelled D&B or DBB rather than the genuinely collaborative model the contracting authority intended. Public contracting authorities adopting ECI should therefore use the contractor's design-phase presence to influence the substantive choices that shape carbon outcomes (material specifications, structural alternatives, construction methods, supplier engagement strategies) rather than only the procedural sequence in which those choices are documented and tendered, and should invest in the in-house capability needed to manage collaborative design. Without both substantive design influence and the client capability to manage it, ECI delivers at best the same carbon outcomes as D&B, since the contractor's expertise is being engaged earlier in time but not earlier in the decision chain.

In ECI, use pre-construction phases to set realistic budgets and enable gainsharing.

A practical benefit of ECI is that pre-construction work produces more realistic budgets than competitive design under DBB. The client and contractor work out the budget jointly, on the basis of shared information about risks, costs and design options, rather than the contractor having to price the work from the outside under competitive pressure. Public contracting authorities running ECI tenders should use this opportunity to set a realistic budget jointly with the contractor, and then structure the contract so that any savings against that budget are shared between the two parties on agreed terms. A typical arrangement is a defined split of any below-budget delivery, paid out only if the agreed carbon performance is also met. Without a gain-sharing structure of this kind, the contractor has no reason to share what it has learned in pre-construction. The result is that the budget realism that distinguishes ECI from Design & Build is lost, and the client pays for pre-construction work without getting the full benefit of it.

In alliancing, treat carbon as a shared responsibility rather than a transferred risk.

Where alliancing arrangements are used, the partnership structure itself is a mechanism for sharing responsibility for the carbon outcome between client and contractor. This is the cleanest expression of shared accountability among standard procurement models, and the alliance contract should be used deliberately for that purpose rather than as a relabelled D&B or ECI arrangement. Public authorities entering alliance contracts should therefore embed carbon outcomes into the same shared risk-and-reward structure that governs cost and time, meaning that under-delivery on carbon affects all alliance members through the pain-share, and over-delivery is shared through

the gain-share, rather than carving carbon out as a contractor-only obligation. For contractors, this distinction matters because alliance arrangements that retain the integrated team structure but quietly reallocate carbon-related risk back to the contractor reproduce the very allocation problem the model is designed to address. This is particularly important when using novel low-carbon materials that may require further performance-based testing, insurance or risk-sharing.

5.3 Policy recommendations for EU and national policymakers

The Commission's revision of the Public Procurement Directives, for which a legislative proposal is expected by mid-2026, constitutes the principal European-level instrument through which CO_2e assessment can be embedded in public works tenders at scale. The voluntary character of the 2014 Green Public Procurement framework has produced uneven adoption across Member States and has left a substantial share of the available abatement potential unrealised. The forthcoming revision presents an opportunity to address these limitations. **This part synthesises the recommendations of Parts 1 and 2 into priorities relevant to EU institutions and Member States preparing the revised Directive and associated legislative framework and instruments**.

Priority 1 — Recognise procurement model differentiation in the legal framework and accompanying guidance

A central finding of the study is that the carbon outcomes of public procurement depend heavily on the procurement model. The Directive's neutrality on procurement model is appropriate as a matter of principle and should be retained: contracting authorities must remain free to choose the model that fits the project. The accompanying guidance and GPP criteria should be revised to make the procurement-model dependency explicit, with scope and granularity calibrated to contractor influence, product-level versus project-level criteria weighted differently across DBB, D&B and ECI, and award mechanisms (weighted MEAT versus shadow pricing) deployed to fit each model, calibrated in each case to have a meaningful influence on the tender outcome. The Commission's GPP toolkit should accordingly be restructured around procurement-model-specific guidance for the construction sector, not solely by asset type. Several national authorities (e.g. Netherlands, France, Sweden) have already moved in this direction, while the EU-level guidance has not. A revised legislative framework accompanied by procurement-model-specific GPP guidance would give contracting authorities a defensible basis for selecting and operating the model best suited to the carbon ambition of each project, and would give contractors clarity on the rules under which they will be evaluated[8]. From a contractor perspective, this change at EU level would do most to convert procurement model choice from a procedural matter into a deliberate carbon lever.

Priority 2 — A proportionate and phased pathway towards best practice of CO_2e assessment

The 2014 Public Procurement Directive treats environmental considerations as enabling provisions, allowing contracting authorities to apply quality and environmental criteria but not requiring them to address CO_2 emissions specifically. The complementary EU GPP toolkit, including sectoral criteria for road and building construction, has been useful but its voluntary status has produced uneven uptake. Member States with strong national mandates such as Sweden's Klimatkalkyl and the Netherlands' DuboCalc and ECI approach have moved well beyond the voluntary GPP baseline; many other Member States have not. The forthcoming revision of the

[8] There are contractual schemes currently under development that can help in this process (notably the FIDIC Carbon Management Guidelines, NECX29).

legislative framework presents an opportunity to move towards CO_2e assessment as a clearer feature of public works tenders through a proportionate and phased approach. The process and resulting requirements should apply suitable value thresholds and consider the effective scale depending on the type of project, the procurement model, the influence of the contractor, and the practical (administrative) capacity of contracting authorities and contractors. This should extend through to contractual delivery so that carbon commitments made at bid stage are monitored and delivered during execution, supported by emerging contractual frameworks. A phased trajectory towards requirements, allowing Member States to begin with prescriptive product-level requirements (such as minimum clinker substitution for cement and concrete) and move to project-level performance criteria as data and capacity mature, would embed carbon as a routine procurement consideration without imposing a uniform calculation burden on contracting authorities or contractors before the data infrastructure can support it. For this trajectory to translate into actual abatement, carbon performance should be weighted in a way that gives it a meaningful influence on tender evaluation, anchored in the project-specific emission drivers on which the bid was evaluated, and carried into contract execution as an enforceable deliverable with proportionate bonus/malus at completion. Only when this link between award criteria, contractual obligations and project-specific emission drivers is strengthened does the shift from prescriptive to performance-based criteria deliver the reductions it is designed to enable. The Commission should investigate the possibility of establishing a common method for the calculation of life-cycle costs, as foreseen in Article 68 of the current Directive 2014/24/EU.

Priority 3 — Strengthen the EU methodological and database framework through interoperability

The layered architecture (common methodology at EU level, sector-validated databases at sectoral or national level, common tools per project) is largely in place for buildings. Here, the methodological level is defined in the European LCA standards and the Level(s) framework and will be reinforced from 2028 by the Whole Life Carbon disclosure requirement under the recast EPBD. For infrastructure construction, the granularity of methodology standards varies across sub-sectors. A key remaining gap sits at the data layer: national databases operate in parallel and produce divergent results for substantively the same products and processes, which weakens comparability across borders and complicates cross-border bidding even where methodology is aligned. From a single market perspective, this is where EU-level action could be most helpful. The Commission could support, through existing instruments such as the LIFE programme and the Technical Support Instrument, the development of an openly accessible interoperability layer between national databases, with shared conventions for upstream emission factors, transport, electricity mix and end-of-life modelling. This work could usefully be coordinated with the revised Construction Products Regulation, which already provides for environmental information on construction products to be declared in harmonised form, and with the Ecodesign for Sustainable Products Regulation, under which secondary legislation is expected to set product-specific carbon-related requirements for cement and steel. Aligning procurement-side data with these product-side instruments would help avoid parallel and inconsistent regimes for the same materials.

Priority 4 — Underpin frameworks with accessibility, formal recognition and coordinated capacity building

A consistent observation across the study is that frameworks have limits in practice not because they are poorly designed but because the conditions for their use are missing and carbon management is not integrated along the broader design and decision-making process. Tools may be costly or restricted in their user base, recognition by contracting

authorities may be limited, and procurement officers, designers and bidders may not have the guidance or training to operate them. These three gaps reinforce one another: a tool that is free but not formally recognised will not be used, recognition without accessibility excludes SMEs, and accessibility and recognition together still yield poor outcomes if the people on both sides of the tender lack the capability to apply the framework.

EU-level action on each of these would strengthen the others. On accessibility and recognition, the Commission could maintain and resource the EU GPP helpdesk and multilingual toolkit as a publicly available reference, coordinate with Member States on the formal recognition of national tools that align to a common methodological framework (along the lines of France's recognition of SEVE-TP in 2025), and ensure that any future binding requirements under the revised legislative framework can be discharged through more than one recognised tool, to avoid lock-in to a single proprietary platform. A mutual-recognition provision for assessment tools meeting common methodological criteria would build on the equivalent-means-of-proof logic already present in the current Directive and would give cross-border bidders confidence that a tool recognised in one Member State is accepted in another.

On capacity, the Commission could mobilise existing instruments such as the Technical Support Instrument, LIFE Clean Energy Transition and the European Social Fund Plus to co-finance Member State training programmes for procurement officers, designers and the supply chain, with materials developed jointly with sector federations including FIEC, EIC and EuDA. In parallel, initiating a process for moving towards the development of standardised model tender documents (covering harmonised foundations for scope definition, product-level versus project-level criteria, shadow pricing and bonus/malus mechanisms) could help lower the entry cost for contracting authorities adopting CO_2e assessment for the first time and would reduce the variability of carbon clauses across the internal market. Without coordinated action across all three elements, the methodological frameworks recommended in Parts 1 and 2 are likely to outpace the conditions needed to apply them.

ANNEX 1 – FACT SHEETS ON CO_2E ASSESSMENT FRAMEWORKS

This Annex consolidates all fact sheets produced during the in-depth analysis. The accompanying legend outlines the key elements used to differentiate between fact sheet types.

Legend: Key elements for Fact Sheet Identification	
Type of framework	
Methodology	**Dataset**
Tool	**Certification scheme**
Covered sectors	
Rail	**Other engineering works**
Road	**Buildings**
Regulatory status of the framework	
Mandatory framework	**Voluntary framework**

Fact sheet – FTIA: Low Carbon Assessment Method for Infrastructure Construction (FI)

FACT SHEET – FTIA: Low Carbon Assessment Method for Infrastructure Construction – Finland (FI)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	In Finland, the carbon footprint assessment of infrastructure projects is based on the Finnish Transport Infrastructure Agency's (FTIA) low-carbon assessment method for infrastructure construction (VO 43/2023), which in turn is grounded in European standards for sustainable construction (including EN 15643, EN 15804, and EN 17472). Standard EN 17472 structures the infrastructure life-cycle into modules and defines their system boundaries. In line with the standard, the assessment is based on scenarios representing the life-cycle phases of the infrastructure under review (VO 43/2023). Under the method, the emissions from construction (life-cycle stages A1–A5) and from replacement of construction products (life-cycle stage B4) are assessed over 30- and 50-year service periods. The **method does not require the use of a specific tool**, but FTIA and ELY Centre projects use the *Ihku* calculation service (infrastructure cost calculation). *Ihku* automatically calculates construction-phase emissions alongside cost estimation, but it does not calculate the emissions or costs of product replacement. The assessment is required for all FTIA and ELY Centre projects for which a project appraisal is prepared. For contracts starting in 2025 where a project appraisal was prepared during the design phase, a requirement has entered into force to collect real-time data for the monitoring and reporting of actual CO_2 emissions during contract execution. The data are used to track the project's emissions and to verify emission-reduction measures throughout implementation.
1.2 Methodological definition	A life-cycle carbon accounting methodology defining: • system boundaries • life-cycle modules • functional units • mandatory assumptions and datasets • reporting and verification rules It is **not**: • Not a certification scheme • Not an organisational decarbonisation framework • Not a procurement scoring tool (though its results feed procurement decisions)

2. System Boundaries & Technical Specification

2.1 Life-cycle modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
	✓	✓	✓	✓	✓				✓									

	Any caveats on the system boundaries	NA.
	LULUC included?	Excluded.
	Biogenic carbon quantified?	Not quantified.
2.2 Functional unit	One infrastructure asset (specific scope defined per project), evaluated over defined lifetime (30–50 years). Functional unit would be kg CO_2e.	
2.3 Data sources	• Emission data can be obtained from the national emissions databases for infrastructure construction and building construction, which describe the emissions of typical products used in Finland. If specific products are known, Environmental Product Declarations (EPDs) for construction products or equivalent climate reports may also be utilised, provided that the use of specific emission factor data is justified. • For estimating the number of working hours for site activities, users may refer to estimates per construction element from the *Ihku* System, contractor-provided data, or information from similar projects. • If emission factor data for a project-relevant input is unavailable from the specified sources, alternative data may be used, provided it is clearly stated in the calculation report, along with an assessment of its reliability and relevance (e.g., recency and geographical applicability).	
3. Implementation tools		
3.1 Implementation	• The *Ihku* system calculates emissions by multiplying activity data (e.g., material volumes, transport distances) by standardised emission factors from the SYKE national database. • It integrates with the design and procurement process, with data entry structured by project phase: early stages use high-level quantities (e.g., bulk earthworks), while procurement and construction phases require detailed inputs (e.g., plant fuel use, component lists). • For contracts starting in 2025, real-time emission monitoring is mandatory, with standardised Excel templates and the Velho system used for data collection and reporting. • Results inform cost-benefit analyses, guide procurement decisions, and enable benchmarking of emission efficiency across projects.	
3.2 Scenarios and assumptions	• Uses standardised emission factors maintained by Finnish Environment Institute (SYKE) but can be replaced with project-specific data. • The methodology does not contain predefined scenarios.	
3.3 Data submission requirements	During the project execution phase, real-time data must be collected on the following inputs and their resulting CO_2e emissions: • CO_2e emissions based on the actual quantities of construction materials and products used. • Emissions from both internal and external transportation of materials, masses, products, and waste, calculated based on actual transport distances and load factors.	

	• Work performance (Work stages). The carbon footprint of work stages consists of the energy/fuel consumption of the machinery and equipment used on-site. This can be calculated based on either actual consumption or the average consumption of the specific machine and actual operating hours. • The actual electricity and heating energy consumption of the construction site. The data must be applicable for monitoring project emissions during execution, e.g., for tracking annual emission targets. A report will be compiled from the results, presenting, among other things, the total construction emissions and the most significant emission reduction measures implemented in the contract, along with their impact on CO_2e emissions.
4. Degree of adoption	
4.1 Maturity level	• The method has transitioned from piloting (2022–2023) to mandatory implementation as of November 1, 2023. • It is currently in a phase of continuous refinement based on user experience. It used as the default for every new design tender and also construction projects that have had emission calculated by the method are required to monitor emissions during construction.
4.2 Project types affected	• FTIA methodology is mandatory for all FTIA and ELY Centre planning projects that require project appraisal. Project appraisals in Finland are typically required for large-scale infrastructure developments (generally above a ~€2 million threshold) and cover roads, railways, streets, and parks commissioned by the FTIA and ELY Centres. • For contracts starting in 2025 where a project appraisal was prepared during the design phase, a requirement has entered into force to collect real-time data for the monitoring and reporting of actual CO_2 emissions during contract execution. • The data are used to track the project's emissions and to verify emission-reduction measures throughout implementation.
4.3 Adoption level	• In 2025, 30 formal project assessments utilised the low-carbon methodology. • A recent analysis[9] by the Finnish Environment Institute (SYKE) compiled data from approximately 500 projects from recent years where method has been applied.
5. Procurement integration	
5.1 Relevant procurement models	• Framework not developed for a specific procurement model. FTIA works with DBB, Design&Build and integrated project delivery models (e.g., Project Alliance model).

5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	✕	While shadow carbon costs are used in socio-economic project appraisals to evaluate viability, they are not yet integrated into the comparative price of contracts, though this is being piloted (Vt6 Koria). The project piloted an incentive model that successfully achieved emission reductions. One key area for these reductions was the use of low-carbon binders.

[9] As of March 2026, this report has not been published yet and can therefore not be referenced here. We will check and update this again for the final version of the report.

• **Shadow pricing**	✓	The EU shadow price of CO_2 is applied to both transport and construction emissions. For construction emissions, the internalised share is estimated using the forecasted EU ETS allowance price, from which the estimated allowance price component is deducted from the full shadow price. As distinguishing the precise cost components affected by the EU ETS is challenging, this deduction is applied uniformly across all costs.
• **Baseline**	✕	Incentive models for contractors have been developed for the procurement phase, though they have not yet been piloted. These models commence with the client establishing a baseline using general data from the CO_2data database, which serves as a benchmark for contractors to refine their calculations and propose emission reduction measures. A standardised methodology is essential to ensure equitable and comparable evaluations. The calculation process involves an initial baseline followed by contractor refinement using specific Environmental Product Declaration (EPD) data. During the bidding phase, these incentive models are integrated into the quality evaluation. Contractors are awarded points based on the volume of emission savings they commit to delivering. To ensure accountability, sanctions or partial penalties are imposed if the committed emission savings are not realised during project execution.
• **Variants / value engineering**	✓	Used to compare alternative designs early on in the project.
5.3 Monitoring	• Monitoring is done by saving standardised Excel sheets and reports into the Velho information system. • For contracts starting in 2025, where a project appraisal was prepared during the design phase, a requirement has entered into force to collect real-time data for the monitoring and reporting of actual CO_2 emissions during contract execution.	
5.4 Verification rules	• Checked by FTIA reviewers. • For contracts starting in 2025 where a project appraisal was prepared during the design phase, a requirement has entered into force to collect real-time data for the monitoring and reporting of actual CO_2 emissions during contract execution.	
5.5 Enforcement	• To ensure accountability for the incentive structures (developed, but not piloted yet), a sanction or partial penalty is imposed if the emission savings presented during the tender phase are not realised during the project.	
6. Strengths, limitations and risks		
6.1 Strengths	• **Technology-neutral and standardised approach**: The framework provides clear, non-discriminatory instructions on how to perform calculations and report results. This ensures consistency while allowing for the methodology to be updated without technical limitations. • **Utilisation of open and industry-standardised data:** A significant strength is that the assessment relies on an open-access emission database. This database has been adopted as the industry-standardised source for emission data, a practice that has also been recognised as a "best practice" across other Nordic countries. • **Seamless integration with the IHKU system**: The methodology is directly linked to the IHKU system (the national infrastructure cost calculation system). This allows	

	for the simultaneous and uniform linking of emission data and cost data, enabling the use of diverse indicators. • **Enhanced benchmarking and emission efficiency**: By correlating emissions with outputs or monetary values (e.g., CO_2e/€), the framework provides a broader perspective on emission efficiency. This allows for long-term tracking of how emissions develop across different project types. • **Comparability and integration into CBA**: The harmonised and comparable nature of the assessments allows emission data to be integrated into broader socio-economic evaluations (H/K-laskelmat). This ensures that the framework serves multiple strategic needs beyond simple carbon accounting. • **Strong institutional backing**: The framework is already widely utilised by major public clients, ensuring its reliability and long-term viability in large-scale infrastructure projects.
6.2 Limitations and risks	• **Scoping and Life-cycle Exclusions**: The framework currently excludes certain key emission sources, such as land-use change impacts (LULUC), biogenic carbon, and the decommissioning phase (Module C) for structures intended to be maintained. End-user traffic emissions (B8) are also excluded and must be assessed via separate appraisal methods. • **Data Granularity and Use of Generic Values**: The framework relies heavily on generic data from emission databases. As a project moves closer to the execution phase, the ability to incorporate specific alternative products or low-carbon solutions is limited, as the database values cannot represent individual commercial products. • **Varying Coverage Across Project Types**: The comprehensiveness of the calculation varies significantly depending on the project type. For instance, there are notable gaps in the IHKU system regarding emission calculations for certain major infrastructure components, such as tunnels. • **Precision and Influence at Different Design Stages**: It is critical to understand the level of precision required at different design stages. While the IHKU model allows for granular calculation even at the early stages (project-part level), there is a risk of "pseudo-precision" where the output looks more accurate than the underlying data justifies.
7. Examples and reference documents	
7.1 In-practice examples	
7.2 Reference documents	• Väylävirasto (2023). Infrarakentamisen vähähiilisyyden arviointimenetelmän luonnos kommenttikierrokselle • Väylävirasto (2025). Liikenneväylien korjausvelka 2025.

Fact sheet – Trafikverket: Klimatkalkyl (SE)

FACT SHEET – Trafikverket: Klimatkalkyl – Sweden (SE)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	Klimatkalkyl is a carbon-calculation framework developed and maintained by the Swedish Transport Administration (Trafikverket). It is used to estimate the life-cycle emissions of transport infrastructure projects, including roads, railways, and major civil works. The tool is primarily used by Trafikverket, consultants, and contractors during planning, design, and procurement phases of infrastructure projects. It provides a standardised method for calculating emissions from materials, construction activities, and maintenance over the project life-cycle. Klimatkalkyl supports Sweden's infrastructure climate policy by enabling carbon benchmarking, reduction targets in procurement, and climate reporting for publicly funded projects.
1.2 Methodological definition	Klimatkalkyl is both a calculation tool and methodological framework. It is implemented as a software tool with a standardised calculation structure. It includes a built-in database with emission factors and default data for common infrastructure materials and processes, maintained by the Swedish Transport Administration. The tool also allows users to refine calculations with project-specific data, including their own quantities and their own emission factors (which must be verified with an EPD). Key elements include: • A carbon-calculation framework developed and maintained by the Swedish Transport Administration (Trafikverket) for estimating life-cycle emissions of transport infrastructure projects. • A methodological framework based on Life Cycle Assessment (LCA) principles, aligned with ISO 14040/44, which supports standardised emission factor calculations and scenario comparisons. • An open-access software tool that integrates a built-in database of default emission factors and allows for project-specific data input (e.g., Environmental Product Declarations). Key elements do not include: • A certification tool.

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
✓	✓	✓	✓	✓		✓	✓	✓	✓								

Any caveats on the system boundaries	NA.
LULUC included?	Yes, emissions from deforestation (permanent and temporary) and emissions from peatland/wetland drainage (included since 2026). Other LULUC activities (land/farmland conversion) are not included.

		The tool does include the climate impact from soil excavation, but is limited to the emissions for the process (e.g. the emissions from machine engine/transport) and does not account for the loss of a potential carbon sink.
	Biogenic carbon quantified?	Yes. Permanent deforestation (722.05 kg CO_2e/m3 forest), Temporary usage of forest areas (fuels + stump cutting, 5.5 kg CO_2e/m3 forest) wetland drainage (varying factors depending on region and type) and wetland/peatland excavation (189.74 kg CO_2e/m3) are quantified.
2.2 Functional unit	The functional unit in Klimatkalkyl is the entire infrastructure project/asset (1 infrastructure project), assessed over a reference service life of 60 years that determines estimated maintenance and replacement activities. Results are also presented as annualised values. One variant of these values includes only components with a lifespan shorter than 60 years, and one includes all components regardless of lifespan.	
2.3 Data sources	Primarily secondary datasets provided in the tool's built-in database, which is maintained by Trafikverket. Primary data can be used when available to replace default values.	
3. Implementation tools		
3.1 Implementation	• **Klimatkalkyl** calculates emissions by multiplying project activity data (e.g., material volumes, transport distances, fuel use) by standardised emission factors from its built-in database. Users can refine calculations with project-specific quantities and project-specific emission factors, which must be verified by EPDs. • The tool integrates with the STA design and procurement process, with data structured by project phase: early stages use high-level quantities, while procurement and construction phases require detailed inputs (e.g., fuel use on site, component lists). • For projects exceeding 150 MSEK (50 MSEK until 2026), percentage-based CO_2 reduction targets are set relative to a 2015 baseline, verified via the tool. Contractors submit climate declarations using Klimatkalkyl, with supplier-specific EPDs required for key materials (steel, concrete, asphalt), as well as documentation for any other emission factors that deviate from the standard default values. • Real-time monitoring and reporting are mandatory for compliance, with bonuses for exceeding targets and penalties for underperformance. The STA uses the tool to track progress towards national climate goals, including fossil-free infrastructure by 2040.	
3.2 Scenarios and assumptions	• Klimatkalkyl uses standardised emission factors and default datasets in its built-in database maintained by the Swedish Transport Administration, but can be replaced with project-specific data. • The tool does not contain predefined scenario modelling functions. Instead, users can create and compare different project calculations manually (e.g., different design options, materials, or construction methods) by setting up separate calculations.	
3.3 Data submission requirements	• Klimatkalkyl requires the submission of a climate declaration for all development projects exceeding 50 million SEK. • This declaration must be generated using the Klimatkalkyl tool and include both default and supplier-specific emission factors, verified through third-party certified Environmental Product Declarations (EPDs) conforming to EN 15804 standards.	
4. Degree of adoption		

4.1 Maturity level	• The framework was initially implemented in 2015. Since then, both the tool and the framework have been updated regularly.
4.2 Project types affected	Carbon assessments using Klimatkalkyl are required by the Swedish Transport Administration for all projects in the National Transport Plan, as well as projects over 50 million SEK. Specific requirements include: • For STA projects with an investment cost ≥150 MSEK, requirements include percentage-based CO_2 reduction relative to a baseline calculation. • For STA projects below 150 MSEK, procurement typically applies specific requirements for materials, fuels, vehicles, and construction machinery rather than percentage reduction targets. More information below. • Carbon assessments are mandatory for STA projects ≥50 million SEK.
4.3 Adoption level	• Widely applied in projects commissioned by the Swedish Transport Administration, where climate calculations (using Klimatkalkyl) are used to set baselines and verify emission reductions in contracts. • Overall, the projects completed to date that have been subject to percentage reduction requirements have reduced emissions significantly more than the targets set. • In 2025, projects with percentage reduction requirements (and thereby those for which calculations were mandatory) are estimated to account for approximately 43% of the procurement budget for larger investment projects (>1 billion SEK) and around 20% of the procurement budget for other new investment/development projects.

5. Procurement integration		
5.1 Relevant procurement models	• Klimatkalkyl is not developed for a specific procurement model. The sector mainly uses DBB and D&B, with some use of collaborative/alliance approaches in recent projects while PPP is relatively rare in Swedish transport infrastructure procurement.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	✕	No. Considerations of CO_2e-footprints/GWP are currently not included as award criteria in public procurement projects by STA. Instead, they are included as requirements. Exceptions are possible with special innovation procurements.
• **Shadow pricing**	✕	No, not part of procurement procedure.
• **Baseline**	✓	There are both fixed and benchmark requirements for CO_2. - For larger development projects (≥150 MSEK): requirements to reduce emissions in line with the Swedish Transport Administration's reduction targets, compared with a reference scenario based on 2015 emissions data (i.e. how climate impact would have occurred using 2015 practices), calculated using Klimatkalkyl. The percentage reduction requirement is decided by STA based on a proposal from the contractor, and can be adjusted according to the project's level of difficulty and technical requirements. The average reduction in climate impact across all contracts in a given year should meet the established target levels (see above). By

		using project requirements that apply to what should be done, not how it should be done, the intention is to create room for innovation. - In addition to project-level requirements, there are fixed CO_2 requirements for certain products (steel, concrete and cement, asphalt; phases A1-A3) and vehicles, working equipment and fuels. These requirements apply to all projects regardless of size and type (new development or maintenance) - From 2030 onwards, a requirement of 100% renewable fuel applies, regardless of the size of the measure or project. The requirements are continuously improved based on experience from their use, developments in the market, and collaboration within the industry.
• **Variants / value engineering**	✓	Klimatkalkyl does not include predefined scenario modelling functions; however, it enables users to assess and compare variants through manual calculations by creating separate project scenarios within the tool. This allows practitioners to evaluate different design options, materials, or construction methods, facilitating value engineering and comparative analysis to identify optimal solutions for emission reduction.
5.3 Monitoring	• Monitoring in Klimatkalkyl is conducted through the systematic tracking of climate declarations submitted by contractors, which detail the CO_2 levels and effectiveness of implemented emission reduction measures compared to the 2015 baseline. • STA is developing a structured digital system for managing climate declarations, which aims to facilitate annual aggregated monitoring of total climate impacts across construction, operation, and maintenance phases. Further improvements, such as digital delivery notes for fuel reporting and enhanced data transfer capabilities between tools like Geokalkyl and Klimatkalkyl, are also under consideration to streamline monitoring and reporting processes.	
5.4 Verification rules	• For project-level percentage emission reduction requirements (projects >150 MSEK), the contractor must generate a climate declaration using the Klimatkalkyl tool. Default emission factors can be replaced with supplier-specific emission factors, which are verified through a third-party certified EPD Type III that follows the EN 15804 standard (or in some cases other EPDs combined with production data covering at least 90% of the product's climate impact). Before completion of the contract, the contractor must submit a climate declaration for the project, showing CO_2 levels and the effect of implemented measures compared with the 2015 baseline (reference year). If substantial changes occur during the project, a revised baseline may be calculated to adjust the reference point. • Supplier-specific emission factors must always be provided for reinforcing steel, steel products, road and bridge railings, concrete, and asphalt mixtures used in the project. To verify an EPD of a certain material/product, the contractor submits a request via Klimatkalkyl tool (the "Verification" tab) and receives an approval by the STA's review function. • For fuel requirements, the STA provides a template where receipts and invoices must document the quantity and type of fuel used in the project. For reporting zero-emission vehicles, construction machinery, and rail-borne work machinery, a list must be submitted including information on the number of units and their powertrain	
5.5 Enforcement	• Enforcement in Klimatkalkyl is primarily achieved through a combination of bonuses and penalties, designed to ensure compliance with climate performance requirements. Bonuses are applied restrictively, proportionate to the cost of	

	mitigation measures and the extent of emission reductions achieved, particularly for projects exceeding their reduction targets. • Penalties, where applicable, are imposed when underperformance results in potential damage to the STA, calculated at 0.1% of the contract value for each percentage point of underperformance for projects with reduction requirements, capped at 1%. Penalties are not used for material-specific requirements.
6. Strengths, limitations and risks	
6.1 Strengths	• Strong methodological framework and tool (Klimatkalkyl) supports ambitious climate targets, including carbon neutrality by 2040 and interim goals. As Sweden's largest infrastructure client, the STA's clear policies and requirements strongly influence the wider construction sector. • Climate requirements have increased sectoral capacity, supporting stakeholders to understand better how to reduce emissions from infrastructure projects. • The tool includes the possibility of using default emission factors as well as product-specific data from supplier EPDs. • Continuous adjustments and improvement; the tool is updated every other year, and requirements are revised when needed. • Open access: Klimatkalkyl is freely available to all users, and is user-friendly, also to non-experts. • Strong industry collaboration: the STA is a signatory of the Fossil-Free Sweden roadmap for a fossil-free construction and civil engineering sector.
6.2 Limitations and risks	• Limited integration and usability: the process is relatively manual, and all users must conduct CO_2 assessments using Klimatkalkyl (STA's tool). This limits innovation and usability compared to a framework where multiple tools and integrations (e.g., via APIs) could be used. • Incomplete land-use accounting: while deforestation and peatland/wetland conversion are now included, conversion of farmland is not. This may skew CO_2 assessments when choosing between routing a road through wetlands or agricultural land. • Monitoring and enforcement challenges: climate measures are implemented in projects, but the climate requirements set in procurement are not always met. Both the STA and contractors call for a simpler follow-up process, as current monitoring is perceived as time-consuming and data-intensive. • Time lag in calculations: the current system does not account for potential CO_2 reductions that may occur between the time of the climate calculation and the actual construction phase.
7. Examples and reference documents	
7.1 In-practice examples	• N/A. All tenders have CO_2 elements, so no specific projects to be highlighted here.
7.2 Reference documents	• Trafikverket (2026). Climate calculation – infrastructure's climate impact and energy use in a life cycle perspective • Trafikverket (2025). Trafikverkets klimatkrav • Trafikverket (2022). TDOK 2015:0007

	• Trafikverket (2024). Rapport: Klimatkalkyl – Beräkning av infrastrukturens klimatpåverkan och energianvändning i ett livscykelperspektiv

Fact sheet – Rijkswaterstaat: Aanpak Duurzaam GWW / DuboCalc (NL)

FACT SHEET – Rijkswaterstaat: Aanpaak Duurzaam GWW / DuboCalc (NL)

Framework components:

Sector: ( )

Regulatory status:

1. Purpose and nature

1.1 Summary	Duurzaam bouwen Calculator (DuboCalc), developed as part of the Sustainable Civil Engineering Approach (Aanpak Duurzaam GWW), is a tool for mapping environmental costs. It is accompanied by a database, the National Environmental Database for its calculations. DuboCalc is based on the Life Cycle Assessment (LCA) calculation methodology specified in the SBK Determination Method for the Environmental Performance of Buildings and Structures. Sustainable Civil Engineering is a partnership between market players, government clients, and knowledge institutes to achieve sustainability goals in the civil engineering sector. In infrastructure projects by Rijkswaterstaat, the sustainability of the design and the implementation of the tender itself is an award criterion. This is done based on the Environmental Cost Indicator (ECI). The ECI value allows for an objective comparison of different designs and/or tenders.
1.2 Methodological definition	**DuboCalc** is both a tool and an integrated methodology, provided as an Excel or web-based calculator with an embedded database of emission factors, following ISO 14040/44 life-cycle assessment principles and the Dutch environmental performance method. It is widely used by **Rijkswaterstaat** to evaluate the sustainability of infrastructure projects. Key elements of the framework include: • A structured Excel or web-based calculator with an embedded database of emission factors, known as the **National Environmental Database** • Compliance with **ISO 14040/44** and alignment with **EN 15804/15978** standards for environmental performance assessment • Integration within the **Sustainable Civil Engineering Approach (Aanpak Duurzaam GWW)**, a collaborative initiative involving market players, government clients, and knowledge institutes • Life-cycle assessment (LCA) methodology consistent with international standards, facilitating objective comparisons of designs and tenders • Support for sustainability goals, including the reuse of materials, reduction of primary raw materials, and selection of low-CO_2 working methods Key elements **do not** include: • A certification tool (even though DuboCalc is often combined with a certification tool, the CO_2 Performance Ladder[10]).

2. System Boundaries & Technical Specification

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D

[10] For more information on the CO_2 Performance Ladder, please see: link

2.1 Life-cycle modules	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	(✓)		✓	✓	✓	✓	✓
	Any caveats on the system boundaries	RWS applies all life-cycle modules (A–D) in almost all projects, whereas ProRail typically covers A1–A5 (materials+construction).																
	LULUC included?	Included, weight = 0.116 €/kg CO_2e																
	Biogenic carbon quantified?	Included, weight = 0.116 €/kg CO_2e																
2.2 Functional unit	Environment Cost Indicator is calculated in € across life-cycle: for construction, operation and management, and end of life. Lifetime is defined on product level. It is based on 11 environmental effects.																	
2.3 Data sources	• DuboCalc uses the National Environmental Database for its calculations. This database is managed by the National Environmental Database Foundation. The NMD Foundation is an independent organisation that facilitates consistent calculations of the environmental performance of buildings in the Netherlands. • This is a secondary database of vetted product/process LCA entries (often based on Ecoinvent, industry EPDs, etc.). By default, the built-in library references NMD category-3 (generic) data. Contractors may supply primary LCA data for unique designs, but only if reviewed by a certified LCA expert. All submitted calculations must clearly show which NMD entries were used (via the DuboCalc standard report and Excel export).																
3. Implementation tools																		
3.1 Implementation	• The Procurement Process: • A) RWS provides organisations that have expressed an interest in bidding with a document containing: the functional specifications including a minimum and maximum ECI value, between which the bidders can submit proposals for discounts; the DuboCalc assessment tool; a description of how to use DuboCalc as a design tool; and the calculation procedure to monetise the ECI value. • B) Bidders submit an offer with a description of the solution: A project (e.g. civil engineering) design, which is optimised using DuboCalc as a design tool. This also includes a description of materials including the quantity, transport distances and working processes. At this time tenderers also submit their price quotes along with the ECI value generated by DuboCalc and which rung of the CO_2 performance ladder their offer would correspond to. • C) Each bidder's quote is then reduced according to the ECI values of their designs (the lower the environmental impact, the higher the ECI value (an inverse calculation)) and according to their level of commitment to reducing CO_2 emissions (the greater the ambition, the greater the price reduction). The project is awarded to the bidder with the lowest adjusted quoted price. By monetising efforts made to reduce environmental externalities in this way and deducting them from the quoted prices as part of the assessment, tenderers with the best quality offers have a higher chance of winning the tender.																
3.2 Scenarios and assumptions	• DuboCalc lets users model a project's life-cycle (construction, use, end-of-life) and calculates all material/energy inputs via Life Cycle Assessment (LCA) methodology.																	

	• It converts those impacts (including CO_2) into a single Environmental Cost Indicator (ECI) – a monetary "shadow price" score. • The DuboCalc database ("bibliotheek") contains standardised items (e.g. "1 m³ concrete" or "1 pile (steel)") with validated LCA data. Users can also enter project-specific LCA data (category-1) subject to validation.	
3.3 Data submission requirements	• Bidders submit their DuboCalc results as follows: (a) the DuboCalc calculation file (extension .pdc), and (b) the auto-generated "Standard Report" (PDF) plus "Total Overview" (Excel) from the DuboCalc "Report" function. These documents list all inputs and the ECI breakdown, ensuring transparency. The protocol mandates these outputs so the authority can fully replicate/inspect the calculation.	
4. Degree of adoption		
4.1 Maturity level	• DuboCalc is a mature and widely adopted software tool in the Netherlands, specifically designed for calculating the sustainability and environmental costs of civil engineering works (Grond, Weg en Waterbouw, or GWW). • DuboCalc/ECI is not mandated by law, but RWS has made it standard practice. Since about 2012 RWS has required bidders to submit an ECI calculation with tenders that include sustainability (EMVI) criteria. • The central government's general sustainable procurement rules (MVI) have applied since 2010, and RWS specifically includes ECI in its Best Price-Quality (EMVI/BPKV) tenders.	
4.2 Project types affected	• All infrastructure projects / engineering works by Rijkswaterstaat. • Additionally, the tool is used for local / regional road projects, as well as rail (through ProRail).	
4.3 Adoption level	• DuboCalc is widely adopted in the Netherlands. It is a standard tool for calculating environmental costs in tenders, mandated or recommended by Rijkswaterstaat and other contracting authorities for projects involving ground, road, rail and water construction.	
5. Procurement integration		
5.1 Relevant procurement models	• DuboCalc can be applied across DBB, D&B and ECI, all three models are worked with by Rijkswaterstaat. DuboCalc was not developed with a specific procurement model in mind.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	✓	The ECI forms part of the award criteria, as projects are assessed based on their ECI performance, which translates into a fictitious discount within the Most Economically Advantageous Tender (MEAT) evaluation. However, the magnitude of this discount remains subject to debate and is influenced by the type and complexity of the project. To ensure validity, a mandatory reduction of at least 25% from the reference ECI value is required for a tender to qualify. Failure to meet this threshold results in disqualification. This requirement incentivises contractors to transition from generic to project-specific or sector-specific

		data, as the use of such tailored data inherently reduces the ECI value—generic data being typically augmented by a 30% addition. Once the 25% reduction threshold is achieved, contractors become eligible for rewards based on further ECI reductions. The reward structure is designed to increase incrementally as the ECI value decreases, encouraging contractors to initially implement simpler and more cost-effective sustainability measures while also allowing for more substantial investments to further reduce environmental impacts. Consequently, the financial benefits associated with ECI reduction grow as the ECI value diminishes, fostering continuous improvement.
• **Shadow pricing**	✓	Yes, shadow price is set on the basis of these environmental costs, via the MEAT approach. While this is a fictional price, it results in a potential discount.
• **Baseline**	✓	Within projects, the ECI reference value serves as the baseline, establishing the upper limit of the evaluation graph and the starting point for assessment. This reference value is derived from generic data, providing a standardised benchmark for all participants.
• **Variants / value engineering**	✓	Contractors use DuboCalc early on to optimise designs. After construction, RWS verifies the delivered ECI. No value engineering during construction phases by contractors.
5.3 Monitoring	• Rijkswaterstaat and the contractor work in partnership to track progress against the predefined environmental cost targets. This oversight is conducted through a systematic, system-oriented contract management approach. Rather than conducting direct compliance checks, lead auditors apply the SCB (System-oriented Contract Management) methodology to evaluate the effectiveness of the contractor's quality management system. This ensures that the delivered outcomes consistently meet the required quality standards. • The SCB methodology is now applied across all procurement contracts where quality management is a contractual obligation. In the civil engineering sector, this approach is nearly universal, reflecting its critical role in maintaining high standards. Under this system, the contractor assumes primary responsibility for the quality of the delivered products. Rijkswaterstaat facilitates this process by engaging in ongoing discussions with the contractor, addressing potential risks, and reviewing (partial) deliverables. Regular assessments are conducted to validate the contractor's adherence to quality requirements throughout the project life-cycle.	
5.4 Verification rules	• Submitted DuboCalc data are subject to thorough review to ensure accuracy and compliance. Under the Rijkswaterstaat (RWS) Environmental Cost Indicator (ECI) Protocol, full transparency of all life-cycle assessment (LCA) data is required. Any custom data, categorised as Category 1, must be verified by a recognised LCA expert. • RWS reserves the right to audit the DuboCalc files provided by bidders. At the conclusion of the project, RWS assesses the actual ECI against the values proposed in the bid. Contractual terms generally bind bidders to the materials and processes outlined in their submissions, ensuring that any discrepancies are carefully evaluated. This approach reinforces the emphasis on transparency and sustainability within civil engineering projects.	
5.5 Enforcement	• The ECI score is treated as contractual. RWS states that the bidder's promised ECI becomes a contract requirement; the final ECI is checked at handover.	

	• If the ECI value is not reached with project realisation, then the contractor gets fined on the basis of their received fictional discount multiplied by a multiplier (e.g., 1.5x). However, this is a last step; at first, the aim is to solve problems informally and bilaterally.
6. Strengths, limitations and risks	
6.1 Strengths	• DuboCalc/ECI provides a standardised, quantitative way to include life-cycle CO_2 (and other impacts) in procurement. It also harmonises assessments across tenders and clients, replacing ad hoc qualitative ratings. By converting all impacts into a single indicator, it simplifies decision-making and enables clear "best-value" comparisons. The required LCA data library (NMD) ensures consistency of inputs • Using ECI "strongly contributed" to greening projects. It motivates bidders to propose greener solutions (e.g. recycled asphalt, low-carbon concrete, energy-efficient machinery) because lower ECI bids score higher.
6.2 Limitations and risks	• Future-oriented designs (e.g., wider bridges) might receive a lower ECI score, while they might actually be set up with future-oriented design to a larger extent. • One risk is that bidders "game" the system by focusing only on ECI rather than broader sustainability. Focusing solely on ECI may miss best solutions – e.g. a very durable, reusable design might not score lowest ECI if its upfront emissions are higher.
7. Examples and reference documents	
7.1 In-practice examples	• A12 Utrecht Lunetten Veenendaal - Highway widening by Rijkswaterstaat • A15 Maasvlakte - Vaanplein - Highway renewal by Rijkswaterstaat • A12 N61 Corner - Schoondijke - Motorway by Rijkswaterstaat • A12 Ede-Grijsoord by Rijkswaterstaat
7.2 Reference documents	• Rijkswaterstaat (2024). Protocol berekenen en aantonen MKI-waarde • PIANOo (2024). STAPPENPLAN: INKOPEN MET DE MKI - HET BEHALEN VAN DUURZAAMHEIDSDOELSTELLINGEN IN DE GWW • Rijkswaterstaat (2023). DuboCalc gebruik - Waar komen we vandaan? Waar gaan we heen?

Fact sheet – Infrastructure NSW: Decarbonising Infrastructure Delivery (AU)

FACT SHEET – Infrastructure NSW: Decarbonising infrastructure delivery – Australia (AU)

Framework components:

Regulatory status:

Sector:

1. Purpose and nature

1.1 Summary	The NSW Government introduced the **Decarbonising Infrastructure Delivery Policy** to regulate the embodied ("upfront") carbon emissions associated with major public infrastructure projects. Administered by Infrastructure NSW since its inception in April 2025, the policy stipulates that all state-led infrastructure projects exceeding specified financial thresholds must undergo a mandatory carbon assessment. Embodied carbon is assessed using a life-cycle methodology, aligned with international standards (PAS 2080, EN 15978/17472). Project teams utilise sector-specific instruments, such as the forthcoming NABERS Embodied Carbon Calculator for new buildings—which documents methods and factors according to the NABERS Emission Factors Database and the Transport for NSW Carbon Tool (with the upcoming Engineering Cost & Carbon Library for transport assets).
1.2 Methodological definition	The framework represents a dual structure, comprising both a policy directive and a technical protocol. The policy component, established by Infrastructure NSW, delineates mandatory requirements, while the technical guidance—embodied in the "Measurement Guidance" and associated documentation—defines the methodology and supporting tools. **Key elements include:** • A structured framework integrating policy mandates and technical methodologies • Compliance with international life-cycle assessment standards (PAS 2080, EN 15978/17472) • Sector-specific tools and calculators, including the NABERS Embodied Carbon Calculator and Transport for NSW Carbon Tool • An Excel-based NSW Embodied Carbon Databook for default emission factors and benchmarks • Data sources such as Environmental Product Declarations (EPDs) and national inventories **Key elements do not include:** • A certification tool

2. System Boundaries & Technical Specification

2.1 Life-cycle modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
	✓	✓	✓	✓	✓	(✓)	(✓)	(✓)	(✓)	(✓)				(✓)	(✓)	(✓)	(✓)	
	Any caveats on the system boundaries					The NSW methodology prioritises the assessment of "upfront carbon" (modules A1 to A5). Operational (in-use) emissions												

		(modules B) and end-of-life emissions (module C) are not mandatory under the current policy.
	LULUC included?	Module A5 captures emissions from vegetation clearing, and the guidance instructs users to report land use/LULUCF emissions separately if substantial.
	Biogenic carbon quantified?	Biogenic carbon, such as that sequestered in timber or soil, is explicitly accounted for within the framework. The protocol classifies total carbon into GWP-Fossil, GWP-Biogenic, and GWP-LULUC, with biogenic uptakes and removals tracked distinctly from fossil-based emissions.
2.2 Functional unit	All embodied carbon calculations must be performed using Global Warming Potential (GWP) over a 100-year time horizon (GWP100) in line with ISO 14067:2018. In practice, carbon results are usually reported as total kg or tonnes CO_2e per asset (often with the asset's design life assumed, or per year of service) so that alternatives of different scale can be compared on a consistent basis.	
2.3 Data sources	• The framework uses both primary and secondary data, prioritising actual project-specific information as it becomes available. The selection of data follows a strict data hierarchy, where more accurate primary data is preferred over generalised secondary benchmarks. Contractors are contractually required to provide this as-built data to enable accurate reporting at project completion. • Infrastructure NSW has worked with NABERS and Transport for NSW (TfNSW) to consolidate and align on the underlying emission factors and assumptions to enable consistent measurement of embodied carbon across asset types. • The NSW Embodied Carbon Databook workbook presents those harmonised emission factors that underpin the NABERS Embodied Carbon Calculator, the TfNSW Carbon Tool and the TfNSW Engineering Cost and Carbon Library. These factors and assumptions are presented in the Embodied Carbon Databook, to be used by projects beyond the building and transport sectors.	
3. Implementation tools		
3.1 Implementation	• Procurement of design and construction services is typically split: first consultants/designers are procured (including architects, engineers for pre-construction stages) and later contractors are procured for the works. In this framework, carbon evaluation begins in the planning/design phase (during business case and detailed design) and continues into construction. • The government treats the project life-cycle as at least three stages (consistent with NSW Treasury business case steps): Stage 1 (Business Case), Stage 2 (Design/Planning/Procurement), and Stage 3 (Construction/Completion). • Each stage has its own carbon reporting. Practically, contracts at each stage include carbon obligations: e.g. design consultants might need to submit carbon estimates, and building contractors must track and report the actual emissions of supplied materials. For longer-term life-cycle beyond construction (operation/maintenance), the current framework does not impose additional procurement actions, but agencies are encouraged to reduce whole-life carbon where possible.	
3.2 Scenarios and assumptions	• The framework primarily uses standardised emission factors; there are no adjustable emission scenarios. Emission factors come from up-to-date LCI datasets and EPDs.	

3.3 Data submission requirements	• Agencies and contractors must use the provided templates for submitting carbon data. The Carbon Management Plan (CMP) template – with sections for each project stage – is submitted at final business case. • In addition, a standardised reporting template collects the quantified emissions and assumptions. Both templates were released on the website of Infrastructure NSW[11].
4. Degree of adoption	
4.1 Maturity level	• The Embodied Carbon Measurement Guidance was first released in April 2024 (v1.0) and updated in June 2024 (v1.1) to align nationally, and again in April 2025 (v1.2) with templates. It was initially voluntary, but as of 4 April 2025 it became mandatory for eligible projects. • The framework has passed the pilot/voluntary phase and is now a formal requirement. Implementation details (e.g. KPIs, data dashboards) are still being refined as of 2026.
4.2 Project types affected	• All state-led infrastructure projects exceeding specified financial thresholds must undergo a mandatory carbon assessment, namely A$50 million or more for buildings projects, and A$100 million or more for linear infrastructure. • Compliance is obligatory for all NSW delivery agencies, including Transport for NSW, Health Infrastructure, and Education Infrastructure.
4.3 Adoption level	• The framework is new. Full adoption data is not yet published, but by design all large projects must comply. • Currently, the framework is in early rollout: so far, around six projects have shared documentation (mainly at the business case stage), with roughly ten more underway.
5. Procurement integration	
5.1 Relevant procurement models	• Infrastructure NSW uses a wide range of procurement models. Core methods include Construct Only (traditional DBB), Design & Construct (D&B), Incentivised Target Cost contracts, and Alliance/Managing Contractor models (ECI). The framework is not developed for a specific procurement model only.

5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	✕	Currently, carbon itself is not explicitly an award-scoring criterion in NSW tenders. The primary evaluation factors remain price, quality, schedule, and technical compliance. Embodied carbon enters the process as a mandatory requirement rather than a competitive differentiator. Bidders must demonstrate they will meet the project's carbon reduction targets (via the Carbon Management Plan) to be considered compliant.
• **Shadow pricing**	✓	The costs of emissions, and benefits of reduced emissions, must be included in CBA. In 2026, this carbon value is A$133 per tonne and will increase to A$350 per tonne by 2050.
• **Baseline**	✓	The framework provides baselines through benchmarks. These benchmarks allow early-stage estimation and carbon reduction targets. However, there are no fixed emission limits imposed. Instead, each project is expected to

[11] To access the templates, please click here: link

		set its own reduction target in its Carbon Management Plan that contractors ought to meet.
• **Variants / value engineering**	✓	In business case and option selection, teams calculate and compare the total embodied CO_2 of design alternatives. During contract procurement and construction, compliance is enforced: bidders must commit to the carbon targets and report on emissions**.**

5.3 Monitoring	• The policy requires monitoring embodied carbon at key milestones. Agencies must report carbon at three points: at Business Case (Stage 1), at Planning/Design/Procurement (Stage 2), and at Project Completion (Stage 3). This ensures actual delivery is tracked. • In practice, the contractor or project delivery team will update the Carbon Management Plan with as-built data for the final report. The department will then compare the Stage 3 results to the Stage 1/2 estimates. • Over time, this monitoring should reveal how well projects meet their reduction targets.
5.4 Verification rules	• Carbon data will be verified at practical completion as part of the data collation process and this process is still in development. Primarily self-assurance by delivery agencies, with the central team doing completeness/consistency checks and ad hoc deeper spot checks. There is no strict requirement for assessor qualifications at this stage. • However, usual business case review and Development Approval (DA) processes provide additional checks.
5.5 Enforcement	• There are currently no central penalties or fines for non-reporting/non-compliance. The approach is collaborative, with an emphasis on getting assessment to happen rather than creating burdensome requirements. • The policy does not define fines or cancellations specifically for carbon non-compliance. Instead, it is enforced by treating carbon measurement as a project deliverable (akin to safety or planning requirements).
6. Strengths, limitations and risks	
6.1 Strengths	• The framework incorporates a consistent, detailed approach to documentation and the use of specific tools throughout the project life-cycle. This includes the development of a Carbon Management Plan from the final business case stage, followed by carbon assessments and reporting at the detailed design and practical completion phases. • The framework emphasises consistency and harmonisation across projects and jurisdictions. It promotes the use of common reporting templates and the development of an Embodied Carbon Databook, which consolidates common emission factors and assumptions. • Focus is on implementation of the framework, set out to actively allow for low-carbon construction to emerge, rather than setting up a documentation exercise that does not drive outcomes.
6.2 Limitations and risks	• The framework sets a target of 80% completeness for carbon assessments to lower participation barriers. This focus on major elements achieves administrative burden reduction but also reduces the completeness of the carbon assessments.

	• No minimum carbon weighting in tender evaluation; treatment varies by project and may be folded into broader sustainability criteria.
7. Examples and reference documents	
7.1 In-practice examples	• Embedding carbon reduction in procurement: Sydney Metro City & Southwest (While not delivered by infrastructure NSW, this project still provides interesting insights). • Reusing and repurposing assets: Walsh Bay Arts Precinct • Using structural timber to reduce carbon – New Sydney Fish Market
7.2 Reference documents	• NSW Government (2025). Embodied Carbon Measurement for Infrastructure – Technical Guidance • NSW Government (2024). Decarbonising Infrastructure Delivery Policy • NSW Government (2025). Decarbonising Infrastructure Roadmap • NSW Government (2025). Decarbonising Infrastructure Delivery Policy – At a glance

Fact sheet – Vejdirektoratet: InfraLCA (DK)

FACT SHEET – Vejdirektoratet: InfraLCA – Denmark (DK)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature	
1.1 Summary	InfraLCA is Denmark's common LCA tool for infrastructure construction and maintenance. Its purpose is to give the Danish civil works sector a standardised, transparent, and uniform method for calculating environmental and climate impacts of infrastructure projects. InfraLCA was developed as a national initiative by Vejdirektoratet and Banedanmark. It is free to download and used by different actors, such as municipalities, consultants, contractors, etc. It is used for large and small road, rail, bridge and tunnel projects.
1.2 Methodological definition	InfraLCA is both a tool and a methodology, providing a standardised LCA structure with built-in datasets. It includes predefined material/process datasets and supports importing EPD-based primary data. Key elements of the framework **include**: • A structured Excel-based calculator with an embedded database of emission factors and default datasets, supplemented by user-imported EPD data • Compliance with EN 15804 and EN 15978 standards for infrastructure life-cycle assessment • Functional units defined by the user according to project requirements (e.g., road segments, bridges, or tunnels) Key elements do **not** include: • A certification tool • Legal enforcement mechanisms or penalties

2. System Boundaries & Technical Specification																			
2.1 Life-cycle modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D	
	✓	✓	✓	✓	✓				✓		✓			✓	✓	✓	✓	✓	
	Any caveats on the system boundaries					NA.													
	LULUC included?					Only from materials based on EPD data.													
	Biogenic carbon quantified?					Only from materials based on EPD data.													
2.2 Functional unit	The functional unit is the infrastructure project or asset (e.g. 1 road segment, 1 bridge, 1 km rail), which is defined by the user.																		
2.3 Data sources	• InfraLCA is designed around primary EPD data whenever available, supplemented with generic/default datasets included in the tool.																		

3. Implementation tools		
3.1 Implementation	• InfraLCA is used through all project phases. In early planning (phases 0–2), a basic CO_2 estimate is prepared using standardised reporting. After political approval (phases 3–5), a more detailed baseline is calculated, including any required climate measures, and all changes are logged in a climate change log. • During construction, contractors submit contract-specific EPDs. At completion, a total climate account and a post-calculation are prepared, and data is collected across projects to inform future climate measures.	
3.2 Scenarios and assumptions	• InfraLCA works with a combination of standardised emission factors, default modelling assumptions, and user-defined project data, ensuring comparability across Danish infrastructure projects while allowing refinement where high-quality data is available. • Users can adjust transport distances, quantities, maintenance intervals, and material choices to create project-specific scenario comparisons, although InfraLCA does not automate scenario modelling beyond this.	
3.3 Data submission requirements	• Clients may request the InfraLCA model file or results in reports. There are no national submission requirements.	
4. Degree of adoption		
4.1 Maturity level	• InfraLCA remains at an early stage of maturity. As it is not tied to legislation, it remains voluntarily and is continuously updated by Vejdirektoratet. As of now, Vejdirektoratet is experimenting with integration with procurement via pilot projects. • InfraLCA is gradually expanding climate requirements, including mandatory EPD documentation, to additional material groups. The intention is that eventually most materials included in infrastructure projects will require EPD-based climate documentation.	
4.2 Project types affected	• Vejdirektoratet applies InfraLCA in tenders for major road infrastructure projects. Banedanmark also uses it for its rail infrastructure projects.	
4.3 Adoption level	• Given its maturity and ongoing pilot projects and collaborative initiatives, adoption at larger scale remains limited as of now.	
5. Procurement integration		
5.1 Relevant procurement models	• Most infrastructure projects of the Danish Road Directorate are DBB (approximately 90%). InfraLCA is not developed with a specific procurement model in mind.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	×	No formal scoring criterion as of now. Instead, carbon assessment is for documentation only.

• **Shadow pricing**	✓	The Danish Road Directorate aims to select climate actions based on an expected CO_2 shadow price, defined as the socio-economic cost per tonne of CO_2 reduction. The Directorate has set a price of 200 DKK/t CO_2 during 2026.
• **Baseline**	✓	No fixed CO_2 limits or national benchmarks exist for Danish infrastructure procurement. Vejdirektoratet instead builds project-specific CO_2 baselines during early phases using EPD-based emission factors in InfraLCA. These baselines evolve as more EPDs are required in tenders.
• **Variants / value engineering**	(✓)	InfraLCA enables contractors to incorporate value engineering and alternative construction variants during the construction phase. While the tool itself does not prescribe or enforce specific optimisation strategies, it allows users to adjust construction scenarios, transport distances, maintenance cycles, and material choices to compare project-specific scenarios and refine design decisions. Contractors can submit EPDs of products used during construction, facilitating the evaluation of proposed design changes or material substitutions against the project's baseline LCA.

5.3 Monitoring	• The lists of materials and processes in InfraLCA are the same as the list of costs that the contractors need to provide for each project in order to get paid, making it easy to monitor over time.
5.4 Verification rules	• There is no formal verification mechanism because use of InfraLCA is voluntary. Verification depends entirely on tender-specific instructions.
5.5 Enforcement	• No penalties, bonuses, or enforcement mechanisms exist because CO_2 calculations are not legally required or incentivised.
6. Strengths, limitations and risks	
6.1 Strengths	• InfraLCA provides a standardised methodology enabling Danish infrastructure actors, such as Vejdirektoratet and Banedanmark, to document CO_2 calculations and assess the most effective strategies for reducing environmental impact. • The data structure is designed to mirror contractors' material lists, allowing for straightforward updates across different stages of project development.
6.2 Limitations and risks	• A recurring challenge is the difficulty in obtaining accurate EPD values for specific materials and assessing their data quality. Stakeholders may misinterpret LCA results as absolute truths, even though outcomes are highly dependent on data quality and assumptions—particularly in early design phases. • Since Denmark lacks legal CO_2 requirements for infrastructure, adoption is driven by Vejdirektoratet's own guidelines. Inconsistent alignment among infrastructure owners could diminish the tool's overall impact.
7. Examples and reference documents	
7.1 In-practice examples	• Vejdirektoratet (2019). Klimavenlig asfalt • Vejdirektoratet (2022). Nordhavnstunnel

7.2 Reference documents	• Sweco (2024). Dokumentation i InfraLCA skærpes • Vejdirektoratet (2022). The InfraLCA tool - Implementation • Vejdirektoratet (n.d.). The Danish Road Standards portal

Fact sheet – TII: Carbon Tool (IE)

FACT SHEET – TII: Carbon Tool – Ireland (IE)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	The TII Carbon Tool is a life-cycle carbon assessment tool and methodology developed by Transport Infrastructure Ireland (TII) to quantify CO_2 emissions for national road, greenway, and light-rail projects. It is used by TII and its contractors (design consultants, engineers) during project design and to monitor CO2 emissions during construction. While not included as an award criterion or shadow carbon price in public procurement, the tool encourages the use of low-carbon materials and construction methods by raising awareness of carbon hotspots, driving supplier engagement in reducing emissions.
1.2 Methodological definition	The TII framework is both a tool with integrated methodology, provided as an Excel or web-based calculator with an embedded database of emission factors, following ISO 14040/44 life-cycle assessment principles and the UK PAS 2080 standard for infrastructure carbon management. Key elements of the framework include: • A structured **Excel or web-based calculator** with an embedded database of emission factors • Compliance with **ISO 14040/44** and **UK PAS 2080** standards for infrastructure carbon management • **System boundaries** aligned with life-cycle assessment principles • **Life-cycle modules** for embodied and construction-phase emissions • **Functional units** tailored to road and light rail project requirements Key elements do not include: • A certification tool.

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	✓	✓	✓	✓	✓

Any caveats on the system boundaries	NA.
LULUC included?	Included as part of Pre-Construction, under 'Land Use Change and Vegetation Loss' assessed through the type and quantity of vegetation and planting that will be lost as part of the project.
Biogenic carbon quantified?	Not quantified.

2.2 Functional unit	One infrastructure asset (specific scope defined per project), evaluated over defined lifetime (default operational lifespan is 60 years). This includes operation and maintenance (including repair, replacement and refurbishment).
2.3 Data sources	• Primary supplier data is used where available during the project. Ahead of the project, secondary datasets from published LCA databases and regulations are used to calculate the baseline. • As part of this, the TII Carbon Tool uses an embedded factor library based largely on UK Government GHG conversion factors (annual update) and industry EPDs.
3. Implementation tools	
3.1 Implementation	• The TII Carbon Tool computes emissions by multiplying activity data by emission factors (Excel formulas or database lookups). • It integrates with TII's design process in that each TII project "phase" has a corresponding section of the tool (Concept, Design, Statutory, Procurement, Construction, Closeout). At early phases (Options, Preliminary Design) users enter high-level quantities (e.g. "bulk earthwork: 10,000 m^3"). • By procurement and construction phases, more detailed data are entered (plant fuel use, component lists, etc.).
3.2 Scenarios and assumptions	• The tool typically compares design scenarios against a business-as-usual baseline. • The user can define an alternative (against a "baseline" set by the client). • The tool itself uses fixed emission factors (no temporal scenarios) – it does not model future technology changes or decarbonising grids directly.
3.3 Data submission requirements	• Data is submitted via the standardised Carbon Tool templates. • Each phase of the project uses a provided spreadsheet or web form, which the project team completes and saves.
4. Degree of adoption	
4.1 Maturity level	• The TII Carbon Tool was initially developed and launched in 2018. • TII is taking a collaborative approach on implementation, with contractors working with TII to optimise the tool for future widespread adoption. At this stage, TII encourages contractors to propose as many reduction opportunities as possible, to further refine the tool and integrated carbon factors. They want to gather as much information as possible and learn from pilot projects.
4.2 Project types affected	• The projects affected will be any national road, light-rail or greenway project subject to EIA.
4.3 Adoption level	• Only used in a limited number of infrastructure projects as of now. The plan is for the TII Carbon Tool to be implemented at national level for national roads and light rail.
5. Procurement integration	
5.1 Relevant procurement models	• Ireland uses a mix of DBB, D&B, and some value-add build. Early contractor involvement is not standard but collaborative arrangements and design

	opportunities do occur in complex projects. TII Carbon Tool is not developed with a specific procurement model in mind.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	✕	No formal scoring criterion as of now. While TII is working on optimising low-carbon construction, this has not translated yet into award criteria specifically.
• **Shadow pricing**	✕	No shadow carbon price established as of now. It uses a modular whole-life carbon accounting with carbon emission factors, but no government-set carbon price.
• **Baseline**	✓	Baseline set up by client using non-project specific data ahead of the project. Then, during the project, contractors report carbon using actual data.
• **Variants / value engineering**	✓	TII Carbon Tool encourages finding carbon-saving measures (e.g. using recycled materials, optimising structures) before final design. During construction, progress is reviewed against the forecast CO_2 (e.g. construction teams may record actual material use to compare with estimates).
5.3 Monitoring	• Contractor provides data on a monthly basis. • CO_2 performance is monitored against the contractually defined carbon emission baseline. Reconciliation is done element-by-element.	
5.4 Verification rules	• Data entered in the tool must be backed by project records and calculations. • Following the baseline provided by the client containing high-level, generic data and carbon factors, the contractor conducts the carbon assessment during the project. • There is a monthly meeting between the contractor and the client during which they walk through every element of the carbon assessment reporting and provide all the necessary evidence to substantiate it. • No third-party mandatory verification, but TII does work with external consultants that conduct reviews of the reported carbon.	
5.5 Enforcement	• As implementation remains in a piloting phase, different mechanisms are set up for different projects. In some of the projects, incentives are provided for (1) reporting carbon, and (2) emissions falling below the baseline. • Some projects also incorporate penalty mechanisms in the form of fines if the baseline is not met, while others do not, with the specific approach depending on the contract between TII and the contractor.	
6. Strengths, limitations and risks		
6.1 Strengths	• Tailored to TII's project phases and types, making it user-friendly for transport engineers. • Raises awareness across the project team (client, contractor, subcontractors).	

	• Through its collaborative approach to the implementation of the tool, TII works with contractors to effectively develop and refine the tool. This benefits both the public authority and the contractors.
6.2 Limitations and risks	• Missing/ lack of tailored carbon factors in some cases (e.g., Personal Protective Equipment (PPE)) and some duplicate ones (e.g., multiple concrete factors with unclear differences). • Some of the innovations or materials proposed by the partners/contractors do not meet/fit the categories/standards/ requirements of the client. In case materials/solutions are not added to the tool yet, innovative solutions are hindered. • Without third-party verification, risk of strategic under-reporting
7. Examples and reference documents	
7.1 In-practice examples	• Tool is only being used for a limited number of pilot projects as of now. • Examples include projects such as the Adare Bypass[12] and the M28 Cork to Ringaskiddy project[13].
7.2 Reference documents	• Transport Infrastructure Ireland (2024). Transport Infrastructure Ireland Carbon Tool for Road, Greenway and Light Rail Projects: User Guidance Document GE-ENV-01106 • Transport Infrastructure Ireland (2022). TII Climate Guidance for National Roads, Light Rail, and Rural Cycleways (Offline & Greenways) – Overarching Technical Document (OTD) PE-ENV-01104-01 • Transport Infrastructure Ireland (2022). TII Climate Assessment of Proposed National Roads Projects - Standard (SD) PEENV-01105

[12] For more information on the Adare Bypass, see link

[13] For more information on the M28 project, see link

Fact sheet – Puertos del Estado: Carbon Footprint in Ports (ES)

FACT SHEET – Puertos del Estado: Methodology Guide for Carbon Footprint Assessment in Ports – Spain (ES)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	Spain's state ports authority (Puertos del Estado, PdE) has spearheaded a carbon-footprint framework for ports. First published in 2020 and updated in 2025, PdE published a methodology guide (Guía Metodológica) for port carbon accounting. Intended as an advisory instrument for port authorities, it does not prescribe a central database or automated tool; rather it references official emission factors (from Spain's Carbon Registry and other sources) and suggests using port data (fuel, energy, traffic). Developed with wide expert input from state ports, the climate office, and relevant ministries, its dual aims are: (1) to support each port authority in calculating its GHG emissions within system boundaries (Scopes 1–3) and (2) to enable the assessment of emissions across port-related freight chains.
1.2 Methodological definition	The framework spearheaded by Spain's state ports authority is a methodology guide rather than a software tool and database. Key elements of the framework include: • Alignment with ISO 14064 and the GHG Protocol scopes (1-3) • Defined system boundaries (Scopes 1-3), with the option to include upstream "well-to-tank" emissions • Calculation methods supported by official emission factors from Spain's Carbon Registry and other national sources • Use of port-level operational data (fuel, electricity, traffic) as the primary input for calculations Key elements **do not include:** • Life-cycle modules A1–A5, B1–B8, C1–C4 or D, since the framework is not structured as a building LCA • A central database or automated reporting tool; ports are instead expected to use their own operational data (fuel, energy, traffic) together with the official emission factors • Certification tool

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D

Any caveats on the system boundaries	The carbon framework led by PdE is not structured as a building LCA under EN 15978. It is designed as an organisational GHG inventory aligned with ISO 14064 and the GHG Protocol (Scopes

		1–3). As a result, it does not map to life-cycle modules A1–A5, B1–B8, C1–C4 or D.
	LULUC included?	LULUCF is not included, as ports do not manage relevant land-based carbon sinks.
	Biogenic carbon quantified?	Biogenic carbon is not quantified, since biomass fuels are considered as neutral in CO_2 emissions, with only CH_4 and N_2O being reported.
2.2 Functional unit	The framework does not define a single functional unit for CO_2 assessments. In port works, calculations can be carried out by just considering a limited number of materials with the highest carbon relevance, typically fill material from borrow pits, high-volume aggregates (graded riprap, all-in-one, rockfill), concrete (mass and reinforced), reinforcing steel, and materials used for paving breakwaters, esplanades and roads. For other carbon footprints, no fixed functional unit or lifetime is defined beyond per-year reporting.	
2.3 Data sources	• The methodology relies exclusively on secondary data. To estimate the emission factor associated with the production of each material, one or more publicly available databases, both free and paid, can be used. Among others, the Guide references the official emission factors published by the Spain's Carbon Footprint Registry. • Rather than prescribing a single central database or automated tool, the Guide advises users to select the most appropriate datasets for their context.	
3. Implementation tools		
3.1 Implementation	The approach is not an LCA of construction works. It is designed as an organisational GHG inventory aligned with ISO 14064 and the GHG Protocol (Scopes 1–3). As such, for port expansion and improvement works, the framework takes into account the following emission sources instead: 1. Cradle-to-gate emissions associated with the production of construction materials used in the works. 2. Well-to-wheel emissions resulting from transporting these materials from their production site to the construction site (and, where relevant, from transporting waste materials to landfill). 3. Well-to-wheel emissions produced by machinery and auxiliary equipment used on-site during the execution of the works. • CO_2 values are generated by multiplying activity data by the corresponding emission factors. • Puertos del Estado provides tables of default emission factors (for example, for diesel or LNG), which users apply directly to their activity data.	
3.2 Scenarios and assumptions	• The guide does not fix any common baselines or benchmarks for CO_2 at either the project or product level. • However, some port authorities have recently published tenders ("pliegos") including mandatory CO_2 ranges within which bidders must fall. Being outside these ranges, whether above or below, leads to disqualification or penalties.	

	• This is the case of the Port of Valencia, whose tender includes a specific CO_2 calculation formula and a fixed list of machinery and fuel consumption values that bidders must use when estimating their emissions.
3.3 Data submission requirements	• There are **no** specific requirements regarding the type or format of data that bidders must submit as part of the CO_2 assessment. The guide does not prescribe a standardised data-submission template or reporting tool. • In the case of the Port of Valencia tender, all bidders are required to use the same fixed CO_2 calculation formula and a list of pre-defined machinery and fuel-consumption values, which ensures that calculations follow a common approach, even in the absence of broader data-submission rules.
4. Degree of adoption	
4.1 Maturity level	• The carbon-footprint framework for ports remains in an early stage of development, having been first spearheaded in 2020, and later updated in 2025. • Because the methodology guide is non-binding, its adoption and the depth of implementation depend entirely on the discretion of each port authority. Ports are only beginning to pilot carbon-footprint calculations.
4.2 Project types affected	• The methodology guide is specifically developed for ports, thus its scope is limited to port-related operations, activities and projects. • Within port construction works, port expansion and improvement works are explicitly included. • It also includes the assessment of emissions across port-related freight chains, extending the analysis beyond individual projects to consider the broader movement of goods linked to port operations. • No formal requirements defining which projects must include CO_2 or GWP assessments.
4.3 Adoption level	• Adoption of CO_2 assessment practices in ports remains limited at this stage. Only a small number of ports have begun to engage with the methodology, and even these efforts are still at a pilot, exploratory level.
5. Procurement integration	
5.1 Relevant procurement models	• Contract models include traditional DBB and D&B for work. Framework is not designed to be tailored to a specific procurement model.

5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	×	CO_2 is not currently part of award scoring in the framework. Some port authorities (Port of Valencia) have recently published tenders ("pliegos") where there is a weighting assigned to CO_2 in tender scoring, obliging bidders to demonstrate carbon performance as part of the award process.
• **Shadow pricing**	×	The methodology does not introduce any shadow price or monetary valuation of carbon. CO_2 figures are used purely as emissions metrics, not as costed externalities.

• **Baseline**	✕/(✓)	The guide does not fix any common baselines or benchmarks for CO_2 at either the project or product level. However, Port of Valencia has recently published tenders ("pliegos") including mandatory CO_2 ranges within which bidders must fall. Being outside these ranges, whether above or below, leads to disqualification or penalties.
• **Variants / value engineering**	✕	No value engineering between alternatives is foreseen as part of the overall framework. In the case of the implementation by Port of Valencia, they require contractors to use fixed machinery and fuel-consumption values, which restricts innovation. This prevents bidders from proposing electric machinery, HVO fuels, or other low-carbon alternatives, limiting the potential for more ambitious or forward-looking decarbonisation solutions.

5.3 Monitoring	• There are no monitoring requirements in place for tracking CO_2 performance during construction or operation. • Despite the lack of external requirements, some big construction companies (e.g. Acciona) conduct their own internal carbon tracking across all projects. This is done using the company's own tools and procedures, independent of any port-level obligations, and reflects internal corporate practices rather than a sector-wide monitoring framework.
5.4 Verification rules	• Ports are only beginning to pilot carbon-footprint calculations, and these early efforts have not yet evolved into any form of mandatory monitoring or procurement-linked verification.
5.5 Enforcement	• At this stage, implementation remains voluntary; therefore, there are no enforcement mechanisms currently in place related to CO_2 performance. • Because CO_2 assessments are not integrated into procurement, there are no penalties, bonuses, or contract-cancellation provisions linked to carbon performance. • In the case of the Port of Valencia tender, because it establishes mandatory CO_2 ranges that bidders must fall within, disqualification occurs when results fall outside these ranges, whether above or below, even when emissions would be lower.
6. Strengths, limitations and risks	
6.1 Strengths	The methodology guide represents a first step in establishing a more structured approach to carbon accounting within the port sector. Its development aligns with the broader direction of the current Spanish government, which is strongly pushing decarbonisation in line with national net-zero 2050 commitments, and with the ambitions of Puertos del Estado, which has set a target of achieving a 70% reduction in the carbon footprint of projects by 2030.
6.2 Limitations and risks	• **Low adoption due to low maturity:** The framework remains voluntary and advisory, with limited adoption across ports. While some ports, such as Valencia, are beginning to pilot carbon footprint calculations, there is no legal mandate requiring all ports to adopt the methodology. • **Methodological limitations:** The framework is not structured as a full life-cycle assessment (LCA) under EN 15978 but rather as a corporate/organisational GHG inventory aligned with ISO 14064 and the GHG Protocol. This means it does not map to standard LCA modules (A1–D) and lacks a fixed functional unit or lifetime assessment beyond annual reporting. Additionally, it excludes LULUCF and treats biogenic CO_2 as neutral, which may not fully capture the climate impact of port activities.

	• **Data and tool limitations:** The framework does not prescribe a central database or automated tool, requiring ports to rely on multiple public databases for emission factors. These databases may not reflect Spanish production conditions or align with the criteria used in the guide, leading to potential inaccuracies.
7. Examples and reference documents	
7.1 In-practice examples	• No specific project, but the Port of Valencia is considered a front runner in Spain for innovation and decarbonisation. • Other ports active in innovation and decarbonisation: La Coruña, Algeciras (circular economy) and Canary Islands ports (mostly focused on energy and water challenges, especially linked to cruise traffic).
7.2 Reference documents	• Puertos del Estado (2025). Guía metodológica para el cálculo de la huella de carbono en puertos • MITECO (n.d.). Carbon footprint registration, offsetting and carbon dioxide absorption projects • Port of Valencia (n.d.). Website

Fact sheet – FNTP: SEVE-TP (FR)

FACT SHEET – FNTP: SEVE-TP – France (FR)

Framework components:

Regulatory status:

Sector:

1. Purpose and nature

1.1 Summary	SEVE-TP is a life-cycle environmental assessment tool and methodology developed by the French National Federation of Public Works (FNTP) using databases from INIES and ADEME. It is designed to quantify and compare the environmental impacts of infrastructure projects, including roads, greenways, and other public works, from material extraction to construction and maintenance. While not currently used as an award criterion in all public procurement, it encourages the adoption of low-impact materials and methods by providing standardised environmental impact reports and promoting transparency in environmental decision-making.
1.2 Methodological definition	SEVE-TP is not a design software or detailed tool for the project life-cycle or Cost-Benefit Analysis (CBA). It is used in relation to contractor selection and verification of material selection during/after completion. SEVE-TP is primarily a tool to calculate and compare project-specific data to generate environmental reports. This is connected to a methodology of a partial LCA. Key elements include: • A web-based eco-comparator platform with an embedded database of environmental impact data • Aligned with recognised LCA principles and methodologies (ISO 14040/44, EN 15804 (+A2)), as well as RE2020. • A scope focused primarily on material production, transport, and construction processes, with optional consideration of maintenance • Functional units designed to compare variants of similar projects, particularly in roadworks and earthworks • Standardised summary reports providing transparent assessment of environmental impacts Key elements do not include: • A certification tool.

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	

Any caveats on the system boundaries	NA.
LULUC included?	No, this would be considered in the initial planning decision and CBA. Relevance is considered low as most works are maintenance rather than construction.

	Biogenic carbon quantified?	No specific consideration of biogenic carbon, but considered for future developments. For bio-based materials, the "Climate Change – Total" indicator includes biogenic carbon stored in the material, following the EN 15804 A2 standard for stages A1–A3.
2.2 Functional unit	In SEVE-TP, the functional unit is not a single fixed value for the entire system; rather, it is specific to the element or material being modelled to allow for accurate comparisons between base solutions and variants. A lifetime is not defined, as only the upfront emissions are quantified.	
2.3 Data sources	Data comes in three layers from different sources: 1. **Generic database**: A collective database common to all users, providing average environmental costs for supplies/products, construction machinery, and transport modes. Data sources include recognised bodies such as ADEME, Ecoinvent, INIES, and DIOGEN. 2. **Specific database**: Allows individual users to add products or machinery specific to their own company, provided they attach supporting documents such as Environmental Product Declarations (EPD) or FDES (Fiche de Déclaration Environnementale et Sanitaire). 3. **Mix design database** (Base de formules): Specific to production facilities (such as concrete or asphalt plants), allowing users to calculate the environmental cost of custom material recipes based on their specific components and transport distances	
3. Implementation tools		
3.1 Implementation	The system tracks several mandatory indicators: greenhouse gas emissions (t CO_2e), energy consumption (MJ), transport volume (tonne-kilometres), and resource preservation. The framework calculates CO_2 results using a linear multiplication approach: project-specific quantities are multiplied by established emission factors to obtain total environmental impacts. • Materials: Impact = Quantity (tonnes or units) × Emission Factor (t CO_2e/unit). • Transport: Impact = Unit Emission Factor (kg CO_2e/t.km) × Weight (tonnes) × Distance (km). • Machinery: The impact of using machinery for one day or hour includes four components: fuel consumption, the amortised impact of the machine's manufacturing over its lifespan, equipment transfer, and maintenance	
3.2 Scenarios and assumptions	Key assumptions include: • For **transport**: Default scenarios assume specific loading rates and empty return trips are automatically included in the cost of transport unless "double freight" is selected. • For **machinery**: Daily use is generally defined as 7 hours (8 hours for earthworks), with fixed assumptions for machine mass and lifespan.	
3.3 Data submission requirements	The results are to be integrated into standardised reports (PDF and Excel) that feature comparative tables, bar charts, and radar charts to visualise the trade-offs between different technical solutions	

4. Degree of adoption	
4.1 Maturity level	SEVE-TP has been available since 2010 and updated frequently (3-4 updates per year). In mid-2025, SEVE-TP was formally referenced by the French government as an approved tool for public procurement environmental analysis, meaning it is officially recommended and validated for use in public calls for tenders. This government recognition increases uptake and legitimacy across contracting authorities.
4.2 Project types affected	The SEVE-TP framework is designed as a universal tool for the entire public works profession, serving a diverse range of stakeholders. While it provides a "common language" to standardise environmental evaluation, the way it is managed and the specific regulatory pressures (such as the Climate and Resilience Law) can vary depending on the type of client.
4.3 Adoption level	• SEVE-TP has over 15,000 users and 1,500 organisations, 25% of which are project owners. In France, a small share of public construction works tenders include CO_2 assessment requirements. • Most roads contracts and other sectors do not use environmental criteria. However, a legal mandate under the Climate and Resilience Law will make environmental criteria mandatory from August 2026.

5. Procurement integration		
5.1 Relevant procurement models	• SEVE-TP was developed as a tool for Design-Bid-Build (DBB) public procurement, where it is most commonly applied. It is also used in Design and Build (D&B) contracts.	
5.2 Procurement levers	**Use**	**Notes**
Award criteria	✓	The result of CO_2 calculations, potentially alongside other environmental criteria, is incorporated as a weighted award criterion within a points-based scoring system. The weighting assigned to this criterion typically ranges from 5% to 30%, depending on the specific case. Points are awarded based on the performance of each offer relative to the best-performing offer, which is defined as the one with the lowest environmental impact. The best-performing offer receives the maximum score. For all other offers, a proportional score is calculated by comparing the environmental performance of each offer to that of the best offer, then multiplying by the points allocated to each indicator. The cumulative score across the five indicators determines the final score, for example, out of a total of 20 points.
Shadow pricing	✕	No shadow carbon price established as of now.
Baseline	(✓)	Not mandatory, nor automatic. However, it is possible to add a baseline solution.
Variants / value engineering	✓	The SEVE-TP tool allows for specific elements or materials to be modelled to allow for accurate comparisons between base solutions and variants. This can be used for value engineering.

5.3 Monitoring	• The SEVE-TP tool facilitates monitoring and verification of emission results during or after construction, which administrations may utilise if deemed necessary.
5.4 Verification rules	• Input data on construction materials is independently verified if it stems from another database, such as ADEME or INIES. While SEVE-TP does not verify individual EPD inputs, the contracting administration retains the authority to request verification of such data where deemed necessary.
5.5 Enforcement	• No enforcement mechanisms introduced as part of the SEVE-TP framework.
6. Strengths, limitations and risks	
6.1 Strengths	• Through its simplicity, SEVE-TP enables a broad uptake by users without the need for dedicated teams and skillsets. Instead, public authorities and contractors are able to get familiar with the tool and carbon assessment framework via a short training. • By using publicly available databases, the framework is transparent on its assumptions, allowing contractors to understand how they can optimise their projects.
6.2 Limitations and risks	• SEVE-TP allows for the creation of environmental data for additional products in the tool. This is done by bidders without otherwise common third-party verification. Verification of such data is only possible by the client/public authorities, which is not always traceable. • There is a lack of some important secondary environmental indicators (e.g. water use), which are understood to substantially add to the carbon footprint.
7. Examples and reference documents	
7.1 In-practice examples	• DEPARTEMENT DU TARN - Direction des Routes - Service Études et Travaux Neufs • CHEMIN PAS DU LOUP - LES TRAVAUX DE MAILLAGE ET DE RENFORCEMENT DU RESEAU AEP D'EXTENSION DU RESEAU EU ET DE DE CREATION D'UNE ANTENNE EP
7.2 Reference documents	• FNTP (2025). Manuel Utilisateur - Guide pratique pas-à-pas pour une utilisation optimale de l'éco-comparateur SEVE-TP • FNTP (2025). Méthodologie et sources • FNTP (2025). SEVE-TP Presentation brochure

Fact sheet – Bygningsreglementet BR18 (BR18 Climate Requirement) (DK)

FACT SHEET – Bygningsreglementet BR18: Buildings sustainability class – Denmark (DK)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	The BR18 Climate Requirement is a mandatory life-cycle carbon assessment (LCA) framework embedded in the Danish Building Regulations (Bygningsreglementet BR18), requiring quantification of CO_2 emissions for new buildings above 5 m² above ground. It applies to building owners (developers), their design advisors, and contractors across the full construction supply chain. The framework mandates an LCA calculation covering materials production, transport to site, and the construction process itself, performed using standardised methods (EN 15978) and tools such as the free LCAbyg software or equivalent. BR18 compliance is a legal condition for obtaining a certificate of occupancy. While not currently an award criterion in public procurement, the mandatory nature of the limit values drives supplier and contractor engagement in reducing embodied carbon through material substitution, low-emission transport, and efficient site operations.
1.2 Methodological definition	The BR18 Climate Requirement Law defines calculation rules for LCAs based on a nationally adapted application of the European standard EN 15978. BR18 deviates from EN 15978 in that not all building materials must necessarily be included, and generic data can be used to a large extent. The law defines a hierarchy of data sources from product-specific EPDs to generic data provided in a legal annex. A free calculation tool is also provided (LCAbyg), but not mandatory. Ultimately, LCAs have to be calculated and remain under a mandatory limit. This is the responsibility of the owner or developer, but translates to designers and contractors.

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
✓	✓	✓	✓	✓				✓		✓					✓	✓	(✓)

Any caveats on the system boundaries	Module D (potential end-of-life credits/burdens) must be calculated but does not count towards meeting the limit value.
LULUC included?	Not included.
Biogenic carbon quantified?	Not quantified.

2.2 Functional unit

- The legal frameworks define limit values for building construction, operation, replacement and end-of-life. The functional unit is m^2 per year for a standard period of 50 years. This also applies where specific requirements for certain LCA stages such as A4 are being applied in the future.

2.3 Data sources	• The authorities provide a database of datasets that must be used for the calculation. The database is based on generic Ökobau data and a national initiative to create representative EPDs of the Danish industry. Specific product EPDs which are not included in the database can also be used. Material suppliers are supported in the development of product-specific EPDs.
3. Implementation tools	
3.1 Implementation	• There is no mandatory tool. As long as the calculation method follows the referred standard and guidelines, any tool can be used. The Danish "LCAbyg" tool, developed specifically in this context, is free and accepted as a possible tool to use for compliance with the building regulation. Commercial tools (One Click LCA, Real-Time LCA, etc.) are also accepted provided they follow the legal scope and methodology
3.2 Scenarios and assumptions	• Operational energy emission factors are provided in a legal annex. • Service life data for replacement (B4) is standardised and always assumed for 50 years. If the service life of a product is shorter than 50 years, it is assumed to be replaced within the consideration period, and the climate impact of replacement must be included in B4. • The climate impact of directly reused building materials is set to zero across the entire 50-year period, including replacements. Reused materials must still be listed in the LCA so their use is visible.
3.3 Data submission requirements	• The LCA report is submitted as part of the building permit application and occupancy approval process to the local municipality. • There is no predefined mandatory format for the emission data itself — in most cases, data from product-specific EPDs is manually transferred to LCA tools. • Contractors are expected to provide as-built quantities and EPDs to the developer or the LCA consultant.
4. Degree of adoption	
4.1 Maturity level	• Legal limits according to the law have been in place since 2023. A fixed three-year application period without any changes ends in 2026. After this, updates and increased ambitions will be defined. • The development of the mandatory legislation started in 2014 when the ambition to have sustainability classes was formulated by the national government. In the time since then, the Danish GBC has created a national version of DGNB certification that started the practice of LCA calculations.
4.2 Project types affected	• The projects affected are new building construction projects for defined building use typologies. Exemptions exist for hospitals and buildings of critical infrastructure (e.g. defence purposes).
4.3 Adoption level	• Adoption levels are high, as the legal obligation covers all buildings, not limited to public procurement. However, the number of cases is still relatively low, as only newly started projects have to comply with the full requirements. In a time of low construction activity, not many new projects have been started.
5. Procurement integration	

5.1 Relevant procurement models	• As regulatory framework, it is applicable regardless of selected procurement models.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	(✓)	CO_2 targets and scoring of offers based on emission totals are increasingly embedded in tender specifications, often as award criteria alongside price. However, this is much more common for design tenders than construction contractors.
• **Shadow pricing**	✕	No pricing of emissions.
• **Baseline**	✓	Limit values are defined by law and specified during design stages. Tenderers have to respect these limit values. Contractors in practice have to at least be able to provide EPDs for materials and quantify construction site emissions to be considered for projects.
• **Variants / value engineering**	✕	Through the baseline set ahead of the project and carbon reporting during the project, contractors are encouraged to adopt carbon-saving measures to ensure that the baseline is met, to avoid penalties or receive bonuses.
5.3 Monitoring	• The law only requires a final as-built LCA at completion. • Commonly, LCA calculations are continuously updated throughout the design and construction phases, requiring alignment and exchange at project stage gates.	
5.4 Verification rules	• No requirement for an independent third-party check. • The final LCA report is submitted as part of the occupancy approval process to the local municipality for the compliance check. • There is no predefined mandatory format for the emission data itself — in most cases, data from product-specific EPDs is manually transferred to LCA tools. • Contractors are expected to provide as-built quantities and EPDs to the developer or the LCA consultant.	
5.5 Enforcement	• Local building authorities conduct checks on a random selection of LCAs during the occupancy approval process. • Contracts between the developer and contractors, designers and other suppliers foresee corrections if the mandatory limit is exceeded. However, there is still a level of uncertainty and varying models on determining the responsible party.	
6. Strengths, limitations and risks		
6.1 Strengths	• Developers now include requirements for environmental documentation in cooperation agreements, and product-specific EPDs typically show lower emissions than generic values— incentivising contractors and product manufacturers to invest in EPDs as a commercial differentiator. • A free, publicly funded tool is provided and widely adopted, lowering the barrier for small companies and enabling a common baseline across projects	

	• The zero-carbon treatment for reused materials creates a clear, unambiguous incentive for circular procurement choices.
6.2 Limitations and risks	• EPD validity is tied to the date of material installation — an EPD that expires mid-project forces a fallback to generic (less favourable) data, which can push the project towards the CO_2 limit and create a late-stage compliance risk that falls on the contractor • The absence of a formal material substitution protocol means that a contractor substituting a specified product — even with equivalent performance — takes on implicit LCA liability if the replacement has a higher carbon footprint and no valid EPD • Where CO_2 is an award criterion, the absence of standardised scoring methodology means that the weighting and interpretation of LCA results vary between contracting authorities — undermining comparability and creating a risk of gaming
7. Examples and reference documents	
7.1 In-practice examples	
7.2 Reference documents	• Official regulatory text and guidance - Bygningsreglementet.dk • Information by the Building and Housing Agency - Social- og Boligstyrelsen • Technical background reports on methodology and data sources by BUILD (Aalborg University) – LCAbyg.dk • Nordic Council of Ministers report on building LCA methodologies – pub.norden.org

Fact sheet – RE2020 (FR)

FACT SHEET – RE2020: Buildings Sustainability Class – France (FR)

Framework components:

Sector:

Regulatory status:

1. Purpose and nature

1.1 Summary	RE2020 is a mandatory environmental regulation for all new buildings in France, in force since January 2022, that requires a whole-life-cycle carbon assessment (LCA) for every new construction project. It sets statutory limits on embodied carbon from materials and construction and operational carbon from energy use, calculated using verified environmental product data from the national INIES database. Compliance is verified at two formal gateways: building permit application and project completion, with limit thresholds tightening progressively through to 2031. In public procurement, carbon performance requirements must be embedded in tender documents, driving contractors and manufacturers to provide verified environmental product declarations and to demonstrate that proposed materials meet the project's carbon budget.
1.2 Methodological definition	The LCA must cover all life-cycle modules: A1–A3 (raw material extraction and manufacturing), A4–A5 (transport to site, construction process), B1–B7 (use phase including maintenance, replacements, energy), C1–C4 (end-of-life deconstruction and disposal), and the optional module D (credits for material reuse/recovery beyond the life-cycle). RE2020 uses dynamic LCA: the later an emission occurs, the lower its weighted impact. This incentivises use of materials that store carbon (biobased materials such as timber) early in the building's life. Thresholds are modulated upwards (i.e., relaxed) based on several factors: deep foundations; roadworks and networks; climate zone; floor area (very small or very large buildings get adjusted thresholds); and, until 2028, a higher allowance if the share of default data is above ~50%. The building LCA standard is NF EN 15978; product-level environmental data must comply with NF EN 15804+A2 (mandatory as of 1 January 2026 — older A1-format FDES are no longer valid).

2. System Boundaries & Technical Specification

2.1 Life-cycle modules

A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	(✓)	(✓)	✓	✓	✓	✓	✓

Any caveats on the system boundaries	Two indicators are calculated. • IC construction: embodied carbon of the building's materials, construction site works, and end-of-life. • IC énergie: operational carbon from energy use over the analysis period (in line with existing EPBD obligations) Projects must pass both indicators to comply.
LULUC included?	Not included.

	Biogenic carbon quantified?	RE2020 relies on a dynamic LCA with an assessment of the impact of biogenic carbon storage. This is chosen because it emphasises the immediate and short-term carbon impacts of materials and aligns with the national legislation ELAN. Biogenic carbon storage in the building is tracked via the StockC indicator.
2.2 Functional unit	• The legal frameworks define limit values for building construction, operation, replacement and end-of-life. The functional unit is kg CO_2e / m^2 for a standard period of 50 years.	
2.3 Data sources	• The INIES database is used for calculations, which includes both primary and secondary data. Only data from this database and validated configurators, based on EN 15804, are accepted. The list of EPDs is growing and their use is increasingly incentivised through calculation coefficients in the establishment of maximum values.	
3. Implementation tools		
3.1 Implementation	• No standardised calculation tool is in place. Calculations are usually done by a specialist thermal and environmental engineering consultant. • The LCA software used must be certified compatible with the RE2020 reference framework and validated by the INIES programme before use in regulatory calculations. Validated tools interface with INIES via a digital data webservice. • Examples of certified tools include One Click LCA, ELODIE (CSTB), and others validated by the Ministry.	
3.2 Scenarios and assumptions	• The environmental performance calculation is organised into 14 trade lots. Two of them — lots 9 (plumbing and drainage) and 10 (earthworks and fencing) — are calculated on a flat-rate basis, meaning the designer cannot optimise them. Together these typically represent around 17% of the ICconstruction total. • Transport (module A4) is part of the compulsory LCA scope. Distances are either taken from the product-specific EPDs or usually assumed using default conventions in the calculation software. • Under the dynamic LCA weighting, an emission in year 0 is weighted at 1.00; an emission in year 50 is weighted at approximately 0.58. Earlier emissions therefore count proportionally more. A timber beam shows a very favourable carbon balance under the dynamic method because it captures CO_2 during growth — this negative emission at the production stage is weighted most heavily. At end-of-life, the CO_2 is largely re-emitted, but this occurs at year ~50, when it carries a much lower weighting. • The UDD indicator (Usage of Default Data) measures the share of default/flat-rate data in the calculation. Until 2028, projects with a high UDD receive a relaxed threshold; from 2028 this modulation inverts, penalising heavy reliance on defaults.	
3.3 Data submission requirements	• The LCA study is produced by a specialist engineering office and synthesised into the RSEE (Récapitulatif Standardisé Énergie et Environnement), which also includes the energy study (RSET). These two documents are the reference files used by the independent verifier at project completion. • The contractor's key practical obligation is to install the materials actually specified and modelled in the LCA. Therefore, contractors are expected to provide as-built quantities and EPDs to the developer or the LCA consultant.	

4. Degree of adoption	
4.1 Maturity level	• Regulatory framework is mature and legally complete: RE2020 has been fully operational since January 2022 with mandatory calculation rules, approved software, and formal compliance gateways. Thresholds tightened in 2025 with further steps planned through to 2031. • The supporting data ecosystem is growing but still catching up: EPDs on INIES roughly doubled in three years, but gaps remain for key product categories, and the expiry of older-format declarations has created short-term data risks. • Use of carbon as a procurement lever remains uneven: while the legal basis for embedding carbon criteria into tender documents and bid evaluation is clear, active use beyond mandatory compliance is concentrated among larger, more sophisticated contracting authorities. Skills gaps, particularly among SME contractors and smaller public clients, remain a barrier to consistent adoption.
4.2 Project types affected	• The regulation applies to new residential buildings, offices, educational buildings, and tertiary buildings such as hotels, shops, and gymnasiums. • From 1 May 2026, RE2020 extends to new categories of buildings, including universities, hospitals, and airport terminals.
4.3 Adoption level	• Because RE2020 is a mandatory regulation for new buildings, compliance is not optional. • However, the step from mandatory compliance to active use of carbon criteria as a competitive award lever in public procurement is still slow and varies highly across public buyers. • The French Building Association (FFB) estimates that public spending on buildings amounted to €37 billion in 2024. However, this includes a range of building-related activities, while only new construction projects have to comply with RE2020 (with some exemptions). Therefore, the actual applicable total can be assumed to be a part of this, likely under 50%.

5. Procurement integration		
5.1 Relevant procurement models	• As regulatory framework, it is applicable regardless of selected procurement models.	
5.2 Procurement levers	**Use**	**Notes**
• **Award criteria**	(✓)	Public contracting authorities have begun weighting environmental performance criteria in bid scoring (e.g. 15% weighting). Tenderers must submit technical statements identifying the carbon impact of their proposed materials, along with the FDES or PEP references they intend to use.
• **Shadow pricing**	✕	No pricing of emissions.
• **Baseline / fixed limits**	✓	Limit values are defined by law and specified during design stages. Tenderers have to respect these limit values. The tender documents include a carbon budget to be respected per trade lot.

• **Variants / value engineering**	✓	Where a contractor proposes a variant, they are required to be able to justify the carbon impact of those changes.
5.3 Monitoring	• A common approach for the developer is to cite in the tender specification the product ranges and brands corresponding to the emission values used in the LCA, while leaving contractors the possibility of proposing an equivalent product on condition that they can prove its GHG performance over the 50-year building life is equivalent, by supplying their own valid EPD in INIES. • For larger projects, it is considered good practice to provide contractors with standardised DPGF (Décomposition du Prix Global et Forfaitaire) templates pre-structured by trade lot. This simplifies bid analysis and also facilitates the entry of actual installed quantities and FDES references for the as-built LCA update at completion.	
5.4 Verification rules	• At completion, an independent qualified professional, who must be independent of both the developer and the construction manager, conducts a site visit and verifies the consistency of the project as built against the design-stage documents produced by the thermal/environmental engineering office. • The verifier must conduct a coherence check on 10 specific environmental data points used in the as-built LCA, cross-checking that the EPDs used in the RSEE correspond to products actually installed on site. • A report generated digitally from the RSEE via the government portal must be attached to the Completion and Conformity Declaration and submitted to the local authority.	
5.5 Enforcement	• Non-compliance with RE2020 triggers a cascade of consequences. Most importantly, if the required calculations and attestations exceed limits, are absent or invalid, the Completion and Conformity Declaration will be refused, preventing the building from being legally occupied and used. • Without an approved Completion and Conformity Declaration, final acceptance of works is blocked, which may trigger the contractor's liability and can delay release of contractual retentions, depending on the cause for non-compliance.	
6. Strengths, limitations and risks		
6.1 Strengths	• The dynamic LCA method is a genuine methodological advance: it rewards early-stage carbon reduction and correctly weights the timing of emissions and storage, giving a more accurate picture of climate impact than static approaches. • The single mandatory database (INIES) and certified software ecosystem creates comparability across projects and removes ambiguity over which data to use. • The threshold modulation system (for building type, climate zone, foundation complexity, data quality) is well-designed: it avoids penalising structurally complex projects while maintaining a consistent underlying ambition. Similarly, the transition mechanism for generic vs. product-level data allows the market to mature, but creates predictable penalties from 2028. • The requirement to translate LCA results into trade lot-level carbon budgets within the tender documents creates a direct, traceable link between the design-stage LCA and what contractors are contractually required to deliver.	
6.2 Limitations and risks	• Calculation reflects design intent, not real-world performance: flat-rate lots (earthworks, plumbing) lock in ~17% of ICconstruction beyond anyone's control;	

	transport distances rely on defaults that cannot reward local sourcing; and the regulation captures only two snapshots (permit and completion) with no mechanism to verify whether the building's carbon performance holds over its 50-year modelled life. • Significant data gaps remain in INIES — particularly for heat generation equipment (boilers, heat pumps, hybrid systems), ventilation units, and bio-sourced insulation materials. First-generation EPDs are also already outdated and considered non-compliant. • The core carbon verification at completion — the 10-point coherence check — is a spot-check on 10 environmental data items, not a full audit of the as-built LCA. For a complex building using hundreds of products, this provides limited assurance. The verifier cross-checks the components against the DOE (Dossier des Ouvrages Exécutés) and the site visit, but the DOE is itself produced by the contractors. There is no independent material testing or quantity take-off verification.
7. Examples and reference documents	
7.1 In-practice examples	
7.2 Reference documents	• Official regulatory portal — Ministry of Ecological Transition, including the guidance report updated in May 2025 • INIES database and its annual reports