BUILDING LIFE-CYCLE CARBON REGULATION BENCHMARK FOR SELECTED EUROPEAN COUNTRIES

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1. INTRODUCTION

Construction sector is responsible for a considerable amount of resource usage and greenhouse gases globally. The increasing need for measuring the construction sector emissions and the regulatory conversation throughout Europe has led to governments creating their own national regulations to drive and reduce future emissions to become net zero by 2050 or earlier.

This report addresses how six European countries regulate their emissions coming from built environment, concentrating on buildings. The regulations presented are either in development and testing or fully in use. This comparison was written to provide a perspective on Estonia's most common trade partners and their building regulation development. As many of the regulations and methodologies from countries included in this review are under development, details on regulations and life-cycle assessment methodologies might change before their implementation.

2. BENCHMARKED COUNTRIES

This paper investigates the regulatory frameworks of countries listed below due to their proximity and importance for the Estonian construction sector.

Country	Regulation	Methodology
Denmark	Building regulation	Sustainability class
Finland	Land use and construction Law	Low carbon building assessment method
France	Construction and housing regulation	RE2020
GLA, UK	The London Plan	Whole Life Carbon (WLC) Calculation methodology
Norway	Energy requirements act for buildings	Simplified NS 3720:2018
Sweden	The act on climate declaration for buildings	Climate declaration 2022

Denmark

The Danish life cycle accounting methodology, called Sustainability class, is still under development and undergoing a two-year period of testing, until mid-2022. This testing is driving towards establishing a basis for regulatory changes in terms of sustainability of the built environment and the sustainability class assessments are still entirely voluntary.

- The voluntary sustainability class information
- Sustainability class method for building LCA calculations

Finland

The Finnish regulation is the new zoning and construction act that has been sent to consultation in September 2021. Once it is enacted into law, it will replace the old land use and construction law. The LCA methodology related to the regulation is a specific Finnish building carbon assessment methodology. The methodology used in assessment went through consultation in the summer of 2021.

- Consultation draft of the new zoning and construction act
- Consultation draft of the new low carbon building assessment methodology

France

The French RE2020 is the new French environmental policy that will come into force in the beginning of 2022. Where the building LCA methodology is based on EN 15978 standard, the RE2020 has some key deviations from the European standard and has set strict rules on data usage.

- Legislation on energy and environmental performance
- The methodology on energy and environmental performance assessment
- Information on RE2020

GLA, UK

While the Greater London Authority's (GLA) London Plan and the associated Whole Life Carbon (WLC) methodology are not used all around UK, they are an important part of the environmental regulatory framework. GLA's whole life carbon methodology is based on UK's RICS Professional Standard. The new regulation has been in force since March 2021.

- The London Plan
- WLC Methodology and Assessment template
- RICS PS

Norway

The Norwegian energy and greenhouse gas emission code is a revision of the old Norwegian energy code. The new code is set to come into force in January 2022 with a one-year transition period. The new code is not yet final and might change before its implementation. The life-cycle assessment methodology tied to the regulation is a simplified version of the old Norwegian LCA methodology NS 3720:2018.

- Hearing draft of the regulation
- NS 3720

Sweden

The new Swedish regulation on climate declaration will come into force in January 2022, together with the national Klimatdeklaration 2022 methodology. The methodology is expected to evolve in the oncoming years.

- The National Board of Housing, Building and Planning's regulations on climate declaration for buildings
- Klimatdeklaration 2022

3. REGULATORY BENCHMARK

3.1. TIMING, STRUCTURE AND MECHANISM OF THE REGULATIONS

All the countries and their regulatory frameworks differ from each other both in content, as well as the stage of development of these regulations. While some are already in force, the majority of the regulations are still in draft stages and can change content wise in the oncoming months and years.

Where all these regulations and their methodological approaches are aligned with the European EN 15978 standard, the national methodologies present some deviations as well as added clarity.

Table 1. Timing, structure and mechanisms.

	DENMARK	FINLAND	FRANCE	GLA, UK	NORWAY	SWEDEN
STATUS	Test phase	Awaiting legislation	In force	In force	Awaiting legislation	In force
TIMING	2023	Estimated 2024	January 2021	March 2021	January 2022, 1 year transition	January 2022
NEW OR REVISION	New	New	Revision of energy code	Revision of London Plan	Revision of energy code	New
METHOD	Sustainability class	Climate declaration	RE2020	WLC Assessment	Simplified NS 3720: 2018	Klimatdeklaration 2022
STANDARD ALIGNMENT	EN 15978	EN 15978	EN 15978 w/ deviations	EN 15978	EN 15978 / NS 3720	EN 15978
GUIDANCE	Housing and planning agency guidance	Government guidance	RE2020 Guidance	WLC guidance & RICS PS	None additional as of now	Handbook
LIMIT VALUES	2023 for >1000 m^2, 2025 for all	Expected 2025	Yes	No*	No**	Expected in 2027
ENFORCING TIME	Construction permit and completion	Construction permit	Construction permit	Pre-application, planning submission & post-construction	Upon completion	Before completion

* / ** - see following further notes

Further notes on limit values

(*) GLA: While the GLA has not set exact limit values to be followed, they have presented Benchmark data that has intention similar to limit values. The project values do not have to be below the benchmark values in any of the stages. However, they can be referred to as aspirational targets and all applicants must explain in their assessment why they have not managed to meet the targets if they go above these benchmark values.

(**) Norway: While Norway does not present mandatory limit values, they have a concept of voluntary limit values. When these voluntary limit values are met in projects, the projects are offered benefits, like not having to meet the u-value requirements.

3.2. TARGETED BUILDING TYPES

In all national regulatory frameworks, apartment buildings are included into the targeted building types. Other building types are also often included, especially commercial (including offices). Many on the national regulations apply a project size limit, to avoid e.g., one-time builders to have to report their emissions. On

top of the size limit requirements to ease on individual builders' responsibility on life cycle calculation, the requirements can also state for example that no self-built vacation homes / cottages need to be reported. These are often tied to energy certificate requirements.

Table 2. Targeted building types.

	DENMARK	FINLAND	FRANCE	GLA, UK**	NORWAY ***	SWEDEN
RESIDENTIAL	Yes	> 50 m^2	> 150 m2*	> 150 units or > 30 m in height	Yes	> 100 m^2
COMMERCIAL	Yes	> 50 m^2	Yes	> 2500 m^2	Yes	> 100 m^2
EDUCATIONAL	Yes	> 50 m^2	Yes	No	No	> 100 m^2
NEW CONSTRUCTION	Yes	Yes	Yes	Yes	Yes	Yes
RENOVATIONS & REFURBISHMENTS	Yes	Yes, with restrictions	No	No	Yes	No
TEMPORARY BUILDINGS	Yes, if regulated	Yes, if in use for > 2 yrs	Not defined	Yes, if referable	No	Yes, if in use for > 2 yrs

* / ** / *** - see following further notes

Further deviations

(*) France: The limit on > 150 m^2 buildings is in force currently. However, this is to be changed in 2023, so that all buildings are to be included into the calculation scheme

(**) GLA: The precise criteria on whether a whole life carbon assessment needs to be performed is also tied to geographical location of the construction work, and whether the location is within the city of London, inner London, or the outer boroughs, and whether the proposed site is on green belt land. However, the Greater London Authority encourages all projects, even though they would not fit into the scope, to apply the policy and the guidance to non-referable applications.

(***) Norway: The draft of the regulation suggests leaving out detached houses and smaller scale buildings. However, the size limits have not been decided upon yet.

3.3. SCOPE OF THE REGULATORY ASSESSMENT – BUILDING ELEMENTS

The building element scope included in the assessment differs considerably between the assessed countries. The GLA's whole life carbon assessment being the most comprehensive and the Norwegian and Swedish ones being the most simplified. The structure used below is following RICS classification.

Table 3. Building elements scope.

Building Element Group	Building Element	DK	FI	FR	GLA	NO	SE
Demolition	Toxic/Hazardous/contaminated material treatment				x		
	Major Demolition works				x		
0 Facilitating works	Temporary/enabling works				x		
	Specialist groundworks			x	x		
1 Substructure	Substructure	x	x	x	x		x
2 Superstructure	Frame	x	x	x	x	x	x
	Upper floors, inc. balconies	x	x	x	x	x	x
	Roof	x	x	x	x	x	x
	Stairs and ramps	x	x	x	x	x	x
	External walls	x	x	x	x	x	x
	Windows and external doors	x	x	x	x	x	x
	Internal walls and partitions	x	x	x	x	x	x
	Internal doors	x	x	x	x	x	x
3 Finishes	Wall finishes		x	x	x	x	x
	Floor finishes		x	x	x	x	x
	Ceiling finishes		x	x	x	x	x
4 Fittings, furnishing & equipment	Fittings, furnishing & equipment		x	x	x		
5 Building services / MEP	Buildings services	x	x	x	(x)		
8 External works	Site preparation works	x	x	x	x	x	
	Roads, paths, paving and surfacing	x	x	x	x		
	Soft landscaping, planting and irrigation systems			x	x		
	Fencing, railings and walls	x	x	x	x		
	External fixtures	x	x	x	x		
	External drainage	x		x	x		
	External services	x		x	x		
	Minor building works and ancillary buildings	x		x	x		
Maintenance	Refrigerants			x	x		

Where the above building elements are included in the assessment scope, there are often agreed deviations provided to facilitate the assessment. The below items are often excluded from the material scope:

- Nails, screws, glue and other adhesives separate of the product
- Vegetation
- Interior paints and wallpaper
- Lightning equipment

Some national regulations have introduced limit values as part of the regulation. As the scope of the limit values might differ from the assessment scope, the below table presents the scope of the limit values for countries that have the limit values specified. The below table includes only those countries that have specified and disclosed limit value data and have stated their usage currently or in future regulation.

Table 4. Building element scope for limit values.

Building Element Group	Building Element	FI	FR	GLA
Demolition	Toxic/Hazardous/contaminated material treatment			
	Major Demolition works			
0 Facilitating works	Temporary/enabling works			
	Specialist groundworks		x	x
1 Substructure	Substructure		x	x
2 Superstructure	Frame	x	x	x
	Upper floors, inc. balconies	x	x	x
	Roof	x	x	x
	Stairs and ramps	x	x	x
	External walls	x	x	x
	Windows and external doors	x	x	x
	Internal walls and partitions	x	x	x
	Internal doors	x	x	x
3 Finishes	Wall finishes	x	x	x
	Floor finishes	x	x	x
	Ceiling finishes	x	x	x
4 Fittings, furnishing & equipment	Fittings, furnishing & equipment	x	x	x
5 Building services / MEP	Buildings services	x	x	x
8 External works	Site preparation works		x	x
	Roads, paths, paving and surfacing		x	x
	Soft landscaping, planting and irrigation systems		x	x
	Fencing, railings and walls		x	x
	External fixtures		x	x
	External drainage		x	x
	External services		x	x
	Minor building works and ancillary buildings		x	x
Maintenance	Refrigerants		x	

3.4. SCOPE OF THE REGULATORY ASSESSMENT – LIFE-CYCLE PHASES

The scope of the regulatory assessment differs between the most comprehensive scopes in France and GLA, and the most simplified scopes, such as in Sweden, where only before use -phase is included in the assessment. The below table presents the life cycle stages accounted for in the assessment. Default values are marked with an (x)* whereas life-cycle stages with actual project data are marked with an x.

Table 5. Life cycle stages included in the assessment.

	DENMARK	FINLAND	FRANCE	GLA, UK	NORWAY	SWEDEN
A1 Raw material acquisition	x	x	x	x	x	x
A2 Transport	x	x	x	x	x	x
A3 Manufacturing	x	x	x	x	x	x
A4 Transport to site	x*	(x)**	x	x		x
A5 Construction works	x*	(x)**	x	x		x
B1 Use in building			x	x		
B2 Maintenance			x	x		
B3 Repairs			x	x		
B4 Replacements	x	x	x	x	x	
B5 Refurbishment			x	x	x	
B6 Operational energy use	x	x	x	x		
B7 Operational water use			x	x		
C1 Demolition works		(x)**	x	x		
C2 Transport		(x)	x	x		
C3 Waste management	x	(x)**	x	x		
C4 Final disposal	x	(x)**	x	x		
D Benefits/loads beyond system boundary	x	x	x***	x		

* / ** / *** - see following further notes

Further notes

(*) Denmark: An LCA must be performed twice during the construction project, at the time of applying for a construction permit and upon completion of the construction works. The documentation in connection with the application for a building permit shall not include modules A4-A5, as they can only be reliably assessed and reported after the construction has been completed.

(**) Finland: The Finnish methodology encourages the usage of national database's default values for specific life-cycle stages. Default values for construction and demolition works are based on national values for construction site emissions per square meter, depending on building type. The transportation values (A4 and C2) are given as emissions per type of transportation mode and for transportation distances either real values or national database values can be used where given. Waste management and final disposal emissions are given by material type.

(***) France: In majority of the reviewed regulations, D module is accounted separately and not subtracted from total emissions. However, in the French RE2020 methodology, the D-module is subtracted from the total emissions.

3.5. SCOPE OF THE REGULATORY ASSESSMENT – ASSESSMENT METHOD

The assessment methodologies differ slightly across all the national methodologies. The below table presents the assessment methodologies in each assessed country.

Table 6. Assessment methodologies.

	DENMARK	FINLAND	FRANCE	GLA, UK	NORWAY	SWEDEN
Assessment period	50 years	50 years	50 years	60 years	60 years	Completion only – 0 yrs
Unit for reporting	kg $CO_2e/m^2/a$	kg $CO_2e/m^2/a$	kg CO_2e, kg CO_2e/m^2 & kg CO_2e/occupant	kg CO_2e & kg CO_2e/m^2	Undefined	kg CO_2e/m^2
Biogenic carbon storage	Yes	Yes	Yes	Yes	Yes	No
Carbon handprint	No	Yes	No	No	No	No
Discounting of energy emission factors	No	No	Yes	Yes	No	No
Impact categories	GWP, ODP, POCP, AP, EP, ADPe, ADPf, Petot	GWP	GWP, ODP, AP, EP, POCP, ADPE, ADPF, PoA, PoE**	GWP	GWP	GWP
Mandatory tool(s)	No	No	Yes	No	No	No
Tool approval process	No	No	Yes	Yes	No	No
Quality requirements for assessor	No	No	No	No	No	No
Mandatory verification of assessment	No	No	Yes	No	No	(Yes)*
Quality standards	Not disclosed	95 % of total mass included	100 % included	98 % of monetary value included	Biggest contributors to GWP included***	

* / ** / *** - see following further notes

Further notes

(*) Sweden: The Swedish climate impact assessments must be saved for five years, and they may be verified during this storage period. However, they do not need to be third-party verified before submittal.

(**) France: Impact categories not mentioned in the table also include indicators on the usage of resources, outputs and all waste categories.

(***) Norway: The requirement applies to the steps that contribute most to greenhouse gas emissions during the building's lifetime, which are raw material extraction, production of materials, transport of raw materials and materials, repair and maintenance, corresponding to steps A1-A3 and B4 / B5 in NS 3720: 2018.

Biogenic carbon

Biogenic carbon is accounted for differently between different countries.
For example, in GLA (UK) and France biogenic carbon is accounted for as a separate indicator, as well as deduced in A1-A3 and then compensated in C3, as per in EN 15804 +A2 compliant EPDs.
In Finland biogenic carbon is predominantly accounted for in module D. However, it is also identified as part of A1-A3 GWP total.

3.6. DATA USED FOR REGULATORY ASSESSMENT

All the regulations and methodologies and the data used in the assessment are based on the European EN 15804 standard. However, many methodologies have not yet specified which amendment is to be used in the assessments. This is expected to change in many methodologies due to the increasing amount of EN 15804 +A2 compliant EPDs in the future. Also, some regulations and methodologies have introduced national databases that can be used as generic data, when no specific EPD data can be found.

Table 7. Data usage in the assessment.

	DENMARK	FINLAND	FRANCE	GLA, UK	NORWAY	SWEDEN
Standard alignment	Version undefined	EN 15804 +A2	EN 15804 +A1	EN 15804 +A1 & +A2	EN 15804	EN 15804 +A1 & +A2
Government generic data exists	No	Yes	Yes	No	No	Yes
Source of generic data	OKOBAU.DAT	SYKE	Inies	Undefined	Undefined	Boverket
Conservative factors	Yes	Yes	Yes	Not present	Not present	Yes
Amount of generic data	1 400	200	1 400	Not relevant	Not relevant	170
Market data allowed	Yes	Yes	Restricted	Yes	Yes	Yes
Market data requirements	EN 15804	EN 15804 +A2	EN 15804, EN 50693	EN 15804, ISO 21930, ISO 14067, ISO 14025, ISO 14040, ISO104044, PAS 2050	EN 15804	EN 15804 +A1 & +A2
Verified data requirement	Yes	Yes	Yes, only verified data	No	Undefined	Yes
Service life for products / elements defined	Yes	Yes	EPD	Yes	No	Yes
Trade barriers	Yes, limited*	No	Yes, heavy**	No	No	No
Source of energy emissions factor data	National scenarios	National scenarios	Inies, Ministry of environment scenarios	National Building regulation, Future energy gov	Not relevant	Not relevant

* / ** - see following further notes

Further notes

(*) Denmark: Denmark requires practically to use SBI Aalborg LCAByg, instead of encouraging an open system that would allow using any approved software tool. This affects and limits data usage in the market only to data integrated in the tool.

(**) France: Currently the French methodology only accepts EPDs published in the French system. However, this is due to change in the future, as France has declared they will allow the usage of other databases. However, while the French government will have a mechanism to separately allow different systems, all systems must apply for recognition one by one, enforcing still the existing trade barrier.

Conservative factors

Generic databases often have conservative values to compensate for heterogeneity in the markets. Conservative values represent an additional top up factor for a product's emission factor, to better represent the market average. In Finnish national database the top up factor is always 20 % and in the Swedish national database 25 %. OKOBAU.DAT on the other hand considers the dataset's representativeness and completeness and assigns them an uncertainty margin of 10 %, 20 % or 30 %.

4. OBSERVATIONS ON INFLUENCE OF REGULATIONS

There are multiple differences in all the regulatory frameworks, national methodologies, and their current development stages. However, many of these countries have already earlier implemented similar requirements and tested life cycle assessment in their markets. Where these regulatory frameworks are good drivers in increasing LCAs done in the market, there are many voluntary certification schemes, such as BREEAM, that do the same. As they are voluntary, they do not reach the whole market, but are still widely used for example in UK and France. Also, organization specific climate targets and environmental strategies have driven life-cycle assessments in the private sector.

National regulations often aim towards clarifying and facilitating life cycle assessments in national markets. They have also increased the amount of data disclosed and thus raised awareness on the environmental performance of building materials and built environment. The regulations implemented have increased knowledge on life-cycle accounting and emissions of built environment in the market. They have also altered material procurement and thus increased demand for transparency on environmental performance of construction products as well as increased demand for low-carbon construction products.

The limit values set in some national regulations have not been widely implemented yet. However, the limit values have a possibility to ease the transition to national emission reduction and net-zero targets, when implemented correctly.

However, there are some downsides to national regulations, especially if they differ greatly from the underlying European standards. This can be especially seen in the French regulation that can be seen to create barriers to global trade with its restrictions on market data used in life cycle assessment. As the French methodology only accepts EPDs published by the French Program Operator, they have excluded any company not publishing in French outside of their market scope.

Where the underlying standard is the same in all compared national methodologies, and the frameworks are similar with the European Commission's Level(s) framework, there are deviations between national methodologies and Level(s). As national methodologies are equally recognized, this does not pose significant problems. However, some scopes of assessments are relatively simpler than others, especially in terms of building elements and life cycle stages assessed. This can cause some distortion in knowledge, if heavily emitting building parts are left out, or if certain materials are chosen because their manufacturing emissions are low, but in reality their use phase and end of life emissions result to higher emissions in total.

5. SUMMARY

	DENMARK	FINLAND	FRANCE	GLA, UK	NORWAY	SWEDEN
Status of Regulation	Test phase	Awaiting legislation	In force	In force	Awaiting legislation	In force
Regulation timing	2023	Estimated 2024	January 2021	March 2021	January 2022, 1 year transition	January 2022
New or revision	New	New	Revision of energy code	Revision of London Plan	Revision of energy code	New
LCA Methodology	Sustainability class	Climate declaration	RE2020	WLC Assessment	Simplified NS 3720: 2018	Klimatdeklaration 2022
Methodological Standard Alignment	EN 15978	EN 15978	EN 15978 w/ deviations	EN 15978	EN 15978 / NS 3720	EN 15978
Limit values	2023 for >1000 m^2, 2025 for all	Expected 2025	Yes	No	No	Expected in 2027
Enforcing time	Construction permit and completion	Construction permit	Construction permit	Pre-application, planning submission & post-construction	Upon completion	Before completion
Life-cycle stages included in assessment	A1–A5 B4 B6 C3–C4 D	A1–A5 B4 B6 C1–C4 D	A1–A5 B1–B5 B6–B7 C1–C4 D	A1–A5 B1–B5 B6–B7 C1–C4 D	A1–A3 B4–B5	A1–A5
Assessment period	50 years	50 years	50 years	60 years	60 years	Completion only – 0 yrs
Unit for reporting	kg $CO_2e/m^2/a$	kg $CO_2e/m^2/a$	kg CO_2e, kg CO_2e/m^2 & kg CO_2e/occupant	kg CO_2e & kg CO_2e/m^2	Undefined	kg CO_2e/m^2
Biogenic carbon storage	Yes	Yes	Yes	Yes	Yes	No
Carbon handprint	No	Yes	No	No	No	No
Product standard alignment	Version undefined	EN 15804 +A2	EN 15804 +A1	EN 15804 +A1 & +A2	EN 15804	EN 15804 +A1 & +A2
Government generic data	No	Yes	Yes	No	No	Yes
Market data allowed	Yes	Yes	Restricted	Yes	Yes	Yes
Market data requirements	EN 15804	EN 15804 +A2	EN 15804, EN 50693	EN 15804, ISO 21930, ISO 14067, ISO 14025, ISO 14040, ISO104044, PAS 2050	EN 15804	EN 15804 +A1 & +A2
Source of energy data	National scenarios	National scenarios	Inies, Ministry of environment scenarios	National Building regulation, Future energy gov	Not relevant	Not relevant

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