ANNEX 2

Study for the application of assessment principles for the carbon footprint of construction works in Estonia

CALCULATION METHOD

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Kalamees, Targo
Kertsmik, Kadri-Ann
Kurnitski, Jarek
Lylykangas, Kimmo
Oviir, Anni
Pasanen, Panu
Tikka, Sara

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks

Abbreviations

AR5	IPCC Fifth Assessment Report
CCI-EE	The Estonian construction classification system
CO_2	Carbon dioxide
GHG	Greenhouse gas
GWP	Global warming potential
EN 15804+A2:2019	Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
EN 15978:2011	Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method
EN 16258:2012	Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)
EPD	Environmental product declaration
IEA	International Energy Agency
KeM	Ministry of Environment
KUK	Keskkonnauuringute Keskus, Environmental research center
LCA	Life cycle assessment
MKM	Ministry of Economic Affairs and Communications
NECP 2030	The Estonian national energy and climate plan
RITA	A programme supported by the European Regional Development Fund that aims to increase the role of the state in the strategic managing of research and the capabilities of R&D institutions in carrying out socially relevant research.
RT	*Riigi Teataja*, publication channel issued by the Estonian Ministry of Justice

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1. INTRODUCTION

The introduction of carbon footprint calculation methodology aims at reducing the greenhouse gas emissions of the Estonian building stock, increasing the awareness of the climate impacts of built environment and supporting the competitiveness of the Estonian construction industry by developing the environmental performance of products. The methodology can be applied to all types of buildings. It can also be applied to renovations and construction works with minor adjustments.

The purpose of this proposal is to establish an initial methodology that can be introduced to the Estonian construction sector, tested and developed further. The proposed calculation methods are straight-forward and apply simplified default values.

The rationale behind this proposal is to include an extensive number of modules already in the initial version of the method, in order to provide a complete picture of the emission sources and the climate impacts of Estonian buildings. Furthermore, adding modules later in the assessment framework might cause confusion. Therefore, the future development of this methodology could be based on the proposed scope but could update the calculation methods and the default values as well as develop further the database on the construction materials, as more information on the processes and products is available. The first priority is to update the scenarios for the CO_2e emission factors of the energy carriers, especially grid electricity, as the scenarios have a major impact on the calculation result. The on-going initiatives aiming at harmonization among Nordic countries and among the EU member states, as well as the developments of the Level(s) framework, Taxonomy regulation and the Energy Performance of Buildings directive should be followed and, if necessary, reacted on in the method development.

A database on the CO_2e emission factors of Estonian construction materials is a crucial component in the method. As the number of environmental product declarations for Estonian products is still very limited, the generic CO_2e emission factors were at this stage localized from the foreign database values, mainly from the Finnish *CO2data.fi* database, as the range of products and construction materials is very similar in Estonian and Finnish buildings. The updates will be needed when the Estonian grid electricity is gradually decarbonized and more information on the Estonian construction materials and products is available.

Before considering any limit values, the method needs to be tested and a sufficient number of calculation results collected on all building types. All support mechanisms generating more environmental product

declarations for Estonian products would be welcome, as they also provide more information to base the generic emission factors on.

The carbon footprint methodology is based on the life cycle assessment (LCA) in accordance with ISO 14040 as illustrated in the Figure 1. The method is aligned with the European Standards EN 15804+A2:2019 and EN 15978, the European Level(s) framework and with international best practice. Furthermore, the methodological approach takes into consideration the European Taxonomy regulation which entered into force on July 12, 2020.

The significant exceptions from the relevant European standards are:

- The method applies a scenario for the CO_2e emissions for energy carriers.[1]
- Tenant electricity (plug-in electricity) is included in delivered energy.[2]

This method proposal was created by the researchers of TalTech and the experts of One Click LCA in a project *Assessment principles for the carbon footprint of construction works in Estonia* in 2021, financed by the Estonian Ministry of Economic Affairs and Communications and co-financed by the RITA programme.

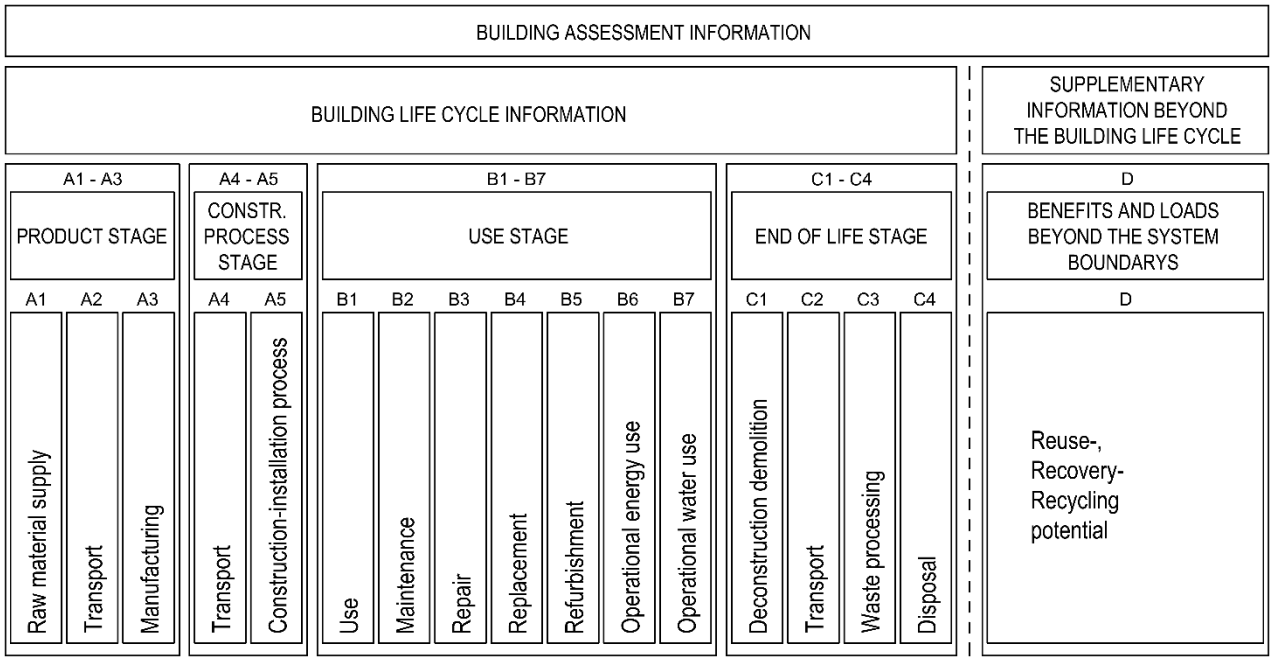

Figure 1. Life cycle assessment framework for estimating the carbon footprint of construction works. Source: EN 15804+A2:2019.

[1] According to Energy Performance of Buildings Directive and EN 15978, the CO_2e emission factor for a each energy carrier is constant over the assessment period.

[2] According to Energy Performance of Buildings Directive and EN 15978, tenant electricity is not included in delivered energy.

2. OBJECT OF ASSESSMENT

TARGETED TYPES OF CONSTRUCTION WORKS

This methodology is designed for the construction of new buildings and for major renovations.

SCOPE OF THE ASSESSMENT

For the purpose of comparability, a minimum scope of building elements described below is to be considered and the assessment should cover all of the building elements listed in the table below, using the Estonian construction classification system CCI.

The scope follows MKM Regulation No 63 (RT I, 13.12.2018, 14), so that the new requirements can be incorporated into MKM No 63 as a new section.

The scope of the assessment shall be specified as a new section in MKM No 58 (RT I, 09.06.2015, 21).

A minimum scope of building elements to be included in the assessment as follows:

- Foundation
- Load-bearing structure (beam, post, plate, wall)
- Roofing
- Exterior wall
- Balcony and terrace
- Partition wall
- Stairs
- Facade cladding and shading
- Window, glass facade, door and other openings
- Roof
- Suspended ceilings
- Wall and ceiling finishing
- Flooring and finishing.

The methodology includes wall, floor and ceiling finishes, as these elements have short lifespans in a building and therefore will have significance due to their frequent replacements in the building level assessment.

EXCLUSIONS AND CUT-OFF RULES

The following elements of the construction works are always excluded from the assessment:

- External areas.
- Separate nails, screws, glue and other adhesives not part of the products they are used to install.
- All temporary constructions.
- All tools, machinery, equipment, scaffolding and systems that are used in the construction project, but which are not permanently installed in the building.
- All furniture and appliances, regardless of whether permanently installed or moveable.

A further allowance to omit insignificant materials for a total of up to 2 % of the total mass of the in-scope construction works is permitted. Any omitted material may have a maximum mass of 0.5 % of the total mass of the in-scope construction works. This can only be used to omit insignificant materials entirely, not to reduce the quantity of assessed materials. The purpose of this allowance is to reduce the data collection burden from the assessors.

The refrigerants of HVAC systems and all material-related GHG-emissions (A- and C-modules) of external areas (plot) are excluded from the scope of the assessment. The inclusion of such elements does not contribute significantly to the building overall life cycle impacts, the quantitative material data would be difficult or impossible to obtain at the early stage of the project, and the material emission data would need to be based on default values that would not indicate the impacts accurately.

3. SYSTEM BOUNDARIES

ESTONIAN ENERGY SYSTEM AND ENERGY AND CLIMATE PLAN

Estonia has one of the most carbon intensive energy grids of all IEA countries, due to the dominant role of oil shale (*põlevkivi*) in the energy sector (IEA 2019). Thus, an LCA methodology without operational energy usage cannot be recommended in the Estonian context. In consideration of the above, the method applies a scenario on the Estonian electricity system emission factor, considering the reduction of emission intensity over the course of the building assessment. The existing scenarios (Table 1) need to be updated, because existing factor data is not complete and is not based on the climate neutrality target for 2050.

Table 1. Estonia's electricity and district heating CO_2e emission factor scenario (Mändmets & Štõkov 2021).

tCO_2e/MWh	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Grid electricity	0.717	0.637	0.509	0.425	0.359	0.344	0.32	0.27	0.22	0.17	0.11
District heating	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

SYSTEM BOUNDARY

The system boundary is set as **cradle-to-gate with options** according to EN 15804+A2:2019 standard. The explanations for the proposed scope of assessment are provided in Table 2 on the last column to the right. The emissions in Module D, Beyond System Boundary, are not summed up together with other impacts.

Table 2. The scope of assessment (the life cycle stages included in the assessment).

Stage	Scope	Definition	Explanation
A1–A3 Product phase	X	'Cradle-to-gate' emissions from materials and services used in production.	Key source of emissions
A4 Transport to construction site	X	Emissions from the transport of building materials to the building site.	Allows distinguishing source of supply
A5 Construction site	X	Material wastage on the construction site.	Default values from the material database.
B1 Use[3]	-	Use of the building.	Low impact. If included, typically required for refrigerants
B2 Maintenance	-	The maintenance of construction products.	Usually only via default values > low impact
B3 Repair	-	The repair of construction products.	
B4 Replacements	X	Replacement of building materials	Important source
B5 Refurbishments[4]	-	Planned refurbishments for the building.	Major renovations not expected during the assessment period.
B6 Operational energy	X	Operational purchased energy used by the building's technical systems	Key source of emissions
B7 Operational water	-	Water used and its treatment.	Very low impact
C1–C4 End-of-life	X	Demolition, transport to waste processing sites, waste processing and final disposal.	Usually only via default values > low impact
D Beyond system boundary	X	Net environmental benefits or loads from recycling, reuse and energy recovery.	Supports circularity strategies and reuse

.

[3] B1 to be excluded because of minor impact and being difficult to estimate.

[4] Refurbishments (B5) will be analysed in the LIFE IP BUILDEST project.

ASSESSMENT PERIOD

The assessment period is the period over which the assessment is conducted. The assessment shall be carried out for a reference service life of 50 years for all building types.

BUILDING TYPES AND EXCLUSIONS

This method is not applicable for any temporary or transportable buildings whose permitted lifespan is less than 5 years. In practise, the input data is available from all projects that require energy certificate. The method can be applied in major renovations in accordance with the Building Code.

According to this proposal, the new Estonian regulation on the carbon footprint of buildings would be implemented as an extension to the existing regulation on the energy efficiency of buildings. Therefore, the exclusions of energy performance regulation would apply also to carbon footprint requirements. Thus, no limit values would be set to detached houses or building types that are excluded in MKM No 63 (RT I, 13.12.2018, 14).

4. ENVIRONMENTAL DATA FOR THE ASSESSMENT

ENVIRONMENTAL DATA USED IN THE ASSESSMENT OF BUILDING PRODUCTS

The level of specificity of the data used in the assessment differs depending on the stage of the project. Data quality shall follow the EN 15804+A2:2019 standard. The assessment follows the following hierarchy:

1) **Product specific data**: product-specific third party verified EPDs fulfilling EN 15804+A2:2019 and ISO 14025 requirements. Only when the product is specified to be used in the construction project. (However, such info is rarely available at the early stage of the project.)
2) **Supplier specific data**: supplier-specific third party verified EPDs fulfilling EN 15804+A2:2019 and ISO 14025 requirements. Only when a product covered by the EPD from the supplier has been specified to be used in the construction project.
3) **Product category averaged data**: third party verified EPDs fulfilling EN 15804+A2:2019 and ISO 14025 requirements, representing products and suppliers which will be used.
4) **Generic data**: Estonian average database. This data can always be used when a supplier or specific product is not selected.
5) **Other generic data**: If no matching data from any of the above categories can be found, using the conservative generic values from following national databases only is allowed: *Boverkets*

klimatdatabas[5] (Sweden), *www.CO2data.fi*[6] (Finland) and *Ökobaudat*[7] (Germany). Each of these national databases provide conservative generic values, including a top-up factor on the emissions to represent uncertainty in an averaged datapoint. The values with the top-up factors must be used.

No other data sources are accepted. For products used in small quantities, projects may use the cut-off rules to exclude highly specific small quantity materials from the assessment (See "Exclusions and cut-off rules" in Chapter 2).

ENVIRONMENTAL DATA USED FOR THE SITE OPERATIONS

CO_2e emissions related to machinery work, equipment, heating and water use on site are not included in the assessment. Only material wastage shall be accounted for, and this follows rules set out above for construction materials.

ENVIRONMENTAL DATA USED FOR TRANSPORT

All transport-related environmental data shall use default values that are specified in this document.

ENVIRONMENTAL DATA USED IN THE ASSESSMENT OF REFRIGERANTS

Refrigerant leakages during use of the building are currently not included in the method. If included in the future, only leakage-caused GWP of refrigerants shall be considered (production of refrigerant is excluded). GWP values published in the IPCC Fifth Assessment Report (AR5) shall be used for refrigerants. For refrigerants that do not have a factor provided in AR5, a factor published by European Commission may be used.

[5] https://www.boverket.se/sv/klimatdeklaration/klimatdatabas/

[6] www.CO2data.fi

[7] https://www.oekobaudat.de/

ENVIRONMENTAL DATA USED IN THE ASSESSMENT OF ENERGY SUPPLY

All environmental data for the energy supply used, in any form, shall use Estonian average database values. An exception to this are grid-specific values that have a third-party verified and valid Environmental Product Declaration in line with ISO 14025 and EN 15804+A2:2019.

In practice, the values with 5-year steps, which are to be interpolated linearly for the years in between, are to be provided for energy carriers specified in MKM No 63 (RT I, 13.12.2018, 14).

ENVIRONMENTAL DATA USED IN THE ASSESSMENT OF MODULE D

Exported energy and any other benefits and loads outside the system boundary, shall use Estonian average database values.

5. CALCULATION METHODOLOGY

ENVIRONMENTAL IMPACTS CONSIDERED

The assessment methodology focuses on the environmental impact category of climate change (carbon footprint) pursuant to standard EN 15804+A2:2019. The impact category measured is the Global Warming Potential Fossil (GWP-fossil) and it follows the definition of the EN 15804+A2:2019 standard. This indicator quantifies the Global Warming Potential contributions of a building and it accounts for the Global Warming Potential from greenhouse gas emissions that originate from oxidation or reduction of fossil fuels or materials that contain fossil carbon.

In the initial version, biogenic carbon emissions and impacts and land use and land use change on global warming potential are excluded from calculation. Other environmental impacts (e.g. ozone depletion, acidification, eutrophication etc.) are not considered in this assessment methodology.

CALCULATING THE CARBON FOOTPRINT OF CONSTRUCTION MATERIALS

The carbon footprint of materials consists of the manufacturing of acquired materials (A1–A3), transport to the construction site (A4) and replacements during the building's life cycle (B4). The calculation should be performed on defined building elements and based on a quantity assessment.

The quantities of construction materials are obtained in a bill of materials based on the building elements included in the assessment. The bill of materials must also include an assumption of material wastage, which is assessed in module A5. A default wastage percentage for each construction material is included in the Estonian material database.

When calculating extensions or refurbishments, only new and added materials shall be included in the calculations. All existing structures are excluded. The existing parts that are not being refurbished belong to the building's anterior 50 year life cycle and thus do not contribute to the refurbishment's emissions.

If some materials or structures used in the project are directly reused or salvaged as surplus from a previous building on the same site or any other projects, the manufacturing emissions of these materials shall be excluded from the assessment, however all transport impacts (A4 stage) shall be included.

A1–A3 Carbon footprint of materials

Building manufacturing impacts (A1–A3 module) will be calculated by multiplying the material emission factor (GWP) by the quantity of material (mass).

(1) $GWP_{A1\text{-}A3} = GWP_{building\ services} \times S + GWP_{material1} \times m_{material1} + GWP_{material2} \times m_{material2} + \ldots$

s is the heated floor area

m is the material mass.

Building services are the systems installed in buildings to make them comfortable, functional, efficient and safe, including building management systems; energy generation, distribution and supply; escalators and lifts; facade engineering; fire safety, detection and protection; heating, ventilation and air conditioning

(HVAC); information and communications technology (ICT) networks; lighting; lightning protection; refrigeration; security and alarm systems; and water, drainage and plumbing.[8]

The material emission factors shall be derived from the Estonian database (Annex 6) or alternatively from a valid third party verified EPD (in accordance with standards EN 15804, ISO 14025). If an EPD data is used, evidence must be provided.

A4 Transport to construction site

The GHG emissions for transportation are calculated as tank-to-wheel emissions. The Estonian material database table does not include the transportation distance value, but the sourcing region of the material (local/global). The module A4 will be calculated based on the default distance of 500 km for locally sourced materials, and 3000 km for globally sourced materials, by multiplying transportation distance with the emission factor.

(2) Locally sourced materials: $GWP_{A4_local} = m_{material1} \times (450 \times EF_{highway\ driving} + 50 \times EF_{urban\ driving})$

(3) Globally sourced materials: $GWP_{A4_global} = m_{material1} \times (2950 \times EF_{highway\ driving} + 50 \times EF_{urban\ driving})$

$m_{material1}$ is the mass of material

$EF_{highway\ driving}$ is the emission factor for road transport in highway driving

$EF_{urban\ driving}$ is the emission factor for road transport in urban driving

(4) $GWP_{A4} = GWP_{A4_local} + GWP_{A4_global}$

The emission factors are from the Finnish LIPASTO database. The initial version of the method includes a single transportation option (road transport, 40-tonne truck fully loaded) as a simplified consideration. However, when the methodology is developed further, alternative modes of transport can be added.

When the specific supplier is known, the transport is calculated by estimating the transport distance (using the distance the actual vehicle travels) and the mass of the product(s) transported. The assessment shall be done for one way transport only, but the resulting carbon footprint shall be multiplied by a factor of 1.4 representing a partial lack of commercially viable return trips.

[8] Building services definition as in https://www.designingbuildings.co.uk/wiki/Types_of_building_services.

Instructions for more detailed calculation are provided in standard EN 16258:2012 and the guide "Calculating GHG emissions from freight forwarding and logistics services in accordance with EN 16258. Terms, Methods, Examples." (Schmied et al. 2012).

A5 Construction site

This phase is calculated using a materials wastage factor on the amount of materials installed per material. Wastage is calculated in addition to the installed amounts, using the installed amount as the base. Transport and end of life (module C1–C4) impacts shall be calculated also for the wasted amounts.

(5) $GWP_{A5} = GWP_{A1\text{-}A3_material} \times w\%_{material} + GWP_{A4_material} \times w\%_{material} + GWP_{C1\text{-}C4_material} \times w\%_{material}$

w% is the material wastage percentage.

The wastage factor, by default, comes from Estonian database; however, it may be adjusted when the installation technique and associated wastage can be accurately and reliably quantified.

The default value is derived from the One Click LCA tool[9] that applies the best practises in European carbon footprint calculation. Wastage defines the construction site wastage for the material. Wastage default values are set based on typical wastages, however, they will vary based on construction process, building, and design. High degree of prefabrication reduces the wastage percentage.

B4 Replacements

The material database provides a value for a material service life for each construction material. Service life determines how long the product is in the use phase before it is replaced.

When any product's service life is shorter than the building assessment period (50 years), the product must be replaced at each end of service life until at least the full building assessment period is achieved. All replacements of buildings materials during the building's life cycle shall be accounted for. In relation to replacements, all impacts from the replaceable materials need to be considered, including the transportation of the new product and end of life impacts of the removed product.

[9] https://www.oneclicklca.com

All replacements are calculated with the same carbon footprint as the initially installed product, with the exception of reused or salvaged products. When any initially reused or salvaged products require replacement during the life cycle of the building, the same assumption on reused materials cannot be extended for the replacements. The replacements must be calculated as new material with average impacts instead.

Manufacturers' technical documentation and EPDs may be used if the material is not included in the database.

(6) $GWP_{B4} = GWP_{A1\text{-}A3_material} \times i_{material} + GWP_{A4_material} \times i_{material} + GWP_{C1\text{-}C4_material} \times i_{material}$

i is the number of replacements required for material within 50 years service life of a building

The GWP value in the database is derived from the One Click LCA tool as these values have been adjusted based on real data. The service life is derived from European databases on material longevity[10]. However, in this relation service lives can also be taken from the Finnish database[11] for building elements depending on building type or a similar guidance could be provided. Service life determines how long the product is in the use phase before it is replaced. Foundations are never replaced. For some products default service life is the building lifetime, for others they will be replaced to meet the assessment period as often as requested. Replacements will not occur in the last year of the assessment period. The service life of each product can be adjusted.

B6 Calculating the carbon footprint of operational energy

Operational energy calculation is defined in MKM Regulation No 63 (RT I, 13.12.2018, 14) and MKM Regulation No 58 (RT I, 09.06.2015, 21). No changes are needed: the delivered energy values are used to

[10] German BNB Nutzungsdauern von Bauteilen (https://www.nachhaltigesbauen.de/austausch/nutzungsdauern-von-bauteilen/); Finnish guidance document by Finnish Building Information Foundation (https://cer.rts.fi/wp-content/uploads/rts-pcr-versio-020616.pdf); British "Life Expectancy of Building Components. Surveyors' experiences of buildings in use A practical guide" (BCIS, 2006).

[11] https://CO2data.fi

calculate operational energy emissions (B6). Calculated energy use value shall be multiplied with energy emission factor for respective energy carrier.

The specific CO_2 equivalent emission factor scenarios for energy carriers (as listed in MKM Regulation No 63 (RT I, 13.12.2018, 14)) are to be updated.[12] For the carbon footprint assessment, the scenarios should reach further than 50 years from present.

Some cities in Estonia also have municipal district heating plans in operation. A national average emission factor is applied for such plants. Alternatively, the plants can provide a valid, third-party verified Environmental Product Declaration (EPD) to permit the use of a specific emission factor in the assessment.

[12] This issue needs coordination with KeM, because existing factor data is not complete and is not based on the climate neutrality target for 2050.

Emissions from operational energy are calculated from all energy carriers delivered to the building with specific CO_2e emission factors provided in Table 1.

(7) $$GWP_{B6} = \sum_{i} \sum_{j=1}^{50} E_{tar,j}^{i} GWP_{E,j}^{i}$$

$E_{tar,j}^{i}$ is delivered energy by energy carrier *i* in year *j* kWh
$GWP_{E,j}^{i}$ is specific emission factor of energy carrier *i* in year *j* $kgCO_2e/kWh$

C1 Demolition

Demolition impacts are dependent on building materials, however it's extremely difficult to assess the impacts of a single material on a building scale. It is not suggested to use material resource related C1 impacts, but the use of generic values instead. Therefore, the material database does not include C1 impacts attributed to material resources. This approach is also chosen by the Finnish system, in the *CO2data.fi* database. Demolition impacts are estimated per net m² of a building type. The floor area (m²) based values are derived from literature review on average energy consumption of demolishing 1 m² of building (international studies, from across Europe) and average size of building types in Finland. Assuming that the building sizes are comparable in Estonia and Finland, the C1 values can be used as follows:

- Demolition, office building -14 $kgCO_2e/m^2$
- Demolition, residential building -7 $kgCO_2e/m^2$
- Demolition, school or kindergarten -9.8 $kgCO_2e/m^2$.

It is recognized that the building type categorisation in Estonia is more extensive. Considering the scope and limitations of this study, it is not possible to generate any further C1 emission values. In the adoption of the calculation method it is the CO_2e calculation assessor's choice to make the most suitable selection based on the options available.

(8) GWP (C1) = building net floor area x emission factor

C2 Transport

C2 module can be calculated using an average distance of 50 km and LIPASTO emission factor 0.0116 $kgCO_2e/tkm$[13] for 50% loaded delivery driving lorry. The default distance is assumed 50 km.

(9) $GWP_{C2} = m_{material} \times EF_{50\%\ loaded\ delivery\ lorry} \times 50$

$m_{material}$ is the mass of material

$EF_{50\%\ loaded\ delivery\ lorry}$ is the emission factor for 50 % loaded heavy goods vehicle.

C3 Waste processing

In the Finnish system C3 module impacts are assessed based on the material class. The Estonian material database is extended to include one of the following three classes for each material resource. The default values based on material class are:

- mineral materials 0.006 $kgCO_2e/kg$
- wooden materials 0.02 $kgCO_2e/kg$
- metal materials 0.002 $kgCO_2e/kg$.

C3 module is calculated based on material type recycling impacts emission factor, material's recycling rate, and material mass.

(10) $GWP_{C3} = R_{material1} \times EFR_{material1} \times m_{material}$

R is material recycling rate (1 or 0.75 or 0)

EFR is material recycling impacts emission factor (based on material type).

[13] http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/tieliikennee/kajaksuurijakelue.htm

C4 Final disposal

C4 module is assessed based on an average value of 0.06 $kgCO_2e/m^2$ of building area.

C4 is calculated based on the material disposal impacts emission factor, material's disposal rate, and material mass.

(11) $GWP_{C4} = D_{material1} \times EFD_{material1} \times m_{material1}$

D is material disposal rate (0 or 0.25 or 1)

EFD is material disposal impacts emission factor (0.06 $kgCO_2e/m^2$ of building net floor area)

m is material mass

D module

Module D entails the benefits and loads beyond the system boundary that would not be occurring without the construction project, including the following:

- Component reuse and the recycling of materials
- Energy recovery from material flows
- Exported energy (energy sold to the grid).

Module D shall not be deduced from the carbon footprint but presented as a separate result. Calculated according to the EN 15978 standard.

For each material resource, the Estonian material database specifies recycling or recovery benefits of the product after its lifecycle. The database values are based on the data from a large number of real-life cases assessed in the One Click LCA tool.

REUSE OF MATERIALS

All materials that can be reused as a material may be assessed with their original impacts or impacts of the material for which they are substituting.

RECYCLING OF MATERIALS

All materials that are recycled are assessed based on the substitution effect they have on the feedstock.

ENERGY RECOVERY FROM INCINERATED MATERIALS

All incinerated materials shall be assessed based on an average energy that is assumed to be substituted.

EXPORTED ENERGY

The quantity of exported energy shall be analysed as a yearly amount. All electricity, cooling and heating exported to the grid must be accounted in module D.

REPORTING

The amount of new material and a CO_2e data table that combines input and output data should be added to MKM Regulation No 58 (RT I, 09.06.2015, 21). These will follow the logic of current Lisa2[14] and Lisa4[15] that will report data in condensed and easy to read format. This can be a max 2-page breakdown of the inputs and results of the modules A, B, C and D.

A new report (certificate) sheet should be added to MKM Regulation No 36 (RT I, 06.05.2015, 2). This sheet reports the results of the life cycle assessment for each life cycle stage included in the assessment. The results shall be presented as totals for the whole building life-time as tonnes (without decimals) and in $kgCO_2e/(m^2a)$[16] with one decimal precision, where the total result is annualized for one year of the assessment period.

The report sheet shall also include the basic information on the building, the assessor, date and other appropriate information required for suitability in the Estonian regulatory context. The report shall include the results in a table format. A proposed format outline is provided below in Table 3 and Table 4.

[14] https://www.riigiteataja.ee/aktilisa/1220/8201/9005/MKM_11012019_m3_lisa2.pdf#

[15] https://www.riigiteataja.ee/aktilisa/1220/8201/9005/MKM_11012019_m3_lisa4.pdf#

[16] Heated floor area

Table 3. Proposed input data format.

Parameter	Information
Building type	Office building
Address	Suur-Ameerika 1, Tallinn, 10122
Floor area	3500 m^2
Assessor	Assessor Tom
Date	18 August 2021
Building mass	4530 tonnes
Type of foundation	Concrete piling
Type of structure	Precast concrete

Table 4. Proposed output data format.

Life cycle stage	tCO_2e/building[17]	$kgCO_2e/(m^2a)$[18]
A1–A3 Construction Materials	1575	9.0
A4 Transport	53	0.3
A5 Construction Site	63	0.4
B4 Replacement	189	1.1
B6 Operating Energy	4725	27.0
C1 Demolition		
C2 Transport		
C3 Waste processing		
C4 Final disposal		
Building total (A+B+C)	**6605**	**37.8**
D Beyond system boundary	-284	-1.6

[17] During the service life (50 years).

[18] Heated floor area.

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