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# Impact of circular economy on achieving the climate targets: case housing

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# Impact of circular economy on achieving the climate targets: case housing

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# Summary

*In this report the contribution of circular economy in reaching the climate goals has been assessed for residential housing. The goals in the draft Flemish climate policy plan consider the territorial emissions, i.e. the operational phase of housing. In reaching the goals of the plan, the material and carbon footprints of its implications on building and renovation need to be considered as well. The material footprints of building new dwellings and of renovating existing dwellings are 60.5 and 26.1 Mton, respectively, while 48.1 Mtons of waste will be produced. The carbon footprint of renovation, with 42.1 Mton $CO_2$-eq., is slightly more than twice that of construction of new dwellings, with a value of 20.5 Mton $CO_2$-eq. The total renovation effort till 2050 will emit the equivalent of 57% of the territorial emissions of Flanders for the year 2017. In order to fulfill the housing need with less materials and impacts, one scenario is to reduce the size of new dwellings and to split up larger existing dwellings. This leads to a reduction of the material and carbon footprint with 8.1% and 4.0%, respectively. Another scenario is to focus on construction materials, by applying alternative construction methods or building materials and increasing the use of recycled and reused materials from renovation waste. This leads to a reduction of the material and carbon footprint with ca. 20%. Hence the potential impact of circular economy is large, and can be further increased for instance via enhanced building material selection or modular building.*

Expenditures related to residential housing are linked to just over a quarter of the overall Flemish carbon footprint[1]. In turn, the direct emissions of households and the indirect emissions related to the production of energy carriers make up around three quarters of the total carbon footprint of residential housing[2]. This makes residential housing an important target to reduce the overall carbon footprint of the Flemish economy and realize the goals set forth by policy. The draft Flemish climate policy plan has targeted a reduction of the territorial GHG emissions in Flanders by 35% by 2030 relative to 2005 levels. The emissions related to buildings are set to decrease by 48% by 2030, with objectives for the reduction of the carbon emissions of residential housing at 50% by 2030. Additionally, a further complete phase-out of the use of carbon-intensive energy carriers for heating is targeted for 2050.

This study will first discuss the policy objectives set forth in the draft climate policy plan for residential housing. Then, we evaluate the material, carbon and waste footprint related to the update of the building stock to the standards determined in the climate policy plan and to the construction of new dwellings. Finally, we evaluate what the potential is of increased circularity in the construction industry in reducing the overall material, carbon and waste footprint associated with the expected future construction activity. Given the size of the building stock, the long lifetime of buildings and the sheer magnitude of the efforts required of the construction industry, the analysis is carried out until 2050 rather than the 2030 horizon that is the central focal point of the draft Flemish climate policy plan. In doing so, an overview of the entire construction effort is obtained as well as an indication of the effectiveness of possible circular strategies over the longer term. Our analysis of the carbon and material footprints of

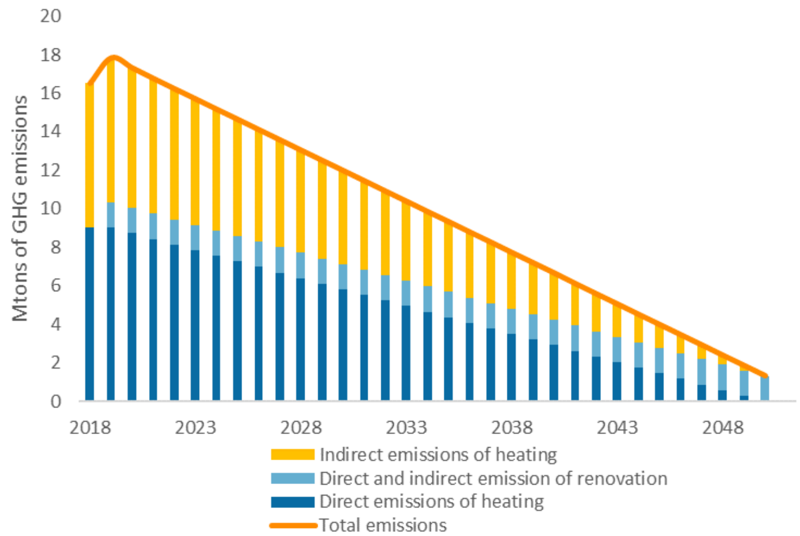
[1] Including the carbon footprint linked to the investment in housing.

[2] Vercalsteren, A., Boonen, K., Christis, M., Dams, Y., Geerken, T., Van der Linden, A., Vander Putten, E. 2017. Koolstofvoetafdruk van de Vlaamse consumptie. Onderzoeksrapport MIRA/2017/03.

the construction industry over a period to 2050 focuses on those building elements relevant to the energy performance of residential dwellings[3].

The results shows that the material footprint of the construction of new dwellings is more than double the material footprint of the renovations required to the current building stock in order for it to meet the policy targets (60,5 million tons for new buildings compared to 26,1 million tons for renovating old buildings). Additionally, a considerable waste footprint is associated with the demolition of old buildings and building elements from houses that are renovated. **The carbon footprint of the renovation effort is, however, slightly more than double the carbon footprint related to the materials used in the construction of new houses (42,1 million tons CO2-eq. for renovating old buildings compared to 20,5 million tons CO2-eq. for the construction of new houses).** This is a direct result of both the relatively large size of the existing Flemish building stock, over half of which was built prior to 1970, compared to the new dwellings that are expected to be added by 2050 and the carbon intensity of applying insulation materials and installing new window frames and glass. If one assumes that the renovation effort is equally spread across all years until 2050 and one takes into account the greenhouse gas emissions of households, the indirect impact of producing the energy carriers that are burnt by households and the carbon footprint of the renovation effort, Figure 0- 1 shows that the overall carbon emissions of the renovation effort and of residential housing will first rise, before the impact of the renovation effort leads to lower emissions after 4 years.

*Figure 0- 1: Evolution of yearly total greenhouse gas emissions of residential housing stock and the renovation activity required to update these buildings to the standard of the Flemish climate policy plan*




Next, two circular strategies are analysed that study the potential of reducing the material and carbon footprint of the construction industry over the period to 2050. The first strategy aims to make more intensive use of the living space in houses by reducing the size of new dwellings and through the splitting up a small fraction of existing larger detached houses into semi-detached

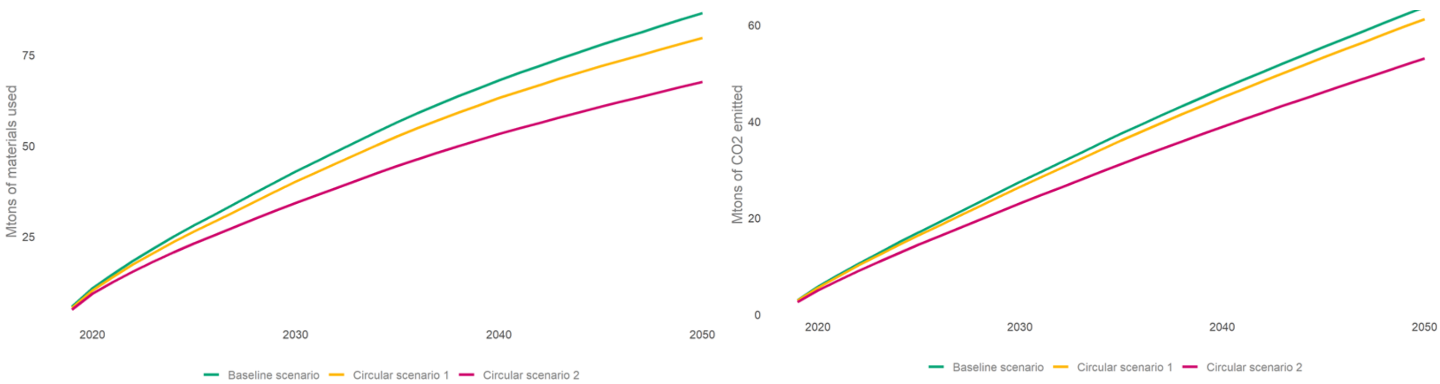
[3] The final climate policy action plan was released in december 2019, after the finalisation of the analysis. The total reduction target for the greenhouse gas emissions of buildings in Flanders was set at 40%, with residential buildings having to reduce their emissions by 43% in 2030 compared to 2005.

houses. **This strategy reducing the living space leads to a reduction of the material and carbon footprint by 8,1 percent and 4,0 percent by 2050, respectively, compared to the baseline scenario.** The reduction in the material footprint is mostly realized through the decreased need for concrete and clay bricks, while the reduction of the carbon footprint is driven by several building materials such as concrete, clay bricks, materials related to new windows and insulation material.

The second circular scenario looks at the impact of using a different construction method and the increase of recycling and reuse of demolished materials. As an example of an alternative construction method, this study opted to increase the fraction of homes built with timber frames. With respect to recycling and reuse, a large supply of materials will be produced as a result of demolition. Simultaneously, a large demand for materials will exist as these are required for the building and renovation effort. Therefore, increasing the use of recycled and reused materials can be a particularly potent way to reduce the material and carbon footprint. **The results of the second circular scenario of using different building materials and increasing recycling and reuse show a reduction of the material footprint and carbon footprint by approximately 20 percent by 2050[4].**

Figure 0- 2 shows the evolution of the cumulative mass and carbon footprints associated with Flemish construction activity in the baseline policy scenario as determined in the draft climate policy plan and the two circular scenarios.

*Figure 0- 2: Comparison of cumulative material and carbon footprint of the construction industry by 2050*




In order to reduce the overall impact of the construction industry while achieving the climate goals, this analysis has shown that increasing circularity holds considerable potential. While the cumulative impact of implementing both the circular scenarios studied here is likely to be slightly lower than the sum of the two individual scenarios, they can easily be combined to increase the overall reduction in the carbon and material footprint. Additionally, the scenarios are not exhaustive in nature and as such do not cover all potential routes for decreasing the footprint of the construction industry. In this light, increasing the use of other sustainable building materials and applying other circular strategies could further decrease the impact of the construction industry. This would ensure that meeting the climate targets for residential housing set forth in policy plans are realized with a reduced carbon footprint.

[4] The material footprint decreases by 13% as a result of increasing the application of timber frames in new dwellings and by 8.9% as a result of reusing materials. The carbon footprint decreased by 6.3% with increased use of timber frames and by 13.8% through reusing demolished materials.

# Samenvatting

*In dit rapport is de bijdrage van de circulaire economie in het bereiken van de klimaatdoelstellingen bestudeerd voor residentiële huisvesting. De doelen in het voorstel van het Vlaamse klimaatbeleidsplan betreffen de territoriale emissies, dus de operationele fase van huisvesting. In het bereiken van de doelen van het plan moeten de materialen- en de koolstofvoetafdruk van de implicaties ervan op bouwen en renoveren bekeken worden. De materialenvoetafdrukken van de bouw van nieuwe woningen en van de renovatie van bestaande woningen bedragen respectievelijk 60.5 en 26.1 Mton, terwijl 48.1 Mton afval geproduceerd zal worden. De koolstofvoetafdruk van renovatie, 42.1 Mton $CO_2$-eq., is iets meer dan tweemaal die van de bouw van nieuwe woningen, met een bedrag van 20.5 Mton $CO_2$-eq. De totale renovatie-inspanningen tot 2050 zullen het equivalent van 57% van de territoriale emissies van Vlaanderen voor het jaar 2017 uitstoten. Om de behoefte aan huisvesting met minder materialen en impacten in te vullen, is één scenario de vermindering van de grootte van nieuwe woningen en het opsplitsen van grotere bestaande woningen. Dit leidt tot een afname van de materialen- en koolstofvoetafdruk met respectievelijk 8.1 en 4.0%. Een ander scenario focust op bouwmaterialen, door toepassen van alternatieve bouwmethodes of bouwmaterialen en een toename van het gebruik van gerecycleerde en herbruikte materialen van afval van renovaties. Dit leidt tot een vermindering van de materialen- en de koolstofvoetafdruk met ongeveer 20%. De potentiële impact van de circulaire economie is dus groot, en kan verder vergroot worden bijvoorbeeld via een doorgedreven selectie van bouwmaterialen of modulair bouwen.*

Huisvesting is geassocieerd met net meer dan een kwart van de totale Vlaamse koolstofvoetafdruk[5]. Daarenboven zijn de directe emissies van huishoudens en de indirect emissies gerelateerd aan de productie van energiedragers verantwoordelijk voor ongeveer drie kwart van de totale koolstofvoetafdruk van residentiële huisvesting[6]. Hierdoor is residentiële huisvesting een belangrijke sector voor de reductie van de algemene koolstofvoetafdruk van de Vlaamse economie en om de beleidsobjectieven te realiseren. Het draft Vlaams klimaatbeleidsplan stelt als objectief een reductie van de territoriale broeikasgasemissies in Vlaanderen met 35% tegen 2030 ten opzichte van het niveau in 2005. De emissies gerelateerd aan gebouwen worden voorzien om tegen 2030 met 48% te dalen terwijl de geplande reductie van de koolstofemissies van residentiële gebouwen 50% bedraagt tegen 2030. Daarnaast wordt een complete uitfasering van koolstof-intensieve energiedragers geambieerd tegen 2050[7].

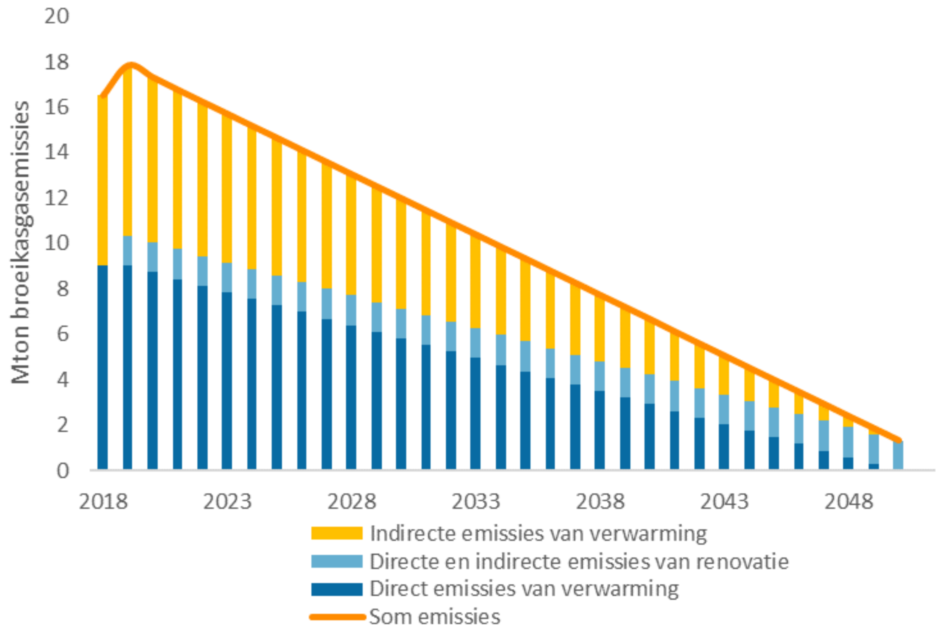
Eerst worden in deze studie de uitgezette beleidslijnen van het draft klimaatbeleidsplan voor residentiële gebouwen besproken. Vervolgens worden de materialen-, koolstof- en afvalvoetafdrukken gerelateerd aan het updaten van het residentiële gebouwenpark naar de standaard uiteengezet in het klimaatbeleidsplan, geëvalueerd. Deze worden bovendien ook vergeleken met de voetafdrukken van de voorspelde nieuwbouw die eveneens in de tussentijd

[5] Inclusief de koolstofvoetafdruk verbonden aan investeringen in huisvesting.
[6] Vercalsteren, A., Boonen, K., Christis, M., Dams, Y., Geerken, T., Van der Linden, A., Vander Putten, E. 2017. Koolstofvoetafdruk van de Vlaamse consumptie. Onderzoeksrapport MIRA/2017/03.
[7] Het finale Vlaams klimaatbeleidsplan werd gelanceerd in December 2019, na het uitvoeren van de studie. Hierin wordt de reductie van de broeikasgasemissies in 2030 tegenover 2005 vastgelegd op 40 percent, waarbij de reductie van de residentiële gebouwen vastgelegd is op 43 percent.

zou plaatsvinden. Tot slot wordt aan de hand van twee circulaire strategieën nagegaan wat het potentieel is van het verhogen van de circulariteit in de constructiesector bij het reduceren van de algemene materiaal-, koolstof- en afvalvoetafdruk geassocieerd met de toekomstige bouwactiviteit. Gegeven de grootte van het gebouwenpark, de lange levensduur van een woning en de aanzienlijke inspanningen die noodzakelijk zijn van de bouwsector, wordt de analyse uitgevoerd tot 2050 in plaats van de 2030 horizon die centraal wordt gebruikt in het draft Vlaams klimaatbeleidsplan. Zo genereert deze studie zowel een overzicht van de volledige impact van de bouwindustrie als een inzicht in de effectiviteit van circulaire strategieën over de langere termijn. Onze analyse van de koolstof- en materialenvoetafdruk van de bouwsector over een periode tot 2050 focust uitsluitend op bouwelementen die relevant zijn voor de energieprestatie van een residentiële woning.

De resultaten tonen aan dat de materialenvoetafdruk voor de bouw van nieuwe residentiële gebouwen over een periode tot 2050 meer dan dubbel zo groot is dan de materiaalvoetafdruk geassocieerd met het renoveren van het huidige residentiële gebouwenpark naar de klimaatdoelstellingen (60,5 miljoen ton voor nieuwbouw tegenover 26,1 miljoen ton voor renovatie). Daarnaast is er een aanzienlijke afvalvoetafdruk gerelateerd aan de afbraak van oude woningen en oude bouwelementen van woningen die worden gerenoveerd. **De koolstofvoetafdruk van de materialen gebruikt in de renovatie is dan weer net meer dan het dubbel van de koolstofvoetafdruk van de materialen gebruikt tijdens de bouw van nieuwe huizen (42,1 miljoen ton CO2-eq. voor de renovaties tegen 2050 tegenover 20,5 miljoen ton CO2-eq. voor nieuwbouw).** Dit is een direct gevolg van zowel de relatieve grootte van het bestaande Vlaamse residentiële gebouwenpark, de helft waarvan werd gebouwd vóór 1970, ten opzichte van de verwachte nieuwbouw tot 2050 en de hoge koolstofintensiteit van isolatiematerialen en het vervangen van raamprofielen en glaswerken. Indien wordt verondersteld dat de renovatie-inspanning elk jaar even groot is tot 2050 en rekening gehouden wordt met de indirecte impact van de productie van energiedragers die worden verbrand door huishoudens en de koolstofvoetafdruk van de renovatie, dan toont Figuur 0- 1 dat de algemene koolstofvoetafdruk eerst zal stijgen ten gevolge van de renovaties. Na 4 jaar zullen de totale emissies gerelateerd aan de renovaties en de emissies van de huishoudens pas lager zijn dan het initiële punt voor het aanvangen van de renovaties. Hierna blijft de daling zich continu verder zetten.

*Figuur 0- 1: evolutie van de jaarlijkse broeikasgasemissies van het residentiële gebouwenpark en de renovatie-activiteit noodzakelijk tot het realiseren van de doelstellingen van het Vlaams klimaatbeleidsplan*

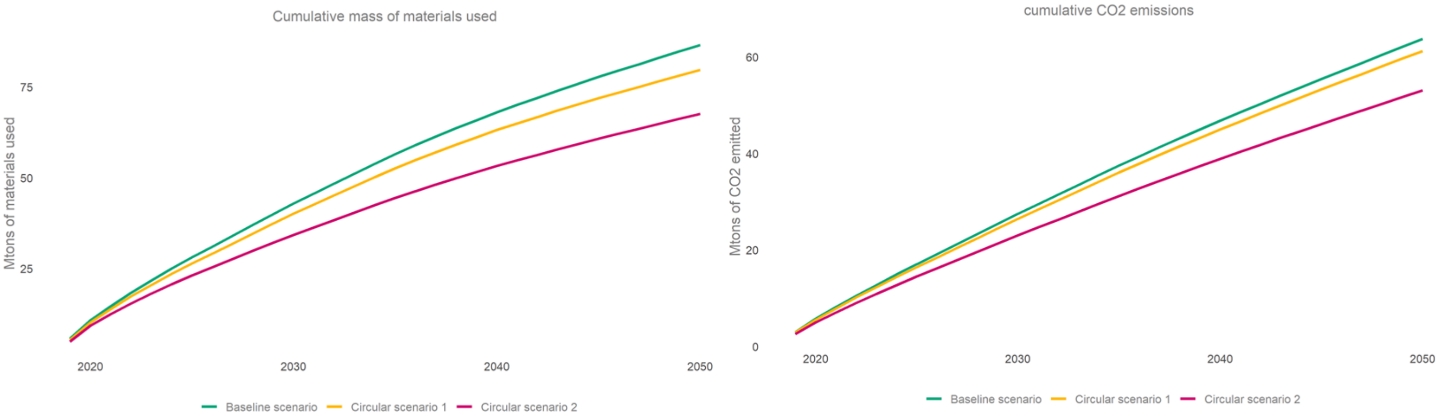



Twee circulaire strategieën werden geanalyseerd die het potentieel nagaan van een reductie in de materialen- en koolstofvoetafdruk van de bouwindustrie over de periode tot 2050. De eerste strategie tracht meer intensief gebruik te maken van de beschikbare leefruimte van huizen door een reductie in de grootte van nieuwe gebouwen en door een kleine fractie, namelijk 5 percent, van de bestaande grotere open woningen op te splitsen in halfopen woningen. **Deze strategie verkleint de woonoppervlakte en leidt tot een reductie van de materialenvoetafdruk en de koolstofvoetafdruk met respectievelijk 8,1 en 4,0% tegen 2050 ten opzichte van het basisscenario.** De reductie in de materialenvoetafdruk wordt gerealiseerd door een afgenomen vraag naar beton en baksteen, terwijl de reductie in de koolstofvoetafdruk kan gerelateerd worden aan een afgenomen vraag naar materialen zoals beton, baksteen, het installeren van nieuwe ramen en isolatiemateriaal.

Het tweede circulaire scenario kijkt naar de impact van een verschillende constructiemethode en de toename van recyclage en hergebruik van afgebroken materialen. Als voorbeeld van een verschillende constructiemethode werd gekozen voor een toegenomen toepassing van houtskeletbouw. Een substantieel aanbod aan (afval-)materialen zal geproduceerd worden ten gevolge van de afbraak van woningen en tijdens renovatie. Daarnaast zal eveneens een aanzienlijke vraag naar deze (afval-)materialen bestaan om tegemoet te komen aan de noden voor nieuwbouw en renovatie. Daarom is een toename in het gebruik van gerecycleerde materialen en het hergebruik van bouwmaterialen een bijzonder vruchtbare weg om de materialen- en koolstofvoetafdruk te reduceren. **De resultaten van het tweede circulair scenario tonen aan dat de impact van het aanwenden van andere bouwmaterialen en de stijging in recyclage en hergebruik tot een reductie van de materiaal- en koolstofvoetafdruk**

**met ongeveer 20% tegen 2050 kan leiden**[8]**.** Figuur 0- 2 toont de evolutie van de cumulatieve materiaal- en koolstofvoetafdruk van de bouwactiviteit in Vlaanderen voor het basis beleidsscenario zoals bepaald door het draft Vlaams klimaatbeleidsplan en de twee circulaire scenario's.

*Figuur 0- 2: Vergelijking van de cumulatieve materiaal- en koolstofvoetafdruk van de bouwactiviteit tegen 2050*




Teneinde de algemene impact van de benodigde bouwactiviteiten te reduceren en terwijl de klimaatdoelstellingen en materiaaldoelstelling van het klimaatbeleidsplan te realiseren, toont de analyse aan dat een toename in de circulariteit aanzienlijk potentieel inhoudt. De cumulatieve impact door beide circulaire scenario's simultaan te implementeren zal wellicht lager zijn dan de som van de impact van de individuele circulaire scenario's. Beide strategieën kunnen echter gemakkelijk worden gecombineerd om zo te komen tot een verdere reductie van de koolstof- en materiaalvoetafdruk gerelateerd aan de bouwactiviteiten die de reductie van individuele scenario's afzonderlijk overstijgt. Daarnaast zijn de scenario's niet exhaustief en dekken ze niet alle mogelijke routes voor het reduceren van de voetafdruk van de bouwsector. In dit opzicht kunnen andere duurzame bouwmaterialen worden toegepast of andere circulaire strategieën worden nagestreefd die aanleiding geven tot een verdere afname van de impact van de bouwsector.

[8] De materialenvoetafdruk dealt met 13% door de toepassing van houtskeletbouw bij nieuwbouw en met 8,9% door het hergebruik van (afval-)materialen. De koolstofvoetafdruk daalt met 6,3% door de toepassing van houtskeletbouw en 13,8% door het hergebruik van (afval-)materialen.

# Table of Contents

# Chapter 1: Introduction

International climate policy sets specific and clear targets to greenhouse gas (GHG) emissions: global GHG emissions need to be reduced with 90% by 2050 compared to 1990. In a regional context, the draft of the Flemish Climate Policy Plan defines targets for the GHG emissions that occur in Flanders[9] and starts from the objective of reducing the GHG emissions within Flanders with 35% by 2030 relative to 2005, following the Belgian target set by the EU. The objective for the reduction of the material footprint by 2030 was 30%. Although the plan focusses on the territorial emissions (in Flanders) it is stated that burden shifting should be avoided and footprint (consumption) indicators are preferably considered additionally to identify potential risks of burden shifting. Indeed, an important share of the carbon footprint of Flanders is caused by GHG emissions elsewhere. Emissions in Flanders and abroad are due to the extraction of materials, transportation, production, use, and end of life of all kinds of products. A detailed analysis of the carbon and material footprint of Flanders is already performed and reported[10], which illustrates the relation between both.

Circular Economy is in the Flemish Climate Policy Plan referred to as one of the transversal measures and it is explicitly stated that a transition towards a green and circular economy is necessary to reach the climate targets. This study intends to define different measures to reach the climate target and assesses the added value of circular economy measures, which by nature focuses on reducing the material footprint. In a previous case study, the impact of circular economy on reaching the climate goals in mobility was analysed[11]. The current study will deal with housing, given its large importance in terms of materials and emissions.

This case study focusses on the residential housing market exclusively, as almost half of the area of the built environment is used for residential use[12] and no typological data are available on tertiary or industrial buildings. The assessment in this study is based on a quantitative model that uses available data on the material and environmental impact of renovations and the construction of new dwellings. The assessment starts from a footprint or consumption perspective and thus includes the stages in the life cycle of products related to the construction/renovation of dwellings (e.g. the extraction of raw materials, production of building products, and their transportation to the building site). The environmental impact caused by the usage of a building, such as operational energy use and maintenance, is excluded from this assessment, as the focus is on the residential real estate and how it can support the reduction of GHG emissions. The end-of-life treatment of construction and demolition waste caused by renovation, construction and at the end-of-life of the dwellings is included in this study. In short, this case study analyses the embodied carbon of renovating and constructing residential buildings in Flanders.

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[9] This is according to the international and European climate policy, which is based on reduction targets on a country (territorial)-level.

[10] "Koolstofvoetafdruk van de Vlaamse consumptie" (commissioned by VMM-MIRA, executed by VITO, finalized in 2017) and "Secundaire Materialen in de Input-Outputtabellen" (commissioned by OVAM, executed by VITO, finalized in 2018)

[11] https://ce-center.vlaanderen-circulair.be/nl/publicaties/publicatie-2/6-impact-of-circular-economy-on-achieving-the-climate-targets-case-mobility

[12] https://www.statistiekvlaanderen.be/bebouwde-oppervlakte

In an introductory chapter 2 the report summarizes the targets, measures and scenarios included in the draft Flemish Climate Policy Plan for residential buildings. Chapter 3 describes the methodology that is applied during the analysis. Chapter 4 presents the results in three parts. In a first part, it shows the materials of which the current residential housing stock is composed. Next, it discusses the material and carbon footprint of realising the climate policy plan objectives for the dwellings. The final part of this chapter analyses two circular economy scenarios. Finally, chapter 5 lists the conclusions that follow from the analysis performed in this study.

# Chapter 2: Summary of the draft Flemish climate policy targets 2021-2030

## 2.1 Introduction

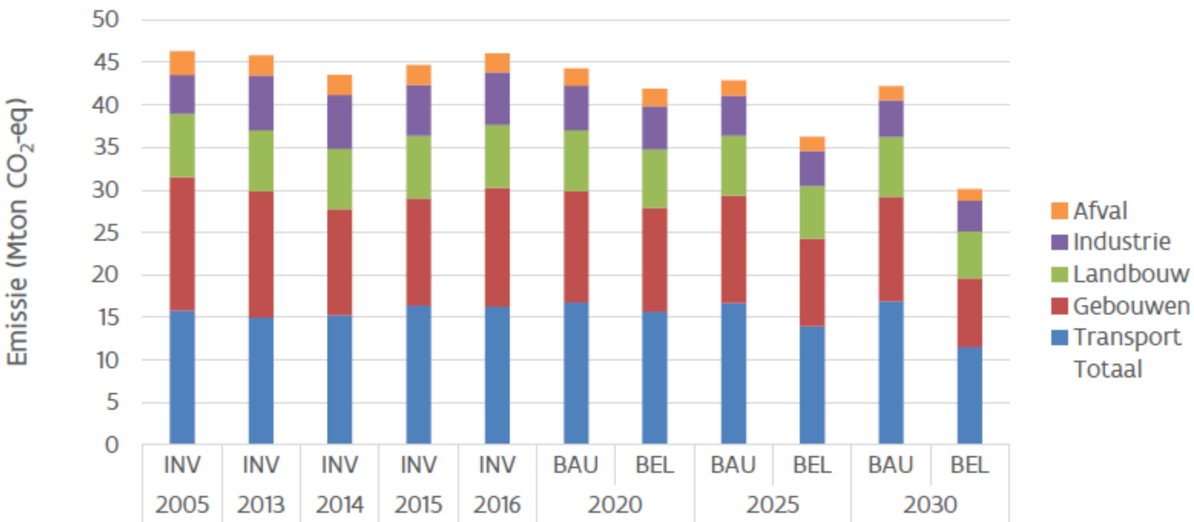
The Flemish Climate policy plan starts from the objective of reducing the GHG emissions in Flanders with 35% by 2030 relative to 2005, following the Belgian target set by the EU. The plan identifies efforts for different sectors and sets sector-specific (sub)targets if necessary. The plan includes measures as well that are necessary to reach the targets.
It is defined by the European Effort Sharing Regulation[13] (ESR) that GHG emissions should be reduced according to a linearly decreasing trend for the period 2021-2030, with the starting point in May 2019 (average of 2016-2018) and the end point in 2030 (set on -35% of non-Emission Trading System (ETS) emissions in 2005).

The Flemish Climate policy plan focusses on the direct emissions of non-ETS sectors - built environment, transport, agriculture, waste and some industry. For each sector reduction measures are formulated. However, it is of importance that the reduction measures cause as little indirect emissions as possible in ETS-sectors or outside Flanders, e.g. by electrification of the vehicle fleet.
An additional point of attention is the fact that the 'accounting' method (as agreed on European level) might lead to a distorted image of the climate efforts of the respective sectors when they are looked at individually. This is particularly relevant for the agriculture and industry sector. As such it is important to look at the efforts in a larger context and to appreciate and stimulate cross-sectoral efforts. For instance, agriculture depends in part on synthetic fertilizers and pesticides, the production of which is part of the chemical industry. Moreover, the climate impact must be assessed from a life cycle perspective. Imported emissions related to products that are imported in Flanders for our Flemish consumption need to be considered as well.

## 2.2 General prognoses

In 2016 transport (35%) and buildings (30%) contributed most to the non-ETS GHG emissions within Flanders. Agriculture (16%), industry (13%) and waste (5%) were responsible for a smaller share. Based on the inventory of emissions between 2005-2016 and two scenarios (BAU and BEL-policy scenario) for 2016-2030, prognoses are made for GHG emissions related to the non-ETS sectors.

[13] https://ec.europa.eu/clima/policies/effort/proposal_en




| | INV 2005 | INV 2013 | INV 2014 | INV 2015 | INV 2016 | BAU 2020 | BEL 2020 | BAU 2025 | BEL 2025 | BAU 2030 | BEL 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Afval | 2,8 | 2,4 | 2,3 | 2,4 | 2,2 | 2,0 | 2,0 | 1,8 | 1,7 | 1,7 | 1,4 |
| Industrie | 4,5 | 6,5 | 6,3 | 6,0 | 6,2 | 5,2 | 5,1 | 4,7 | 4,1 | 4,3 | 3,6 |
| Landbouw | 7,5 | 7,2 | 7,1 | 7,3 | 7,4 | 7,3 | 6,9 | 7,0 | 6,2 | 7,1 | 5,5 |
| Gebouwen | 15,7 | 14,8 | 12,5 | 12,6 | 14,0 | 13,0 | 12,2 | 12,6 | 10,3 | 12,3 | 8,1 |
| Transport | 15,8 | 15,0 | 15,3 | 16,4 | 16,3 | 16,8 | 15,7 | 16,7 | 14,0 | 16,9 | 11,5 |
| Totaal | 46,3 | 45,8 | 43,5 | 44,7 | 46,1 | 43,6 | 41,9 | 42,2 | 36,3 | 41,5 | 30,1 |

*Figure 1: Non-ETS GHG emissions in Flanders 2005-2030 (Mton CO2-eq) (Source: Vlaams Klimaatbeleidsplan 2021-2030).*

Non-ETS GHG emissions in Flanders decreased from 46.3 million ton $CO_2$-eq. in 2005 to 46.1 million ton $CO_2$-eq. in 2016. According to a BAU-scenario a reduction of 10% will be realized in 2030 relative to 2005, according to a policy scenario (BEL) a reduction of 35% will be realized. Between 2005-2016 the most important reduction has been observed in the building sector (-11%) and the waste sector (-22%). The transport sector shows an increase of 3%, the industry sector of 36%. This plan foresees in a further reduction by 2030 in the building sector (-46%) and a switch to a reduction in the transport sector to -27% and in industry to -21%.

## 2.3 Sector building

### 2.3.1 Relevant parameters

The contribution of the different sectors to the total GHG emission of the building sector is given in Figure 2. The residential buildings and the tertiary[14] buildings are contributing for 76% and 24 %, respectively. A very small part is due to off-road activity.

[14] Tertiary sector is defined as the non-residential and non-industrial buildings

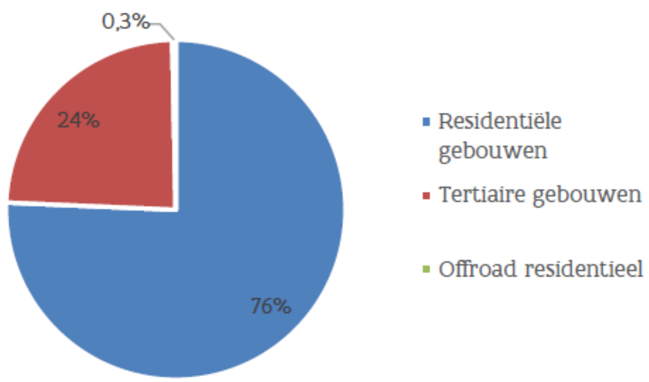



*Figure 2: Share of Flemish non-ETS GHG-emission of the building sector in 2016. (source: Vlaams Klimaatbeleidsplan 2021-2030)*

**Residential sector**

- Emission of greenhouse gasses:
  The GHG emission is dependent on the heating needs. Therefore, the degree days[15] are considered. The numbers that are reported in the Flemish climate plan do not take this renovation effort into account but are exclusively limited to the GHG emitted during the use of the building through heating[16].

  In 2016:
    - Natural gas and fuel oil account for 49% and 48% of the GHG-emission respectively

  Between 2005-2016:
    - Decrease with 13% of total GHG-emission
    - Natural gas demand per household decreased with 26% (corrected for the number of degree days)
    - Fuel oil demand per household decreased with 15% (corrected for the number of degree days)

[15] The heating requirement in a year is expressed in number of degree days, usually assuming a limit value of 15 ° C for starting the heating. For the calculation of the number of degree days in a year, each 24-hour average temperature is compared to a constant 24-hour average. Thus, every degree that the average 24-hour temperature is below 15 ° C is called a degree day.

[16] In the context of this study, it is important to establish that the analysis that will be extensively discussed later on, only pertains to the minimal energy renovation of several building elements. We will look at the embodied carbon footprint of the materials that are required to update the residential buildings while not accounting for the impact of techniques such as the specific heating installation or the use of e.g. solar panels. These renovations are performed to reduce the operational energy usage during the use phase of buildings.

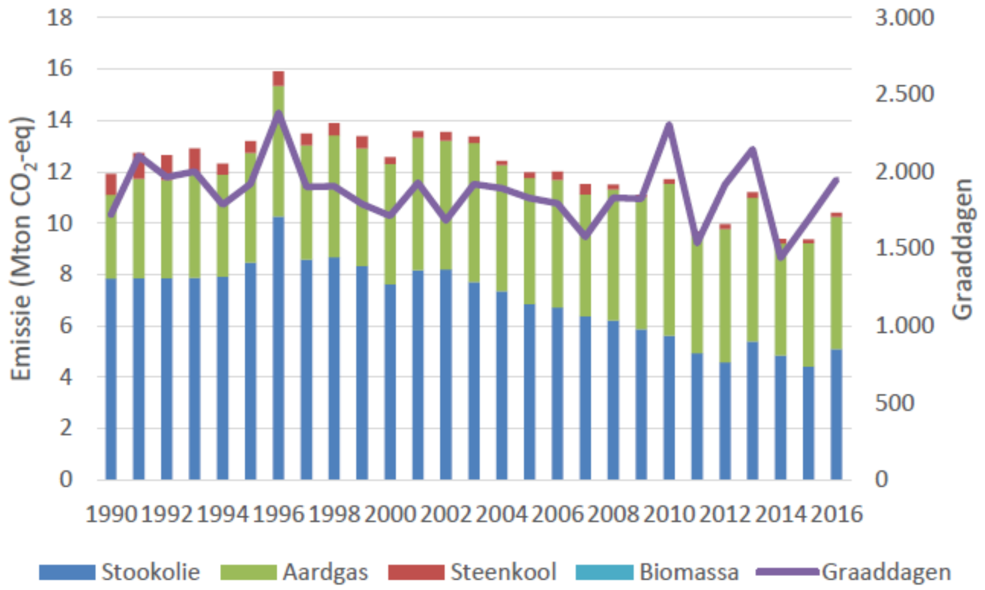



*Figure 3: GHG-emission residential buildings between 2005-2016 (source: Vlaams Klimaatsbeleidsplan 2021-2030).*

- Type of combustible:
  There is a switch from combustibles with a high carbon content such as fuel oil and charcoal to combustibles with a lower carbon content such as natural gas and in a lesser extent to renewables such as wood, heat pumps and solar water heaters.

  Between 2005-2016:
  - # households using fuel oil decreased with 21%
  - # households using natural gas increased with 34%

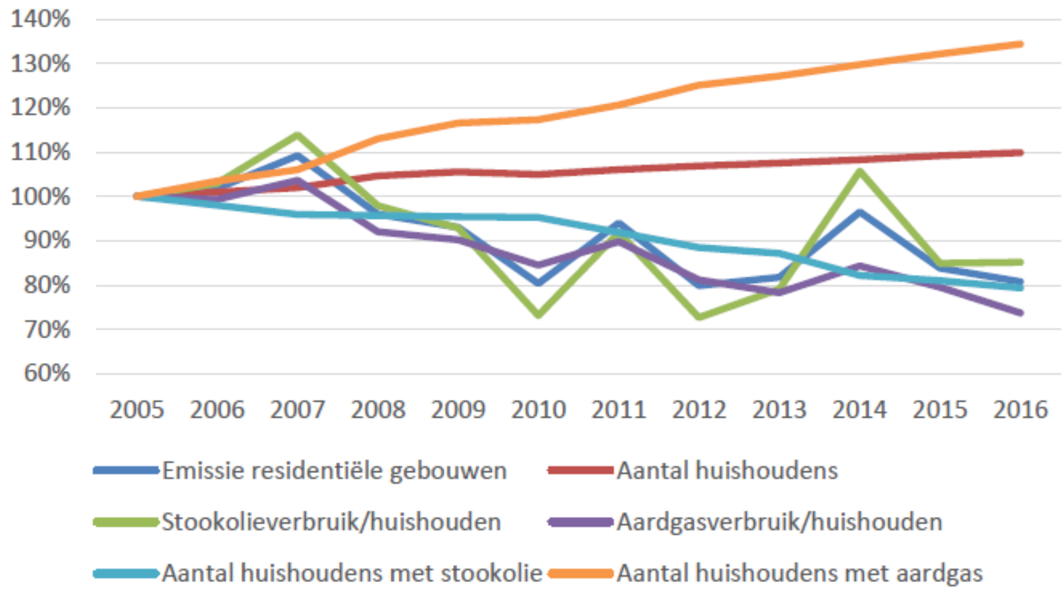



*Figure 4: Overview of the evolution in the residential buildings, corrected for the number of degree days. (source: Vlaams Klimaatsbeleidsplan 2021-2030)*

**Tertiary sector**[17]

- Emission of greenhouse gasses:

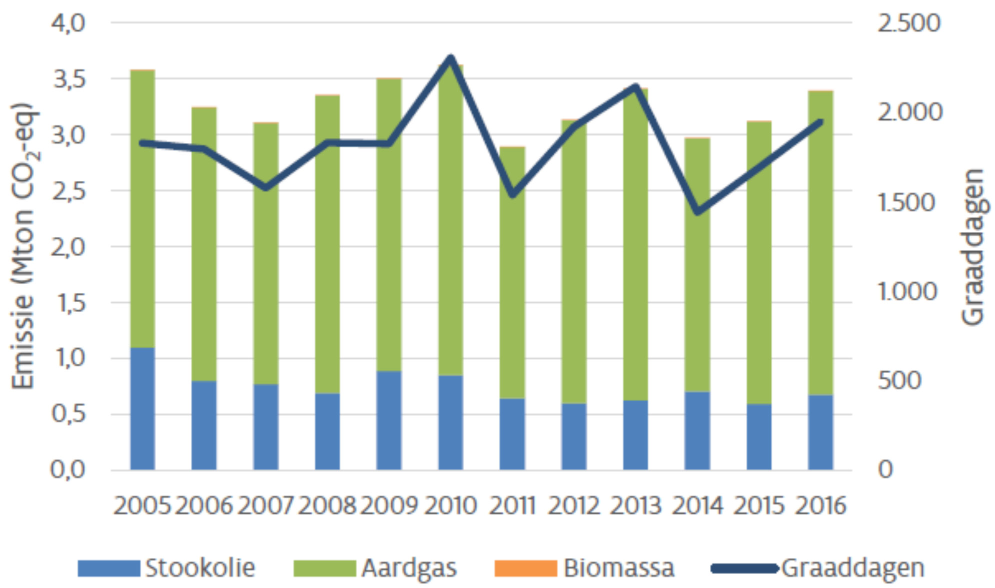



*Figure 5: Evolution of GHG-emission in the tertiary sector from 2005-2016. (source: Vlaams Klimaatsbeleidsplan 2021-2030)*

Emissions before 2005 showed the same upward trend as the economic activity.

Between 2005-2016 a slight decrease in GHG-emission with 3% was monitored. This is the result of:

- Energy efficiency

[17] Tertiary sector is defined as the non-residential and non-industrial buildings

The increase in economic activity is compensated with the increasing energy efficiency (source: Vlaams Klimaatsbeleidsplan 2021-2030).

- Type of combustible
  Transition from combustibles with high carbon content to combustibles with low carbon content

### 2.3.2 Targets

**Residential buildings**

- Renovation: Realisation of the targets of the Renovation Pact.
- Decrease in fossil fuels in houses with zero use of fossil fuel by 2050.

**Tertiary buildings**

- A $CO_2$ neutral tertiary building stock for heating, sanitary water, cooling and illumination will be realized in 2050.
- By 2050, no fossil fuels will be used anymore in tertiary buildings.

### 2.3.3 Policy measures

- New buildings energy requirements:
  - By 2021 all new buildings will have to ensure that new buildings meet the minimum energy performance requirements. This means an energy level E30.
  - This will be achieved in different steps:
    - 2018: E40
    - 2020: E35
    - 2021: E30
  - For schools and offices:
    - 2018: E50
    - 2020: E45
    - 2021: E30
- Renovation pact:
  - An action plan to decrease the average 'EPC' of existing buildings by renovation. (from EPC 400 to 100)
- Energy pact:
  - Decrease of the use of fossil fuels to zero by 2050
  - Only gas and electricity from sustainable origin

### 2.3.4 Prognoses

As reported before, the prognoses included in the Flemish climate plan only consider the operational phase. The actual embodied carbon footprint of the renovation effort is excluded and will be quantified in the analysis of this study.

**Residential buildings**

- BAU scenario:

- Evolution of the premium of the network operators until 2030
- ‘Nieuwbouw pad’ to E30 in 2021
  - ⇨ **Reduction with 24% compared to 2005**
- Policy scenario:
  - 2018: E40
  - 2020: E35
  - 2021: E30 (BEN)
  - Reduction of fossil fuel use for heating to 0% in 2050.
  - No use of wood by 2050
  - Thermal insulation in 2050
    - ⇨ **Reduction with 50% in 2030 compared to 2005**

**Tertiary buildings**

- BAU:
  - ⇨ **Reduction with 12% compared to 2005**
- Policy scenario:
  - ⇨ **Reduction with 43% in 2030 compared to 2005**

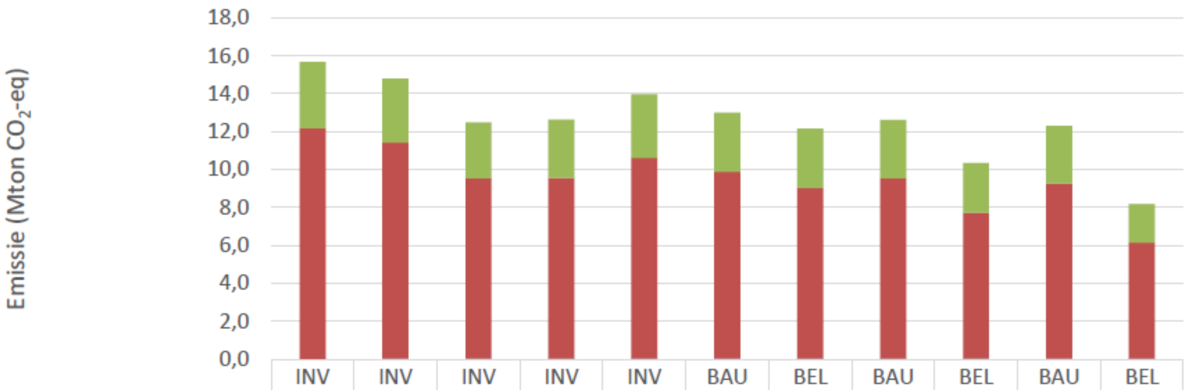
**Off-road**

The residential off-road emissions (e.g. lawn mowers) will be reduced by:

- Product norms
- Replacing of old equipment by equipment fulfilling to the Ecodesign rules
- Efficient usage of equipment by e.g. sharing

**Summary for entire building stock (residential, tertiary and off-road)**

- BAU:
  - ⇨ **Reduction of GHG-emission with 22% in 2030 compared to 2005.**
- Policy scenario:
  - ⇨ **Reduction of GHG-emission with 48% in 2030 compared to 2005.**




| | INV 2005 | INV 2013 | INV 2014 | INV 2015 | INV 2016 | BAU 2020 | BEL 2020 | BAU 2025 | BEL 2025 | BAU 2030 | BEL 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tertiaire gebouwen | 3,5 | 3,4 | 2,9 | 3,1 | 3,4 | 3,1 | 3,1 | 3,1 | 2,6 | 3,0 | 2,0 |
| Residentiële gebouwen | 12,1 | 11,4 | 9,5 | 9,5 | 10,6 | 9,8 | 9,0 | 9,5 | 7,7 | 9,2 | 6,1 |
| Offroad residentieel | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |

*Figure 6: Overview GHG emissions and prognosis for the building sector 2005-2030 (source: Vlaams Klimaatsbeleidsplan 2021-2030)*

*Table 1: Emission and prognose for the building sector 2005-2030 (source: Vlaams Klimaatsbeleidsplan 2021-2030)*

| | | 2005 | 2013 | 2014 | 2015 | 2016 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| Totale broeikasgasuitstoot sector gebouwen (Mton CO2-eq) | BAU | 15,7 | 14,8 | 12,5 | 12,6 | 14,0 | 13,0 | 12,6 | 12,3 |
| | BEL | 15,7 | 14,8 | 12,5 | 12,6 | 14,0 | 12,2 | 10,3 | 8,1 |
| Evolutie broeikasgasuitstoot ten opzichte van 2005 sector gebouwen (%) | BAU | | -6% | -20% | -19% | -11% | -17% | -19% | -22% |
| | BEL | | -6% | -20% | -19% | -11% | -22% | -34% | -48% |

# Chapter 3: Methodology

## 3.1 Current materials in the Flemish housing stock

Information on the current housing stock at the end of 2018 was obtained from Statbel. It reports a yearly update of the housing stock register ('kadaster'). These data reveal the number of housing units (by different types of housing units) from each construction period in the current housing stock of Flanders. This forms the basis on which we build to get an estimate of the elements and materials contained in the current housing stock and the renovations that are required to get these houses in conformity with the Flemish climate action plan. While the Flemish climate plan is mainly focused on 2030, the ultimate goal is to reach a climate-neutral residential building stock by 2050. We report the entire intermediate period from now until 2050 for our calculations.

To determine the current materials for the different building elements and building periods the following sources were used:

- For the compositions and U-value of the elements per building period before 2006: the master thesis by Fien Eeckhout[18] was used which is based upon the IEE TABULA project (2009-2012)[19]. The mentioned master thesis as well as the report of the TABULA project[20] were consulted to have a complete picture of all the needed details.
- For the elements from 2006 and onwards: the master thesis by Eeckhout was used for the compositions, but the U-value were based upon the EPB-cijferrapport[21]. Surface weighted U-values for the periods 2006-2011 and 2012-2017 were calculated based on the surface weighted U-values per year in the EPB-cijferrapport. As U-value for the elements from 2018 and onwards, the surface weighted U-values of the year 2017 were taken as starting point and not the maximum U-value requirement of 0.24 W/m$^2$K, as the EPB-cijferrapport show that the residential buildings in Flanders have better U-values than the legal requirements since 2006.
- A deviation was made from the master thesis by Eeckhout regarding the composition of the windows for solid construction after 1990: instead of only considering aluminium frames for dwellings from 1991 to 2011 inclusive and only PVC for dwellings after from 2012, both types were considered for all periods after 1990 with a 50-50 division[22], as the $CO_2$-footprint of aluminium frames stood out compared to the renovation impact of older dwellings.

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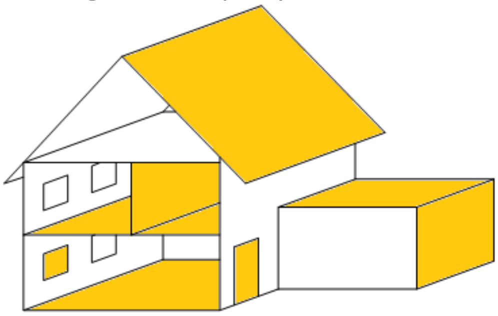
[18] Eeckhout, F. (2019). *Development of environmental benchmarks for residential buildings*, master thesis KU Leuven.
[19] http://episcope.eu/iee-project/tabula/
[20] W. Cyx , N. Renders, M. Van Holm, S. Verbeke (2011). *IEE TABULA – Typology Approach for Building Stock Energy Assessment,* scientific report, VITO.
[21] Vlaams Energieagentschap (2019). *EPB-Cijferrapport, Procedures, resultaten en energetische karakteristieken van het Vlaamse gebouwenbestand – periode 2006-2018.*
[22] The market share of PVC frames is increasing and is around 50% currently in Belgium; followed by aluminium frames with a share of around 40%. The European market is showing a similar picture. (sources: https://www.ikgabouwen.be/ramen-in-hout-pvc-of-aluminium-wat-is-de-beste-keuze-voor-je-woning/; https://www.bouwenwonen.net/artikel/Omvang-Europese-kozijnmarkt-daalt/3178; http://www.abramenendeuren.be/wp-content/uploads/2011/09/Newsflash072009prestigebroch.pdf)

- The expert calculation model of MMG[23] was used to model the building elements. To be specific: the amounts, thickness, thermal conductivity (λ) or thermal resistance (R) and weight of the materials, and the carbon footprint to produce, to transport and to install, and the end-of-life (EOL) of the building materials[24].

Annex A presents the compositions and U-values per building period and building element applied within this study: the left side shows the values when it would be newly built and the right side show the values for the renovation scenario (more explanation on the renovation scenario is included in section 2.2). However first some remarks:

- The impact data and weight are based on current life cycle inventory (LCI) databases. The production processes used to model the environmental impacts represent current production processes and not processes from the respective building period, as such data is not available in LCI databases.
- The thermal conductivity (λ) values applied in this study to determine the U-value of an element are current values of modern building materials, and not values from the respective building period. The current thermal conductivity of materials are better than in the past, this means that a smaller thickness is calculated and consequently less material is considered.
- We have tried to reproduce the U-values as presented in the TABULA project and EPB-cijferrapport as much as possible, however there could be small differences due to the λ-values assumed in MMG, or because certain materials were not available in MMG in a certain thickness and could not be simply extrapolated because it would deviate to much from the building practice. For instance, MMG has some specific doors in its database with certain R-values that are very different than the ones presented in TABULA.
- Element variants were modelled within the following nine element types: pitched roof, flat roof, external wall, outside door, outside window, floor on grade, storey floor, load-bearing internal/party wall, and non-load-bearing internal wall.

  The foundation and internal doors were excluded as there are no data on the amounts within the sources used. In addition, building services were excluded due to data issues to model them currently and in line with the other building elements.
- The internal walls and storey floors are modelled based on the composition of the external wall and flat roof respectively. No U-values are calculated for these internal

[23] MMG is the method and model behind the Belgian building calculation tool TOTEM, https://www.ovam.be/materiaalprestatie-gebouwen-0. Calculation model version of 08.06.2019 was used.

[24] In terms of the CEN EN 15804 standard, the European building product LCA standard: module A1-A3 (production), modules A4 and A5 (transport and installation on building site), and module C (EOL).

elements, as they are not considered as heat loss surfaces of a building, and there are no legal U-value restrictions for these elements.

- Only one type of floor finishing and wall finishing is considered per building period. There are no variations considered.

The data from Statbel, Eeckhouts master thesis and TABULA were combined to define the different types of housing units by construction period. The following table reports which types of housing units are included in our dataset.

| Construction period | Building style | Type of housing unit |
|---|---|---|
| Pre-1945 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| 1946-1970 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| 1971-1990 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| 1991-2005 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| 2006-2011 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| | Timber frame construction | Building: detached, semi-detached, attached |
| 2012-2017 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| | Timber frame construction | Building: detached, semi-detached, attached |
| 2018 | Solid construction | Building: detached, semi-detached, attached<br>Apartment: enclosed, exposed |
| | Timber frame construction | Building: detached, semi-detached, attached |

In total 44 types of buildings are included in our dataset. For each combination of the construction period and the type of housing unit TABULA reports specific data on the surface area of each building element. This information on the surface area of the building element can be combined with the current housing stock data and the data on the building elements to perform the necessary calculations. Some small remarks remain concerning the construction of the final dataset:

- TABULA nor the building stock registry available through Statbel hold information on the number of timber frame constructed buildings. These are instead derived from a questionnaire launched by Hout info bois [25]. This questionnaire does not have information on the fraction of timber frame constructed buildings prior to 2011 and the master thesis from Eeckhout only gives details for timber constructed dwellings from 2006 and onwards. We therefore assume it to have been zero in the building periods before 2006-2011 and assume it to be half of the fraction of 2011 of timber frame constructed buildings for the period of 2006-2011, implicitly assuming that it started taking hold during this period. Timber frame construction techniques are generally not used for the construction of apartment buildings which is therefore assumed to have no timber frame constructed buildings. For the timber frame constructed buildings, it is assumed that they have the same surface area as solid constructed buildings.
- Flat and pitched roofs consist of different building element compositions. While we have information on the composition of both roof systems, the building registry system that

[25] Hout info bois (2018). Houtbouw in België 2017-2018. https://houtinfobois.be/nl/nieuw-houtbouw-in-belgie-2017-2018/

we use does not contain information on the roof system. It is thus necessary that for each period we obtain estimates on the fraction of buildings that use each roof system. We derived this from the analysis of the EPC databank by the Steunpunt Wonen[26]. We assume that after 2011 the ratio of flat-to-pitched roof remained constant.

- Enclosed and exposed flats are included separately in the TABULA databank, whereas the building registry data of Statbel only contains data on the apartment buildings themselves. We therefore use a rough estimate of the number of apartments per apartment building based on the estimated increase of apartment buildings from one year to the next over the period of 2016 to 2018 and the number of flats that were added to the building stock according to license construction data. Next, we use the number of building layers for apartment buildings in several construction periods to derive how many apartments are situated on the top floor (i.e. how many apartments in an average building are 'exposed' to outdoors). In this way we can translate the numbers of the apartment buildings reported in the building registry to exposed and enclosed apartments. While the method is admittedly rough, the authors are not aware of better estimates that are available.

## 3.2 Material, carbon and waste footprint of renovating houses to the standards of the Flemish climate policy plan

### 3.2.1. Renovations

As already mentioned above, the tables in Annex A show the data for the renovation scenario of the building elements per building period. The cells are colored light green if certain values of a material are changed due to the renovation. To model the renovation scenario the following assumptions were considered:

- The energy goals 2050[27] are met by following track 1 which means that the following separate requirements[28] are met:
  - Roof, floor and walls: U = 0.24 W/m$^2$K
  - Glazing: Ug = 1.0 W/m$^2$K
  - Windows (= glazing and window frames together): Uw = 1.5 W/m$^2$K
- To meet the 0.24 U-value requirement of the roof, floor on grade and external wall, additional insulation is added:
  - The type of insulation material stayed the same in the renovation scenario. Existing insulation is completely removed before adding the new insulation, with the exception of cavity insulation which is assumed to be left in cavity as it was.
  - In practice, there are different ways of adding insulation to an existing construction (from the outside, inside or in case of cavity walls in the cavity), only

[26] Verbeeck, G. and Ceulemans, W. (2015). Analyse van de EPC databank. Resultaten tot en met 2012. Steunpunt Wonen. Table 30 is the basis for our approximation. Since the frequency of the building periods than the one we apply in this study, we use the middle of the period estimates when necessary.

[27] https://www.energiesparen.be/energiedoelstellingen-tegen-2050

[28] Track 1 of the energy goals 2050 also has a fourth requirement regarding the efficiency of heating systems. This is not included in this study, as no data on heating systems is included.

one way is considered in this study based on the most likely option that can be applied in most situations. Except for solid constructed external walls: adding insulation from the inside as well as from the outside are considered. The way of insulating extra from the outside was specifically added for detached dwellings.
    - In case there are finishing layers or other layers applied on the insulation layer, then those layers are removed and newly installed for the renovation in case the materials cannot be reused properly, otherwise a 5% of replacement/repairs is considered with the reuse.
- To meet the requirements for the windows and glazing, the frame needs to be replaced completely by a new frame as in practice existing frames will not be suitable for triple glazing due to a bigger thickness of the glazing. Based on the most recent numbers found on the distribution of the types of frames[29], it is assumed that 50% of the renovated frames used in solid construction buildings consist of PVC, 40% consist of aluminium and, finally, 10% are wooden frames. For timber frame construction, it is assumed that all the renovated frames consist of wood.

It is important to remark that the assumed renovation scenario is only considering a minimal energy renovation to meet the abovementioned energy goals at the minimal level. It is often the practice that when dwellings are renovated more parts (e.g. internal walls, the kitchen or the bathroom) are also renovated at the same time. However, our analysis is solely focused on the building elements mentioned above and the inclusion of kitchens, bathrooms, etc. would thus overly expand the scope of the analysis with elements that do not directly affect the energy performance of a dwelling within the scope of the Flemish climate plan. Yet, to account for potential additional renovations performed within the scope of the building elements that are included in our analysis, a sensitivity analysis was performed. It is assumed that for detached, semi-detached and attached houses, an average of 6m² of non-load-bearing walls are demolished and rebuilt. For apartments, this is assumed to be 2m². Additionally, a quarter of all walls are assumed to be repainted[30].

### 3.2.2. New dwellings

**VEA scenario**

In order to obtain a complete picture of all the required construction materials up to 2050, one equally needs a picture of how construction of new housing units is set to evolve. This also offers a reference framework to which the required mass of materials and the carbon emissions related to renovation can be compared. Currently, there are no available sources that have made projections of construction activity as far along as 2050. However, VEA, the Flemish Energy Agency, has performed an exercise that attempted to quantify the carbon emission impact of the housing stock if climate policy objectives were realized, i.e. they approximate the impact of using the houses but not the indirect emissions impact of the actual renovations

[29] Ik ga bouwen en renoveren. (2016). Ramen in hout, pvc of aluminium: wat is de beste keuze voor je woning? Consulted on 29th of October, 2019. https://www.ikgabouwen.be/ramen-in-hout-pvc-of-aluminium-wat-is-de-beste-keuze-voor-je-woning/.

[30] These numbers were determined at random.

themselves, which is the objective of our analysis[31]. In this light, they accounted for the addition of new houses to the housing stock (and the demolition of old houses). The original exercise was performed in 2017 with data available at that time and the prognosis ran until 2030. We extended this prognosis by dividing the apartments into exposed and enclosed apartments to align the estimates with our types of buildings. Additionally, we also extended the prognosis to 2050 for the purpose of our calculations. We did so by assuming that the number of homes increases according to the population growth while assuming that a small surplus of homes is continuously built equal to the one used by VEA in their original projections up to 2030.

**VEA+ scenario**

Aside from this we also updated the estimates of VEA in a VEA+ scenario. This VEA+ scenario uses the updated information on the number of buildings that were built in the intermediate period since the original VEA estimates were made and the end of 2018. Additionally, the VEA+ scenario uses information on the building permits that were granted to make projections of construction occurring in the near future[32]. These figures show a clear increase in constructing housing compared to the original VEA estimates. Additionally, we updated the prognosis of VEA by using new estimates for the growth in the number of households (which were revised upwards compared to the moment when VEA made their original analysis).

In the VEA+ scenario, we also accounted for the expected gradual increase in single-person households. Specifically, we observed the trend that the construction of apartments is gradually accounting for a growing share of total residential construction and assume that this trend is set to continue. Since there is a correlation (0.48) between the growth of the share of apartments in the total construction and the increase in single-person households, we assumed that increasing the share of constructed apartments will cover the demographic evolution of increasing single-person households which is set to continue into the future. We revised the construction of houses upwards with the revised demographic evolution and downwards with the expected increase in single-person households accordingly.

The data on demolition are left unaltered in the VEA+ scenario with those reported by VEA. Since these were calculated by assuming that it is a fixed share of the number of additional households in any given year, the calculation is extended to 2050. By including demolition, we are able to get a better insight into the construction materials that will be released continuously from now until 2050. Since buildings from different time periods differ in terms of the building materials, it is also relevant to account for the original building period of the dwelling that is to be demolished. Given the lack of data on the building period of the houses that are demolished, we assumed that all demolished buildings stem from before 1945.

The figure below portrays the projections of both scenarios. It is clear that the updated VEA+ scenario, which contains recent construction and building permit data, shows a clear peek in

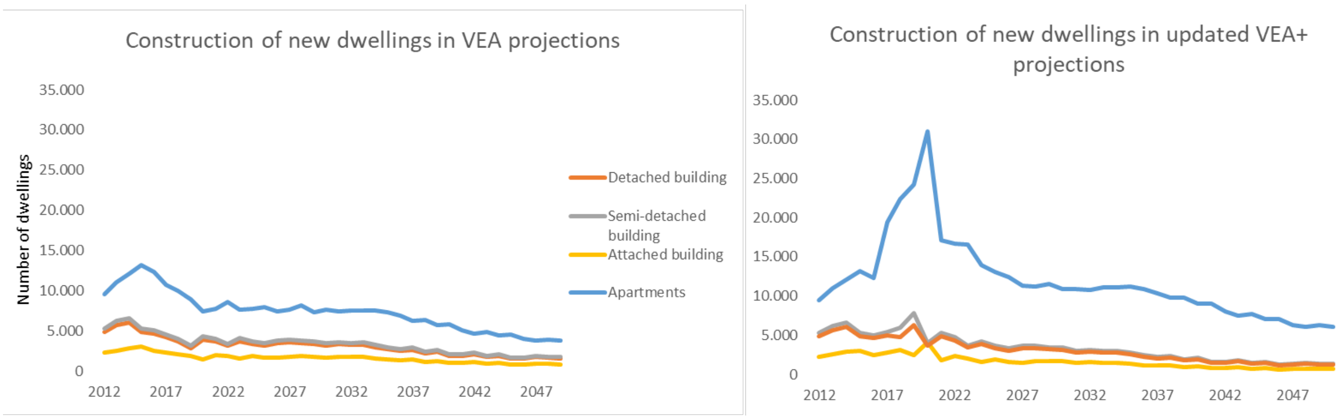
[31] The authors wish to explicitly thank Katleen Briffaerts of VEA for sharing these data and providing ample explanation.

[32] For its specific purposes, VEA focuses its analysis on when a building is actually used and assumes a delay between the moment when a building permit is granted (the information for which is available by type of building via Statbel) and the actual moment when a household is assumed to make use of the building. We assume that the house is constructed one year prior to the moment when it is taken in use, and 1.5 year prior if it’s an apartment building.

activity which far exceeds the current demographic evolution. The projections assume that this building activity will peter out and normalize.

The building registry does not provide data on the number of extensive renovations that have already occurred in the current building stock. However, the exploration of the EPC databank by the Steunpunt Wonen revealed that there is a negative correlation between the energy performance of a building and the building period, even if the buildings date from well before 1945 and could thus be assumed to already have undergone some kind of renovation[33].

*Figure 7: Projected construction of new dwellings under the VEA scenario and the updated VEA+ scenario that accounts for revised household projections*




## 3.3 Footprint calculations of alternative scenarios

Aside from assessing the impact of updating the building stock to the standards of the climate action plan and a sensitivity analysis including some additional renovations that are likely to occur simultaneously, we also analyzed two scenarios that cover different aspects of the circular economy. The impact of these scenarios on the material and carbon footprint is assessed.

### Scenario 1: Building and living more compactly

The first scenario is mainly geared towards making more intensive use of the buildings. This is achieved through two ways. First, we assume that newly constructed dwellings are smaller in size. Attached houses are assumed to decrease by 5% in size, semi-detached houses by 10% and, finally, detached houses by 15%. Additionally, it is assumed that around 5% of detached houses in the housing stock in 2018 are divided into two contiguous semi-detached houses. The renovation effort required to split the houses is equally spread over a period from 2019 to 2050. Although additional renovation is required to divide the detached house into two semi-detached houses (we assume 50% more internal non-load-bearing walls and an additional outside door), overall the split of the detached houses can house double the amount of

[33] See table 2 in the aforementioned report.

households. Therefore, the demand for new semi-detached housing is expected to decline in line with the additional housing generated through dividing the detached houses.

Note that the decrease in the volume of the dwellings needs to be explicitly translated to a decrease in the height, width and depth dimensions of the house. These are all diminished by a similar factor to meet the size decrease requirements. Note that all building elements (the size of which is expressed in square meters) in the dwelling are adjusted with that same factor to easily perform the necessary calculations, even if it might be unrealistic from a practical point of view. One could argue that it is unlikely that a dwelling would decrease considerably in the height dimension in order to not reduce the living quality of the house. Therefore, most reductions are likely to incur in the width and the depth dimensions. Our assumption that changes occur equally along all dimensions has two practical impacts for our estimations. Firstly, it reduces the height of windows, doors and walls, thus underestimating the materials required for new dwellings. This underestimation of the required materials is likely to be nullified by the overestimation of required materials as a result of smaller reductions in the width and depth dimensions. Secondly, the floor and roof of a house requires a considerable amount of materials. The depth and width dimensions are the most important ones determining the material requirements. This would entail that material requirements are thus underestimated. Overall, the impact estimates based on the size reduction of new construction dwellings probably underestimate the reduction in materials (and the carbon footprint linked to that) in comparison to the actual size reduction of new dwellings. The reader should keep this limitation in mind.

## Scenario 2: Increasing recycling rate in the construction industry

The second scenario focuses on decreasing the demand for new materials by optimally recycling those fractions that are released during the demolition of old dwellings or the limited demolition required during the renovation efforts. Additionally, it also assumes that the fraction of timber frame houses, which as shall be shown below have a lower mass and carbon footprint than solid construction houses, increases to 30% of newly constructed houses by 2030 and holds at that level. Hence, rather than making more efficient use of materials during the use phase of the materials as in the first scenario, the second circular scenario is focused on optimally reusing any discarded materials in the end-of-life phase and choosing less material intensive building methods. We relied on expert judgment in order to assess which materials could potentially be reused and in what form. Next, we analyzed whether the supply of recycled materials suffices to meet or supersedes the demand in the construction market. Although we only focus in this scenario on the replacement of other building materials, there are likely to be other applications outside of construction sector which are not considered for the purposes of not overburdening the present analysis.

The table below shows which materials could be recycled into new products in the construction industry. We generally assume that 90% of the original material can be recycled, thereby accounting for a fraction of the materials that cannot be recovered due to contaminations or other problems in recovering the material from its original construction application. For aluminium and PVC window frames, we assume that there is both a possibility to reuse the original frames and to recycle the frames. Given the hypothetical nature of this scenario, there are no clear indications as to the fraction of recycled window frames versus the fraction of reused window frames. We therefore assume a 50-50 division. Note that the reuse of existing window frames would entail a substantial change to the current end-of-life treatment of window frames and is thus an optimistic assessment of future practices. The carbon footprint associated with reuse only consists of a transport and installation carbon footprint, which we assume doubles the installation and transport carbon footprint of virgin window frames to account for both the removal and the installation of the window frames elsewhere.

While recycling ensures that virgin raw materials do not need be mined, it also has a carbon footprint which for some materials can be substantial (e.g. for glass it entails the melting of glass which requires substantial energy inputs). Therefore, scientific literature was consulted to get an estimate of the carbon footprint of the recycling activity.

Finally, some materials can only be reused as a stony fraction which is part of the foundation of homes, a building element which is not considered in our analysis. Therefore, this recycling option is not included. Sometimes it can also be used as concrete fraction. This concrete fraction can replace up to 30% of the natural coarse fraction used to make concrete. The natural coarse fraction, in turn, makes up around 50% of concrete. Hence, materials that can be recycled in concrete, can make up a maximum of 15% (30%*50%) of the required concrete without loss of performance. Materials that can only be used in the stony fraction used in the foundation, are not considered. A similar fate befalls materials made of softwood, which can in principle be recycled as chipboards. However, since there is no direct chipboard material included in our analysis, it could not be properly accounted for. Taking into account these materials would thus further increase the circularity of the construction industry.

Note that some materials which could in principle be recycled, might lose their potential for recyclability as a result of their specific application (e.g. recyclability of EPDM becomes troublesome when glued).

## 3.4. Limitations of the study

Given that data on the composition of different types of houses is sparse, it was necessary to make several assumptions throughout the analysis that are important to bear in mind as a reader when interpreting the results.

First and foremost, it was necessary to assume a similar composition for building elements of different types of dwellings that only varies with the specific building period. This implies that the number of materials that are used in the shell of buildings is underestimated. Similarly, the renovation efforts required to ensure that houses meet the necessary energy requirements consist of a limited number of materials that are applied in each renovation. Hence, the diversity of insulation materials is not fully captured within the scope of this study. Additionally, due to limited data availability on certain building products within the LCI database used (i.e. MMG based on ecoinvent v3.3) we could only use data on triple glazing with a Ug value of 0.5 $W/m^2K$ to meet the energy goal requirement of a maximum Ug of 1.0 $W/m^2K$ within the renovation scenario. This implies that the number of replacements of window frames is highly likely to be overestimated, as in reality there are well performing double glazing products on the market with a Ug of 1.0 W/m$^2$K meaning that in some cases the window frame does not need to be replaced to fit well performing double glazing with a Ug of 1.0 W/$^2$K or even lower.

It is important to note that we exclusively take into account the building shell. New buildings require many more additions that are not related to the shell (e.g. kitchens, bathrooms,etc.). Hence, the total material and carbon footprints of new dwellings will underestimate the true footprints. Due to data limitations, we also do not look at the type of heating system, the photovoltaic installation, etc. that are used and which are relevant to reach the objectives of the climate policy plan. These are clearly relevant for the emissions of a dwelling and would further add to the material and carbon footprint of the renovations required to meet the new energy standards of the Flemish climate policy plan.

| Original Material | Application | New application (Recycling/Reuse) | Assumed carbon footprint associated with reuse/recycling | Max. replacement fraction | Sources from literature |
|---|---|---|---|---|---|
| **Aluminium** | Window frame | Window frame (50% Reuse, 45% Recycling – loss of 5%) | Reuse: double transport and assembly footprint virgin material (11,2kg CO2 eq./m²) Recycling: double transport and assembly footprint virgin material (11,2kg CO2 eq./m²) + 10% carbon footprint of production virgin material | Reused and Recycled material replaces 100% virgin material | Expert judgment & AG, interstruct. Aluminium recycling-développement durable. *recycling.world-aluminium.org*. Retrieved 29/10/2019. |
| **PVC** | Window frame | Window frame (50% Reuse, 45% Recycling – loss of 5%) | Reuse: double transport and assembly footprint virgin material (6,26kg CO2 eq./m²) Recycling: double transport and assembly footprint virgin material (6,26kg CO2 eq./m²) + 5% carbon footprint of production virgin material | Reused and Recycled material replaces 100% virgin material | Expert judgment & Stichnothe, H., and Azapagic, A. (2013). Life cycle assessment of recycling PVC window frames. Resources, Conservation and Recycling. 71. pp. 40-47. |
| **Gypsum** | Plaster boards | Plaster boards (Recycling-90% of demolished material recycled) | double transport and assembly footprint virgin material + recycling carbon footprint (=0.91 kg CO2 eq./m²) | Recycled material replaces 100% virgin material | Expert judgment |
| **Concrete** | Concrete | Concrete (Recycling-90% of demolished material recycled) | double transport and assembly footprint virgin material + recycling carbon footprint (=15.98 kg CO2 eq./m²) | Recycled material replaces 15% virgin material | Expert judgment |
| **Cement, Sand** | Screed | Concrete (Recycling-90% of demolished material recycled) | double transport and assembly footprint virgin material + recycling carbon footprint (=15.98 kg CO2 eq./m²) | Recycled material replaces 15% virgin material | Expert judgment |
| **Glass** | Window | Window (Recycling-90% of demolished material recycled) | 70% of production carbon footprint + double transport and assembly footprint (impact per m² varies depending on original glass) | Recycled material replaces 100% virgin material | Expert judgment |
| **Rockwool** | Insulation roof/walls | Insulation roof/walls (Recycling-90% of demolished material recycled) | EoL treatment of rockwool + double transport and assembly footprint (impact per m² varies depending on thickness original application) | Recycled material replaces 100% virgin material | Expert judgment & rockwool (2019). Recycling at Rockwool. https://www.rockwool.co.uk/ . Consulted on 29th of October 2019. |

We assume that the newly built timber frame homes are constructed using materials with low carbon footprints. Note however that we only considered the impact category global warming potential of the materials. When considering other impact categories, such as land use and ozone depletion, the environmental footprint of a timber frame compared to a solid construction will show a different picture. Therefore it is necessary to note that only considering timber frame constructed dwellings might not be a sustainable solution when looking from a broader sustainability point of view. The ecoinvent data used to model the LCI datasets of this assessment consider only sustainable forest management, while in reality it could be differently.

# Chapter 4: Results

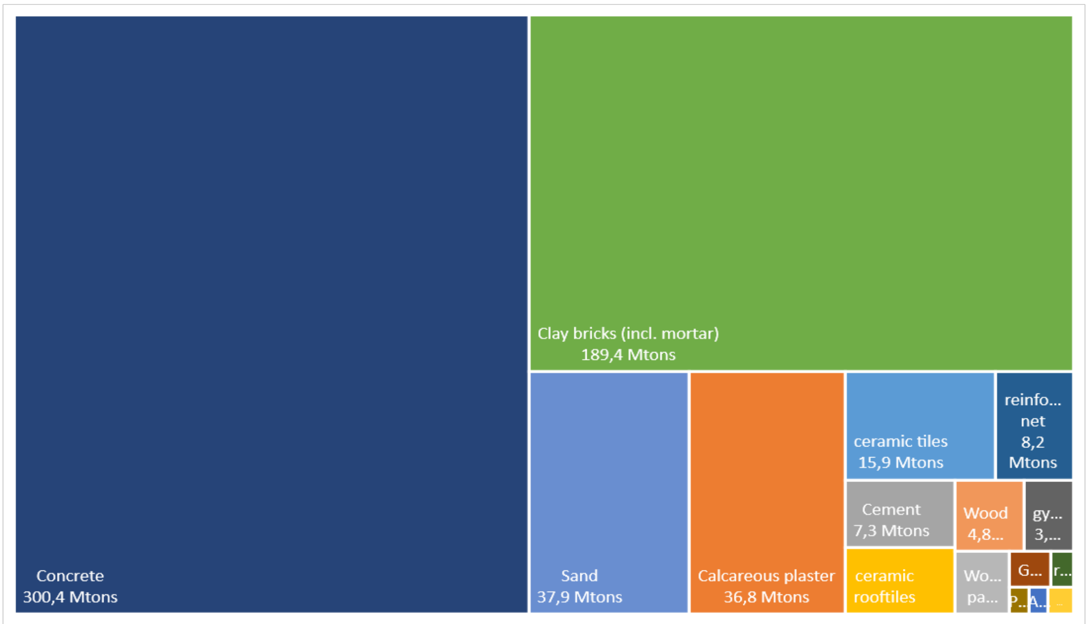
First we report the results of the current composition of the Flemish building stock based on the methodology reported above. Next we report the results of the updates of the Flemish building stock according to the Flemish climate plan. Finally, we discuss alternative circular scenarios that explore some circular economy scenarios through which some of the detrimental side effects of updating the building stock can be mitigated.

## 4.1 Current Flemish Building stock

While our data consist of a multitude of dimensions, we particularly focus on the materials and the distribution of the mass in the Flemish building stock by building period of the dwelling. Note that we exclusively look at the building elements of the building shell, the interior walls of the house and all materials relevant to the insulation of the house. Hence, kitchens, bathrooms, ventilation units, electrical wiring, solar panels etc. are all absent. Nevertheless, we will always refer to this as the Flemish building stock and the reader is to keep this caveat in mind throughout the presentation of the results.

Figure 8 shows the material composition of the Flemish building stock. Concrete and clay bricks stand out as the two most occurring elements in the building stock. A considerable amount of sand is used in screed and given its importance in buildings, an estimated total of 37,9 Mtons of sand is present in the Flemish building stock. In total, the elements of the Flemish building stock have a total mass of 618,3 Mtons[34].

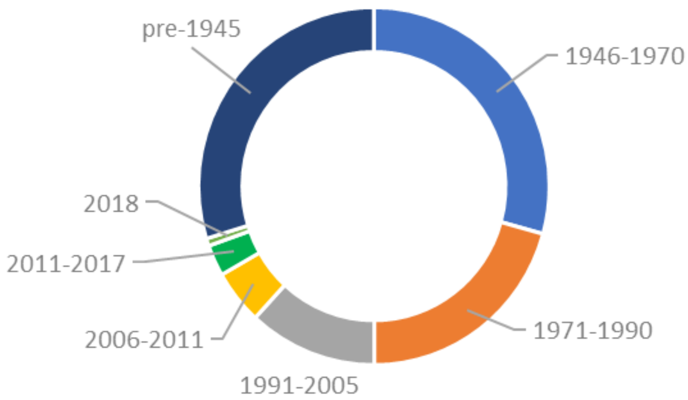
*Figure 8: Material composition of the Flemish building stock at the end of 2018*

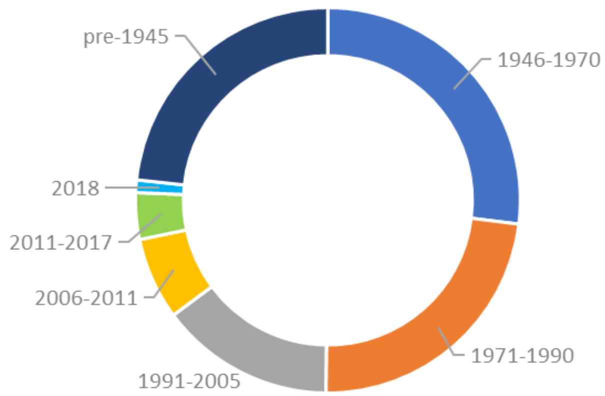



[34] Full detail of all materials available in Annex B

Figure 9 presents a different perspective. Again, the distribution of all the mass contained in the Flemish building stock is presented, but this time we focus on the original building period. Naturally, the more recent building periods only represent a small share of the total mass. Around two thirds of the mass comes from buildings that were constructed prior to the year 1970. This is of course closely tied to the fact that most residential buildings in the Flemish building stock date from this period as can be seen in the lower figure of Figure 9.

*Figure 9: Distribution of mass of materials by building period in current residential building stock (above) and distribution of the housing units by building period in current residential building stock (below)*




## 4.2 Material, carbon and waste footprint of renovating houses to the standards of the Flemish climate plan

The methodology section has described how we have combined data on the different building elements of dwellings constructed in different time periods with the underlying materials that make up those building elements. Before exploring what the projected impact is over time from realizing the update of the building stock according to the Flemish climate plan, we compare the material and embodied carbon footprints of the different types of dwelling that are present in our dataset.

Figure 10 and Figure 11 compare the total mass and carbon footprint of building new enclosed and exposed apartments with the renovation of those same apartments from earlier building periods. An exposed apartment is that part of the apartment building that is situated under the roof and the construction and renovation of the roof is thus taken into account for those apartments, while it is excluded with the enclosed apartments. This explains why more materials are needed both for the construction and for the renovation of exposed apartments compared to enclosed apartments. Additionally, in general more materials are required when renovating older apartments compared to relatively new apartments from more recent building periods. However, as a result of differences in the surface area of the apartments in general and the windows specifically, there are more materials required for an energy renovation of an apartment from the building period 1991 to 2005 compared to an apartment built before 1990. Of course, it is important to reiterate that the renovation of kitchens, bathrooms, etc. are not taken into account in the present analysis but could substantially affect the overall picture.

The same pattern as was observed for the material footprint is also visible for the carbon footprint associated with updating apartments to the standards of the Flemish climate plan. While minimally renovating apartments is still substantially less carbon intensive than building anew, the renovation of more recent apartments is less carbon intensive than the renovation of older apartments. For enclosed apartments the carbon footprint of renovations is comparable independent of the original building period of the apartment. This directly results from the fact that all windows of currently built apartments are assumed not to meet the standards of the Flemish climate plan and these form the only major carbon-intensive renovation work that is required for enclosed apartments. The picture is distinctly different for exposed apartments where a renovation of the roof is also required for apartments in older apartment buildings. A similar renovation is not required for exposed apartments from more recent building periods.

*Figure 10: Mass requirements and embodied CO2 emissions of building new enclosed apartments and renovating apartments from different building periods*

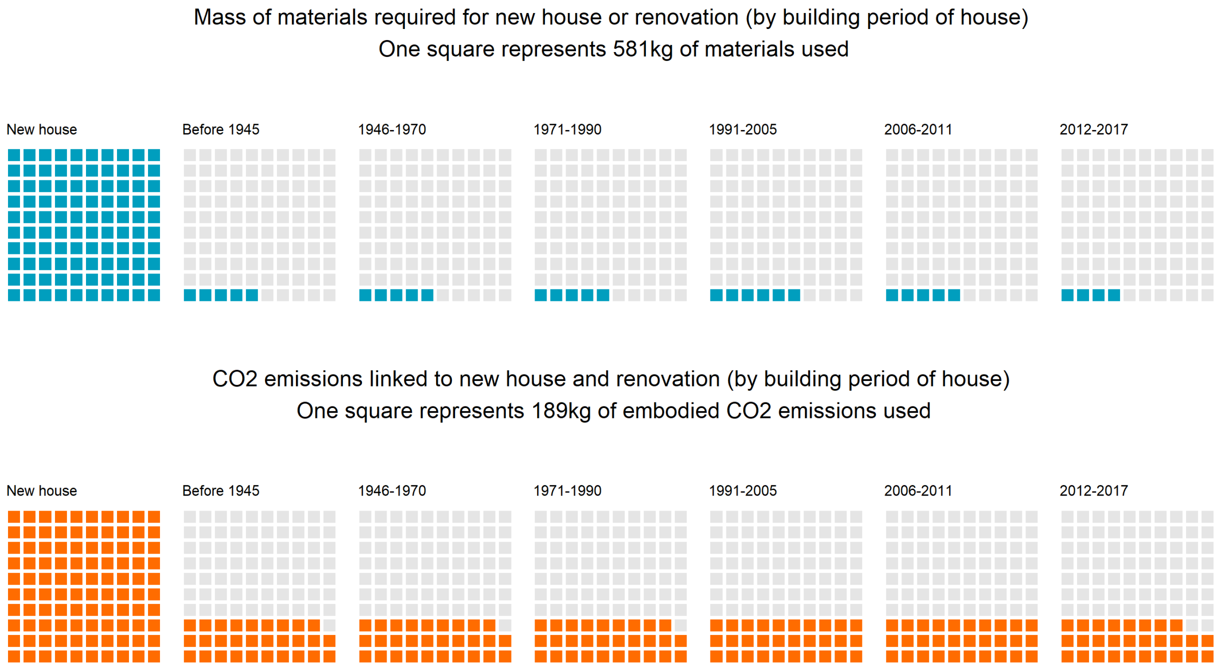



*Figure 11: Mass requirements and embodied CO2 emissions of building new exposed apartments and renovating apartments from different building periods*

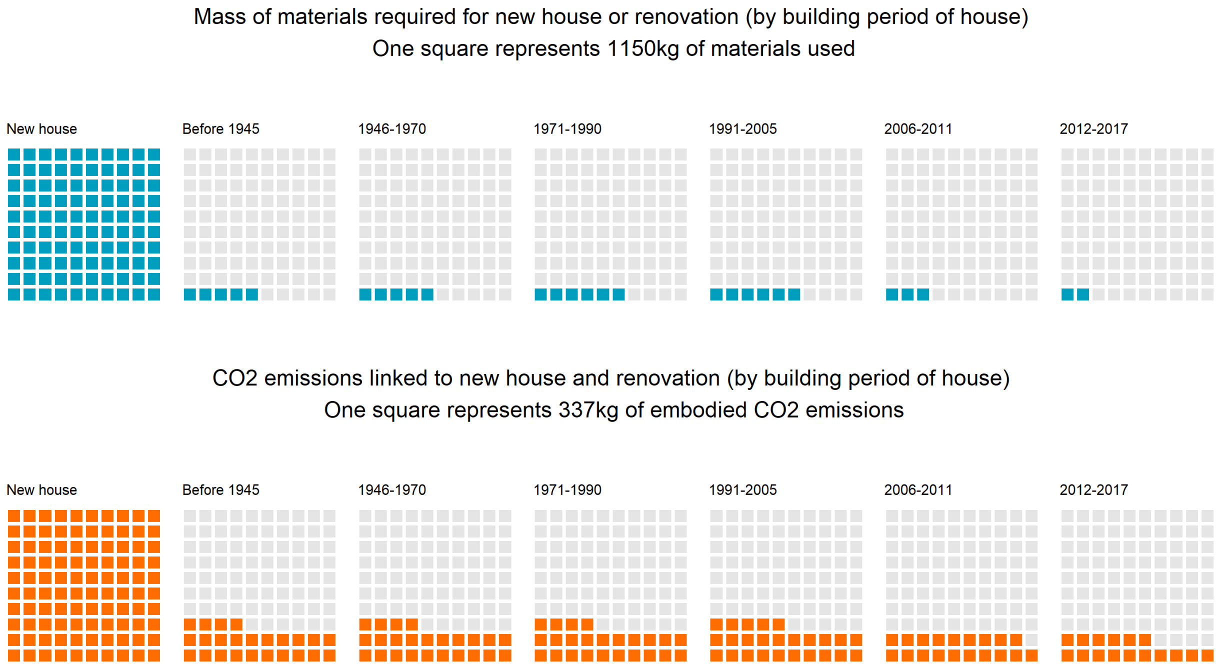



Figure 12, Figure 13 and Figure 14 present the same result but now for houses instead of apartments. Specifically, it looks at attached, semi-detached and detached houses. Aside from building a new house with a solid construction, we also show the results of building the house with a timber frame and wooden window frames. The results show that the carbon footprint of a new house with a timber frame is just over half the carbon footprint of that of a solid construction house[35]. Again, when all building elements are taken into account (aside from the shell and interior walls accounted for here) the difference will of course become less outspoken. Nevertheless, it clearly underlines the importance of the type of construction that is used for the general carbon and material footprint.

The figures reveal that renovations of larger detached houses require more mass in absolute terms compared to for instance a semi-detached or attached house[36]. In relative terms, detached houses generally have a higher carbon footprint for renovation compared to building a new house compared to attached houses[37]. A similar conclusion cannot be unequivocally drawn for the renovation of detached houses compared to semi-detached houses since semi-detached houses built from 1991 to 2011 have a higher relative carbon footprint associated with renovation efforts compared to the carbon footprint of building a new house than for detached houses. These differences generally reflect the surface area of specific building elements (especially windows) in specific building periods that need to be replaced.

In the second scenario, we assess the potential of using recycled and reusable demolished materials. For this assessment the ecoinvent model “allocation, cut-off by classification” has been used, meaning that  the ecoivent data used have considered recycled content of certain materials based on historical data. Hence, the scenario looks at the effects of improving recycling and reuse and expanding the current uptake of recycled material in the construction sector.

The carbon and material footprint of the end-of-life treatment of demolished materials was obtained from a historical assessment that showed how much of each fraction flowed to each type of waste treatment. No update was found on this historic assessment, which means that the end-of-life treatment impact might not be fully representative of what it would be in reality. Moreover, changes in future end-of-life treatment methods that currently cannot be foreseen could still occur. In this sense, the end-of-life impacts are approximations with the best available data.

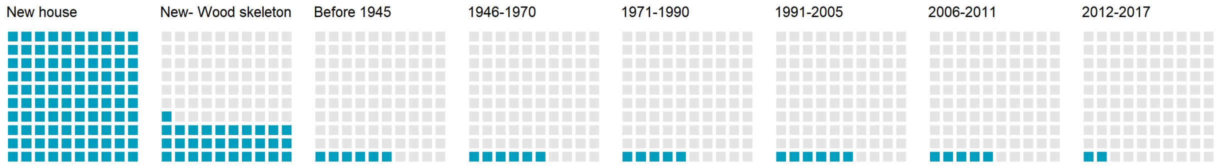
[35] The underlying European standard which MMG refers to, the EN 15978:2011 on building level and consequently the EN 15804+A1:2013 on product level, allows that biogenic carbon is not declared separately if the uptake as well as the release is considered, i.e., if the total lifecycle leads to a net zero impact of biogenic carbon. Please note that from the new amendment onwards (+A2, scheduled to be published by the end of 2019 with a transition period of 3 years) biogenic carbon needs to be declared in the life cycle stage where the impact occurs.

[36] Each square of the diagrams in Figure 14 represents more mass of materials for detached houses compared to the diagrams in Figure 13 for semi-detached houses.

[37] This can be seen by comparing the number of squares in the diagrams for the renovation of different types of houses by building period.

*Figure 12: Mass requirements and embodied CO2 emissions of building new attached house and renovating attached houses from different building periods*

Mass of materials required for new house or renovation (by building period of house)
One square represents 1756kg of materials used




CO2 emissions linked to new house and renovation (by building period of house)
One square represents 534kg of embodied CO2 emissions used

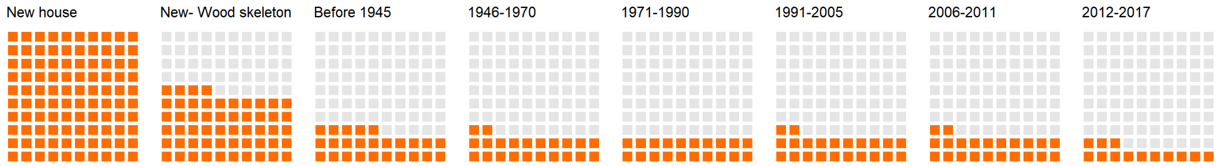
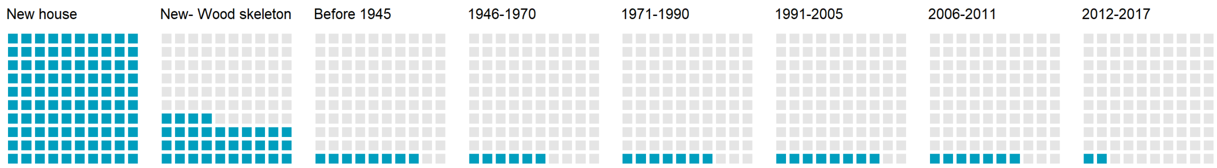



*Figure 13: Mass requirements and embodied CO2 emissions of building new semi-detached house and renovating semi-detached houses from different building periods*

Mass of materials required for new house or renovation (by building period of house)
One square represents 2006kg of materials used




CO2 emissions linked to new house and renovation (by building period of house)
One square represents 636kg of embodied CO2 emissions

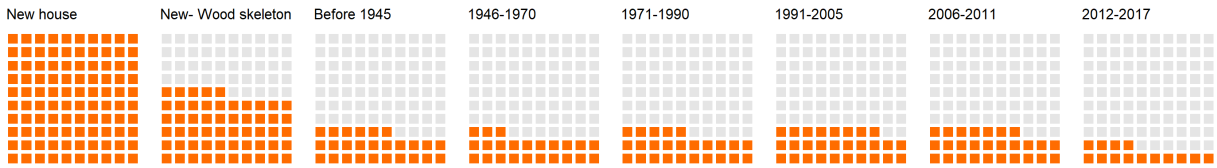
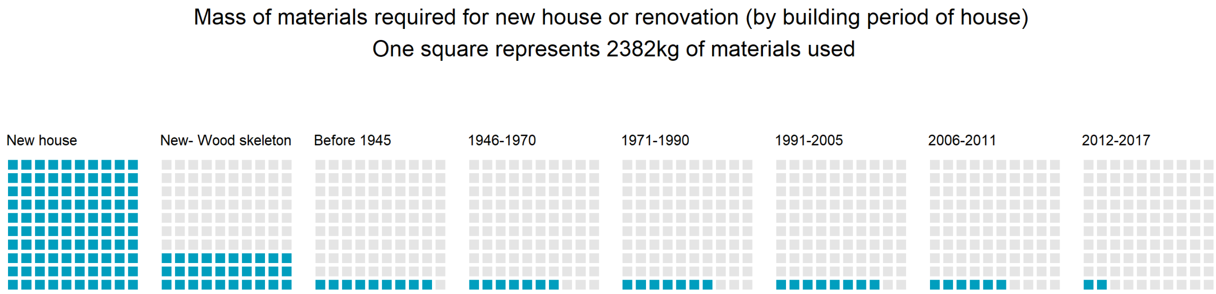
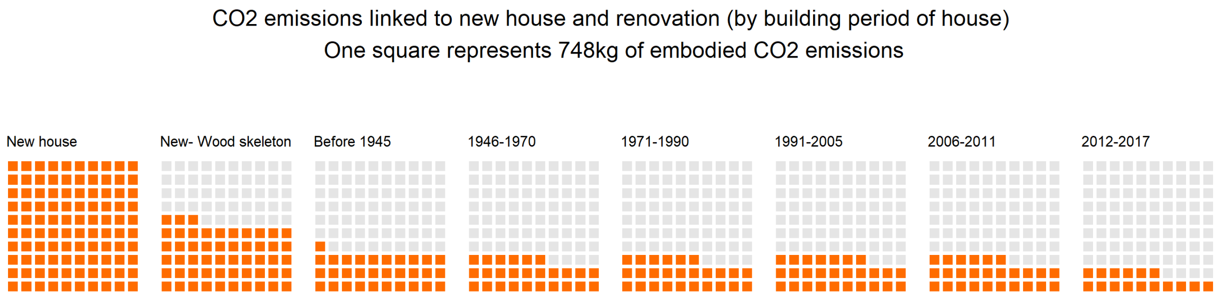


*Figure 14: Mass requirements and embodied CO2 emissions of building new detached house and renovating detached houses from different building periods*

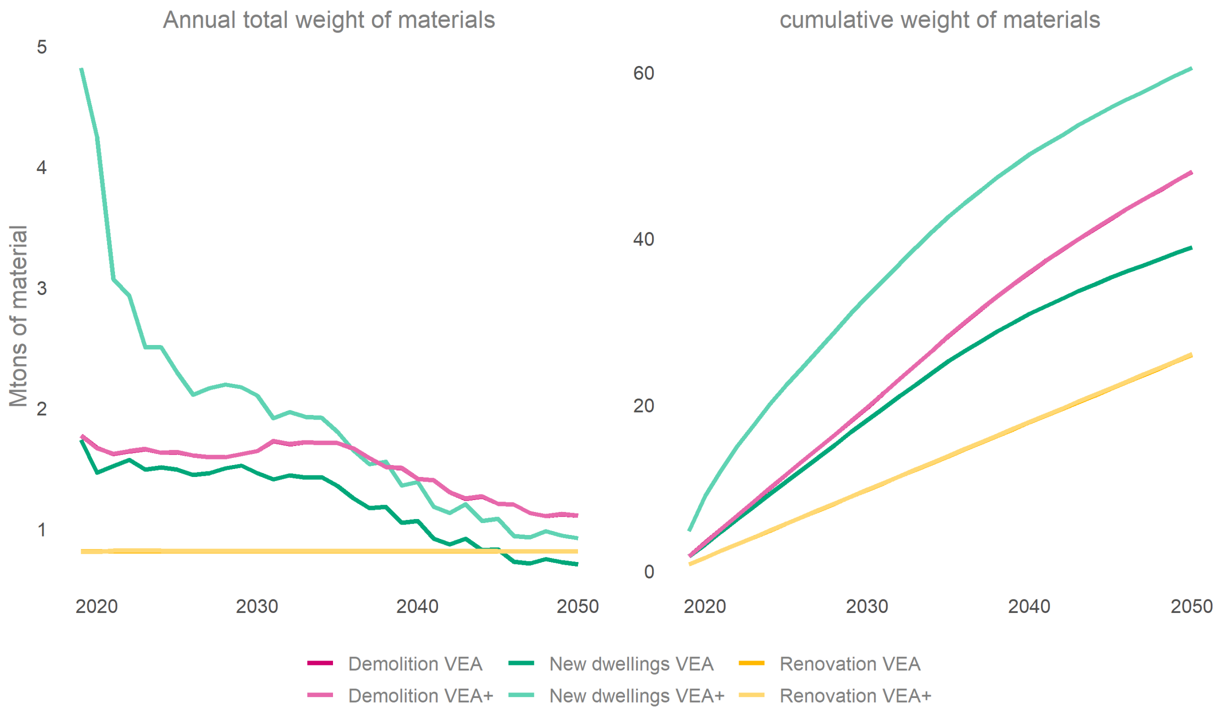



While the above figures show the impact of renovating an individual house from different building periods, they do not reveal anything on updating the building stock as a whole to the standards set forth in the Flemish climate plan. This is particularly relevant as most of the Flemish building stock will remain intact, while the newly constructed houses only make up a fraction of the total construction activity that will be required to get the building stock up to the required standards given the many older houses that will need to undergo renovations. Figure 15 shows the annual total material requirement until 2050 for the VEA and the VEA+ scenario on the left-hand side, and the cumulative weight of materials required on the right-hand side. The early activity boom is linked to the high level of permits that have recently been granted and which the projections expect will normalize in the near future.
While new dwellings overall still require the most materials, it is also clear that the demolition during renovation activities and the demolition from old dwellings that are replaced by new dwellings will generate a large amount of materials. This already indicates that the recycling of this waste stream could provide a possible pathway to reduce the total mass footprint by 2050 of construction. The renovation effort was linearly divided over the different years, explaining why an equal amount of materials are required in each given year. While the total effort is substantially smaller than that of the new buildings, it also generates a cumulative material footprint of 26,1 Mtons by 2050[38].

[38] The VEA and VEA+ scenario overlap for the demolition and renovation material footprint since the effort to be considered the same under both scenarios and the scenarios only differ with respect to the construction of new houses.

*Figure 15: Total material requirements for updating building stock*




Next, we turn to the total carbon footprint in Figure 16. Here it becomes immediately apparent that the carbon footprint of the renovation effort is greater than the carbon footprint of the new dwellings added to the building stock by 2050. In total, the cumulative effort of renovating old houses amounts to 42,1 Mtons of embodied CO2 emissions, while the newly built houses have a carbon footprint of 20,5 Mtons CO2. In comparison, the total CO2 emissions of the region of Flanders in 2017 amounted to 75,5 Mtons of CO2 (MIRA, 2019)[39]. Hence, the renovation effort will emit the equivalent of (42,1/75,5=) 56 percent of the total direct emissions of Flanders in 2017. Stated differently, the total renovation effort will cumulatively emit the equivalent of more than half of Flanders' current carbon emissions by 2050. When considering the entire footprint of construction (new dwelling + renovation + demolition) the total effort amounts to ((42,1+20,5+1,2)/75,5=)85% of Flemish direct emissions in 2017. On a yearly basis, the renovation effort has a carbon footprint of 1,32 Mtons of carbon dioxide. The end goal of the renovation effort is to have a completely climate neutral residential building stock by 2050. Since emissions of households in 2017 amounted to 9,42 Mtons of greenhouse gasses, this is equal to (1,31/9,42=) 14 percent of those emissions[40].

Figure 17 shows how the current direct and indirect emissions of heating for the 2018 building stock will evolve until 2050 if the entire building stock is gradually renovated. It shows the current direct emissions of households related to heating in 2017[41], the indirect emissions

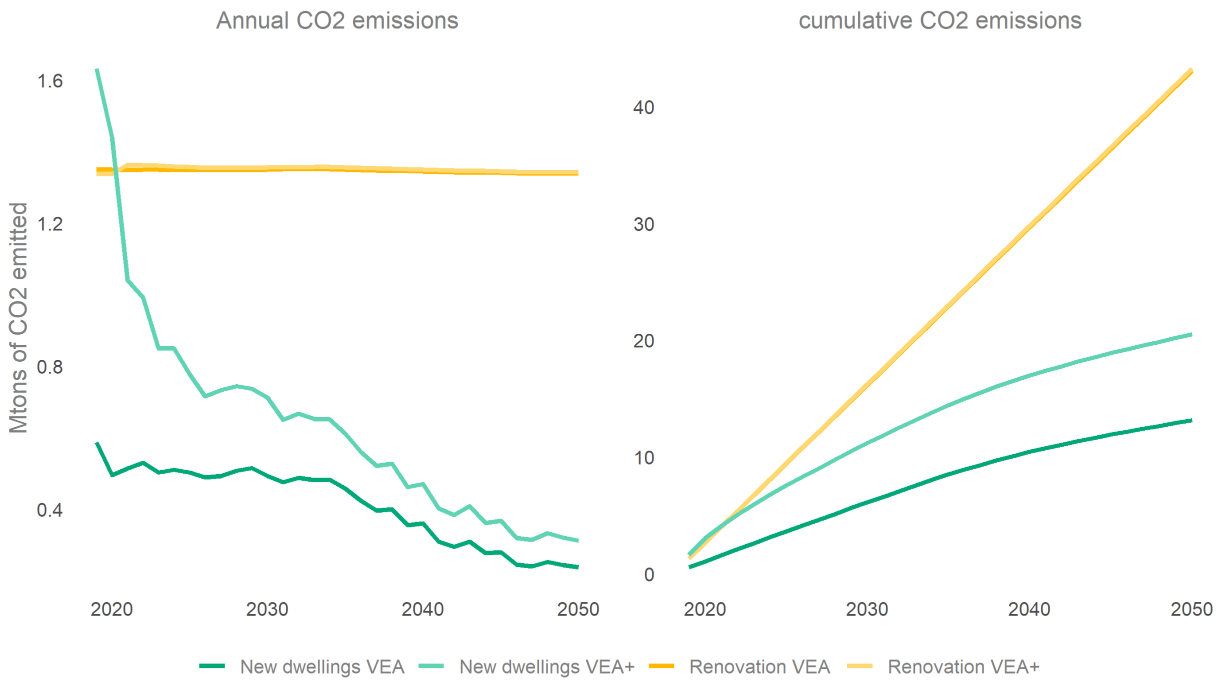
[39] MIRA (2019). Milieudata kernset. Consulted via https://www.milieurapport.be/milieudata/kernset in September 2019.

[40] When considering the entire average carbon footprint of construction (including new dwellings and demolition), the average yearly construction effort is equal to (1,99/9,42=)21% of household direct emissions. Note that the construction of new dwellings varies from year to year in the VEA+ scenario, therefore we only report the average yearly construction effort.

[41] The bulk - 95% - of total direct emissions of households is made up of heating the house and heating sanitary water (source: MIRA).

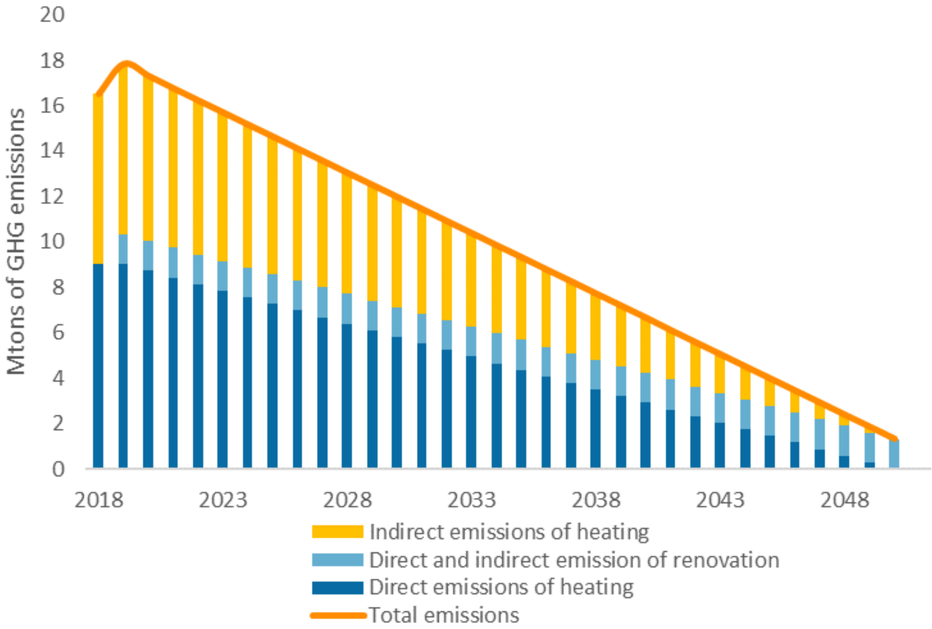
related to the production of energy carriers used for heating and the total carbon footprint of the renovations (direct emissions during the building phase and indirect emissions of production and transport). It is assumed that the renovation effort is applied linearly up to 2050. Note that the renovation is a one off-carbon footprint that will decrease the total emissions of the households living in the renovated dwellings continuously[42]. The figure shows that total emissions related to housing in Flanders initially increase with the renovation effort and that around four years of these renovation efforts are required before the total carbon footprint in Flanders starts decreasing (again, recall that the figure only considers the building stock in 2018 and not new dwellings). Note that these emissions do not all occur directly in Flanders, as they are embedded in the production of aluminium frames, glass, insulation materials, etc. the carbon emissions of which may occur outside Flanders. If one does not account for the indirect emissions of households related to the production of energy carriers, the renovation effort will decrease the overall carbon footprint of housing in Flanders after six years.

*Figure 16: CO2 emissions from updating Flemish building stock*




[42] As households require less heating from fossil-based fuels following the renovation, so to do the indirect emissions of producing the energy carriers decrease if the energy in the future is produced in a carbon-neutral way. It thus assumes that e.g. the electricity required for a heating pump is also carbon-neutrally produced.

*Figure 17: Evolution of CO2 eq. emissions of households including renovation effort required in climate policy plan*




Next, we look at individual material requirements. The tables below quantify the cumulative demand for materials by 2050 (Table 2) and their embodied carbon footprint (Table 3). In annex B we present the evolution from 2019 to 2050 by aggregated groups of material[43]. As the VEA+ scenario uses the most recent projections on household growth, we have used this scenario to compute the material requirements and the embodied carbon footprint. This will remain the reference scenario throughout the remainder of this study.

[43] For purposes of presentation, the materials have been grouped into larger material groups (e.g. different wooden products are bundled together in the group wood).

*Table 2: Cumulative demand for materials by 2050 for newly constructed houses and renovations under the VEA+ scenario. Waste generation shows the total mass of materials that will be released by 2050.*

| Material | Newly constructed housing | Renovation | Waste generation from renovation |
|---|---|---|---|
| Acrylic paint | 0,1 Mtons | 0,1 Mtons | 0,1 Mtons |
| Aluminium | 0,1 Mtons | 0,6 Mtons | 0,2 Mtons |
| Calcareous plaster | 0,7 Mtons | 2,7 Mtons | 2,2 Mtons |
| Cement | 0,9 Mtons | 1,1 Mtons | 1,5 Mtons |
| ceramic rooftiles | 0,7 Mtons | 0,0 Mtons | 0,3 Mtons |
| ceramic tiles | 1,9 Mtons | 2,5 Mtons | 3,2 Mtons |
| Clay bricks (incl. mortar) | 12,5 Mtons | 0,0 Mtons | 12,1 Mtons |
| Concrete | 34,1 Mtons | 0,0 Mtons | 14,3 Mtons |
| EPDM | 0,0 Mtons | 0,2 Mtons | 0,2 Mtons |
| Glass | 0,8 Mtons | 2,5 Mtons | 1,4 Mtons |
| gypsum | 1,3 Mtons | 1,5 Mtons | 1,2 Mtons |
| PE damp-proof membrane | 0,0 Mtons | 0,0 Mtons | 0,0 Mtons |
| PIR | 0,0 Mtons | 0,0 Mtons | 0,0 Mtons |
| PUR foam | 0,0 Mtons | 0,4 Mtons | 0,1 Mtons |
| PUR panel | 0,0 Mtons | 1,2 Mtons | 0,0 Mtons |
| PVC | 0,3 Mtons | 1,8 Mtons | 0,5 Mtons |
| reinforcement net | 0,9 Mtons | 0,0 Mtons | 0,4 Mtons |
| rockwool | 0,4 Mtons | 1,2 Mtons | 0,3 Mtons |
| Sand | 4,6 Mtons | 5,9 Mtons | 7,6 Mtons |
| Steel | 0,0 Mtons | 0,0 Mtons | 0,0 Mtons |
| Wood | 0,7 Mtons | 0,8 Mtons | 2,4 Mtons |
| Woodfiber panel | 0,3 Mtons | 0,0 Mtons | 0,1 Mtons |
| Aerated autoclaved blocks | 0,0 Mtons | 3,6 Mtons | 0,0 Mtons |
| **Total** | **60,5 Mtons** | **26,1 Mtons** | **48,1 Mtons** |

Table 2 shows that the entire mass required for the construction of new housing until 2050 is mostly made up of clay bricks, concrete and, as a distant third, sand. As a material used for making screed, which will have to be renewed during the insulation of floors, sand is an important ingredient to realize the ambitions of the Flemish climate policy plan for the residential building stock in our analysis. Glass and insulation materials also feature in this list. Demolition waste mostly consists of concrete and clay bricks. The potential reuse of these materials could thus ease the demand pressure generated from the construction of new dwellings if successful recycling of the materials could be realized. For the purposes of renovation, the reuse of the glass and aluminium waste streams could help in reducing the total overall mass footprint (and carbon footprint as we will see shortly) of renovations.

Table 3 focuses on the carbon footprint of the materials. For the newly constructed housing and renovation, we only take into account the production, transport and actual construction phase while the carbon footprint of the generated waste only looks at the end-of-life treatment impact of the materials. Interestingly, the ranking of the carbon emission impact of the different materials substantially differs from that of the material footprint. Specifically, PUR insulation materials, PVC and aluminium frames, and glass all have a considerable carbon footprint. Hence, although the total mass footprint of the materials is less outspoken, their carbon footprint features prominently thereby causing the cumulative carbon footprint to outstrip that of newly constructed houses. The end-of-life treatment of demolition waste generally has a lower carbon footprint, but through its reuse could also lower the carbon footprint of newly constructed housing.

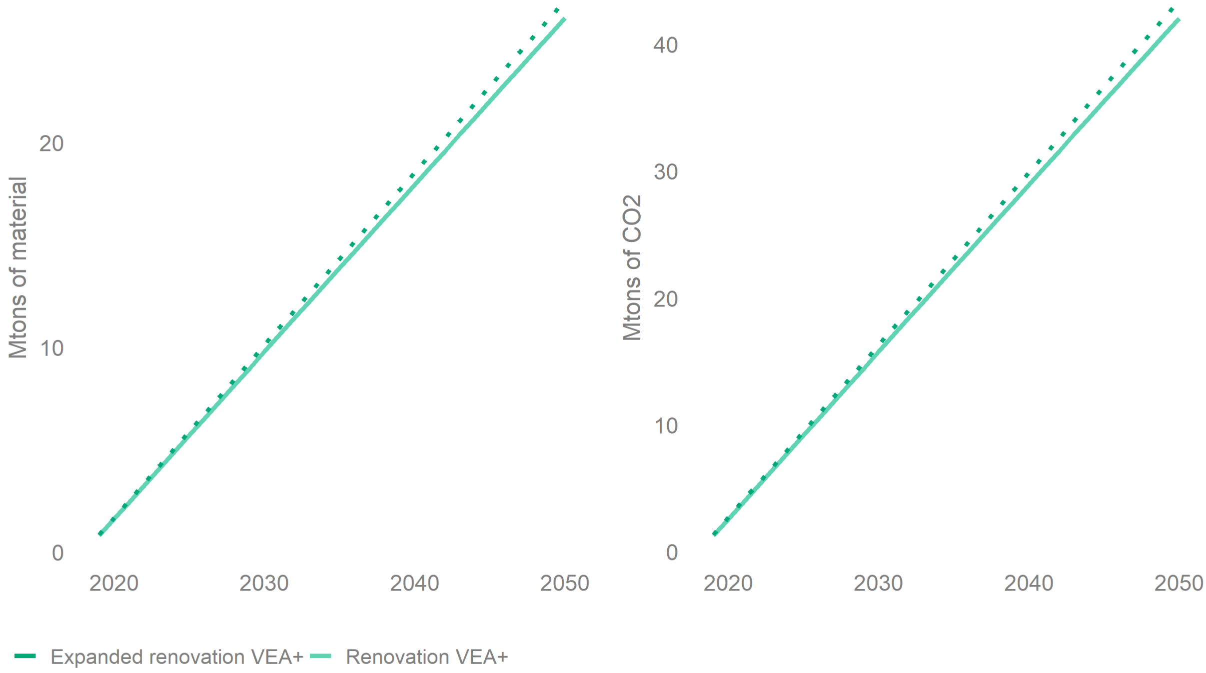
One could equally imagine that such energy renovations would generally be carried out within the context of a broader renovation project. As mentioned before, upon considering additional renovation efforts for kitchens, bath rooms, etc. the discrepancy between the carbon footprint of building a new home or renovating an older house are likely to be less outspoken than those shown in Figure 10 to Figure 14. However, as the current analysis only concerns the impact of improving the energy performance of dwellings, including other building elements not directly related to the Flemish climate plan is superfluous. Yet, to grasp the impact that more extensive renovation efforts could have on those building elements that are included in our analysis, we construct a scenario where a fraction of non-load-bearing walls are demolished and rebuilt. Additionally, up to a quarter of walls are repainted. For the exact details of this sensitivity analysis we refer the reader to section 3.2. The analysis is only performed for the updated VEA+ scenario.

Figure 18 reveals that such expanded renovation efforts are insufficiently large to be visually distinguishable from the original VEA+ scenario. While there are effectively differences in both material and carbon footprint, which are both higher for the expanded renovation scenario, their impact is of insufficient relevance compared to the impact of the required renovation effort within the frame of the Flemish climate plan. Bearing in mind these results, we shall in the next section exclusively focus on comparing the VEA+ scenario to alternative circular scenarios and not explicitly account for this expanded renovation scenario.

*Table 3: Cumulative carbon footprint of all materials demanded for construction of new houses and renovation efforts by 2050 in the VEA+ scenario. Waste generation shows the cumulative carbon footprint from end-of-life treatment of demolition waste.*

| Material | Newly constructed housing | Renovation | Waste generation from renovation |
|---|---|---|---|
| Acrylic paint | 0,3 Mtons | 0,4 Mtons | 0,0 Mtons |
| Aluminium | 2,1 Mtons | 10,7 Mtons | 0,0 Mtons |
| Calcareous plaster | 0,2 Mtons | 0,8 Mtons | 0,0 Mtons |
| Cement | 0,8 Mtons | 1,1 Mtons | 0,0 Mtons |
| ceramic rooftiles | 0,3 Mtons | 0,0 Mtons | 0,0 Mtons |
| ceramic tiles | 2,0 Mtons | 2,6 Mtons | 0,0 Mtons |
| Clay bricks (incl. mortar) | 3,4 Mtons | 0,0 Mtons | 0,1 Mtons |
| Concrete | 4,0 Mtons | 0,0 Mtons | 0,2 Mtons |
| EPDM | 0,0 Mtons | 0,4 Mtons | 0,0 Mtons |
| Glass | 1,8 Mtons | 5,3 Mtons | 0,0 Mtons |
| gypsum | 0,4 Mtons | 0,5 Mtons | 0,0 Mtons |
| PE damp-proof membrane | 0,0 Mtons | 0,1 Mtons | 0,0 Mtons |
| PIR | 0,2 Mtons | 0,0 Mtons | 0,0 Mtons |
| PUR foam | 0,7 Mtons | 5,4 Mtons | 0,2 Mtons |
| PUR panel | 0,0 Mtons | 4,1 Mtons | 0,0 Mtons |
| PVC | 0,8 Mtons | 5,4 Mtons | 0,5 Mtons |
| reinforcement net | 1,9 Mtons | 0,0 Mtons | 0,0 Mtons |
| rockwool | 0,5 Mtons | 1,6 Mtons | 0,0 Mtons |
| Sand | 0,1 Mtons | 0,1 Mtons | 0,0 Mtons |
| Steel | 0,0 Mtons | 0,0 Mtons | 0,0 Mtons |
| Wood | 0,4 Mtons | 1,0 Mtons | 0,0 Mtons |
| Woodfiber panel | 0,4 Mtons | 0,0 Mtons | 0,0 Mtons |
| Aerated autoclaved blocks | 0,0 Mtons | 2,6 Mtons | 0,0 Mtons |
| **Total** | **20,5 Mtons** | **42,1 Mtons** | **1,2 Mtons** |

*Figure 18: Comparison of the material (left) and carbon (right) footprint of an expanded renovation scenario to the original VEA+ scenario. Footprint is only shown for renovation efforts and not new buildings or demolition.*




## 4.3 Footprint calculations of alternative scenarios

In this section we analyze two circular scenarios that aim to decrease the material footprint of Flemish construction and analyze what the expected impacts are on the carbon footprint associated with future construction in Flanders. For the purposes of this analysis we will continue with the VEA+ scenario established above as this scenario accounts for the updated population projections. The methodology applied to implement both scenarios was described in section 3.3. The scenarios portray the impact of increased circularity in Flemish construction activity as a whole, thereby including the building of new dwellings and demolition of old dwellings along with the renovation efforts included in the Flemish climate plan.

We first discuss how the cumulative material and carbon footprints until 2050 are affected in the different scenarios. Thereafter, we compare all the scenarios simultaneously to obtain an appreciation of the relevance of the different scenarios in reducing the footprint of the construction industry.

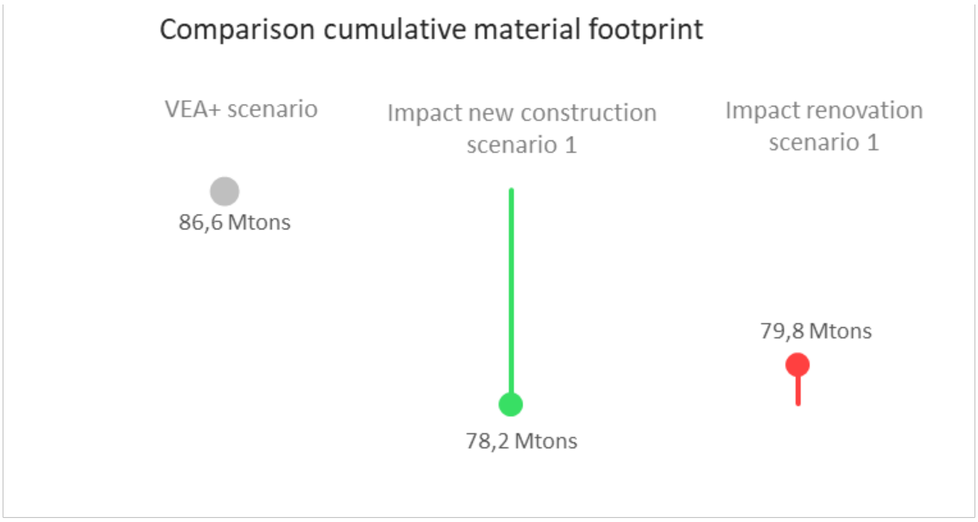
### Scenario 1: Building and living more compactly

Scenario 1 analyzes the material and carbon footprint of building both smaller new houses and splitting up five percent of all detached houses into two semi-detached houses. These actions would first of all avoid the use of construction material by decreasing the size of the houses, as well as reducing the amount of semi-detached houses that needs to be built in the future to provide housing for the projected growing number of households. While an additional renovation effort is required to split up the open houses, the overall impact can be expected to reduce the impact of construction activity.

Figure 19 compares the cumulative mass and carbon footprints of the VEA+ scenario and circular scenario 1 by looking at the impact of each specific construction activity in circular scenario 1 to observe how the VEA+ cumulative footprint differs from that of the VEA+ scenario footprint. Note that we do not consider the demolition phase in the material footprint decomposition. The reason for this is that the material footprint is only considered to consist of new materials.

It becomes immediately apparent that circular scenario 1 mainly decreases the footprints through its lower construction activity. This flows naturally from the assumption that the scenario consists of diminishing the total size of the houses that are to be built and splitting up detached houses so that it can house double the amount of households thereby diminishing the demand for new semi-detached housing. Nevertheless, there is also a slight increase in the renovation and demolition activity as a result of the splitting of the house. We assumed that additional effort would be required in terms of restructuring the non-load-bearing walls in the house. This manifests itself by undoing part of the decrease in the cumulative footprints. However, given that the construction of these non-load-bearing walls is performed with materials that in general carry a relatively lower carbon footprint than many other construction materials, the cumulative carbon footprint is barely affected by this additional renovation effort. The additional demolition effort is also associated with a slight increase in the cumulative carbon footprint due to the end-of-life treatment of the relevant materials. Overall, the cumulative material footprint decreases by 8 percent and the cumulative carbon footprint decreases by 4 percent as a result of building and living more compactly. Further decreasing the size of newly constructed houses or housing more households in currently existing dwellings than currently assumed would logically further decrease the specific footprints.

*Figure 19: Comparison of cumulative footprints of VEA+ scenario and circular scenario 1*



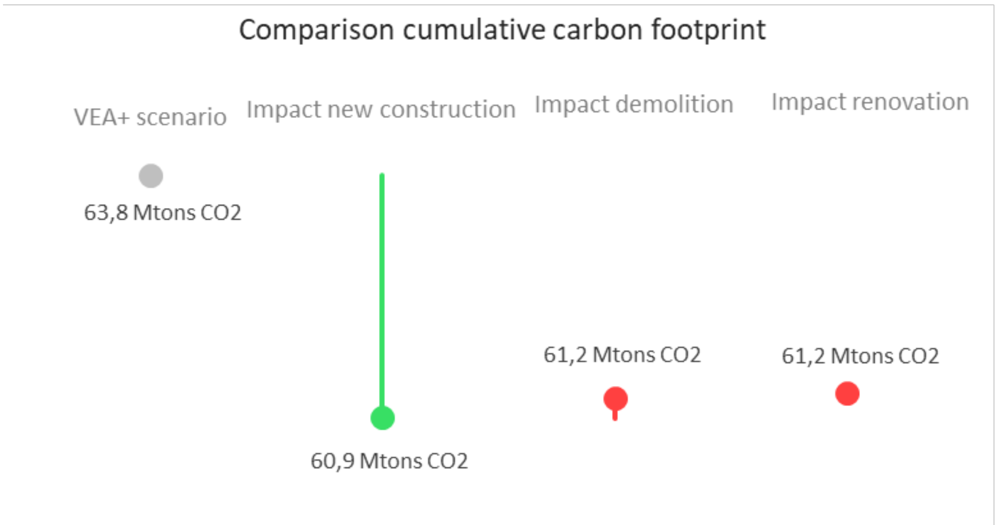
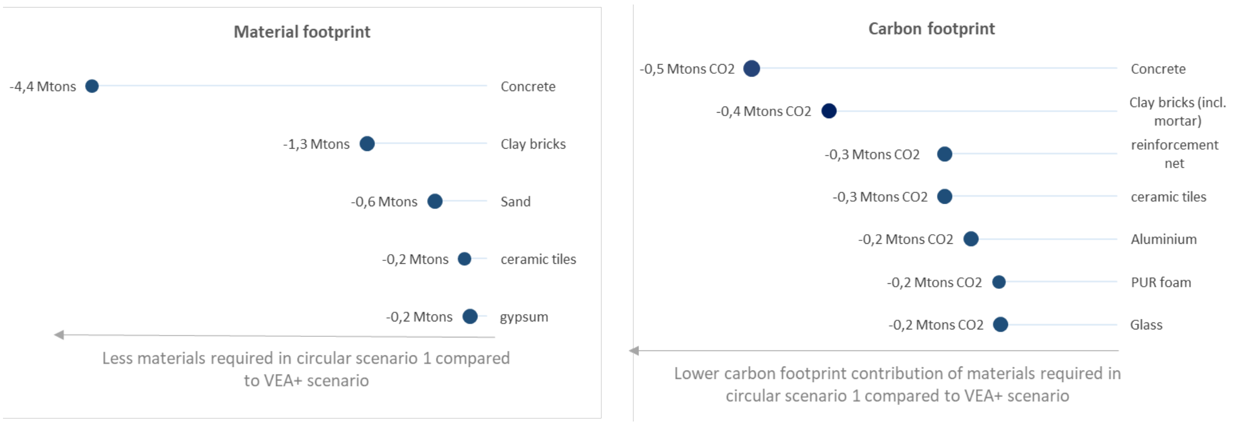




Figure 20 compares the contributions of several materials to the difference in the material and carbon footprints between the VEA+ scenario and the circular scenario 1. The decreased use of concrete in the circular scenario compared to the VEA+ scenario is the main driver of the overall decrease in the material footprint. In total, concrete accounts for 64 percent of the total decrease in the material footprint. While concrete is also the main contributor the overall decrease in the cumulative carbon footprint when comparing the circular scenario 1 to the VEA+ scenario, its overall contribution to the decrease in the carbon footprint is much more limited. Given that the circular scenario 1 mainly limits the amount of new dwellings that are to be constructed and does not aid towards the decrease of the footprint of the renovation effort, several materials used extensively in renovations (e.g. glass, aluminium, PVC, etc.) with high carbon footprints only contribute to a limited extent to the overall decrease of the carbon footprint.

*Figure 20: Comparison of contribution of most important materials in the material and carbon footprints*




The above reductions in the sizes of new dwellings were chosen rather arbitrarily. From the Tabula project, we collected average gross floor areas for different types of new houses for the Netherlands[44] and compared these to the average sizes of new Belgian houses as a reference for new dwellings in the Belgian region of Flanders[45]. Making this comparison, it becomes apparent that new buildings in the Netherlands are smaller on average. Detached houses in the Netherlands are 25 percent smaller on average, semi-detached houses are 21 percent smaller and attached houses are 18 percent smaller. Performing the calculations with these parameters and reducing all dimensions of the building accordingly, the reduction of new dwellings in Flanders to Dutch standards would lower the material footprint by 9,8 percent compared to the VEA+ scenario, which is an additional reduction compared to the current scenario 1 size reductions of new dwellings of 1,7 percentage points (8,1% for current scenario 1 sizes vs. 9,8% for applying Dutch building sizes to new Flemish dwellings) . The carbon footprint would lower by 4,8 percent compared to the VEA+ scenario which is an additional 0,8 percentage point reduction in carbon footprint compared to the current scenario 1 (4,0% for current scenario 1 sizes vs 4,8% for applying Dutch building sizes to new Flemish dwellings). Hence, it is feasible to lower the overall material and carbon footprint by further size reductions while still maintaining similar living standards. However, given the projected decrease in new building activity associated with declining demographic growth, the efforts do not considerably alter the picture that only limiting circular initiatives to new dwellings leaves the large bulk of the carbon footprint associated with renovations unaltered.

It is important to note that while the direct impact of reducing the size of dwellings is limited, its indirect impact implies that less energy sources are required in heating the house if the house is heated with sources that are carbon-intensive. While the use of fossil fuels for heating will be completely phased out by 2050 according to the draft Flemish climate policy plan and electricity will likely be produced from carbon-neutral strategies, heating through use of fossil fuels could still be likely in the short term. Hence, reducing building sizes could help in reducing the carbon footprint in the short term by reducing the need for energy carriers.

[44] Agentschap NL, 2013, Referentie-woningen nieuwbouw 2013.
[45] Cuypers, D., Vandevelde, B., Van Holm, M. and Verbeke, S. 2014. Belgische woningtypologie. Nationale brochure over de TABULA woningtypologie. Tabula Project Deliverable 2.3. Data not specifically available for Flanders alone.

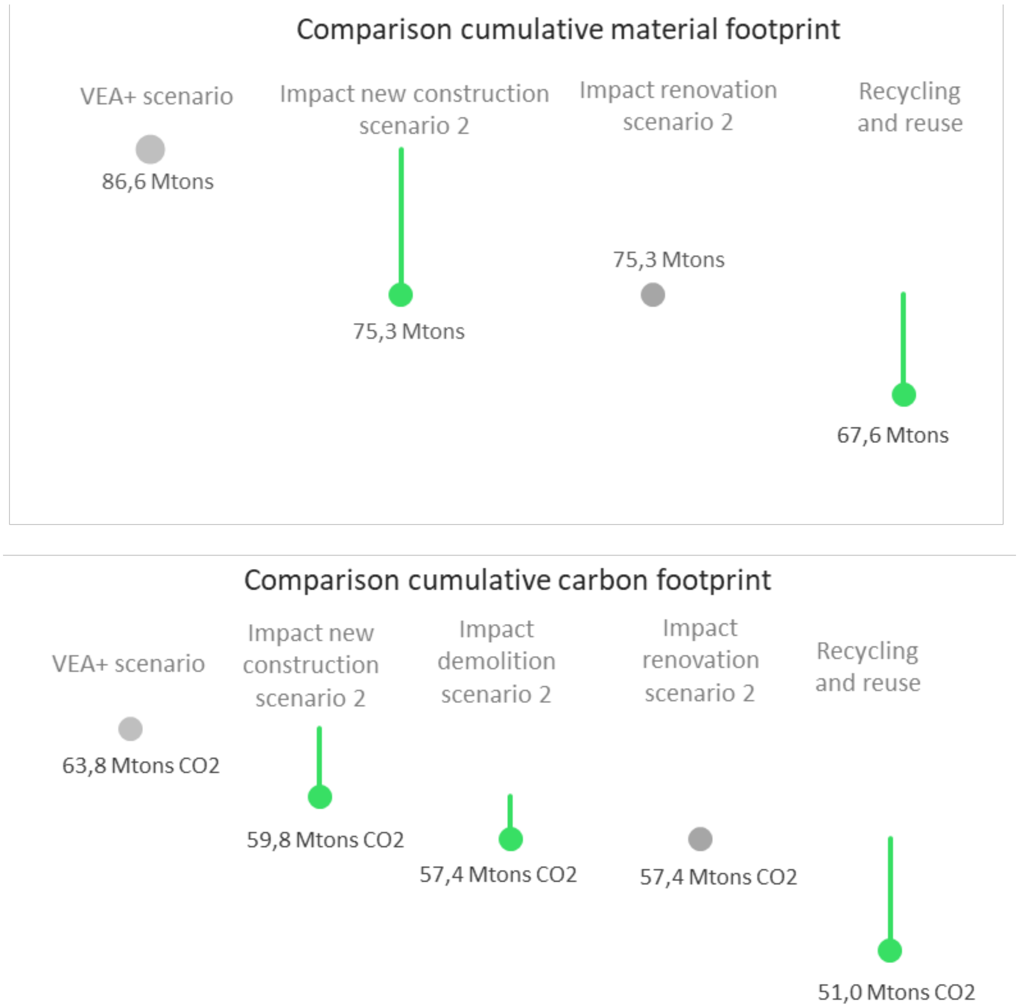
## Scenario 2: Increasing recycling rate in the construction industry

Scenario 2 analyzes how changes in building techniques and recycling or reusing materials recovered from demolished houses and from renovations can affect the material and carbon footprint. Unlike scenario 1, it does not assume a change in the living habits of households. However, through the recycling or reusing of recovered materials it has the potential to also lower the footprint of renovations, something which did not occur in scenario 1. Note that the footprint of the recycled materials also accounts for the recuperation and reinstallation efforts as well as the actual footprint of the recycling effort. We have made no specific assumption as to whether the recycled or reused materials are applied in new buildings or in renovations. Hence, the potential reduction of the material and carbon footprint through using recycled or reused materials is reported separately and not deducted from the footprints of renovation or new construction based on assumptions. However, this scenario explicitly looks at the demand for the specific materials and the supply of the materials after recycling or reuse.

Figure 21 shows how the actions of the second circular scenario lead to a reduction of the cumulative material and carbon footprint of the Flemish construction activity. While no specific renovation actions are undertaken in scenario 2, the increase of timber frame constructed houses leads to a reduction of the material footprint as less clay bricks are required, which are more massive and have a higher carbon footprint[46]. Additionally, we assume that wooden window frames are used for houses with a timber frame, which also have a substantially lower carbon footprint than aluminium and PVC frames. While demolition itself is not linked to a demand for new materials and therefore does not feature in the mass footprint decomposition, the avoidance of demolishing and applying end-of-life treatment to demolished materials does lead to a reduction of the carbon footprint. Hence, the avoidance of demolition is what causes demolition to have a lower overall carbon footprint in circular scenario 2 compared to the baseline VEA+ scenario. The reuse of half of the aluminium and PVC window frames in other dwellings is of particular importance. Since PVC has a considerable carbon footprint linked to the end of life treatment, the avoidance of this end-of-life treatment reduces the overall carbon footprint of demolition. While increasing the share of houses constructed with a timber structure has a relatively larger impact on reducing the mass footprint and less on the carbon footprint, recycling and reusing construction materials have a larger relative impact on the carbon footprint.
Overall, the cumulative material footprint is reduced by 22 percent while the cumulative carbon footprint of construction until 2050 is reduced by 20 percent through the actions undertaken in the second circular scenario.

[46] We reiterate here that the impact in terms of other environmental categories is not taken into account and may very well reveal that timber frame homes also have more detrimental impacts on some other fronts.

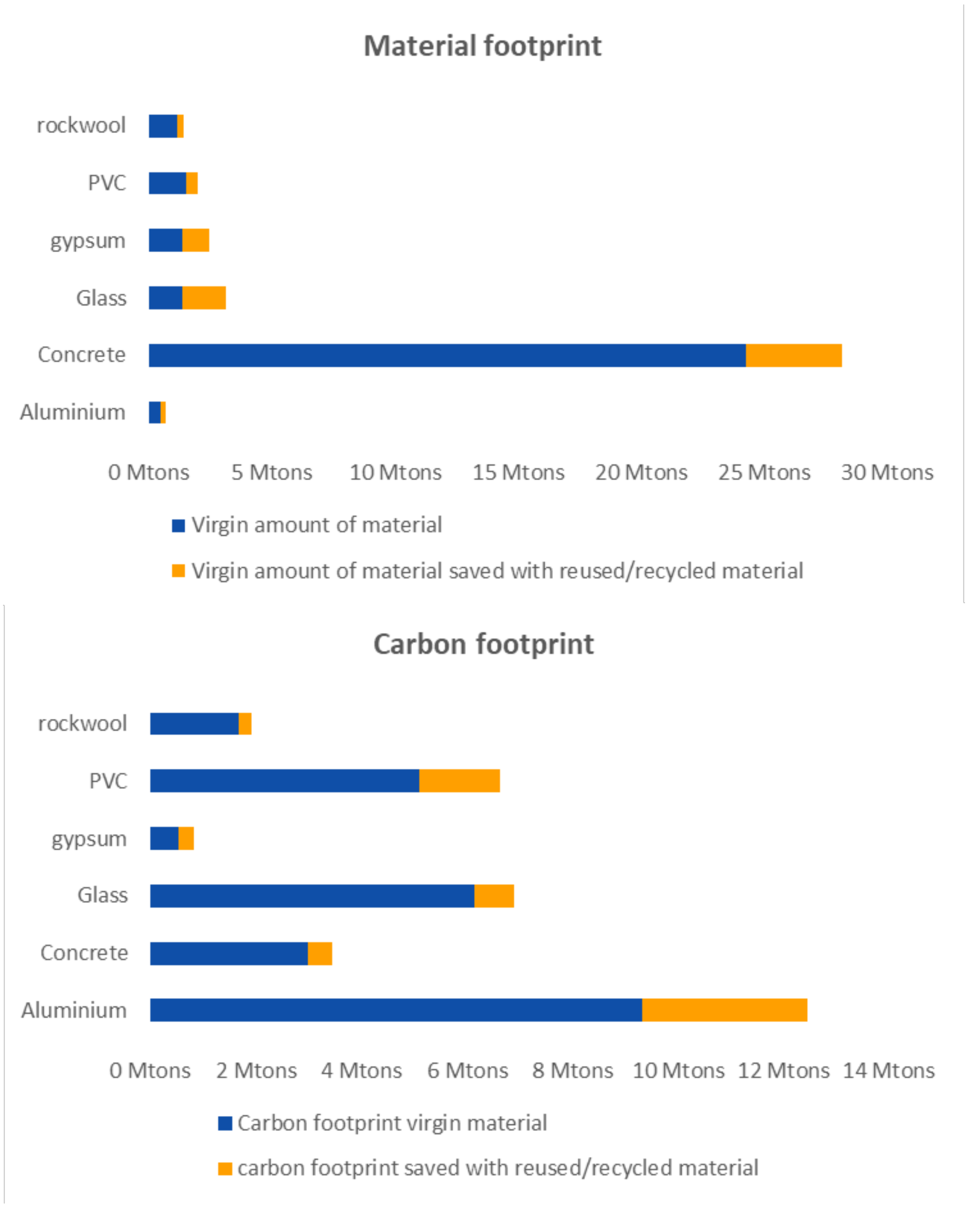
*Figure 21: Comparison of cumulative footprints of VEA+ scenario and circular scenario 2*




To understand how recycling and reusing materials to avoid the use of virgin materials is relevant to the reduction of the material and carbon footprint, Figure 22 portrays the total material and carbon footprint of all the materials with recycled content or refurbished material that can be used to reduce the virgin footprint within scenario 2. As noted before, there is still further potential to recycle (or even reuse) other materials in construction applications, but this generally concerns building items such as foundations that are not considered in our analysis.

The figure decomposes the footprint into two components. First, the contribution of the remaining virgin material fraction to the material and carbon footprint. Second, the fraction of the material and carbon footprint that is reduced as a result of using recycled content or reused construction items. The carbon footprint of transporting, installation and, in the case of recycled content, the actual recycling is taken into account for the carbon footprint decomposition.
For the material footprint, the reduction of concrete through recycling old concrete and cement and reusing it as a granulate is particularly important. For the carbon footprint, the reuse and recycling of PVC and aluminium window frames is particularly relevant. This is in line with our findings before that showed that these items are important contributors to the carbon footprint of renovations.

*Figure 22: Impact of recycling/reusing materials on overall material and carbon footprint*



## Conclusions of scenario analysis

In this section, we present the yearly impact of the different scenarios and compare them to one another. As the baseline scenario, we include the VEA+ scenario with the updated household projections for Flanders.
*ire* lifecycle of some materials and the lifecycle of the building itself.
Figure 23 and Figure 24 show that both circular scenario 1 and circular scenario 2 reduce the yearly mass and carbon footprints of the construction industry. Overall, circular scenario 2 leads to the most outspoken reduction of both material and carbon footprints. As discussed before, for the material footprint this is particularly caused by the reduction in use of materials to build houses by increasing the share of timber frame houses while for the carbon footprint further expanding the use of recycled and reused building materials is particularly of note.

Circular scenario 1 clearly represents an improvement relative to the baseline VEA+ scenario. However, since a substantial fraction of the carbon footprint of the VEA+ scenario results from the use of carbon intensive materials in updating houses to the standards of the Flemish climate plan, constructing smaller houses and splitting up existing houses only contributes marginally in the reduction of the carbon footprint of the renovation activity.

Nevertheless, since the two scenarios analyzed in this framework both target different circular strategies (making more efficient use of houses by living smaller in scenario 1 and reusing and recycling in scenario 2), a combination of the two strategies would achieve the greatest reduction in both the material and carbon footprint. Admittedly, the total effects would be lower than the sum of the impacts of the two individual scenarios as a result of both scenarios targeting different future ways of constructing new houses. A combined scenario would for instance entail less semi-detached houses that need to be built, the construction of smaller houses and of houses with a timber frame. However, this would only slightly decrease the reduction in both mass and carbon footprint of the sum of the two individual circular scenarios. Moreover, considering the need for renovation of windows to improve the energy performance of houses, the recycling and reuse of window frames would still cause substantial reductions in the carbon footprint of a combined circular scenario.

Of course, the circular scenarios are not exhaustive in terms of the options available to the construction industry. The aim of the scenario analysis was to show the potential of specific actions rather than to list the full array of all possibilities at hand. It is feasible to further reduce the impact of the construction activity through the choice of building materials[47] (e.g. the type of insulation material or finishing material) and other activities which have not been considered in this analysis. The scope for reducing the material and carbon footprint could thus clearly extend beyond what is currently considered in this study. Nevertheless, it is relevant to note that applying different building materials could, depending on the material, in the short term also increase the overall material and carbon footprint but lead to a dwelling that is more robust or lead to a material that can easier be reused at a later date, thereby diminishing its overall lifecycle footprint. In this sense, it is important to look at the entire lifecycle of some materials and the lifecycle of the building itself.

[47] See e.g. Di Maria, A., Snellings, R., Alaerts, L., Quaghebeur, M., Van Acker, K. 2019. CO2 mineralisation for sustainable construction materials. SuMMa report nr. 5.

*Figure 23: Annual and cumulative material footprint of Flemish construction for baseline VEA+ scenario and circular scenarios 1 and 2*

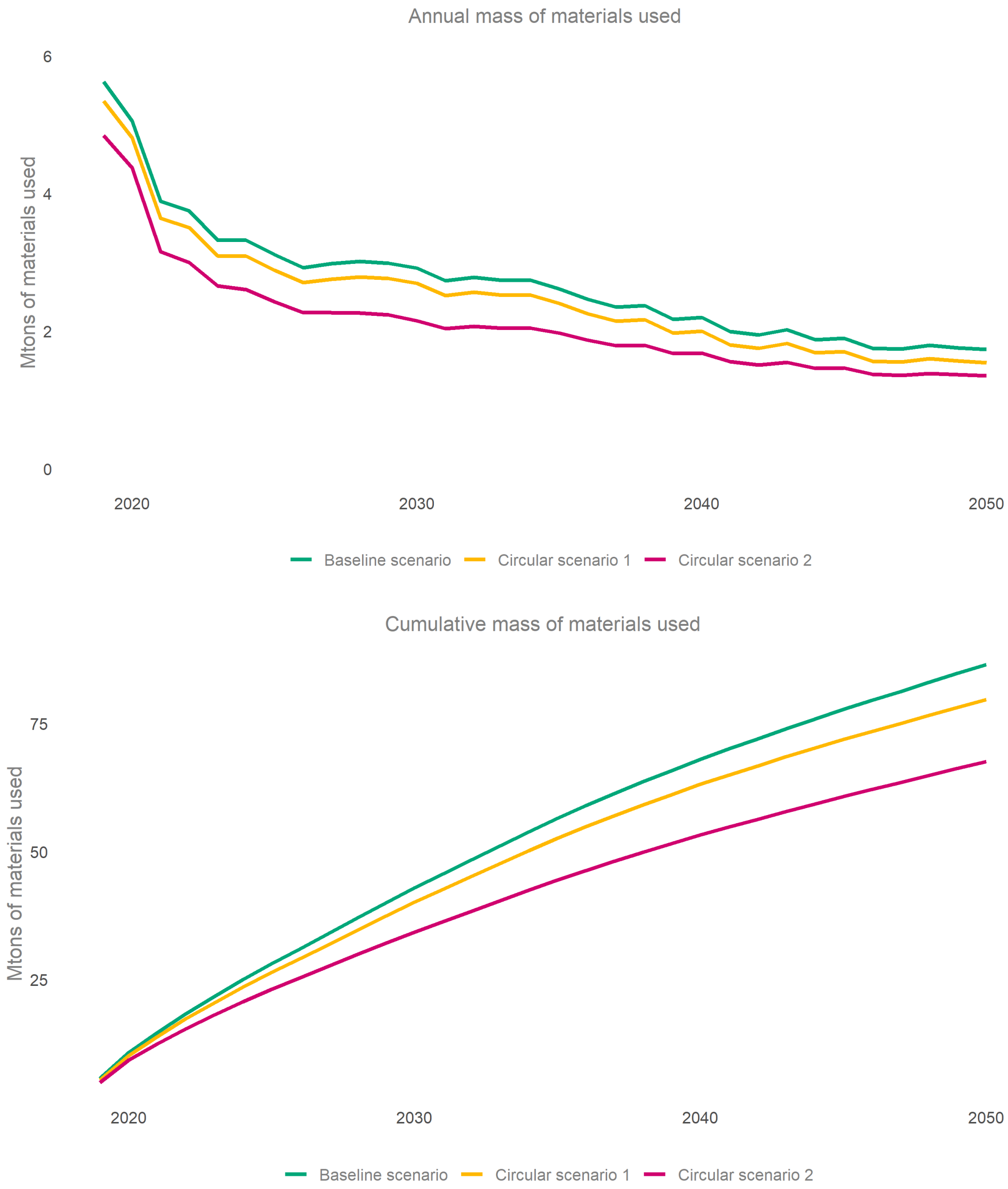
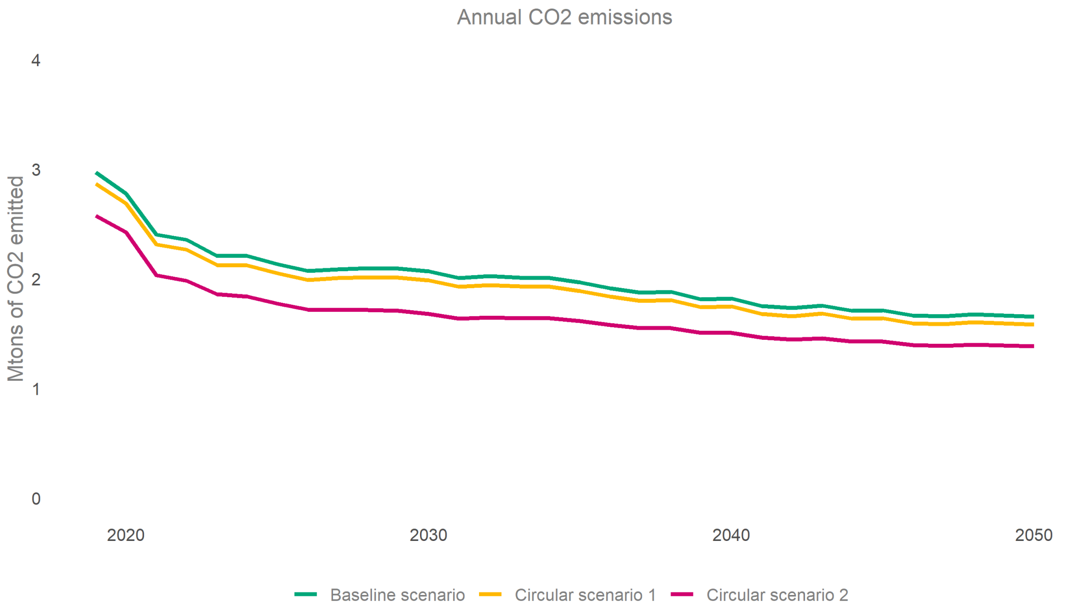
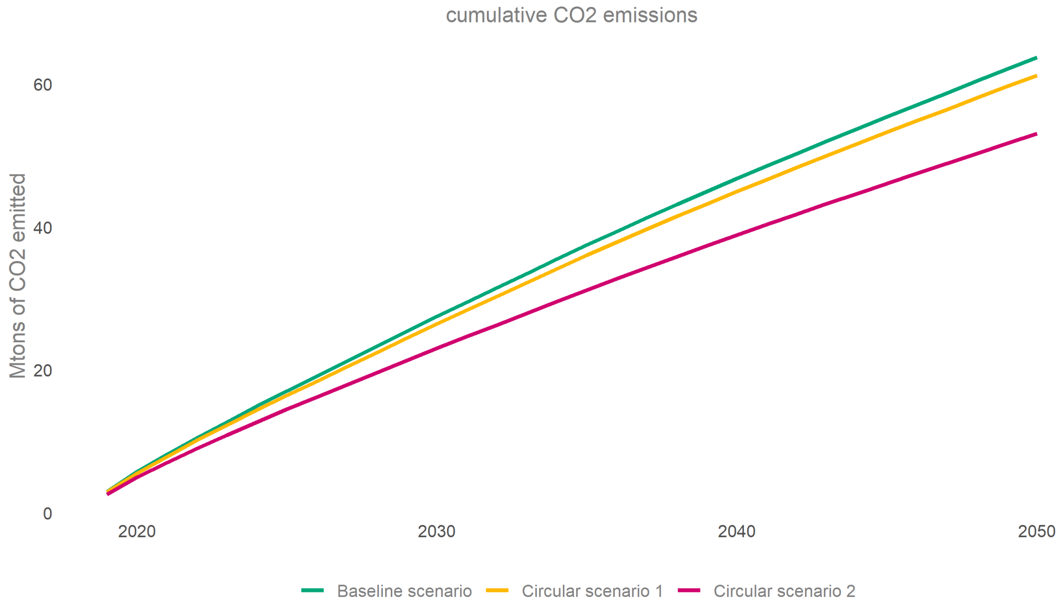


*Figure 24: Annual and cumulative carbon footprint of Flemish construction for baseline VEA+ scenario and circular scenarios 1 and 2*



# Chapter 5: Conclusions

This study analyses the potential of two circular strategies for the construction industry and the likely material and carbon footprint impacts associated with the realization of the objectives for residential housing in the draft Flemish climate policy plan. This plan targets a carbon neutral housing stock by the year 2050.

The research strategy first aimed to reconstruct the current average composition of the housing stock accounting for the different types of housing, the building periods of the houses, the building elements of the dwellings and the different materials used during construction. It also accounted for the future construction of new dwellings. Subsequently, it was determined which renovations are required in the current building stock and which building elements need to be replaced to meet the targets of the draft Flemish climate policy plan for housing. This allowed us to obtain estimates of the impact of both the renovation effort and the construction of new houses. This initial assessment indicated that 60,5 million tons of material are required for new buildings, while 26,1 million tons are required for renovations. Concrete and clay bricks make up the bulk of the weight of building materials required in the future to meet the demand for new dwellings. However, **the carbon footprint associated with the renovation effort is twice the size of the carbon footprint associated with the construction of new dwellings.** This mostly results from the need for new window frames, new glass and insulation materials, which are all carbon intensive, for a large stock of old houses over half of which predate the 1970s. Compared to other industries such as food, textiles and cars, the construction industry has a slower turnover of its products (new dwellings). Therefore, applying circular principles has to be done while considering the large stock of current dwellings rather than exclusively focus on applying circularity to new products.

Two specific circular scenarios were analyzed to grasp the potential of circularity in the construction industry for residential housing. The first scenario entailed a decrease in the size of new dwellings as well as the division of a fraction of existing detached houses into semi-detached houses, thereby increasing the occupancy of existing dwellings and decreasing the need for new dwellings to be constructed. **As a result of making more efficient use of the living space, the cumulative material footprint by 2050 decreases by 8,1 percent compared to a baseline scenario that assumes a continuation of current construction practices, whereas the carbon footprint decreases by a less outspoken 4,0 percent.** Using the Dutch average gross floor area of homes as an indicator of how much dwelling sizes can be diminished while maintaining sufficient living quality, it was shown that these reductions in the material and carbon footprint could be even larger. A second circular strategy aims towards limiting both the impact of new construction activity as well as renovation activity by increasing recycling and reuse and applying different, less carbon intensive building materials through an increase in the share of new dwellings constructed with a timber frame skeleton to 30 percent by 2030. **A circular strategy of increased reuse, recycling and use of different construction materials has the potential to reduce the cumulative material and carbon footprint by 2050 by approximately 20 percent compared to the baseline scenario.** Note that an alternative building method such as timber frames could have more detrimental impacts upon considering other environmental impacts than the material and carbon footprint.

While both strategies target different approaches to increase the circularity of the construction industry, their effects are likely to overlap for some aspects, thereby slightly reducing the cumulative impact of simultaneously implementing both circular strategies. However, it is important to note that the scenarios are not exhaustive in terms of the sustainable and circular options available for the construction and renovation of dwellings. Other options entail the reuse and recycling of materials outside of construction that would otherwise be designated as waste and reuse them as construction materials, the construction of modular dwellings that can flexibly be altered, build in layers of lifetime of materials such that layers with a shorter expected lifetime can more easily adjust in future, use of materials that can be composted, use of components consisting of a single material, etc[48]. In this sense, the implementation of different circular strategies and the application of multiple sustainable building materials could offer further potential to increase the circularity and sustainability of construction as it tries to meet the challenge of making the housing stock carbon-neutral by 2050.

This study has also highlighted that there are still clear knowledge gaps in terms of how the housing market will come to evolve. There are no clear insights as to how the construction of new dwellings will evolve and how the anticipated demographic trends interact with the housing market. Therefore, this study has opted to update existing policy scenarios with newly available data. However, historic construction of dwellings has on a yearly basis continuously surpassed the number of new households, implying that additional factors aside from demographic trends also need to be accounted for when estimating future construction activity. While in the context of this study these projections matter for estimating the footprint and increasing the circularity of construction, it is also relevant for the purpose of organizing the shift in construction that policy makers wish to realize in Flanders.

Finally, this study has tried to overcome the lack of data concerning houses (e.g. components and materials used) and building practices. The research strategy has consisted of defining several types of dwellings, the size of several building elements in these dwellings according to the building period and the materials used for each building element in each period. While this led to a relatively rich dataset of 44 types of dwelling/building period combinations, it implies that the variation in houses and used materials is still vastly underestimated. The principle of every good functioning market rests on the availability of information. For the circular economy this is particularly relevant as insights into current stocks of materials is key to guarantee the circular (re-)application of said materials. In order to fully grasp the circular potential and be able to successfully carry out projections, it is thus necessary to expand the available data on building components and houses.

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[48] Cambier, C., Elsen, S., Galle, W., Lanckriet, W., Poppe, J., Tavernier, I., Vandervaeren, C. 2019. Bouwen voor een circulaire economie: ontwerpkwaliteiten om architecten en opdrachtgevers te begeleiden en inspireren. Vrije Universiteit Brussel.

# Annex A: Overview of elements

This annex presents the compositions and U-values per building period and building element applied within this study: the left side shows the values when it would be newly built and the right side show the values for the renovation scenario. The cells are colored light green if certain values of a material are changed due to the renovation. We only considered the necessary minimal energy renovation processes. Necessary replacements of existing materials due to the technical lifespan of the materials or because certain technical requirements are no longer met after the renovation (such as the bearing power of a roof structure) were therefore excluded.

## ≤ 1945, solid construction[49]

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m$^2$K/W] | $U_{element}$ [W/m$^2$K] | $U_{element}$ TABULA [W/m$^2$K] | Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m$^2$K/W] | $U_{element}$ [W/m$^2$K] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Floor on grade, ≤1945, solid construction** | **465,11** | **95,94** | **19,59** | **6,69** | **0,235** | | | **0,85** | 0,85 | **Renovation scenario** | **468,09** | **2,49** | **51,69** | **41,93** | **0,320** | | | **0,24** | | **97,59** | **100,56** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR, spray foam, 25 mm | 0,88 | 3,03 | 7,02 | 1,82 | 0,025 | 0,028 | 0,893 | | | PUR, spray foam, 110 mm | 3,85 | 1,82 | 16,69 | 38,59 | 0,110 | 0,028 | 3,929 | | D | 0,88 | 3,85 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Storey floor, ≤1945, solid construction** | **523,64** | **101,94** | **14,08** | **5,29** | **0,243** | | | **n.a.** | n.a. | **Existing (no renovation)** | **523,64** | **0,00** | **0,00** | **0,00** | **0,243** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | | Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |
| **External wall, ≤1945, solid construction** | **280,31** | **42,33** | **4,95** | **1,62** | **0,140** | | | **2,12** | 2,20 | **Renovation scenario** | **316,30** | **0,00** | **21,27** | **0,48** | **0,310** | | | **0,24** | | **0,00** | **35,99** |
| Clay bricks, bricklaid (incl. mortar) | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | | Clay bricks, bricklaid (incl. mortar) | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |
| | | | | | | | | | | Aerated autoclaved blocks, glued, 160 mm | 25,54 | 0,00 | 17,22 | 0,33 | 0,160 | 0,043 | 3,721 | | N | | 25,54 |
| | | | | | | | | | | Gypsum plaster | 10,00 | 0,00 | 2,59 | 0,07 | 0,010 | 0,400 | 0,025 | | N | | 10,00 |
| | | | | | | | | | | Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **External wall, detached dwelling, ≤1945, solid construc** | **280,31** | **42,33** | **4,95** | **1,62** | **0,140** | | | **2,12** | 2,20 | **Renovation scenario** | **294,58** | **0,00** | **20,92** | **1,91** | **0,310** | | | **0,24** | | **0,00** | **14,27** |
| | | | | | | | | | | Plaster on insulation | 8,16 | 0,00 | 1,96 | 0,38 | 0,070 | | 0,020 | | N | | 8,16 |
| | | | | | | | | | | PUR board w/ aluminium cover foil + glue, to plaster | 6,11 | 0,00 | 18,97 | 1,53 | 0,100 | 0,027 | 3,760 | | N | | 6,11 |
| Clay bricks, bricklaid (incl. mortar) | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | | Clay bricks, bricklaid (incl. mortar) | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |
| **Load-b. internal/party wall, ≤1945, solid construction** | **301,21** | **50,43** | **5,73** | **1,77** | **0,160** | | | **n.a.** | n.a. | **Existing (no renovation)** | **301,21** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | | Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | | Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Clay bricks, bricklaid (incl. mortar) | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | | Clay bricks, bricklaid (incl. mortar) | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | | Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | | Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Non-l-b. internal wall, ≤1945, solid construction** | **124,51** | **33,62** | **3,76** | **1,12** | **0,110** | | | **n.a.** | n.a. | **Existing (no renovation)** | **124,51** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | | Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | | Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Clay bricks, bricklaid (incl. mortar) | 103,61 | 25,53 | 2,98 | 0,98 | 0,090 | 0,430 | 0,209 | | | Clay bricks, bricklaid (incl. mortar) | 103,61 | 0,00 | 0,00 | 0,00 | 0,090 | 0,430 | 0,209 | | E | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | | Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | | Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Flat roof, ≤1945, solid construction** | **693,03** | **97,44** | **16,89** | **7,47** | **0,299** | | | **3,49** | 3,50 | **Renovation scenario** | **697,47** | **0,03** | **18,21** | **1,41** | **0,399** | | | **0,22** | | **1,85** | **6,29** |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | | EPDM, partially glued | 1,85 | 0,03 | 3,65 | 0,21 | 0,001 | 0,250 | 0,005 | | D | 1,85 | 1,85 |
| | | | | | | | | | | PUR board with aluminium cover foil, partially glued | 4,44 | 0,00 | 14,56 | 1,20 | 0,100 | 0,024 | 4,167 | | N | | 4,44 |
| In situ poor or light concrete sloping layer | 142,35 | 8,73 | 2,92 | 1,41 | 0,065 | 1,650 | 0,039 | | | In situ poor or light concrete sloping layer | 142,35 | 0,00 | 0,00 | 0,00 | 0,065 | 1,650 | 0,039 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | | Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | | Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | | Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |

[49] In the Master thesis by Eeckhout[18] slight adaptations were made to the element compositions regarding the insulation compared to the element descriptions provided within the TABALU project[20] in order to meet the given U-value. These adaptations were kept in if based on our modelling the adaptations were still needed to meet the U-value. Therefore it could be that there are certain unrealistic materials included in the element compositions, such as the PUR insulation in the floor on grade. For the selection of materials we followed the thesis by Eeckhout and the report of the TABULA project.

## (continuation of: ≤ 1945, solid construction)

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ $[m^2K/W]$ | $U_{element}$ $[W/m^2K]$ | $U_{element}$ TABULA $[W/m^2K]$ | Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ $[m^2K/W]$ | $U_{element}$ $[W/m^2K]$ | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Pitched roof, ≤1945, solid construction** | **72,57** | **41,35** | **3,46** | **4,63** | **0,383** | | | **2,78** | 1,70 | **Renovation scenario** | **90,65** | **0,00** | **10,66** | **0,88** | **0,418** | | | **0,23** | | **0,00** | **18,08** |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | | Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | | Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | | Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | | | | | Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| | | | | | | | | | | Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 3,30 | 0,21 | | 0,036 | 2,451 | | N | | 2,63 |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | | | | | Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| | | | | | | | | | | Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,77 | 0,05 | | 0,036 | 1,446 | | N | | 0,70 |
| | | | | | | | | | | Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,85 | 0,09 | | | | | N | | 2,57 |
| | | | | | | | | | | PE vapour barrier, stapled | 0,20 | 0,00 | 0,57 | 0,05 | 0,000 | | | | N | | 0,20 |
| | | | | | | | | | | Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,47 | 0,04 | 0,022 | | | | N | | 0,91 |
| | | | | | | | | | | Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 3,25 | 0,36 | 0,013 | 0,250 | 0,050 | | N | | 10,63 |
| | | | | | | | | | | Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **Window, ≤1945, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 | **Renovation scenario** | **45,73** | **1,06** | **100,20** | **6,02** | | | | **1,13** | | **35,43** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | | Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,06 | 41,98 | 2,53 | | | | | D | 10,30 | 20,60 |
| **Window, ≤1945, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 | **Renovation scenario** | **51,25** | **1,06** | **100,20** | **6,02** | | | | **1,16** | | **35,43** | **51,25** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | PVC frame (U = 1.6 W/m2K) | 30,65 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 30,65 |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | | Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,06 | 41,98 | 2,53 | | | | | D | 10,30 | 20,60 |
| **Window, ≤1945, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 | **Renovation scenario** | **35,12** | **1,06** | **264,71** | **13,98** | | | | **1,16** | | **35,43** | **35,12** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 1,00 | 218,71 | 11,20 | | | | | D | 25,13 | 12,55 |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | | Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,06 | 46,00 | 2,78 | | | | | D | 10,30 | 22,57 |
| **Outside door, ≤1945, solid construction** | **26,44** | **33,70** | **2,31** | **1,42** | | | | **2,97** | 4,00 | **Existing (no renovation)** | **26,44** | **0,00** | **0,00** | **0,00** | | | | **2,97** | | **n.a.** | **n.a.** |
| Uninsulated wooden door | 24,58 | 32,60 | 2,18 | 0,82 | | | 0,167 | | | Uninsulated wooden door | 24,58 | 0,00 | 0,00 | 0,00 | | | 0,167 | | E | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 1,10 | 0,12 | 0,60 | | | | | | Wooden door frame, varnished (incl. nails) | 1,87 | 0,00 | 0,00 | 0,00 | | | | | E | | |

## 1946-1970, solid construction

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ $[m^2K/W]$ | $U_{element}$ $[W/m^2K]$ | $U_{element}$ TABULA $[W/m^2K]$ | Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ $[m^2K/W]$ | $U_{element}$ $[W/m^2K]$ | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Floor on grade, 1946-1970, solid construction** | **465,11** | **95,94** | **19,59** | **6,69** | **0,235** | | | **0,85** | 0,85 | **Renovation scenario** | **468,09** | **2,49** | **51,69** | **41,93** | **0,320** | | | **0,24** | | **97,59** | **100,56** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR, spray foam, 25 mm | 0,88 | 3,03 | 7,02 | 1,82 | 0,025 | 0,028 | 0,893 | | | PUR, spray foam, 11 cm | 3,85 | 1,82 | 16,69 | 38,59 | 0,110 | 0,028 | 3,929 | | D | 0,88 | 3,85 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Storey floor, 1946-1970, solid construction** | **523,64** | **101,94** | **14,08** | **5,29** | **0,243** | | | **n.a.** | n.a. | **Existing (no renovation)** | **523,64** | **0,00** | **0,00** | **0,00** | **0,243** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | | Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |
| **External wall, 1946-1970, solid construction** | **434,03** | **80,02** | **9,37** | **3,08** | **0,280** | | | **1,39** | 1,70 | **Renovation scenario** | **470,01** | **0,00** | **21,27** | **0,48** | **0,450** | | | **0,22** | | **0,00** | **35,99** |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | | Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, unventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,050 | | 0,180 | | | Air cavity, unventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,050 | | 0,180 | | E | | |
| Clay brick cavity wall, inner leaf | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | | Clay brick cavity wall, inner leaf | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |
| | | | | | | | | | | Aerated autoclaved blocks, glued, 160 mm | 25,54 | 0,00 | 17,22 | 0,33 | 0,160 | 0,043 | 3,721 | | N | | 25,54 |
| | | | | | | | | | | Gypsum plaster | 10,00 | 0,00 | 2,59 | 0,07 | 0,010 | 0,400 | 0,025 | | N | | 10,00 |
| | | | | | | | | | | Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **External wall, detached dwelling, 1946-1970, solid con** | **434,03** | **80,02** | **9,37** | **3,08** | **0,280** | | | **1,39** | 1,70 | **Renovation scenario** | **448,29** | **0,00** | **20,92** | **1,91** | **0,450** | | | **0,22** | | **0,00** | **14,27** |
| | | | | | | | | | | Plaster on insulation | 8,16 | 0,00 | 1,96 | 0,38 | 0,070 | | 0,020 | | N | | 8,16 |
| | | | | | | | | | | PUR board w/ aluminium cover foil + glue, to plaster | 6,11 | 0,00 | 18,97 | 1,53 | 0,100 | 0,027 | 3,760 | | N | | 6,11 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | | Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, unventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,050 | | 0,180 | | | Air cavity, unventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,050 | | 0,180 | | E | | |
| Clay brick cavity wall, inner leaf | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | | Clay brick cavity wall, inner leaf | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |

# (continuation of: 1946-1970, solid construction)

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ TABULA [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| **Load-b. internal/party wall, 1946-1970, solid construct** | **301,21** | **50,43** | **5,73** | **1,77** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Clay bricks, bricklaid (incl. mortar) | 280,31 | 42,33 | 4,95 | 1,62 | 0,140 | 0,463 | 0,302 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 1946-1970, solid construction** | **124,51** | **33,62** | **3,76** | **1,12** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Clay bricks, bricklaid (incl. mortar) | 103,61 | 25,53 | 2,98 | 0,98 | 0,090 | 0,430 | 0,209 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 1946-1970, solid construction** | **693,03** | **97,44** | **16,89** | **7,47** | **0,299** | | | **3,49** | 3,50 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| In situ poor or light concrete sloping layer | 142,35 | 8,73 | 2,92 | 1,41 | 0,065 | 1,650 | 0,039 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | |
| **Pitched roof, 1946-1970, solid construction** | **84,56** | **46,52** | **3,94** | **4,89** | **0,418** | | | **2,44** | 1,90 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | | | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Window, 1946-1970, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | |
| **Window, 1946-1970, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | |
| **Window, 1946-1970, solid construction** | **35,43** | **74,79** | **4,53** | **1,06** | | | | **4,69** | 5,00 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Single glazing (U = 5.8 W/m2K) | 10,30 | 16,57 | 1,05 | 0,06 | | | | | |
| **Outside door, 1946-1970, solid construction** | **26,44** | **33,70** | **2,31** | **1,42** | | | | **2,97** | 4,00 |
| Uninsulated wooden door | 24,58 | 32,60 | 2,18 | 0,82 | | | 0,167 | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 1,10 | 0,12 | 0,60 | | | | | |

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing (no renovation)** | **301,21** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Clay bricks, bricklaid (incl. mortar) | 280,31 | 0,00 | 0,00 | 0,00 | 0,140 | 0,463 | 0,302 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **124,51** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Clay bricks, bricklaid (incl. mortar) | 103,61 | 0,00 | 0,00 | 0,00 | 0,090 | 0,430 | 0,209 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **697,47** | **0,03** | **18,21** | **1,41** | **0,399** | | | **0,22** | | **1,85** | **6,29** |
| EPDM, partially glued | 1,85 | 0,03 | 3,65 | 0,21 | 0,001 | 0,250 | 0,005 | | D | 1,85 | 1,85 |
| PUR board with aluminium cover foil, partially glued | 4,44 | 0,00 | 14,56 | 1,20 | 0,100 | 0,024 | 4,167 | | N | | 4,44 |
| In situ poor or light concrete sloping layer | 142,35 | 0,00 | 0,00 | 0,00 | 0,065 | 1,650 | 0,039 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |
| **Renovation scenario** | **90,65** | **0,26** | **10,66** | **0,88** | **0,418** | | | **0,23** | | **11,99** | **18,08** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 3,30 | 0,21 | | 0,036 | 2,451 | | N | | 2,63 |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,77 | 0,05 | | 0,036 | 1,446 | | N | | 0,70 |
| Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,85 | 0,09 | | | | | N | | 2,57 |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,57 | 0,05 | 0,000 | | | | N | | 0,20 |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,05 | 0,47 | 0,04 | 0,022 | | | | D | 0,91 | 0,91 |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,21 | 3,25 | 0,36 | 0,013 | 0,250 | 0,050 | | D | 10,63 | 10,63 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | D | 0,45 | 0,45 |
| **Renovation scenario** | **45,73** | **1,06** | **100,20** | **6,02** | | | | **1,13** | | **35,43** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,06 | 41,98 | 2,53 | | | | | D | 10,30 | 20,60 |
| **Renovation scenario** | **51,25** | **1,06** | **100,20** | **6,02** | | | | **1,16** | | **35,43** | **51,25** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,06 | 41,98 | 2,53 | | | | | D | 10,30 | 20,60 |
| **Renovation scenario** | **35,12** | **1,06** | **264,71** | **13,98** | | | | **1,16** | | **35,43** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 1,00 | 218,71 | 11,20 | | | | | D | 25,13 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,06 | 46,00 | 2,78 | | | | | D | 10,30 | 22,57 |
| **Existing (no renovation)** | **26,44** | **0,00** | **0,00** | **0,00** | | | | **2,97** | | **n.a.** | **n.a.** |
| Uninsulated wooden door | 24,58 | 0,00 | 0,00 | 0,00 | | | 0,167 | | E | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 0,00 | 0,00 | 0,00 | | | | | E | | |

# 1971-1990, solid construction

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ TABULA [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Floor on grade, 1971-1990, solid construction** | **465,11** | **96,70** | **21,34** | **7,15** | **0,235** | | | **0,85** | 0,85 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR, spray foam, 25 mm | 0,88 | 3,79 | 8,77 | 2,27 | 0,025 | 0,028 | 0,893 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, 1971-1990, solid construction** | **523,64** | **101,94** | **14,08** | **5,29** | **0,243** | | | **n.a.** | n.a. |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | |
| **External wall, 1971-1990, solid construction** | **246,01** | **61,20** | **7,12** | **2,34** | **0,280** | | | **0,95** | 1,00 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,080 | | | | |
| Cavity insulation, stone wool, 20 mm | 0,80 | 1,01 | 0,06 | 0,03 | 0,020 | 0,036 | 0,556 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| **External wall, detached dwelling, 1971-1990, solid con** | **246,01** | **61,20** | **7,12** | **2,34** | **0,280** | | | **0,95** | 1,00 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,080 | | | | |
| Cavity insulation, stone wool, 20 mm | 0,80 | 1,01 | 0,06 | 0,03 | 0,020 | 0,036 | 0,556 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| **Load-b. internal/party wall, 1971-1990, solid construct** | **158,22** | **41,87** | **4,73** | **1,44** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 137,32 | 33,77 | 3,95 | 1,30 | 0,140 | 0,344 | 0,407 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 1971-1990, solid construction** | **112,40** | **30,61** | **3,41** | **1,01** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 1971-1990, solid construction** | **686,10** | **102,38** | **17,03** | **7,79** | **0,324** | | | **0,90** | 0,85 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 4,02 | 5,60 | 0,37 | 0,43 | 0,030 | 0,036 | 0,833 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Calcareous plaster | 59,40 | 9,03 | 1,51 | 0,41 | 0,033 | | | | |
| **Pitched roof, 1971-1990, solid construction** | **85,26** | **47,39** | **4,00** | **4,91** | **0,418** | | | **0,94** | 0,85 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (20 mm thick, placed between rafters) | 0,70 | 0,88 | 0,06 | 0,02 | | 0,036 | 0,654 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Renovation scenario** | **468,09** | **2,94** | **51,69** | **41,93** | **0,320** | | | **0,24** | | **97,59** | **100,56** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR, spray foam, 11 cm | 3,85 | 2,27 | 16,69 | 38,59 | 0,110 | 0,028 | 3,929 | | D | 0,88 | 3,85 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **523,64** | **0,00** | **0,00** | **0,00** | **0,243** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |
| **Renovation scenario** | **279,74** | **0,00** | **20,29** | **1,36** | **0,430** | | | **0,23** | | **0,00** | **33,72** |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,080 | | | | E | | |
| Cavity insulation, stone wool, 20 mm | 0,80 | 0,00 | 0,00 | 0,00 | 0,020 | 0,036 | 0,556 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Aerated autoclaved blocks, glued, 140 mm | 23,27 | 0,00 | 16,25 | 1,21 | 0,140 | 0,043 | 3,256 | | N | | 23,27 |
| Gypsum plaster | 10,00 | 0,00 | 2,59 | 0,07 | 0,010 | 0,400 | 0,025 | | N | | 10,00 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **Renovation scenario** | **259,88** | **0,00** | **19,19** | **1,77** | **0,440** | | | **0,23** | | **0,00** | **13,87** |
| Plaster on insulation | 8,16 | 0,00 | 1,96 | 0,38 | 0,070 | | 0,020 | | N | | 8,16 |
| PUR board w/ aluminium cover foil + glue, to plaster | 5,71 | 0,00 | 17,24 | 1,38 | 0,090 | 0,027 | 3,343 | | N | | 5,71 |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,080 | | | | E | | |
| Cavity insulation, stone wool, 20 mm | 0,80 | 0,00 | 0,00 | 0,00 | 0,020 | 0,036 | 0,556 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| **Existing (no renovation)** | **158,22** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 137,32 | 0,00 | 0,00 | 0,00 | 0,140 | 0,344 | 0,407 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **112,40** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **699,30** | **0,46** | **25,84** | **1,64** | **0,434** | | | **0,24** | | **5,87** | **19,07** |
| EPDM, partially glued | 1,85 | 0,03 | 3,65 | 0,21 | 0,001 | 0,250 | 0,005 | | D | 1,85 | 1,85 |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 0,43 | 22,19 | 1,43 | 0,140 | 0,036 | 3,889 | | D | 4,02 | 17,22 |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Calcareous plaster | 59,40 | 0,00 | 0,00 | 0,00 | 0,033 | | | | E | | |
| **Renovation scenario** | **90,65** | **0,28** | **10,66** | **0,88** | **0,418** | | | **0,23** | | **12,69** | **18,08** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,02 | 3,30 | 0,21 | | 0,036 | 2,451 | | D | 0,70 | 2,63 |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,77 | 0,05 | | 0,036 | 1,446 | | N | | 0,70 |
| Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,85 | 0,09 | | | | | N | | 2,57 |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,57 | 0,05 | 0,000 | | | | N | | 0,20 |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,05 | 0,47 | 0,04 | 0,022 | | | | D | 0,91 | 0,91 |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,21 | 3,25 | 0,36 | 0,013 | 0,250 | 0,050 | | D | 10,63 | 10,63 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | D | 0,45 | 0,45 |

## (continuation of: 1971-1990, solid construction)

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ TABULA [$W/m^2K$] | Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Window (single-family), 1971-1990, solid construction** | **38,86** | **82,86** | **5,01** | **1,08** | | | | **2,66** | 3,50 | **Renovation scenario** | **45,73** | **1,08** | **100,20** | **6,02** | | | | **1,13** | | **38,86** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Double glazing, w/o argon (U = 2.9W/m2K) | 13,73 | 24,64 | 1,52 | 0,08 | | | | | | Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,73 | 20,60 |
| **Window (single-family), 1971-1990, solid construction** | **38,86** | **82,86** | **5,01** | **1,08** | | | | **2,66** | 3,50 | **Renovation scenario** | **51,25** | **1,08** | **100,20** | **6,02** | | | | **1,16** | | **38,86** | **51,25** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | PVC frame (U = 1.6 W/m2K) | 30,65 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 30,65 |
| Double glazing, w/o argon (U = 2.9W/m2K) | 13,73 | 24,64 | 1,52 | 0,08 | | | | | | Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,73 | 20,60 |
| **Window (single-family), 1971-1990, solid construction** | **38,86** | **82,86** | **5,01** | **1,08** | | | | **2,66** | 3,50 | **Renovation scenario** | **35,12** | **1,08** | **264,71** | **13,98** | | | | **1,16** | | **38,86** | **35,12** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | | Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 1,00 | 218,71 | 11,20 | | | | | D | 25,13 | 12,55 |
| Double glazing, w/o argon (U = 2.9W/m2K) | 13,73 | 24,64 | 1,52 | 0,08 | | | | | | Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,08 | 46,00 | 2,78 | | | | | D | 13,73 | 22,57 |
| **Window (multi-family), 1971-1990, solid construction** | **27,60** | **245,71** | **12,87** | **0,16** | | | | **2,69** | 3,50 | **Renovation scenario** | **35,12** | **0,16** | **264,71** | **13,98** | | | | **1,16** | | **27,60** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | | Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 12,55 |
| Double glazing, w/o argon (U = 2.9W/m2K) | 15,05 | 26,99 | 1,67 | 0,09 | | | | | | Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 22,57 |
| **Outside door, 1971-1990, solid construction** | **26,44** | **33,70** | **2,31** | **1,42** | | | | **2,97** | 4,00 | **Existing (no renovation)** | **26,44** | **0,00** | **0,00** | **0,00** | | | | **2,97** | | **n.a.** | **n.a.** |
| Uninsulated wooden door | 24,58 | 32,60 | 2,18 | 0,82 | | | 0,167 | | | Uninsulated wooden door | 24,58 | 0,00 | 0,00 | 0,00 | | | 0,167 | | E | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 1,10 | 0,12 | 0,60 | | | | | | Wooden door frame, varnished (incl. nails) | 1,87 | 0,00 | 0,00 | 0,00 | | | | | E | | |

## 1991-2005, solid construction

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ TABULA [$W/m^2K$] | Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Floor on grade, 1991-2005, solid construction** | **465,29** | **97,46** | **23,10** | **7,60** | **0,240** | | | **0,74** | 0,70 | **Renovation scenario** | **468,09** | **3,40** | **51,69** | **41,93** | **0,320** | | | **0,24** | | **97,76** | **100,56** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR, spray foam, 30 mm | 1,05 | 4,55 | 10,52 | 2,72 | 0,030 | 0,028 | 1,071 | | | PUR, spray foam, 11 cm | 3,85 | 2,72 | 16,69 | 38,59 | 0,110 | 0,028 | 3,929 | | D | 1,05 | 3,85 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Storey floor, 1991-2005, solid construction** | **476,69** | **97,47** | **13,03** | **5,01** | **0,222** | | | **n.a.** | n.a. | **Existing (no renovation)** | **476,69** | **0,00** | **0,00** | **0,00** | **0,222** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | | Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | | Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | | Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | | Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | | Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | | Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | | Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **External wall, 1991-2005, solid construction** | **246,81** | **62,21** | **7,18** | **2,37** | **0,280** | | | **0,62** | 0,60 | **Renovation scenario** | **278,23** | **0,00** | **19,30** | **1,27** | **0,410** | | | **0,23** | | **0,00** | **31,41** |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | | Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,060 | | | | | Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,060 | | | | E | | |
| Cavity insulation, stone wool, 40 mm | 1,60 | 2,01 | 0,13 | 0,05 | 0,040 | 0,036 | 1,111 | | | Cavity insulation, stone wool, 40 mm | 1,60 | 0,00 | 0,00 | 0,00 | 0,040 | 0,036 | 1,111 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | | Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| | | | | | | | | | | Aerated autoclaved blocks, glued, 120 mm | 20,96 | 0,00 | 15,25 | 1,12 | 0,120 | 0,043 | 2,791 | | N | | 20,96 |
| | | | | | | | | | | Gypsum plaster | 10,00 | 0,00 | 2,59 | 0,07 | 0,010 | 0,400 | 0,025 | | N | | 10,00 |
| | | | | | | | | | | Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **External wall, detached dwelling, 1991-2005, solid con** | **246,81** | **62,21** | **7,18** | **2,37** | **0,280** | | | **0,62** | 0,60 | **Renovation scenario** | **260,68** | **0,00** | **19,19** | **1,77** | **0,430** | | | **0,22** | | **0,00** | **13,87** |
| | | | | | | | | | | Plaster on insulation | 8,16 | 0,00 | 1,96 | 0,38 | 0,070 | | 0,020 | | N | | 8,16 |
| | | | | | | | | | | PUR board w/ aluminium cover foil + glue, to plaster | 5,71 | 0,00 | 17,24 | 1,38 | 0,080 | 0,027 | 2,927 | | N | | 5,71 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | | Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,060 | | | | | Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,060 | | | | E | | |
| Cavity insulation, stone wool, 40 mm | 1,60 | 2,01 | 0,13 | 0,05 | 0,040 | 0,036 | 1,111 | | | Cavity insulation, stone wool, 40 mm | 1,60 | 0,00 | 0,00 | 0,00 | 0,040 | 0,036 | 1,111 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | | Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |

## (continuation of: 1991-2005, solid construction)

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ TABULA [$W/m^2K$] |
| **Load-b. internal/party wall, 1991-2005, solid construct** | **158,22** | **41,87** | **4,73** | **1,44** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 137,32 | 33,77 | 3,95 | 1,30 | 0,140 | 0,344 | 0,407 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 1991-2005, solid construction** | **112,40** | **30,61** | **3,41** | **1,01** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 1991-2005, solid construction** | **643,95** | **103,95** | **16,36** | **7,66** | **0,343** | | | **0,44** | 0,45 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 8,82 | 11,64 | 0,75 | 0,58 | 0,070 | 0,036 | 1,944 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, 1991-2005, solid construction** | **85,96** | **48,27** | **4,05** | **4,93** | **0,418** | | | **0,58** | 0,60 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (40 mm thick, placed between rafters) | 1,40 | 1,76 | 0,11 | 0,05 | | 0,036 | 1,307 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Window, 1991-2005, solid construction** | **27,60** | **245,71** | **12,87** | **0,16** | | | | **2,69** | 2,00 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, w/o argon (U = 2.9 W/m2K) | 15,05 | 26,99 | 1,67 | 0,09 | | | | | |
| **Window, 1991-2005, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 1991-2005, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 1991-2005, solid construction** | **44,16** | **111,06** | **7,96** | **29,80** | | | | **2,69** | 2,00 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, w/o argon (U = 2.9 W/m2K) | 13,51 | 24,24 | 1,50 | 0,08 | | | | | |
| **Window, 1991-2005, solid construction** | **44,16** | **111,06** | **7,96** | **29,80** | | | | **2,69** | 2,00 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, w/o argon (U = 2.9 W/m2K) | 13,51 | 24,24 | 1,50 | 0,08 | | | | | |
| **Window, 1991-2005, solid construction** | **44,16** | **111,06** | **7,96** | **29,80** | | | | **2,69** | 2,00 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, w/o argon (U = 2.9 W/m2K) | 13,51 | 24,24 | 1,50 | 0,08 | | | | | |
| **Outside door, 1991-2005, solid construction** | **26,44** | **33,70** | **2,31** | **1,42** | | | | **2,97** | 3,50 |
| Uninsulated wooden door | 24,58 | 32,60 | 2,18 | 0,82 | | | 0,167 | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 1,10 | 0,12 | 0,60 | | | | | |

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Existing (no renovation)** | **158,22** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 137,32 | 0,00 | 0,00 | 0,00 | 0,140 | 0,344 | 0,407 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **112,40** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **652,35** | **0,62** | **25,84** | **1,64** | **0,413** | | | **0,24** | | **10,67** | **19,07** |
| EPDM, partially glued | 1,85 | 0,03 | 3,65 | 0,21 | 0,001 | 0,250 | 0,005 | | D | 1,85 | 1,85 |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 0,58 | 22,19 | 1,43 | 0,140 | 0,036 | 3,889 | | D | 8,82 | 17,22 |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **90,65** | **0,31** | **10,66** | **0,88** | **0,418** | | | **0,23** | | **13,39** | **18,08** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,05 | 3,30 | 0,21 | | 0,036 | 2,451 | | D | 1,40 | 2,63 |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,77 | 0,05 | | 0,036 | 1,446 | | N | | 0,70 |
| Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,85 | 0,09 | | | | | N | | 2,57 |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,57 | 0,05 | 0,000 | | | | N | | 0,20 |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,05 | 0,47 | 0,04 | 0,022 | | | | D | 0,91 | 0,91 |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,21 | 3,25 | 0,36 | 0,013 | 0,250 | 0,050 | | D | 10,63 | 10,63 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | D | 0,45 | 0,45 |
| **Renovation scenario** | **35,12** | **0,16** | **264,71** | **13,98** | | | | **1,16** | | **27,60** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 22,57 |
| **Renovation scenario** | **45,73** | **0,16** | **100,20** | **6,02** | | | | **1,13** | | **27,60** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 0,07 | 58,22 | 3,49 | | | | | D | 12,55 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,09 | 41,98 | 2,53 | | | | | D | 15,05 | 20,60 |
| **Renovation scenario** | **50,92** | **0,16** | **128,12** | **8,96** | | | | **1,16** | | **27,60** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 0,07 | 86,82 | 6,47 | | | | | D | 12,55 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,09 | 41,31 | 2,49 | | | | | D | 15,05 | 20,27 |
| **Renovation scenario** | **45,73** | **29,80** | **100,20** | **6,02** | | | | **1,13** | | **44,16** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 29,72 | 58,22 | 3,49 | | | | | D | 30,65 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,51 | 20,60 |
| **Renovation scenario** | **50,92** | **29,80** | **128,12** | **8,96** | | | | **1,16** | | **44,16** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 29,72 | 86,82 | 6,47 | | | | | D | 30,65 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,08 | 41,31 | 2,49 | | | | | D | 13,51 | 20,27 |
| **Renovation scenario** | **35,12** | **29,80** | **264,71** | **13,98** | | | | **1,16** | | **44,16** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 29,72 | 218,71 | 11,20 | | | | | D | 30,65 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,08 | 46,00 | 2,78 | | | | | D | 13,51 | 22,57 |
| **Existing (no renovation)** | **26,44** | **0,00** | **0,00** | **0,00** | | | | **2,97** | | **n.a.** | **n.a.** |
| Uninsulated wooden door | 24,58 | 0,00 | 0,00 | 0,00 | | | 0,167 | | E | | |
| Wooden door frame, varnished (incl. nails) | 1,87 | 0,00 | 0,00 | 0,00 | | | | | E | | |

# 2006-2011, solid construction

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | $U_{element}$ EPB-cijfer-rapport [W/m²K] |
|---|---|---|---|---|---|---|---|---|---|
| **Floor on grade, 2006-2011, solid construction** | **467,56** | **107,32** | **45,90** | **13,50** | **0,305** | | | **0,27** | 0,27 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR, spray foam, 95 mm | 3,33 | 14,41 | 33,32 | 8,62 | 0,095 | 0,028 | 3,393 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, 2006-2011, solid construction** | **476,69** | **97,47** | **13,03** | **5,01** | **0,222** | | | **n.a.** | n.a. |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, 2006-2011, solid construction** | **249,21** | **65,23** | **7,38** | **2,44** | **0,280** | | | **0,31** | 0,31 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,000 | | | | |
| Cavity insulation, stone wool, 100 mm | 4,00 | 5,03 | 0,32 | 0,13 | 0,100 | 0,036 | 2,778 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **External wall, detached dwelling, 2006-2011, solid con** | **249,21** | **65,23** | **7,38** | **2,44** | **0,280** | | | **0,31** | 0,31 |
| | | | | | | | | | |
| | | | | | | | | | |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,000 | | | | |
| Cavity insulation, stone wool, 100 mm | 4,00 | 5,03 | 0,32 | 0,13 | 0,100 | 0,036 | 2,778 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| **Load-b. internal/party wall, 2006-2011, solid construct** | **158,22** | **41,87** | **4,73** | **1,44** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 137,32 | 33,77 | 3,95 | 1,30 | 0,140 | 0,344 | 0,407 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 2006-2011, solid construction** | **112,40** | **30,61** | **3,41** | **1,01** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 2006-2011, solid construction** | **652,35** | **114,50** | **17,04** | **7,93** | **0,413** | | | **0,24** | 0,24 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 22,19 | 1,43 | 0,86 | 0,140 | 0,036 | 3,889 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, 2006-2011, solid construction** | **90,65** | **52,01** | **4,35** | **5,56** | **0,418** | | | **0,23** | 0,24 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,77 | 0,05 | 0,02 | | 0,036 | 1,446 | | |
| Extra battens, softwood (incl. nails) | 2,57 | 0,85 | 0,09 | 0,14 | | | | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Renovation scenario** | **468,09** | **9,30** | **51,69** | **41,93** | **0,320** | | | **0,24** | | **100,04** | **100,56** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR, spray foam, 110 mm | 3,85 | 8,62 | 16,69 | 38,59 | 0,110 | 0,028 | 3,929 | | D | 3,33 | 3,85 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **476,69** | **0,00** | **0,00** | **0,00** | **0,222** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **272,59** | **0,00** | **15,83** | **0,96** | **0,340** | | | **0,22** | | **0,00** | **23,38** |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Cavity insulation, stone wool, 100 mm | 4,00 | 0,00 | 0,00 | 0,00 | 0,100 | 0,036 | 2,778 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Aerated autoclaved blocks, glued, 50 mm | 12,93 | 0,00 | 11,78 | 0,81 | 0,050 | 0,043 | 1,163 | | N | | 12,93 |
| Gypsum plaster | 10,00 | 0,00 | 2,59 | 0,07 | 0,010 | 0,400 | 0,025 | | N | | 10,00 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | N | | 0,45 |
| **Renovation scenario** | **260,68** | **0,00** | **8,81** | **0,90** | **0,390** | | | **0,22** | | **0,00** | **11,47** |
| Plaster on insulation | 8,16 | 0,00 | 1,96 | 0,38 | 0,070 | | 0,020 | | N | | 8,16 |
| PUR board w/ aluminium cover foil + glue, to plaster | 3,31 | 0,00 | 6,85 | 0,51 | 0,040 | 0,032 | 1,260 | | N | | 3,31 |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Cavity insulation, stone wool, 100 mm | 4,00 | 0,00 | 0,00 | 0,00 | 0,100 | 0,036 | 2,778 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| **Existing (no renovation)** | **158,22** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 137,32 | 0,00 | 0,00 | 0,00 | 0,140 | 0,344 | 0,407 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **112,40** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **652,35** | **0,00** | **0,00** | **0,00** | **0,413** | | | **0,24** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 0,00 | 0,00 | 0,00 | 0,140 | 0,036 | 3,889 | | E | | |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,65** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,23** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,446 | | E | | |
| Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |

# (continuation of: 2006-2011, solid construction)

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Window, 2006-2011, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,58** | 1,71 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2006-2011, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2006-2011, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2006-2011, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, 2006-2011, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, 2006-2011, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Outside door, 2006-2011, solid construction** | **38,80** | **124,11** | **7,37** | **7,16** | | | | **1,26** | 2,90 |
| Insulated door with steel frame and wood-aluminium panel | 38,80 | 124,11 | 7,37 | 7,16 | | | 0,625 | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Renovation scenario** | **35,12** | **0,16** | **264,71** | **13,98** | | | | **1,16** | | **27,60** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 22,57 |
| **Renovation scenario** | **45,73** | **0,16** | **100,20** | **6,02** | | | | **1,13** | | **27,60** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 0,07 | 58,22 | 3,49 | | | | | D | 12,55 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,09 | 41,98 | 2,53 | | | | | D | 15,05 | 20,60 |
| **Renovation scenario** | **50,92** | **0,16** | **128,12** | **8,96** | | | | **1,16** | | **27,60** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 0,07 | 86,82 | 6,47 | | | | | D | 12,55 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,09 | 41,31 | 2,49 | | | | | D | 15,05 | 20,27 |
| **Renovation scenario** | **45,73** | **29,80** | **100,20** | **6,02** | | | | **1,13** | | **44,16** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 29,72 | 58,22 | 3,49 | | | | | D | 30,65 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,51 | 20,60 |
| **Renovation scenario** | **50,92** | **29,80** | **128,12** | **8,96** | | | | **1,16** | | **44,16** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 29,72 | 86,82 | 6,47 | | | | | D | 30,65 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,08 | 41,31 | 2,49 | | | | | D | 13,51 | 20,27 |
| **Renovation scenario** | **35,12** | **29,80** | **264,71** | **13,98** | | | | **1,16** | | **44,16** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 29,72 | 218,71 | 11,20 | | | | | D | 30,65 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,08 | 46,00 | 2,78 | | | | | D | 13,51 | 22,57 |
| **Existing (no renovation)** | **38,80** | **0,00** | **0,00** | **0,00** | | | | **1,26** | | **n.a.** | **n.a.** |
| Insulated door with steel frame and wood-aluminium panel | 38,80 | 0,00 | 0,00 | 0,00 | | | 0,625 | | E | | |

# 2006-2011, timber frame construction

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Floor on grade, 2006-2011, timber frame construction** | **466,92** | **105,31** | **12,68** | **4,89** | **0,290** | | | **0,28** | 0,27 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR board with aluminium cover foil | 2,68 | 12,41 | 0,11 | 0,01 | 0,080 | 0,024 | 3,333 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, 2006-2011, timber frame construction** | **82,38** | **42,92** | **3,86** | **7,03** | **0,355** | | | **n.a.** | n.a. |
| Parquet, hardwood, glued | 14,04 | 13,30 | 1,04 | 3,23 | 0,022 | 0,180 | 0,122 | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 6,37 | 0,70 | 0,35 | 0,025 | | | | |
| Stone wool, 30 mm | 4,20 | 5,28 | 0,34 | 0,14 | 0,030 | 0,036 | 0,833 | | |
| OSB | 10,80 | 4,68 | 0,51 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Softwood joists and beams, treated | 20,35 | 8,12 | 0,79 | 1,07 | 0,225 | 1,097 | 0,205 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, 2006-2011, timber frame construction** | **63,51** | **28,13** | **2,70** | **4,85** | **0,371** | | | **0,31** | 0,31 |
| Timber claddings, untreated larch | 8,83 | 2,78 | 0,30 | 0,47 | 0,022 | | | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,41 | 0,04 | 0,06 | 0,038 | | | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | |
| Bituminous soft wood fibre board | 4,58 | 3,31 | 0,28 | 0,84 | 0,018 | 0,050 | 0,360 | | |
| PE water barrier, stapled | 0,20 | 0,55 | 0,05 | 0,44 | 0,000 | | | | |
| Insulating clay brick strip (ground floor) | 4,76 | 1,17 | 0,14 | 0,04 | 0,220 | 0,344 | | | |
| Timber frame, hard- and softwood | 18,29 | 5,92 | 0,62 | 0,23 | | 0,137 | | | |
| Stone wool, 100 mm | 2,80 | 3,52 | 0,23 | 0,09 | | 0,036 | 2,376 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| PE vapour barrier, taped | 0,20 | 0,53 | 0,05 | 0,43 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Renovation scenario** | **467,52** | **0,69** | **50,01** | **3,45** | **0,310** | | | **0,22** | | **99,39** | **99,99** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,24 | 24,53 | 1,63 | 0,010 | 0,810 | 0,012 | | D | 25,21 | 25,21 |
| Screed - part cement | 11,50 | 0,12 | 10,26 | 0,71 | 0,050 | 1,350 | 0,037 | | D | 11,50 | 11,50 |
| Screed - part sand | 60,00 | 0,32 | 0,21 | 1,01 | | | | | D | 60,00 | 60,00 |
| PUR board with aluminium cover foil | 3,28 | 0,01 | 15,00 | 0,11 | 0,100 | 0,024 | 4,167 | | D | 2,68 | 3,28 |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **82,38** | **0,00** | **0,00** | **0,00** | **0,355** | | | **n.a.** | | **n.a.** | **n.a.** |
| Parquet, hardwood, glued | 14,04 | 0,00 | 0,00 | 0,00 | 0,022 | 0,180 | 0,122 | | E | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 0,00 | 0,00 | 0,00 | 0,025 | | | | E | | |
| Stone wool, 30 mm | 4,20 | 0,00 | 0,00 | 0,00 | 0,030 | 0,036 | 0,833 | | E | | |
| OSB | 10,80 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Softwood joists and beams, treated | 20,35 | 0,00 | 0,00 | 0,00 | 0,225 | 1,097 | 0,205 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **65,47** | **0,89** | **11,86** | **0,94** | **0,371** | | | **0,24** | | **15,50** | **17,46** |
| Timber claddings, untreated larch | 8,83 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,00 | 0,00 | 0,00 | 0,038 | | | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | E | | |
| Bituminous soft wood fibre board | 4,58 | 0,00 | 0,00 | 0,00 | 0,018 | 0,050 | 0,360 | | E | | |
| PE water barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Insulating clay brick strip (ground floor) | 4,76 | 0,00 | 0,00 | 0,00 | 0,220 | 0,344 | | | E | | |
| Timber frame, hard- and softwood | 18,29 | 0,00 | 0,00 | 0,00 | | 0,137 | | | E | | |
| Stone wool, 170 mm | 4,76 | 0,09 | 5,98 | 0,38 | | 0,036 | 3,330 | | D | 2,80 | 4,76 |
| OSB, screwed | 10,82 | 0,10 | 0,24 | 0,03 | 0,018 | 0,130 | 0,138 | | R | 0,54 | 0,54 |
| PE vapour barrier, taped | 0,20 | 0,43 | 0,53 | 0,05 | 0,000 | | | | D | 0,20 | 0,20 |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,05 | 0,47 | 0,04 | 0,022 | 0,129 | 0,170 | | D | 0,91 | 0,91 |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,21 | 3,19 | 0,35 | 0,013 | 0,250 | 0,050 | | D | 10,60 | 10,60 |
| Acrylic paint | 0,45 | 0,00 | 1,45 | 0,08 | 0,000 | | | | D | 0,45 | 0,45 |

# (continuation of: 2006-2011, timber frame construction)

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | $U_{element}$ EPB-cijfer-rapport [W/m²K] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Load-b. internal wall, 2006-2011, timber frame constru** | **47,96** | **30,00** | **2,45** | **2,71** | **0,258** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,79 | 0,08 | 0,02 | 0,045 | 0,130 | | | |
| Stone wool, 45 mm | 1,40 | 1,76 | 0,11 | 0,05 | | 0,036 | 0,971 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 2,47 | 0,23 | 0,08 | 0,140 | 0,130 | | | |
| Stone wool, 140 mm | 4,36 | 5,48 | 0,35 | 0,14 | | 0,036 | 3,021 | | |
| Steel spring rail | 1,02 | 5,38 | 0,29 | 0,01 | 0,030 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 2006-2011, timber frame constr** | **29,21** | **14,86** | **1,28** | **0,69** | **0,169** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,63 | 0,07 | 0,07 | 0,100 | 0,130 | | | |
| Stone wool, 100 mm | 3,20 | 4,02 | 0,26 | 0,10 | | 0,036 | 1,825 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 2006-2011, timber frame construction** | **652,35** | **114,50** | **17,04** | **7,93** | **0,413** | | | **0,24** | 0,24 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 22,19 | 1,43 | 0,86 | 0,140 | 0,036 | 3,889 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, 2006-2011, timber frame construction** | **90,65** | **52,01** | **4,35** | **5,56** | **0,418** | | | **0,23** | 0,24 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,77 | 0,05 | 0,02 | | 0,036 | 1,446 | | |
| Extra battens, softwood (incl. nails) | 2,57 | 0,85 | 0,09 | 0,14 | | | | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Window, 2006-2011, timber frame construction** | **38,86** | **82,90** | **5,01** | **1,08** | | | | **1,55** | 1,71 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,73 | 24,68 | 1,52 | 0,08 | | | | | |
| **Outside door, 2006-2011, timber frame construction** | **38,80** | **124,11** | **7,37** | **7,16** | | | | **1,26** | 2,90 |
| Insulated door with steel frame and wood-aluminium panel | 38,80 | 124,11 | 7,37 | 7,16 | | | 0,625 | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Existing (no renovation)** | **47,96** | **0,00** | **0,00** | **0,00** | **0,258** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,00 | 0,00 | 0,00 | 0,045 | 0,130 | | | E | | |
| Stone wool, 45 mm | 1,40 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| OSB, screwed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 0,00 | 0,00 | 0,00 | 0,140 | 0,130 | | | E | | |
| Stone wool, 140 mm | 4,36 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Steel spring rail | 1,02 | 0,00 | 0,00 | 0,00 | 0,030 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **29,21** | **0,00** | **0,00** | **0,00** | **0,169** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,00 | 0,00 | 0,00 | 0,100 | 0,130 | | | E | | |
| Stone wool, 100 mm | 3,20 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **652,35** | **0,00** | **0,00** | **0,00** | **0,413** | | | **0,24** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| Stone wool (partially glued, incl. glass fibre felt) | 17,22 | 0,00 | 0,00 | 0,00 | 0,140 | 0,036 | 3,889 | | E | | |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,65** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,23** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (20 mm thick, placed between purlins) | 0,70 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,446 | | E | | |
| Extra battens, softwood (incl. nails) | 2,57 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **45,73** | **1,08** | **100,20** | **6,02** | | | | **1,13** | | **38,86** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,73 | 20,60 |
| **Existing (no renovation)** | **38,80** | **0,00** | **0,00** | **0,00** | | | | **1,26** | | **n.a.** | **n.a.** |
| Insulated door with steel frame and wood-aluminium panel | 38,80 | 0,00 | 0,00 | 0,00 | | | 0,625 | | E | | |

# 2012-2017, solid construction

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | $U_{element}$ EPB-cijfer-rapport [W/m²K] |
|---|---|---|---|---|---|---|---|---|---|
| **Floor on grade, 2012-2017, solid construction** | **468,79** | **112,63** | **58,18** | **16,68** | **0,340** | | | **0,20** | 0,21 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR, spray foam, 13 cm | 4,55 | 19,72 | 45,60 | 11,80 | 0,130 | 0,028 | 4,643 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, 2012-2017, solid construction** | **476,69** | **97,47** | **13,03** | **5,01** | **0,222** | | | **n.a.** | n.a. |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, 2012-2017, solid construction** | **251,61** | **68,24** | **7,57** | **2,52** | **0,370** | | | **0,20** | 0,20 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,030 | | | | |
| Cavity insulation, stone wool,160 mm | 6,40 | 8,04 | 0,52 | 0,21 | 0,160 | 0,036 | 4,444 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| **Load-b. internal/party wall, 2012-2017, solid construct** | **158,22** | **41,87** | **4,73** | **1,44** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 137,32 | 33,77 | 3,95 | 1,30 | 0,140 | 0,344 | 0,407 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 2012-2017, solid construction** | **112,40** | **30,61** | **3,41** | **1,01** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 2012-2017, solid construction** | **630,71** | **82,97** | **12,38** | **5,77** | **0,393** | | | **0,19** | 0,19 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| PIR board with aluminium cover foil, 120 mm | 3,88 | 17,60 | 0,11 | 0,01 | 0,120 | 0,024 | 5,000 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete precast hollow-core slab - part concrete | 357,00 | 26,24 | 5,62 | 2,85 | 0,150 | | 0,130 | | |
| Reinforced concrete precast hollow-core slab - part reinforcement | 2,21 | 4,72 | 0,27 | 0,03 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, 2012-2017, solid construction** | **90,54** | **53,86** | **4,43** | **5,49** | **0,418** | | | **0,21** | 0,19 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 3,48 | 0,22 | 0,09 | | 0,036 | 1,898 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing (no renovation)** | **468,79** | **0,00** | **0,00** | **0,00** | **0,340** | | | **0,20** | | **0,00** | **0,00** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PUR, spray foam, 13 cm | 4,55 | 0,00 | 0,00 | 0,00 | 0,130 | 0,028 | 4,643 | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **476,69** | **0,00** | **0,00** | **0,00** | **0,222** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **251,61** | **0,00** | **0,00** | **0,00** | **0,370** | | | **0,20** | | **0,00** | **0,00** |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,030 | | | | E | | |
| Cavity insulation, stone wool,160 mm | 6,40 | 0,00 | 0,00 | 0,00 | 0,160 | 0,036 | 4,444 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| **Existing (no renovation)** | **158,22** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 137,32 | 0,00 | 0,00 | 0,00 | 0,140 | 0,344 | 0,407 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **112,40** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **630,71** | **0,00** | **0,00** | **0,00** | **0,393** | | | **0,19** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| PIR board with aluminium cover foil, 120 mm | 3,88 | 0,00 | 0,00 | 0,00 | 0,120 | 0,024 | 5,000 | | E | | |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete precast hollow-core slab - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | | 0,130 | | E | | |
| Reinforced concrete precast hollow-core slab - part reinforcement | 2,21 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,54** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,21** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,898 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |

# (continuation of: 2012-2017, solid construction)

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Window, 2012-2017, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,48 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2012-2017, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2012-2017, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, 2012-2017, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, 2012-2017, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, 2012-2017, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Outside door, 2012-2017, solid construction** | **36,50** | **120,34** | **7,11** | **6,74** | | | | **1,13** | 1,60 |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 120,34 | 7,11 | 6,74 | | | 0,714 | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Renovation scenario** | **35,12** | **0,16** | **264,71** | **13,98** | | | | **1,16** | | **27,60** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 22,57 |
| **Renovation scenario** | **45,73** | **0,16** | **100,20** | **6,02** | | | | **1,13** | | **27,60** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 0,07 | 58,22 | 3,49 | | | | | D | 12,55 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,09 | 41,98 | 2,53 | | | | | D | 15,05 | 20,60 |
| **Renovation scenario** | **50,92** | **0,16** | **128,12** | **8,96** | | | | **1,16** | | **27,60** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 0,07 | 86,82 | 6,47 | | | | | D | 12,55 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,09 | 41,31 | 2,49 | | | | | D | 15,05 | 20,27 |
| **Renovation scenario** | **45,73** | **29,80** | **100,20** | **6,02** | | | | **1,13** | | **44,16** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 29,72 | 58,22 | 3,49 | | | | | D | 30,65 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,51 | 20,60 |
| **Renovation scenario** | **50,92** | **29,80** | **128,12** | **8,96** | | | | **1,16** | | **44,16** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 29,72 | 86,82 | 6,47 | | | | | D | 30,65 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,08 | 41,31 | 2,49 | | | | | D | 13,51 | 20,27 |
| **Renovation scenario** | **35,12** | **29,80** | **264,71** | **13,98** | | | | **1,16** | | **44,16** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 29,72 | 218,71 | 11,20 | | | | | D | 30,65 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,08 | 46,00 | 2,78 | | | | | D | 13,51 | 22,57 |
| **Existing (no renovation)** | **36,50** | **0,00** | **0,00** | **0,00** | | | | **1,13** | | **n.a.** | **n.a.** |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 0,00 | 0,00 | 0,00 | | | 0,714 | | E | | |

# 2012-2017, timber frame construction

| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
| **Floor on grade, 2012-2017, timber frame construction** | **467,82** | **109,21** | **12,68** | **4,89** | **0,320** | | | **0,21** | 0,21 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR board with aluminium cover foil | 3,58 | 16,30 | 0,11 | 0,01 | 0,110 | 0,024 | 4,583 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, 2012-2017, timber frame construction** | **82,38** | **42,92** | **3,86** | **7,03** | **0,355** | | | **n.a.** | n.a. |
| Parquet, hardwood, glued | 14,04 | 13,30 | 1,04 | 3,23 | 0,022 | 0,180 | 0,122 | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 6,37 | 0,70 | 0,35 | 0,025 | | | | |
| Stone wool, 30 mm | 4,20 | 5,28 | 0,34 | 0,14 | 0,030 | 0,036 | 0,833 | | |
| OSB | 10,80 | 4,68 | 0,51 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Softwood joists and beams, treated | 20,35 | 8,12 | 0,79 | 1,07 | 0,225 | 1,097 | 0,205 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, 2012-2017, timber frame construction** | **66,87** | **32,35** | **2,97** | **4,96** | **0,371** | | | **0,21** | 0,20 |
| Timber claddings, untreated larch | 8,83 | 2,78 | 0,30 | 0,47 | 0,022 | | | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,41 | 0,04 | 0,06 | 0,038 | | | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | |
| Bituminous soft wood fibre board | 4,58 | 3,31 | 0,28 | 0,84 | 0,018 | 0,050 | 0,360 | | |
| PE water barrier, stapled | 0,20 | 0,55 | 0,05 | 0,44 | 0,000 | | | | |
| Insulating clay brick strip (ground floor) | 4,76 | 1,17 | 0,14 | 0,04 | 0,220 | 0,344 | | | |
| Timber frame, hard- and softwood | 18,29 | 5,92 | 0,62 | 0,23 | | 0,137 | | | |
| Stone wool, 22 cm | 6,16 | 7,74 | 0,50 | 0,20 | | 0,036 | 3,831 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| PE vapour barrier, taped | 0,20 | 0,53 | 0,05 | 0,43 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
| **Existing (no renovation)** | **467,82** | **0,00** | **0,00** | **0,00** | **0,320** | | | **0,21** | | **0,00** | **0,00** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PUR board with aluminium cover foil | 3,58 | 0,00 | 0,00 | 0,00 | 0,110 | 0,024 | 4,583 | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **82,38** | **0,00** | **0,00** | **0,00** | **0,355** | | | **n.a.** | | **n.a.** | **n.a.** |
| Parquet, hardwood, glued | 14,04 | 0,00 | 0,00 | 0,00 | 0,022 | 0,180 | 0,122 | | E | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 0,00 | 0,00 | 0,00 | 0,025 | | | | E | | |
| Stone wool, 30 mm | 4,20 | 0,00 | 0,00 | 0,00 | 0,030 | 0,036 | 0,833 | | E | | |
| OSB | 10,80 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Softwood joists and beams, treated | 20,35 | 0,00 | 0,00 | 0,00 | 0,225 | 1,097 | 0,205 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **66,87** | **0,00** | **0,00** | **0,00** | **0,371** | | | **0,21** | | **0,00** | **0,00** |
| Timber claddings, untreated larch | 8,83 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,00 | 0,00 | 0,00 | 0,038 | | | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | E | | |
| Bituminous soft wood fibre board | 4,58 | 0,00 | 0,00 | 0,00 | 0,018 | 0,050 | 0,360 | | E | | |
| PE water barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Insulating clay brick strip (ground floor) | 4,76 | 0,00 | 0,00 | 0,00 | 0,220 | 0,344 | | | E | | |
| Timber frame, hard- and softwood | 18,29 | 0,00 | 0,00 | 0,00 | | 0,137 | | | E | | |
| Stone wool, 22 cm | 6,16 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,831 | | E | | |
| OSB, screwed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| PE vapour barrier, taped | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | 0,129 | 0,170 | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |

# (continuation of: 2012-2017, timber frame construction)

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq] Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| **Load-b. internal wall, 2012-2017, timber frame constru** | **47,96** | **30,00** | **2,45** | **2,71** | **0,258** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,79 | 0,08 | 0,02 | 0,045 | 0,130 | | | |
| Stone wool, 45 mm | 1,40 | 1,76 | 0,11 | 0,05 | | 0,036 | 0,971 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 2,47 | 0,23 | 0,08 | 0,140 | 0,130 | | | |
| Stone wool, 140 mm | 4,36 | 5,48 | 0,35 | 0,14 | | 0,036 | 3,021 | | |
| Steel spring rail | 1,02 | 5,38 | 0,29 | 0,01 | 0,030 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, 2012-2017, timber frame constr** | **29,21** | **14,86** | **1,28** | **0,69** | **0,169** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,63 | 0,07 | 0,07 | 0,100 | 0,130 | | | |
| Stone wool, 100 mm | 3,20 | 4,02 | 0,26 | 0,10 | | 0,036 | 1,825 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, 2012-2017, timber frame construction** | **67,32** | **49,62** | **3,82** | **4,83** | **0,499** | | | **0,19** | 0,19 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 20,82 | 26,72 | 1,72 | 0,97 | 0,170 | 0,036 | 4,722 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Prefabricated wooden elements with slope, treated | 1,29 | 0,61 | 0,05 | 0,07 | 0,050 | | | | |
| OSB, nailed | 10,82 | 4,78 | 0,51 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Softwood joists and beams, treated | 20,35 | 8,12 | 0,79 | 1,07 | 0,225 | 1,097 | 0,205 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, 2012-2017, timber frame construction** | **90,54** | **53,86** | **4,43** | **5,49** | **0,418** | | | **0,21** | 0,19 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 3,48 | 0,22 | 0,09 | | 0,036 | 1,898 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Window, 2012-2017, timber frame construction** | **38,86** | **82,90** | **5,01** | **1,08** | | | | **1,55** | 1,48 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,73 | 24,68 | 1,52 | 0,08 | | | | | |
| **Outside door, 2012-2017, timber frame construction** | **36,50** | **120,34** | **7,11** | **6,74** | | | | **1,13** | 1,60 |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 120,34 | 7,11 | 6,74 | | | 0,714 | | |

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq] EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing (no renovation)** | **47,96** | **0,00** | **0,00** | **0,00** | **0,258** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,00 | 0,00 | 0,00 | 0,045 | 0,130 | | | E | | |
| Stone wool, 45 mm | 1,40 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| OSB, screwed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 0,00 | 0,00 | 0,00 | 0,140 | 0,130 | | | E | | |
| Stone wool, 140 mm | 4,36 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Steel spring rail | 1,02 | 0,00 | 0,00 | 0,00 | 0,030 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **29,21** | **0,00** | **0,00** | **0,00** | **0,169** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,00 | 0,00 | 0,00 | 0,100 | 0,130 | | | E | | |
| Stone wool, 100 mm | 3,20 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **67,32** | **0,00** | **0,00** | **0,00** | **0,499** | | | **0,19** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| Stone wool (partially glued, incl. glass fibre felt) | 20,82 | 0,00 | 0,00 | 0,00 | 0,170 | 0,036 | 4,722 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Prefabricated wooden elements with slope, treated | 1,29 | 0,00 | 0,00 | 0,00 | 0,050 | | | | E | | |
| OSB, nailed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Softwood joists and beams, treated | 20,35 | 0,00 | 0,00 | 0,00 | 0,225 | 1,097 | 0,205 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,54** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,21** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,898 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **45,73** | **1,08** | **100,20** | **6,02** | | | | **1,16** | | **38,86** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,73 | 20,60 |
| **Existing (no renovation)** | **36,50** | **0,00** | **0,00** | **0,00** | | | | **1,13** | | **n.a.** | **n.a.** |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 0,00 | 0,00 | 0,00 | | | 0,714 | | E | | |

# ≥2018, solid construction

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | $U_{element}$ EPB-cijfer-rapport [W/m²K] |
|---|---|---|---|---|---|---|---|---|---|
| **Floor on grade, ≥2018, solid construction** | **469,14** | **114,14** | **61,68** | **17,59** | **0,350** | | | **0,19** | 0,19 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR, spray foam, 140 mm | 4,90 | 21,24 | 49,11 | 12,71 | 0,140 | 0,028 | 5,000 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, ≥2018, solid construction** | **476,69** | **97,47** | **13,03** | **5,01** | **0,222** | | | **n.a.** | n.a. |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, ≥2018, solid construction** | **252,01** | **68,74** | **7,60** | **2,54** | **0,380** | | | **0,19** | 0,19 |
| Clay brick cavity wall, outer leaf | 153,72 | 37,68 | 4,42 | 1,45 | 0,090 | 1,328 | 0,068 | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,030 | | | | |
| Cavity insulation, stone wool,170 mm | 6,80 | 8,55 | 0,55 | 0,22 | 0,170 | 0,036 | 4,722 | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| **Load-b. internal/party wall, ≥2018, solid construction** | **158,22** | **41,87** | **4,73** | **1,44** | **0,160** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 137,32 | 33,77 | 3,95 | 1,30 | 0,140 | 0,344 | 0,407 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, ≥2018, solid construction** | **112,40** | **30,61** | **3,41** | **1,01** | **0,110** | | | **n.a.** | n.a. |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Building clay bricks | 91,50 | 22,51 | 2,63 | 0,86 | 0,090 | 0,344 | 0,262 | | |
| Gypsum plaster | 10,00 | 2,59 | 0,31 | 0,07 | 0,010 | 0,400 | 0,025 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, ≥2018, solid construction** | **631,01** | **84,27** | **12,38** | **5,77** | **0,403** | | | **0,17** | 0,18 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| PIR plaat met aluminium cachering, 13 cm | 4,18 | 18,90 | 0,11 | 0,01 | 0,130 | 0,024 | 5,417 | | |
| In situ poor or light concrete sloping layer | 131,40 | 8,06 | 2,69 | 1,30 | 0,060 | 1,650 | 0,036 | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 11,93 | 2,67 | 1,37 | 0,050 | 1,350 | 0,037 | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 6,20 | 0,36 | 0,03 | | | | | |
| Reinforced concrete precast hollow-core slab - part concrete | 357,00 | 26,24 | 5,62 | 2,85 | 0,150 | | 0,130 | | |
| Reinforced concrete precast hollow-core slab - part reinforcement | 2,21 | 4,72 | 0,27 | 0,03 | | | | | |
| Gypsum plaster | 12,00 | 3,11 | 0,37 | 0,13 | 0,012 | 0,400 | 0,030 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, ≥2018, solid construction** | **90,54** | **53,86** | **4,43** | **5,49** | **0,418** | | | **0,21** | 0,18 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 3,48 | 0,22 | 0,09 | | 0,036 | 1,898 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq]: EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [m²K/W] | $U_{element}$ [W/m²K] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing (no renovation)** | **469,14** | **0,00** | **0,00** | **0,00** | **0,350** | | | **0,19** | | **0,00** | **0,00** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PUR, spray foam, 140 mm | 4,90 | 0,00 | 0,00 | 0,00 | 0,140 | 0,028 | 5,000 | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **476,69** | **0,00** | **0,00** | **0,00** | **0,222** | | | **n.a.** | | **n.a.** | **n.a.** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **252,01** | **0,00** | **0,00** | **0,00** | **0,380** | | | **0,19** | | **0,00** | **0,00** |
| Clay brick cavity wall, outer leaf | 153,72 | 0,00 | 0,00 | 0,00 | 0,090 | 1,328 | 0,068 | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,030 | | | | E | | |
| Cavity insulation, stone wool,170 mm | 6,80 | 0,00 | 0,00 | 0,00 | 0,170 | 0,036 | 4,722 | | E | | |
| Brick cavity wall, inner leaf, building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| **Existing (no renovation)** | **158,22** | **0,00** | **0,00** | **0,00** | **0,160** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 137,32 | 0,00 | 0,00 | 0,00 | 0,140 | 0,344 | 0,407 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **112,40** | **0,00** | **0,00** | **0,00** | **0,110** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Building clay bricks | 91,50 | 0,00 | 0,00 | 0,00 | 0,090 | 0,344 | 0,262 | | E | | |
| Gypsum plaster | 10,00 | 0,00 | 0,00 | 0,00 | 0,010 | 0,400 | 0,025 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **631,01** | **0,00** | **0,00** | **0,00** | **0,403** | | | **0,17** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| PIR plaat met aluminium cachering, 13 cm | 4,18 | 0,00 | 0,00 | 0,00 | 0,130 | 0,024 | 5,417 | | E | | |
| In situ poor or light concrete sloping layer | 131,40 | 0,00 | 0,00 | 0,00 | 0,060 | 1,650 | 0,036 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part concrete | 119,00 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Reinforced concrete pressure layer, cast in situ - part reinforcement | 2,91 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Reinforced concrete precast hollow-core slab - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | | 0,130 | | E | | |
| Reinforced concrete precast hollow-core slab - part reinforcement | 2,21 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| Gypsum plaster | 12,00 | 0,00 | 0,00 | 0,00 | 0,012 | 0,400 | 0,030 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,54** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,21** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,898 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |

# (continuation of: ≥2018, solid construction)

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
| **Window, ≥2018, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, ≥2018, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, ≥2018, solid construction** | **27,60** | **245,76** | **12,87** | **0,16** | | | | **1,55** | 1,31 |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 218,71 | 11,20 | 0,07 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 15,05 | 27,04 | 1,67 | 0,09 | | | | | |
| **Window, ≥2018, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, ≥2018, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Window, ≥2018, solid construction** | **44,16** | **111,10** | **7,96** | **29,80** | | | | **1,58** | 1,71 |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 86,82 | 6,47 | 29,72 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,51 | 24,28 | 1,50 | 0,08 | | | | | |
| **Outside door, ≥2018, solid construction** | **36,50** | **120,34** | **7,11** | **6,74** | | | | **1,13** | 1,60 |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 120,34 | 7,11 | 6,74 | | | 0,714 | | |

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Renovation scenario** | **45,73** | **0,16** | **264,71** | **13,98** | | | | **1,13** | | **27,60** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 20,60 |
| **Renovation scenario** | **50,92** | **0,16** | **128,12** | **8,96** | | | | **1,16** | | **27,60** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 0,07 | 86,82 | 6,47 | | | | | D | 12,55 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,09 | 41,31 | 2,49 | | | | | D | 15,05 | 20,27 |
| **Renovation scenario** | **35,12** | **0,16** | **264,71** | **13,98** | | | | **1,16** | | **27,60** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 0,07 | 218,71 | 11,20 | | | | | D | 12,55 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,09 | 46,00 | 2,78 | | | | | D | 15,05 | 22,57 |
| **Renovation scenario** | **45,73** | **29,80** | **264,71** | **13,98** | | | | **1,13** | | **44,16** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 29,72 | 218,71 | 11,20 | | | | | D | 30,65 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 46,00 | 2,78 | | | | | D | 13,51 | 20,60 |
| **Renovation scenario** | **50,92** | **29,80** | **128,12** | **8,96** | | | | **1,16** | | **44,16** | **50,92** |
| PVC frame (U = 1.6 W/m2K) | 30,65 | 29,72 | 86,82 | 6,47 | | | | | D | 30,65 | 30,65 |
| Triple glazing (U= 0.5 W/m2K) | 20,27 | 0,08 | 41,31 | 2,49 | | | | | D | 13,51 | 20,27 |
| **Renovation scenario** | **35,12** | **29,80** | **264,71** | **13,98** | | | | **1,16** | | **44,16** | **35,12** |
| Aluminium frame, powder coated (U = 1.6 W/m2K) | 12,55 | 29,72 | 218,71 | 11,20 | | | | | D | 30,65 | 12,55 |
| Triple glazing (U= 0.5 W/m2K) | 22,57 | 0,08 | 46,00 | 2,78 | | | | | D | 13,51 | 22,57 |
| **Existing (no renovation)** | **36,50** | **0,00** | **0,00** | **0,00** | | | | **1,13** | | **n.a.** | **n.a.** |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 0,00 | 0,00 | 0,00 | | | 0,714 | | E | | |

# ≥2018, timber frame construction

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
| **Floor on grade, ≥2018, timber frame construction** | **468,12** | **110,51** | **12,68** | **4,89** | **0,330** | | | **0,19** | 0,19 |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 24,53 | 1,63 | 0,24 | 0,010 | 0,810 | 0,012 | | |
| Screed - part cement | 11,50 | 10,26 | 0,71 | 0,12 | 0,050 | 1,350 | 0,037 | | |
| Screed - part sand | 60,00 | 0,21 | 1,01 | 0,32 | | | | | |
| PUR board with aluminium cover foil | 3,88 | 17,60 | 0,11 | 0,01 | 0,120 | 0,024 | 5,000 | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 35,47 | 7,93 | 4,08 | 0,150 | 2,300 | 0,065 | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 22,43 | 1,29 | 0,12 | | | | | |
| **Storey floor, ≥2018, timber frame construction** | **82,38** | **42,92** | **3,86** | **7,03** | **0,355** | | | **n.a.** | n.a. |
| Parquet, hardwood, glued | 14,04 | 13,30 | 1,04 | 3,23 | 0,022 | 0,180 | 0,122 | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 6,37 | 0,70 | 0,35 | 0,025 | | | | |
| Stone wool, 30 mm | 4,20 | 5,28 | 0,34 | 0,14 | 0,030 | 0,036 | 0,833 | | |
| OSB | 10,80 | 4,68 | 0,51 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Softwood joists and beams, treated | 20,35 | 8,12 | 0,79 | 1,07 | 0,225 | 1,097 | 0,205 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **External wall, ≥2018, timber frame construction** | **66,87** | **32,35** | **2,97** | **4,96** | **0,371** | | | **0,21** | 0,19 |
| Timber claddings, untreated larch | 8,83 | 2,78 | 0,30 | 0,47 | 0,022 | | | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,41 | 0,04 | 0,06 | 0,038 | | | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | |
| Bituminous soft wood fibre board | 4,58 | 3,31 | 0,28 | 0,84 | 0,018 | 0,050 | 0,360 | | |
| PE water barrier, stapled | 0,20 | 0,55 | 0,05 | 0,44 | 0,000 | | | | |
| Insulating clay brick strip (ground floor) | 4,76 | 1,17 | 0,14 | 0,04 | 0,220 | 0,344 | | | |
| Timber frame, hard- and softwood | 18,29 | 5,92 | 0,62 | 0,23 | | 0,137 | | | |
| Stone wool, 22 cm | 6,16 | 7,74 | 0,50 | 0,20 | | 0,036 | 3,831 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| PE vapour barrier, taped | 0,20 | 0,53 | 0,05 | 0,43 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |

| | | Environmental impact climate change [kg CO2 eq] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Element composition | Weight [kg/m2 element] | EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
| **Existing (no renovation)** | **468,12** | **0,00** | **0,00** | **0,00** | **0,330** | | | **0,19** | | **0,00** | **0,00** |
| Ceramic tiles (incl. adhesive and grout) | 25,21 | 0,00 | 0,00 | 0,00 | 0,010 | 0,810 | 0,012 | | E | | |
| Screed - part cement | 11,50 | 0,00 | 0,00 | 0,00 | 0,050 | 1,350 | 0,037 | | E | | |
| Screed - part sand | 60,00 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| PUR board with aluminium cover foil | 3,88 | 0,00 | 0,00 | 0,00 | 0,120 | 0,024 | 5,000 | | E | | |
| Reinforced concrete, cast in situ - part concrete | 357,00 | 0,00 | 0,00 | 0,00 | 0,150 | 2,300 | 0,065 | | E | | |
| Reinforced concrete, cast in situ - part reinforcement | 10,52 | 0,00 | 0,00 | 0,00 | | | | | E | | |
| **Existing (no renovation)** | **82,38** | **0,00** | **0,00** | **0,00** | **0,355** | | | **n.a.** | | **n.a.** | **n.a.** |
| Parquet, hardwood, glued | 14,04 | 0,00 | 0,00 | 0,00 | 0,022 | 0,180 | 0,122 | | E | | |
| Gypsum plaster board as sub-structure, double, screwed | 21,00 | 0,00 | 0,00 | 0,00 | 0,025 | | | | E | | |
| Stone wool, 30 mm | 4,20 | 0,00 | 0,00 | 0,00 | 0,030 | 0,036 | 0,833 | | E | | |
| OSB | 10,80 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Softwood joists and beams, treated | 20,35 | 0,00 | 0,00 | 0,00 | 0,225 | 1,097 | 0,205 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **66,87** | **0,00** | **0,00** | **0,00** | **0,371** | | | **0,21** | | **0,00** | **0,00** |
| Timber claddings, untreated larch | 8,83 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Softwood support structure for timber cladding (incl. nails) | 1,07 | 0,00 | 0,00 | 0,00 | 0,038 | | | | E | | |
| Air cavity, ventilated | 0,00 | 0,00 | 0,00 | 0,00 | 0,020 | | | | E | | |
| Bituminous soft wood fibre board | 4,58 | 0,00 | 0,00 | 0,00 | 0,018 | 0,050 | 0,360 | | E | | |
| PE water barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Insulating clay brick strip (ground floor) | 4,76 | 0,00 | 0,00 | 0,00 | 0,220 | 0,344 | | | E | | |
| Timber frame, hard- and softwood | 18,29 | 0,00 | 0,00 | 0,00 | | 0,137 | | | E | | |
| Stone wool, 22 cm | 6,16 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,831 | | E | | |
| OSB, screwed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| PE vapour barrier, taped | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | 0,129 | 0,170 | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |

## (continuation of: ≥2018, timber frame construction)

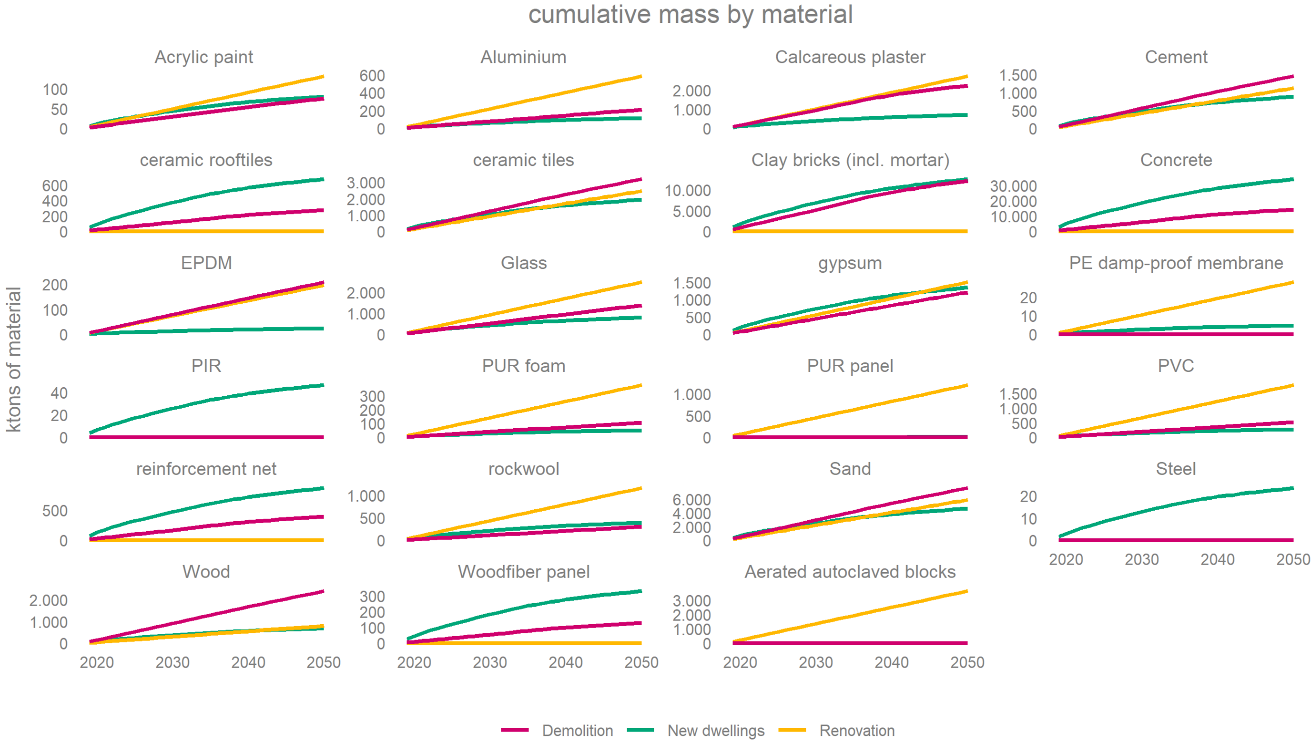
| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq] Production stage (A1-A3) | Transport to + construction on site (A4-A5) | EOL stage (C1-C4) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | $U_{element}$ EPB-cijfer-rapport [$W/m^2K$] |
|---|---|---|---|---|---|---|---|---|---|
| **Load-b. internal wall, ≥2018, timber frame constructio** | **47,96** | **30,00** | **2,45** | **2,71** | **0,258** | | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,79 | 0,08 | 0,02 | 0,045 | 0,130 | | | |
| Stone wool, 45 mm | 1,40 | 1,76 | 0,11 | 0,05 | | 0,036 | 0,971 | | |
| OSB, screwed | 10,82 | 4,84 | 0,52 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 2,47 | 0,23 | 0,08 | 0,140 | 0,130 | | | |
| Stone wool, 140 mm | 4,36 | 5,48 | 0,35 | 0,14 | | 0,036 | 3,021 | | |
| Steel spring rail | 1,02 | 5,38 | 0,29 | 0,01 | 0,030 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Non-l-b. internal wall, ≥2018, timber frame constructic** | **29,21** | **14,86** | **1,28** | **0,69** | **0,169** | | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,63 | 0,07 | 0,07 | 0,100 | 0,130 | | | |
| Stone wool, 100 mm | 3,20 | 4,02 | 0,26 | 0,10 | | 0,036 | 1,825 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | 0,170 | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 3,19 | 0,35 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Flat roof, ≥2018, timber frame construction** | **68,52** | **51,13** | **3,92** | **4,87** | **0,509** | | | **0,18** | 0,18 |
| EPDM, partially glued | 1,85 | 3,65 | 0,21 | 0,03 | 0,001 | 0,250 | 0,005 | | |
| Stone wool (partially glued, incl. glass fibre felt) | 22,02 | 28,22 | 1,82 | 1,01 | 0,180 | 0,036 | 5,000 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Prefabricated wooden elements with slope, treated | 1,29 | 0,61 | 0,05 | 0,07 | 0,050 | | | | |
| OSB, nailed | 10,82 | 4,78 | 0,51 | 1,99 | 0,018 | 0,130 | 0,138 | | |
| Softwood joists and beams, treated | 20,35 | 8,12 | 0,79 | 1,07 | 0,225 | 1,097 | 0,205 | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Pitched roof, ≥2018, timber frame construction** | **90,54** | **53,86** | **4,43** | **5,49** | **0,418** | | | **0,21** | 0,18 |
| Ceramic roof tiles | 42,02 | 15,50 | 1,46 | 0,40 | 0,015 | | | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,70 | 0,07 | 0,08 | 0,046 | | | | |
| Wood fibre board sub-roof | 19,80 | 21,27 | 1,56 | 3,66 | 0,022 | 0,100 | 0,220 | | |
| Softwood rafters, treated | 3,63 | 1,55 | 0,15 | 0,19 | 0,075 | 0,130 | | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 3,30 | 0,21 | 0,08 | | 0,036 | 2,451 | | |
| Softwood purlins, treated | 5,57 | 2,32 | 0,22 | 0,30 | 0,225 | 0,130 | | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 3,48 | 0,22 | 0,09 | | 0,036 | 1,898 | | |
| PE vapour barrier, stapled | 0,20 | 0,57 | 0,05 | 0,44 | 0,000 | | | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,47 | 0,04 | 0,05 | 0,022 | | | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 3,25 | 0,36 | 0,21 | 0,013 | 0,250 | 0,050 | | |
| Acrylic paint | 0,45 | 1,45 | 0,08 | 0,00 | 0,000 | | | | |
| **Window, ≥2018, timber frame construction** | **38,86** | **82,90** | **5,01** | **1,08** | | | | **1,55** | 1,31 |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 58,22 | 3,49 | 1,00 | | | | | |
| Double glazing, HR with argon (U = 1.1 W/m2K) | 13,73 | 24,68 | 1,52 | 0,08 | | | | | |
| **Outside door, ≥2018, timber frame construction** | **36,50** | **120,34** | **7,11** | **6,74** | | | | **1,13** | 1,60 |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 120,34 | 7,11 | 6,74 | | | 0,714 | | |

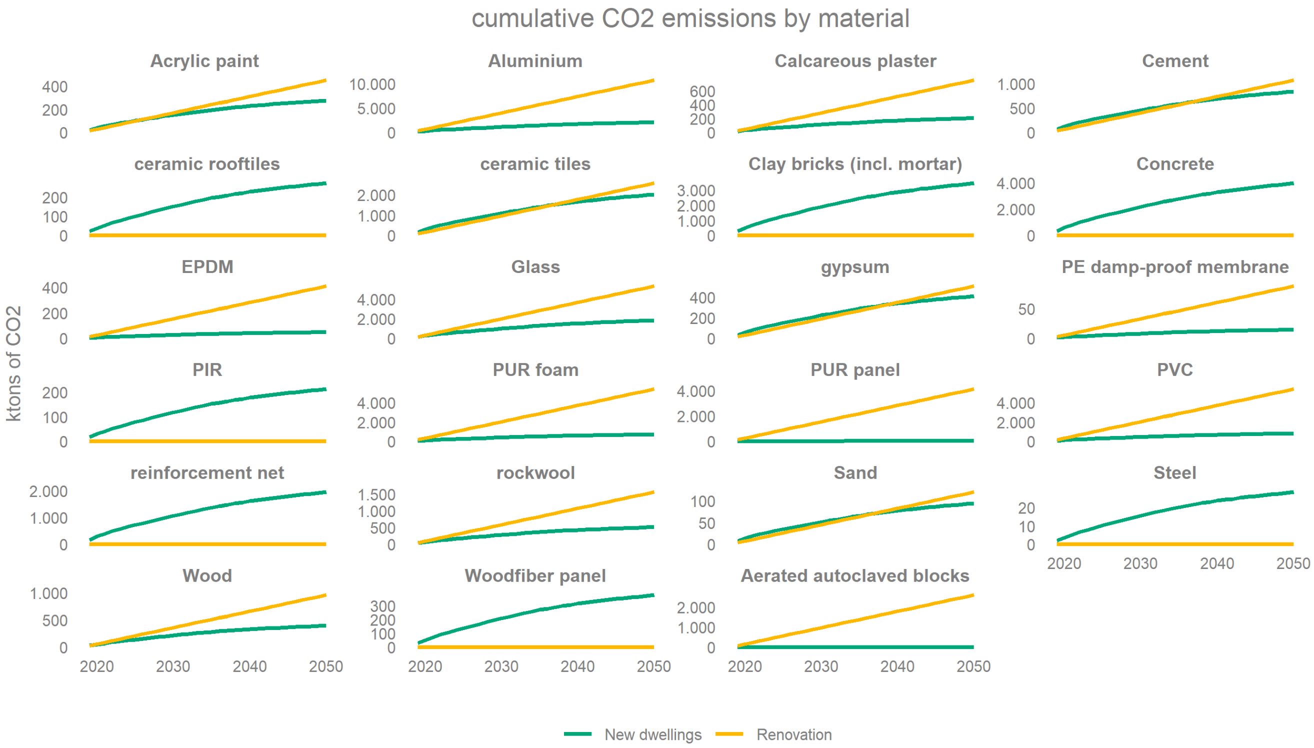
| Element composition | Weight [kg/m2 element] | Environmental impact climate change [kg CO2 eq] EOL stage (C1-C4) | Production stage (A1-A3) | Transport to + construction on site (A4-A5) | Thickness [m] | λ [W/mK] | $R_{mat}$ [$m^2K/W$] | $U_{element}$ [$W/m^2K$] | Existing/ new after Demolition/ New/ 5% Replacement at renovation | Demolition waste [kg/m2 element] | Newly added material [kg/m2 element] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing (no renovation)** | **47,96** | **0,00** | **0,00** | **0,00** | **0,258** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Timber structure, treated softwood, 45 mm | 2,01 | 0,00 | 0,00 | 0,00 | 0,045 | 0,130 | | | E | | |
| Stone wool, 45 mm | 1,40 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| OSB, screwed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Timber structure, treated softwood, 140 mm | 6,25 | 0,00 | 0,00 | 0,00 | 0,140 | 0,130 | | | E | | |
| Stone wool, 140 mm | 4,36 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Steel spring rail | 1,02 | 0,00 | 0,00 | 0,00 | 0,030 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **29,21** | **0,00** | **0,00** | **0,00** | **0,169** | | | **n.a.** | | **n.a.** | **n.a.** |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Timber structure, softwood, 100 mm | 2,08 | 0,00 | 0,00 | 0,00 | 0,100 | 0,130 | | | E | | |
| Stone wool, 100 mm | 3,20 | 0,00 | 0,00 | 0,00 | | 0,036 | 3,330 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,60 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **68,52** | **0,00** | **0,00** | **0,00** | **0,509** | | | **0,18** | | **0,00** | **0,00** |
| EPDM, partially glued | 1,85 | 0,00 | 0,00 | 0,00 | 0,001 | 0,250 | 0,005 | | E | | |
| Stone wool (partially glued, incl. glass fibre felt) | 22,02 | 0,00 | 0,00 | 0,00 | 0,180 | 0,036 | 5,000 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Prefabricated wooden elements with slope, treated | 1,29 | 0,00 | 0,00 | 0,00 | 0,050 | | | | E | | |
| OSB, nailed | 10,82 | 0,00 | 0,00 | 0,00 | 0,018 | 0,130 | 0,138 | | E | | |
| Softwood joists and beams, treated | 20,35 | 0,00 | 0,00 | 0,00 | 0,225 | 1,097 | 0,205 | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Existing (no renovation)** | **90,54** | **0,00** | **0,00** | **0,00** | **0,418** | | | **0,21** | | **0,00** | **0,00** |
| Ceramic roof tiles | 42,02 | 0,00 | 0,00 | 0,00 | 0,015 | | | | E | | |
| Tile laths and counter battens, treated softwood | 1,55 | 0,00 | 0,00 | 0,00 | 0,046 | | | | E | | |
| Wood fibre board sub-roof | 19,80 | 0,00 | 0,00 | 0,00 | 0,022 | 0,100 | 0,220 | | E | | |
| Softwood rafters, treated | 3,63 | 0,00 | 0,00 | 0,00 | 0,075 | 0,130 | | | E | | |
| Stone wool blanket (75 mm thick, placed between rafters) | 2,63 | 0,00 | 0,00 | 0,00 | | 0,036 | 2,451 | | E | | |
| Softwood purlins, treated | 5,57 | 0,00 | 0,00 | 0,00 | 0,225 | 0,130 | | | E | | |
| Stone wool board (225 mm thick, placed between purlins) | 3,15 | 0,00 | 0,00 | 0,00 | | 0,036 | 1,898 | | E | | |
| PE vapour barrier, stapled | 0,20 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| Support structure for boards, softwood (incl. nails) | 0,91 | 0,00 | 0,00 | 0,00 | 0,022 | | | | E | | |
| Gypsum plaster boards (incl. screws and joint filler) | 10,63 | 0,00 | 0,00 | 0,00 | 0,013 | 0,250 | 0,050 | | E | | |
| Acrylic paint | 0,45 | 0,00 | 0,00 | 0,00 | 0,000 | | | | E | | |
| **Renovation scenario** | **45,73** | **1,08** | **100,20** | **6,02** | | | | **1,16** | | **38,86** | **45,73** |
| Wooden frame, varnished (U = 1.5 W/m2K) | 25,13 | 1,00 | 58,22 | 3,49 | | | | | D | 25,13 | 25,13 |
| Triple glazing (U= 0.5 W/m2K) | 20,60 | 0,08 | 41,98 | 2,53 | | | | | D | 13,73 | 20,60 |
| **Existing (no renovation)** | **36,50** | **0,00** | **0,00** | **0,00** | | | | **1,13** | | **n.a.** | **n.a.** |
| Insulated door with steel frame, wood-aluminium panel and glazing | 36,50 | 0,00 | 0,00 | 0,00 | | | 0,714 | | E | | |

# Annex B: Approximate total amount of materials in current building stock

| Material | weight |
|---|---|
| Concrete | 300,4 Mtons |
| Clay bricks (incl. mortar) | 189,4 Mtons |
| Sand | 37,9 Mtons |
| Calcareous plaster | 36,8 Mtons |
| ceramic tiles | 15,9 Mtons |
| reinforcement net | 8,2 Mtons |
| Cement | 7,3 Mtons |
| ceramic rooftiles | 7,0 Mtons |
| Wood | 4,8 Mtons |
| gypsum | 3,4 Mtons |
| Woodfiber panel | 3,3 Mtons |
| Glass | 1,5 Mtons |
| rockwool | 0,8 Mtons |
| PVC | 0,5 Mtons |
| Acrylic paint | 0,5 Mtons |
| Aluminium | 0,3 Mtons |
| EPDM | 0,2 Mtons |
| PUR foam | 0,1 Mtons |

# Annex C: Evolution of cumulative demand until 2050 by material



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