



The Financial Tab

An explanation of the financial module within the Madaster platform

Made for
Madaster users

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1 Introduction

1.1 Motivation

On September 29, 2017, the Madaster platform was launched. From this public online library, a digital materials passport can be generated for every real estate object. As a result, Madaster provides insight into which materials have been used in a building and in what quantities. Madaster gives materials an identity so that waste streams can be eliminated, and in doing so Madaster contributes to a transition to a circular economy.

In addition to documenting the materials in a building, Madaster aims to attach a financial value to the documented materials. This financial value counts as personal characteristics such as date of birth or place of birth for a 'personal' passport. The idea behind this is that if you really want to stimulate the circular economy, there should be a financial trigger attached to it. Therefore, in the financial tab, the residual value of materials is calculated. This data can be used, among other things, for making circular propositions in the market. Where now demolition-related depreciations of building owners are estimated based on feeling and key figures, the financial tab can determine more precisely what the final value is based on material value as an absolute minimum value. As more detachable and sustainable materials are built, the residual value becomes higher. Thus, the financial module is a driver for the circular economy and translates circularity into money. For banks, investors and other property owners, determining a terminal value is important for a number of reasons. First, knowledge of the buildings reduces the risk factor for demolition-related write-offs. In addition, the material value of a building can be representative of the terminal value of a building. This end value can provide a more positive business case when making the investment decision at construction or when purchasing the building. In this way, circularity is linked to residual value and thus to money. Through the financial tab, Madaster facilitates the market with opportunities for new business models.

1.2 Scope and assumptions

Within the scope of the financial tab is the spectrum from material, product, layers of fire to building. The building value and layers of fire value represent the sum of the material and product values. Below the material value, the most low-grade level of recycling is approached. This is the lower limit for reusing materials. The product level valuation is most likely a higher valuation because the material is manufactured into a usable object. Product value is represented by the reuse value of products. A product is a usable creation of one or more materials. A product can also consist of multiple products.

For example, an air conditioning unit can be considered a product, but also just the outside cabinet can be considered a product or the screw that secures it to the wall can be considered a product. This definition is flexible in size of the product.

2 Theoretical principles

2.1 Material value

2.1.1 Material

The material value is determined by taking the commodity value or market value of materials as the basis. This value is then reduced by the correction factors. These correction factors represent the difference between the new materials to be reused and the materials as they are in the building. Everything in between is:

- Demolition and dismantling costs
- Additional transport costs to the processor
- Processing and machining costs
- Correction for size of raw material flow

The formula for calculating the material value of one specific material at $t=0$ is:

$$W_{K.1;t=0} = (W_{k.1} - F_{k.1.1} - F_{k.1.2} - F_{k.1.3}) * F_{k.1.4}$$

where:

$WK. 1; t=0$	Value of material K.1 at time $t=0$
$Wk.1$	Value of material K.1
$Fk.1.1$	Correction factor 1: Demolition and dismantling costs
$Fk.1.2$	Correction factor 2: Additional transport costs to the processor
$Fk.1.3$	Correction factor 3: Processing and machining costs
$Fk.1.4$	Correction factor 4: Correction for the size of the raw material flow

2.1.2 Correction factors

2.1.2.1 Demolition and dismantling costs

The demolition and dismantling costs for a building are currently assumed at predefined Dutch standards per m^2 GFA. The total demolition costs are divided among the materials based on volume.

The formula for this is as follows:

$$F_{K.1.1;t=x} = (TSDK_{Gebouw} / M_{gebouw}) * M_{K.1}) * (1 - LI_{k.1}) * i_{bdb;t=x}$$

Where:

$FK.1.1; t=x$	Demolition and dismantling costs of material K.1 at time x
$TSDKGebouw$	Total demolition and dismantling costs of a building
$Mgebouw$	Total mass of the building
$LIk.1$	The looseness index of the material
$ibdb; t=x$	BDB index from $t=0$ to $t=x$

2.1.2.2 Additional transport costs to the processor

The additional transport costs to the processor are calculated using the following formula:

$$F_{K.1.2;t=x} = A_{Verwerker} * \frac{\text{€}}{\text{km/kg}} * i_{inflatie;t=x}$$

Where:

$F_{K.1.2;t=x}$	Additional transportation costs to the processor at t = x
$A_{Verwerker}$	Distance to processor
$i_{inflatie;t=x}$	Inflation from t=0 to t=x

2.1.2.3 Processing and machining costs

$$F_{K.1.3;t=x} = K_{Verwerker} * i_{inflatie;t=x}$$

Where:

$F_{K.1.3;t=x}$	Processing and machining costs at t = x
$K_{Verwerker}$	Processor cost per kg
$i_{inflatie;t=x}$	inflation from t=0 to t=x

2.1.2.4 Correction for size of raw material flow

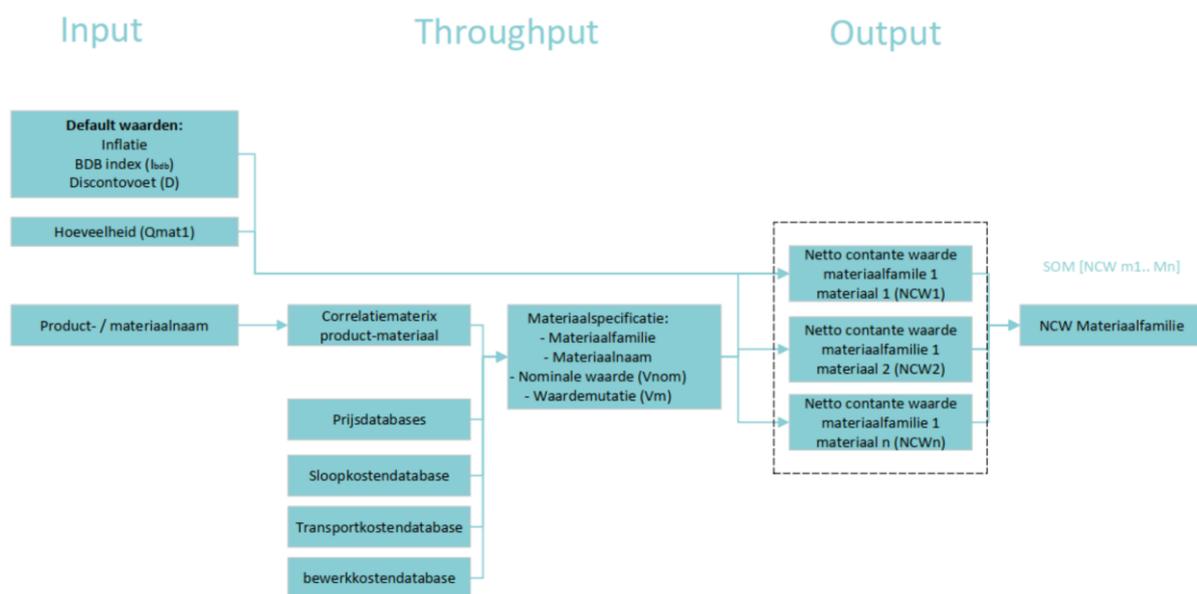
In development

2.1.3 Future Value

Knowing the value of the materials within a building at $t=0$ is already very innovative and valuable. However, it is even more valuable to know the net present value (NPV) of the materials within a building; assuming a building is disassembled low when its functional life is over.

To determine the future value of the materials, it is important to know whether a material is increasing or decreasing in value and to what extent. To determine this, only past data was looked at in the most objective way possible. This historical data from commodity prices was then corrected for inflation and exchange rates to give the fair value. Using the fair values from the past, a trend line is drawn towards the future. This is done using regression analysis called the least squares method.

This method is applied for each material. To then calculate the net present value of the material family, the net present values of the different materials are added together. The process diagram explaining how a net present value was arrived at is shown below.



2.1.4 Product Value

In development

3 Sources

3.1 Materials

Material	€/kg	Historical prices
LDPE flake		Supply & Demand
LDPE pellet		Supply & Demand
LLDPE		Supply & Demand
HDPE		Supply & Demand
PP gay		Supply & Demand
PP copolm		Supply & Demand
PVC		Supply & Demand
ABS natural		Supply & Demand
ABS black		Supply & Demand
PA 6 natural		Supply & Demand
PET crystal clear		Supply & Demand
PC crystal clear		Supply & Demand
PBT natural		Supply & Demand
POM natural		Supply & Demand
PMMA crystal clear		Supply & Demand
Material	€/kg	Historical prices
Aluminum		LME
Copper		LME
Zinc		LME
Nickel		LME
Lead		LME
Tin		LME
Aluminum Alloy		LME
NASAAC		LME
Steel Billet		LME
Steel Scrap		LME
Steel Rebar		LME
Cobalt		LME
Molybdenum		LME
Gold		LME
Silver		LME
Palladium		LME
Platinum		LME

Material	€/kg	Historical prices
Hardwood log	0,18	
B-wood	0,18	
Softwood log	0,18	
Cork	1,00	
Material	€/kg	Historical prices
Concrete Granules	0,0035	Interview BRBS & GBN
Mixing Granule	0,0030	Interview BRBS & GBN
Ceramics	0,05	Sand Complete
Asphalt granules	0,0075	Hellinga
Plaster	0,024	Cobouw Construction Costs
Gravel	0,016	Cobouw Construction Costs
Asbestos	0	
Material	€/kg	Historical prices
Flat Glass	0,19	Addition of material prices of the composition
Material	€/kg	Historical prices
Wool	source	https://www.quandl.com/data/ODA/PWOOLC_USDCoarse-Wool-Price
Rubber	source	https://www.quandl.com/data/COM/WLD_RUBBER_TSR20Rubber-TSR20-kg
Cotton (airtight)	source	https://www.quandl.com/data/COM/COTTON-Cotton-ICE
Sand	0,033	Average price from different sources
Material	€/kg	Historical prices
Unknown	0,00	

3.1.1 Pricing approach

Some material prices are not found in commodity prices. This is often the case with materials that have a local market rather than a global one. An example is stony materials. These materials are worth relatively little, but cost a lot of money to transport. As a result, there is no national, European or global outlet. So the price is determined locally based on supply and demand. An average price for this was found out on the basis of interviews.

The price of flat glass was determined by ordering the raw materials for glass per ton. Based on the purchase prices, a value of €0.19 per kg comes from the inventory.

For the material family 'Wood' the calorific value of wood was taken into account. Here, therefore, the downcycling scenario, i.e. incineration, was assumed. The calorific value is set against an average energy price of 3.5 cents. This is the average price of energy of 2017 excluding tax, delivery costs etc.

The price of sand was determined based on a comparison of a number of providers. The other prices are based on community prices from various world markets.

3.1.2 Correction factors

Starting points for the correction factors are as follows:

- Demolition costs are based on Dutch standards
- Transport costs are €0,00048 per kg per km
(the table below shows which materials travel which distances)
- Treatment and processing costs for plastics are €0.75 per kg
- Machining and processing costs for metals are 35% of the value
- Other material specific machining and processing costs are as stated

Transport distances					
Plastic	Metals	Wood	Stone	Glass	Organic
150	150	50	20	150	150

Hardwood log	€ 0,05
B-wood	€ 0,10
Softwood log	€ 0,10
Concrete Granules	€ 0,007
Mixing Granule	€ 0,007
Plaster	€ 0,015
Gravel	€ 0
Asbestos	€ 0,23
Flat glass	€ 0,20

3.2 Products

In development

3.2.1 Product Value

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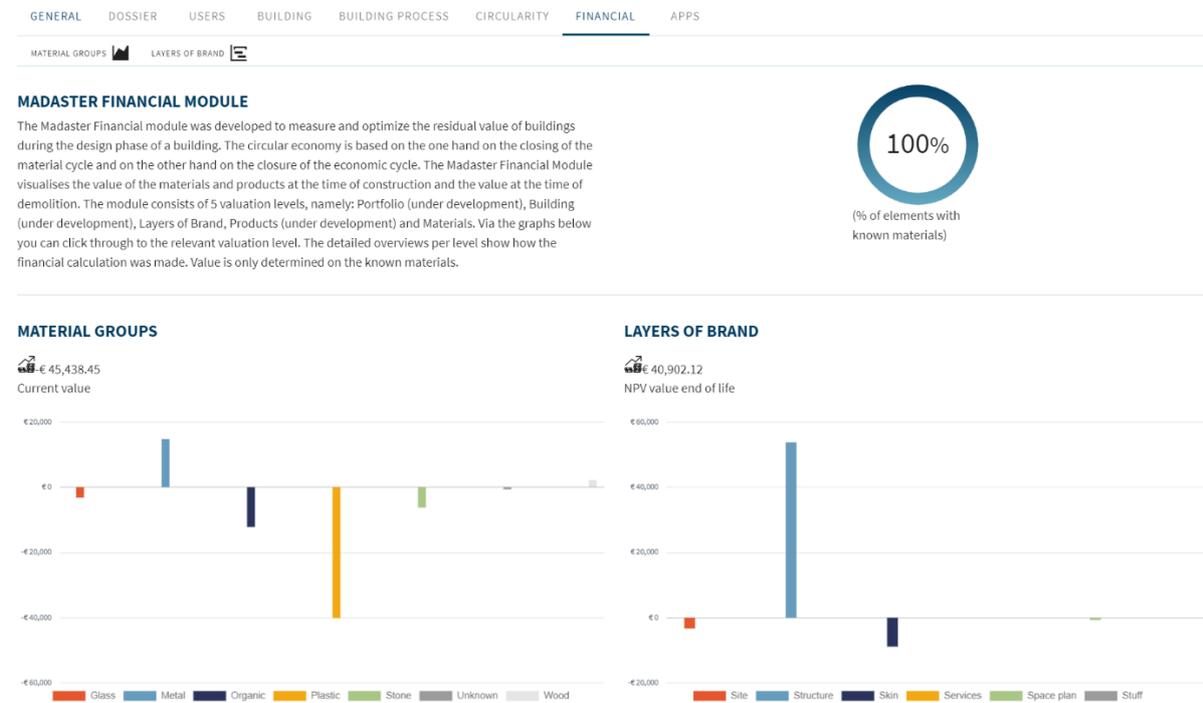
3.2.2 Correction factors

In development

4 Madaster Financial module

4.1 Start page

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4.1.1 What do I see

On the start page of the financial module, the top left corner contains a brief explanation of the financial tab and the different levels at which it was measured. At the top right is the level at which the model is correctly linked to the materials known within Madaster. Then there is a dashboard showing what the value of the different materials within the building is and in which building layer this value is located. From the start page you can navigate to the detail screens: 'material groups' and 'building layers'.

4.1.2 What does it mean

Materials known

The round figure at the top right shows how many materials have been identified. This includes: The proportion of volume of materials identified according to the Madaster materials list for the financial tab in relation to the total volume of materials in the building.

Material groups

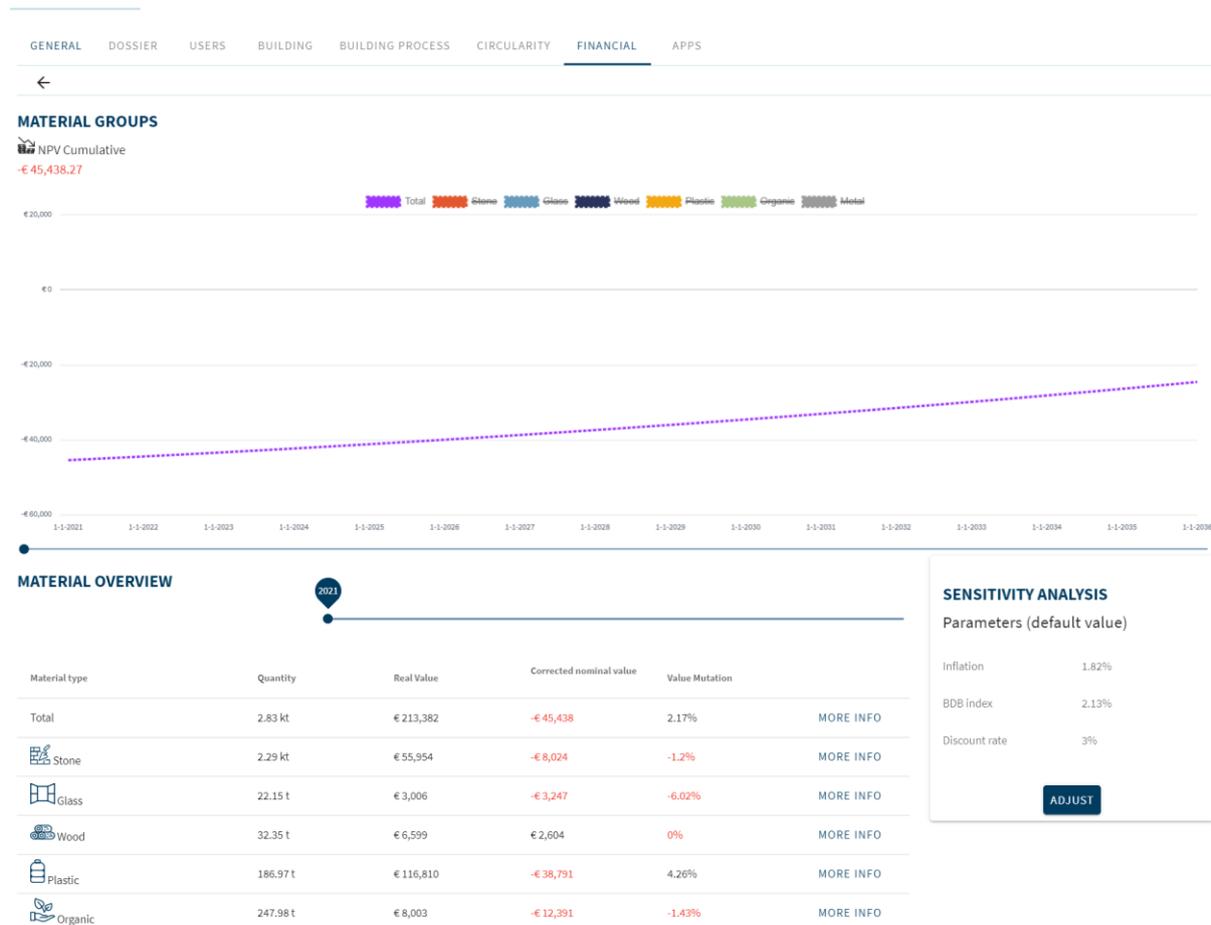
The chart on the lower left shows the value of the material groups. The value shown here is the current value of the materials. When the user hovers the mouse over the bars in the bar graph, the current value of the sum of the materials in the respective material family appears.

Building layers

The graph on the bottom right shows the net present value of the different building layers based on the functional lifetime. The future value of the materials is calculated back to today using the discount rate which can be changed on the detail page.

4.2 Material groups

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4.2.1 What do I see

The material groups page shows how the material value of material families develops over time. Above the graph the display buttons of the different material families can be switched on and off. The future value is calculated according to the formulas described in the chapters 1,2 and 3. This means that they were calculated on the basis of historical value. Inflation is not included in the valuation towards the future. Thus, the future value is the fair value of the materials. The column next to fair value shows the adjusted nominal value of the materials. This value does include inflation and the BDB index. In addition, the correction factors have already been deducted from the material value. This last value can be seen in the graph.

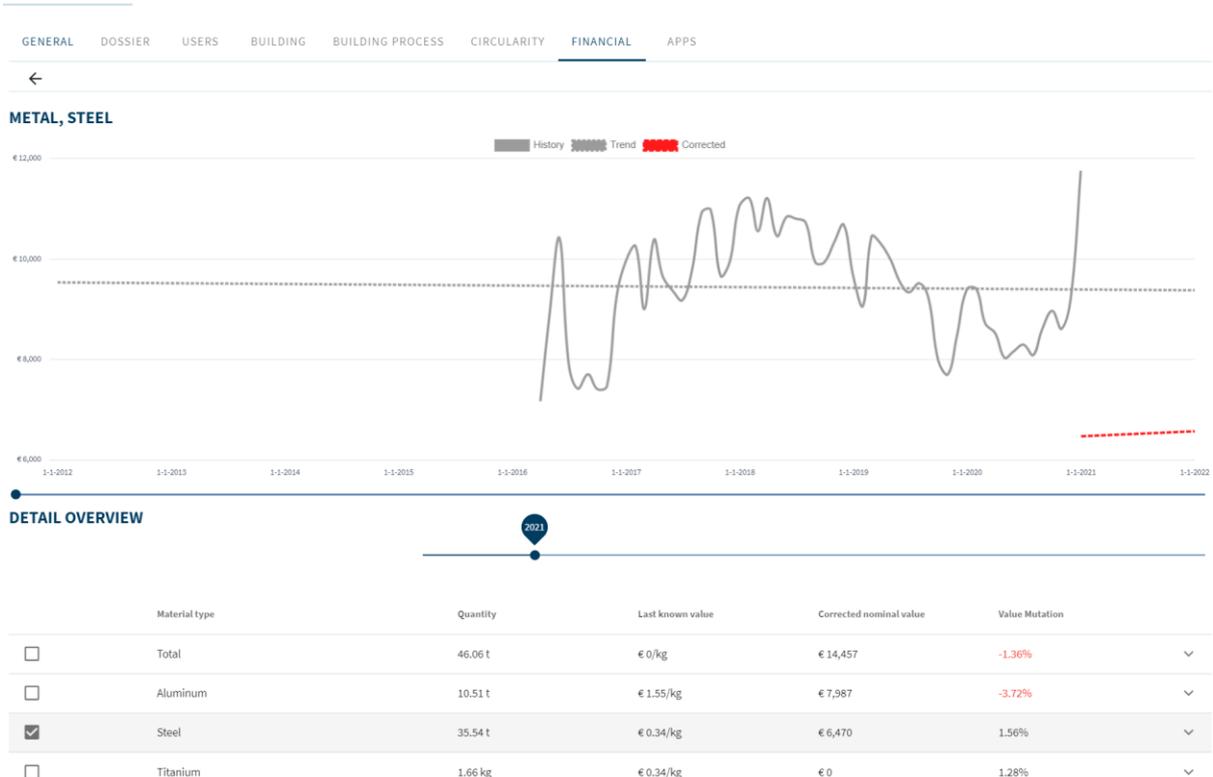
4.2.2 How was this calculated

The value of the families of materials was determined by adding the values of the materials within the families. The value of the materials is determined as described in Chapter 2. When the 'more info' button is clicked, a screen appears with further explanation of this value. The graph in the detail screen of a material family also shows the historical price series when a material is clicked. This is shown as the grey solid line. Through this a trend line has been drawn which is represented by a grey dotted line. The red dotted line is the corrected nominal value of the material. This is corrected with the correction factors, inflation and BDB index.

4.2.3 What does it mean

The total value of the product groups added together represents the material-level value for the entire building. The course of this value is shown in the graph. This does not yet include the discount rate. The value shown is the nominal value in the relevant year.

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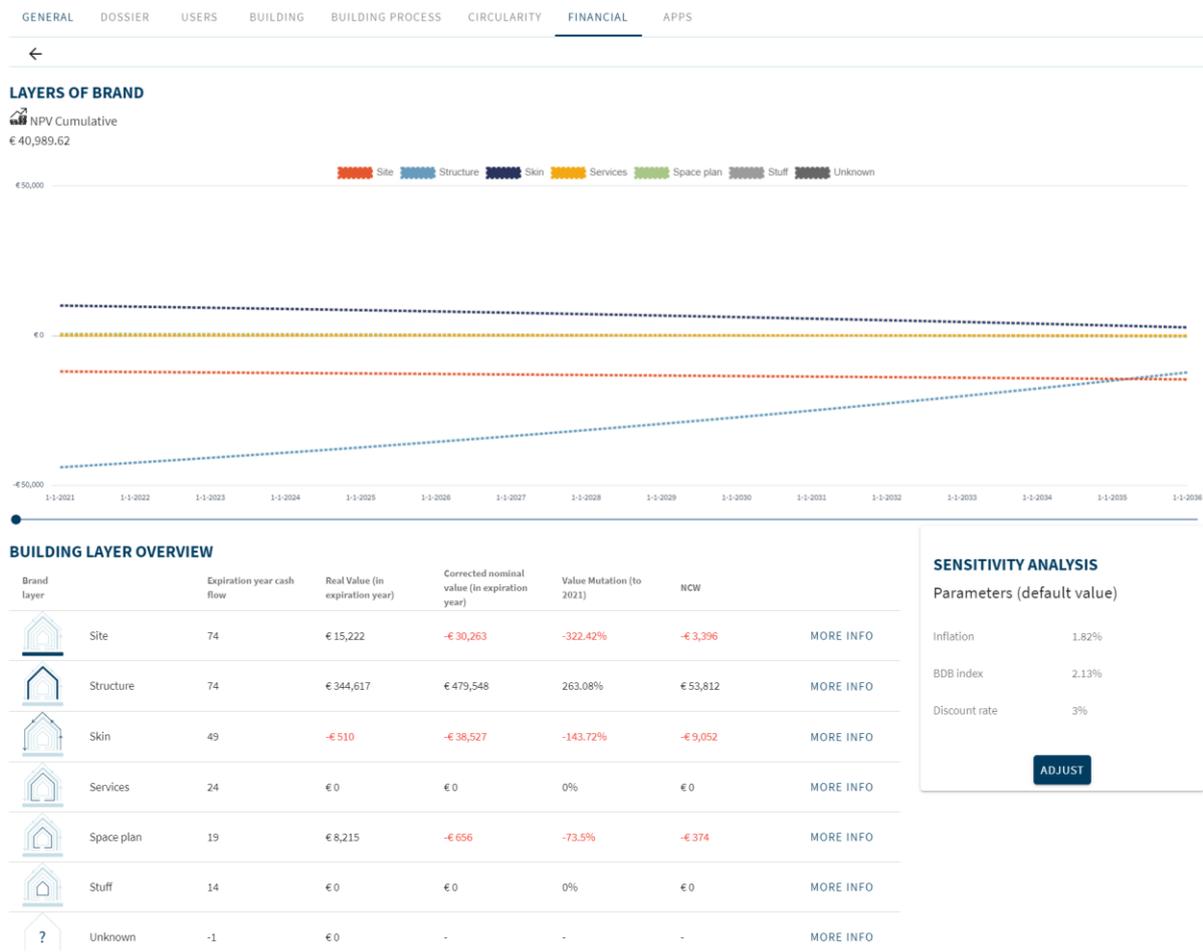


4.3 Detail screen products

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4.4 Building layers page

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4.4.1 What do I see

In the building layers page, the future value of materials at the end of their functional life was calculated. This was then discounted back to today. The assumptions for future value are, as described in chapter 2, based on historical price series which have been corrected with macro-economic effects by deduction of inflation and exchange rate.

4.4.2 How was this calculated

The net present value of a material flow with a given functional life is calculated by calculating the material value from $t = \text{functional life}$ back to $t = 0$. This is done according to the following formula:

$$NCW_{\text{materiaalstroom } x \text{ op } t=Lf} = \frac{NW_{\text{materiaal } x \text{ op } t=Lf}}{(1+d^t)}$$

Where:

$NCW_{\text{materiaalstroom } x \text{ op } t=Lf}$	Net present value of material flow x based on technical lifetime
$NW_{\text{materiaal } x \text{ op } t=Lf}$	The nominal value of material flow x at the end of its functional life
D	Discount rate
t	time

4.4.3 What does it mean

The different cash flows are put in time in this overview. That is, each material is removed from the building at the end of its functional life. At this time, the value of the material at that specific moment is calculated back with time effects calculated to $t = 0$. From this comes the net present value of the various cash flows. The sum of these net present values is the net present value of the various material flows over the maintenance period of the building. This value is the value today/now of making a particular material choice and, looking at the investment decision, is the most important value.