REVALUE

Building Efficiency Guide: Raising Awareness of users to building archetype specific renovations and data collection options

Work package 2 D2.2

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Editor(s):	*Luwoge Consult*
Contributor(s):	*Bax & Company, Vanhier Accountants,*
Reviewers:	*RICS, Maastricht University*
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BaxCo	Bax & Company
Savills	Savills UK
MU	Maastricht University
RICS	Royal Institution of Chartered Surveyors UK
Luwoge	Luwoge Consult
Vanhier	Vanhier Accountants

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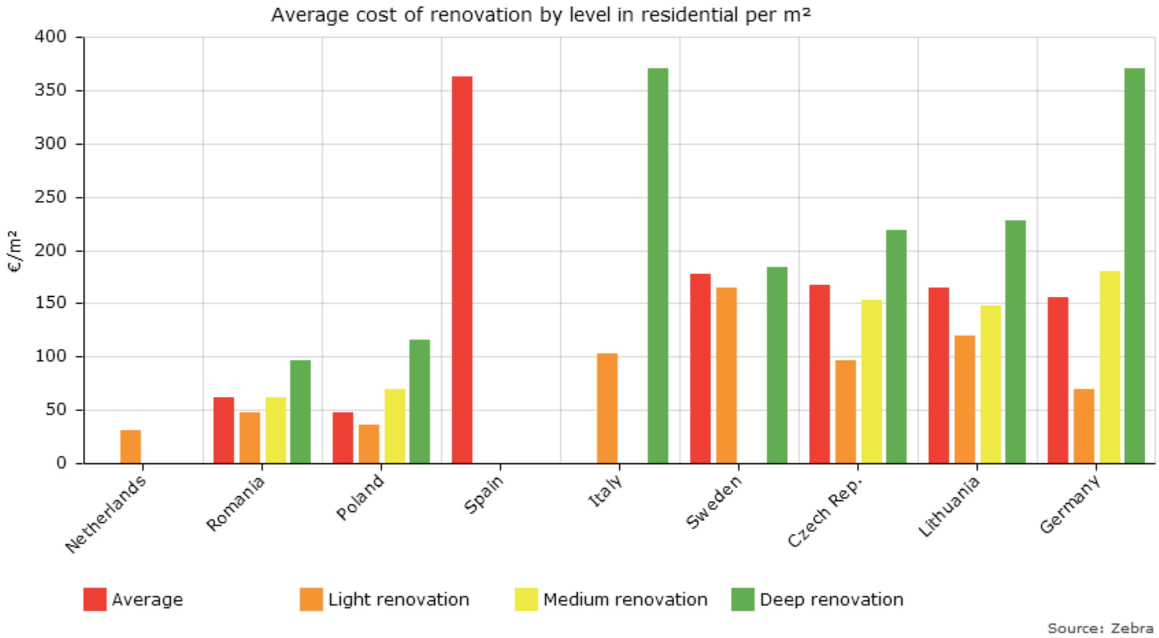
Executive Summary

The Revalue project has sought to establish any connections between the benefits and challenges of energy efficiency (EE) in the built environment, how they might impact on the way a building is valued and the resulting figure. Throughout Europe much of the housing stock needs renovation. More than 40% of buildings were built before 1960 and 90% before 1990. We know that older buildings are less energy efficient because of the then less stringent energy laws, fewer regulations regarding energy efficiency and environmentally lower graded materials. The current renovation rate of existing buildings is low with only about 1-2% of the building stock renovated each year.[1] These facts contribute to the observations by valuers that there is only a low impact of EE in new and renovated buildings.

As shown in the chart below, estimates of energy renovation costs range from EUR 200 to 450 per m² depending on the depth of the renovation.[2]



Defining what energy efficient renovation means across EU legislation and in practice varies. Recital 16 of the Energy Efficiency Directive (Directive 2012/27/EU) defines "deep renovations" in a very broad way. They are deemed to be "renovations which lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-

1 http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU(2016)587326_EN.pdf
2 http://zebra2020.eu/tools/
The Economist, 2013. Investing in energy efficiency in Europe's buildings. A view from the construction and real estate sectors.

renovation levels leading to a very high energy performance".[3] It is estimated that of the current renovations, only 1% meet this definition.

ReValue has identified that housing providers, asset managers and investors often do not have a clear awareness of how to drive EE in their portfolios and ask, if so driven, will it be reflected in the value of their assets? Valuers also struggle with identifying which EE measures have the greatest impact and how to apply these in their valuations. They work on market observations and data and if data is not available and the market does not seem to reflect EE within transaction prices they will not be included. The question that this deliverable intends to help answer is: can a Guide to Building Efficiency measures help valuers to advice clients as to potential value impacts due to enhanced data and technical knowledge of the property that they are considering?

The introduction of the Building Efficiency Guide v3, (BEG) (German Language) is an attempt to see what it would mean for a building to meet these legislative goals and also to bring better awareness to valuers, asset managers and investors by informing them of archetype and specific building renovations and data collection options.

The BEG does this by providing software built into the guide. This software can assist the users in configuring their buildings, providing benchmark buildings as comparisons and then specifying the appropriate components for the building.

The building's configuration plays an important role in governing the energy consumption of a building and refers to the geometry of the building and surroundings. How a building is used (residential, commercial, industrial, etc.), its energy needs (including climatic zone) and how that energy is generated are also parts of the building's configuration. These characteristics along with some financial parameters all have an impact on the life-cycle assessment (LCA) of that building. The life-cycle assessment information can be used by the valuers in their discounted cash flow (DCF) appraisals and reported 'book' values. The investor and portfolio managers to aid in the decision-making process of both short and long-term goals for reducing risk may also use a LCA.

The ReValue project identified, that in some countries valuers, asset managers and investors lack reliable benchmark data from which they can derive relevant inputs by which they can compare their buildings. The reference buildings included in the guide give a baseline from which to compare other building variations and to help set benchmark norms in that location. The six different reference buildings within the BEG software database vary in configuration, components and energy needs; the buildings range from those with very high energy demands to those meeting the deep renovation definition. Additionally a custom building may be configured as reference.

A building is made up of specific physical components and in the BEG, these components are divided into the five major areas: roof, wall, windows, base foundation and the ground floor. Each major building element can be selected from a drop-down list. These components are defined by their thickness, material and U-values and all these characteristics impact on the final energy consumption and costs of a building.

By working through the exercises in the BEG, the users of the guide will be able to understand how different EE strategies may affect the building's energy efficiency, life-cycle and estimated investment costs.

Raising the awareness and informing valuers, social housing providers/asset managers and investors of EE options on a technical level may help them understand what types of questions to ask, what data is needed and how this information is a critical part in deciding on and establishing value in one's portfolio.

Purpose of this Document

This document is the deliverable of task 2.2; in work package 2 guidelines to data collection. The task leader is Luwoge Consult. Its other contributors are; Bax&Company, Savills, Maastricht University (MU), Vanhier, and RICS.

Luwoge Consult as a subsidiary of BASF's Wohen and Bauen, have developed The Building Efficiency Guide (BEG). The guide is an information and planning tool to be used by valuers, investors, and design professionals during the planning phases of a project. The guide can assist in establishing the results of design decisions with their relationship to energy use, technical and economic aspects and even help in materials selection of the major building components. This document clarifies the benefits to those users and the owners. This document combines an overview of the BEG with images from the English version along with explanations and tips on how to use the tool for a particular building.

Table of contents

Introduction: A Detailed Walk Through the Guide

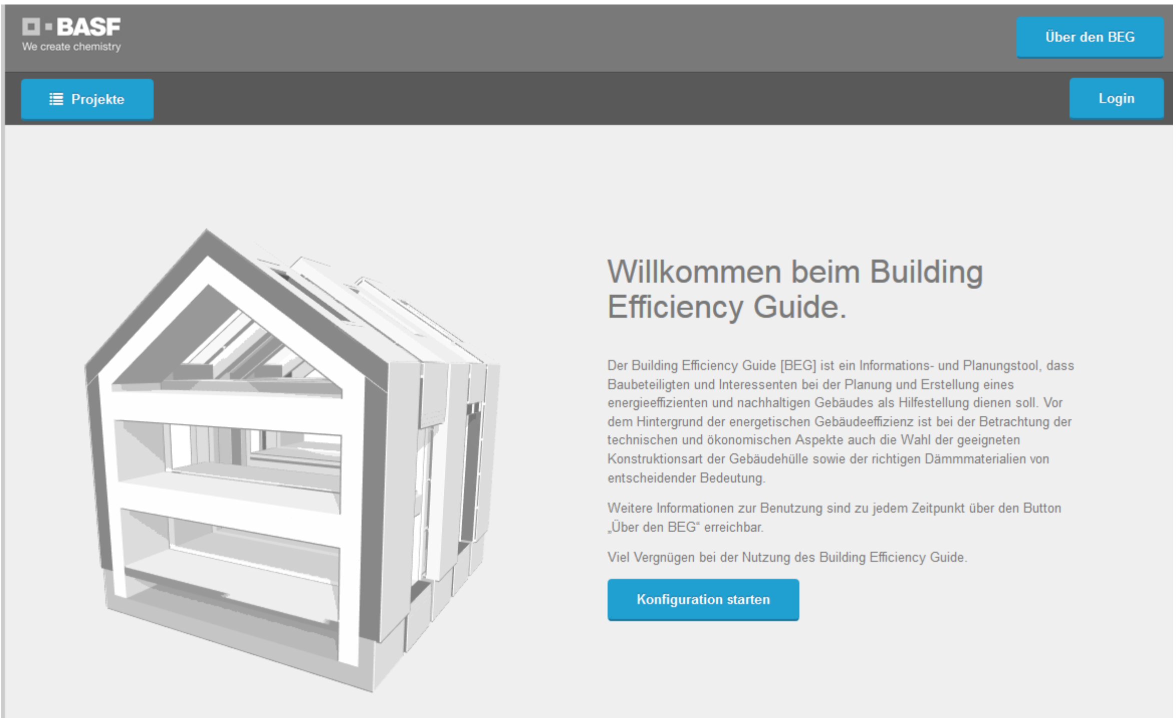
Disclaimer: The tool can be found at: http://v3.building-efficiency-guide.com/#/

Whilst LUWOGE consult has ensured that the information in these Guides is as timely and accurate as possible, they make no claims, promises, or guarantees about the accuracy, completeness, or adequacy of the contents of the site, and expressly disclaim liability for errors and omissions in the contents.

The German v.3 Building Efficiency Guide

The German v.3 Building Efficiency guide is an information and planning tool that construction partners and design professional can utilize during the planning phases of a project. The Guide can assist in establishing the results of design decisions to the relationship of energy use, technical and economic aspects and even help in materials selection of the major building components. We have attempted below to give guidance in English because the most advanced version of the tool is currently only available in the German language. An English modified version is currently under development.

The Guide enables the selection of location, building conditions and building geometry. Dropdown menus are provided to assist the user in selecting building envelope composition and technical components, and once these calculations have been inputted, results regarding life-cycle costs (LCC) and energy demand are provided. Below is an introduction along with screen shots to reference. The Guide is written in a step-by-step format.



BASF
We create chemistry
Über den BEG
Projekte
Login
Willkommen beim Building Efficiency Guide.
Der Building Efficiency Guide [BEG] ist ein Informations- und Planungstool, dass Baubeteiligten und Interessenten bei der Planung und Erstellung eines energieeffizienten und nachhaltigen Gebäudes als Hilfestellung dienen soll. Vor dem Hintergrund der energetischen Gebäudeeffizienz ist bei der Betrachtung der technischen und ökonomischen Aspekte auch die Wahl der geeigneten Konstruktionsart der Gebäudehülle sowie der richtigen Dämmmaterialien von entscheidender Bedeutung.
Weitere Informationen zur Benutzung sind zu jedem Zeitpunkt über den Button „Über den BEG“ erreichbar.
Viel Vergnügen bei der Nutzung des Building Efficiency Guide.
Konfiguration starten

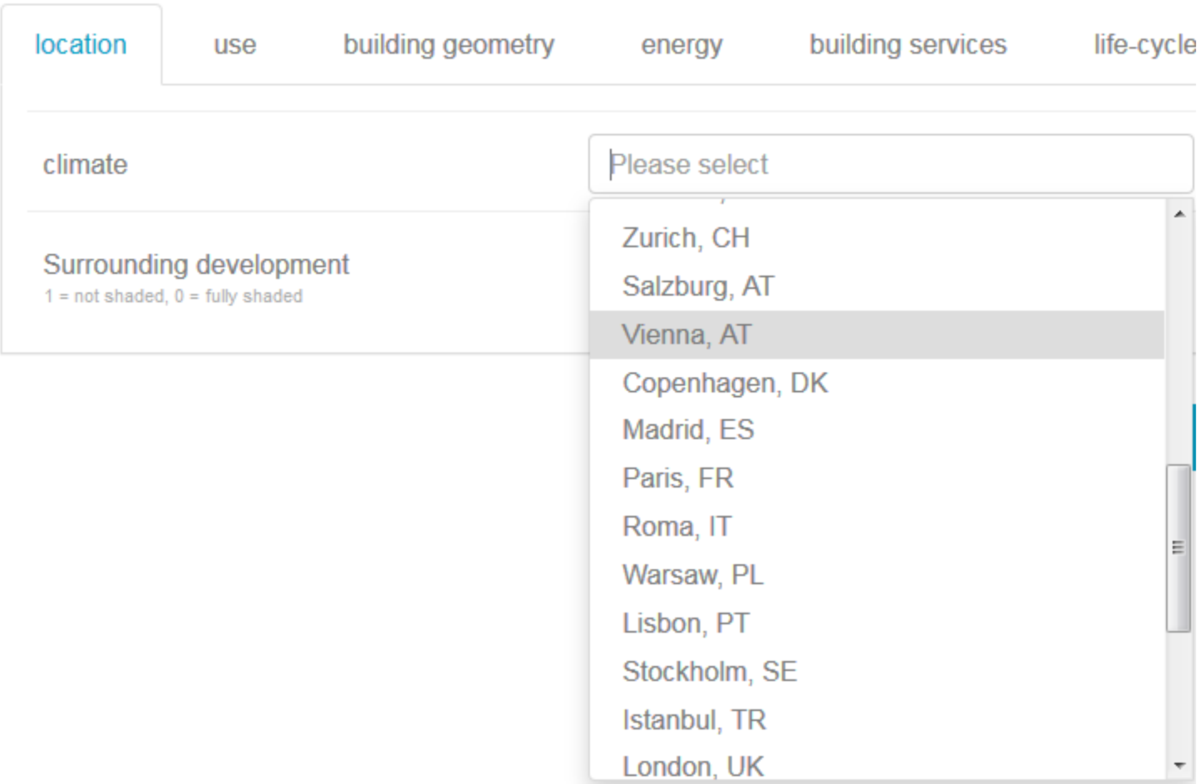
Chapter 1 Configuration of the Building

The first step in using this software is to determine the configuration of the building. The configuration of a building plays an important role in governing the energy consumption of a building. The building configuration refers to the geometry of the building and surrounding areas. How a building is used, (residential, commercial, industrial, etc.), its energy needs (including climatic zone), and how that energy is generated, are parts of the building's configuration. These characteristics along with some financial parameters all have an impact on the life-cycle assessment of that building.

1.1. Location

The climate of your building's location plays an important role in the consideration of refurbishments.

- The Guide's climate data is provided by NASA satellite data, EOSWEB interface and METEONORM.
- It is important to select the most similar climate to one of the listed cities. Many German and European cities as well some international cities are available in the data base
- Selecting from the drop-down list the most similar climate to the actual building site will provide results that are more accurate.



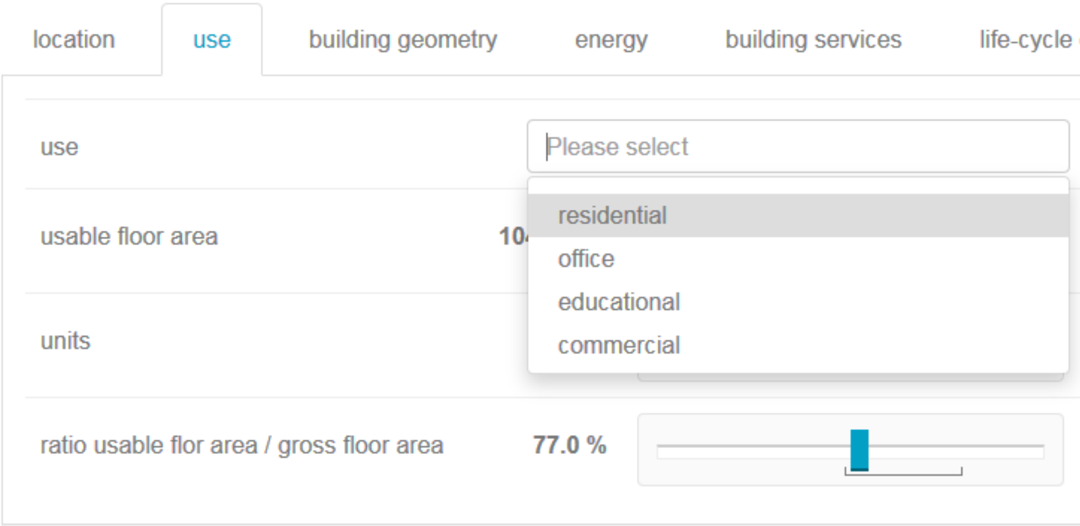
1.2. Use

A building's use refers to its function, how and for what the building is used. A building's typology will provide reference to its use and function.

The function of a building is important because different functions will demand different specific needs of both the physical building as well as the occupants. Comparison of buildings is based on values specific to the function/typology of the buildings.

Because the usable floor area is different from the gross area, the software requires the usable-to-gross area ratio. This ratio is an indicator of the geometric economy of the building

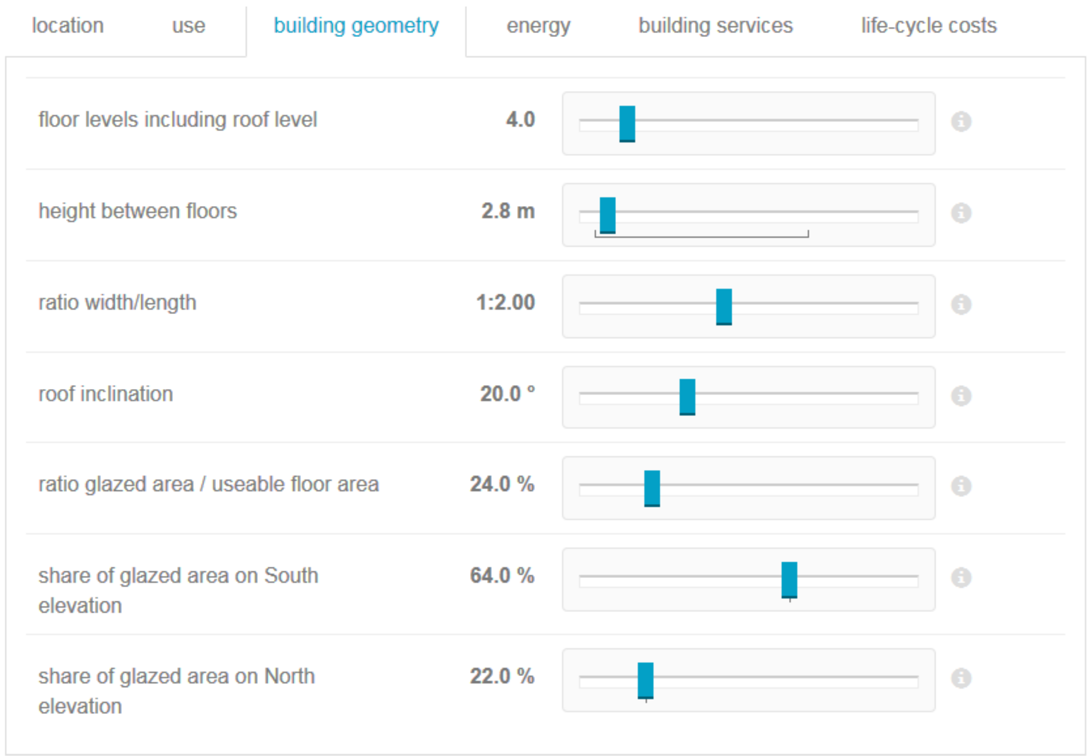
- Usable floor area: lettable space within user units
- Units: number of user units
- Ratio usable-to-gross area: ratio of net lettable area to gross floor area (GFA)



1.3. Building Geometry and Envelope

The third step is to define the building dimensions and to describe/define the envelope (walls, roof, floor) of the building. The following information is required:

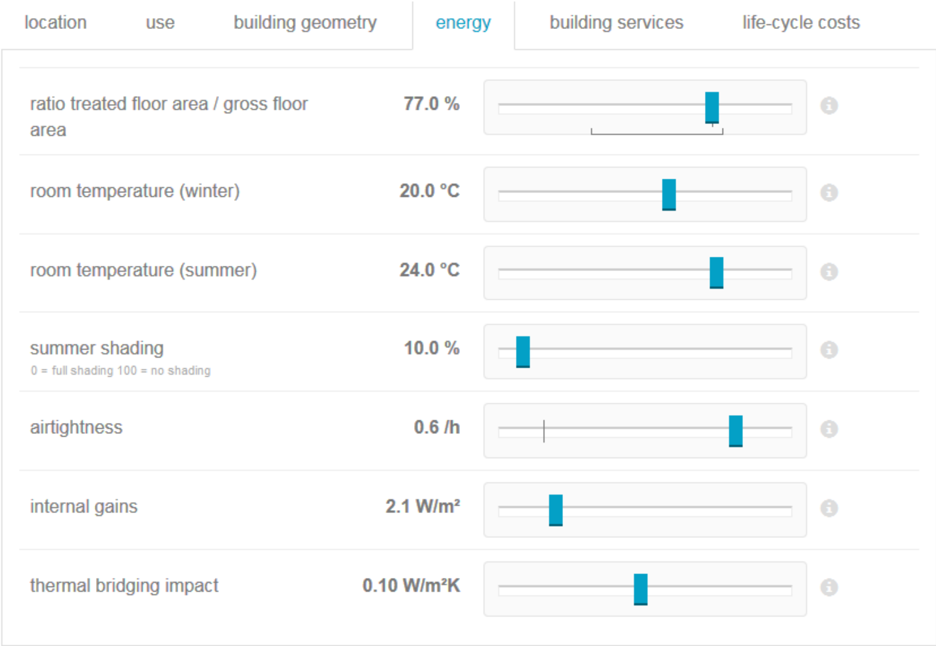
- Number of levels: number of full-stories above ground, including the roof-storey. The basement is excluded.
- Floor height: from top of floor, including construction, to top of floor of next level.
- Building ratio: describes the building geometry in plan view, depth (d) to width (w) ratio
- Roof inclination: describes the slope/angle of the roof in degree (0°= flat, 15°= slight slope, 45° = steep sloped roof)
- Ratio glazed area / lettable floor area: approx. amount of window area to the lettable area. This is regarded as a minimum of.10% for livable space.
- Glazing on South façade: South facing portion of total window area of the building
- Glazing on North facade: North facing portion of total window area of the building


location
use
building geometry
energy
building services
life-cycle costs
floor levels including roof level
4.0
height between floors
2.8 m
ratio width/length
1:2.00
roof inclination
20.0 °
ratio glazed area / useable floor area
24.0 %
share of glazed area on South elevation
64.0 %
share of glazed area on North elevation
22.0 %

1.4. Energy

Specific information in required about the energy needs of your building. Energy requirements of a building include both projected information along with information which can change depending on the users' behavior.

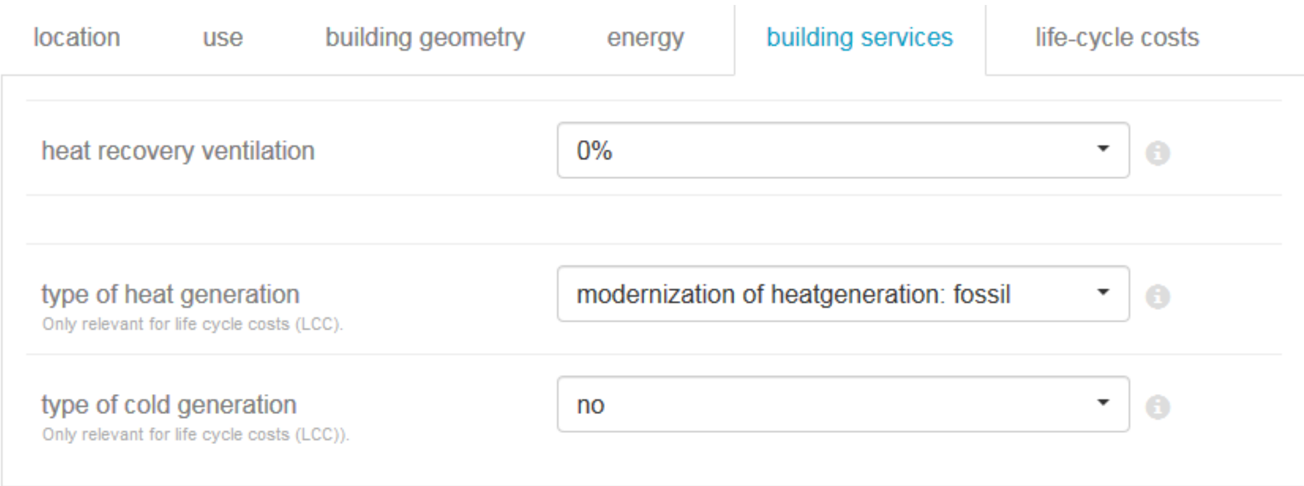
- Treated floor area/gross floor area: this is the sum of all floor areas of a building being heated or temperature controlled, usually less than the gross floor area.
- Room temperatures: Minimum acceptable temperatures in winter and summer are to be set. This determines the onset of heating or cooling
- Summer shading: Reduction factor for dynamic shading to avoid overheating the expected value is between 0-100.
    - Benchmark values:
        - full shading = 0
        - no shading = 100
        - exterior shading = 10
        - interior blinds = 70
- Airtightness: This is an essential strategy for energy efficient buildings which create an entire heat-insulated building volume with a permanent airtight layer which controls and optimizes the air change of the building and with it the related energy losses. Note that airtightness is seldom a part of older building construction
- EnEV 2014 benchmarks: buildings with mechanical ventilation = 1.5/hr.
- Internal gains: heat produced through its use by occupants, machines, appliances, lighting, etc.
- Thermal bridging impact: This is also known as the thermic transmission or U-value. It is an important factor in the calculation of the heat losses. EnEV 2014 benchmarks between 0.05 to 0.15 W(m^{2}k)


location
use
building geometry
energy
building services
life-cycle costs
ratio treated floor area / gross floor area
77.0 %
room temperature (winter)
20.0 °C
room temperature (summer)
24.0 °C
summer shading
0 = full shading 100 = no shading
10.0 %
airtightness
0.6 /h
internal gains
2.1 W/m²
thermal bridging impact
0.10 W/m²K

1.5. Building Services

The building services tab asks for information on a building´s energy use:

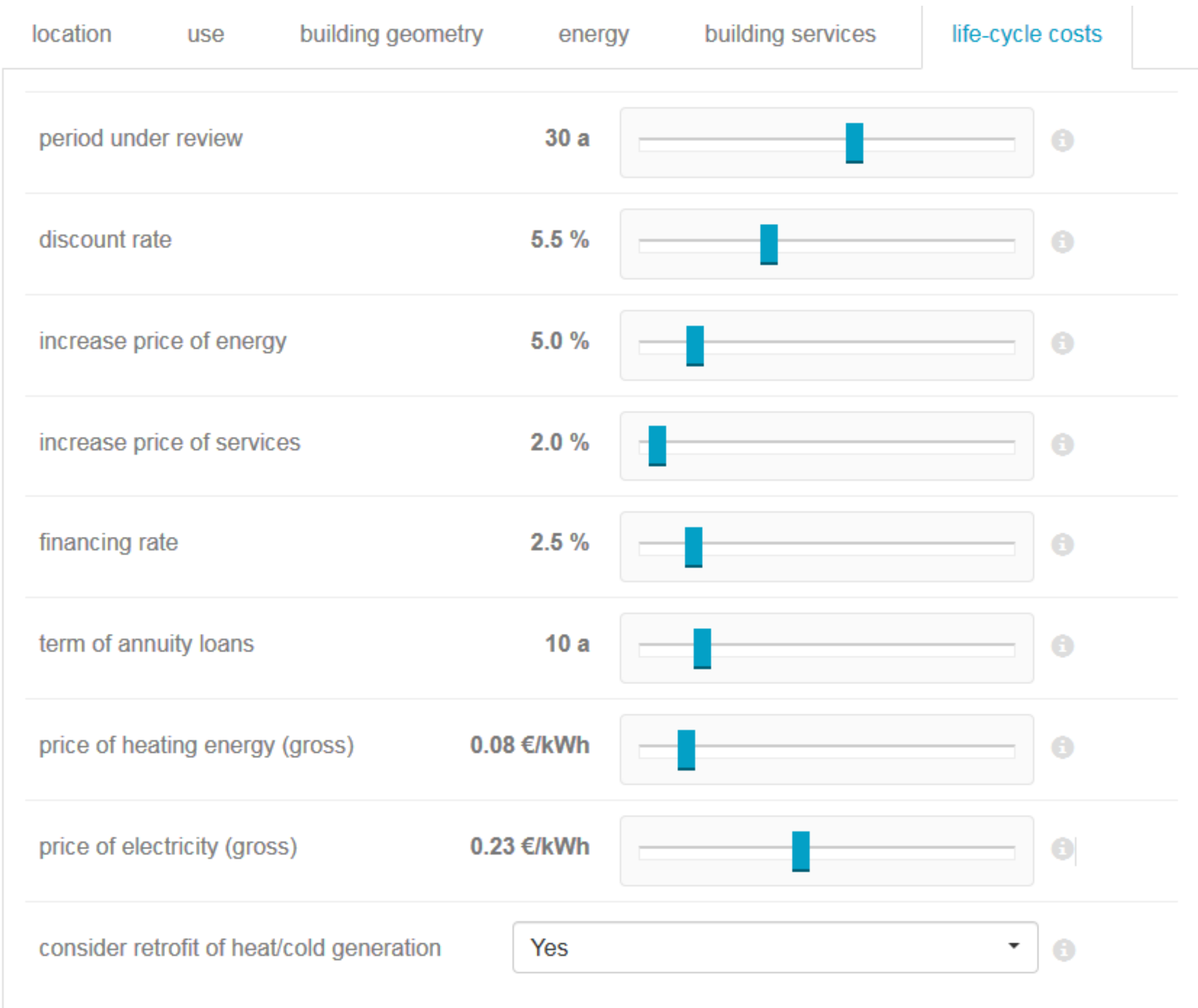
- Heat Recovery ventilation: not present in all heating systems
- Type of heat generation: this is where renewables can be considered
- Type of cooling generation: only relevant in climates where air conditioning is used



1.6. Life-cycle costs

Life-cycle costs (LCC) refer to economic related information of the total cost throughout the projected, planned life of a building. This includes planning, design, acquisition, support costs and any other costs directly attributable to owning or using the building.

- These factors may vary considerable from country to country
- They are distinctive to each investors/owners individual portfolio

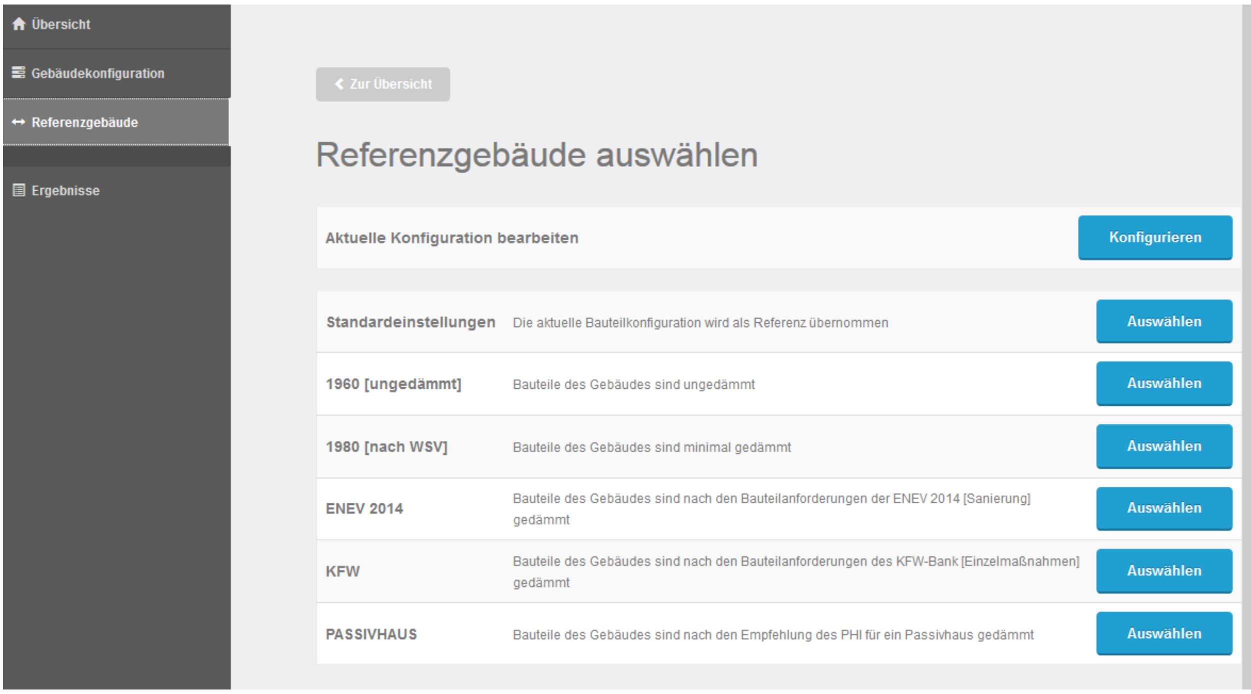


Chapter 2 Reference Building

Within the BEG software there are six (6) reference buildings as benchmarks with which the user can compare their building. The six buildings vary in configuration, components and energy needs. The reference buildings become newer and more energy efficient as you move down the list:

- Standard Settings: This refers to your current configuration. It would be adopted as the reference building
- 1960 (uninsulated): This is an older building which would have been built without insulation[3]
- 1980 (insulated to WSV "Wärmeschutzverordnung"): This building refers to WSV, the German energy standard established in 1980
- EnEV 2014: This is an energy saving regulation which sets out thermal insulation standards for residential and commercial buildings. These legislative regulations must be observed during the refurbishment of existing buildings as well during the construction of new buildings. As proof of compliance, an Energy Performance Certificate must be issued for the new or refurbished building.
- KFW: German building EE standard that reduces the Primary Energy Use and Energy Transmission through the building envelope to 55% of EnEV requirements.
- Passive House standard: The Passive House concept is the only internationally recognized, performance-based energy standard in construction and is the most stringent of the reference buildings

[3] All these will vary depending on the country's individual regulations

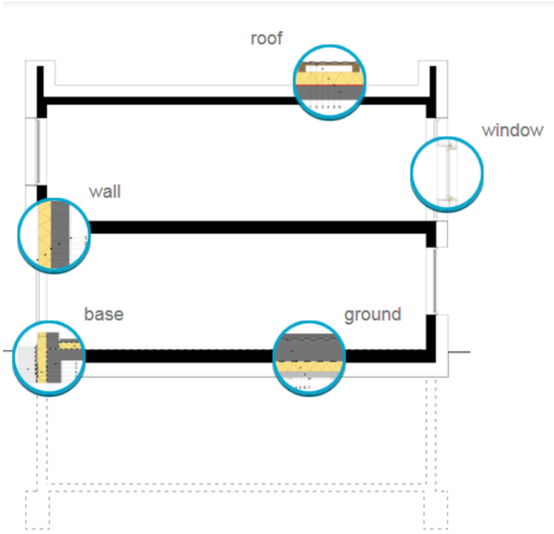

Übersicht
Gebäudekonfiguration
Referenzgebäude
Ergebnisse
Zur Übersicht
Referenzgebäude auswählen
Aktuelle Konfiguration bearbeiten
Konfigurieren
Standardeinstellungen
Die aktuelle Bauteilkonfiguration wird als Referenz übernommen
Auswählen
1960 [ungedämmt]
Bauteile des Gebäudes sind ungedämmt
Auswählen
1980 [nach WSV]
Bauteile des Gebäudes sind minimal gedämmt
Auswählen
ENEV 2014
Bauteile des Gebäudes sind nach den Bauteilanforderungen der ENEV 2014 [Sanierung] gedämmt
Auswählen
KFW
Bauteile des Gebäudes sind nach den Bauteilanforderungen des KFW-Bank [Einzelmaßnahmen] gedämmt
Auswählen
PASSIVHAUS
Bauteile des Gebäudes sind nach den Empfehlung des PHI für ein Passivhaus gedämmt
Auswählen

Chapter 3 Components

After this general description of the building, come more specific details of how the building is actually built and/or is designed to be built. In the BEG, with the components of a building are divided into the five major areas; roof, wall, windows, base foundation and the ground floor

- Each major building element can be selected from a drop-down list
- These components are characterized by their thickness, material and U-values
- All of these characteristics impact the final energy consumption and costs

Component Overview

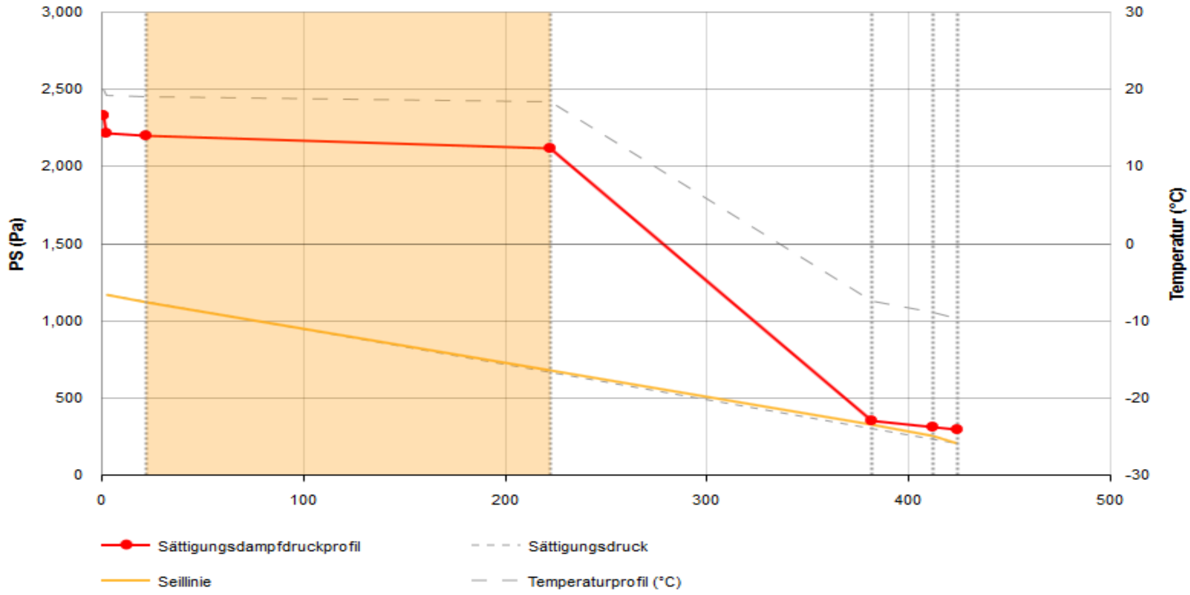


building: BuildTog Common Design		
climate/location	Frankfurt, DE	
use	educational	
useable floor area	1040.0	m^2
building size (length x width x height)	28×14×13	m
surface-to-volume ratio	0.4	
HT´	0.33	W/m^2K
energy		
set room temperature summer	24	°C
set room temperature winter	20	°C
heating demand	33.26	KWh/m^2a
heating load	18.46	W/m^2
cooling demand	1.91	KWh/m^2a
cooling load	6.05	W/m^2
life-cycle costs		
Please configure reference building to display life-cycle costs.		

Changes to the building envelope system can have undesired and sometimes detrimental effects to the moisture-temperature gradients in the envelope systems. The BEG does provide limited information (see below as an example). It is advisable to engage a knowledgeable building physics expert/ buildings services engineer to evaluate proposed changes.

U-Wert	0.23	W/m²K
HT´	2.02	W/m²K
Heizwärmebedarf	220.36	KWh/m²a
Kühlbedarf	0.00	KWh/m²a

Tauwasser- und Temperaturverlauf nach Glaser (Berechnung gem. DIN 4108-3):

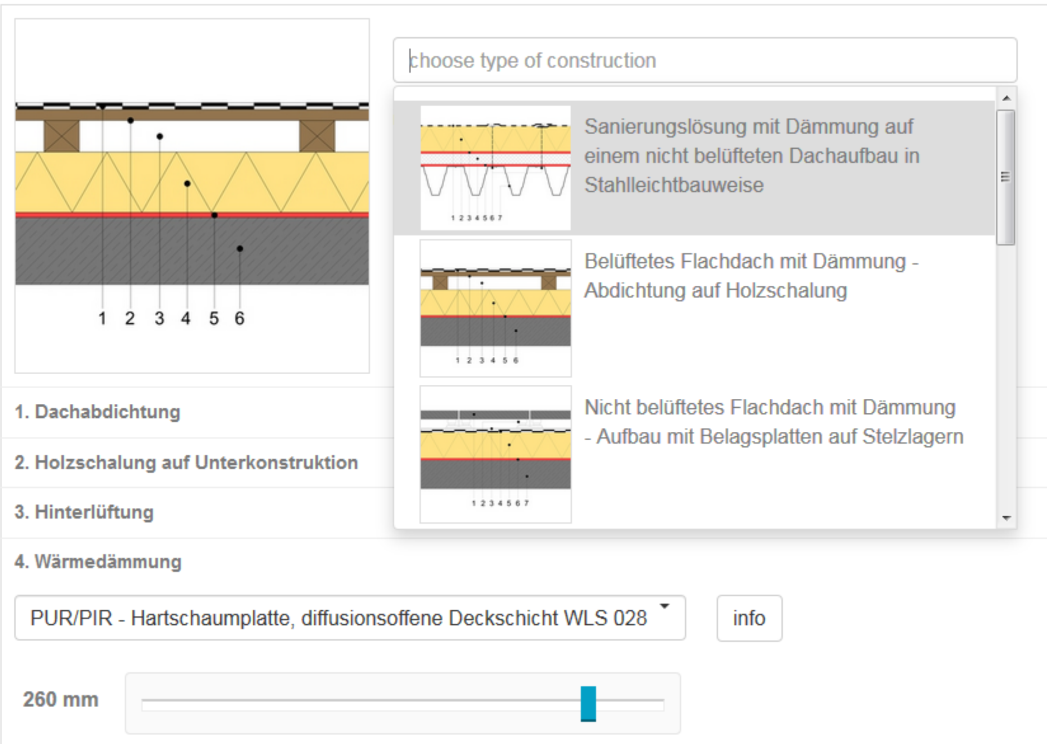


3.1. Roof

Overall the roof should have the best insulation of all the components because warm air rises and therefore most of the heat loss happens through the roof.

- It involves installing thicker and/or better insulation materials on top of, or between, the roof structures
- Sometimes this is feasible on the underside of the interior of the roof in the attic space of the building
- It may be possible to insulate the floor of the attic but there is a need to check that these area can continue to support non-static loads (e.g.people accessing this space)
- The most efficient time is when the roof covering is replaced but this tends to occur only occasionally being dependent on the longevity of the roofing material

Roof Detail

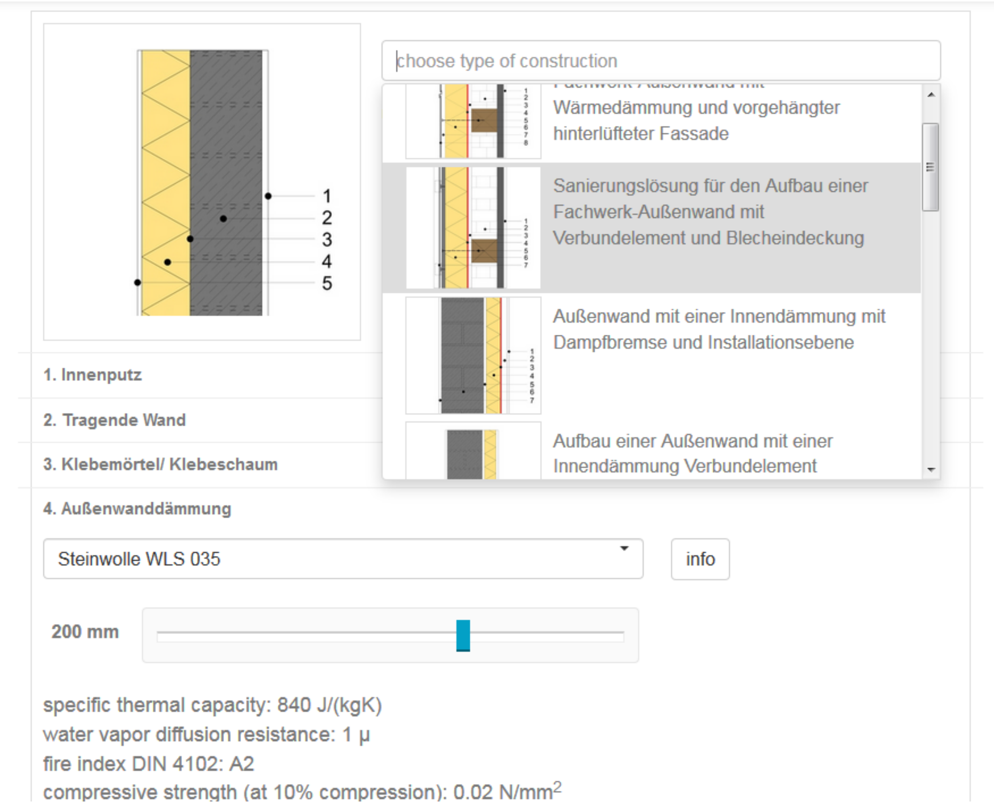


3.2. Wall

This refers to the exterior vertical building envelope. Different set-ups are available in the drop down menu.

- There are different options to select from the drop down menu. From this menu it is possible to select the thickness and other variables of the walls' performance
- It is recommended to add insulation to the exterior. However where that is not possible, interior insulation can be added but this may result in loss of floor area, displacement of the occupants (if building is not vacant) and may create detrimental moisture problems.
- Internally it is best done during a complete renovation to minimize disruption to people and services.

Wall detail

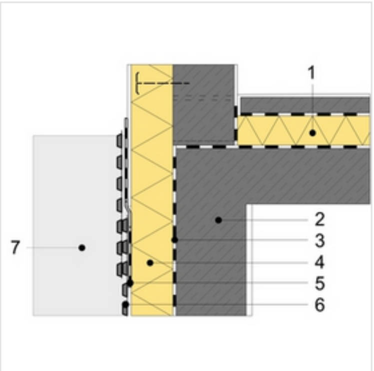


3.3. Base or Foundation

The Base of the building refers to the connection of the exterior wall to the ground level structure. The ground level structure is sometimes referred to as the foundation, whether or not there is floor level below ground level.

- The base detail is especially important to prevent upward and sideways water penetration and provides a thermal break. The thermal break prevents unwanted heat exchanges between the inside and outside of a building.
- The base detail can also improve air tightness. Air tightness involves air barrier systems that reduce unwanted air exchange of conditioned air
- Obviously, this is most feasible for new construction; however, it may be possible during major refurbishments.

Base Detail



Außenwand gegen Erdreich mit Perimeterdämmung

note: existent insulation is not considered for thermal calculation

1. Fußboden/Deckenaufbau

2. Kelleraußenwand

3. Bauwerksabdichtung

4. Perimeterdämmung

EPS Neo - Expandierbares Polystyrol WLS 031

info

200 mm

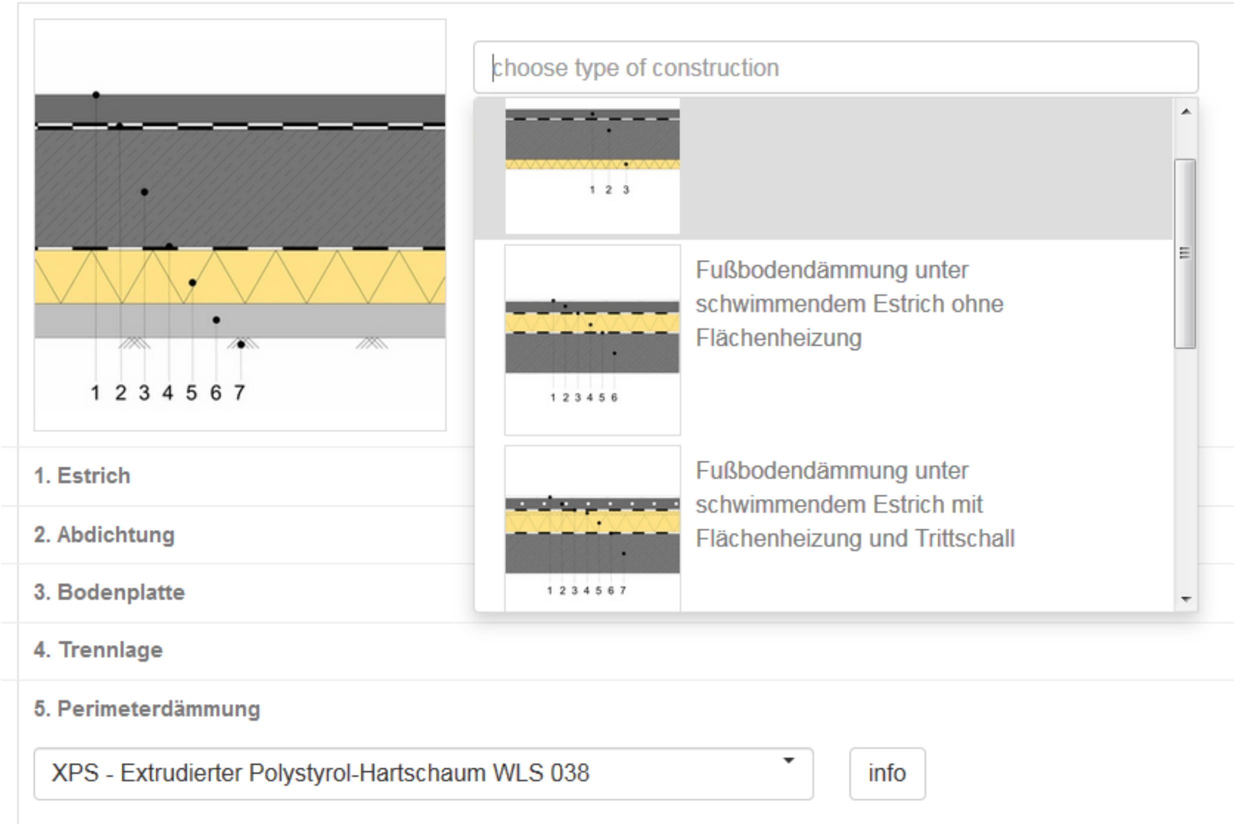
Innovatives, expandierbares Polystyrol mit Graphit, einem Infrarotreflektor, versetzt. Schaumstoffe aus Neopor sind silbergrau. Sie bieten eine besonders hohe Dämmleistung auf. Sehr gutes Wärmedämmvermögen,hohe Druckfestigkeit, geringes

3.4. Ground

The ground level is defined as the layer of structure which sits above the basement or crawlspace. In existing buildings, this layer marks the lowest level of the building envelope.

- The ground floor plan can have the lowest energy rating
- Modern energy efficient buildings should have basement and attic spaces included in the thermal envelope

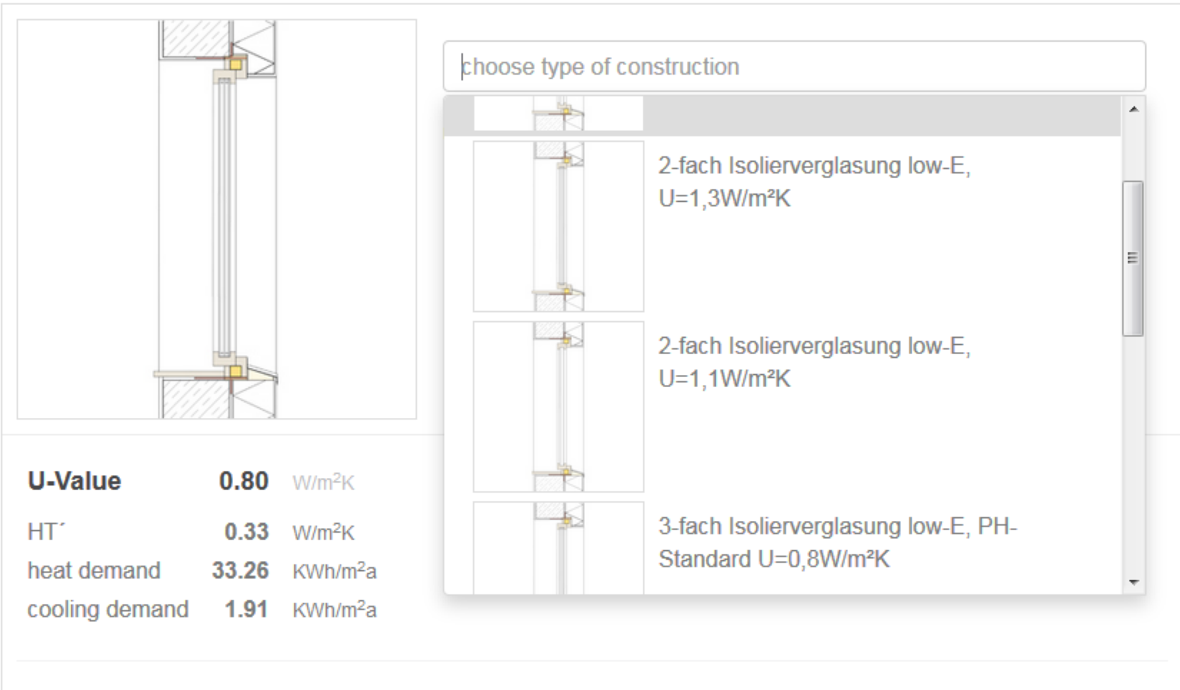
Ground Detail



3.5. Window

Windows are a very important component of every building. They provide light, ventilation and view. In comparison to the wall, windows are an inefficient area of a building. Care must be taken regarding the appropriate U-values for the climate and proper installation.

- In choosing a window, the various glazing and U-value options will depend on specific situations of the project
- Install modern windows with low heat losses and/or heat gains through the installed window system
- Replacing windows is normally feasible for refurbishments as it can be implemented while building is occupied.



3.6. Results

The Building Efficiency Guide's results page provides the Heat Transmission losses (H'T), which are an indication of the level of energy efficiency of your building. The lower the H'T the more efficient your building. The results provide the additional/reduced cost equivalent for the Life-cycle cost and estimated investment costs in comparison to the selected reference building. An overview of your building's configuration and components is also provided.

Other items to note:

- Installing a mechanical ventilation system with heat recovery allows heating energy from ventilation exhaust air to preheat ventilation fresh air
- Installing heat recovery to an existing ventilation system, is a valuable method of increasing saved energy
- Check the construction costs, they are given +/- 20% depending on the quality of comfort and architecture
- Check the costs in relation to saved energy. Different interventions can have vastly different cost to energy saving potential
- As with any results, the better the data, the more accurate the results

Chapter 4 Conclusion

Overall the BEG is a method to inform users on how changes in materials, climate and/or systems can impact a building's energy performance. Selecting the correct improvements in the building envelope and/or systems will have an impact on the cost per-saved energy unit and the construction costs. Applying that knowledge, early on in the design process either at the point of new build or refurbishment of how a material or system may affect the building's overall energy uses allows for more transparency in the planning process. This may strengthen the understanding and identification of a building's 'invisible' sustainable qualities. This may in turn provide a better feel of a building's financial performance. Examples of 'invisible' sustainable qualities revolve around elements of a building which are not immediately apparent on limited inspection. Daylighting and orientation are examples, which are apparent on a preliminary inspection. Envelope insulation and massing are not apparent. Within the BEG, these elements can be addressed. By including these 'invisible' impacts, it can help define the investment costs an owner may incur to bring an existing building up to their required standard.

Potential future development of the tool will allow users to input materials from their region. Specifications and current prices of products and materials would potentially allow architects; contractors, owners and valuers to get a more accurate view of how these elements will affect the overall construction pricing and potentially impact future building value as the need for EE in buildings gains traction.

Energy consultants understand there are both costs and benefits to a renovation which is geared towards energy efficiency and sustainability. Investment worth can impact the owner and investor's collective goals. Gathering the appropriate data on existing portfolios and realizing that there is not a 'one size fits all' solution will enable wide application of this methodology and thus enable improvements. As methods improve, so will the accuracy of the benefits and burdens in choosing sustainability over just the status quo. The results may inform legislation and drivers in innovative EE technologies. Ultimately, it will be the people living and working in the buildings and our planet as a whole who and which will benefit.