Carlos Vaño Navarro **409731**

Thesis Supervisor: Vincent Inja

Hanze University Groningen

Reader:

Gerrit Ribberink

Hanze University Groningen

Client:

Marteen Vieveen

Hanze University Groningen,

Research Centre, Area development

INDEX

Internal insolation
Energy effect
How this measure affect the historical value.

4.2.2 Floors

a. Goal
b. Degree of aplicability
c. Influence of energy demand
d. Technical implementation
    -External insolation
    -Internal Insolation
e. Measured used.

4.3.4 Windows

a. Goal
b. Degree of aplicability
c. Influence of energy demand
d. Technical implementation
    - Replacement glass
    - Replacement of timber and glass
    - Installing double-glazing
e. Measured used.
    Double-glazing
    Energy effect
    How this measure affect the historical value.

4.3 Active meassures

4.3.1Introduction

4.3.2 Improved installation and equipment

c. Goal
d. Degree of aplicability
c. Influence of energy demand
d. Technical implementation
    - Fossil fuel boilers
    - Biomass (Pellets)
e. Measured used.
    Biomass (Pellets)
    Energy effect
    How this measure affect the historical value

4.3.3 Energy from renewable

a. Goal
b. Degree of aplicability
c. Influence of energy demand
d. Technical implementation
    -Solar Thermal Energy
    -Solar photovoltaics

6-Annex

I- Thermal-picture report

II- MCA (Multi-criteria analysis)

III- Resistance calculation

IV- Enorm Results

V- DA DB-HE / 1 Calculation of characteristic parameters of the envelope

VI- Specifications conditions for the restoration of the former police Eise Eisingasthaat 10 in Franeker to a home.

VII- Specifications conditions for the restoration of the former police eise eisingasthaat 10 in Franeker to a home. (Instllation-technical)

+ Central heating

+Gas main

+ Hot and cold water pipes and plumbing

+ Electrical installation

+Zinc Work.

Introduction

Sustainability of buildings is again in the spotlight. After the oil crisis in the 70 years and acidified forests in 90 years, now leads the awareness of the finite nature of resources and global warming to the call for a balanced approach to our environment. What is new, is that there is no such broad support existed like in the past society. In this context, and since February 2014, I have worked at my final thesis at Hanzehogeschool Groningen University of Applied Sciences. The major topic of my work is Energy Efficiency of a Historical building from Franeker.

Since 1988,the city of Franeker has many historic and listed buildings. The law guarantees maintained all these monuments. These buildings often do not meet the comfort requirements demanded by the user and also with the current standards. Current users are now facing the problem of using a lot of energy to acclimate their homes, which results from high costs on their bills.

In this city, Franeker, an initiative was born to preserve historical buildings and to invest in improved comfort and sustainability. Due to this fact, a group called WERF was created and it started to be interested in the ideas of students' projects. The Hanze University suggests a connection between this group and the students with final thesis, in this case, me. The building with which I work is located on the street Eise Eisingastraat 10 and it is owned by one of the people who formed the WERF group.

My idea is to resolve this problem, through energetic measures and to reduce consumption. In this study, it is illustrated all the possible variants and the best option for each case. Moreover, it has explanations and a clear view that the used solution respects the historical values. The problem described above leads us to ask the following research question:

"How can we update the energy efficiency of an historical building without compromising the architectural value of the building?" (In the house in Eise Eisingastraat 10)

In this study I will answer the next Sub questions:

Which architectural measures are appropriate to access without compromising the outward manifestations of a building? Building energy efficient

Which installation-technical measures are suitable to access without compromising the outward manifestations of a building? Building energy efficient

Which (external) architectural values should stay intact?

Which structural measures are needed to improve energy efficient without compromising the architectural values?

Which installation-technical measures are needed to access without compromising the architectural values?

Which general construction and installation engineering hints must be taken into account in the implementation?

After all the information collected and all the researches, I have the knowledge to start with the empirical research. In the first part, I start making an introduction about how the historical building works. Then I continue studying with a thermal-study the different building pathologies. There are air leakages, insulation black and spalling. The different information that I collected help me to explain the reason, and later to find a solution.
With the Enorm software, a program that helps you to know the energy efficient, I purpose different measure to resolve the problems found it previously. I made a comparison between the current situation and the improvement measure situation.
In the next step, I explain with details the measures selected in the previous step, with the help

of MCA. In every measure it is explained the goal, the degree of applicability, influence of energy demand, technical implementation, energy effect and how this measure affect the historical value. Finally I wrote the conclusion and recommendation.

2- How a traditional building works?

When taking into account the traditional building works, it is important to understand how that building was designed to work. In simple terms, many traditional buildings were designed with passive ventilation, which ensured air flow around building elements to keep the free from excessive moisture and subsequent decay. The construction was further designed to allow an element of vapor movement within the structure. It is vital to ensure that when taking steps to improve the thermal performance of a traditional structure, these dynamics are not compromised to the detriment of the building. This is not to say that we should live in draughts, but it is important that sufficient air movement is maintained.

Heating regimes and equipment

Before considering any upgrade to building fabric, it is important first to ensure the space heating equipment such as boilers and radiators, which are used efficiently. Studies have shown that the effective use of such equipment can have a larger impact on reducing emissions and fuel consumption than fabric interventions. Where central heating is used this should be fitted with proper controls and these should be well understood by the building owner or occupier.

Roofs and attics

Around 25% of heat is lost through a typical roof, so suitable levels of loft insulation are a good starting point in improving the thermal performance of a traditional building. At least 270mm of insulation is required to be fully effective. There are many types available, from natural materials such as hemp fiber or sheep's wool to recycled products made from newspaper, and others made from glass and modern materials. In most circumstances natural materials are preferable in traditional buildings, as they are better able to disperse moisture and prevent condensation. It is essential, when the loft insulation is installed to ensure that the coombs are effectively insulated whilst at the same time maintaining ventilation throughout the roof space. Recent guidance is that there should be a 5 cm gap between the top of the insulation and the underside of sarking boards.

Floors

Where timber flooring is preserved on a ground floor it may be sufficient crawl space to allow insulation in order to be installed on the underside without the need to lift the floor boards. If it proves necessary to lift the boards to install the insulation, this should be done with care to avoid damage to the original fabric and may be deemed not worth the risk. Lifting floorboards invariably will result in damage, and often requires entirely new boards being laid. The cost of this should be weighed with the benefit of improved insulation being installed. Whether installed from above or below, as with loft insulation, a material which allows some degree of moisture movement should be used. Laying non-permeable insulating board on top of a timber floor will inhibit water vapour movement, and may give rise to timber decay.

In most cases flagged floors should be left in situ as lifting them may cause damage. However, where a flagstone floor requires to be lifted for other reasons it may be worth considering laying an insulated lime concrete floor under the flags.

Where original floor finishes have been lost and a more recent concrete floor laid there are considerable benefits in insulating this using a proprietary insulated board.

External doors

Whilst the frame of a traditional timber door generally performs well thermally, improvement can often be made to the panels which are typically made of thinner wood. This can be done by adding a layer of appropriate insulation material on the indoor side whilst maintaining the character of the door from the outside. In all cases, the finished insulation should be kept flush with the door framework, new beads may be required to finish the edge. Draught or weather stripping around the edge of the door and the letter box can also help. There is little need to insulate internal doors, unless there are significant heat differences between rooms.

Windows

Whilst a single pane of glass has a fairly poor thermal performance with a U-value for most traditional glass of around 5.2, there is a range of sensitive upgrade options which can considerably improve this.

Draft stripping of the sashes can reduce air leakage by 80%, as well as allowing the full use of the window in terms of opening and closing, although it will not improve the U-value. Many companies provide this service, which combines the upgrading work with a general overhaul of the window and the sash cords.

There are many improvements which can be made to the thermal performance of a window without intervening in its fabric. These are summarized in Table 1 which gives the results of tests on a range of improvement measures. These tests showed that secondary glazing is the most effective option, as it reduced heat loss through the window by 63%. Timber shutters are the most effective option of the traditional methods, reducing heat loss by 51% with the level of improvement gained by the other options shown below.

The greatest reductions in heat loss came from a combination of measures. Using secondary glazing, or combinations of blind and shutters, reduced the U-value of the window to around or below 1.6. Whilst many of these options do shut out natural light, the period of lowest temperature (and therefore greatest heat loss), is at night when this is not an issue.

Improvement method	**Reduction in heat loss**	**U-value W/m^2K**
Unimproved single glazing		5.4
Fitting and shutting heavy curtains	14%	3.2
Closing shutters	51%	2.2

Modified shutters, with insulation inserted into panels	60%	1.6
Modern roller blind	22%	3.0
Modern roller blind with low emissivity plastic film fixed to the window facing side of the blind	45%	2.2
Victorian blind	28%	3.2
A "thermal" duette honeycomb blind	36%	2.4
Victorian blind and shutters	58%	1.8
Victorian blind, shutters and curtains	62%	1.6
Secondary glazing system	63%	1.7
Secondary glazing and curtains	66%	1.3
Secondary glazing and insulated shutters	77%	1.0
Secondary glazing and shutters	75%	1.1
Double glazed pane fitted in existing	79%	1.3

Table 1: Results of U-value testing for improvement measures to sash and case windows

For more significant improvements, building fabric interventions are required to involve alterations to glazing. This includes a range of double glazed units which can be retrofitted into existing sash and case windows to greatly improve energy efficiency, but without adversely altering the character of the window. These come in a range of types from fairly simple slimmed down double glazing to more advanced vacuum pane technology. Whilst sash and case windows are extremely durable and when well maintained will last many years, if extensive repair or replacement of windows is necessary, such glazing options may be beneficial. Other options such as: acrylic "conservation glazing" which can be inserted against the existing wooden glazing bar are being developed. Not all options are appropriate in all cases and there will always be something which can be done to improve the thermal performance of windows in traditional buildings.

Walls

External Insulation

External insulation will not be appropriate in all circumstances. Where there is ashlar work of a high quality or a sensitive façade its application would not be appropriate due to the negative visual impact. However, in a situation where a building has been rendered or hurled in the past the application of an insulated replacement may be considered. This is particularly the case where the render is an inappropriate cement based material, the removal of which would help both the health of the building and its thermal performance. When considering external insulation it is important to use a material which is appropriate. This is likely to take the form of an insulated lime render containing a material such as: hemp fiber or expanded clay aggregate. Boards and spray applied material which does not allow a degree of moisture movement through the structure should not be used as these are likely to damage the building over time.

Internal Insulation

There is a range of insulation types which can be applied to walls internally, all types are shown in table 2. These and other products can be applied in a variety of different ways. The board type insulation is fitted between existing or new timber strapping and can be finished with a skim coat of plaster. Material such as: the blown cellulose is sprayed on damp and finished with a board being placed over the material. The polystyrene bead was injected behind the existing wall finish after some re-wiring work had taken place for safety reasons. All the materials tested gave significant improvement to the thermal performance of the building. When considering any form of internal insulation, it is vital to ensure that they have a degree of moisture permeability and are not creating a vapor barrier which could lead to a buildup of moisture in a wall and associated decay. Internal insulation which requires the removal of existing wall linings is only appropriate where there are no historic interiors present.

Insulating behind lath and plaster

When lath and plaster remain in situ, it is not recommended its removal. There are options which may be tried in terms of putting material such as polystyrene bead behind the lath. Another option, which is being developed, is using a thin (10mm) insulation applied as wallpaper. Tests have shown, however, that lath and plaster with a void behind provides a degree of insulation in itself and it may be better not to intervene where such lath and plaster is still in place.

Insulation type	Unimproved U-value	Improved U-value
100mm Hemp board between timber	1.1	0.21
90mm Wood fibre fitted between timber	1.1	0.19
30mm Insulated board onto timber	1.1	0.36
50mm Cellulose fibre damp sprayed between timber straps	1.1	0.28
40mm Insulated board onto timber	1.1	0.22
50mm Bonded polystyrene bead	1.1	0.31

Table 2: Improvements in U-value given by various internal insulation options applied to a solid walled tenement

2- Thermal Study

2.1 Why a Thermo graphic Study?

2.2 How It Works

2.3 Results

2.1 Why a Thermo graphic Study?

I made a thermo graphic study because it is essential to know the current state of the house. With the pass of time some materials start to lose her properties. This is a good way to know the specific points where we should focus our restoration.
Without a thermal imaging survey it would not have been possible to identify the issues exposed in this report with a large amount of invasive work such as removing ceilings to identify where insulation is missing or using smoke bombs to show where windows and doors are leaking air. This also means that only the affected areas of ceilings need to be removed to rectify these issues dramatically cutting down the expense and disruption of any remedial works.

2.2 How It works

For a thermal imaging survey it is more effective when outside is colder and inside the property is. The images in this report were taken with an ambient air temperature of around 1 degree centigrade, and the heating was turned up in the property to ensure good results.
It should be noted that when images are taken from the outside of the property then areas where heat is leaking out show as orange and red, while well insulated areas show as blue. The opposite is true for images taken from inside the property where blue areas show where heat is leaking out of the property. The thermal imaging camera

incorporates a digital still image camera to allow the various thermal images to be easily identified. Not every color corresponds to the same temperature all the time. It depends on the heat difference that we have in the image.

2.3 Results

2.3.1 Air leakages

Typical air leakage places were around and through windows and doors, in the junction of ceiling/floor with the external wall, penetrations through the air barrier systems, and walls and floors between apartments.

The main typical air leakage place was in detached houses in the junction of the roof and the external wall. In apartments most typical air leakage was around the doors and windows.

In our building, the main air leakage is placed in the windows, in the part where we can open it. If we change the entire window for a double glassed, we will spend a lot of money with poor results. I think that the smarter solution is address tochtstrips. We are not going to spend a lot of money, and we will lose less energy in those points.

2.3.2 Spalling

As we can see in some pictures of the thermal-study some interior and exterior walls suffer spalling. After an investigation, I arrived to the conclusion that the water penetrates by capillarity. But, where is this water from? There was water flowing In parallel canal to Eise Eisingastraat. This canal was removed, but some years later, in a house in Eise Eisingastraat started to appear a big infiltration water. The owner had to use an extractor water pump, like a provisional solution. My conclusion is that when they removed the canal, some water started to flow under the Eise Eisingastraat street. And this is the water of the infiltration.

2.3.3 Insulation lack.

There isn't any area where there is a thermal bridge due to lack of insulation. But I can see that the isolation is not the best, and is possible a good improvement. So the conclusion is that is possible and highly recommended to increase the insulation thickness.

3-Energy efficiency calculation

3.1 Energy Label Introduction.

The energy label is a label according to various European directives (92/75/CEE, 94/2/CE, 95/12/CE, 96/89/CE, 2003/66/CE) should be included in the sale, among other car 's electrical appliances, lighting and buildings.

This label is a measure of the consumer to see how efficient, environmentally friendly and / or energy saving the purchased product. Also there is often information about the performance of the product and the materials used in the production.

In the Netherlands, the Directive is implemented as the Decree of 25 February 2012 laying down rules on the energy labeling of energy-related products (Decree energy labeling of energy-related products) . Pursuant to Directive 2010/30/EU, the Commission shall adopt delegated regulations (also called delegated acts) fixed. Those delegated acts have direct effect and therefore do not require implementation by ministerial regulation. For the product categories for which there is no regulation, the ministerial order remains in force provisionally.

3.2 Buildings

A + +	Less than 0.5
A +	Less than 0.7
A	Less than 1.05
B	Less than 1.3
C	Less than 1.6
D	Less than 2.0
E	Less than 2.4
F	Less than 2.9
G	More than 2.9

In 2002, the European Parliament adopted the EPBD directive. This Directive aims at reducing the energy consumption of buildings , with a view to reducing emissions include CO_2 and to reduce dependence on fossil fuels. On the basis of this European Directive is mandatory since January 1, 2008 in the Netherlands that energy should be handed over to the new user on any transaction of a dwelling or non-residential building over 10 years. Housing associations have to comply with this obligation, provided they or their entire building stock suddenly with an energy until January 1, 2009

The rules for granting greatly simplified since 2010: It is estimated how many giga joules of energy the home used each year per square meter for heating, hot water and lighting. These will be deducted the estimated heat from sewage and ventilation, and the estimated energy via solar collectors (both electrical and hot water). It is assumed average occupancy, average outdoor climate and an average combustion behavior.

A property with an A + + label fired in theory, four times less energy than a house with a D-tag. That saves a house of 100 square meters each year roughly 3,000 euros on energy bills. Incidentally, anyone who uses the energy during the night and working hours, the heating layer always move, usually much less than the label suggests.

The obligation of the energy also applies to the sale or lease of a different building than a home. The energy label is required for construction, sale or rental of residential and non-residential buildings, which are: offices, schools, factories, barracks, hospitals and others. The requirement also applies to new leases of non-independent units, such as student rooms and also for some holiday. In buildings larger than 1000 m^2 in which public authorities or public institutions are located and accessible to the public, is from 1 January 2009 a permanent energy to be present. This label must be visible to the public.

In the Netherlands, there are approximately 350 certified companies that can provide an energy end of 2008. Since November 1, 2008 we must have a certificate issued by CITO. It states that every energy sensor and / or a property consultant can adopt it. Without this degree, one is no longer authorized to provide energy labels for homes.

3.3 ENORM

3.3.1 introduction

Since July 1, 2012, the new energy performance standard BS 7120 EPG forces and makes architects, engineering consultants and municipalities to use the new energy software HUGE. This package is the logical sequel to the successful software EPU NPR NPR EPW 2917 and 5129, as developed in recent years. DGMR through in collaboration with NEN ENORM allows you to perform, for example, the energy building from a calculation in a simple way. These modern techniques can be measured to achieve EPC requirement. The results of a calculation are always clearly presented. In the context of the review of the planning application the HUGE program connects seamlessly with the new EPC program of the municipalities. The use of the ENORM program fits in well with the NEN NPR software as it was used. Till July 1, 2012 this allows you to get started quickly with the new HUGE software.

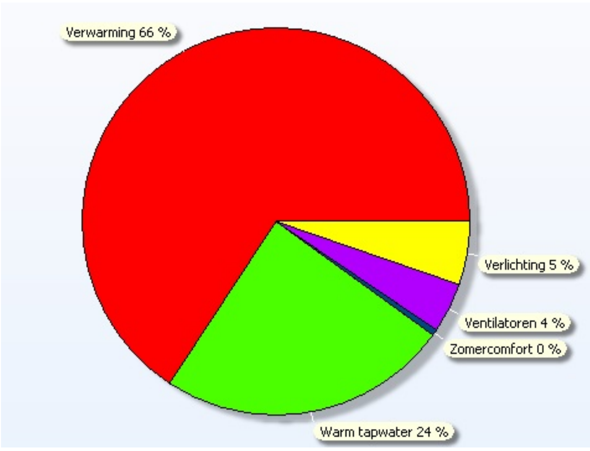
3.3.2Possibilities of the program

The ENORM program is very user-friendly layout. The input data is always checked for accuracy. To assist in entering data, the user is included specific help information in several places (i). The EPC is immediately recalculated after each change in the input data and displayed (live). Both residential and commercial buildings are seamlessly integrated into one program.

3.3.3 Enforcement

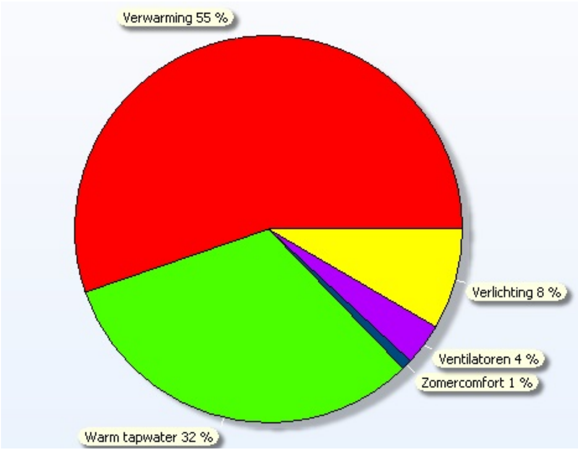
3.3.3.1 Existing situation

The calculation of the EPC with the ENORM program, with the existing situation, give the result of 2,08. As we can see in the table above,we are in the D energy label.
A new building has to respect the current rules and should have the EPC below 0.6. But this case is not a new building, so we don’t have to be under 0.6. Anyway, I’m going to implement some improvements to reduce our EPC.



3.3.3.2 New situation

I have introduced in the program the next list of improvements. The initial value of EPC is 2.08 and after the improvements is 1, 19. We've gone to a D energy level to a B energy level. In this point we arrive to ALARA. I mean, we can not improve more the energy eficient. If the owner wants to invest more money is not profitable.



Improvement	EPC decrease	%	EPC total
Existing	2,08		2,08
HR-107 boiler	0,31	34,83146067	1,77
Tappaint warm water: u-6mm ; pipe diameter: 8mm	0,08	8,988764045	1,69
Pilot light	0,02	2,247191011	1,67
Wall insulation Rc=2,5	0,02	2,247191011	1,65
Windows U= 5,7 --- 2,8	0,22	24,71910112	1,43
Roof R c= 1,1--- 2,5	0,14	15,73033708	1,29
DC fans	0,03	3,370786517	1,26
Solar panel 10m2 east Roof	0,07	7,865168539	1,19
	0,89	100	

4- Construction procedures

4.1 Introduction

We have two big groups of measures.

Firstly, passive measures which improve casing. They help to reduce the demand for great heating and/or the cooling demand ideal.

Secondly, the measures which improve air conditioning systems. They can be divided into two blocks: those which contribute for reducing consumption due to an increase of Seasonal Performance systems; and those which lower the consumption following a reduction ratio demands.

1. Measures which improve performance enhancing: replacement of boilers, chillers and autonomous teams, division of power and incorporating evaporation air condensers.
2. Improvement measures which decrease the ratio of demands: reduction of distribution losses and accumulation, free cooling and recovery energy from the exhaust air.
3. Measures which improve transport systems: they contribute to a reduction in transport factor.
4. Improvement measures through the contribution of renewable energies such as:solar thermal use of production.
5. Measures which improve lighting systems: contribute for improving lighting consumption by reducing the installed capacity while maintaining or improving the level of luminance.

4.1. Passive measures

4.1.1 Introduction

Passive measures are those that impact by reducing energy demand of existing buildings. They affect the thermal envelope of the building and its infiltration and air changes.

a) It is important to place the building in its general context in order to assess their inputs and losses, especially in the oldest buildings in hydrothermal behavior, which directly depends on this:

- Geographic location, climate zone and local microclimate, temperatures, sunlight, rainfall, altitude, mountain area, interior or coast, winds dominant.

The immediate environment can generate constraints that require rehabilitation focus on a certain way:

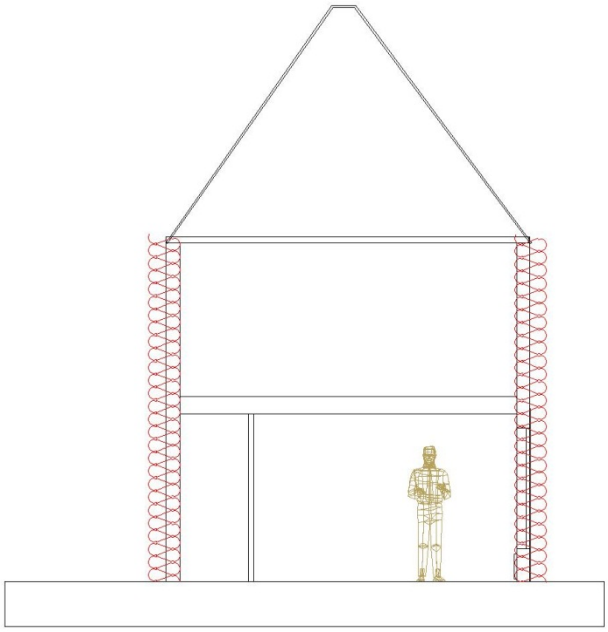
- Vegetation, vegetation type, height, foliage expiration.
- Building orientation, sunlight, weathering...
- The year of construction. It provides the information about period which was built (inertia, airflow, etc.).
- Classification of the building. Existing buildings can be cataloged and protected by heritage laws affecting rehabilitation.

b) According to the analysis of the context, it is necessary to scrutinize the architectural conditions which influence the energy for rehabilitating the building, include:

- Compactness of the building.
- Thermal envelope (insulation level, thermal bridges, thermal mass).
- Holes in walls and cover (surface, orientation, permeability, level insulation).
- Presence of the unheated spaces (attics or attics uninhabitable, clotheslines, sanitary chambers or underground parking floors, commercial ground floor ...).
- Presence of greenhouses and/or space solar gain.

After all this analysis we start to talk about the different parts of the house, and the different solutions for each.

4.1.2 Walls



Introduction

The insulation in the facade walls in the rehabilitation projects consist of adding a layer of thermal insulation to walls and / or dividing existing accessible, in order to reduce the thermal transmittance.

a. Goal

Reduce the energy demand by reducing the overall mass transfer coefficient in external opaque enclosures, primarily vertical walls. Primarily, it is aimed to reduce the energy losses in winter.

b. Degree of applicability

The energy measure is always interesting if the facade is not, or is insufficiently isolated. The effectiveness (energy savings from implementation) increases as the weather is cooler and the facade is less exposed to the sun, I mean, orientations north, east and west by the order and / or shaded facades during the winter and / or exposed to the prevailing wind. In generally, it is more effective for residential than non-residential buildings.

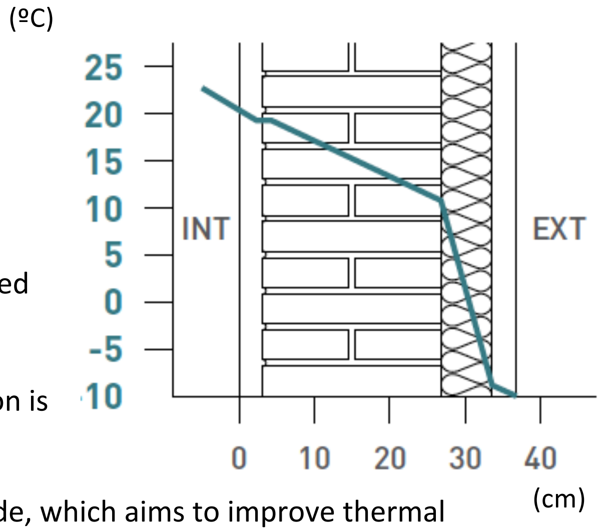
c. Influence on energy demand

Energy demand for transmission through walls and roofs is reduced proportionally to the decrease in the overall coefficient of the same.

d. Technical Implementation

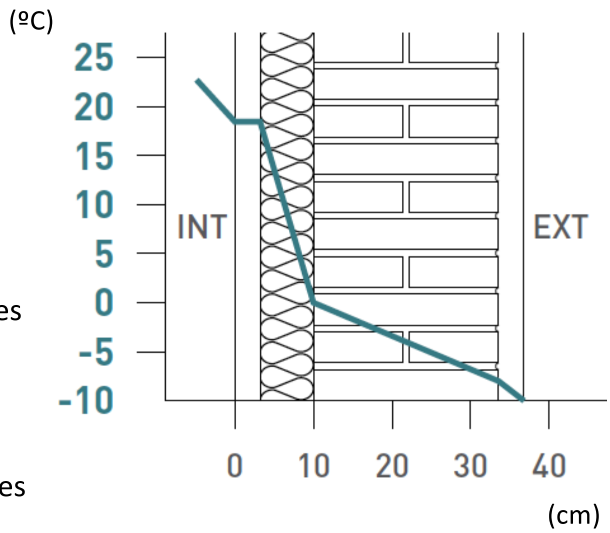
Implementations can undertake external, internal insulations and ventilated facade.

Exterior thermal insulation



The exterior insulation on rehabilitation projects consist in add a surface layer of insulation attached externally to the existing dividing walls and then protect it with a new exterior finish. Its application is especially recommended when the building facade, which aims to improve thermal insulation, is substantially flat and vertical. The outer surface is reasonably easy placement in buildings 1 or 2 levels. For buildings, higher altitudes increase the difficulty of access and therefore the cost aids.

Interior thermal insulation



This system deployment insulation is a good choice, when there is an inability to act from the outside, as it is buildings whose facades are cataloged and protected. It is based on the placement of thermal insulation on the inner faces of the facades and then it covers with a new interior finish. The system generates easily numerous thermal bridges, especially on the edges of slabs. To avoid isolation is necessary to apply also in the first meter of the top face of the slab. This system leaves out of the envelope thermal mass of the enclosure (if any), and thus allows rapid heating of the living space. In return the enclosures will not accrue or radiate heat into the interior.

Ventilated facade

The ventilate facade is a constructive exterior cladding system consisting of an inner leaf, an insulating layer, and an outer sheet unsealed. This type of facade usually allows durable and high quality of finishing works, and offers good thermal performance, although it has a high price. It is a common solution and representative institutional buildings.

Now we compare the different options that I explained with a Multi-criteria analysis. The score that I give depends on the quality or how the advantage/ disadvantage fit in the option.

The best solution is the internal solution, because we have a protected facade, and with this solution we can work from the interior.

The system is based on the placement of thermal insulation on the sides domestic needs of the facades and then cover it with a new finished interior.

The fact that an option also uses to isolate acoustically is very important, because it gives a second application to the solution used.

The fact that you can work from outside or inside the building is not very important, because the discomfort is only during the period of work.

Thermal insulation

The insolation is well positioned on metal wall guides or in the support. Dimensioning the correct size for the climate zone and the existing enclosure type. This technique increases the risk of moisture condensation in cold areas (thermal bridges), especially in wet rooms (kitchens, toilets...) so it is essential to use closed cell insulation, or apply a moisture vapor barrier primer or on the warm side of the insulation.

Vapor barrier

When you install the interior insulation, we have the possibility of occurrence of interstitial moisture due to condensation.

One of the problems is the connection with the wrought, because it can produce a thermal bridge.

Energy effect

The actual R value in the walls of the house is 1,3 m2xK / W, and with a better isolation will increase the R value to 2,5 m2xK / W. We increase in 1,2 m2xK / W the R value of the house. With this insolation the EPC decreases 0.2 points.

How this measure affect the historical value.

Using the internal insolation we respect the facade, because the reformation is totally inside.

4.1.3 Roofs

Introduction

Is to add a layer of thermal insulation to existing decks in order to reduce the thermal transmittance. Resolve adequately the roof of the buildings has a strong impact on the conditions of users comfort (from the thermal point of view) and hygiene spaces, since the presence of condensation causes a direct effect on the health of users: the deterioration of certain allergic reactions, bronchial asthma, asthmatic bronchitis.

a. Goal

Reduce energy demand by reducing the overall coefficient of transfer covered. The insulation helps reduce both losses in winter as in summer reduce contributions .

b. Degree of applicability

This measure is of great interest for buildings 1 or 2 levels.

Should initially be excluded cover-high rise buildings and / or that have a thermal buffer cap space, such as storage or storage areas uninhabitable.

c. Influence on energy demand

Energy demand for transmission through walls and roofs is reduced proportionally to the decrease in the overall coefficient of the same.

d. Technical Implementation

Thermal insulation on the outside

This measure is interesting when the current status of deck sets of outstanding repairs.

Thermal insulation on the inside covers

The insulation from the inside is achieved by isolating the roof of the upper housing. It is simple to implement and allows the use of thermal insulation materials of lower quality and lower cost than in the exterior insulation.

e. Measure used

Thermal insulation on the inside covers

In addition to the isolation of the surface may also be chosen for the insulation on the inside. It is important to add on the warm side of the structure a vapor control layer to prevent moisture.

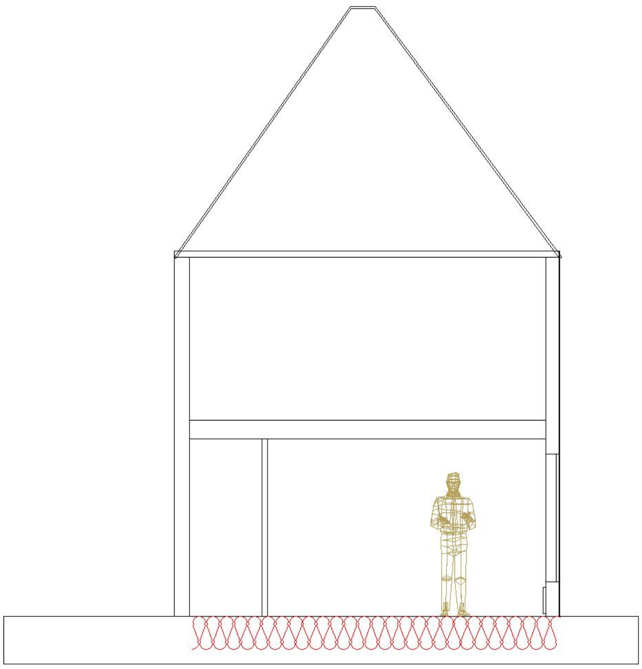
Energy effect

The actual R value in the roof of the house is 1,1 m2xK / W, and with a better isolation will increase the R value to 2,5 m2xK / W. With this insolation the EPC decreases 0.14 points.

How this measure affect the historical value.

Using the internal insolation we respect the roof, because the reformation is totally inside.

4.1.4 Floors



<u>Increased levels of floors insulation</u>

-Adding a layer of thermal insulation to existing soil in order to reduce the thermal transmittance.

a. Goal

Part of the energy losses that occur in a building happens through the soil, whether they are in contact with the ground (hearth) on ventilated chamber inaccessible (forged health) on unheated spaces (basements, garages) or outdoors (porches).

b. Degree of applicability

This upgrade is recommended for buildings with 1 or 2 levels.

c. Energy demand influence

Energy demand for transmission through walls and roofs is reduced proportionally to the decrease in the overall coefficient of the same.

d. Technical Implementation

Implementations can undertake insulation inside and outside.

External Thermal insulation

The external thermal insulation can be made only when there is a space high enough to work comfortably to install insulation system. Using closed pore insulation thermal performance is not lost even if the insulation is wet.

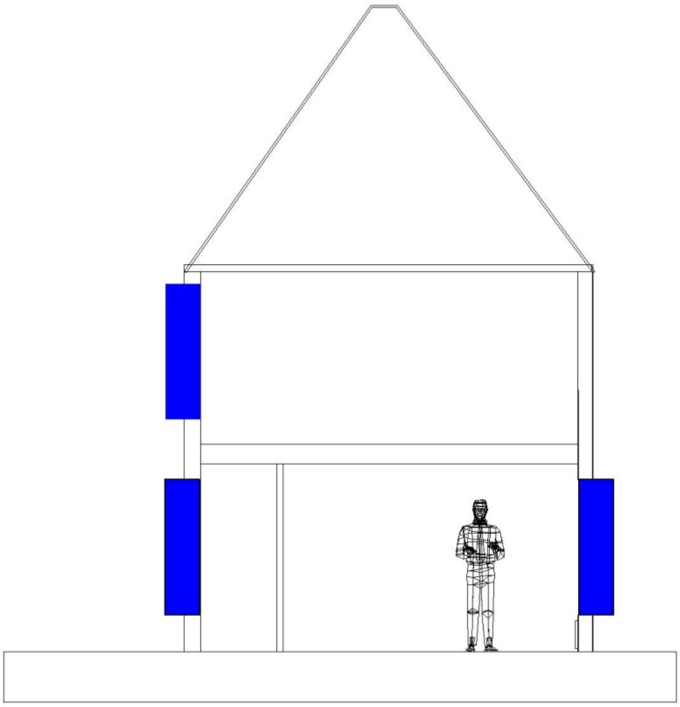
Internal thermal insulation

The insulation from the inside is achieved by isolating the lower housing floor. This simple implementation is necessary in order to replace the floor of the living downstairs. The insulation inside necessarily produce an elevation of the level of the ground in about 7 to 10 cm, which should be taken into account especially for housing affordability.

Measure used

Finally, I decided to don’t use any measure in the floor. The house just has a good insolation, and any measure will be very expensive and not too useful.

4.1.5 Windows



a. Goal

-Is to reduce energy demand by replacing, conversion of glazing, joinery and / or installation of double glazed windows. On one hand, it should limit the energy losses through the windows (one square meter of space loses the order of five times more energy than the same area of enclosure). Moreover, it may be beneficial to introduce sunlight into the inner space through the holes in front and skylights and skylights for a passive heating in winter.

b. Degree of applicability

The interest of this measure should be carefully contrasted on an annual basis, as the positive effects of a performance regime for winter are usually opposite effect for summer regime. In the towns of warm areas, the summer regimen is usually dominant, so the best performance in summer will be the best option on an annual basis. Consequently, the interest of this measure, keeping to the heating season, increases in buildings with a significant percentage of single glazing on facades facing north or shaded facades. In summer conditions, the actions proposed in this section are primarily intended to reduce solar radiation entering the building facades mentioned and may represent the most important component of energy demand for cooling.

c. Influence on energy demand

The performances of glazing originate changes in gain Solar and heat transmission losses. The optimal regimen in winter: the first factor would increase while the second is reduced, which It is not always possible. However, keep in mind those losses transmission glazing can represent a significant percentage global energy demand, so their reductions in these cases would priority over other considerations.

d. Technical Implementation

We considered three types of actions in hollow facade: the replacement of windows, replacement windows and trim and installing double-glazing

Replacement glass

Placement specific glasses with thermal insulation characteristics.

To prevent heat loss in winter, in the recesses oriented north and greater losses, the use of low-e insulating glass is recommended to reduce thermal loads and provide better comfort in the perimeter zones.

Replacement of timber and glass

This measure consists of raised the existing for replacement with new ones with specific characteristics of thermal insulation and sealing joinery. The change in carpentry can affect leaves, frames, or both parties.

Installing double glazing

It is a solution for cold areas, traditionally used in high mountain areas. You should verify that the front thickness is sufficient to support the installation of a second carpentry. An air chamber is created between the two windows, which provide the overall thermal resistance, reducing the transmittance. The most suitable for this installation is sliding windows because it is not encountered in their opening path. Sealing is important to prevent infiltration that can erase the thermal resistance of the camera.

Measure used

Double glazing

“There is an epidemic spreading across the country: in the name of energy efficiency and environmental responsibility, replacement window manufacturers are convincing people to replace their historic wood windows. The result is the rapid erosion of a building's character, the waste of a historic resource, and a potential net loss in energy conservation. Typically replacement windows are vinyl, aluminum, or a composite with wood, and none will last as long as the original window. Repairing, rather than replacing, wood windows is most likely to be the “greener option” and a more sustainable building practice “

With this introduction, I want to explain in what is based my opinion to decide the measure used. With the new law, we can put a double glass, and we will notice the decrease in heat loss. You should verify that the front thickness is sufficient to support the installation of a second carpentry. In addition, an air chamber is created between the two windows set provides thermal resistance, reducing the transmittance.

But, as we can see in the introduction, It isn´t always the best option. The investment for double glazing is sometimes non-viable for the owner. Only addressing tochtstrips in the opening part, we will have good results, investing little money.

Energy effect

The actual U value in the windows of the house is 5,7 W/m2 ·K, and with a double glass we decrease the U value to 2,8 W/m2 ·K. We decrease in 2,9 W/m2 ·K the U value of the house. With this measure the EPC decrease 0.22 points.

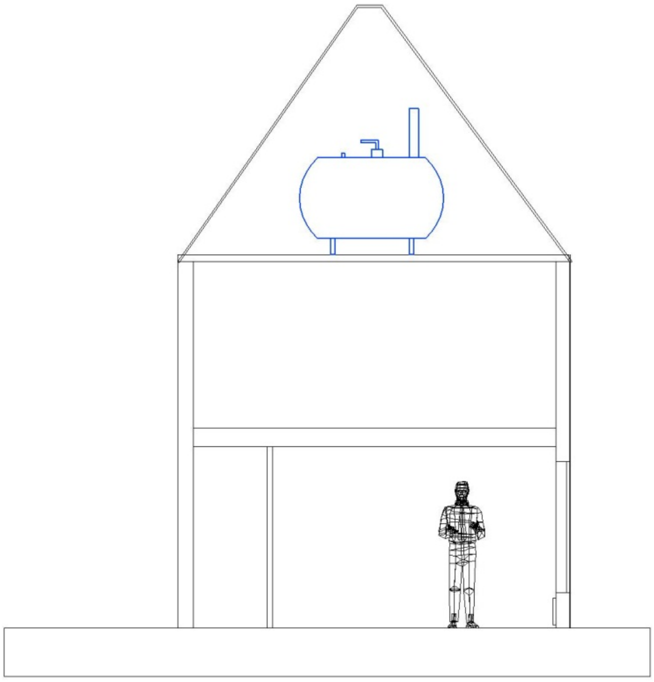
Monumental influence legislation and historical value

The application of restoration glass creates an architectural intervention, but the characteristic appearance is guaranteed. Before applying restoration with glass rods of the frame, a permit must be applied for modified or replaced. Cover glass can be placed on the outside or inside. When placed on the inside the view is hardly affected. When taking the rods of the frame, a custom permission must be sought. To customize the frame a permit must be applied for.

4.2.Active measures

Active measures are those that affect production systems of cold or heat in existing buildings. As we saw in the introduction, these improvement measures can be divided into two groups: those that contribute to lower consumption as a result of an increase in average seasonal performance of systems; and those for lowering consumption due to a reduction ratio demands.

4.1.6 Improved installation and equipment



a. Goal

The heat production systems in buildings are traditionally formed by fossil fuel boilers such as coal, oil or gas. The importance of reducing the consumption of these sources energy is because the polluting factor. Therefore it must be reduced to maximum use through efficient equipment and systems incorporating auxiliary from renewables.

b. Degree of applicability

The interest of this measure should be carefully contrasted on an annual basis, as the positive effects of a performance regime for winter are usually opposite effect for summer regime. In the towns of warm areas, the summer regimen is usually dominant, so the best performance in summer will be the best option on an annual basis. Consequently, the interest of this measure, keeping to the heating season, increases in buildings with a significant percentage of single glazing on facades facing north or shaded facades. In summer conditions, the actions proposed in this section are primarily intended to reduce solar radiation entering the building facades mentioned and may represent the most important component of energy demand for cooling.

c. Influence on energy demand

The performances of glazing originate changes in gain Solar and heat transmission losses. The optimal regimen in winter the first factor would increase while the second is reduced, which

It is not always possible. However, keep in mind that losses transmission glazing can represent a significant percentage global energy demand, so their reduction in these cases would priority over other considerations.

d. Technical Implementation

There are two big groups for heat system: fossil fuel boilers and Biomass.

Fossil fuel boilers

Standard boilers operate at a constant temperature,

approximately 80 ° C on average. There aren´t allowed to adapt consumption to the different demands that occur depending on the time of year, time of day or outside temperature.

Biomass

Biomass is all organic matter, plant origin and also animal origin, where those materials are included from their natural or artificial transformation. Examples of biomass are wood products derived from farming, animal manure, shavings or pellet and others.

Measure used

Biomass (Pellets)

Wood pellets are a refined and densified biomass fuel that is formed when wood residues are compressed into a uniform diameter under high pressure. Wood pellets have a uniform shape, size and density and are ideal for automatic combustion heating systems such as pellet stoves and boilers. By pelletizing wood residues from sustainably harvested biomass and quality waste wood, millions of tons of biomass can be put to work for the local economy while at the same time preserving the environment.

The main economic advantage of biomass on natural gas or diesel, and more respect to liquefied petroleum gas or electricity, lies in the lower fuel costs and greater price stability thereof, does not depend on oil prices. This advantage has to balance and prevail against representing initial install a biomass equivalent gas or oil.

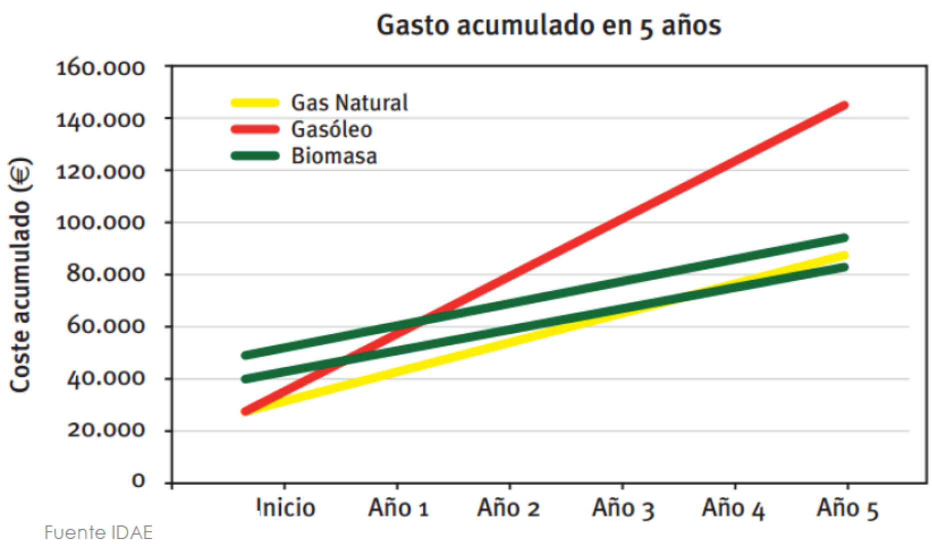
Energy effect

Wood pellets are an efficient source of heat because they contain very low levels of moisture and ash, when compared to woodchips or cordwood.
Virtually all of the material is burned and converted to heat.Wood pellets are economically competitive with home fossil fuel options and electric heat. Relative to other home heating alternatives, pellet fuel prices are less volatile.

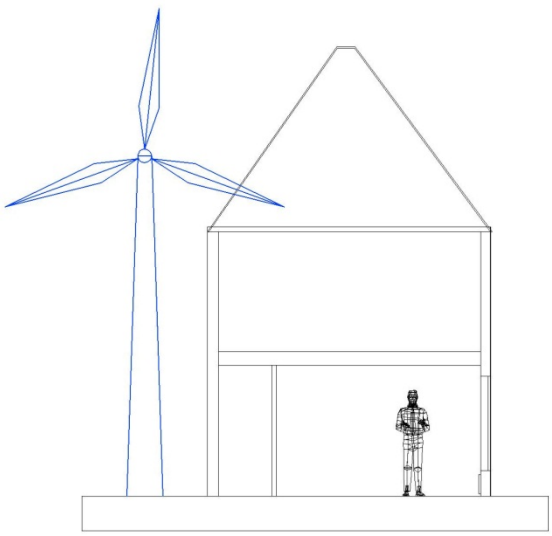
The first investment is expensive compared with other alternatives. However, in only 5 years we amortize the money invested. Sometimes the owner of the house don't decide this measure because the first big invest. So I decided to use in Enorm a better boiler. With a HR-107 boiler, the EPC decrease 0,31 points.

How this measure affect the historical value.

In the historical buildings, the stove or fireplace always played a central role in the living room. When the central heating had not appeared yet, the stove was the only way of heat. So, in my opinion, the pellets system is similar than the stove and fireplace, and not the boiler system. Of course, It does not affect any historical value like the facade or the roof, but looking the historical aspect, it is important to mention the measure.



Energy from renewable



Add systems with renewable energy

-Is to add a renewable energy system to existing heat system in order to reduce the consumption.

a. Goal

As support for the above named production systems, there may be included contribution systems with renewable energy.

b. Degree of applicability

In an installation of a biomass boiler, considering it as renewable energy, it is no more necessary to implement the system. In other cases it will be necessary to install a backup system for the production of sanitary hot water. The most common of these is solar thermal.

c. Energy demand influence

Reduce energy costs in proportion to the contribution from renewable energy.

d. Technical Implementation

We have the next renewable energy systems: Solar Thermal Energy, Solar photovoltaic, Geothermal, Mini wind and Aero-thermal.

Solar Thermal Energy

Solar collection can reduce energy bills with minimal maintenance costs. The main application of these facilities is the hot water supply, usually in conjunction with other conventional systems that it helps.

Solar photovoltaics

The use of solar radiation is direct transformation into electricity by the photovoltaic effect. This process is achieved by materials that have the ability to absorb photons and emit electrons. When these free electrons are captured, the result is a stream power that can be used as electricity.

Mini wind

-Is when we use the wind resources using lower power turbines than 100 kW. According to international standards, the mills of this technology should have a swept area not exceeding the 200 m2.

Aerothermal

Aerothermics is the harnessing of the energy contained in the air around us. This energy is constantly renewed from the solar energy received by the Earth's crust, making the air in a inexhaustible source of energy. With the aerothermal, can capture this energy and use it for free heat a home.

Geothermal

Geothermal energy is energy that can be obtained by taking advantage in the heat storage capacity that is in the earth. The earth has the property of maintaining a constant temperature in all the year seasons, due to the large mass and the materials that compose the earth.

Measure used

Solar tiles

Looking the MCA (Multi-criteria analysis in the Annex), we have in the first position, the mini-wind system. But we don't have enough space in the house to install it. So I focus in the second option, and second and third option has the same punctuation: Solar thermal energy and Geothermal. The geothermal is not for rehabilitations, and we are working in a rehabilitation, so our definitely system is Solar thermal energy.

We cannot forget that we are working in a historical building, and we cannot alter the facade and the roof. So a good solution is a solar tile. Solar tile links protection of historical buildings with power generation.

Energy effect

With the implementation of 10m2 of solar panel in the east roof, the EPC decreases 0,07 points. The best position of solar panels is in the South, but in our house there isn't space in the south roofs.

How this measure affects the historical value.

The tiles' collector surfaces are much smaller than conventional solar panels, because the historical roofs can only be used to generate energy despite monument protection regulations if their optical impression is preserved. A roof oriented toward the south with a size of 18 square meters and an inclination of 30 degrees thus produces 1,650 kilowatt-hours per year (see table) under the Southern Italian sun. That is enough energy to cover five sixths of the annual power consumption of a one-person household in Netherlands.



5. Conclusions

5.1 Walls

Energy reduction

By isolating the party walls, the value of R increases. The energetic effect of this adjustment is tested in Enorm. The actual R value in the thermic insulation of the house is 1,3 m2xK / W, and with 100 mm of insolation will increase the R value to 2,5 m2xK / W. We increase in 1,2 m2xK / W the R-value of the house. With this insolation the EPC decreases 0.2 points.

Comfort

By isolating within the wall, residents no longer suffer from the cold radiation medians, so increases Comfort.

Regulation

License is required to implement this improvement

Historical value

There is a risk of damage at the end of wooden beams by the occurrence of condensation in the connections with the wall. To avoid this we should inject a chemical product in the connection between the wall and wooden beam.

Architectural intervention

When thermal insulation is used, care must be taken with the wooden beams. By isolating the wall in the area of the beam, vapor pressure changes occur in the structure, which can cause wood rot. There should always be a vapor barrier on the warm side and /or use chemical product in the end part of the wooden beam.

In addition, the mortar of the wall, used in the beam part, should be water-repellent. In this way we prevent that the rainwater can contact with wooden beam.

5.2 Roofs

Energy reduction

By isolating the party walls, the value of R increases. The energetic effect of this adjustment is tested in Enorm. The actual R value in the roof of the house is 1,1 m2xK / W, and with a better isolation will increase the R value to 2,5 m2xK / W. With this insolation the EPC decreases 0.14 points.

Comfort

inside temperature remains constant, in the summer it remains cooler for longer and longer in the winter warmer.

Regulation

For remodeling, a license must be applied for.

Historical value

to insulate under the roof deck, the historical value is not adjusted. The insulation is made demountable.

Architectural intervention

isolating the inner side is the most suitable design. This is because the view is not affected and Rc can be extracted. 3.0 The construction is thereby faster and cheaper than in the isolation on the roof boarding

5.2 Windows

Energy reduction

By isolating the party walls, the value of R increases. The energetic effect of this adjustment is tested in Enorm. The actual R value in the thermic insulation of the house is 1,3 m2xK / W, and with 100 mm of insolation will increase the R value to 2,5 m2xK / W. We increase in 1,2 m2xK / W the R-value of the house. With this insolation the EPC decreases 0.2 points.

By double-glazing the windows, the value of U decreases. the actual U value is 5,7 W/m2 ·K, and with a double glass we decrease the U value to 2,8 W/m2 ·K. We decrease in 2,9 W/m2 ·K the U value of the house. With this measure the EPC decrease 0.22 points.

Comfort

Comfort is increased by being drafts, condensation and cold radiation is reduced. In addition, the sound insulation is also greatly improved compared with single glazing.

Regulation

License is required to implement this improvement. Enough space in the windows frame is necessary. Sometimes this space is not enough.

Historical value

Double glazing a window not only results in the loss of its old glass, but also adds more weight. This can cause problems for small and often fragile timber sections, and is generally best avoided.

From the perspective of historic and aesthetic significance, secondary glazing solutions have the advantage over double-glazing systems that they are reversible: the window can be returned to its original condition in the future if required. Almost the only permanent alteration is the fixing holes where a frame is secured, and otherwise the original details remain undamaged.

Architectural intervention

In double-glazing restoration, the next steps should be done; glazing beads disassemble, pull out existing glass, frame rebate, places new glass and assemble it again. This is a procedure that must be carried out carefully.

5.3 Improved installation and equipment

Energy reduction

By using a better heat system, HR-107 boiler, the EPC decrease 0,31 points. This is the 34,8 % of Total EPC.

Comfort

The use of a pellet stove will be seen as a comfort-enhancing solution. The heat radiation from a wood stove is better experience than the radiation from a radiator. In addition, with a pellet is easier to get a comfortable temperature in the living room.

Regulation

This needs to be a requested license.

Historical value

Placing a pellet stove has little effect on the historic value. Pellet stove is "similar" than the old chimney, so from the perspective of historic and aesthetic significance is better.

Architectural intervention

The installation of a pellet stove requires a small architectural intervention by the realization of the pipeline route.

5.4 Energy from renewable

Energy reduction

By the implementation of 10m2 of solar panel in the east roof, the EPC decreases 0,07 points. This is the 7,86 % of Total EPC.

Comfort

Solar panel has no effect on comfort.

Regulation

An authorization must be requested.

Historical value

I decided tiles' collector ,because the historical roofs can only be used to generate energy despite monument protection regulations if their optical impression is preserved.

Architectural intervention

To install solar panels only a little work is needed

6. Recommendations

6.1 Walls

With Internal insulation we will decrease the R value of the wall, respecting the historical value of the facade.

6.2 Attic Floor

Last decision is the insolation of the attic floor, because it is the most effective with respect to the isolation of the entire roof surface.

6.3 Windows

The investment for double-glazing is sometimes non-viable for the owner. Only addressing tochtstrips in the opening part, we will have good results, investing little money.

6.4 Heat system

My expensive recommendation is the biomass (Pellets).

My cheap recommendation is easier:

By moving the central heating boiler, the distance is decreased to the taps. As a result, less energy is lost. Additionally, you can choose to use thinner lines to go to the taps. Again, it is energy saving.

6.5 Energy from renewable

The best option for renewable energy sources is thermal tile. It is the only option compatible with the historic roof. The problem is that today, this option is not very developed. But in a few years it is a serious option to consider.

Annex I

Annex II

Description

MCA describes any structured approach used to determine overall preferences among alternative options, where the options accomplish several objectives. In MCA, desirable objectives are specified and corresponding attributes or indicators are identified.

The actual measurement of indicators need not be in monetary terms, but are often based on the quantitative analysis (through scoring, ranking and weighting) of a wide range of qualitative impact categories and criteria. Different environmental and social indicators may be developed side by side with economic costs and benefits. Explicit recognition is given to the fact that a variety of both monetary and nonmonetary objectives may influence policy decisions. MCA provides techniques for comparing and ranking different outcomes, even though a variety of indicators are used. MCA includes a range of related techniques, some of which follow this entry.

I used the MCA like a complementation to help me deciding the best measure.

Punctuation is between 0 and 10. In one hand, when is 0 or close to 0 means that is a expensive measure, or It will cause damage in some part of the building, or it´s really hard to do It. In the other hand, when is 10 or close, thats means that the measure is cheap, or easy to do it.

Evaluation criteria

* Depending on the importance of the factor described, I multiplied by 2 or 0.5 for more realistic valuation.

Walls

Windows

Advantages and Disadvantages	Internal Insulation	External Insulation	Ventilated Facade
The filler added to the foundation structure is minimal	3	9	4
The interior space is respected, not affecting their votes surfaces.	0	9	7
Work can be done from the outside, without disturbing building occupants.	0	5	1
Protects the original envelope building	8	8	8
Fixes cracks and fissures support avoiding possible leaks	8	7	0
Reduce the thermal load of the structure (expansion)	9	7	5
Optimize the use of thermal inertia.	7	8	5
It can improve the sound insulation of the building according to the solution employed	16	12	8
Improve the aesthetics of the building.	1	4	5
You can use in buildings that are going to receive severe and repeated impacts.	9	0	8
It resist strong winds	9	0	8
You can use in buildings with protected facades .	10	0	0
You can use in some regular facades or multiple protrusions.	10	0	3
Total	90	69	62

0,5x

2x

Floors

Advantages and Disadvantages	Internal Insulation	External Insulation
You can use in buildings where there is a space high enough to work comfortably to install the insulation system	8	8
It is simple to implement	10	0
The insulation inside necessarily produce an elevation of the level of the ground in about 7 to 10 cm,	0	7
Protect the system of mechanical, weather and chemical stresses and give the final look of the building	3	10
Total	21	25

Windows

Advantages and Disadvantages	Replace the existing glass joinery	Replace the complete windows with new windows or bending	Double windows, with the implementation of new windows next to the existing ones.
Cleaning identical to single glazing x 0,5	5	5	0
Fast and easy implementation	10	6	0
Increases sound and heat insulation. X 2	14	14	20
An air chamber is created between the two windows, which provides the overall thermal resistance, reducing the transmittance	0	0	10
Total	29	25	30

Improved installation and equipment

Advantages and disadvantages	Fossil fuel boilers	Biomass
Lower fuel costs and greater price stability because does not depend on oil prices.	0	10
Higher initial investment cost	10	5
Cheapest option long term	3	8
Total	13	23

Energy from renewable

Advantages and disadvantages	Solar Thermal Energy	Solar photovoltaics	Geothermal	Mini wind	Aerothermal
Save Fuel and Environmental Improvement	10	8	9	10	9
Warranty and Reliability Technology.	10	9	9	9	9
users do not know how the system works Consequently, many do not know whether or not benefit them,	0	1	6	5	6
Enables the delivery of electricity in isolated and remote places of the grid.	5	5	5	10	5
Generate a distributed energy thereby reducing the transmission and distribution losses.	6	6	6	10	6
· Produce electricity at the point of consumption, adapting to renewable resources and energy needs of each location.	0	0	0	10	0
Can be combined in hybrid photovoltaic installations.	0	0	0	10	0
No work requires almost	5	3	0	10	0
Small footprint	7	3	0	10	2
Has a high price	5	5	0	0	0
Unwise and impractical rehabilitation measure.	10	10	0	8	0
Very high yields	2	2	10	5	3
High equipment life	5	5	10	6	6
Production of heat, cold and hot water all year round.	0	0	10	3	5
Total	65	57	65	106	51

Annex III

WALL			
Material	Conductivity	Espessor (m)	Resistance(m2K/W)
Brick	0,61	0,24	0,393442623
Air	0,026	0,05	1,923076923
Isolation			1,3
Air	0,026	0,05	1,923076923
Pladur	0,51	0,0125	0,024509804
Rsi			0,04
Rse			0,13
			5,734106273

FLOOR			
Material	Conductivity	Espessor (m)	Resistance(m2K/W)
Plastic	0,2	0,01	0,05
Isolation	0,057	0,05	0,877192982
Concrete slab	0,51	0,1	1,3
Wood	0,34	0,07	0,205882353
Rsi			0,04
Rse			0,17
			2,643075335

WINDOWS			
Material	Conductivity	Espessor (m)	Resistance(m2K/W)
Glass	0,58	0,005	0,00862069
Rsi			0,04
Rse			0,13
			0,17862069

ROOF			
Material	Conductivity	Espessor (m)	Resistance(m2K/W)
Wood	0,34	0,03	0,05
AIR	0,026	0,04	0,877192982
Tile	0,76	0,02	0,026315789
Rsi			0,04
Rse			0,1
			1,093508771

Annex !V

Annex V

Annex VI