

ADVICE REPORT

INTEGRAL ASSIGNMENT HBO BACHELOR ARCHITECTURE - PHASE 2



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FOREWORD

A few months ago, I created an Energy & Installation advisory report commissioned by the NCOI Institute. It concerns an advisory report on the corner house at Dorpsdijk 181 in Rhoon. This report is a follow-up to the first report.

I am currently still a student at NCOI. Making this advisory report gives me the opportunity to test all the knowledge I have acquired so far on a physical home. When making the previous advisory report, I was given the opportunity to photograph and study the house. This was necessary because the municipality had no building plans for the house.

For that, I want to thank my good friend Silvano. He has made his home available to me. And of course, I also thank the institute for giving me the opportunity to learn more about the renovation of a home, which must also meet the BENG requirements.

- Nadia Monsengo
The Hague, August 10, 2023

SUMMARY

Over the years, I have experienced different types of housing in the Netherlands, both personally and homes of family and friends. I have noticed that many homes do not have good or any insulation at all. This mainly concerns old rental properties. Homes of housing corporations and private homes. Unfortunately, there are still too many homeowners and housing corporations that do not work on improving the rental properties. As a structural engineer, it is interesting to investigate what can be done to make these homes energy efficient and to write an advisory report about this. write.

An advisory report was written about the same property a few months ago. This advisory report is a follow-up to the first advisory report. In addition to the installation, this advisory report looks at how the house can be made energy efficient in terms of construction. We look at the materials and properties of the current construction: The foundation, the facade and the roof. Homes in the Netherlands were founded on wooden piles before the 1970s and via the traditional construction method built, namely stacking construction. The floors were made of wood, the roof was largely made of wood and the facade consisted of an uninsulated cavity wall.

Based on the condition of the house at the moment and the requirements from the client and the legislation, I started looking at the possibilities for an alternative. The choice was made for cast construction in combination with modular construction. Modular construction for the placement of prefab sandwich roof elements and the placement of (insulated) wide slab floors and cast construction for the construction of new load-bearing inner walls and pouring concrete on wide slab floors. The glass of the windows is replaced by HR++ glass or triple glazing and the frame of the frames is replaced by a PVC window profile. The doors can be insulated by, among other things, using draught strips and draught tapes.

In terms of installation, we can conclude that the house, in addition to an electric heat pump and a balanced ventilation also needs solar panels and a solar boiler to provide the house with the necessary energy needs and the recovery of energy.

The RC calculations show that the roof, floors and cavity wall meet the requirements of the Building Decree. Derived from the calculations made in Uniec 3, we can also conclude that in the adapted house, the energy requirement does not exceed the requirement, less primary fossil energy is used than is permitted and the share of renewable energy is higher than 50%. 50% renewable energy is the minimum BENG requirement. The advice is therefore to make use of the materials and installations in this report.

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INTRODUCTION

In the Netherlands, many people still live in poorly insulated homes. Mainly homes with single glazing, but also enough homes without proper floor, wall or roof insulation. There are even homes that lack it entirely. According to a NOS news article from 2022, one in six private rental homes have single glazing in the living room and a quarter of tenants have single glazing in the bedrooms. A tenant cannot solve this problem. This must be solved by the owner or by the housing association. In my area there are friends and family members who live in such homes. The property in this report is a property rented by a good friend. The house was built in 1960. Before 1975, homes were not insulated. A number of homes had a cavity wall, but no insulation in the cavity wall. A poorly insulated home leads to high energy consumption without actual heating of the house. The house is leaking, so to speak. A solution must be found for the above problem. One solution is the house to be renovated in such a way that it meets the BENG requirements. The central question is also as follows: "How can the house at Dorpsdijk 181 in Rhoon be so renovated to meet the BENG requirements?"

In the first chapter of the advisory report, we look at the materials and properties of the elements of the current home. Namely the foundation, construction method, roof and facade construction. What are the materials made of and what are the properties of these materials? For clarification, architectural details and photos have been added in the appendices.

Chapter 2 contains a Program of Requirements, consisting of functional, technical and performance requirements. The program includes the client's wishes and the requirements set are made from the legislation.

After the current state of the home and the client's wishes are clear, there will be looked at a possibility to renovate the house so that it meets the BENG requirements. This information can be found in the third chapter. The aspects that are covered in this chapter are the construction method, building physics and installation technology.

The fourth chapter contains detailed drawings, which show how the construction parts of the renovated house fit together. The detailed drawings are also included in the appendix.

In addition to a nice story about the new home variant and a number of detailed drawings, it is also important to show, based on the calculations, whether the new variant actually meets the BENG requirements. This is done by making R_c calculations and ventilation calculations and a global outline of the energy needs and generation. The latter was carried out using the program Uniec 3.

Finally, the last chapter provides a concluded, substantiated advice on the chosen method and the possible bottlenecks and points of attention that occur during the renovation of Dorpsdijk 181 in Rhoon.

CONTENT

STEP 1: DESCRIPTIONS

This advisory report is a follow-up to the BENG-ENERGY advisory report from the Energy & module Installation. The house used is a corner house at Dorpsdijk 181, in 3161 Rhoon. Rhoon is part of the municipality of Albrandswaard.

Short Summary: The house was built in 1960, has an area of 78m² and has no energy label. Because the municipality indicated that they did not have building plans for the house, some certain information about the house is based on online research.

Foundation

Material + Properties

Houses before the 1970s were built on wooden foundations. In the Netherlands there were wooden foundation piles made of softwood. A type of wood that is susceptible to bacteria and fungi. The foundation methods “foundation on piles” then consisted of the Amsterdam method and the Rotterdam method. Because Rhoon is near Rotterdam, I assume that this house uses the Rotterdam method is used. With this method, the foundation consists of the wooden pile, longitudinal wood, sliding wood and the masonry above it.

The properties of wooden foundation piles, wood in general, and softwood are as follows:

Wooden foundation piles	Wood in general	Softwood
<ul style="list-style-type: none"> • They are environmentally friendly and can be reused • The weight of the piles is low, making it easy to move and little manpower is needed to drive piles. • Piling with wooden foundation piles causes little noise pollution • Have a low load capacity. Approx. 80-120 kN • Is only used under water. 	<ul style="list-style-type: none"> • Sustainable • Flammable • Low burning rate • Strong • Light • Biological (natural) material • Wood is tough and flexible • Wood swells and shrinks • Wood is hygroscopic: The wood moisture adapts to the humidity of the environment 	<ul style="list-style-type: none"> • Fast growth • Soft wood type (in compared to hardwood) • Yellow color/light color • Has resin • Has a coarse structure • Has clear growth rings • Has wide growth rings • Has a hard structure • Has many knots

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van Kuijeren, F. (2021, April 18) Construction defects in houses from the 60s and 700s, VK Makerlaars, <https://vkmakelaars.nl/blog/bouwkundig-advies/bouwkundige-gebreken-woningen-jaren-60-70/>

² Bone, A.H.L.G. (2021). Basic Book of Architecture (5th edition). ThiemeMeulenhoff bv

³ Wood properties, n.d. Retrieved on September 15, 2023 from DPV Parket, <http://www.dpvparket.nl/houteigenschappen/>

Construction/Building method
Material + Properties

In my estimation, the traditional construction method/stack construction was used for the house. This is a construction method where everything is built on the construction site. The stones are placed one by one on top of each other stacked. This construction method is common for low-rise houses consisting of masonry. The inner leaf then consists of calcium silicate brick (nowadays this is standard for interior walls) and the outer leaf consists of bricks. The exact types of bricks used are unknown. There is a good chance that the interior walls also consist of brick masonry.

The type of floor that is most common nowadays in stack construction is a wide slab floor or a

hollow core slab floor. However, wooden floors were still used for houses in the early 1960s. Only from

⁴ Begin jaren 60 werden echter voor woningen nog houten vloeren toegepast. Pas vanaf

the mid-1960s, non-insulated 'kwaaitaal' floors or jacket floors were used. A 'kwaaitaal' floor

is a floor consisting of reinforced prefabricated concrete, in which calcium chloride was used for the hardening of the floor. ⁵

The table below shows the properties of wide slab floors and hollow core slab floors.

Wide slab floor	Hollow core slab floor
<ul style="list-style-type: none"> ● Maximum span is 8 -10m ● Width is 2, 3, 5 or 7 m ● Thickness is 200 - 300 mm ● Has great freedom of form ● Has lattice girders that act as main reinforcement, lifting device and provide strength and stiffness ● Have a large weight. ● Assembly takes a long time ● Can easily accommodate ductwork in the compression layer ● The seams are not visible 	<ul style="list-style-type: none"> ● Large span ● Use of few raw materials ● Fast assembly ● Low costs ● Have hollow channels ● Can carry high loads ● Thickness: 135 to 500 mm ● Width: 600 or 1200 mm ● Length: 5 to 18 m ● Low own weight ● Available with or without (thermal) insulation on the bottom. ● Has seams that need to be finished. ● Are airtight

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Roof and facade construction
Material + Properties

Roof: The roof of the house is a gable roof, type rounded gable roof. The gable roof is constructed from a wooden roof structure, a wooden roof boarding and a roof covering consisting of roof tiles. Insulation

⁴ Stack construction, n.d. Retrieved on September 15, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/stapelbouw.shtml>

⁵ 'Kwaaitaal' floor, n.d. Retrieved on September 15, 2023 from Wikipedia, <https://nl.wikipedia.org/wiki/Kwaaitaalvloer>

Wide slab floor, Formwork slab floor, n.d., Joost de Vree, Retrieved on September 16 from <https://www.joostdevree.nl/shtmls/breedplaatvloer.shtml>

Hollow core slab floor, n.d. Retrieved on September 16, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/kanaalplaatvloer.shtml>

was only used in roofs from 1975 onwards. Based on the photo taken of the inside of the house, see photos in appendix 2, I would say that this is a purlin roof construction and not a

truss roof because the horizontal beams run lengthwise and the roof boarding is on top of that

⁸ Het is niet zeker of het dak van de woning vanaf het bouwmoment tot op heden is geïsoleerd.

From the conversations I had with the resident and my own experience in the house, I dare say that the roof is not insulated or the correct insulation has not been applied.

Facade: The facade of the house consists of a cavity wall. The outer leaf consists of brickwork of bricks. The material of the inner wall is unknown. Sand-lime brick is a well-known material that is used as load-bearing and non-load-bearing inner walls, but was only used in the 1970s in

residential construction and introduced at the Jaarbeurs. There is a good chance that the inner wall also consists of ⁹ De kans is groot dat de binnenmuur ook bestaat uit brickwork. Given that no building drawings are available, this is not 100% certain to say.

The properties of the roof construction and the roof boarding (sheet material, battens and tile battens) are not included in the table below, because the material consists of wood. The properties of wood are described in the table under the title "Foundation". The properties of ceramic roof tiles and bricks are described:

Roof covering: Roof tiles (ceramic)	Bricks
<ul style="list-style-type: none"> ● Non-flammable ● Sustainable ● Easy to use ● Weather resistant ● Affordable ● Long lifespan ● Authentic appearance 	<ul style="list-style-type: none"> ● High compressive strength ● Frost resistant ● Reusable ● Can retain and release heat ● Sustainable ● Flexible: Suitable for many types of work ● Does not shrink ● Soundproofing ● Fire resistant ● Available in different colors

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Detail drawings

The detail drawings are included in appendix 1 and the photos in appendix 2. It is not entirely clear from the photos see what the construction method is, except for the photos where you see part of the roof on the inside and

⁸ D. 1960s and 70s, n.d. Accessed on September 16, 2023 from Duurzaam010, <https://duurzaam010.nl/thema/jaren-60-en-70/>
 Sand-lime brick, n.d. Accessed on September 16, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/kalkzandsteen.shtml>
 Roof tiles: types + price, n.d. Accessed on September 16, 2023 from Mijn Dak Dekker <https://www.mijn-dakdekker.nl/dakbedekking/dakpannen>
 Sand-lime brick, n.d. Accessed on September 16, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/kalkzandsteen.shtml>

¹² Brick, general, n.d. , Joost de Vree, Accessed on September 16, 2023 from https://www.joostdevree.nl/bouwkunde2/baksteen_algemeen.htm#Voornaamste%20eigenschappen%20van%20baksteen

the outer wall, consisting of masonry bricks.

STEP 2: PROGRAM OF REQUIREMENTS

The program of requirements is included in the appendix.

STEP 3: STRUCTURAL ALTERNATIVE

According to the BENG requirements, the house must meet the following requirements:

BENG 1 - Maximum energy demand:	Max 25 kWh/m ² /year
BENG 2 - Primary fossil energy use:	Below 25 kWh/m ² /year
BENG 2 - Share of renewable energy: such as solar panels or wind energy.	Use at least 50% renewable energy

¹³

Construction method

The current construction method is stacking construction. A structural alternative in terms of construction method is cast construction in combination with modular construction (prefab). In this case, formwork is poured on the construction site with concrete mortar, with the load-bearing floor and inner walls attached to each other. Cast construction is more often used when building a series of houses. The house in this advisory report is one corner house, which means that the use of cast construction is different. The walls and floors are not poured together (tunnel formwork). This is possible, but is more common with a series of houses instead of one house. For the house in question, the inner walls are poured and a system floor is used. ¹⁴ A wide slab floor is the best choice as a system floor for this house, because a wide slab floor has great freedom of form. Applying recesses is not difficult and there is space in the floor to process pipes and cables. ¹⁵ In addition, the floor can also be used as a ground floor, provided that insulation is applied under the floor. The floor can also be used as a roof floor be used. The inner wall is subsequently covered on the outside with insulation and a outer cavity wall consisting of masonry. The roof is covered with insulating sandwich elements (prefab) and roof tiles.

Other, heavier materials are used for the alternative construction method. This means that the foundation, to transfer the load to the load-bearing soil, must be replaced by a concrete foundation with a wider foundation beam. This is shown in the detailed drawing of the new variant.

Building physics

In order to make the house meet the BENG requirements, the following alternatives are feasible:

1. First of all, the house must meet the following requirements of the Building Decree:
 - a. Rc value ground floor: >3.7 m²K/W
 - b. Rc value facade: >4.7 m²K/W
 - c. Rc value roof: >6.3 m²K/W
 - d. U-value facade openings: <1.65 W/m²K

What is BENG and what do the BENG requirements entail, n.d. Accessed on September 25, 2023 from van Schijndel Bouwgroep, <https://vanschijndel-bouwgroep.nl/nieuws/wat-is-beng/>

¹⁴ Cast construction, n.d. Accessed on September 25, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/gietbouw.shtml>
Wide slab floor, Formwork slab floor, n.d., Joost de Vree, Accessed on September 25, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/breedplaatvloer.shtml>

- e. The separating structure between a heated and unheated space must also be at least $>4.7 \text{ m}^2\text{K/W}$
2. Replace the wooden ground floor with a system floor, such as a wide slab floor, with insulation attached underneath. A wide slab floor consists of reinforced prefabricated concrete slab, lattice girders, reinforcement mesh and a reinforced concrete layer. Concrete is a material that can insulate well, store heat and is moisture resistant. 16
 3. Also replace the wooden upper floor with a wide slab floor, with insulation underneath and finished with plasterboard ceilings.
 4. The same applies to the roof floor as point 2.
 5. An alternative to the roof itself is to use insulated sandwich elements, such as Unidek Aero DeLuxe. These elements are prefabricated and have a thick insulation layer of 19mm and an R_c value of 6.09 to 7.01 $\text{m}^2\text{K/W}$. Plus using sandwich elements saves time. 17
 6. An alternative to the facade is to add insulation in a cavity wall. The facade becomes insulated and there is space at the connection of the facade with the roof, so that ventilation in the cavity prevents. Adding an open weep hole at the roof connection, above the ground level and above the foundation will also ensure ventilation in the cavity and drainage of rainwater.
 7. An alternative to the inner wall is to use concrete mortar to create a load-bearing wall. The concrete is poured into formwork. Concrete is a material of great mass. It can retain heat well and release it at a later time. It reduces energy consumption for heating and cooling, which saves energy costs. It also reduces peak temperatures, requiring less or no air conditioning is needed. By using little energy, it contributes to the reduction of the greenhouse effect.
 8. For the facade openings, instead of single or double glazing, HR++ or triple glazing must be used. HR++ has a coating and insulating gas between the glass, which provides insulation. Triple glazing too, only has triple glazing 3 panes of glass. Another more expensive option is vacuum glass.
 9. In addition to the glasses themselves, attention must be paid to the entire window. According to the EPB (Energy Performance of Buildings)¹⁸⁾ a window may have a maximum U-value/heat transfer coefficient of 1.5 $\text{W/m}^2\text{K}$. The complete U-value (U_w) is determined

U-WAARDE RAMEN

U-waarde profiel (U_f) ?

1,9 W/m²K

U-waarde glas (U_g) ?

0,6 W/m²K

thermisch verbeterde afstandhouders? ?

U-waarde geheel (U_w) ?

1.20 W/m²K

BEREKEN

Wide slab floor, Formwork slab floor, n.d., Joost de Vree, Accessed on September 25, 2023 from Joost de Vree, <https://www.joostdevree.nl/shtmls/breedplaatvloer.shtml>

¹⁷Unidek Aero Deluxe n.d., Kingspan, Accessed on September 25, 2023 from Kingspan,

<https://www.kingspan.com/content/dam/kingspan/unidek/products/netherlands/unidek-aero-deluxe/kingspan-unidek-aero-deluxe-product-data-sheet-nl-nl.pdf>

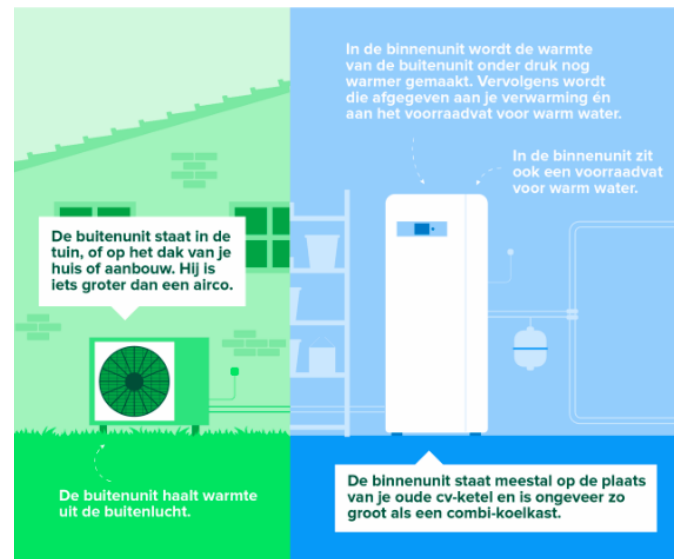
First part of European EPB standards published, June 27, 2017, Building energy performance <https://www.gebouwenergieprestatie.nl/veelgestelde-vragen/>

door glass (Ug value), profile (Uf value) and spacers. The glass may have a maximum heat transfer coefficient of 1.1 W/m²K. When using a PVC window profile in combination with triple glazing and thermally improved spacers, we arrive at a U-value of 1.20 W/m²K. This falls within the requirement of 1.5 W/m²K. ¹⁹

10. Regarding the doors, no alternative is needed for a door. The same doors can be used with a careful insulation method. A door can be insulated by using draught strips and apply draught strips, by placing a letterbox brush or valve or replacing a door frame. ²⁰

Installation technology Heating

Currently, the Vaillant VR combi boiler is the heat source of the house. It provides both hot water in the shower and kitchen as well as the temperature in the house. A alternative to this method is an electric heat pump. The electric heat pump consists of 2 parts: A outdoor unit and an indoor unit. The outdoor unit takes (warm) air, soil or groundwater and passes it on to the indoor unit, which then heats it further. For warm water, there is a storage tank in the indoor unit. The only condition for using an electric heat pump is that the house is completely and very well must be insulated, because an electric pump only delivers temperatures between 45 and 55 degrees. ²¹



Ventilation

The ventilation in the house is currently regulated by system A (natural supply and natural discharge) and system C (natural supply and mechanical discharge). A number of windows in the house have a ventilation grille at the top and a mechanical exhaust against the ceiling in the bathroom and toilet. An alternative to this is balanced ventilation with heat recovery system (HRV). The balanced ventilation ensures that the supply and exhaust of air are equal and with the addition of a CO₂ and humidity sensor, the exact amount of air is monitored and updated. For example, during cooking, showering or when more people are present in the house than normal. ²² The HRV (heat recovery unit) ensures that the cold air that enters

¹⁹What does the mysterious U-value mean, n.d., Accessed on October 02, 2023 from Kwadro,

<https://www.kwadro.be/nl/blog/wat-betekent-de-mysterieuze-u-waarde#:~:text=Volgens%20de%20EPB%2Dregelgeving%20mag,zijn%20dan%201.5W%2Fm%C2%B2K> . Double glazing, HR glass, Triple glazing and vacuum glass, n.d., Accessed on October 02, 2023 from Milieu Centraal, <https://www.milieucentraal.nl/energie-besparen/isoleren-en-besparen/dubbel-glas-hr-glas-triple-glas/> Fully electric heat pump, n.d., Accessed on October 02, 2023 from Milieu Centraal, <https://www.milieucentraal.nl/energie-besparen/duurzaam-verwarmen-en-koelen/volledige-warmtepomp/>

²²Energy-efficient Ventilation, n.d., Accessed on October 02, 2023 from Feenstra,

<https://www.feenstra.com/ventilatie/energiezuinig/#:~:text=Balansventilatie%20is%20een%20energiezuinig%20vorm,over%20een%20warmte%2Dterugwin%20systeem>.

is heated with the heat of the air that is discharged. A valve is placed in each room placed.

STEP 4: DETAIL DRAWINGS ALTERNATIVE HOUSING

The detail drawings (foundation detail including ground floor, roof edge detail, window detail and floor-facade detail) are included in the appendix.

STEP 5: SUBSTANTIATION ALTERNATIVE & CALCULATIONS

Rc calculations (roof, facade and ground floor) Thermal resistance

To meet the BENG requirements, it is important that the house meets the following thermal resistance according to the Building Decree:

- Roof floor: A thermal resistance of at least 3.7 m² x K/W
- Ground floor: A thermal resistance of at least 3.7 m² x K/W
- Cavity walls: A thermal resistance of at least 4.7 m² x K/W
- Roof: A thermal resistance of at least 6.3 m² x K/W

The following rules apply to thermal resistances:

- Thermal conductivity coefficient (λ value): The higher this is, the better the conductivity and therefore a poorer insulation.
- Thickness: The thicker the material, the better the thermal resistance of the material.

The calculations of the thermal resistances of the architectural alternatives are included in appendix 4. These calculations show that the thermal resistances of the various construction components meet the requirements of the Building Decree.

Ventilation calculations

The ventilation calculations are included in appendix 5.

Global setup energy demand and energy generation

In Uniec 3, the data of the house and the required installations have been entered to energy label A+++ to come. The result is included in appendix 6. This also includes the energy demand and generation to see.

STEP 5: SUBSTANTIATION ALTERNATIVE & CALCULATIONS

Advice

Renovating a home can be done in several ways. Cast construction has been chosen in combination with modular construction (prefab), because that is the fastest method. With cast construction, a large part of the house will be demolished. Another option would have been to place partition walls against the outer walls, but the disadvantage of this is that the house becomes smaller on the inside. Plus because the wall is finished with (gypsum) boards, the chance of a cold bridge is greater if this is not done properly done, in contrast to an inner wall consisting of one whole. The outer wall is also demolished

and stacked on top of each other again. This is done because cast construction is otherwise not possible (there is formwork used) and because checking the quality, cracks and other exterior walls imperfections plus repairs cost a lot of money. Because the concrete shell is made, it provides a contribution to a healthy indoor environment, thermal comfort and therefore a low energy bill.

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The calculations made to formulate the energy label concluded that in addition to a electric heat pump, the house variant also needs a solar water heater and solar panels (PV system) to meet the energy needs and at the same time produce renewable energy.

It is advised to apply 6 PV panels from Astroenergy on both sides of the roof. For the solar water heater, it is recommended to use the Remasol Solar Water Heater RemaSOL 200SE_2S(+2DB200) type to take from the Remeha brand. This is a solar water heater that preheats. The solar water heater contributes to thermal sustainable energy, provides hot tap water and has a back-up function.

Bottlenecks or Points of Attention

When implementing the house variant, specific attention must be paid to the following points:

- The inner wall and floors are not attached to each other. If the insulation is not placed properly, cold bridges and heat loss can occur between the construction components. In connection with the operation of the electric heat pump, this must absolutely not occur. If this happens If so, the electric heat pump must be replaced by another type of generator. The The transition between the roof and the facades and the floors and facades must also be monitored be held.
- In addition to the construction components, the above also applies to transparent components (glass of windows and doors). ²⁴ A cold bridge can occur with insufficient insulation at screens and shutters and when insulation is pierced by pipes. This must absolutely not occur.

Advice to prevent cold bridge

- Connect insulation seamlessly by using, for example, aluminum tape.
- Keep cavity walls clean.
- No holes in the insulation
- Place tape where drafts occur.

Buijt-Haverhals, D., (n.d.) Cast construction, Apartments & Owner, Accessed on October 20, 2023 <https://www.appartementeneigenaar.nl/Bouwen-verbouwen/bouwtechniek/bouwmethoden-deel-2>

²⁴Psi value (n.d.). Joost de Vree, Accessed on October 20, 2023 from <https://www.joostdevree.nl/shtmls/psi-waarde.shtml>

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<https://www.kingspan.com/content/dam/kingspan/unidek/products/netherlands/unidek-aero-deluxe/kingspan-unidek-aero-deluxe-product-data-sheet-nl-nl.pdf>

<https://www.gebouwenergieprestatie.nl/veelgestelde-vragen/>

<https://www.kwadro.be/nl/blog/wat-betekent-de-mysterieuze-u-waarde#:~:text=Volgens%20de%20EPB%20Dregelgeving%20mag,zijn%20dan%201.5W%2Fm%C2%B2K.>

<https://www.milieucentraal.nl/energie-besparen/isoleren-en-besparen/dubbel-glas-hr-glas-triple-glas/>

<https://www.milieucentraal.nl/energie-besparen/duurzaam-verwarmen-en-koelen/volledige-warmtepomp/>

<https://www.feenstra.com/ventilatie/energiezuinig/#:~:text=Balansventilatie%20is%20een%20energiezuinige%20vorm,over%20een%20warmte%20terugwin%20systeem.>

<https://www.appartementeigenaar.nl/Bouwen-verbouwen/bouwtechniek/bouwmethoden-deel-2>

<https://www.joostdevree.nl/shtmls/psi-waarde.shtml>

APPENDIX 2: PHOTOS CURRENT HOME



APPENDIX 3: PROGRAM OF REQUIREMENTS - BENG

Functional requirements	Performance requirements	Technical requirements
Provide protection against precipitation, wind and other extreme temperatures (waterproof and rainproof)	BENG 1 - Maximum energy demand: Energy demand of the house limit by looking at the maximum energy required to heat and cool the house.	BENG 1 - Maximum energy demand: Max 25 kWh/m ² /year
Provide protection against intruding people and animals.	BENG 2 - Primary fossil energy use: The necessary maximum amount of primary fossil fuel for heating, cooling, ventilating and creating hot water for the home.	BENG 2 - Primary fossil energy use: Below the 5 kWh/m ² /year
Provide a place where one can sleep, eat, rest and possibly work.	BENG 2 - Share of renewable energy: Looking at "the minimum share of renewable energy as a percentage of total energy consumption"	BENG 2 - Share of renewable energy: At least 50% use of renewable energy such as solar panels or wind energy.
A place with a comfortable atmosphere and air flow	"A structure has such a lighting installation that the structure can be used and left safely."	"A living space has a ventilation facility with a capacity of at least 0.7 dm ³ /s per m ² floor area with a minimum of 7 dm ³ /s."
A place where one does not suffer from noise from outside or the neighbors (soundproof)	"An existing structure has such separating structures that the formation of allergens due to moisture in living areas, toilet rooms and bathrooms is sufficiently limited."	"...a living space with a installation site for a cooking appliance or with a installation site for an open combustion appliance for hot water has a ventilation facility with a capacity of at least 21 dm ³ /s."
The house has no cold bridge and heat loss	"An external separating structure of a living space, a toilet room or a bathroom is waterproof."	"A toilet room has a facility for ventilation with a capacity of at least 7 dm ³ /s."
A place where one can generate heat, energy and hot water in a sustainable way	"An existing structure has such a facility for ventilation that the development of a quality of the indoor air that is harmful to health is prevented."	"A bathroom has a facility for ventilation with a capacity of at least 14 dm ³ /s."
A home that protects against both	"The discharge of indoor air from a toilet room or a bathroom takes place	"At least 21 dm ³ /s of the capacity of the discharge

the cold as against the heat. (good ventilation)	directly outside place.”	from indoor air from a room in which a location for a cooking appliance is located, is discharged directly to the outside.”
A fire-safe building	“An existing structure has a provision for quick being able to discharge heavily polluted indoor air if necessary”.	“A room has a purge ventilation facility with a purge ventilation capacity of at least 3 dm ³ /s per m ² of floor area of that room.”
	“A building to be built is almost energy-neutral.”	“A vertical external separating structure of a residential area, a toilet room or a bathroom, has a thermal resistance of at least 4.7 m ² x K/W”
	“A building to be built is such that the environmental impact of the materials to be used in the building is limited.”	“A horizontal or sloping external separating structure of a residential area, a toilet room or a bathroom, has a thermal resistance of at least 3.7 m ² x K/W”
	“A building has a lighting installation such that the building can be used and left safely.”	“A structure that forms the separation between a residential area, a toilet room or a bathroom and a crawl space, including the parts of other structures connected to that structure, insofar as those parts influence the thermal resistance, has a thermal resistance of at least 3.7 m ² x K/W”
	A lighting installation is connected to an electricity supply.	“An internal separating structure that forms the separation between a residential area, a toilet room or a bathroom, and a room that is not heated or that is heated for exclusively a purpose other than the stay of persons, has a thermal resistance of at least 4.7 m ² x K/W”.
	A building with a facility for taking and using energy has a safe facility for taking and using energy.	“Windows, doors and frames have a heat transfer coefficient of at most 2.2 W/m ² •K.”

	<p>An electricity supply is connected to the electricity distribution network if:</p> <p>a. the connection distance is no greater than 100 m, or</p> <p>b. the connection distance is greater than 100 m and the connection costs are not higher than with a connection distance of 100 m.</p>	<p>“The average heat transfer coefficient of the windows, doors and frames of a building is, determined at most 1.65 W/m²•K.”</p>
	<p>A building with a drinking water or hot water supply has a drinking water or hot water supply that does not adversely affect health.</p>	<p>The air volume flow of the total of living areas, toilet rooms and bathrooms of a function is no greater than 0.2 m³/s.</p>
	<p>A hot water supply meets NEN 1006 .</p>	<p>When renewing or replacing insulation layers, a thermal resistance of at least 2.6m².K/W applies to a floor, 1.4 m².K/W for a facade and 2.1m².K/W for a roof. When renewing or replacing windows, doors and frames a heat transfer coefficient of at most 2.2W/m².K.</p>
	<p>An air cavity larger than 40 mm</p>	<p>In the event of a major renovation involving a technical building system for space heating or space cooling or a combination thereof is placed, partially renewed, changed or enlarged, a function meets a minimum value renewable energy of 30 x (A_{roof} / A_{g,tot}) kWh/m².year, determined according to NTA 8800, where A_{roof} / A_{g,tot} is at most 1.0.</p>
		<p>“An enclosed space through which a protected escape route or protected route passes has a lighting installation that measures on a floor, a tread or a ramp illuminance can give of at least 1 lux.”</p>
		<p>An electricity supply complies with 1000 volts at low voltage, and at high voltage.</p>

APPENDIX 4: CALCULATION OF THERMAL RESISTANCE OF ALTERNATIVE HOUSING

Ground floor			
Material	λ value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/ W)
Rockwool mineral wool board insulation	0,035	0,16	4,571
Wide slab floor (concrete)	2,00	0,2	0,100
Screed/finishing layer (cement mortar)	1,03	0,08	0,078
Rc (total R-value)			4,749
Upper floor			
Material	λ value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/ W)
Plasterboard ceiling	0,16	0,0125	0,078
Rockwool mineral wool board insulation	0,035	0,16	4,571
Wide slab floor (concrete)	2,00	0,2	0,100
Screed/finishing layer (cement mortar)	1,03	0,08	0,078
Rc (total R-value)			4,827
Roof floor			

https://voorschrijvers.nibe.eu/kennis-en-inspiratie/beng-eisen-voor-bijna-energieneutrale-gebouwen?utm_source=google&utm_medium=cpc&utm_campaign=voorschrijvers+search+beng&utm_term=beng%20eisen&utm_content=beng&gclid=CjwKCAjwjaWoBhAmEiwAXz8DBYo2E3ykIQ76JQBzpNpyHG6-kqIVZcnX2hxb1efVmhbImWa1YZN5-RoCIG4QAvD_BwE

²⁶ <https://zoek.officielebekendmakingen.nl/stb-2019-501.html>

²⁷ <https://vanschijndel-bouwgroep.nl/nieuws/wat-is-beng/>

Material	λ value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/W)
Ceiling plasterboard	0,16	0,0125	0,078
Rockwool mineral wool board insulation	0,035	0,16	4,571
Wide slab floor (concrete)	2,00	0,2	0,100
Screed/finishing layer (cement mortar)	1,03	0,08	0,078
Rc (total R-value)			4,827
Roof			
Material	λ value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/W)
Roof tiles	1,28	0,00055	0,0004
Insulating sandwich element: <ul style="list-style-type: none"> • 3mm Chipboard • 300 mm Fire retardant modified EPS Platinum • 3 mm chipboard • 10 mm gypsum fiber board²⁸ 	<ul style="list-style-type: none"> • 0,038 • 0,038 • 0,038 • 0,40 	<ul style="list-style-type: none"> • 0,003 • 0,3 • 0,003 • 0,01 	<ul style="list-style-type: none"> • 0,079 • 7,9 • 0,079 • 0,025
Rc (total R-value)			8,08
Cavity wall			
Material	λ value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/W)

²⁸

<https://www.kingspan.com/content/dam/kingspan/unidek/products/netherlands/unidek-aero-deluxe/kingspan-unidek-aero-deluxe-prod-uct-data-sheet-nl-nl.pdf>

Wall finish stucco	0,48	0,01	0,02
Interior wall; High-strength concrete (dry)	1,28	0,1	0,078
Insulation Rockfit Premium Silver	0,033	0,15	4,545
Stainless steel cavity anchors diameter 4mm		0,17	
Weakly ventilated cavity ²⁹	0,026	0,04	1,5
Exterior wall; Brick masonry	0,82	0,1	0,12
Rc (total R-value)			6,263
Dwelling separating wall - Anchorless cavity wall			
High-strength concrete (dry)	1,28	0,1	0,078
Weakly ventilated cavity ³⁰	0,026	0,04	1,5
High-strength concrete (dry)	1,28	0,1	0,078
Rc (total R-value)			1,656
Interior wall			
Material	λ -value/ thermal conductivity coefficient (W/mK)	Material thickness (m)	R/thermal resistance (m ² K/ W)
Gypsum fiberboard (finish)	0,4	0,015	0,0375
Vapor-tight foil Miofol 125 AV	200	0,00031	0,00000155

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<https://stores.utopis-platform.net/rockwool-2022-nl/channels/rockwool/20220608%20Luchtpouwventilatie%20NTA%208800%20en%20NPR%202068%20Rekenhulp.pdf>

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<https://stores.utopis-platform.net/rockwool-2022-nl/channels/rockwool/20220608%20Luchtpouwventilatie%20NTA%208800%20en%20NPR%202068%20Rekenhulp.pdf>

Insulation Rockfit Mono	0,035	0,08	2,286
High-strength concrete (dry)	1,28	0,4	0,3125
Insulation Rockfit Mono	0,035	0,08	2,286
Vapor-tight foil Miofol 125 AV	200	0,00031	0,00000155
Gypsum fiberboard (finish)	0,4	0,015	0,0375
Rc (total R-value)			4,966

APPENDIX 5: VENTILATION CALCULATION

Areas of living areas, living spaces and other space _____

Living areas	Surface area	Living spaces	Surface area	Other space	Surface area
Living area 1	32m ²	Living space 1	27m ²	Unnamed space (ground floor)	0,5m ²
Living area 2	32m ²	Living space 2	5m ²	Technical room	0,3m ²
Living area 3	45m ²	Living space 3	6m ²	Toilet room	1m ²
		Living space 4	12m ²	Traffic area (ground floor)	8m ²
		Living space 5	14m ²	Bathroom	2m ²
				Unnamed space (attic)	45m ²

The above data has been taken from the BENG Energy Advisory Report by N. Monsengo.

Space	Area	Requirement	Required ventilation (dm ³ /s)	Supply Provision	To space	Cap.	Provision Discharge	To space	Cap.
VG 3 - Attic	45m ²	Unknown							
Unnamed space (attic)	45m ²	> 1 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	45	Valve for balanced ventilation	Attic	45	Stairwell 2 and valve for balanced ventilation	VKR 2	45
VKR 2	8m ²	n.a.	45	- Stairwell 2	VKR 2	45	Doors first floor and stairwell 1	VG2, bathroom and VKR1	45
VG 2 - First floor	32m ²	> 0.9 dm ³ /s per m ² floor area plus min. 7 dm ³ /s	28,8						
VR 3: Bedroom 1	6m ²	> 0.7 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	4,2	Door and valve for balanced ventilation	VR 3	6	Valve for balanced ventilation	Outside	6
VR 4: Bedroom 2	12m ²	> 0.7 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	8,4	Door and valve for balanced ventilation	VR 4	11	Valve for balanced ventilation	Outside	11
VR 5: Bedroom 3	14m ²	> 0.7 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	9,8	Door and valve for balanced ventilation	VR 5	11,8	Valve for balanced ventilation	Outside	11,8
Total			22,4			28,8	45 - 28,8 = 16,2		28,8
Bathroom	2m ²	> 14 dm ³ /s	14	Door and valve	Bathroom	14	Valve for	Outside	14

				for balanced ventilation			balanced ventilation		
Total							16,2 - 14 = 2,2		2,2
VG1 - Ground floor	32m ²	> 0.9 dm ³ /s per m ² floor area plus min. 7 dm ³ /s	28,8						
VKR 1	8m ²	n.a.	n.a.	Stairwell 1	VKR 1	2,2	Doors VG1, door toilet room, door storage room and door MC	VG1, storage room, toilet room and MC	2,2
VR 1: Living room	27m ²	> 0.7 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	18,9	Valve for balanced ventilation	VR 1: Living room	62,8	Door VKR 1 and valve for balanced ventilation	VKR 1	43,9
Toilet room	1m ²	> 7 dm ³ /s	7	Door VKR 1 and valve for balanced ventilation	Toilet	7	Valve for balanced ventilation	Outside	7
Unnamed space (Storage)	0.9m ²	> 1 dm ³ /s per m ² floor area plus min. of 7 dm ³ /s	0,9	Door	Storage	0,9	No drain so back through door to VKR 1	VKR 1	0,9
**Technical room (MC)	0.3m ²	ventilation opening of 200 cm ² /20dm ²	80	Door	MC	80	No drain so back through door to VKR 1	VKR 1	80
VR 2: Kitchen	5m ²	> 21 dm ³ /s	21	- Back door - Valve for balanced ventilation	VR 2: Kitchen	65	Door VKR 1 and valve for balanced ventilation	Outside VKR 1	21 44

Total						215, 7			196,8
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Technical room: A meter cupboard must have a ventilation opening of 200 cm² at the top and bottom near the door according to the NEN

2768³¹ 200 cm² = 20dm². 20dm² x 4dm (thickness) = 80dm³

** The Building Decree does not set any requirements for an unnamed space (VG3). ** VKR 1 = Ground floor traffic area ** VKR 2 = First floor traffic area **Stairwell 1 = first floor stairwell **Stairwell 2 = attic stairwell

The above data has been taken from the BENG Energy Advisory Report by N. Monsengo. The adjustments in the table, the places where a valve is placed, are marked in green.

APPENDIX 6: ENERGY USAGE AND REQUIREMENTS RESULT

Resultaten

Energieprestatie			
indicator		eis	resultaat
energiebehoefte	$E_{WH+Cind,ventil,el+CI}$	60,00 kWh/m ²	51,04 kWh/m ² ✓
primaire fossiele energie	$E_{wEP_{Tot}}$	30,00 kWh/m ²	29,78 kWh/m ² ✓
aandeel hernieuwbare energie	RER_{RenTot}	50,0 %	66,0 % ✓
hernieuwbare energie indicator	$E_{wePFenTot}$		57,86
temperatuuroverschrijding	$TO_{j\mu,max}$	1,20	0,44 ✓
energie label			A+++
netto warmtebehoefte (EPV)	$E_{itrdnet}$		21,58 kWh/m ²

Jaarlijkse hoeveelheid energiegebruik voor de ene functie					
functie		energie niet-primair	energie primair	hulpenergie niet-primair	hulpenergie primair
verwarming	$E_{H,ci}$				
elektrisch		413 kWh	5995 kWh	304 kWh	440 kWh
warm tapwater	$E_{W,ci}$				
elektrisch		1012 kWh	1012 kWh	22 kWh	32 kWh
ventilatoren	$E_{V,ci}$	512 kWh	743 kWh	0 kWh	0 kWh
Totaal		7749 kWh	7749 kWh	0 kWh	472 kWh

Jaarlijkse hoeveelheid hernieuwbare energie		
verwarming	$E_{Ren,H}$	4121 kWh
warm tapwater	$E_{Ren,W}$	1474 kWh

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Jaarlijkse hoeveelheid hernieuwbare energie		
koeling	$E_{Ren,C}$	0 kWh
elektriciteit	$E_{Ren,el}$	3528 kWh
totaal	$E_{Ren,Tot}$	9123 kWh

Elektriciteitsgebruik op de meter	
gebouwegebonden installaties	5670 kWh
niet gebouwegebonden installaties	2600 kWh
opgewekte elektriciteit	2433 kWh
totaal	5837 kWh

Oppervlakten		
totale gebruiksoppervlakte	$A_{g,tot}$	157,65 m ²
verliesoppervlakte	A_{ls}	214,61 m ²
compactheid		1,36

CO ₂ -emissie	
CO ₂ -emissie	1101 kg

Alle bovenstaande energiegebruiken zijn genormeerde energiegebruiken gebaseerd op een standaard klimaatjaar en een standaard gebruikersgedrag. Het werkelijke energiegebruik zal afwijken van het genormeerde energiegebruik. Aan de berekende energiegebruiken kunnen geen rechten ontleend worden.

TO _{juli} conform NTA 8800	
rekenzone	RZ1
noord	0,24
oost	0,00
zuid	0,44
$TO_{j\mu,max}$	0,44