UNIVERSITY OF TWENTE.

VAN WIJNEN

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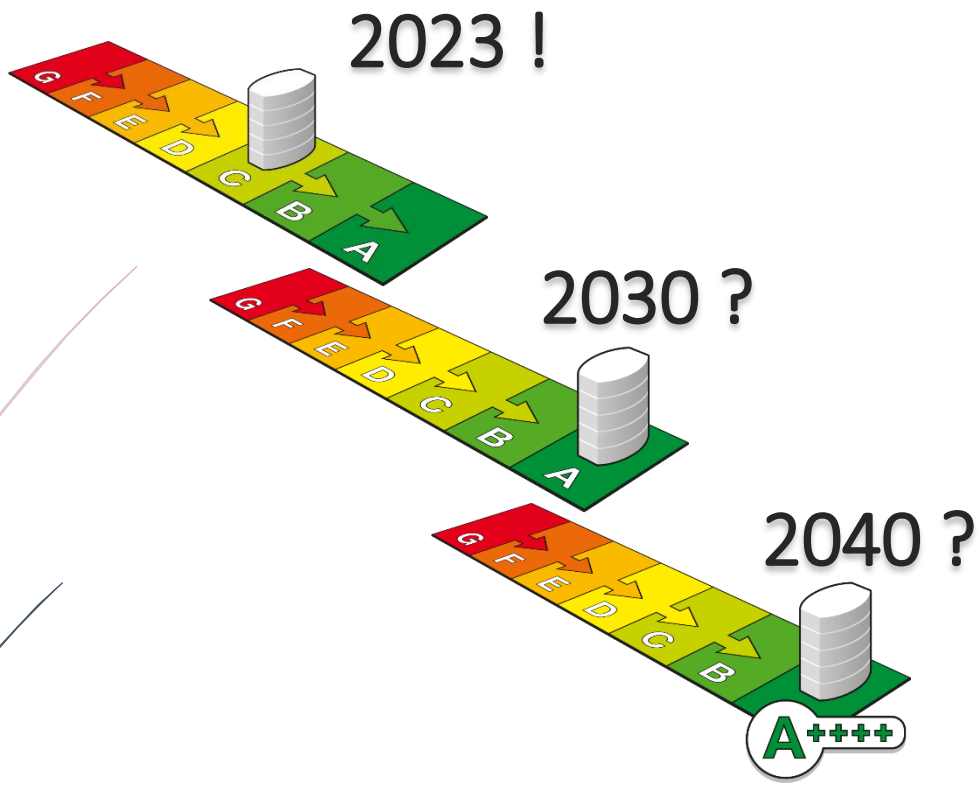
Strategy development to approach the market of office buildings that require at least an energy label C

Master's Thesis

Master Civil Engineering Management



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Master's Thesis

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Preface

The thesis “Strategy development to approach the market of office buildings that require at least an energy label C” is the result of a research at Van Wijnen Eibergen. The purpose of the research project has been to develop a process model which can be used to assess the energy efficiency of office buildings. This research is the final proof of competence for obtaining my Master of Science (MSc) degree in Civil Engineering and Management (CEM) at the University of Twente.

This research was conducted on behalf of Van Wijnen Eibergen, under the supervision of Peter Spelt and earlier in the process Bas Bredewold. I would like to thank my supervisors for their input and guiding during the research in my graduation process. Additionally, I would like to thank the other employees of Van Wijnen that helped me conducting this research as well as people who formed the expert panel.

Conducting this research has been one of the most interesting, educational and toughest challenges during my study. In this period, I was supervised by dr. ir. W. Tijhuis and prof. dr. ir. J.I.M. Halman. They have been very helpful in guiding the research, providing feedback and keeping me on track in this research. Therefore, I would like to thank my supervisors for their guidance and support.

Finishing this thesis, will also end my time as a student at the University of Twente. During this study I learned a lot, developed myself and met a lot of people. This was not able without the loving support of my parents, family, friends and girlfriend Evelien. I would like to take this opportunity to thank them all.

Stephan Hesselink

Enschede, June 2019

Summary

Climate change is one of the main challenges the world faces nowadays. Global warming changes the climate with major consequences for flora and fauna, harvests and water levels. In the Paris climate agreement, 195 countries obliged themselves to draw up national climate plans to limit global warming. The Netherlands have the target of achieving 49% reduction of greenhouse gasses by 2030, compared to the emission level in 1990. Drawing up a national climate and energy agreement and introducing a climate law should ensure that this goal is achieved.

One of the components of the agreement is the obligation of at least an energy label C for office buildings in 2023. This measure forces building owners or users to apply energetical improvements to their office buildings. It is estimated that over 50% of all office buildings does not meet these requirements yet, which means many office buildings need to be improved energetically within a few years.

Van Wijnen Eibergen sees opportunities in this market. However, they are not sure how to approach the market and what risks are involved. A preliminary research showed that Van Wijnen Eibergen finds it difficult to approach new markets or innovation in markets. According to employees of Van Wijnen Eibergen, market opportunities are noticed, but there is a lack of guiding structure within the company to adapt quickly to these opportunities.

Van Wijnen Eibergen wants a different approach for the new market of office buildings that require at least an energy label C. Therefore, this study is conducted towards the feasibility of this market and towards a structural approach of it. The following research question is answered during this research:

What approach will fit Van Wijnen Eibergen and its customers, in which the market of office buildings, that require at least an energy label C, can be approached?

Within this masters' thesis a theoretical and empirical research is executed. In the theoretical part, a literature study is conducted towards assessment methods for sustainability of a building. Furthermore, is investigated how an energy label is calculated and what input is needed to calculate this. Combined this led to an approach which was used to conduct a case study.

In the empirical part of the research this case study was conducted. An office building in the municipality of Enschede is energetically assessed. The energy label was determined, and a proposition was presented to the building user for improvements to the building. The used process during this phase of the research was evaluated and incorporated in a process model.

To validate whether the process model fits different office buildings and the demands of its potential customers, an expert panel was organized. During a meeting the panel is asked to give their opinion towards the model. This validation has led to several changes of the model after which the final model was established.

This developed process model, presented in Figure 11, is the most important discovery in this research. This model is a guideline for Van Wijnen Eibergen to approach the market of office buildings that require at least an energy label C. With the model employees of Van Wijnen Eibergen have a structured and uniform approach.

A second finding in this research is that a full package should be offered to the client by Van Wijnen Eibergen. The strength of Van Wijnen Eibergen lays in the contact with the client and in unburdening

this client. Herein they make a difference to comparable companies in this market. In this full package, a multiple year maintenance plan must be included. This plan shows when maintenance or replacement of construction elements or installations is scheduled. This is necessary in the consideration when to execute energetical improvements.

A third finding is that to successfully approach the market of office building that require at least an energy label C, an installation company is necessary. Together with this installation company, Van Wijnen Eibergen is able to analyse and improve office buildings.

Finally, some recommendations are presented to Van Wijnen Eibergen. Three of these are shortly outlined. The first recommendation is to test the process model during the first couple of office buildings that are assessed. The process model can be adjusted according to the findings of these assessments. Secondly, as stated in before, Van Wijnen Eibergen should offer a full package for management, control and maintenance of the office building including a multiple year maintenance plan. As third, the research made clear that Van Wijnen Eibergen has an EPA-U advisor who is not certified to officially register an energy label. Therefore, another certified company is necessary. Preferably a party which can use the (software) data of the building, which is already collected by Van Wijnen Eibergen.

Samenvatting

Tegenwoordig is klimaatverandering een van de grootste uitdagingen die de wereld heeft. De opwarming van de aarde heeft grote gevolgen voor flora en fauna, oogsten en waterlevels. 195 landen hebben zich met het Parijsakkoord tot doel gesteld om een nationaal klimaatplan te schijven, om zo de opwarming van de aarde zoveel mogelijk te stoppen. Nederland heeft zich tot doel gesteld om in 2030 49% minder broeikasgassen uit te stoten ten opzichte van het niveau van 1990. Om dit doel te halen is er een nationaal klimaat en energie akkoord geschreven en is er een klimaatwet aangenomen.

Een van de onderdelen van de klimaatwet is de verplichting van minimaal een energielabel C voor kantoorgebouwen in 2023. Deze maatregel dwingt gebouweigenaren of gebruikers tot het toepassen van energetische verbeteringen aan het kantoorgebouw. Geschat wordt dat meer dan 50% van de kantoorpanden nog niet aan de eis van minimaal energielabel C voldoet. Dit betekent dat in een korte periode veel kantoorgebouwen energetisch verbeterd moeten worden.

Van Wijnen ziet mogelijkheden in deze markt. Echter weten ze niet hoe ze deze markt het beste kunnen benaderen en welke risico's er zijn. Een vooronderzoek toonde aan dat Van Wijnen Eibergen moeite heeft met het benaderen van nieuwe markten of innovaties in markten. Volgens medewerkers van Van Wijnen Eibergen worden nieuwe markten wel gezien, maar is er geen vaste structuur in het bedrijf om hier snel op in te kunnen springen.

Van Wijnen Eibergen wil deze nieuwe markt van kantoorgebouwen die minimaal energielabel C moeten hebben anders aanpakken. Daarom is er in dit onderzoek gekeken naar de haarbaarheid van deze markt voor Van Wijnen Eibergen en naar een gestructureerde aanpak ervan. Onderstaande onderzoeksvraag is in dit onderzoek beantwoord:

Welke aanpak past bij Van Wijnen Eibergen en zijn klanten, waarmee de markt van kantoorgebouwen die minimaal een energielabel C moeten hebben benaderd kan worden?

In deze thesis zijn een theoretisch en empirisch onderzoek uitgevoerd. In het theoretische deel is een literatuurstudie gedaan naar evaluatiemethoden voor de duurzaamheid van een gebouw. Verder is onderzocht hoe een energylabel berekend wordt en welke input hiervoor nodig is. Gecombineerd heeft dit geleidt tot een aanpak om een casestudie mee uit te voeren.

In het empirische deel van dit onderzoek is deze casestudie uitgevoerd. Een kantoorgebouw in de gemeente Enschede in energetisch geëvalueerd. Het energielabel van het gebouw is bepaald en voorstellen tot verbetering van het pand zijn gepresenteerd aan de gebouwbeheerder. Het doorlopen proces gedurende deze fase van het onderzoek is geëvalueerd en heeft geleid tot een procesmodel.

Om te valideren of dit procesmodel toepasbaar is op verschillende kantoorgebouwen en voldoet aan de eisen van potentiele klanten, is een expertpanel georganiseerd. In deze sessie heeft het panel het model beoordeeld. Deze validatie heeft geleid tot verschillende aanpassingen van het model. Hierna is het uiteindelijke model tot stand gebracht.

Dit ontwikkelde procesmodel, weergegeven in Figure 11, is de meest belangrijke conclusie van dit onderzoek. Het model dient als richtlijn voor Van Wijnen Eibergen om de markt van kantoorgebouwen die minimaal energielabel C moeten hebben te benaderen. Hiermee hebben de medewerkers van Van Wijnen Eibergen een gestructureerde en uniforme benadermethode.

Een tweede conclusie van het onderzoek is dat Van Wijnen Eibergen een volledig pakket zou moeten aanbieden aan de klant. De sterkte kant van Van Wijnen Eibergen ligt in het contact met en het ontzorgen van de klant. Hierin maken ze verschil met vergelijkbare partijen in deze markt. Binnen dit pakket zouden ze ook een meerjarenonderhoudsplan toe moeten voegen. Dit plan geeft inzicht in het moment van onderhouden of vervangen van constructieonderdelen of installatiecomponenten. Dit inzicht is noodzakelijk om te kunnen afwegen of en wanneer energetische verbeteringen toegepast moeten worden.

Een derde conclusie is dat er een installatiebedrijf nodig is om succesvol de markt van kantoorgebouwen die minimaal energielabel C nodig hebben te benaderen. Samen met dit installatiebedrijf kan Van Wijnen kantoorgebouwen analyseren en verbeteren.

In het onderzoek zijn een vijftal aanbevelingen aan Van Wijnen Eibergen gepresenteerd. Drie van deze worden kort toegelicht. De eerste aanbeveling is om het ontwikkelde model te testen tijdens de eerste paar gebouwen de geanalyseerd worden. Met bevindingen tijdens deze analyses kan het procesmodel vervolgens worden aangepast. Ten tweede zou Van Wijnen, zoals eerder omschreven, een volledig pakket voor management, beheer en onderhoud moeten aanbieden, inclusief een meerjarenonderhoudsplan. Ten derde heeft het onderzoek aangetoond dat Van Wijnen Eibergen een EPA-U adviseur heeft die niet gerechtigd is om gecertificeerde energielabels te maken. Daarom moet er een bedrijf gevonden worden die dat wel kan. Bij voorkeur een partij die de (softwarematige) data van het gebouw over kan en wil nemen van Van Wijnen Eibergen.

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1. Introduction

Climate change is one of the main challenges the world faces nowadays. The global warming changes the climate with major consequences for flora and fauna, harvests and water levels. To reduce this impact, more and more agreements are made, from global to local level. One of those is the Paris climate agreement, which was signed by 195 countries on December the 12th 2016. With this agreement the countries obliged themselves to draw up national climate plans to limit global warming to no more than 2 degrees compared to the pre-industrial levels. In addition, the countries must pursue efforts to prevent the emission of greenhouse gases and pollutants (United Nations, 2015). Another example are the 17 sustainable development goals of the United Nations (United Nations, 2019). These goals aim to end poverty, inequality and climate change in 2030. The 7th goal is to 'ensure access to affordable, reliable, sustainable and modern energy for all'. A target goal hereby is 'to double the global rate of improvement in energy efficiency, by 2030'. The Netherlands is not doing well to meet the agreements. This is illustrated by the status of another agreement, the 10-years plan Europe 2020. The EU members agreed to generate 20% of the energy in a sustainable manner (Rijksoverheid, 2019). According to Eurostat (2019), the Netherlands only reached 6,6% by 2017 which should have been 14% already.

Nonetheless, the Netherlands is trying to change it. The current coalition agreement (VVD, CDA, D66, & ChristenUnie, 2017) focusses more on climate and energy than the European or Worldwide agreements. The government of the Netherlands has set the target of achieving 49% reduction of emissions by 2030. Drawing up a national climate and energy agreement and introducing a climate law should ensure that this goal is achieved.

These challenges are also ongoing within the building sector. Buildings today account for 40% of the energy consumption worldwide (WBCSD, 2009). Therefore, making these buildings more sustainable will help to reach the goals of the agreements mentioned before. Both European and national legislation are focusing on lowering the energy impact of buildings. In the Netherlands for example, companies and institutions are obliged to implement energy saving measures, if the payback period is not more than 5 years (Netherlands Enterprise Agency, 2019). Furthermore, housing associations in the Netherlands are obliged to make their dwellings more energy efficient. By the end of 2020 all houses of a housing association must at least have an average energy label B (Ministerie van Binnenlandse Zaken en Koninkrijkrelaties; Aedes; Nederlandse Woonbond; Vastgoed Belang, 2012).

An energy label is a uniform quality number with which a building can be compared to similar buildings. Furthermore, it gives insight in possible energy saving measures to improve the energetic state of the building. Energy labels are based on the energy index, which will be explained in chapter 3.2 of this report.

Another measure taken by the Dutch Government, is the obligation of an energy label C for office buildings in 2023. This measure forces building owners or users to apply energetic improvements to their office buildings. According to the Netherlands Enterprise Agency (Dutch: RVO), this regulation is for buildings with at least 100 m^2 office area and where 50% or more of the total usable area is used for office purposes (Netherlands Enterprise Agency, 2018). The expectation is that between 50% and 80% of the existing office buildings have a label D or worse (Economical Institution for the Building Industry , 2016) (Van Wijnen Eibergen, 2018-2019)[1].

1.1. Reason for the research

Van Wijnen Eibergen sees opportunities in this market of office buildings that have to be made more sustainable. However, they are not sure how to approach the market and what risks are involved. In a preliminary research, which is presented in Appendix A, recent approached market developments or innovative ideas at Van Wijnen Eibergen are analysed. This research showed that Van Wijnen Eibergen finds it difficult to approach these ideas or markets. There is no policy or strategy towards it and therefore new markets or innovations are often assessed by single employees. This combined with a hesitative attitude and a short-term vision towards the costs, often leads to rejection of the ideas or innovations.

Since the approach process towards these markets or ideas did not go well and involves risks, Van Wijnen Eibergen wants a different approach for the new market of Office buildings that require an energy label C. Therefore, this study is conducted towards the feasibility of this market and towards a structural approach of it.

1.2. Research company

This research is conducted at Van Wijnen Eibergen. Van Wijnen is a Dutch contractor which was founded in 1907. With 24 business locations in the Netherlands and a turnover of 821 million euro in 2017, it is the 9th largest contractor in the Netherlands (Cobouw, 2018). Van Wijnen has a decentralized structure wherein the 24 locations form five different regions; North, East, South, West and central. Those regions all have their regional office. These regions operate individually with their own identity. Thereby, they are supported by the main office which is in Baarn. This structure is presented in Figure 1. Herein, all locations have a thick dot and the lines go from the regional offices to the main office.

The business focus of Van Wijnen lays in the development, construction, transformation and maintenance of houses and utility buildings. The main focus herein differs per business location.

This research is performed at the location Van Wijnen Eibergen. This location is in the east of the Netherlands, in the region of Van Wijnen East, with Arnhem as regional office. The location has 77 employees of which 36 are working in the office in Eibergen and 41 on construction sites.

In their business plan for 2018 till 2020, Van Wijnen Eibergen stated that they aim for projects within the regions of Twente and De Achterhoek (Van Wijnen Eibergen-Hengelo, 2018). Within this region, they focus on the following four markets:

1. Non-residential construction for industry, health care and specialized industries
2. Sustainability projects and major maintenance projects at housing associations
3. Transformation of buildings of investors
4. Rental dwellings for investors

Figure 1: Decentralized organisation of Van Wijnen in the Netherlands, with Eibergen encircled (Van Wijnen, 2019)

1.3. Reading guide

This report is structured into 6 chapters. In the second chapter research design will be addressed. Herein will be explained what the goals of this research are and how the research is conducted. The third chapter presents the relevant theoretical background. This is used during the case study that will be presented in chapter four. The outcome of this case study is a process model to assess office buildings. Chapter five will present the validation of this process model by an expert panel. This validation results in a redesign of the process model, which will lead to the final model. Finally, in chapter six, conclusions of the research will be given, and recommendations will be presented.

2. Design of the research

Chapter two focusses on the conceptual design of the research. First, a background study to the origin of the research is performed. Then the problems that arise are mentioned, which leads to the problem statement. Next, the research goals are set after which some boundaries of the research are presented. This is followed by the main research question and the associated sub-questions. Finally, the technical research design will describe how the research is executed.

2.1. Background of the research

This section elaborates on the origin of this research and the reason why Van Wijnen Eibergen wants to conduct is. It describes why they want to approach the market of office labels that require energy label C and what difficulties they herein have.

2.1.1. Origin of the research

Van Wijnen Eibergen is working on the expansion of their work in maintenance and renovation of buildings in the regions Twente and De Achterhoek. To further expand this business, they want to respond to the regulation that which requires office buildings to have at least an energy label C. More information about this regulation is presented in Appendix B. In this appendix possible subsidies are also outlined.

Van Wijnen Eibergen sees an opportunity in the regulation which requires office buildings to have at least energy label C. Van Wijnen Eibergen wants not only to decrease energy consumption of office buildings, but they also want to analyse other aspects such as the suitability of the building for the current and future functions. Further they expect that building owners are not well informed about their obligations regarding this law. Therefore, they want to consult and guide those building owners. With this, Van Wijnen Eibergen aims to establish long-term customer relationships. These long-term relationships should lead to an increase of the turnover and profit.

This case reveals a broader challenge for Van Wijnen Eibergen, which is the approach of new market segments. According to employees of Van Wijnen Eibergen, market opportunities are noticed, but there is a lack of a guiding structure within the company to adapt quickly to these opportunities. There are no standard processes which can be followed and because of that, new markets or shifts in the existing markets have been approached with variable success (Van Wijnen Eibergen, 2018-2019)[2]. In other regions, Van Wijnen did develop clear strategies. Van Wijnen Noord for example, has started to focus on product development and delivery (Appendix E). The focus of Van Wijnen Eibergen towards new market segments will be explained in the next section.

2.1.2. Strategy of Van Wijnen Eibergen

In the beginning of 2018, Van Wijnen Eibergen made a multiannual business plan for 2018 till 2020 (Van Wijnen Eibergen-Hengelo, 2018). This plan shows that Van Wijnen Eibergen wants to grow to a turnover of 36 million euro in 2018 and 40 million in 2020 with a gross margin of 10% (2018) and 11% (2020) (Van Wijnen Eibergen-Hengelo, 2018). Hereby the goal of Van Wijnen Eibergen is to establish long-term customer relationships, in which they want to become a property manager instead of a builder (Van Wijnen Eibergen, 2018-2019)[6]. As a property manager they want to become a partner, who helps the building owner to keep its building in good condition. In this partnership they want a proactive role instead of reactive like they always did (Van Wijnen Eibergen, 2018-2019)[9]. This means that they want to proactively approach their (potential) customers on time, instead of waiting for them to approach Van Wijnen Eibergen or to start a tender procedure.

Even though Van Wijnen wants to expand its share of the customers in the building sector, they do not want to attract every customer fitting their focus. Their main focus lays on the parties which are

suitable to become a long-term partner. So, there should be a perspective on more work after the first project.

The envisioned long-term relationships with new partners, have to start with a first project. Entering new markets segments, within the earlier mentioned focus, can be a way to gain more 'first projects' at different customers. These first projects are prospected to lead to durable relationships where most, or all potential work will be executed by Van Wijnen Eibergen.

By entering new market segments in order to find the desired costumers in those markets, several problems arise for Van Wijnen Eibergen. These will be outlined in the next session.

2.1.3. Problem statement

As mentioned in the introduction and showed in Appendix A, multiple reasons ensured that opportunities or markets were not adopted or approached by Van Wijnen Eibergen. Thereby it became clear that Van Wijnen Eibergen does not have a standard strategy or a structure to approach possible new markets (Van Wijnen Eibergen, 2018-2019)[2,6]. It is unclear what the best approach is to find a connection between the customer demands and the proposition. For the new market of office buildings which require at least an energy label C, they do want to use a clear strategy. This should contribute to their aim for more long-term customer relationships by penetrating new market segments.

These issues lead to the following problem statement:

Van Wijnen Eibergen has no clear strategy for the identification and selection of possible new markets. This restrains Van Wijnen Eibergen to assess the new market of office buildings that require energy label C.

2.2. Research goals

The first section describes the goal of the research, which is the broader aim of Van Wijnen Eibergen. The goal which will me met during this research will be described in the second section.

2.2.1. Goal of the research

As explained in §2.1.2, Van Wijnen Eibergen wants a to enter and operate profitable in new market segments. This is however a goal within a major issue. As stated by Van Wijnen Eibergen, they have a 'wait and see attitude and are always busy with the day of yesterday'. They think that this approach is not durable and therefore intent to change it (Van Wijnen Eibergen, 2018-2019)[9]. This reveals their underling ambition, which is changing from a reactive builder towards a proactive builder.

This generates the following goal of this research:

Van Wijnen Eibergen wants to change from a reactive to a proactive player within the construction industry.

This goal cannot be met within this research. This research will be a piece of the puzzle to finally reach this goal.

2.2.2. Goal in the research

As mentioned before Van Wijnen Eibergen wants to use a clear strategy to deal with the possible new market of the office buildings that require an energy label C or better.

This generates the following goal in this research:

To develop an approach for Van Wijnen Eibergen in which the market of office buildings that require at least an energy label C can be approached.

To meet this goal, a main research question with related subquestions will be presented in §2.4. But first, some boundaries will be set to define a more concrete research.

2.3. Boundaries of the research

Without boundaries, the research will be too broad to cope with the available time. Therefore, the following two boundaries are set:

- As stated, Van Wijnen Eibergen wants to enter new markets which are 'profitable enough'. Van Wijnen Eibergen sets targets in its business plan (Van Wijnen Eibergen-Hengelo, 2018) for the profit they want to make on projects. Therefore, 'profitable enough' will be explained as the gross profit margin on a project, which should be 10% in 2018 and 11% in 2019 and 2020. This target is set on 'projects', which is normal for a contractor. However, if they want to become property manager, this should change towards gross profit margin on properties or on the portfolio of the specific partner.
- Van Wijnen Eibergen has set its aim to operate within its own region (Van Wijnen Eibergen-Hengelo, 2018). Therefore, the research is limited to Twente and De Achterhoek.

2.4. Research questions

In this section, the general research question and its subquestions will be presented. Answering the research question will ensure to reach the goal in the research. This research question is acquired from the earlier-mentioned problem statement and the goal in the research. The main research question is:

What approach will fit Van Wijnen Eibergen and its customers, in which the market of office buildings, that require at least an energy label C, can be approached?

To answer this question, this research will be structured by four subquestions. The combined answers of these subquestions will provide the answer to the main research question. The subquestions are:

1. **What is a decent process approach that is applicable to develop a process model where office building can be assessed with?**

This question should give the necessary background knowledge to conduct this study. Firstly, sustainable assessment methods will be analysed in order to obtain knowledge about the way energy assessments are conducted. Further will be explained what an energy label is and how this label is calculated. Hereby will also be explained how the energy label is determined in practice. This knowledge is combined to find a process approach that can be used to assess an office building during the case study.

2. **How does a process model with which office buildings energetically can be assessed case look like?**

This phase will start with the case study. Herein firstly, a research is conducted towards a suitable office building. This building will be assessed by using the method obtained by answering the previous sub-question. Then, a strategy will be developed to improve the office building to at least meet the 2023 requirements.

Afterwards, the followed process during the case study will be analysed and adjusted. This analysation will lead to a process model which is applicable to other office buildings.

3. **How will the final process model with which office buildings energetically can be assessed look, after the validation of an expert panel?**

During the answering of the previous sub-question, a process model is developed. This model is based on theory and on the case study. However, it is not tested in practice. Therefore, an expert panel is organised. This will validate the model. After this validation adjustments will be made to the process model after which the final model will be presented.

2.5. Technical research design

In this section the technical design of the research will be addressed. A model for the research will be presented and explained.

The research model is presented in Figure 2. This model outlines the approach that will be used to meet the goal of this research and answer the main research question. This model shows three main phases. The theory phase, the practice phase and the validation phase. These will be explained shortly.

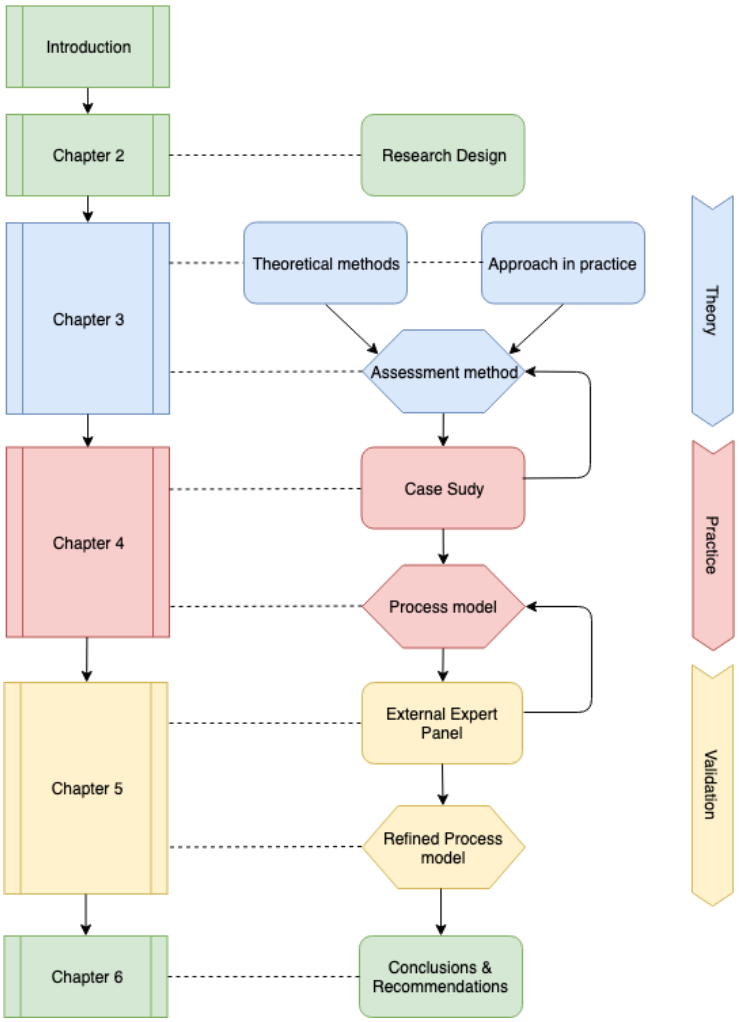

Figure 2: Flowchart of the research process and associated chapters in this repot

Theory phase

During this phase theory of sustainability assessment method is combined with the practical approach of calculating an energy label. This leads to an assessment method which can be used in the practice phase.

Practice phase

During the practice phase a process model is developed based on the theory of the previous phase and the case study of this phase. During the case study, an office building is assessed energetically and improvements to this building are suggested.

Validation phase

The process model developed in the practice phase is validated by an expert panel. During a meeting the panel is asked to give their opinion towards the model. With the input of the experts a final process model is developed.

3. Design of a process approach

This chapter provides the necessary background knowledge to conduct this study. Firstly, sustainable assessment methods will be analysed in order to obtain knowledge about the way energy assessments are conducted. Further will be explained what an energy label is and how this label is calculated. Hereby will also be explained how the energy label is determined in practice. This knowledge is combined to find a process approach that can be used to assess an office building during the case study.

This chapter will answer the following research sub question.

> What is a decent process approach that is applicable to develop a process model where office building can be assessed with?

3.1. Sustainability assessment methods for buildings

For almost three decades, building sustainability assessment methods, or building environmental assessment tools, are used. Initially they were only used in larger developed countries, but with the developing of new regionally adapted methods, the use is more spread (Haapio & Viitaniemi, 2008). Nowadays, many tools or methods are used. In different scientific reviews, more than 20 are mentioned (Haapio & Viitaniemi, 2008) (Ding, 2008). A method used often in The Netherlands, Europe and worldwide is BREEAM, which is developed in the United Kingdom. Another method used in many countries is LEED, which is most popular and developed in the United States.

3.1.1. BREEAM

The first comprehensive building performance assessment method was the Building Research Establishment Environmental Assessment Method (BREEAM). It was developed in the United Kingdom in 1990 by the British Research Establishment (BRE) and this method is still widely used (Ding, 2008). The method was first used as an award system for new office buildings but is now used to assess different types of buildings in different countries. Today, it is one of the global leading green building rating systems that is used to measure the environmental performance of new and existing buildings. The method uses a set of ten categories of indicators on which a building is assessed. These are shown in Figure 3.

Figure 3 The ten categories which are assessed by BREAAM (BREEAM, 2019)

On each category so called credits can be scored, for a range of assessment issues. If these scores pass a benchmark, the scores get a weighting after which the BREEAM rating can be given. Figure 4 shows that at least a 45% score is necessary to score a ‘good’ and that a score over 85% will give a building the BREEAM label ‘outstanding’.

Figure 4 BREEAM rating levels (OnGreening, 2017)

The process to do a BREEAM assessment for existing office buildings consists in the Netherlands of 7 steps (Dutch Green Building Council, 2016). These steps, shortly outlined below, are focusing on formalizing the assessment and not on the analysis of the 10 categories

1. Project definition: A project is made in the assessment tool.
2. The project is registered in the assessment tool. After this, a registration fee can be charged.
3. The project gets a unique registration number.
4. The project team starts to build a file. They deliver proof and hand it over to the assessor.
5. A certified assessor reviews the files, validates them, calculates the BREEAM score and makes a final assessment report.
6. The Green Building Council checks the quality of the assessment report on sampling.
7. After approval of the quality check, the certificate will be delivered.

A technical manual provided by BREEAM (2016) is used to find the steps necessary to conduct the assessment of an office building on the ten mentioned categories. For all these categories the assessment is split in three parts: The asset performance, the building management and the occupier management. Since this research addresses the energetical state of office buildings, the assessment category energy will be explained.

Part 1: Asset performance, Energy

Within this asset performance energy part, 108 credits are available, of which 100 are awarded on basis of the 'BREEAM In-Use International asset energy score'. The first step herein is to assess the performance of seven energy end use components (BREEAM, 2016). These are presented in Table 1 together with several sub-components that have the greatest impact on the end use component score.

Table 1 Energy end use components and subcomponents (BREEAM, 2016)

End use component	Sub-component
Heating	Building Fabric – Thermal Conductance Building Fabric – Air Leakage Rate Ventilation Heat Recovery Efficiency of Heat Generation
Cooling	Solar Gains Building Fabric – Air Leakage Rate Efficiency of Cooling Generation
Heating Distribution	Efficiency of Heating Distribution
Cooling Distribution	Efficiency of Cooling Distribution
Lighting	Efficiency of Lighting Installation
Ventilation	Fan Efficiency Duct Leakage Air Handling Unit Leakage
Hot Water	Efficiency of Heat Generation

The scores of the individual sub-components are calculated by comparing actual performance to a benchmark 'best practice value'. These actual performances are determined by answers to 30

questions about the different sub-components. The scores of those sub-components are multiplied by a weighting factor, which reflects the influence that the sub-component has on the overall performance of the respective end use component (BREEAM, 2016). These scores are summed to find the main end use component score.

To find the overall asset energy rating, the influence of each end use component on the total building energy consumption has to be taken into account. Therefore, these components are weighted also. The weighting factor varies since it depends on the building type and the location of the building. The final score can be calculated by adding together the weighted end use component scores (BREEAM, 2016).

The input for the assessment should be provided by the user of the building. They must present information about the building type, age of the building and the servicing strategy. Further information about the systems installed, can be presented by the used, but this is optional. If it is not presented, the values for those (sub-)components will be estimated based on the age of the building or on the last time the relevant system was replaced (BREEAM, 2016).

Part 2: Building management, Energy

Within this building management energy part, 60 credits are available, of which 40 are awarded by the operational energy rating. The other 20 are awarded for energy consumption monitoring, energy consumption data use and for sub-metering main energy sources, other energy sources and tenanted areas.

The operational energy rating is generated by comparing the actual building CO_2 emissions with the CO_2 emissions of a reference benchmark.

The reference benchmark is set according to the activity type in the assessed building. However, there could be more activity types carried out in the same building. Than the reference benchmark is calculated on an area weighted basis. Next the energy consumption of the reference building is converted to CO_2 by multiplying the electrical and non-electrical energy benchmarks by appropriate carbon emission factors (BREEAM, 2016).

To calculate the actual energy consumption, the metered energy consumption of the building will be the main factor. This energy consumption can be changed by two corrections factors:

- If there is energy use which is not typical standard for the type of building that is being assessed. This energy use can be subtracted, if its separately metered.
- If there is energy exported from the building, it can be subtracted, it its separately metered.

Used energy can be entered in almost all kinds of fuel types. The BREEAM tool will convert the consumption to an amount of CO_2 emission. This conversion could differ for fuel types, depending on the location of the building.

The score is finally established by comparing the reference benchmark with the actual use. On a lineair scale, the maximum credits will be awarded if there is zero CO_2 emission and no credits will be awarded if the emission is more than twice the reference value.

Part 3: Occupier management, Energy

Within this occupier management energy part, 64 credits are available, of which 51 are awarded by energy management arrangements. The other credits are awarded for energy policy, trends in energy performance data, energy objective and energy savings (BREEAM, 2016).

The maximum number of credits awarded for the management arrangements is 51. It depends to what extent the management arrangements set energy targets and how they monitor the implementation.

A long list is provided by BREEAM with all kinds of initiative that could award point. The aim with the 51 points is, to recognise and encourage management arrangements aimed at improving energy performance and usage awareness.

3.1.2. LEED

LEED, which stands for Leadership in Energy and Environmental Design, is a set of green building rating systems widely used in the world. It provides a framework to create healthy, highly efficient and cost-saving green buildings. LEED is used in five different types of construction situations:

- Building Design + Construction
- Interior Design + Construction
- Building Operations + Maintenance
- Neighbourhood Development
- Homes

For each of these situations, a building rating system is available. These systems assess buildings based on a combination of credit categories. There is a total of nine categories available, which are shown in Figure 5.

Figure 5 Credit categories to assess building with LEED (Dawn, 2014)

For each of the five different construction situations a set of credit categories is selected. Subsequently, a weight is given to these categories by attributing a number of credits to it. For all rating systems, these credits add up to a total of 110. The certifications which could be earned for the awarded points are shown in Figure 6. To gain a certificate, there are always a set of minimum requirements, the LEED Prerequisites. If these are met, extra credits can be earned to gain a better certificate.

Figure 6 LEED certifications levels (Everblue Training Institute, 2019)

This research is about the energetical assessment of existing office buildings. Therefore, the Building Operations + Maintenance rating system is applicable. This assessment uses eight of the nine mentioned credit categories. Only the category 'Integrative Process' is not used. Since this research focusses on the energetical assessment of buildings, the credit category 'Energy & Atmosphere' will be further elaborated.

Energy & Atmosphere

There are four prerequisites for this category and 8 credit subjects (US Green Building Council, 2019). For each of these, the requirements will be given as stated in the LEED v4 O+M rating system PDF (US Green Building Council, 2018):

1. Energy Efficiency Best Management Practices (Prerequisite)
2. Minimum Energy Performance (Prerequisite)
3. Building-Level Energy Metering (Prerequisite)
4. Fundamental Refrigerant Management (Prerequisite)
5. Existing Building Commissioning – Analysis
6. Existing Building Commissioning – Implementation
7. Ongoing Commissioning
8. Optimize Energy Performance
9. Advanced Energy Metering
10. Demand Response
11. Renewable Energy and Carbon Offsets
12. Enhanced Refrigerant Management

3.2. Energy Label

Since office buildings require an energy label C in 2023, it is necessary to know what this label means. This section elaborates on the different energy labels for non-residential buildings and on the calculation method to determine the energy label. First an overview of the different labels is given together with their corresponding energy index. Later the measurement method to find this energy index will be presented. Eventually, it will be explained how the energy label is determined in practice.

3.2.1. Energy labels, G to A++

According to the Energy Performance of Buildings Directive, it is since 2008 obliged to provide an energy label when a dwelling or building is sold or rented. The aim of this label is to have a uniform quality number with which buildings can be compared to similar buildings. Furthermore, insights are gained in possible energy saving measures, to improve the energetic state of the building. The label is introduced to encourage building owners to apply these energy saving measures and not to predict the energy use (TNO, 2013). The actual building use and energy consumption is in fact completely disconnected from the label.

An energy label can be given to a specific building if the energy index of this particular building has been calculated. The index has no dimension and the Index values for each label are presented in Table 2. How this Energy Index is calculated will be explained in the next section.

Table 2 Energy Labels for non-residential buildings (Energie Vastgoed, 2018)

Energy Label	**Energy Index Values**	
	From	To
A++	0	0,50
A+	0,50	0,70
A	0,70	1,05
B	1,05	1,15
C	1,15	1,30
D	1,30	1,45
E	1,45	1,60
F	1,60	1,75
G	1,75	∞

3.2.2. Energy Index

The energy index presents the energetic performance of a building. The lower the energy index, the better the energetic performance of the building. The index is calculated for standard weather conditions in the Netherlands and standard users' behaviour. This way buildings can be compared to each other. The method for calculating the energy index is found in ISSO publication 75.1. This is provided by the Dutch independent foundation Institute for study and stimulation of research in the field of building installations (ISSO Kennisinstituut bouw- en installatiesector, 2013). The energy index is calculated by dividing the standardized energy use by the permissible energy use of a building. This is equal to the total energy use per usage function divided by the total permissible energy use per usage function. The usage function describes the function that a building has.

$$Energy\ Index = \frac{Standardized\ energy\ use}{Permissible\ energy\ use} = \frac{\sum energy\ use\ per\ usage\ fuction}{\sum Permissible\ energy\ use\ per\ usage\ fuction}$$

In this formula, the total energy use per usage function is depending on the construction and the installations in the building. If the construction is more insulated, this total energy use per usage function will decrease and so will the energy index. The same effect applies to the technical

installations. If the installations are more efficient, the energy use per usage function will decrease and therefore, the energy index will decrease also.

The permissible energy use per usage function is calculated by the following function, which is found in Isso publication 75.1.

$$Q_{perm\ per\ usage\ function} = \sum_{gf}\left(\frac{1}{f_{cool}}\right) * C_{g;perm} * A_{g;gf} * EPC_{req;gf} * C_{EPC;gf} * C_{EPA;gf} + y_v * c_v * \frac{1}{h} * f_{user;gf} * U_{v;min;gf} * A_{g;gf} * f_{usage\ area} + c_{loss;perm} * y_{loss} * A_{loss})$$

This function contains on the one hand, building specific input, such as the usage surface and the surface towards the outside. On the other hand, it contains many factors for correction or converting. These factors follow European building regulations and Dutch standards published in ISSO 75.3.

3.2.3. Determine the energy label in practice

In practice, the formula to calculate the energy index is incorporated in software programs. The most used application in the Netherlands to assess utility buildings is EPA-U software. This is an application that is made by Vabi Software B.V., which is a company that provides decision supportive software for predicting and assessing the performance of buildings. The EPA-U software can be used to fast analyse buildings energetically and to create customised advice. Within Van Wijnen Eibergen this software is used as well.

To assess buildings, the software needs input of the specific building, but it also uses many standardised parameters. These standardised parameters are for the climate, the occupancy rate and for the users behaviour. In the case of office buildings, an average Dutch occupancy rate is used and an average behaviour of users in offices.

The specific input of the building consists of the dimensions, the technical installations and the construction elements. The technical installation components are presented in Table 3.

Table 3 Technical installation components which are input for the EPA-U software

Ventilation	Heating
Humidification	Cooling
Hot tap water	Solar energy
Lighting	

The relevant construction elements are presented in Table 4Table 6. For each element the geographic orientation will be added in the software. This is relevant because an element directed towards the south will contribute more to the heating of the building.

Table 4 Construction elements which are input for the EPA-U software

Walls	Glass
Panels	Doors
Roofs	Floors connected to the ground

Since these technical installation components and construction elements are the input for determining the energy label, they are also the components on which improvements to the building will be designed.

3.3. Conclusion: comparing the different methods

In section 3.1 some methods are presented to assess the sustainability of buildings. Here is explicitly looked into the energetical assessment of those buildings. In this section the approach of the sustainability assessment methods will be compared with the approach to determine an energy label, which is addressed in section 3.2.

The biggest difference in the approach of the sustainability assessment tools and the energy label is the duration. The energy label method assesses a building one time, after which an energy label is calculated. Next, the building might get improvements. Then, the label is calculated again, after which the process ends. For the sustainability assessment tools, it is an ongoing process. The approach of the management is involved in the score and furthermore the awareness of the users of the building.

Next to that, there is a difference in the approach of a building. Where the energy label approach sees the building components different from the installations. The sustainability tools combine these and take the characteristics of the building into account for the topics heating and cooling. The transportation of the heat or cold however, is split at the sustainability tools, while these are taken together in the calculation for the energy index.

Another difference is the use of metered energy consumption. The sustainability assessment tools require the input of the energy use. The energy label approach however does not incorporate this metered use. Not using the energy consumption makes it more accurate to compare similar building, which is useful. But using the energy consumption makes it possible to compare behaviour of occupiers.

All and all, these approaches might be different, but the necessary input for the methods is almost the same. For the same aspects, assumptions are made based on building age and the same types of calculations are made based on benchmarks.

Since the input for the approaches is more or less the same, the components of the calculation for the energy index will be used as assess method during this research. Since they comply with the input for the EPA-U software, it is obvious to use those. Table 5 presents these key components.

Table 5 Components used to assess an office buliding

Technical installation components	Construction elements
Ventilation	Walls
Heating	Panels
Humidification	Roofs
Cooling	Glass
Hot tap water	Doors
Solar energy	Floors connected to the ground
Lighting	

4. Developing the process model

In this chapter a process model will be developed in which office buildings can be assessed. The process approach outlined in the previous chapter will be used in a single case study. This case study is conducted to find an efficient approach to assess an office building energetically and provide suggestions to improve it.

At the end of this chapter, the following research sub question will be answered.

> How does a process model with which office buildings energetically can be assessed case look like?

The chapter is structured as follows. First the case study will be conducted. Next, the process analysis of the case study is analysed and transformed towards a uniform method. Finally, the designed process model will be presented.

4.1. Case study

In this section, firstly the selection of the case building is explained first. Secondly, the assessment of this building is presented. This assessment will determine the energy index and energy label of the case building. For this building, measures to improve the energy label will be given, which is explained in the third section. This advice is offered to the case company during a meeting and section 4.1.4 will describe the feedback on it. Finally, the conclusion of this case study will be presented.

4.1.1. Selection of a suitable office building

This section describes the research in order to find an office building that it suitable to conduct this study on. First the area is chosen, afterwards the selection is narrowed, based on building year and building size. Then, a session with experts of Van Wijnen Eibergen will leave a set of 15 buildings. These buildings are visited to finally select one.

Selection of an area

To find a suitable office building, first a municipality had to be chosen. Together with the manager innovation and the manager maintenance and renovation of Van Wijnen, the municipality of Enschede was selected. Firstly because of the large number of office buildings that are located in the municipality. Secondly, because renovating a building in Enschede will hopefully lead to exposure which can lead to other projects in Enschede. Although the building will only be examined during this study, Van Wijnen hopes to also do the implementation of the recommended measures.

Refine the selection

The analysis in Appendix C shows that there are 534 office buildings in the municipality of Enschede that are larger than 100 m^2. For Van Wijnen, the bigger buildings are more interesting to approach. Not all buildings need structural measures, for many buildings installation technical measures will be enough to gain an energy label C. Van Wijnen thinks that changing the technical installations in larger buildings can gain profit, while changing the installations in smaller building could cost money and is therefore significantly less interesting. Because of that, the focus should be on larger office buildings. Larger is defined as 1000 m^2 or bigger, which refines the selection to 164 office buildings.

According to Van Loon (2018) office buildings built before 1990 mostly have an energy label worse than C. Therefore, buildings built after 1990 are filtered out. Further a few buildings turned out to have a majority of other functions besides the function office, these were also excluded. This leaves a selection of 60 buildings.

According to the innovation manager of Van Wijnen Eibergen many office buildings were built between 1970 and 1990 and the majority of those have similar building styles (Van Wijnen Eibergen, 2018-

2019)[11]. Therefore, these buildings are very useful for a case study to find a standard approach. Excluding the buildings built before 1970 refines the selection to 38 different office buildings.

Expert session

Thirty-eight is a too large number of office buildings to all visit and ask to contribute to the research. Therefore, the ideal number has been set on fifteen. This means that out of the thirty-eight buildings, fifteen had to be chosen. Two experts of Van Wijnen, the innovation manager and the maintenance and renovation manager, are asked to give their opinion on the buildings. Hereby kept in mind that the building had to be a pilot which should result in a standard approach. Therefore, eccentric buildings were less interesting and buildings with a common style are more interesting. Furthermore, they were asked to estimate the energetic state of the buildings, so buildings which might have an energy label C or better were excluded. Figure 7 shows the whiteboard on which the buildings were assessed.

Figure 7 Impression of the selection of 15 office building out of the 38 remaining

Visitation of the office buildings

The expert session resulted in a top fifteen office buildings. These fifteen were visited and for all contact has been sought with the owner. The results were divers:

- Two tenants of office buildings did not want to cooperate at all;
- One building turned out to be a medical institution, which is not affected by the 2023 law for office buildings;
- Three buildings were renovated already;
- Two were empty and the only contact was a real estate consultancy company. After contacting them, one turned out to have been sold and the other was not in their portfolio anymore;
- Two buildings are planned to be demolished;
- Two buildings were owned by a real estate company. They turned out to have already examined the buildings;
- One building was owned by the municipality of Enschede. They were interested, but it turned out plans were made already to improve the building;
- And for two buildings, email contacts were received, and an email was sent.

A contact person of a company, that seemed to be the owner of an office building, called with the message that their company only rented out the furniture of the office building visited. However, she

also mentioned that their own office building might be interesting to conduct the research on. This building, which is also in Enschede, dates from 1997 and was therefore filtered out in the analysis. But, the contact person stated that there were many complaints about the installations and that they use a lot of energy. Furthermore, they have an ambition for corporate social responsibility, and assessing the environmental impact also belongs to that.

Selection of the office building

After discussing the possibility with the innovation manager, there was doubt about the energy label of the building. It could already be label C, which means that changes are not required by the new 2023 law. However, the research to the current label and to improvements will be similar, whether a building has energy label F or C. Therefore, the decision has been made that the office building was suitable to conduct the research on. An important factor in this consideration was the willingness of the contact person to help. She was eager to search information about the installations and construction details of the building. Furthermore, the company is building a new Technology Centre across the street. This is a modern building which triggers them to also improve their 1997 building. An impression of the building is presented in Figure 8.

Figure 8: Impression of the case office building. (retrieved from GoogleMaps)

4.1.2. Assessment of the building

To determine the Energy Label of the building, it will be assessed both on structural and installation technical state. The assessment will be conducted based on the Energy Performance Buildings Directive (EPBD). This directive states that certified advisors are allowed to asses buildings and determine energy labels. For non-residential buildings, this is an EPA-U advisor, Energy Performance Advisor Utility buildings. At Van Wijnen Eibergen, one employee participated in a course about EPA-U and is now a certified advisor. The course information combined with ISSO 75.1 (ISSO Kennisinstituut bouw- en installatiesector, 2013) was used as input to conduct the assessment on the case building.

The assessment starts with determining the usage functions of the building. Then possible different energy sectors are distinguished. Afterwards the installations in the energy sectors are examined. Finally, the surfaces and specifications of each type of construction which is facing the outside are

calculated. This together is the input for the computer application called VABI EPA-U that is used to calculate the energy index and label.

Determine the usage functions

The usage function describes the function that a building has. This can be sports, education, office, heath, etc. A building can have multiple usage function. Depending on the distribution of the different functions true the building, one or more usage function will be allocated to the specific building. To determine the usage functions, the first step is defining the parts of the building that are obliged to have an energy label. For instance, not heated parts of a building are not obliged. The research showed that within the case building, the whole building is obliged for an energy label.

The usage functions must be determined for every part of the building that's obliged to have an energy label. The distinction for the case building has been made for every layer of the building. The results are shown in Table 6. This clearly shows that there are three different functions within this building: Office, Meeting and Help function.

Table 6 Surface of the different usage function in the case building

Building Layer	**Office function m²**	**Meeting function m²**	**Help function m²**	**Total m²**
Ground Floor	1586	335	1292	3214
First Floor	1875	87	1098	3061
Second Floor	1875	87	1098	3061
Total	5336	510	3489	9335
Percentage	**57,2 %**	**5,5 %**	**37,4 %**	**100%**

According to the EPA-U course, the help function square meters must be distributed proportionally over the other functions. This calculation is presented in Table 7.

Table 7 Usage functions surface with divided help function

	Office function m²	**Meeting function m²**
Surface per function	5336	510
Distribution of Help surface	3185	305
Total	8520	815
Percentage	**91 %**	**9 %**

In this table, the 3489 m² help function are distributed, by area ratio, to both Office function and Meeting function. This provides 8520 m² office function and 815 m² meeting function, which is respectively 91% and 9%. The ISSO 75.1 states that, if a usage function is smaller than 25% of the total label obliged usage surface, it should be added to the main usage function. This means that for this case, the whole building can be designated as office function.

Determine the energy sectors

After determining the usage functions, a consideration must be made, whether to divide the building into multiple energy sectors. If there is more than one separately functioning installation group in the building, different energy sectors should be considered. These different sectors are distinguished by the area which is served by each installation group.

For each sector, installations and construction elements will be identified. The relevant construction elements consist of walls, glass, panels, doors, roofs and floors which are connected to the outside or to the ground. For each element the geographic orientation will be added. This is relevant because an element directed towards the south will contribute more to the heating of the building.

The installation consists of ventilation, heating, humidification, cooling, hot tap water, solar energy and lighting. For these, the installed type will be input to calculate the energy label.

In the case building, two installation groups are installed. Therefore, the building is divided in two energy sectors. For each of the sectors the construction elements and installations are determined. The distribution of the building over the two sectors is visualized in Figure 9.

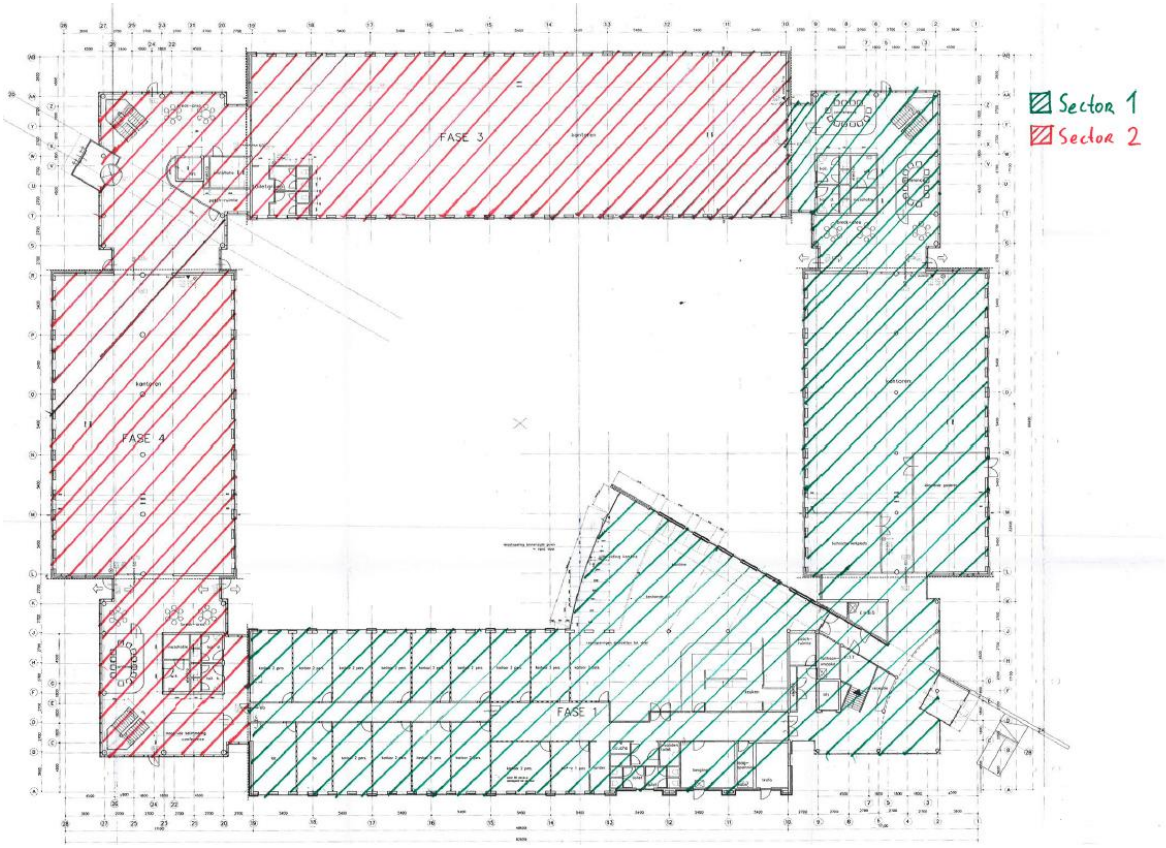

Figure 9 Distribution of the case building in two sectors

Installations in the energy sectors

As explained, the installation consists of ventilation, heating, humidification, cooling, hot tap water, solar energy and lighting. For each of these, the installed systems in both installation groups will be discussed.

Ventilation

The ventilation system installed in both sectors is a mechanical balance system. The system provides the necessary supply of fresh air for the building. The system is balanced with mechanical discharge and with windows that can be opened.

Heating

In both sectors, two improved efficiency boilers are installed, which makes four in total. The two pairs consist of a 313-kWh boiler and a 345-kWh boiler. The heat is distributed via heated air. All boilers date from 1997 and 1998, when the building was constructed, and the installations were installed. In sector 2, a heat recovery ventilation system is installed. This makes sure that during the discharge, heated dirty air from the inside warms up fresh cold air from the outside. This ensures that the cold air from the outside is pre-heated and therefore requires less energy to get the desired temperature. This can lead to huge savings in the heating costs.

Humidification
The installed installation for humidification is an electrical steam humidifier. This is installed in both sectors in the air handling unit.

Cooling
For cooling in both sectors two compressing cooling machines are installed. In sector 1, one machine of 162 kWh and one of 140 kWh. In sector 2, two machines of 140 kWh are installed. The building is cooled by cold air which is distributed through the building.

Besides these compression cooling machines, there are also individual cooling machines installed. These machines each serve one or two separate air conditioner units. However, these do not have to be considered while calculating the energy index since they are not part of the permanent installation of the building.

Hot tap water
At a few locations, hot tap water is available. This water is heated by electrical boilers within near location of the water tap.

Solar energy
In the current situation, there are no solar panels on the building. Because of that, the revenues of solar energy are zero. There is also no other type of system in or on the building which provides (sustainable) electricity.

Lighting
To find out what type of lighting is installed and what the energy demand is, specification drawings of the lighting are assessed. In some parts of the building, led lights are installed, but most of the lights are fluorescent lamps. Two types of fluorescent lighting are used, T5 and T8. T5 lighting is already quite energy efficient, where T8 is more qualified for replacement.

The VABI EPA-U software demands either the average Watt per square meter, or the total Watt used by all lamps. In this case, the average Watt per square meter is calculated, which is 10,2 W/m^2.

Besides the wattage, the usage time of the and the way of using is important for the energy index. According to the Manager Facilities of the case building, the building is used 5 days a week, approximately between 8:00 and 17:00. During these hours, a part of the lighting is constantly on. The other part has presence detection, which means that the lighting is automatically switched on when people are detected in the room.

In both sectors the same division has been made between constantly use and presence detection. This is determined to be 70% with presence detection and 30% constantly in use.

Construction elements in the energy sectors
In the building, seven types of construction elements are adjacent to the outside or the ground. Those seven elements have influence on the temperature inside because they transfer heat inside out or outside in. The thermal transmittance of a material or element is expressed as the U-Value. This value is given in Watts per square meter times the degrees in Kelvin ($U = \frac{W}{m^2}°K$).

The total surface adjacent to the outside is measured for each sector. This is divided on basis of the direction of wind. In Appendix D the calculations of these four directions are given. In total there are five types of construction elements which are vertical and face a wind direction. These are walls, windows with awnings, windows without awnings, panels and doors. Further there are two horizontal elements, which are the roof and the floor.

For each of the elements an assumption is made about the insulation values. According to the EPA-U course these assumptions must be made because it is often not possible to find out the precise values. These assumptions are according standard values of insulation which were required when the building was built.

Some elements of the building need more input to find the value. For the windows, the type of glass and frame needs to be specified. Additionally, for windows with awnings the type of awning and the way of operating it is relevant. This can be done manually or automatically. Automatically is considered to work more efficient since it also protects the building from heating when there is no one in the office.

For the doors, the type of door and material has to be specified. Likewise, should for the walls, floors, roof and panels be indicated whether insulation is present or not and if known, what the thickness of the insulation is.

Determine the energy index and label

With the input of the usage function, energy sectors, installations and construction elements, the energy index can be determined. This calculation is made in the EPA-U software. For the case building an energy index of 1,69 is calculated. This corresponds with an energy label F, which means that the building does not meet the required energy label C, which is obliged in 2023. In the next section, suggestions will be presented to improve the case building.

4.1.3. Improvements to the building

As calculated in the previous section, the energy index of the case building is 1,69. There are multiple options to improve the building towards at least an energy label C. This section will explain possibilities to improve the building. Hereby, several elements will be discussed, such as improved lighting, replacing the glass, improving the ventilation installation, replacing the boilers, adding solar panels to the roof and insulate the roof of the building. For all improvements, the effect on the energy label will be given as well as the costs of it and the payback period.

Improve lighting

According to the NEN 12464-1, offices require 500 lux, which is equal to 500 lumen per square meter (Philips Nederland B.V., 2018). The number of lumens indicates the amount of light produced by a lamp. This is the new standard which indicates the output of a lamp, where the former standard, Watt, indicates the input for a lamp. Where offices need 500 lux, corridors and toilets need 100 lux and canteens 200 lux.

Improvements

Currently, most of the lighting in the building is produced by fluorescent lamps, which is using much more energy compared to led lighting. This conventional lighting is installed on 9000 m^2 of the total 9365 m^2 floor area. These current lights on average use 10,2 W/m^2. If led lighting would be installed, it would use approximately 2,5 W/m^2 to produce the required 500 lux.

Further, many lights in the building are switched on in the morning and switched off at the end of the day, even though they might not be used during the entire day. The loss due to this unnecessary use of lighting can be resolved by presence detection systems. These systems will put on the light for a few minutes when they detect movement.

Most of the light in the building is produced by conventional T5 of T8 lighting and in one part of the building, led lighting is installed. According to EnergieVastgoed (2019), it is hard to benefit financially when changing the T5 lighting to LED. However, it is lucrative to replace the TL8 lighting, although this most of the times also requires replacement of the fixtures.

Nevertheless, the manager facilities of the case building has intimated that they have the intention to replace both the TL5 and the TL8 lighting. Not only because of the financial profit, but also because of the comfort led lighting will give to the employees. Therefore, in the proposition the costs for replacing both the TL5 and TL8 conventional lighting is included. Thereby also presence detection systems will be installed.

Installing led lighting and presence detection will lead to a decrease of the energy index of 14,2%. This means that the measure can make sure that the building goes from an energy index of 1,69 to an index of 1,45, which is equal to an energy label D.

Besides the increase of the energy label, the new lighting will also bring savings on the energy costs. To calculate these savings, it is assumed that the company is opened during week days from 8:00 am to 5 pm and the lighting is on for 9 hours a day. Further, there are approximately 255 workable days each year. With the costs for the company of approximately € 0,06 per kWh energy, the savings per year that will be made by replacing the lighting are shown in Table 8.

Table 8: Energy use and costs of conventional lighting versus led lighting

	Average Watt/m²	**Energy per year in kWh**	**Costs per kWh**	**Energy Costs for lighting per year**
Old lighting	10,2	219.202	€ 0.06	€ 13.152
New led lighting	2,5	53.726	€ 0.06	€ 3.223
Savings		165.476		€ 9.929

Costs

There are two methods to replace the current lighting for led lighting. Either the fixture should be converted, so led lights will fit, or the complete fixture should be replaced with a fixture that is suitable for led lights. According to the cost expert of Van Wijnen Eibergen, there are doubts with converting the fixtures (Van Wijnen Eibergen, 2018-2019)[12]. It is not sure whether the lights will produce the same light as they would do in a led fixture. Further it can yield issues with the insurance company, due to the fire safety. Nevertheless, if these issues are covered, the costs will be around half of the costs of replacing the fixtures.

The costs that are involved with installing the led lighting are displayed in Table 9. These costs are based on key figures, provided by the cost expert of Van Wijnen Eibergen (Van Wijnen Eibergen, 2018-2019)[12]. Further the expected subsidy is added. This subsidy, called the Energy Investment Deduction (Dutch: EIA) is granted for the amount of lumen that is produced by the fixtures. Roughly, for each 1000 lumen produced by the new lighting, €25 subsidy can be claimed (Netherlands Enterprise Agency, 2018). In the last column the payback period is calculated and presented. It is calculated with a discount rate of 3% (The balance, 2019).

Table 9 Costs of installing led lighting and expected payback period

Led lighting	**Installation costs**	**Expected subsidy**	**Reduced energy costs per year**	**Expected payback period (DR: 3%/year)**
New fixtures	€ 539.940	€ 26.998	€ 9.929	> 100 years
Converted fixtures	€ 269.970	€ 26.998	€ 9.929	31 years

The table shows that the payback period for new fixtures is over 100 years. This makes it financially unattractive. The converted fixtures have a payback period of 31 years.

Improve glass type

The case building has approximately 2.600 square meters glass. All this glass is currently double glass with an insulation value of 2,9 W/m^{2}K. If this glass would be replaced by more modern types of glass, this insulation value will decrease. That will lead to less heat loss during the winter and less infiltration of heat during the warmer summer months.

Improvements

There are two options to improve the glass. Either the glass should be replaced by HR++ glass or it should be replaced by triple glass. The HR ++ glass has an insulation value of 1,8 W/m^{2}K and the triple glass has a value of 1,4 W/m^{2}K. The HR++ glass is a little bit thicker than the current glass, but that will not give a problem with the installation. However, the triple glass consists of three instead of two layers glass, which makes it significantly thicker. It is not sure, whether this glass will fit in the existing frames or not. Still the triple glass has been included in the calculations. Table 10 shows the expected reduction in gas use per year and the savings per years for replacing the glass.

If all the glass in the building will be replaced with HR ++ or triple glass, the energy index will change with respectively 11,2 or 14,8 percent. These changes equal energy indices of 1,50 and 1,44, which will give the building a label E for HR++ glass or a label D for triple glass.

Table 10 Reduction in gas use and expected savings for replacing the glass

	Expected reduction in gas use in m^3 per year	**Costs per m^3 gas**	**Expected savings per year**
HR++ glass	28.092	€ 0.31	€ 8.709
Triple glass	39.329	€ 0.31	€ 12.192

Costs

For both types of glass, the costs for the replacement are estimated based on key figures provided by the Cost Expert of Van Wijnen Eibergen. Hereby is assumed that the current frames are suitable for triple glass. According to the Cost Expert, the costs will double or triple if the frames are not suitable, which makes the measure totally unreachable (Van Wijnen Eibergen, 2018-2019)[12].

For the replacement of glass is a subsidy available. Again, the Energy Investment Deduction can be used. In this case up to 55% of the investment could be tax deductible. This could lead to a subsidy of 13,75% of the investment. The costs for the replacement, the expected subsidies and the payback period are presented in Table 11.

Table 11 Costs of installing new glass and expected payback period

	Costs for replacement	**Expected subsidy**	**Reduced gas costs per year**	**Expected payback period (DR: 3%/year)**
HR++ glass	€ 280.260	€ 38.536	€ 8.709	65 years
Triple glass	€ 342.540	€ 47.099	€ 12.192	46 years

The table shows that the payback period for HR++ glass and triple glass are respectively 65 and 46 years.

Improve the ventilation installation with a heat recovery ventilation system

Currently in one of the two energy sectors, a heat recovery ventilation system is installed. A heat recovery ventilation system makes sure that heat is recovered from the exhaust ventilation air. This heat is then used for heating the fresh incoming air.

Improvements

Since only in one of the two sectors of the building a heat recovery ventilation system is installed, it could have a significant effect to install another at the other sector. This measure would change the energy index with 8,9%, from 1,69 to 1,54, which is equal to an energy label E. The reduction in gas use, together with the expected saving are shown in Table 12.

Table 12 Reduction in gas use and expected savings for installing a heat recovery ventilation system

	Expected reduction in gas use in m^3 per year	**Costs per m^3 gas**	**Expected savings per year**
Heat recovery ventilation system	22.474	€ 0.31	€ 6.947

Costs

To find out what the costs are for a system like this both the costs expert of Van Wijnen Eibergen and an installation company are consulted. The costs expert did an estimation of the costs for a system like this. This estimation was presented to the installation company and they advised that the estimation was roughly correct.

With this system, the company can also apply for the Energy Investment Deduction subsidy. This could again lead to a subsidy of 13,75% of the investment. The costs for the heat recovery ventilation system, the expected subsidy and the payback period are presented in Table 13.

Table 13 Costs of installing a heat recovery ventilation system and expected payback period

	Costs for the system	**Expected subsidy**	**Reduced gas costs per year**	**Expected payback period (DR: 3%/year)**
Heat recovery ventilation system	€ 170.000	€ 23.375	€ 6.947	16 years

The table shows that the payback period for the heat recovery ventilation system is 16 years. Therefore, the implementation of this measure could be attractive for the owner as well as for the company who rents the building.

Improve the boilers

Currently in both sectors, two boilers are installed. In one sector these boilers date from 1997 when the building was constructed. The two boilers in the other sector were installed a few years later. Nevertheless, they have the same specifications as the other two.

Improvements

All four boilers are significant less efficient then boilers nowadays made. New types of boilers have an efficiency of 107% where the currently installed boilers have an efficiency of probably 60 to 80%. Therefore, a replacement of these boilers would be a decent measure to update the building. Installing four new boilers would let the energy index change from 1,69 towards 1,56, which is a 7,7% difference. This measure will give the building an energy label E. The reduction in gas use and the expected saving which come accompanied are displayed in Table 14.

Table 14 Reduction in gas use and expected savings for installing four new boilers

	Expected reduction in gas use in m^3 per year	**Costs per m^3 gas**	**Expected savings per year**
Installing new boilers	20.601	€ 0.31	€ 6.386

Costs

The costs for the new boilers are determined in the same way as by the heat recovery ventilation system. First the costs were estimated by the cost expert of Van Wijnen Eibergen, after which the installation company gave their advice. Unfortunately, the company cannot apply for a subsidy for this new boiler system. De total costs and the payback period of this measure are shown in Table 15.

Table 15 Costs of installing four new boilers and expected payback period

	Costs for the system	**Expected subsidy**	**Reduced gas costs per year**	**Expected payback period (DR: 3%/year)**
Installing 4 new boilers	€ 120.000	€ -	€ 6.386	13 years

The payback period for the new boilers is approximately 13 years. This means that it could be an interesting measure for the building owner or for the tenant.

Add solar panels on the roof

In the current situation, all the electricity used by the case company, is provided by the electricity supplier. To generate a part of this by itself, solar panels could be a good solution. The building has a flat roof which is partly used by installations. The other space could be used to provide own energy by solar panels.

Improvements

If half of the roof will be used to put solar panels on, around 1500 m^2 solar panels will fit. These panels can provide over 225.000 kWh of energy each year. Implementing this would give a change of the initial energy index of 1,69 towards 1,53, which is a 9,5% difference. This measure will lead to an energy label E. In Table 16 the reduction in energy demand and the expected yearly savings are presented.

Table 16 Reduction in energy demand and expected savings for installing solar panels

	Expected reduction in energy demand per year in kWh	**Costs per kWh**	**Expected savings per year**
Installing 1500 m^2 PV panels	225.000	€ 0.06	€ 13.500

Costs

To calculate the costs for installing solar panels on the roof, again key figures are used, provided by the cost expert of Van Wijnen Eibergen (Van Wijnen Eibergen, 2018-2019)[12]. In Table 17, the costs for installing the system are shown, together with the expected subsidy and the payback period. For this system the subsidy for Energy Investment Deduction could be granted, which can be 13,75% of the total investment costs.

Table 17 Costs of installing 1500m^2 solar panels and expected payback period

	Costs for the system	**Expected subsidy**	**Reduced energy costs per year**	**Expected payback period (DR: 3%/year)**
Installing 1500 m^2 solar panels	€ 414.000	€ 56.925	€ 13.500	56 years

A 56 years payback period equals about twice the lifespan of solar panels, therefore is this payback period is considered too long. However, in this case, the calculation also includes measures to build safely and costs for the construction site. Those costs could be avoided if the panels would be installed on a so called 'natural moment', when the roofing material has to be replaced. Nevertheless, then would it still be hard to benefit financially because the company is only paying €0,06 for a kWh of electricity.

Add insulation to the roof

During winters heat will be lost via the roof and when it is warm outside the building will heat up via the roof. This could be more prevented if the roof would have an extra layer of insulation. The current insulation is still the same as when the building was built.

Improvements

If the extra layer of insulation will be installed the energy loss via the roof will be reduced. However, the building has three floors, which makes the impact of this measure smaller. The changed energy index approves that. Due to this measure, it will change from 1,69 to 1,65, which is still energy label F. This is a change of 2,4%. The gas reduction and expected savings are shown in Table 18.

Table 18 Reduction in gas use and expected savings for installing an extra layer of insulation on the roof

	Expected reduction in gas use in m^3 per year	**Costs per m^3 gas**	**Expected savings per year**
Insulate the roof	6.626	€ 0.31	€ 2.054

Costs

For this measure can again be applied for the Energy Investment Deduction subsidy. This however, still leaves many costs in comparison with the benefits, which is presented in Table 19.

Table 19 Costs of installing an extra layer of insulation on the roof and the expected payback period

	Costs for the system	**Expected subsidy**	**Reduced gas costs per year**	**Expected payback period (DR: 3%/year)**
Insulate the roof	€ 295.830	€ 40.677	€ 2.054	> 100 years

The expected payback period shows that the costs far outweigh the benefits if this measure would be taken like this. However, it can be more beneficial if the measure would be taken on a 'natural moment'. If this extra layer is installed during the necessary replacement of the roofing material, only the costs for the material and a few labour hours have to be calculated. Then this measure could, unless the marginal savings, be interesting.

4.1.4. Offer to the case company

With the knowledge of both the case building and the possible measures, the offer can be made to present to the case company. The input for this offer will be the current state of the building and its energy label together with advice to make sure that the building will have an energy label C in 2023. This section will first show the offer, followed by the feedback of the case company.

Structure of the offer

Within the offer the measures of section 4.1.3 are combined in three sets. For all sets the costs of the measures are presented as well as the payback period and the energy label that it will provide.

The first set contains the measures that are financially interesting, since they have a reasonable payback period. This set consist of the replacement of the current four boilers and of the installation of a heat recovery ventilation system.

The second set consist of two measures that are not financially attractive. However, they could become attractive if they will be executed on a natural moment. This set contains the extra layer of insulation on the roof and the installation of 1500m^2 solar panels. According to the EPA-U advisor of Van Wijnen Eibergen, the roofing material replacement has to be considered after 18 years lifetime. The current material is 20 years old and might therefore need replacement within a few years. Even on a natural moment the solar panels are not lucrative, they could however contribute to the vision of corporate social responsibility.

The third set consist of measures which are not financially interesting. This could be because it has a low effect on the energy label or because of the low energy price the company pays.

In Appendix F the offer is presented. It consists of an accompanying letter, the sets of measures and the current energy label of the case building.

Feedback on the offer by the case company

The offer was presented to the case company on 4 March 2019. It was presented in a meeting with the manager facilities and her colleague. They were both very glad about the disinterestedness of a student. This proves them that they received a straightforward offer, which is hard to find in the current market. The noticed that they received over 50 offers from companies who wanted to help somehow with improving their building energetically. They also mentioned that they were busy with an obliged EED audit and received many offers for that also. This EED audit is a detailed overview of all energy streams in a building, which is required by the government every four years. This is applicable for companies who have over 250 fte employees or have a turnover of €50 million or more (Netherlands Enterprise Agency, 2019). From all these offers, it was for them really hard to determine what the interest of these companies was and whether they would give an honest advice for a fair price.

For example, the research showed them that the replacement of their current lighting installation for led lighting is financially not attractive. This is because they only pay €0,06 for a kWh energy. Thereby, they already have many TL5 lights installed, which are quite efficient. This makes the payback period of these lights large. The company however, did receive offers which stated that they would recoup an investment for this light within 5-8 years. There were also offers for solar panels with a short payback period which did not get close to the data of the research.

All in all, the facilities manager and her colleague stated that it was really difficult for them to find a partner with who they could discuss their situation open and fair. Some parties wanted to take over the complete maintenance of the company and others wanted to become their main installation company. This was not what the case company had asked for and not what they were looking for.

This conflicts with the intention of Van Wijnen Eibergen to find long term partners and use the energy label C as an entrance for this. The employees stated that, that method is not unique or easy. The facilities manager mentioned that she, influenced by experience in her previous job, sees Van Wijnen Eibergen as open and transparent. Her colleague however, who is not familiar with Van Wijnen, would experience Van Wijnen as one of the many companies who tries to get in. According to them, that is the great challenge for Van Wijnen; being distinctive and finding a way to gain trust of the other party.

4.1.5. Conclusions

The case company was selected out of 543 office buildings in Enschede. It has been assessed and the outcome was an energy index of 1,69. This energy index corresponds with an energy label F, which means that the building should be updated before 2023 to comply with the regulations. To improve the label, several suggestions were made to improve the energetically state of the building. Herein became clear the especially improvements to the installation system are interesting. This complies with the research of Degens, Scholzen, & Odenbreit (2015) wherein they found that the ventilation strategy has a significantly higher influence on the energetic and thermal performance of the building than the structure type or the window-to-wall ratio.

The suggestions for improvements to the case office building are summarized in Table 20. Herein, the changes to the energy index are given as well as the costs and the payback period.

Table 20 Suggestions for improvements to the case office building

Improvements	**Change in Energy index**	**Costs for installation**	**Payback period**
Led lighting with new fixtures	-14,2 %	€ 539.940	> 100 years
Led lighting with converted fixtures	-14,2 %	€ 269.970	31 years
HR ++ glass	-11,2 %	€ 280.260	65 years
Triple glass	-14,8 %	€ 342.540	46 years
Heat recovery ventilation system	-8.9 %	€ 170.000	16 years
Four HR 107 boilers	-7,7 %	€ 120.000	13 years
Solar panels	-9,5 %	€ 414.000	56 years

To change the building from energy label F to energy label C, the energy index should change from 1.69 to at least 1.30. This means a change in energy index of -23,1%. For an energy label A, at least an index of 1.05 is required, which correspondents to a change of -37,9%. In the table, the changes in percentages are given for each measure. Adding up these percentages will show the total change. For example, a combination of led lighting and solar panels would result in a change of -23,7%, which is just enough to update the building to energy label C.

The results of the assessment were presented to the manager facilities and her colleague of the case company. During this meeting became clear that there are many companies who try to get a piece of the pie.

4.2. Process steps for assessing an office building

This section will describe the process steps taken during the assessment of the case building. Hereby the used method will be analysed and transformed towards a uniform method which useful for every office building. Furthermore, the steps of implementing the measures and defining the new energy index and energy label will be added. These were not performed at the case building but will be necessary for Van Wijnen Eibergen in future projects. Together this gives the five steps below. This section discusses these five steps one by one.

1. Intake meeting with the building owner or user
2. Analysis of the office building
3. Advise to improve the office building
4. Implementation of improvements
5. Defining the new energy index and energy label

4.2.1. Intake meeting with the building owner or user

Case building

At the case building, the intake meeting was focused on the suitability of the building for this research and on their willingness to help. More than on the label steps that they were willing to make. However, during this meeting several aspects were revealed which could be similar to another intake. For example, the discussion or lack of knowledge about the current energy label. Further, many issues regarding the technical installations came up. The climate in the building was not satisfactory and there were many complains of employees. Thereby, the building user mentioned that the maintenance was not organized and mostly focused on problem solving.

Further, there was still uncertainty about the follow-up steps. Therefore, these steps and could only partly be discussed with the building user. But the desired outcomes of the research for both Van Wijnen and the case company were discussed.

Additionally, the required input was discussed. It was agreed that the company would put effort in the search to specifications of the building and the installations. Also, another meeting was scheduled. During this meeting, the technical installations without clear specification drawings could be analysed.

Standardised process

The intake meeting with the building owner or user could roughly be separated in two topics;

1. Unravel if there already is an energy label or not
2. Discuss the follow-up phases

During the first topic it will be discussed whether the office building already has an energy label or not. If there is no label, an analysis is necessary since an energy label is obliged. If there is an energy label which is label D or worse, the building should improve to at least energy label C. If there is enough research conducted and data available, the second phase can be skipped and an advice for improvements can be given. The label can also be already C or better. In that case it depends on the building owner or user whether they want to become more energy efficient it or not. If they do not, possible other business together with the company can be discussed. If they do want to improve their building, again it has to be verified if there is enough research conducted and data available to skip the second step.

During the second topic, it should be made clear what input is needed to conduct the analysis. Without the helpfulness of the building owner or user, the label cannot be determined. Furthermore, a meeting should be planned wherein the remaining data can be collected during location visit. Besides that, the demands and preferences of the building owner or user should be clear. These will be input to find the

suitable improvements in the third phase. At last, the output of the process has to be made clear. The output will be the energy label including suggestions for improvements together with a cost indication.

4.2.2. Analysis of the office building

Case building

For the analysis of the building, specification drawings of the building and of technical installations are used. The drawings of the building are used to find out the surfaces of different parts of the building. These were needed to find out what the usage functions are and to distinguish the different energy sectors. In this case, every room in the building which is not help function or canteen, is used for office. Therefore, no further input was needed to calculate different usage functions in the building.

Afterwards was investigated what installations were installed for each energy sector. For each type of installation, specifications have been sought or calculated. Some information was not clear and had to be find out during a location visit. Two of these visits were necessary to complete the data.

Besides the installation, the constructive elements of the building had to be distinguished. Most of the data could be collected from drawings. The remaining data was found during the location visit or was estimated on basis of the standard values applying at the time of constructing.

With these data, the energy index and energy label could be calculated. Therefore, the application VABI EPA-U was used.

Standardised process

For the case building, the necessary input was not clear on forehand. Therefore, more visits of the building were needed. Also, more contact with the building user was needed to gain information. For the standardized process, this input is clear on forehand and this will be discussed during the intake meeting. Therefore, less contact moments and visits are needed. If the building owner or user delivers the right input, most steps can be conducted without more contact. In this way the energy sectors can be distinguished, the installation can be specified, and the constructive element can be determined. Every blanc spot after those steps can be filled in during one location visit. After this visit, the data is complete, and the energy index and energy label can be determined.

4.2.3. Advise to improve the building

Case building

There are two kinds of measures to improve the building, construction technical and installation technical solutions. To find these solutions, two methods were used. One was consulting colleagues of Van Wijnen and ask them for possible measures. These measures could then be added in the software which showed the effect. The other method was using the VABI EPA-U software to do changes in the installations of construction and analyse the effects. This is a quick method of comparing the effect of different solutions. However, the costs were no factor in this comparison.

To find the costs for each measure, a costs expert of Van Wijnen Eibergen was consulted. He gave key figures for many measures or made estimations for the measures he was not sure of. The estimations were mostly for installation components. An installation company was asked to verify those estimations. They could not specify it but told that the estimations were roughly correct.

Next the possible subsidies for each measure had to be sought out. These subsidies are shown in Appendix A. For most of these subsidies, a list of measures and example calculations are available on the website of the Netherlands Enterprise Agency. This can be used to find out whether there is a subsidy available and what the grant amount is.

With these subsidies, the total costs of each measure are calculated. Along with that, the payback period was determined, based on the decrease in costs for electricity or gas.

With the effect of the measures, the costs of it and the payback periods, the advice to improve the building could be made. In this case, there were three groups of measures. One with relatively financially attractive solutions. Another group with solutions which could be interesting if some parts of the building need maintenance. The last group contained measures which are not financially lucrative at all, but maybe interesting for socially responsible reasons.

The results of the analysis and the possible improvements to the building were presented to the case company during a meeting. They were presented together with an accompanying letter wherein the content of the offer was explained. This offer is presented in Appendix F.

For the research, this meeting was just to present the results and to gain feedback on it. For upcoming projects, it could be more a meeting to discuss implementation of the measures.

Standardised process

For all buildings, there will be both constructions technically and installation technically measures. Within Van Wijnen Eibergen, there is enough knowledge about the costs and implementation of the construction technically measures. However, there is a lack of knowledge about the installations. Therefore, it would be useful to partner up with an installation company who is specialised in this field. An installation company can probably give better sophisticated solutions with less effort.

Likewise, the subsidies for the installation technical solutions can best be indicated by the installation company. The subsidies for the constructional improvements on the other hand can best be indicated by Van Wijnen Eibergen.

For all measures the effect on the energy index and label should be determined as well as the decrease in costs for electricity or gas. Taken into account the subsidies, the effect of the measures, the costs of installing, the construction site, risks and profit the payback period can be calculated.

The complete costs overviews and effects of the measures will be presented to the building owner or user. Together with the accompanying letter and the current energy label, this will be the offer for the company.

In other to present the measures structurally, they will be clustered in groups depending on the demands and preferences of the building owner or user. Roughly, the following three groups of measures will be presented:

1. The bare minimum: measures to reach energy label C
2. A step further: measures to reach energy label B or A
3. Preferred measures: measures to reach at least energy label C and company specific demands or preferences.

This advice will be presented to the building owner or user during a meeting. Within this meeting the three options can be explained. Furthermore, the possible implementation of the measures can be discussed. If the company owner or user is willing to implement measures, the process towards the execution can be discussed.

It is also possible that the company owner or user is not willing to implement measures. In that case it can be discussed whether Van Wijnen Eibergen can be helpful for other matters.

4.2.4. Implementation of improvements

If the owner or user of the case company chooses to implement proposed measures, this phase will be entered. In partnership with the installation company, the measures to improve the building will be planned and executed by the department Maintenance and Control of Van Wijnen Eibergen. They have their standard procedures, which are not evaluated during this research.

4.2.5. Defining the new energy index and energy label

After executing the measures to improve the building, the new energy index and energy label should be created. The EPA-U advisor of Van Wijnen Eibergen can calculate the new energy index and label with the VABI EPA-U software. However, he is not certified to officially register it. Therefore, another company is needed to formalise the energy label.

If the owner or user of the building is up for it, besides the new energy index and label, a plan for the future partnership can be presented. Herein will be explained what maintenance should be conducted to the building in the coming years and what measures future laws could ask. For example, a plan can be made to meet the requirements for energy label A which might be obliged by a new law in 2030.

This way, Van Wijnen Eibergen could become the standard partner of the company in maintenance and control of their building. This could lead to a more constant flow of work and turnover for Van Wijnen Eibergen.

4.3. Conclusion: The process model

The process approach outlined in the previous chapter is used in a case study. For the study, a suitable office building has been soughed and evaluated. The process is then analysed to find an efficient approach to assess an office building energetically and provide suggestions to improve it.

The five phases described in the previous section of this chapter are combined in a process model which can be used by employees of Van Wijnen Eibergen. It describes the steps that have to be taken during every phase. Further the required input of the building owner or user is specified. The model is presented in Figure 10 on the next page of this report. The model is evaluated during an expert panel, which will be clarified in the next section.

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Step 1: Intake with the building owner or user

1.1 Find out whether the building already has an energy label

a) There is no label → a label is obliged, so analysis is necessary.

b) There is a label, which is D-G → not label C, so analysis is necessary.

c) There is a label, which is A-C, and the building owner or user has the intention to improve the building → find out whether there is enough research conducted and data available to skip the building analysis.

d) There is a label, which is A-C, and the building owner or user has no intention to improve the building → no further action

1.2 Discuss the subsequent process

a) Make clear which input is necessary from the building owner or user. (specified in "2. Analysis of the building")

b) Make an appointment to collect the remaining building data during a visit of the building.

c) Discuss the preferences and requirements of the building owner or user. These will be taken into account in phase 3, during the consideration to choose for specific improvements.

d) Make clear what the output is: The energy label and an advice with cost estimation

Step 2: Analysis of the building

2.1 Determine what the usage functions and energy sectors of the building are

a) Input from the building owner or user
- Construction plans of the building.
- Specifications of the technical installations in the building.
- If there are more usage functions in the building, specifications of the functions for each part of the building.

b) Steps for the advisor
- Determine the usage functions of the building, following the EPA-U standards.
- Use the usage functions and the specifications of the technical installations to determine the energy sectors.

2.2 Determine which installations are installed in each energy sector

a) Input from the building owner or user
- Specifications of the technical installations in the building.
- Specifications of the individual installation components.
- Specifications of the lights in the building, if available the light plan.

b) Steps for the advisor
- Determine for each energy sector which installations are installed for ventilation, heating, humidification, cooling, hot tap water and solar energy.
- Determine what the consumption (in W/m^3) of the light installation for each energy sector is, and how the lights are operated.

2.3 Determine of what construction elements the building consists

a) Input from the building owner or user
- Construction plans of the building.
- If available, specifications of the walls, floors, roofs, doors and windows.

b) Steps for the advisor
- To determine the Rc values of the specific elements by using the date of construction or renovation, or by using the specifications of the construction elements.

2.4 Collect the remaining building data during a visit of the building

a)Input from the building owner or user
- Access to the building and to the technical installations.
- Cooperation to unravel the necessary data.

b) Steps for the advisor
- To complete the data from 2.2 and 2.3 through inspection of the technical installations and the construction elements in the building.
- To verify whether the data of the supplied drawings is in accordance with the actual situation.

2.5 Determine the energy index of the building and the corresponding energy label

a) Input from the building owner or user
- Annual invoices of the actual gas and electricity use.

b) Steps for the advisor
- Use the input of 2.1-2.4 to perform the building analysis in the Vabi EPA-U software.
- Determine the energy index of the building.
- Compare the findings of the analysis with the actual gas and electricity use.
- Establish the energy label or let a certified company establish it.

Step 3: Proposition for improvement of the building

3.1 Determine and calculate installation technical improvements

a) Determine for each installation component which possibilities there are to improve it. (Ventilation, heating, humidification, cooling, hot tap water, solar energy and light)

b) Discuss the possibilities with an installation company. Adjust the improvements based on costs, energy label improvement, preferences and requirements of the building owner or user and the legal regulations.

3.2 Determine and calculate constructional improvement

a) Determine for each construction component (insulation of walls, floors, roofs, doors and windows) which possibilities there are to improve it.

b) Discuss the possibilities with the calculators of Van Wijnen and if necessary with subcontractors. Adjust the improvements based on costs, energy label improvement, preferences and requirements of the building owner or user and the legal regulations.

3.3 Determine the costs and payback period

a) Find out which subsidies can be granted for improvement to both the technical installation and the construction.

b) Determine the costs for the improvement with deduction of the subsidies and including the percentages for risks and overhead costs of Van Wijnen.

c) Calculate the expected payback period.

3.4 Complement the proposition and offer it to the building owner or user

a) Establish the proposition offer including:
- Accompanying letter.
- The energy label established in 2.5.
- Proposition for improvements to the building which meets the preferences and requirements of the building owner or user, including the costs and payback period.
- Remaining suggestions for improvements, both installation technical and constructional.

3.5 Present the proposition to the building owner or user

a) Present the offer to the building owner or user. Discuss during this meeting which steps should be taken towards the implementation of the measures.
- If the owner or user wants to implement measures. Discuss which steps will be taken and what the time schedule is.
- If the owner or user is not willing to implement measures, discuss whether Van Wijnen can mean something to them.

Step 4: Implementation of the improvements

4.1 preparation and execution of the construction activities

a) Preparation and execution of the activities according to the standards of Van Wijnen. This will be executed by the department maintenance and control.

Step 5: Determine the new energy index and energy label

5.1 Determine the new energy index of the building and the corresponding energy label

a) Implement the executed measures in the VABI EPA-U software.

b) Determine the new energy index and make the new energy label. Or let a certified partner make the energy label.

c) Present the new energy label to the building owner or user.

Figure 10 Developed process model after case study

5. Validation of the process model

To find out whether the process model, presented in the previous section, fits different office buildings and the demands of its potential customers, an expert panel was organized. The goal of this meeting was to improve the model. Since the model was developed after one single case. The outcomes had to be verified. This should lead to a revised model which is applicable to a random office building and which is also in line with the demands of the client.

This chapter will answer the following research sub question.

> How will the final process model with which office buildings energetically can be assessed look, after the validation of an expert panel?

The first section describes the setup of the expert panel and the outcomes of it. With this input of the experts, conclusions are drawn. After these, the revised and final process model will be presented.

5.1. Expert panel

Crucial to the output of the panel are the experts which are asked to form the panel. To make sure the panel consisted of skilled members owners and technical managers of office buildings were invited, since they are professionals who deal with energetical improvements in their daily work field. Eventually six people formed the expert panel:

1. The manager facilities of the case company;
2. The Head of Maintenance and Real Estate of the University of Twente;
3. An employee of the Real Estate company of the Municipality of Enschede;
4. The EPA-U advisor of Van Wijnen Eibergen;
5. The Manager innovation of Van Wijnen Eibergen and supervisor of this master thesis;
6. The supervisor for this master's thesis and Assistant professor at the department of Construction Management & Engineering and the University of Twente.

The panel meeting took place on the 14th of March 2019 in the UParkhotel at the campus of the University of Twente. This location has been chosen since this location at the university represents independency and the expert session was held to improve the model and should not have an acquisition component. The panel took about two hours and the following topics were addressed:

1. Introduction to the research
2. Description of the process model
3. Discussion about the process model
4. The case office building
5. Discussion about the case
6. Final question or remarks

During the introduction to the research the members of the panel were informed by the goals of Van Wijnen Eibergen and by the goal of the research. With this background information, the experts could understand the purpose of the process model.

Secondly was explained that a case study is conducted after which the process model has been developed. The steps to find the case building were shortly mentioned. Then, the process was presented step by step to inform the panel about the steps to be taken. These steps were discussed during the third part of this meeting. The panel was asked to give their opinion to the different steps and about adjustments or missing topics. After this discussion the case building was presented, along

with the results of the analysis of that building. Subsequently these results were discussed with the panel. Finally, there was some space for questions or remarks.

The experts were all actively involved in the meeting and the atmosphere was open and informal. This led to proper discussions which resulted in interesting findings. The next two sections will address feedback on the process steps and on the results of the case building. All statements are retrieved from the summary of the expert panel which is presented in Appendix G.

5.1.1. Feedback on the process steps

Long-term maintenance plan

One of the first things mentioned by the panel, was the lack of a MJOP (Dutch: meerjarenonderhoudsplan), which is a long-term maintenance plan. This MJOP shows when maintenance or replacement of construction elements or installations is planned. With this plan, a building owner or user can see what the difference of the energetically measures are, compared to the measures that have to be taken anyway. This difference are the extra costs of the measure, since the other costs were planned already. Taken that difference in costs into account, compared with the decrease in costs that the measure will create, the payback period will be different.

Thereby another member of the panel mentioned that it can be really interesting to see what the effect is when measures are executed some years earlier than the moment planned. This will mean that the costs for maintenance and exploitation will be lower those years. This can also be a trigger for the tenant to contribute a part of the investment costs. Additionally, the MJOP can help with steps of the analysis. Many data needed for the analysis to calculate the energy index is also needed in a MJOP. This can be very helpful, but according to the panel, many companies do not have an MJOP.

Further was stated that the MJOP could be extended towards BOEI without a lot more effort. BOEI (Dutch: Brandveiligheid, Onderhoud, Energie, Inspecties) includes the fire safety, maintenance, energy and inspections of the building. This will give the complete picture. It is not much more effort since experts already have to visit the building.

Concluding can be said that for every measure that will improve the building energetically, the MJOP is needed to make a decent consideration. Thereby this could be extended with BOEI subjects.

Differences in companies

The panel stated that it is good to know beforehand, what company you are dealing with and what the obligations of this company are. For example, bigger companies (Dutch: Grootzakelijke bedrijven) are obliged to do an EED audit where small and medium-sized enterprises do not. These bigger companies do get a huge task, in a field which is often not their core business. Therein can Van Wijnen offer a helping hand.

Relationship between owner and tenant

According to a member of the panel, there is always a game between the tenant and the owner. This is about what exactly is obliged and about doing more than that. A measure should convince both parties. Than it can be implemented faster and the measure might go a step further in making the building more energy efficient.

Clarity for the customer about the different energy labels

A member of the panel mentioned that customers wants to know what it yields. What are the returns if I go to label C? And what if I go to label B or to label A? And what is the payback time? These are the first things a customer wants to know. Another panel member agreed and stated that for the customer the steps that are at least necessary for Label C should be clear. Thereby he wondered about who claims that the label is right, and what about the supposed savings? This must be someone authorized,

and it involves a complete process, was mentioned by another member. It is however hard for a company to guarantee the savings, since it depends on the weather.

5.1.2. Feedback on the results of the case building

Changed situation

The facilities manager of the case building mentioned that the first scenario was already executed by the building owner of the case building. The building owner was not sure whether this will be enough to reach energy label C. This complies with the findings of the research. Thereby, these measures filled some unused surface on the roof, which will lead to less available space for solar panels.

Payback periods

The panel mentioned that a payback period of 13 or 16 years for installations which will not last much longer than 20 years is unattractive. This because the installations on the market will improve and the costs for maintenance will increase when the installation gets older. This makes it only interesting for the energy label. Another panel member suggested that these installations sometimes have to be replaced. Therefore, the extra costs are €0. However, if you will replace them with more energy efficient solutions then the current standards, the difference in costs will be de extra expenses. These extra costs should be the key figure.

The other members off the panel agreed on this and mentioned again that the MJOP is a crucial factor here. Therein is already defined when maintenance or replacement is planned. Only the extra costs or costs to execute it earlier than planned should be taken into account when calculating the payback period. This could again be discussed with the tenant and the owner, since the exploitation costs will decrease after the implementation, which is attractive for the user.

Led lighting

The facilities manager of the case building mentioned that installing led lighting could, for them, only be interesting for the comfort. Financially it is not lucrative. This statement is confirmed by a majority of the panel. They stated that they only install led lighting if the current lighting is broken or when installing a completely new installation.

Furthermore, they mentioned that where led is installed, the lighting is very beneficial, especially when they are dimmed to 10% to 50% of its capacity. This is also used with presence detection, then the light will change from 10% to a higher percentage depending on the daylight.

Changing the fixtures is not interesting according to the panel. The CE certificate will expire, and a new inspection is financially not interesting. Also, problems with the spread of the light, peak loads and explosion risks make that the panel is not excited by this measure. It was stated that eventually, the risk lays with the injuring company, they have to accept it.

Configure the systems

Besides new measures, the panel gave multiple options to save energy with the current installation. As mentioned before, the lighting can produce light based on daylight and presence. Heating systems can also be configured. In many buildings, energy is used without anyone noticing. Finding out those spots could provide direct profit. Just as checking whether the systems still do what their purpose is.

Next to that, heating office rooms to a basis level and extra heat it when it is used can safe much energy. This can even be personalized. It prevents that rooms are heated too much, and windows are opened to cool again, which is a behaviour that is recognised by a majority of the panel.

However, the problem here is that these systems or measures often have no effect to the energy index. Only detection systems for lighting can make a difference in the energy index. But for heating or cooling, only the basis installation properties are used to calculate the index. Nevertheless, the savings

made with these measures can be financially attractive. Moreover, the savings could be spent to implement other measures which do have effect on the energy index.

Van Wijnen as system integrator

Controlling the installation could be an extra service by Van Wijnen which can be added to the package. The panel stated that Van Wijnen best fit the role of system integrator, since controlling the installations is best done by the installation company. This installation company on his turn, needs the contractor for a part of its activities, which could be the basis for a partnership. A panel member mentioned that this collaboration could also be useful for the insurability.

If all the activities in a building are managed by one party, collaboration is necessary which decreases the individual interests. A member of the panel worked before with Van Wijnen. They only had one contact person of Van Wijnen, who managed the contacts with the other companies. This worked very pleasant and effective. It can cost some extra money on one hand, but it safes a lot of effort and man hours on the other hand.

Another panel member agreed to this. They started to use performance contracts. These took away contracts with 65 different parties. Now they only discuss the key performance indicators each month. This way we have more time to look deeper into our systems, which can eventually reduce the energy consumption.

Over capacity of the systems

A member of the expert panel stated that when buildings are designed, the installations are often based on the worst situations possible. Installation companies on top of that, take a bit margin to be sure also. Put together, this leads to over capacity of the installations. This is unnecessary, and it should be considered dimensioning these systems a bit lower.

5.2. Conclusions

The goal of the expert panel was to find improvements for the model, so it would be applicable to a random office building. The expert panel has led to findings on the model itself, but also on how to implement it:

- A long-term maintenance plan (MJOP) should be part of the model. For every measure that will improve the building energetically, the MJOP is needed to make a decent consideration. Thereby this could be extended with BOEI subjects.
- Since maintenance or replacement is necessary anyway, the payback period should be calculated on basis of the extra costs for a better system than the current standard and on basis of the extra costs for implementing the measures earlier than planned.
- To successfully approach the market of office buildings that have to be improved energetically, Van Wijnen Eibergen needs an installation company to partner up with. This installation company should be able to devise and execute installation technical improvements. Furthermore, they should be capable of configuring both new and existing systems, to prevent unnecessary use.
- To approach this market, Van Wijnen Eibergen should not only offer a solution to get to an energy label C or maybe an energy label A. They should offer a full package for management and control of the building for a long-term period. Here, Van Wijnen Eibergen can be the system integrator who manages all different parties.
- Van Wijnen Eibergen is not authorized to officially register an energy label. Therefore, another party needs to be sought. Preferably a party which can use the data of the building Van Wijnen already collected. Then the work is not done twice, which makes it financially more attractive.

With the input of these points for improvements, the process model is revised. The input of the literature, the case study and the expert panel led to the final process model. This model is presented in Figure 11 on the next page and forms the answer to the sub research question of this chapter.

Step 1: Intake with the building owner or user

1.1 Find out whether the building already has an energy label

a) There is no label → a label is obliged, so analysis is necessary.

b) There is a label, which is D-G → not label C, so analysis is necessary.

c) There is a label, which is A-C, and the building owner or user has the intention to improve the building → find out whether there is enough research conducted and data available to skip the building analysis.

d) There is a label, which is A-C, and the building owner or user has no intention to improve the building → no further action.

1.2 Discuss the subsequent process

a) Make clear which input is necessary from the building owner or user. (specified in "2. Analysis of the building")

b) Make an appointment to collect the remaining building data during a visit of the building.

c) Discuss the preferences and requirements of the building owner and/or user. These will be taken into account in phase 3, during the consideration to choose for specific improvements.

d) Make clear what the output is: The energy label, an advice with cost estimation and a multiple year maintenance plan.

Step 2: Analysis of the building

2.1 Determine what the usage functions and energy sectors of the building are

a) Input from the building owner and/or user
- Construction plans of the building.
- Specifications of the technical installations in the building.
- If there are more usage functions in the building, specifications of the functions for each part of the building.

b) Steps for the advisor
- Determine the usage functions of the building, following the EPA-U standards.
- Use the usage functions and the specifications of the technical installations to determine the energy sectors.

2.2 Determine which installations are installed in each energy sector

a) Input from the building owner and/or user
- Specifications of the technical installations in the building.
- Specifications of the individual installation components.
- Specifications of the lights in the building, if available the light plan.

b) Steps for the advisor
- Determine for each energy sector which installations are installed for ventilation, heating, humidification, cooling, hot tap water and solar energy.
- Determine what the consumption (in W/m^3) of the light installation for each energy sector is, and how the lights are operated.

2.3 Determine of what construction elements the building consists

a) Input from the building owner and/or user
- Construction plans of the building.
- If available, specifications of the walls, floors, roofs, doors and windows.

b) Steps for the advisor
- To determine the Rc values of the specific elements by using the date of construction or renovation or by using the specifications of the construction elements.

2.4 Collect the remaining building data during a visit of the building

a)Input from the building owner and/or user
- Access to the building and to the technical installations.
- Cooperation to unravel the necessary data.

b) Steps for the advisor
- To complete the data from 2.2 and 2.3 through inspection of the technical installations and the construction elements in the building.
- To verify whether the data of the supplied drawings is in accordance with the actual situation.

2.5 Optionally monitor the currently installed installations

a) Input from the building owner and/or user
- Access to the building and to the technical installations.
- Cooperation to unravel the necessary data.

b) Steps for the advisor
- Find out whether the installations still work optimal. Conduct this examination together with an installation company.
- Conduct a BOEI inspection together with the required specialists.

2.6 Determine the energy index of the building and the corresponding energy label

a) Input from the building owner and/or user
- Annual invoices of the actual gas and electricity use.

b) Steps for the advisor
- Use the input of 2.1-2.4 to perform the building analysis in the Vabi EPA-U software.
- Determine the energy index of the building.
- Compare the findings of the analysis with the actual gas and electricity use.
- Establish the energy label or let a certified company establish it.

Step 3: Proposition for improvement of the building

3.1 Determine and calculate installation technical improvements

a) Determine for each installation component which possibilities there are to improve it. (Ventilation, heating, humidification, cooling, hot tap water, solar energy and light)

b) Discuss the possibilities with an installation company. Adjust the improvements based on costs, energy label improvement, preferences and requirements of the building owner or user and the legal regulations.

3.2 Determine and calculate constructional improvement

a) Determine for each construction component (insulation of walls, floors, roofs, doors and windows) which possibilities there are to improve it.

b) Discuss the possibilities with the calculators of Van Wijnen and if necessary with subcontractors. Adjust the improvements based on costs, energy label improvement, preferences and requirements of the building owner or user and the legal regulations.

3.3 Determine the costs

a) Find out which subsidies can be granted for improvement to both the technical installation and the construction.

b) Determine the costs for the improvement with deduction of the subsidies and including the percentages for risks and overhead costs of Van Wijnen.

3.4 Determine the actual costs and the payback period

a) Determine, based on the MJOP, what the extra costs, compared natural replacement, are to implement the measures found in step 3.1 and 3.2.

b) Determine, based on the MJOP, what the payback periods of the proposed measures are.

c) Analyse when a measure best can be implemented, from an economical perspective.

3.5 Complement the proposition for the office building

a) Establish the proposition offer including:
- Accompanying letter.
- The energy label established in 2.6.
- Proposition for improvements to the building which meets the preferences and requirements of the building owner and/or user, including the costs and payback period based on the MJOP.
- Remaining suggestions for improvements, both installation technical and constructional.

3.6 Present the proposition to the building owner and/or user

a) Present the offer to the building owner and/or user. Discuss during this meeting which steps should be taken towards the implementation of the measures.
- If the owner or user wants to implement measures. Discuss which steps will be taken and what the time schedule is.
- If the owner and/or user is not willing to implement measures, discuss whether Van Wijnen can mean something to them.

Step 4: Implementation of the improvements

4.1 Preparation and execution of the construction activities

a) Preparation and execution of the activities according to the standards of Van Wijnen. This will be executed by the department maintenance and control.

4.2 Establish the multiple year maintenance plan

a) Establish the MJOP for the building in compliance with the executed measures.

b) If requested, execute the MJOP.

Step 5: Determine the new energy index and energy label

5.1 Determine the new energy index of the building and the corresponding energy label

a) Implement the executed measures in the VABI EPA-U software.

b) Determine the new energy index and make the new energy label. Or let a certified partner make the energy label.

c) Present the new energy label to the building owner and/or user.

Figure 11 Revised and final process model

6. Conclusions and recommendations

In this chapter, the research conclusions will be given, which answer the main research question of this research. Further recommendations concerning future research about this topic in general and for Van Wijnen Eibergen specifically will be presented.

6.1. Conclusions

National and international legislation demands energetical improvements of buildings. This has presented itself in various laws, including the obligation of minimal an energy label C for office buildings. A market consisting of numerous office buildings which do not meet the demands of the new laws yet, arose. Van Wijnen Eibergen wants to approach this market but was not sure how.

This research has been conducted to find a method for Van Wijnen Eibergen to approach this market of office buildings that require at least an energy label C.

To find this approach method, in Chapter 3 firstly a literature research has been conducted towards energetically assessment methods and to the technique to calculate an energy label. This led to an approach which was used to conduct a case study, this is presented in Chapter 4. During this case study, an office building was analysed and suggestions for improvements were made. Afterwards a process model has been developed with the input of the literature study and the findings of the case study. In the final stage of the research, in Chapter 5, this model has been validated through a discussion meeting with an expert panel. This meeting gave insights in which the final process model has been developed.

This section will present conclusions of this research. Which will give the answer to the main research question:

> What approach will fit Van Wijnen Eibergen and its customers, in which the market of office buildings, that require at least an energy label C, can be approached?

1. The process model

The most important discovery in this research is the developed process model. This model, based on literature, a case study and validation by a review panel, is a guideline for Van Wijnen Eibergen to approach the market of office buildings that require an energy label C. With the model employees of Van Wijnen Eibergen have a structured and uniform approach, which lacked during previous approached markets. The final version of this process model is presented in Figure 11 in the previous chapter. A Dutch version together with a guiding document is presented in Appendix H.

2. Offering a full package to unburden the client

The second finding in this research is that a full package should be offered to the client. The strength of Van Wijnen Eibergen lays in the contact with the client and in unburdening this client. Herein they make a difference to comparable companies in this market. As a property manager Van Wijnen Eibergen can manage the energetical improvements but also the maintenance and control of the existing installations and construction components of the building.

In this full package, a multiple year maintenance plan (MJOP) must be included. This MJOP shows when maintenance or replacement of construction elements or installations is scheduled. This is necessary in the consideration when to execute energetical improvements.

3. Partnering an installation company

The research showed that the analysis of an office building, as well as many energetic improvements to the buildings have an installation component. Technical installations are not an expertise of Van

Wijnen Eibergen. To successfully approach the market of office building that require an energy label C, an installation company is necessary. Together with this installation company, Van Wijnen Eibergen is able to analyse and improve office buildings.

6.2. Recommendations

This section presents the recommendations founded in this research. The section is derived in two parts. The first part elaborates on the limitations of this research. Remarks on the research will be given and some suggestions for future research will be presented. The second part presents suggestions to Van Wijnen Eibergen.

6.2.1. Limitations of the research

During this study, a process model is developed, and conclusion are draws. However, the study has been performed in a certain timescale and there are opportunities to expand it. This section presents the limitations to this research and suggestions to future research.

1. *Implement the model in multiple cases*

In this research the process model is developed after a single case study. It is hard to draw conclusions from just one case, because it cannot be compared to other cases. Therefore, it is not possible to find similarities and differences. This makes it imaginable that inaccurate adjustments or generalisations are made.

During the research, the meeting with the expert panel validated the process model. This makes the conclusion of this research more valid. However, validation of the process model through other case studies could still lead to interesting improvements to the model and conclusions.

2. *Further research to building performance assessment methods*

In this study two methods for assessing the performance of buildings are used to find an approach to conduct the case study. One of those is analysed in-depth, but the other is analysed more on the surface, due to its complexity, the limited time and given the ignorance in the Netherlands. Studying this method elaborately may give extra insights in this study.

Besides this method, there are dozens other methods throughout the world to assess the performance of buildings. It would be interesting to compare these models to find out whether they will be in line with the conclusions of this research.

3. *A new study towards the energy label C regulation*

The Economical Institution for the Building Industry in the Netherlands (Dutch: EIB) presented a report about the obligation of energy label C for office buildings in November 2016 (Economical Institution for the Building Industry , 2016). Their report elaborates on the regulation and the consequences for the construction industry. After it was published, claims were made that the report was written to make the Label C regulation justifiable and that it gave a rosy picture.

Since the announcement of the energy label C regulation, the knowledge about this matter has been improved. Therefore, it could be interesting to conduct a new research towards the regulation. This could on the one hand verify the 2016 report. On the other hand, it would be interesting to find out the effects of the regulation so far.

4. Research to the calculation method of the energy label

The research showed that the configuration of an installation system for heating and cooling has a beneficial effect on the energy use. It therefore lowers the energy demand while the comfort stays the same or grows. However, this has no influence on the energy index or energy label. Research to the measure method could reveal similar examples. It would be interesting to see whether this could be input for a revision of the measure method to calculate the energy index.

6.2.2. Practical suggestions to Van Wijnen Eibergen

Besides recommendations to the literature, this study also led to practical suggestion to Van Wijnen Eibergen. This section describes five recommendations.

1. *An installation company as partner*

The research showed that Van Wijnen Eibergen has not enough knowledge about technical installations to successfully approach this market alone. Therefore, they need an installation company to partner up with. This installation company should be able to advise and execute installation technical improvements. Furthermore, they should be capable of configuring both new and existing systems, to prevent unnecessary use of energy. If this installation company is a fixed partner, the risks will be lower, and the costs and revenues will be clearer.

2. *Offer a full package for management and control of the building including a MJOP*

The expert panel and the case study made clear that Van Wijnen Eibergen is not the party that offers a single solution to get to energy label C. Van Wijnen wants to work together with the customer to find the best solution. Therefore, they should offer a complete package to manage and control the building on the long term. Herein Van Wijnen Eibergen could play the role of property manager.

A part of this package should be the multiple year maintenance plan. The expert panel made clear that, for every measure that will improve the building energetically, the MJOP is needed to make a decent consideration. This could be extended with BOEI aspects, such as fire safety and health inspections. This MJOP will show the costs for maintenance or replacement that are necessary anyway. The extra costs for a more sophisticated and sustainable solution or the costs of implementing the measures earlier than planned should be used to calculate the payback period.

3. *Adjust the process model based on findings during future projects*

This study is limited to a single case building. Although it is validated by experts it has not been tested at other office buildings. Therefore, the recommendation is to test the model during the first couple of office buildings that are assessed. Those projects might reveal some adjustments to the model.

Furthermore, a (bi)annual evaluation of the model could help to remain a critical eye for improvements in the model.

4. *Adjust the process model based on new laws or regulations*

Several steps of the model are created based on current laws or expectations of upcoming laws. In the future, new laws will be applicable. This could be more strict obligations for office buildings, but it could also be laws concerning other types of buildings. It is recommended to Van Wijnen Eibergen to adjust the model to those new regulations.

5. *Find a company which is certified to officially register an energy label*

The research of the case building made clear that Van Wijnen Eibergen has an EPA-U advisor who is not certified to officially register an energy label. Therefore, another certified company is necessary. Preferably a party which can use the (software) data of the building, which is already collected by Van Wijnen Eibergen. Then the work is not done twice, which makes it financially more attractive.

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Summary of (in)formal consultations with employees of Van Wijnen Eibergen

1. 12 January 2018: R. T. J. P. Post, Project Leader maintenance and control.
2. 17 January 2018: S. J. Bredewold, Manager innovation.
3. 7 February 2018: W. Tijhuis, Project Developer/ Supervisor University of Twente; S.J. Bredewold, Innovation manager.
4. 22 February 2018: W. Tijhuis, Project Developer/ Supervisor University of Twente; S.J. Bredewold, Innovation manager.
5. 13 March 2018: W. Tijhuis, Project Developer/Supervisor University of Twente.
6. 28 March 2018: W. Tijhuis, Project Developer/ Supervisor University of Twente; S.J. Bredewold, Innovation manager; H. J. Ebbekink, manager maintenance and control.
7. 3 April 2018: H. J. Ebbekink, manager maintenance and control.
8. 5 April 2018: W. Tijhuis, Project Developer/ Supervisor University of Twente.
9. 18 April 2018: W. Tijhuis, Project Developer/ Supervisor University of Twente; H. J. Ebbekink, manager maintenance and control.
10. 2 May 2018 S. J. Bredewold, Manager innovation.
11. 13 August 2018: P.L.C. Spelt, Manager innovation.
12. 20 December 2018 C.J.M. Venderbosch, Costs expert.

Appendix A Response of Van Wijnen Eibergen towards new markets or market opportunities

This appendix will present how Van Wijnen Eibergen did respond to opportunities in the market or to new market segments. In the past three years, several ideas, innovations or chances came up. Whether these are adopted or not depends on various reasons. This reasoning will be analysed for each individual idea. This will be compared to find similarities.

New markets, innovations and chances

In this section the different ideas, innovation or chances will be explained. Information for all was retrieved either from meetings with the Innovation Manager of Van Wijnen Eibergen (Van Wijnen Eibergen, 2018-2019)[10], or from email messages that have been analysed.

s-Cargoo

S-Cargoo is a collaboration with the 'Stuurgroep Achterhoek 2020' and the municipalities of Winterswijk, Doetinchem and Oude IJsselstreek. Together they wanted to deliver stylish, dismountable and movable dwellings. These could be composed, furnished and expanded, depending on the wishes and financial capability of the tenant.

This opportunity came by in October 2017. It was looked into for a moment, but no further research was conducted, or no consultation was made with people from S-Cargoo. The Van Wijnen employee who received the e-mail with information was not enthusiastic and did not have a good feeling with the project. Therefore, no more time was invested, and the chance was turned down.

All-electric in roof system

The all-electric in roof system was developed in 2015. It is a system which combines several techniques to build and live without natural gas. Where these techniques used to be individual connected with cumbersome ways, this in roof systems integrates the techniques to a standard element. This element is based on the measures of a standard dwelling of Van Wijnen. Therefore, it is an option in new building projects.

The system was used in a pilot project in Enschede and afterwards used in a spinoff project in Neede. However, the product is still the same and not refined after 2015, which is necessary to keep it up to date with the techniques that are used. According to the interviewed Van Wijnen employee it was not refined "because we do not want to make long term arrangements with partners. That is why we do not have co-makers for these projects, but we select a sub-contractor for each project." Further he stated that a sub-contractor is not willing to invest in a product like this if it is only for a single project. The sub-contractor needs the certainty that he can deliver the product for a longer period. Van Wijnen should have the guts to create sustainable relationships with this kind of co-makers. This contributes to become more innovative.

Make UTwente campus dwellings more sustainable.

This project had to be a collaboration between a housing association, students of the University of Twente and Van Wijnen Eibergen. Together they wanted to renovate houses of students on the campus of the University of Twente. Beside renovating, the university and the housing association also wanted to stimulate students to be more aware of their energy use.

According to an employee of Van Wijnen Eibergen, there were three reasons why this collaboration did not happen. The first was the lack of guts and support within in company to start a collaboration like this. Such collaboration involves being open and transparent, which is not in line with the traditional way of thinking within the building industry. Despite the company wants to change towards

more open and trustworthy, there are still many employees within Van Wijnen Eibergen who act traditional. This also led to hesitation for this project.

The second reason was the timing. Due to other ongoing projects and the period of crisis which was just passed, it did not felt the right moment.

The third reason was the responsible employee. The employee did not invest much time in the project and therefore it was not receiving enough priority. Then it sank into oblivion and was not looked into anymore.

Acquisition list for housing associations

This is a list which shows possibilities at housing associations. It indicates the potential work, the contact persons, the previous contact and ongoing and planned actions. It was developed in the end of 2015 and is used ever since. The list is discussed every four weeks in a so-called acquisition meeting. During this meeting, the list is being updated and tasks are allocated to employees.

In the beginning the list was effective. The contact with housing associations increased and it resulted in collaboration with some for Van Wijnen new parties. According to an employee of Van Wijnen there are still many opportunities that arise with this acquisition list. However, there are two reasons why it is not working how it was intended. The first reason is the devotion of the employees concerning the tasks which come out of the acquisition meeting. Most of the time, their priority is on other projects, which leads to delay or adjustment of the acquisition tasks. The other reason, which might be the cause of the low priority, is the lobbying which is not effective. Only in the beginning the lobbying resulted in some new relationships which ensured work. But after this promising start the result was quite low.

Within van Wijnen Eibergen is no clear policy what to do with this list. They use it for the contact persons and because it used to be effective, but there is no further strategy. Therefore, the effectiveness is quite low.

Circular building and renovating

Last decade, there is more and more attention for the environment. Topics like BENG (Bijna Energieneutrale gebouwen: almost energy neutral building) and NOM (Nul op de meter: zero on the power meter) are used more regular, also within Van Wijnen Eibergen. However, this is where the focus ends. Circular building is a step further. Some employees of Van Wijnen Eibergen did a masterclass circular building. This gave the insight that starting with it, could give Van Wijnen a frontrunner position. However, according to an employee of Van Wijnen, the benefits and necessity of circularity are not recognized within the company. In addition to this, they also point to the clients. The clients should ask for more circularity in their tendering process. Many times, they act like they ask for circularity, but at the end of the day, they have too many contra productive demands and still select parties based on price.

In line with the circularity, employees of Van Wijnen visited a housing association where they were informed about an upcoming circular housing renovation research by Anne van Stijn of the TU Delft. In co-creation with partners, she wants to develop circular renovation solutions for the late post-war social housing stock in the Netherlands.

Van Wijnen Eibergen has not made any contact with the researcher after visiting the housing association. Why is unclear, but according to an employee of Van Wijnen, this is one of these, “we should do something with it” projects.

For circular building or renovating, there is no policy within Van Wijnen Eibergen. They do not know what to do with it, and therefore noting happens, despite the opportunities it offers.

Smart grid

This is a project where batteries of cars are used in dwellings, to store during the day collected energy. In the evening, when most people come home, this energy can be used. This way, the energy network is less burdened, and you can use your own generated energy. The idea was to do a pilot project, where batteries would be installed in approximately 20 dwellings.

The pilot was suggested by an employee of Van Wijnen Eibergen. However, these types of innovations have to be coordinated by the regional office. This was where the project stalled. Within the regional office they liked the idea but said that they did not trusted the people who they had to cooperate with. Beside this, there was also no suitable client to do the pilot.

Sowise solar boiler system

The light boiler system is an improvement of the old solar boiler, with a separate collector and tank. This system combines these collector and tank in an in-roof system. It saves space in the dwelling, does not need extra energy, no valves are needed, and it is easy to install.

This system has not been implemented in a project so far. This mainly because of two reasons. The first is the client who is not willing to take the risk of making this step. According to the employee of Van Wijnen Eibergen, Van Wijnen believes that the client should be the party who is paying for the system. This brings up the second reason. That is lack of willingness of Van Wijnen to see this system as an opportunity. If they do so, the first project could be more expensive than with a normal system. But it could also be the eye-opener which leads to more projects/clients/partners in the future.

Point cloud / drone

Point cloud is a system which can be used in renovation projects. A scan device uses laser beams to indicate the area. The measured distances are transformed to a point cloud. This point cloud can be loaded into 3D modelling software, wherein it can be the starting point for the model of the renovation project.

Besides the inside of building, the same technique can be used to measure the outside of buildings. Therefore, a drone is used to make the 3D drawing of the outside.

The knowledge of the techniques is known within the Van Wijnen company, since some offices of Van Wijnen have been using it for multiple years. Nevertheless, these methods are barely used within Van Wijnen Eibergen. The main reason therefore is BIM (Building Information Modelling), which is not implemented within Van Wijnen Eibergen. There is one BIM modeller, who stated that for most projects the 3D models are still converted to conventional 2D drawings. According to the director of the regional office Van Wijnen Noord (Appendix E), implementing BIM takes a few years and has to be company-wide to do it successfully.

Another reason for not using these methods are the costs involved. According to several internal mailings about these systems, the costs are a big obstacle. However, no cost-benefit analysis was conducted and therefore the price was not relativized.

Analysis

As discussed in the previous section, there are several reasons why ideas, new markets or innovations are not adopted within Van Wijnen Eibergen. Roughly these can be divided into external and internal factors.

External analysis

The external factor, which is important for most innovations, is the client. Many ideas or innovations have to be implemented within building projects. Within these projects, an opportunity is needed to implement these ideas or innovations. Therefore, besides a willing contractor, a willing client is necessary. If the client leaves space for innovations in a tender or request, the contractor can use that space to be innovative. According to employees of Van Wijnen, many tenders or request trend towards a conventional solution.

The client can choose to cooperate by monetary rewarding. This will increase the innovation process, since the contractor is able to invest more. The client can also choose to leave it to the free market. Then, the contractor probable has to invest in pilot projects to get a pay off in later projects. Both ways will increase the use of innovative ideas, but crucial is enough space in the tender or request.

Furthermore, many ideas or innovations are custom made for a specific client. Therefore, the intention for a long-term relationship or at least multiple projects is a driver to invest in those innovative ideas. This however, needs a client who dares to becoming partner of a contractor, which is totally in contrast with the old-fashioned building industry.

Internal analysis

Internally, multiple factors can be noticed why ideas, chances or innovations are not adopted within Van Wijnen Eibergen.

Firstly, there is a lack of policy and strategy. There is no standard path which employees can follow to assess new ideas, markets or innovations. Therefore, everyone uses a different approach and often acts alone, without the backup and confidence of the management. Besides this, there is no methodology or philosophy which is spread out within Van Wijnen Eibergen. At Van Wijnen Noord, they saw that the current model is not going to be profitable for ever. They started in 2011 by implementing BIM and LEAN in the whole organisation. This created the climate to start innovating, which resulted in the Fijn Woning dwelling. At Van Wijnen Eibergen, LEAN or BIM is sometimes used in single projects, but it is not the way of working where the whole organisation committed themselves to. If a strategy like this would be implemented, new ideas and innovations better fit the organisation, and therefore have a bigger chance of success.

A second factor, which might be related to the previous one, is the assessment of the ideas by a single employee. Whether an innovation or idea is continued or not, often depends on the personal feeling of the employee. This is very subjective, which could lead to mistakes. Profitable ideas can be declined, or much effort can be put into an idea that will or cannot pay off.

The third factor is the lack of guts. Especially within the management, where multiple ideas or innovations were rejected. Some because they needed a cooperation with a supplier or subcontractor. This supplier or subcontractor needs certainty of an amount of sales, so an affordable price can be offered, and development costs are covered. Within Van Wijnen Eibergen, they are hesitant to get in a partnership like this. This hesitation leads most of the time to rejection. Other projects were rejected because they were, or seemed, too expensive. According to employees, innovation should be stimulated by sometimes spend money without a direct profit. If an idea proves to be profitable, it will eventually deliver the profit. This is also mentioned by the regional director of Van Wijnen Noord

(Appendix E). He stated that innovation hurts and that approximately 90% of the ideas fail. But the 10% can deliver you the golden eye.

The last noticed factor is the traditional building culture which prevails at Van Wijnen Eibergen. Most employees like the way they do their work and do not like change. Therefore, innovative ideas are often seen as cumbersome and unnecessary. Since those employees tent to be in a majority, changing it will take a lot of effort.

Conclusions

It has become clear that not many ideas or opportunities are adopted. Both internal and external factors play a part in this. The mentioned factors in the previous section are summarised to give a complete overview. This summarisation is presented in Table 21. The overview shows that most factors are internally.

Table 21 Summary of factors that contribute to not adopting new markets or ideas

Factor	What does or does not happen
External	
A willing client	A client often does not leave space for innovation in a tender or request.
A client with lack of courage	Clients hesitate too much to go into a long-term relationship or to become a partner of Van Wijnen.
Internal	
Lack of policy and strategy	There is no standard path which employees can follow to assess new ideas, markets or innovations.
Assessment of ideas	New markets or innovations are often assessed by a single employee, which increases the chance of a bad decision.
Lack of guts	A hesitative attitude of Van Wijnen according to ideas leads to the same hesitation at co-makers and leads often to rejection
Lack of guts	Ideas were rejected because of the costs. The short-term expenses were seen as too high, possible long-term profit has not been assessed.
Traditional building culture	Innovative ideas are by most employees seen as cumbersome and unnecessary.

Appendix B Regulations & Subsidies in the Netherlands for energy saving in the Construction industry

In this appendix, the regulations and measures of the government regarding energy use are discussed. First, the Energy Label C regulation will be explained. Next the mandatory energy label for non-residential buildings will be discussed. Further, the obligation to conduct energy saving measures with a short payback time will be mentioned and finally, the subsidies in the Netherlands for relevant energy saving measures are addressed.

Regulation energy label C for office buildings

A law is expected that requires every office building larger than 100 m^2 to have at least an energy label of C. Energy label C means an Energy Index of 1.3 or lower. The expected effective date for this law is the 1st of January 2023. If a building does not meet the requirements on this date, it can no longer be used as an office. The publication of the law is scheduled for mid-2018. (Netherlands Enterprise Agency, 2018)

There are a few exceptions to this regulation:

- Offices used as a secondary function (<50% of the user area has office function)
- Monuments (national/provincial/municipal)
- Building scheduled to be demolished/transformed/expropriate within 2 years.

In order to obtain an energy label C, various measures are required depending on the current energy label. Office buildings with a label D, E of F can often obtain a label C without any structural modifications. Adaptations to the installations are in most cases sufficient. For office buildings with a label G, measures are required such as glass- or roof insulation (Economical Institution for the Building Industry , 2016). In Appendix C, an analysis of Office buildings in Twente and De Achterhoek has been made to give an estimation of the impact of the regulation in these two regions.

Energy label non-residential building sector

Since January 2008, a valid energy label is mandatory for the sale, rental or delivery of non-residential buildings. This energy label shows how energy-efficient a building is and what energy-saving measures are possible.

An energy label indicates the energy-efficiency of a building with an energy index. This energy index can be translated to a label which is shown in Figure 12. The energy label C regulation requires an energy label C which is equal to an energy index of 1.3 or lower.

Figure 12: Example energy label non-residential building sector (Netherlands Enterprise Agency, 2018)

If a building without energy label is sold, rented or delivered, the owner can be fined up to €20.250 (Human Environment and Transport Inspectorate, 2017).

Obligation energy saving measures with short payback time

Since 2015, a law has been set which obliges owners of business buildings to take energy-saving measures with a payback period of less than 5 years. This concerns companies with an energy consumption greater than 50,000 kWh of electricity ad 25,000 m^2 of natural gas equivalents of fuel (Overheid.nl, 2017).

Subsidies

In the Netherlands, there are three financial arrangements to gain subsidy for energetic improvements to office buildings.

The 'energy investment deduction' (Dutch: EIA) is available through clearly defined investments or customized investments that generate substantial energy savings. Up to 55% of the investment costs can be deducted from the taxable profit. This can be added to the usual depreciation. This yields an average benefit of 13,5% (Netherlands Enterprise Agency, 2017).

With the 'investment subsidy sustainable energy', private individuals and business users can get a subsidy for the purchase of solar boilers, heat pumps, biomass boilers and pellet heaters. The amount of the subsidy depends on the type of device and the energy performance of it (Netherlands Enterprise Agency, 2017).

The 'Stimulation sustainable energy production' is a subsidy for companies which (are going to) produce renewable energy. There are six different categories: Biomass, Geothermic, Water, Wind (on land, lake and primary flood defence), Wind (at sea) and Sun. The amount of subsidy depends on the type of measure and the energy performance. (Netherlands Enterprise Agency, 2017) In the coalition agreement it has been decided to broaden this regulation further in order to stimulate other emission reduction technologies, including capture and storage of carbon dioxide (VVD, CDA, D66, & ChristenUnie, 2017).

Appendix C Analysis of Office buildings in Twente and De Achterhoek

This appendix will provide an analysis of the office buildings in Twente and in De Achterhoek, the two regions where the main focus of Van Wijnen Eibergen lays. For the analysis, cadastral data is used. This is used to find the number of office buildings in each municipality and further to find how different sizes of office buildings are distributed.

Office buildings in different municipalities

To better define the scope of the research, an overview of the buildings that should have energy label C by 2023 is needed. Therefore, an analysis is conducted based on cadastral data. The data for the regions Twente and De Achterhoek were obtained from a so-called BAG-extraction, a collection of files with data from the National Provision Basic Registrations Addresses and Buildings. Subsequently, these data were split into the municipalities within the two mentioned regions. After this, the buildings for which the user purpose 'office function' has been given were extracted. Within this selection, buildings with a surface area smaller than 100 m^2 were excluded, since they are not obliged to have an energy label C in 2023. The results of this analysis are shown in Table 22 and Table 23, where for each municipality the number of office buildings larger than 100m^2 and the corresponding surface areas are presented.

Table 22: Number of office buildings (>100m2) and surfaces in Twente (retrieved by analysing BAG data)

Twente			
Municipality	**Number of office buildings larger than 100 m^2**	**Average building surface (m^2)**	**Total office surface in municipality (m^2)**
Almelo	193	1.202	231.986
Borne	52	595	30.940
Dinkelland	50	508	25.400
Enschede	534	1.260	672.840
Haaksbergen	52	741	38.532
Hellendoorn	80	1.174	93.920
Hengelo	305	1.327	404.735
Hof van Twente	110	534	58.740
Losser	45	506	22.770
Oldenzaal	123	862	106.026
Rijssen-Holten	90	692	62.280
Tubbergen	41	605	24.805
Twenterand	75	563	42.225
Wierden	47	457	21.479
Total	**1.797**	**1.022**	**1.836.678**

Table 23: Number of office buildings (>100m2) and surfaces in Twente (retrieved by analysing BAG data)

Achterhoek			
Municipality	**Number of office buildings larger than 100 m²**	**Average building surface (m²)**	**Total office surface in municipality (m²)**
Aalten	62	428	26.536
Berkelland	91	785	71.435
Bronckhorst	92	519	47.748
Doesburg	218	899	195.982
Doetinchem	41	877	35.957
Lochem	89	513	45.657
Montferland	72	661	47.592
Oost Gerle	102	629	64.158
Oude IJsselstreek	101	539	54.439
Winterswijk	75	732	54.900
Zutphen	155	972	150.660
Total	**1.098**	**724**	**795.064**

The two tables show that there are respectively 1.797 and 1.098 office buildings larger than 100 m² in Twente and De Achterhoek. They have a total office surface of respectively 1.836 and 795 thousand square meters.

Reduction of monuments

Since offices with a monument status fall outside the labelling obligation, they must also be excluded in the calculation. This is done by determining a percentage of monumental office buildings based on national figures and deducting this from the total. Research by the Economic Institute for Construction shows that 3.3 million m² of the total 85 million m² of floor space is monumental. This is equivalent to approximately 3.9% (Economical Institution for the Building Industry , 2016). The revised figures for both Twente and De Achterhoek are shown in Table 24.

Table 24: Number of office buildings (>100m2) and surfaces in Twente and De Achterhoek within EL-C regulation

	Number of office buildings	**Total office surface m²**
Twente	1.727	1.765.372
Achterhoek	1.055	764.197

Distribution of different sizes office buildings

For each office building in Twente and De Achterhoek, data on the gross floor area are extracted from cadastral data. This data is used to get an overview of the distribution of the different buildings in terms of the surface area. Buildings smaller than 100 m² are not included since they are not within the energy label C regulation. The results of this analysis are presented in Figure 13 and Figure 14.

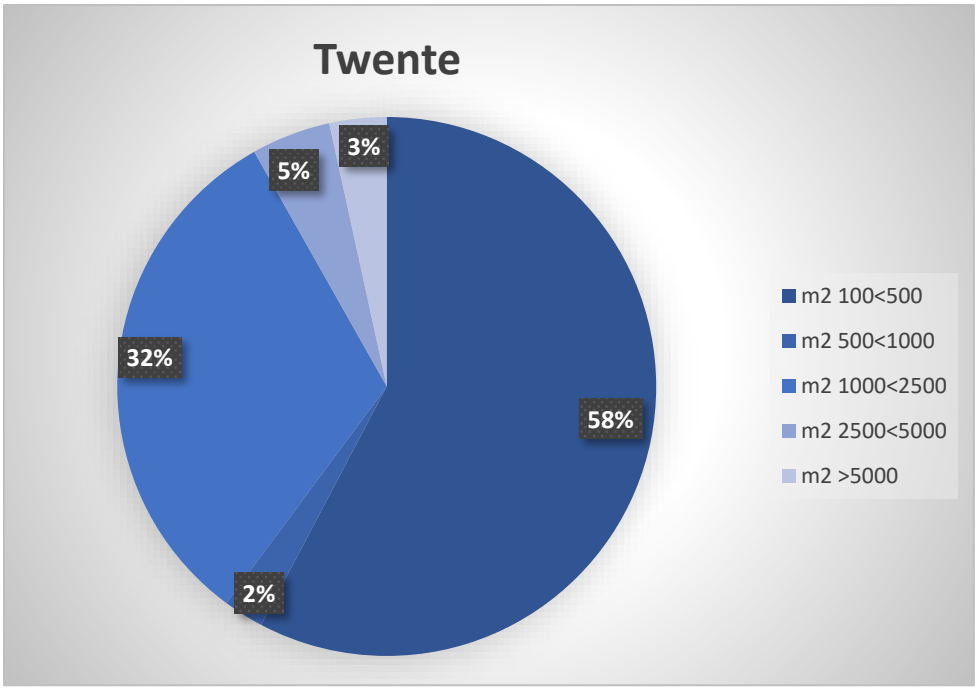


Figure 13: Distribution of surfaces of office buildings in Twente

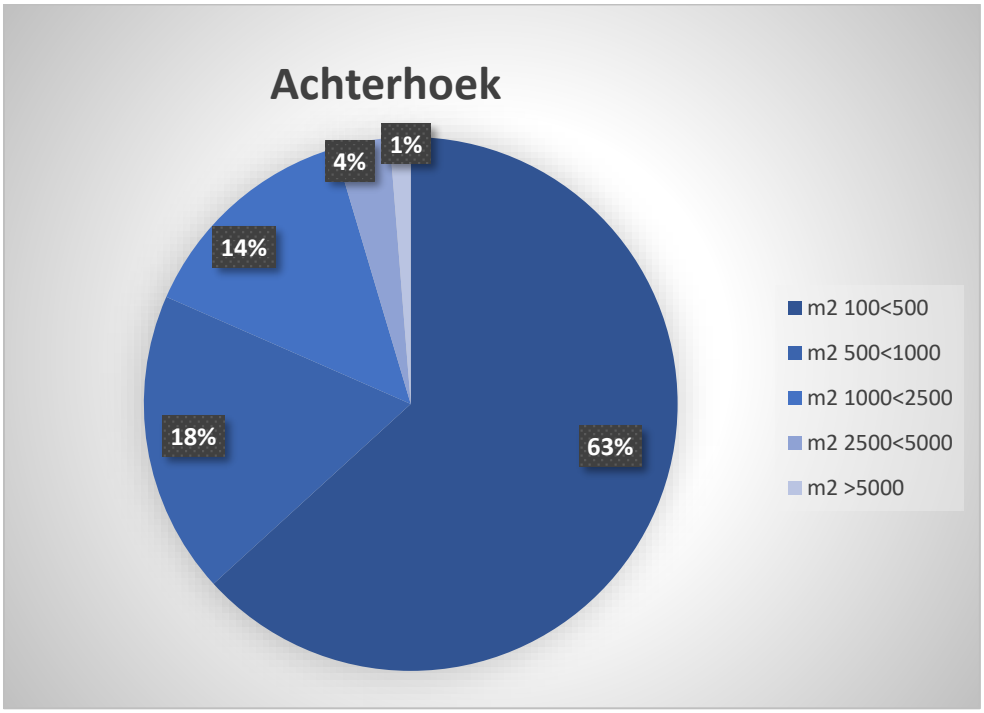


Figure 14: Distribution of surfaces of office buildings in De Achterhoek

These figures show that in both regions, more than half of the buildings have a surface between 100 and 500 square meters. Further, it is notable that there are relatively more larger office buildings in Twente. For example, 40% of the office buildings in Twente are larger than 1.000 m^2 compared to 19% of the buildings in De Achterhoek. Also, 8% of the buildings in Twente is larger than 2.500 m^2 compared to 5% in De Achterhoek.

An explanation for this may be the number of large cities. Twente has more large cities (Enschede, Hengelo, Almelo) than De Achterhoek and the data shows bigger offices in large cities. This is also reflected in the average surface areas in Table 22 and Table 23, where the three cities mentioned have

an average greater than 1.200 m^2 per building, while other municipalities usually have office buildings between 500 and 800 square meters.

Marginalia

Several marginalia can be made to the analysis of the office buildings in Twente and De Achterhoek.

1. A report of the Dutch Economic Institute for Construction (Economical Institution for the Building Industry , 2016) on the effects of the regulation indicates that there are currently many pre-war buildings which do not have a monument status. It is still unclear whether these buildings will also fall within the regulation or whether they will be exempted from the labelling obligation.
2. Office buildings scheduled to be demolished/transformed/expropriate within 2 years are an exception for the EL-C. However, these were not excluded in the analysis since this information is not available.
3. Within the analysed buildings, there are buildings with a double user purpose, of which one is office function. The label C regulation is only applicable on buildings where 50% or more of the surface is used for office purposes. It is therefore very likely that buildings with a dual user purpose have been included in the calculation while they do not fall within the regulation.

Appendix D Case building EPA-U calculations

As input for the VABI EPA-U application, some numbers are needed. This appendix shows the calculation made, to find these numbers. First the surface and usage functions for each floor are calculated. Second the different energy sectors will be distinguished, and its surfaces will be calculated. Finally, the surfaces of different construction elements connecting to the outside will be calculated.

Surface and usage functions of each floor

To calculate the different usage surfaces, specification drawings of the building are used. Every part of each layer of the building is divided in Office function, Meeting function or Help Function. In Figure 15, the specification drawing of the first floor is presented. Herein are parts A to I displayed and are the usage functions marked with blue, green and red. Table 25, Table 26 and Table 27 show the surfaces of each building part and the total surfaces of each floor per usage function.

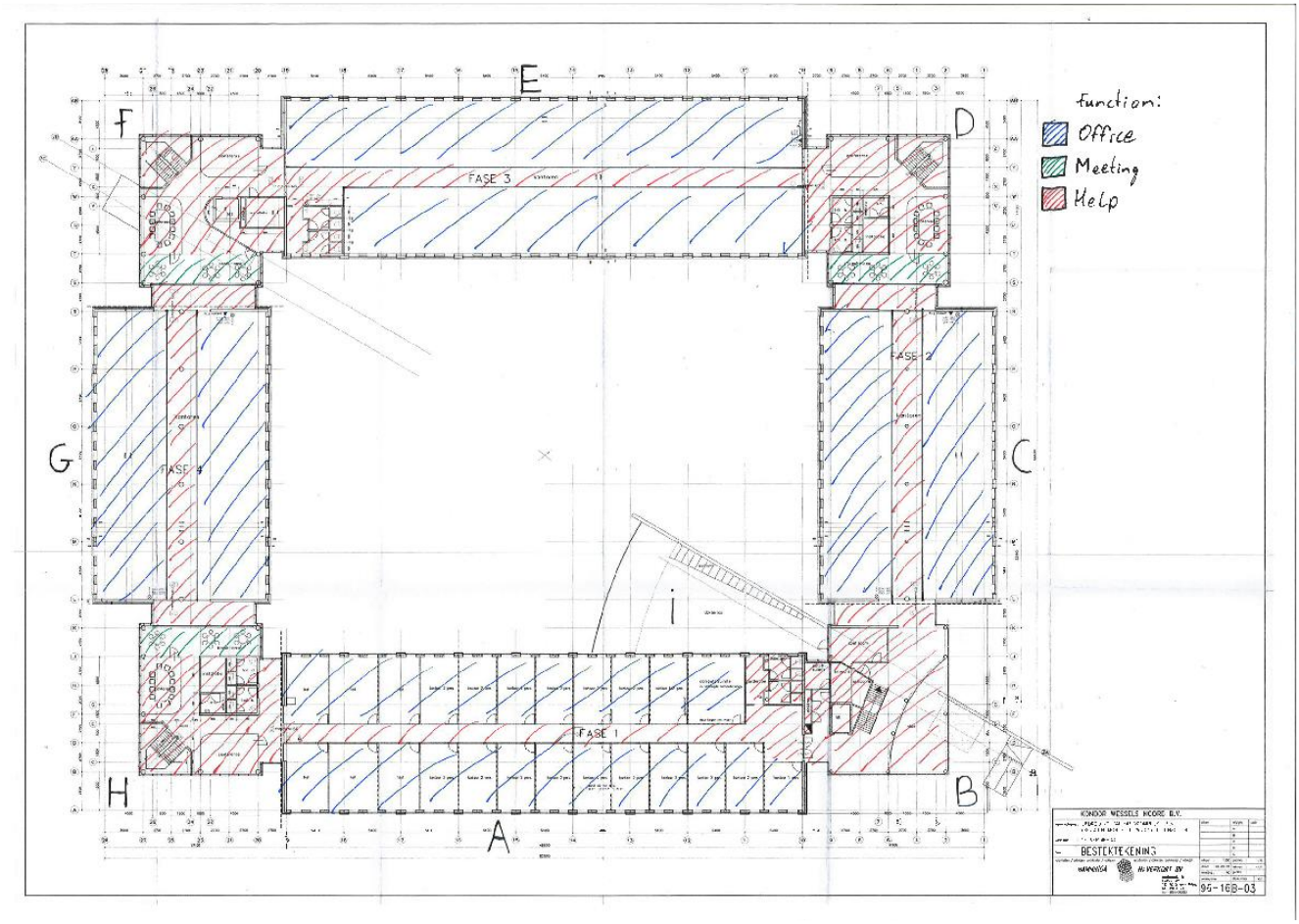


Figure 15 Specification drawing of case building with coloured functions

Table 25 Usage functions surface for each part, Ground floor

Ground Floor	**Office function m²**	**Meeting function m²**	**Help function m²**	**Total m²**
Part A	381	117	203	700
Part B	0	0	192	192
Part C	268	0	164	432
Part D	0	29	170	199
Part E	578	0	122	700
Part F	0	0	199	199
Part G	359	0	73	432
Part H	0	29	199	228
Part I	0	160	0	160
Total	**1586**	**335**	**1322**	**3243**
Percentage	**49%**	**10%**	**41%**	**100%**

Table 26 Usage functions surface for each part, First floor

First Floor	**Office function m²**	**Meeting function m²**	**Help function m²**	**Total m²**
Part A	578	0	122	700
Part B	0	0	199	199
Part C	359	0	73	432
Part D	0	29	170	199
Part E	578	0	122	700
Part F	0	29	170	199
Part G	359,1	0	73	432
Part H	0	29	170	199
Part I	0	0	0	0
Total	**1875**	**87**	**1098**	**3061**
Percentage	**61%**	**3%**	**36%**	**100%**

Table 27 Usage functions surface for each part, Second floor

Second Floor	**Office function m²**	**Meeting function m²**	**Help function m²**	**Total m²**
Part A	578	0	122	700
Part B	0	0	199	199
Part C	359	0	73	432
Part D	0	29	170	199
Part E	578	0	122	700
Part F	0	29	170	199
Part G	359	0	73	432
Part H	0	29	170	199
Part I	0	0	0	0
Total	**1875**	**87**	**1098**	**3061**
Percentage	**61%**	**3%**	**36%**	**100%**

Energy Sectors

The VABI UPA-U application divides a building in different energy sections. In this case, two energy sections are located. In part B and part F are energy installations placed. These serve the two energy sections of the building. Which part of the building is served by which sections is shown in Table 28. The total surface and volume of each section is summed in Table 29. These numbers are necessary input for the program to finally calculate the Energy Index.

Table 28 Distribution of building parts to energy sections

	Energy Section	Ground Floor m^2	First Floor m^2	Second Floor m^2
Part A	A	700	700	700
Part B	A	192	199	199
Part C	A	432	432	432
Part D	A	199	199	199
Part E	B	700	700	700
Part F	B	199	199	199
Part G	B	432	432	432
Part H	B	228	199	199
Part I	A	160	0	0
Total		**3243**	**3061**	**3061**

Table 29 Surface and volume of each energy section

	Total Surface (m^2)	Total volume (m^3)
Energy sector A	4744	17174
Energy sector B	4620	16725
Complete building	**9364**	**33899**

Construction Elements adjacent to the outside

The characteristics of different construction elements, which are connected to the outside, have influence on the heating or cooling of the building. Therefore, the surfaces of all elements connected to the outside will be calculated. These surfaces will be split according to the direction the face. The results of these calculation are in shown in Table 30, Table 31, Table 32 and Table 33.

Table 30 South-East facing construction elements adjacent to the outside

South-East	Total m^2 in sector 1	Total m^2 in sector 2
Wall	320,6	368,9
Window with awnings	154,8	145,8
Window without awnings	269,0	84,3
Doors	5,4	0,0
Panels	152,7	97,2

Table 31 South-West facing construction elements adjacent to the outside

South-West	**Total m^2 in sector 1**	**Total m^2 in sector 2**
Wall	333,8	315,8
Window with awnings	91,8	91,8
Window without awnings	235,9	231,8
Doors	0,0	0,0
Panels	38,3	56,3

Table 32 North-West facing construction elements adjacent to the outside

North-West	**Total m^2 in sector 1**	**Total m^2 in sector 2**
Wall	351,7	334,6
Window with awnings	196,7	210,4
Window without awnings	25,6	226,0
Doors	0,0	0,0
Panels	85,9	133,7

Table 33 North-East facing construction elements adjacent to the outside

North-East	**Total m^2 in sector 1**	**Total m^2 in sector 2**
Wall	202,5	224,0
Window with awnings	0,0	0,0
Window without awnings	308,2	323,6
Doors	0,0	0,0
Panels	18,0	56,3

Appendix E Summary meetings at Van Wijnen Noord

This appendix provides the summary of meetings with employees of Van Wijnen Noord on the 8th of February 2018 in Gorredijk. The first meeting was with the head of product development and the second meeting was with the regional Director of Van Wijnen Noord. Both meeting where initiated because Van Wijnen Noord is frontrunner in standardisation, BIM and Lean, within the Van Wijnen company.

Meeting with the Head product development

Date: 8 February 2018

What are the core values of Van Wijnen North?

- *Driven*
- *Involved*
- *Progressive*

Employees are also selected on these values. Even now with improving market conditions, projects are chosen that fit with these values.

What is Fijn Wonen?

Fijn Wonen is basically the development of a product, especially in and around projects. By looking at where the market is going and figure out what these means, we want to respond to this. This helps to make the company more future-proof.

Why is it disconnected from Van Wijnen Noord?

Fijn wonen is disconnected from Van Wijnen Noord because they otherwise would be more likely to turn back towards the traditional building thinking. Furthermore, they are able to think more out of the box in a separate company.

Fijn Wonen has an executing company, Novus Videre, that is not connected to the development part of the product. They have their focus on selling the product, marketing and customer contact.

What is the origin of Fijn Wonen?

It started with a broad vision, by analysing what is happening in the world and what kind of developments are ongoing. This was reflected to the current market after which this idea came up.

2011: BIM and Lean were implemented

2014: Start with the product development

2016: First dwellings were assembled

What is different regarding traditional building?

Traditionally the main goals were building and the building to be realized. This is changing towards facilitating living/working/learning/etc. For this, business has to be development and additional business models must be sought. Further, the focus is more on marketing and virtual building.

How is the vision and new approach of Van Wijnen Noord reflected in the national Van Wijnen organization or in other regional offices?

The cooperation with the national Van Wijnen organization is increasing, but still not enough. This project was setup by Van Wijnen Noord and is now profitable in this region. Other regional offices can use our experience and knowhow to change their business to become future-proof.

What should I definitely take into account during my research?

1. *Vision*
    - *Where is the world going to?*
    - *Who do you want to be?*
    - *Where do you want to be?*
    - *Target: point on the horizon*
2. *What does this mean for your company and business?*
    - *Is this what you want?*
    - *Can you do it?*
    - *Draw up a road map with strategies*
3. *Resources:*
    - *The right people*
    - *Not partly, but change the whole company*
    - *Do not immediately unplug after one setback, go on*
4. *Do it! Start with it!*

Meeting with the regional Director of Van Wijnen Noord

Date: 8 February 2018

What are the core values of Van Wijnen North?

- *Sincere*
- *Driven*
- *Ground-breaking*

Building together for space and for a better living.

The core in this is:

- *How you look at the world*
- *Where starts building?*
- *Where does it end?*

What is the origin of Fijn Wonen?

2011: *Insight that the current contractors model is not the future (leading in progress)*

2012/2013: *Implementation of BIM & Lean*

2014: *First dwelling*

2015: *Realization of the industry to produce the Fijn Wonen Dwelling*

What is the approach of Van Wijnen Noord?

- *We want to be ground-breaking, which means that we want to push the border and create new limits.*
- *We want to know what the customer wants in 2 years.*
- *Innovating is hard and hurts because 90% of the innovations fail and only the 10% which comes true is visible.*

- *The goal is not innovation, the goal is 100% delivering and 0% waste.*
- *To successfully innovate, a working climate of renewal is needed.*
- *Success stimulates*
- Ideeënjagers: a group of young people with divergent backgrounds who are searching for innovative ideas and opportunities.
- We use artificial intelligence: we parametrise everything to provide data and keep it simple.
- At the end we want to have a file to factory system wherein the customer can compile his own dwelling which directly can be ordered and sent to the factory.
- Technology is not the target, but it is the methods to create affordability and variety.
- We work with a start-up. Start-ups work well in a large company. The company can fund trough a longer process which allows you to go a step further since it is not directly necessary to make profit immediately.

What should I definitely take into account during my research?

1. *Vision*
    - *Where do you want to go?*
2. *Business case (from which the goal appears):*
    - *Of the customer*
    - *Of yourself*
    - *Financial parameter*
3. *Do it!*
    - *Go do it!*

Appendix F Offer to the case company

This appendix presents the offer that was presented to the case company. It consists of an informing letter, the energy label and the propositions for improving the building and thus the energy label.

VAN WIJNEN

[redacted]

Onderwerp: Offerte energetische verbeteringen

Datum: 04-03-2019
E-mail: s.hesselink@vanwijnen.nl / r.post@vanwijnen.nl
Telefoon: 0638306956

Geachte [redacted],

Naar aanleiding van uw verzoek en het afstudeeronderzoek van Stephan Hesselink doen wij u hierbij een aanbieding toekomen met voorstellen tot energetisch verbeteren van het pand [redacted] de [redacted] Enschede. Daarbij ontvangt u het energielabel, opgesteld met VABI EPA-U software. Dit label is niet officieel, en kan dan ook niet als zodanig gebruikt worden.

In de bijlage zijn de verschillende voorstellen uiteengezet. Allereerst een combinatie van twee maatregelen die economisch gezien interessant zijn. Deze bevat de vervanging van de huidige ketels en de plaatsing van een warmteterugwin-installatie.

Als tweede een voorstel voor zonnepanelen en isoleren van het dak. Op dit moment is het economisch niet interessant, echter kan een natuurlijk moment ervoor zorgen dat deze maatregelen wel interessant worden. Na 18 jaar begint dakbedekking in aanmerking te komen om vervangen te worden. De huidige dakbedekking ligt er nu ongeveer 22 jaar dus vervanging zal waarschijnlijk binnenkort noodzakelijk zijn. Als dit natuurlijk moment plaatsvindt, zullen de kosten voor extra isoleren veel lager zijn. Ook is het daarna pas interessant om PV-panelen te plaatsen aangezien deze anders het vervangen van de dakbedekking in de weg staan. Gezien de energieprijs zijn PV-panelen zelfs op het natuurlijke moment niet economisch interessant, maar wel het overwegen waard in het kader van maatschappelijk verantwoord ondernemen.

Als derde zijn overige maatregelen toegevoegd die door de lange terugverdien tijd economisch niet interessant zijn.

Bij alle maatregelen is het effect aangegeven op het verbruik van gas en elektra alsmede de invloed die de maatregel heeft op de Energie Index. Daarnaast zijn de kosten per maatregel beschreven met daarbij de te verwachten terugverdientijd.

Deze offerte is fictief opgebouwd ten behoeve van het afstudeeronderzoek van Stephan Hesselink. Prijzen zijn onderbouwd door indicaties/kengetallen, maar niet door gemaakte afspraken met onderaannemers. Hier kunnen dan ook geen rechten aan worden ontleend.

Wij vertrouwen er op u hiermee een passende aanbieding te hebben gedaan.

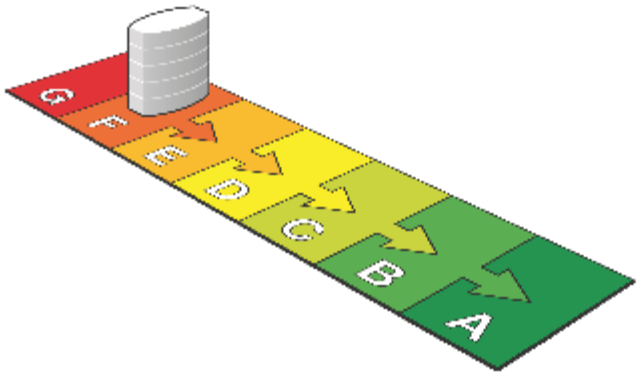
Hoogachtend,	Voor akkoord,
Van Wijnen Hengelo B.V. onderhoud en beheer	
Stephan Hesselink	Handtekening:
Afstudeerstudent	Naam:

Van Wijnen Hengelo B.V. onderhoud en beheer | Langelermaatweg 54-56 | Postbus 340 | 7550 AH | Hengelo
074-349 20 00 | hengelo@vanwijnen.nl | www.vanwijnen.nl | KvK 53238443
E-mailadres voor facturen: facturen.hengelo@vanwijnen.nl

Energielabel gebouw

Afgegeven conform de Regeling energieprestatie gebouwen.

Veel besparingsmogelijkheden



Weinig besparingsmogelijkheden

F

(zie toelichting in bijlage)

Dit gebouw

Labelklasse maakt vergelijking met gebouwen met overeenkomstige samenstelling mogelijk.

Demcon

Kantoorfunctie *(zie de bijlage voor de samenstelling)*

Gebruiksoppervlak	Naam adviseur	Adviesbedrijf
9364.4 m ²	Raymond Post	van Wijnen Groep
Opnamedatum	**Examennummer**	**Inschrijfnummer**
18-10-2018		
Energielabel geldig tot	**Handtekening**	**KvK-nummer**
18-10-2028		
Afmeldnummer		
0		

Straat (zie bijlage)

[redacted]

Nummer/toevoeging

[redacted]

Postcode

[redacted]

Woonplaats

Enschede

Volgnummer gebouw

Energielabel op basis van een ander representatief gebouw of gebouwdeel? *nee*

Adres representatief gebouw of gebouwdeel:

Standaard energiegebruik voor dit gebouw

Energiegebruik per vierkante meter maakt vergelijking met andere gebouwen mogelijk.

- Het standaard energiegebruik van dit gebouw is de hoeveelheid energie die jaarlijks nodig is voor verwarming, gebouwkoeling, de productie van warm tapwater, ventilatie en verlichting (exclusief apparatuur die geen deel uitmaakt van de klimaat- en verlichtingsinstallaties).
- Bij de berekening wordt uitgegaan van het gemiddelde Nederlandse klimaat, een gemiddelde bezettingsgraad van het gebouw en een gemiddeld gebruikersgedrag.
- Het standaard energiegebruik per jaar wordt uitgedrukt in de eenheid 'megajoules' per vierkante meter gebruiksoppervlakte (MJ/m²), dit wordt uitgesplitst naar elektriciteit (kWh/m²), gas (m³/m²) en warmte (GJ/m²).
- De CO_2-emissie per jaar als gevolg van het standaard energiegebruik wordt uitgedrukt in kilogram per vierkante meter gebruiksoppervlakte (kg/m²).

983,6 MJ/m ²

(megajoules)

55,4 kg/m ²

(CO_2-emissie)

56,7 kWh/m ² (elektriciteit)

13,1 m³/m ² (gas)

0 GJ/m ² (warmte)

Advies voor dit gebouw

Een goed moment om energiebesparende maatregelen te treffen is tijdens het uitvoeren van (groot)onderhoud of een renovatie. De kosten van de energiebesparende maatregelen zullen dan lager zijn. Via **www.ep-online.nl** kunt u een indicatie krijgen hoeveel onderstaande maatregelen kosten en wat zij opleveren aan energiebesparing. U kunt ook een advies op maat aanvragen, speciaal op uw situatie afgestemd (maatwerkadvies). De adviseur zet op een rij hoe u energie kunt besparen, hoeveel u daarvoor moet investeren en op welke termijn u de investering kunt terugverdienen. In de praktijk blijkt dat aanvragers van het energielabel dit vaak combineren met een maatwerkadvies.

Het merendeel van de bedrijven en organisaties in Nederland valt direct onder het Activiteitenbesluit. Bij een jaarlijks energiegebruik van meer dan 50.000 kWh elektriciteit en/of 25.000 m3 aeq (aardgasequivalenten) dienen ze alle mogelijke energiebesparende maatregelen te treffen met een terugverdientijd van vijf jaar of minder. Mogelijk zijn een aantal geadviseerde maatregelen verplicht in het kader van het Activiteitenbesluit. Op **www.ep-online.nl** vindt u (een link met) meer informatie over het Activiteitenbesluit.

De volgende verbetermaatregelen kunnen voor dit gebouw van belang zijn:

Toepassing van HR++glas.	HR++glas
Hoog rendement ketel toepassen.	HR-ketel
Toepassing van warmtekrachtkoppeling (WKK).	Warmtekrachtkoppeling
Toepassing van warmteterugwinning uit ventilatielucht.	Warmteterugwinning
Toepassing van veegschakeling en/of dagschakeling en/of aanwezigheidsdetectie.	Energiezuinige schakeling
Toepassing van warmte/koudeopslag in de bodem.	Warmte/koudeopslag
Toepassing van kierdichting.	Kierdichting
Toepassing van zonnepanelen voor elektriciteit.	Zonnepanelen

Sommige energiebesparende maatregelen kunnen gelijktijdig op het energielabel genoemd worden, terwijl slechts één van de maatregelen zinvol is om uit te voeren. Bijvoorbeeld bij 'HR-107 ketel' en 'warmtepomp voor verwarming'. U kunt hieruit een keuze maken. Een maatwerkadvies kan u hierbij helpen.

BIJLAGE

Toelichting gebruiksoppervlakte
De gebruiksoppervlakte is dat deel van de vloeroppervlakte dat direct gericht is op het gebruik van het gebouw of van afzonderlijke delen van het gebouw. De niet-dragende binnenwanden spelen bij de bepaling geen rol. De oppervlakte zal afwijken van Bruto vloeroppervlakte (BVO), Netto vloeroppervlak (NVO) en Verhuurbare Vloeroppervlakte (VVO). De volledige definitie voor de bepaling van de oppervlakte is vastgelegd in de NEN 2580.

Een gebouw kan één of meerdere gebruiksfuncties hebben. De volgende gebruiksfuncties kunnen voorkomen: bijeenkomstgebouw-, celgebouw-, gezondheidsgebouw- (klinisch of niet-klinisch, kantoor-, logiesgebouw-, onderwijsgebouw-, sportgebouw-, en winkelfunctie.
Dit gebouw heeft de volgende samenstelling aan gebruiksfuncties.

Samenstelling/functie	Percentage
Kantoorfunctie	100 %

Energielabelklasse

Voor dit gebouw is de energieprestatie bepaald. Dit getal wordt vertaald naar een energielabelklasse die aangeeft hoe energiezuinig uw gebouw is. De energielabelklasse wordt weergegeven met een letter en kleur in onderstaande balk. De energielabelklasse wordt bij de basismethodiek uitgedrukt in de energie-index (EI), bij de gedetailleerde methodiek wordt deze uitgedrukt in de $E_{P;tot}/E_{P;ader(tot;nb}$ waarde (E/E).

F
1,69 (EI)

Is het energielabel voor dit gebouw opgenomen met de basismethodiek, dan krijgt het gebouw een energielabelklasse in de range G tot en met A. De basismethodiek wordt vooral gebruikt bij bestaande gebouwen.
Is het energielabel voor dit gebouw opgenomen met de gedetailleerde methodiek, dan krijgt het gebouw een energielabelklasse in de range B tot en met A++++. De gedetailleerde methodiek wordt vooral gebruikt bij nieuwbouw en bestaande gebouwen die grondig gerenoveerd zijn (tot bijna nieuwbouw niveau).

Het energielabel wordt berekend op basis van de energieprestatie van de bouwkundige eigenschappen en de gebouwgebonden installaties. De berekening houdt rekening met het gemiddelde Nederlandse klimaat, een gemiddelde bezettingsgraad en gemiddeld gebruikersgedrag.

BIJLAGE

Disclaimer

De op het energielabel voorgestelde maatregelen zijn in de meeste gevallen kosteneffectief of kunnen dit binnen de geldigheidsduur van het energielabel worden.

Of de genoemde maatregelen daadwerkelijk verantwoord toegepast kunnen worden uit oogpunt van bijvoorbeeld binnenmilieu, comfort, technische mogelijkheden, gezondheid, kosteneffectiviteit en dergelijke is afhankelijk van de huidige specifieke eigenschappen van dit gebouw. U kunt hierover nader advies inwinnen bij uw adviseur.

Het energielabel geeft inzicht in het gestandaardiseerd gebouwgebonden energiegebruik en niet in het daadwerkelijke energiegebruik van de gebruikers van dit gebouw. Daarom komt het jaarlijks energiegebruik op het energielabel weilicht niet overeen met de informatie op de jaarlijkse energierekening van dit gebouw.

Alleen een volledig ingevuld energielabel is rechtsgeldig.

VAN WIJNEN

Bijlage 1

Aannames		
Kosten elektra per kWh	€	0,06
Kosten gas per m3	€	0,31
Disconteringsfactor		3%

04-03-2019

Richtprijs opgave tbv: **Case Building**

Ter attentie van: **Manager Facilities**

Opgesteld door van Wijnen Eibergen Hengelo bv: S.J.H. Hesselink

Economisch aantrekkelijke maatregelen

	Eenh.prijs	Aantal	Deelprijzen	Totalen
Werkzaamheden :				
Vervanging Huidige ketels door HR 107% ketels				
Ingeschatte kosten	€ 30.000,00	4	€ 120.000,00	
Ingeschatte subsidie			€ -	
Plaatsen van een warmteterugwinnings installatie				
Ingeschatte kosten	€ 170.000,00	1	€ 170.000,00	
Ingeschatte subsidie			€ -23.375,00	
Totaal kosten exclusief BTW				**€ 266.625,00**

Uitgangspunten

* *werkzaamheden ma-vr 7.00-18.00*
* *Alle genoemde prijzen zijn exclusief 21% BTW*

Effecten op het verbruik en het energielabel

	Verwachte reductie gas m3/jaar	Verwachte reductie elektra kWh/jaar	Energie Index na maatregel		Reductie in uitgaven/jaar	Verwachte terugverdientijd in jaren
Werkzaamheden :						
Vervanging Huidige ketels door HR 107% ketels	20601		1,56	Label E	€ 6.386,00	13
Plaatsen van een warmteterugwinnings installatie	22474		1,54	Label E	€ 6.947,00	16
		Gecombineerde energie Index	1,44	Label D		

VAN WIJNEN

Bijlage 2

Aannames		
Kosten elektra per kWh	€	0,06
Kosten gas per m3	€	0,31
Disconteringsfactor		3%

04-03-2019

Richtprijs opgave tbv: **Case Building**

Ter attentie van: **Manager Facilities**

Opgesteld door van Wijnen Eibergen Hengelo bv: S.J.H. Hesselink

Natuurlijk moment maatregelen

	Eenh.prijs	Aantal	Deelprijzen	Totalen
Werkzaamheden :				
Dak Herisoleren				
Ingeschatte kosten	€ 114,00	2.595	€ 295.830,00	
Ingeschatte subsidie			€ -40.676,63	
Plaatsen van 1500m2 PV-panelen				
Ingeschatte kosten	€ 276,00	1.500	€ 414.000,00	
Ingeschatte subsidie			€ -56.925,00	
Totaal kosten exclusief BTW				**€ 612.228,38**

Uitgangspunten

* *werkzaamheden ma-vr 7.00-18.00*
* *Alle genoemde prijzen zijn exclusief 21% BTW*

Effecten op het verbruik en het energielabel.

	Verwachte reductie gas m3/jaar	Verwachte reductie elektra kWh/jaar	Energie Index na maatregel		Reductie in uitgaven/jaar	Verwachte terugverdientijd in jaren
Werkzaamheden :						
Dak Herisoleren	6626		1,65	Label F	€ 2.054,00	> 50
Plaatsen van 1500m2 PV-panelen		225000	1,53	Label E	€ 13.500,00	> 50
		Gecombineerde energie Index	1,49	Label E		
		Gecombineerd met bijlage 1	1,25	Label C		

VAN WIJNEN

Bijlage 3

Aannames		
Kosten elektra per kWh	€	0,06
Kosten gas per m3	€	0,31
Disconteringsfactor		3%

04-03-2019

Richtprijs opgave tbv: **Case Building**

Ter attentie van: **Manager Facilities**

Opgesteld door van Wijnen Eibergen Hengelo bv: S.J.H. Hesselink

Overige maatregelen

	Eenh.prijs	Aantal	Deelprijzen	Totalen
Werkzaamheden :				
Led verlichting				
Nieuwe armaturen				
Ingeschatte kosten			€ 539.940,00	
Ingeschatte subsidie			€ -26.998,00	
Ombouw bestaande armaturen				
Ingeschatte kosten			€ 269.970,00	
Ingeschatte subsidie			€ -26.998,00	
Vervangen glas				
HR++ glas				
Ingeschatte kosten	€ 108,00	2.595	€ 280.260,00	
Ingeschatte subsidie			€ -38.535,75	
Triple glas				
Ingeschatte kosten	€ 132,00	2.595	€ 342.540,00	
Ingeschatte subsidie			€ -47.099,25	
Totaal kosten exclusief BTW				-

Uitgangspunten

* *werkzaamheden ma-vr 7.00-18.00*
* *Alle genoemde prijzen zijn exclusief 21% BTW*

Effecten op het verbruik en het energielabel

	Verwachte reductie gas m3/jaar	Verwachte reductie elektra kWh/jaar	Energie Index na maatregel		Reductie in uitgaven/jaar	Verwachte terugverdientijd in jaren
Werkzaamheden :						
Led verlichting						
Nieuwe armaturen		165476	1,45	Label D	€ 9.929,00	> 50
Ombouw bestaande armaturen		165476	1,45	Label D	€ 9.929,00	> 50
Vervangen glas						
HR++ glas	28092		1,50	Label E	€ 8.709,00	> 50
Triple glas	39329		1,44	Label D	€ 12.192,00	45

UNIVERSITY OF TWENTE.

VAN WIJNEN

Appendix G Expert panel summary

This appendix provides a summary of the expert panel held on the 14th of March 2019 on the University of Twente. During this meeting feedback was given both on the process steps and the conducted case study. The input of the experts was used to finalise the process model. Since the meeting was in Dutch, the summary is in Dutch also.

Date: 14 maart 2019 U-Parkhotel Universiteit Twente

Aanwezigen:

X	Vastgoedbedrijf Gemeente Enschede	Medewerker
Ray Klumpert	Universiteit Twente	Head of Maintenance and Real Estate
X	Case company	Manager Facilities
Raymond Post	Van Wijnen Eibergen	Projectleider Onderhoud & Beheer (O&B)
Wilco Tijhuis	Universiteit Twente	Begeleider afstudeeronderzoek/ Universitair docent
Peter Spelt	Van Wijnen Eibergen	Begeleider afstudeeronderzoek/ Manager Innovatie
Stephan Hesselink	Universiteit Twente/ Van Wijnen	Afstudeerstudent

Feedback op stappenplan na uitleg stappen

Manager Facilities	Niet-gebouwgebonden processen vertroebelen je beeld. Zeker aangezien deze niet van elkaar te scheiden zijn in het energieverbruik
Universitair docent	Proceswarmte door processen die binnen het gebouw plaatsvinden. (Buiten standaard voor gebouwfunctie)
Projectleider O&B	Ik mag geen label afmelden, wel maken. Moeten geaccrediteerd zijn en zit heel proces aan vast. Ander panellid: dit wil je misschien ook juist onafhankelijk laten.
Universitair docent	Kan het simpeler/duidelijker, het is een verandertraject, kan je de klant meer ontzorgen, overtuigen? Klopt het huidige label, en wie rechtvaardigt dat het nieuwe label klopt? - Ander panellid: Lastig vooraf precies te bepalen af je de verwachte besparing haalt en of je die waardes haalt - Ander panellid: Soms zou het kunnen dat je garanties moet geven, de andere keer heb je gewoon geen keus omdat je naar label C moet
Gemeente Enschede	Klant wil weten: wat levert het mij op, naar C maar ook naar B en A. En wat is de terugverdientijd? Ga ik een stap verder? Naar B of A, als dat mij meer oplevert.
Gemeente Enschede	Ik mis de MJOP. Dan kun je duidelijk zien wanneer je op een natuurlijk moment extra kunt investeren om goedkoper de label stap te maken. Wij hebben vaak iets gepland wat we naar voren halen, zo begint de terugverdientijd eerder. Ook betrekken we de huurder erin en de kostenreductie die zij maken voor energielasten. Deze betrekken we ook om de kosten te delen en daarmee de planning nog verder naar voren te halen.
Head Maintenance UT/ Gemeente Enschede	Handiger om Het MJOP op te stellen. Dan worden de stappen makkelijker.

Universitair docent	Voor klant: minimaal nodig voor C duidelijk maken. En extra voor B en A. Of misschien met 1 maatregel al naar A.
Universitair docent	Betekent dat je voor elk onderdeel de MJOP voor je moet hebben liggen.
Manager Facilities	Veel bedrijven hebben geen MJOP. Afhankelijk van hoe de opdrachtgever zelf de processen intern in kaart heeft. Belangrijk om van tevoren goed te inventariseren bij welke klant je aan tafel zit en welke verplichtingen deze klant heeft. Bijv. Grootzakelijke bedrijven moet een EED-rapportage maken, die moeten ook een toekomst planning maken. MKB'ers hoeven veel minder. Erg belangrijk om te weten in het voortraject hoe de klant erin staat.
Manager Facilities	Spel tussen eigenaar en huurder wordt gespeeld. Wat is verplicht, wil die meer dan verplichtingen? (Naar C en binnen 4 jaar terugverdientijd)
Manager Facilities	Ik denk dat er veel meer bedrijven zijn zoals wij, die druk zijn met hun core business en werken niet toe naar de EED. Die krijgen opeens een groot vraagstuk op hun dak. Dit is interessant voor van Wijnen om hier het totale plaatje in kaart te kunnen brengen.
Head Maintenance UT	MJOP kan ook BOEI (brandveiligheid, onderhoud, Energie, wet en regelgeving) gemaakt worden. Dat geeft een totaaloverzicht. Dit zit ook in de NEN 2767. Kost qua moeite niet extreem veel meer, want je moet toch al met een aantal experts het pand door.

Feedback op case en stappenplan

Manager Facilities	Eerste scenario is inmiddels grotendeels uitgewerkt door de Eigenaar. De eigenaar geeft aan niet te weten of hij hiermee C haalt of op een Label D blijft hangen. Dit komt overeen met de uitkomsten van het onderzoek
Manager Facilities	Het ligt aan het dak of zonnepanelen relevant kunnen zijn. Door installaties op het dak kan er te weinig nuttig oppervlak overblijven.
Gemeente Enschede	Het is ook erg afhankelijk wat voor een type dak het is, betonnen of staal. Een stalen dak is vaak minimaal berekend en kan doorgaans geen panelen dragen. Dit komt door de windbelasting en de sneeuwbelasting.
Head Maintenance UT	Inderdaad, op de UT kan 75% van de platte daken ook geen zonnepanelen dragen.
Universitair docent	Er is nu een terugverdientijd van 13 tot 16 jaar. Normaalgesproken zou je na 13-16 jaar zeggen dat de installatie bijna aan vervanging toe is. Dus de terugverdientijd kan je misschien net rekken tot 20 jaar. Maar in de tussentijd zullen de installaties in de markt verbeterd zijn, en ook het onderhoud zal in de laatste jaren groter worden. Uiteindelijk is het puur economisch ook niet interessant, maar wel puur voor het label.
Manager Facilities	In de tussentijd zijn 2 ketels en een luchtbehandelingskast vervangen.
Manager Facilities	De kosten voor onderhoud zullen lager worden na vervangen. Dit is niet meegenomen in de berekeningen.
Head Maintenance UT	In principe moet je de ketels of luchtbehandelingskosten op een gegeven moment toch al vervangen. Dus eigenlijk kost het 0. Dus je moet alleen het prijsverschil rekenen dat een wat duurzamere ketel kost t.o.v. een standaard vervanging volgens de huidige maatstaven.
Gemeente Enschede	Hierin is de MJOP ook weer ontzettend belangrijk. Daarin staat wanneer je een installatie toch al moet vervangen. Alleen de meerwaarde of als je de vervanging

	in de tijd naar voren haalt, moet je dat deel meenemen in de berekening voor je terugverdientijd. Dus niet de investering van de ketel.
Gemeente Enschede	Dan krijg je ook weer het overleg tussen de huurder en de eigenaar. Want door nieuwe installaties heeft de huurder minder kosten aan gas of elektra. Als er door overleg afgesproken wordt dat beide partijen inleggen voor een energetische verbetering, kan deze maatregel eerder toegepast worden, dan als de huurder dit over laat aan de verhuurder. Deze zal namelijk zo lang mogelijk willen uitzitten met de huidige installatie en het minimale willen doen om aan de regelgeving te voldoen.
Head Maintenance UT	Je kunt ook een huurverhoging met elkaar afspreken die het verschil aan kosten voor gas of elektra denkt.
Universitair docent	Is hier ook stadsverwarming?
Head Maintenance UT	Stadverwarming werkt hier net als bij gas. Je betaalt hetzelfde als voor gas, daardoor is het dus per definitie ook niet goedkoper. Het komt van de bio-energiecentrale en is 100% co2 neutraal
Gemeente Enschede	Wij willen ook het stadskantoor en het stadhuis op de stadsverwarming aansluiten
LedVerlichting	
Manager Facilities	Alleen omdat we zelf nieuwe lampen willen zou het uitkunnen, maar economisch gezien kan het plaatsen van led niet uit.
Head Maintenance UT	Bij ons komen de terugverdientijd berekening voor led ook nooit goed uit. Daarom plaatsen wij bij het vervangen van licht wel ledlampen maar laten we de rest nog voor wat het is. Dit doen we niet om de terugverdientijd, maar ook om het voordeel dat je er bijna geen onderhoud meer aan hebt.
Universitair docent	Dan moet er inderdaad weer een factor onderhoud bij in de tabellen
Manager Facilities	Als je kijkt naar de subsidie die je kunt ontvangen, krijg je alleen subsidie op het aantal lumen dat je nieuwe lampen opbrengen. Dus niet op de installatie die je ervoor nodig hebt. Daarom willen we 1 op 1 armaturen wisselen zodat er in het plafond niets aangepast hoeft te worden.
Head Maintenance UT	Wij hebben nieuwe led armaturen geplaatst die tot ongeveer 15% gedimd worden. Dan zijn ze energetisch gezien heel gunstig. Want het is bij led armaturen zou dat als je ze dimt, dat energieverbruik enorm zakt. Ze zijn daglichtafhankelijk gestuurd en in de meeste gevallen heb je de maximale lichtsterkte niet nodig. Bij ons zijn ze op 50% ingesteld en afhankelijk van het daglicht zakt dat omlaag tot 15%.
Gemeente Enschede	Wij passen dit ook toe in onze fietsenkelders. Daar zorgt het ervoor dat je 10 of 20% licht hebt en dat dit opgekrikt wordt naar een hoger percentage als er iemand aan komt lopen.
Universitair docent	In Duitsland hebben ze lamellen die zorgen dat er voldoende licht het gebouw binnenkomt. Daar is dus overdag geen kunstlicht nodig.
Manager Facilities	Wij krijgen van veel installateurs te horen dat je de armaturen moet vervangen omdat je anders niet het juiste aantal lumen uit je lamp haalt, dan wanneer je alleen je lichtbron zou vervangen. Daarbij zeggen ze ook dat je CE-keurmerk van je lamp vervalt. Echter hebben wij een gepensioneerde adviseur die vanuit hobby nog advies geeft. Hij geeft aan dat er nergens vast staat dat dit keurmerk vervalt. Alleen de bron vervangen zou een goede eerste stap zijn als dit geen gedoe geeft met de verzekering.
Universitair docent	Volgens mij is er ook een explosie risico

Head Maintenance UT	Je haalt het voorschakelapparaat eruit en dan heb je de armatuur gemodificeerd en zit er dus geen CE-keurmerk meer op. Dan kun je hem opnieuw laten keuren maar dat is kostentechnisch niet interessant.
Head Maintenance UT	Er zitten ook meer problemen. Je krijgt een hele andere lichtspreiding dan met TL5 lampen. Ook zorgt het voor piekbelastingen op je net. Dit zorgt ervoor dat je niet eens meer een pc op dit net kan aansluiten. Dit was voor ons de reden om hier niet meer aan mee te doen. Wij vervangen sindsdien alleen maar hele armaturen.
Universitair docent	Uiteindelijk ligt het risico toch bij de verzekeraar. Die moet het accepteren.
Overige Opmerkingen	
Manager Facilities	Wij hebben een hoop aanbiedingen van bedrijven gehad met tooltjes en prachtige terugverdientijden. Echter is dit allemaal niet onafhankelijk. Daarom moet je proberen als Van Wijnen het zo onafhankelijk mogelijk te houden. Hoe het zo reëel mogelijk en maak klanten niet lekker met iets dat niet waar is. Een nadeel is alleen, omdat je zelf niet de installateur bent, dat je met opslagen zit.
Head Maintenance UT	Je kunt ook je advies inclusief een garantie afgeven.
Peter Spelt	Bij woningen worden nu de woonlasten overgenomen door bedrijven die de investering voor het energetisch verbeteren doet.
Universitair docent	Het voordeel uit zo'n model is dat je de fluctuaties uit het systeem haalt. Deze neemt de aanbieder dan over en de klant is altijd hetzelfde kwijt. In Duitsland in Aken is een project waar in het gebouw geen installaties meer zitten maar de warmte uit een aparte warmtekrachtcentrale komt. Op dit manier kiest de klant om geen installatiekosten of onderhoudskosten te betalen. Maar ze betalen voor warme als een service. Het is niet direct goedkoper, maar je haalt het risico door onzekerheid eruit.
Gemeente Enschede	Waar ook veel winst te halen is, is in het inregelen van de installaties. In gebouwen wordt veel energie gebruikt waar niemand weet van heeft. Wij hebben bij een gebouw een ton per jaar bespaard met inregelen. Hiervoor hebben we bijvoorbeeld een nachtronde gedaan om te kijken wat er verbruikt werd. Hier zijn weinig kosten voor nodig, maar je hebt er direct winst van.
Universitair docent	In Duitsland wordt veel overgedimensioneerd qua installaties. Deze worden ingeschat op basis van een aantal dagen per jaar waarin het nodig is. Maar dat is maar 3% per jaar, de rest van de dagen staan ze deels niets te doen. Daarom moet er misschien ook worden nagedacht over het lager dimensioneren van deze installaties om vervolgens die paar dagen per jaar jezelf er op aan te passen.
Head Maintenance UT	Vaak neemt een installatieadviseur reserve, dat doet de installateur ook. Dan heb je dubbele reserve.
Manager Facilities	Van Wijnen heeft de kennis voor het inregelen in huis. Dit is voor Van Wijnen een meerwaarde in het aanbod dat je de klant kunt doen.
Head Maintenance UT	Daarom moet je af en toe een scan doen om te kijken of de installaties nog doen waarvoor ze bedoeld waren
Gemeente Enschede	Als mensen het warm hebben is het eerste wat ze doen het raam open zetten, terwijl er niet wordt gekeken naar waarom het zo warm is.
Head Maintenance UT	Op de universiteit hebben we de collegezalen verwarmd op basis van het reserveringssysteem voor deze zalen. Een kwartier van tevoren gaat het systeem aan en na afloop weer uit. Ook scheelt het veel hoe vol de collegezalen zitten. Dit systeem koste €25.000 en was binnen een week terugverdiend.

Gemeente Enschede	Wij verwarmen nu ook op flex basis. We hebben een basis warmte in de kantoren, en als er dan iemand binnen komt wordt er extra verwarmd tot een aangename temperatuur.
Head Maintenance UT	Mijn kantoor constateert dat ik binnen ben, dan gaat deze naar mijn comfortabele temperatuur, en als ik een half uur weg ben gaat deze weer uit. Dit kan gewoon op een oude installatie gemonteerd worden.
Manager Facilities	Dit is ook voor ons interessant omdat we bij ons ook medewerkers hebben die met de koeling aan ook de verwarming vol aan zetten.
Manager Facilities	Hoeveel telt dit mee in het label? Stephan: Niet, alleen bij licht, want de overige installaties blijven hetzelfde en worden alleen anders geregeld. Bij licht kan een detectiesysteem zorgen voor een verschil omdat dit wordt meegenomen in de berekening van de Energie Index.
Manager Facilities	Ondanks dat je door systemen beter te regelen niet wint qua label, ga je er kostentechnisch wel op vooruit. Deze winst kan gebruikt worden om maatregelen te nemen die wel helpen voor de labelsprong. Dit is ook wat Van Wijnen als extra service voor een totaalplaatje kan bieden.
Universitair docent	Van Wijnen kan het ook. Maar meer als een systeemintegrator. Want de installateur zal ook voor een deel van zijn werkzaamheden de aannemer nodig hebben. Dit kan voor de verzerkerbaarheid ook handig zijn.
Manager Facilities	Als het vanuit één plek wordt aangestuurd krijg je dat je moet samenwerken en dan heb je niet alle individuele belangen. Ik heb toevallig bij Siemens samengewerkt met Van Wijnen. Hier hadden wij één aanspreek partner, Van Wijnen, die alle afstemming met de verschillende partners regelde. Dit levelt de opslag kosten bij Van Wijnen en kost ook minder tijd van het eigen personeel.
Gemeente Enschede	Dit is de reden dat wij overgestapt zijn op prestatiecontracten. We moesten zo'n 65 leveranciers managen, waar we dagelijks mee bezig waren. Nu spreken we de KPI maandelijks door en dat werkt ideaal. Dan ben je ook veel meer bezig met de energielasten. Je hoeft niet meer steeds bezig te zijn met de basis maar kunt een stap verder kijken.
Manager Facilities	Wij hebben meer mensen die we huisvesten dan waar het gebouw voor bestemd is.
Gemeente Enschede	Zijn de bestaande installaties dan wel toereikend voor het huidige gebruik?
Manager Facilities	Nee, als wij bijvoorbeeld onze CO2 pieken meten, zitten die soms te hoog.
Manager Facilities	De maatregelen hoeven niet een directe invloed te hebben om het energielabel, maar kunnen er wel voor zorgen dat het comfort van de werknemer toeneemt en daarmee de productiviteit toeneemt en het ziekteverzuim afneemt.
Universitair docent	Van Wijnen is meer dan bouwen. Wat zijn de drie kernwoorden die dit straks samenvatten? Wat breng je?
Manager Facilities	Iemand gaf aan dat het wel erg veel stappen waren, maar ik heb het niet zo ervaren.
Head Maintenance UT	Het pad is niet zo lang als het lijkt omdat je het natuurlijk langsloopt.
Manager Facilities	Voor de opdrachtgever zit het werk voornamelijk in het verzamelen van de gegevens van het gebouw en de installaties.
Gemeente Enschede	Deze gegevens zou je eigenlijk altijd op orde moeten hebben. Deze kan je namelijk elke dag nodig hebben. Dit kost één keer energie maar je hebt er daarna veel profijt van.

Appendix H Final process model in Dutch with guiding document

This appendix presents the final process model in Dutch, which is useful for Van Wijnen Eibergen. Additionally, a guiding document which is also in Dutch, is added. This iterative document can be used by employees of Van Wijnen Eibergen.

Stap 1: Eerste gesprek met de gebouweigenaar of -gebruiker

1.1 Achterhalen of het gebouw een energielabel heeft

a) Er is geen label → label is verplicht dus analyse.

b) Het label is D-G → nog geen C, dus analyse

c) Het label is A-C en de gebouweigenaar en/of gebruiker heeft intentie tot verbeteren → nagaan of er voldoende onderzoek is gedaan en data voorhanden is om de gebouwanalyse over te slaan.

d)Het label is A-C en de gebouweigenaar en/of gebruiker heeft geen intentie tot verbeteren → geen verdere actie

1.2 Afstemmen vervolgtraject

a) Duidelijk maken welke input nodig is vanuit de eigenaar en/of gebruiker. (gespecificeerd in "2. analyse van het gebouw")

b) Afspraak inplannen om tijdens locatiebezoek de resterende gebouwdata te verzamelen.

c) Afstemmen wat de wensen en eisen van de eigenaar en/of gebruiker zijn. Deze worden meegenomen in fase 3 tijdens de afweging om voor bepaalde oplossingen te kiezen

d) Duidelijk maken wat de output is: Het energielabel, een advies met kostenindicatie en een meerjarenonderhoudsplan.

Stap 2: Analyse van het gebouw

2.1 Bepalen wat de gebruikersfuncties en energiesectoren zijn.

a) Input door de eigenaar en/of gebruiker:

- Bouwtekeningen van het pand
- Tekeningen van de technische installatie(s) van het gebouw
- Als er meerdere functies in het gebouw zitten, specificatie van de functies per vertrek.

b) Stappen voor de adviseur:

- Volgens EPA-U standaarden de gebruikersfunctie(s) van het pand bepalen
- Met de gebruikersfunctie(s) en de installatietekeningen de energiesectoren bepalen

2.2 Bepalen welke installaties per energiesector zijn geïnstalleerd

a) Input door de eigenaar en/of gebruiker:

- Tekeningen van de technische installatie(s) van het gebouw.
- Specificaties van losse installatiecomponenten.
- Specificatie van de lampen in het gebouw, of eventueel het lichtplan.

b) Stappen voor de adviseur:

- Per energiesector bepalen welke installaties er zijn voor ventilatie, verwarming, bevochtiging, koeling, warm tapwater en zonne-energie.
- Bepalen wat het verbruik (in W/m^2) van de lichtinstallatie per energiesector is en hoe deze geregeld wordt.

2.3 Bepalen uit welke constructieve elementen het gebouw bestaat

a) Input door de eigenaar en/of gebruiker:

- Bouwtekeningen van het pand
- Indien voorhanden, specificaties van wanden, vloeren, daken, deuren en ramen.

b) Stappen voor de adviseur:

- Per constructief element aan de hand van verkregen input of aan de hand van (ver)bouwjaar bepalen wat de Rc waarde is voor dat specifieke element.

2.4 De resterende gebouwdata verzamelen tijden een locatiebezoek

a) Input door de eigenaar en/of gebruiker:

- Toegang tot het gebouw en tot de technische installaties
- Medewerking om de benodigde gegevens te achterhalen

b) Stappen voor de adviseur:

- Door de technische installaties of constructieve elementen op locatie te bekijken, de gebouwdata uit 2.2 en 2.3 compleet maken.
- Verifiëren of de data van de aangeleverde tekeningen overeenstemd met de werkelijke situatie.

2.5 Naar wens monitoren van de huidige installaties

a) Input door de eigenaar en/of gebruiker:

- Toegang tot het gebouw en tot de technische installaties
- Medewerking om de benodigde gegevens te achterhalen

b) Steps for the advisor

- Samen met een installateur nagaan of de installaties nog naar behoren werken.
- BOEI inspectie uitvoeren met de benodigde specialisten.

2.6 Bepalen wat de energie-index van het gebouw is en het daarmee corresponderende energielabel

a) Input door de eigenaar en/of gebruiker:

- Jaarrekeningen voor gas en elektra.

b) Stappen voor de adviseur:

- De input van 2.1 t/m 2.4 gebruiken om in Vabi EPA-U software de gebouwanalyse te maken.
- De energie-index voor het gebouw bepalen.
- Verbruik van het pand vergelijken met gas en elektra rekeningen.
- Het energielabel voor het gebouw opstellen, of op laten stellen door een gecertificeerde partner.

Stap 3: Advies maken voor verbeteringen

3.1 Installatietechnische verbeteringen bepalen en doorrekenen

a) Per installatie component bepalen of en welke mogelijkheden er zijn tot verbetering. (ventilatie, verwarming, bevochtiging, koeling, warm tapwater, zonne-energie en licht)

b) De mogelijkheden afstemmen met calculators binnen Van Wijnen en indien nodig met onderaannemers. Afstemming op basis van kosten, verbetering van energie-index en de eisen en wensen van de eigenaar en/of gebruiker.

3.2 Constructieve verbeteringen bepalen en doorrekenen

a) Per constructie component bepalen of en welke mogelijkheden er zijn tot verbetering. (wanden, vloeren, daken, deuren en ramen).

b) De mogelijkheden afstemmen met calculators binnen Van Wijnen en indien nodig met onderaannemers. Afstemming op basis van kosten, verbetering van energie-index en de eisen en wensen van de eigenaar en/of gebruiker.

3.3 Kosten bepalen

a) Bepalen op welke subsidies aanspraak gemaakt kan worden bij zowel installatietechnische als constructieve verbetervoorstellen.

b) De kosten voor de verbetervoorstellen bepalen inclusief subsidie en door Van Wijnen toegevoegde percentages voor risico's en kosten.

3.4 Werkelijke kosten en terugverdientijd bepalen

a) Op basis van een MJOP bepalen wat de extra kosten zijn voor de toe te passen maatregelen gevonden in 3.1 en 3.2.

b) Op basis van de MJOP bepalen wat de terugverdientijd voor de verschillende maatregelen is.

c) Analyseren wanneer een maatregel economisch gezien het beste toegepast kan worden.

3.5 Compleet advies maken voor het gebouw

a) Adviesrapport opstellen met:

- Begeleidende brief.
- Het energielabel bepaald in 2.6
- Set met verbetervoorstellen die voldoen aan de wensen en eisen van de gebouw eigenaar en/of begruiker, inclusief kosten en terugverdientijd op basis van de MJOP
- Overige verbetervoorstellen zowel installatietechnisch als constructief.

3.6 Het advies aanbieden aan de gebouw eigenaar of gebruiker

a) Het adviesrapport aanbieden aan de gebouweigenaar en/of gebruiker en toelichten. Hierbij met de eigenaar of beheerder afstemmen welkestappen er genomen worden richting de implementatie van de verbetervoorstellen.

- Als de eigenaar en/of beheerder over wilt gaan tot implementatie, afstemmen welke stappen er genomen gaan worden en wat de planning is.
- Als de eigenaar en/of beheerder **niet** verder wil met de verbetervoorstellen, afstemmen of Van Wijnen verder nog iets kan betekenen.

Stap 4: Implementatie van de verbetervoorstellen

4.1 Voorbereiding en uitvoer van de werkzaamheden

a) Voorbereiden en uitvoeren van de werkzaamheden volgens standaarden binnen Van Wijnen. Dit zal worden opgepakt door de afdeling Onderhoud & Beheer.

4.2 Meerjaren- onderhoudsplan opstellen

a) Met in achtneming van de toegepaste maatregelen een meerjarenonderhoudsplan (MJOP) opstellen voor het kantoorgebouw.

b) Als gewenst ook het beheer van de het MJOP uitvoeren.

Stap 5: Nieuwe energie-index en energielabel bepalen

5.1 Bepalen wat de energie-index van het gebouw is en het daarmee corresponderende energielabel

a) Met behulp van de VABI EPA-U software de uitgevoerde verbeteringen doorvoeren

b) De nieuwe energie-index bepalen, evenals het nieuwe energielabel en deze opstellen of laten opstellen door een gecertificeerde partner

c) Het nieuwe energielabel aanbieden aan de gebouweigenaar en/of beheerder

UNIVERSITY OF TWENTE.

VAN WIJNEN

Processchema analyse kantoorpand

Handleiding bij processchema voor Van Wijnen

Door: Stephan Hesselink

Datum: 03-06-2019

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Introductie

Dit document dient als leidraad bij het processchema voor de analyse van kantoorpanden. Dit schema is opgesteld gedurende het afstudeeronderzoek van Stephan Hesselink. In dit document wordt per stap van het schema toegelicht wat het doel is, welke procedures er gelden, wat de aandachtspunten zijn en wat de uiteindelijke output van de stap is.

Dit document is iteratief. Verbeteringen aan het model en aan de handleiding zijn daarom welkom.

1. Stap 1: Eerste gesprek met de gebouweigenaar of gebruiker

Stap 1: Eerste gesprek met de gebouweigenaar of -gebruiker

1.1 Achterhalen of het gebouw een energielabel heeft

a) Er is geen label → label is verplicht dus analyse.

b) Het label is D-G → nog geen C, dus analyse

c) Het label is A-C en de gebouweigenaar of gebruiker heeft intentie tot verbeteren → nagaan of er voldoende onderzoek is gedaan en data voorhanden is om de gebouwanalyse over te slaan.

d)Het label is A-C en de gebouweigenaar of gebruiker heeft geen intentie tot verbeteren → geen verdere actie

1.2 Afstemmen vervolgtraject

a) Duidelijk maken welke input nodig is vanuit de eigenaar/gebruiker. (gespecificeerd in "2. analyse van het gebouw")

b) Afspraak inplannen om tijdens locatiebezoek de resterende gebouwdata te verzamelen.

c) Afstemmen wat de wensen en eisen van de eigenaar of gebruiker zijn. Deze worden meegenomen in fase 3 tijdens de afweging om voor bepaalde oplossingen te kiezen

d) Duidelijk maken wat de output is: Het energielabel, een advies met kostenindicatie en een meerjarenonderhoudsplan.

1.1. Doel van deze stap

Het doel van deze stap is allereerst te achterhalen het gebouw al een energielabel heeft. Daarnaast is het doel om af te stemmen wat verwachtingen van beide kanten zijn

1.2. Procedures

Het eerste onderdeel van 1.1 kan op afstand uitgevoegd worden. Als er duidelijkheid is omtrent het label, kunnen tijdens een persoonlijk gesprek de resterende onderdelen van 1.1 en de onderdelen van 1.2 worden behandeld.

1.3. Aandachtspunten

- Zorg dat het duidelijk is dat de output afhangt van de input van de gebouw eigenaar of gebruiker.
- Benoem ook de kosten voor het onderzoek

1.4. Output

- Eventueel huidig energielabel
- Datum voor het locatiebezoek
- Eisen en wensen van de klant

Stap 2: Analyse van het gebouw

2.1 Bepalen wat de gebruikersfuncties en energiesectoren zijn.

a) Input door de eigenaar of gebruiker:

- Bouwtekeningen van het pand
- Tekeningen van de technische installatie(s) van het gebouw
- Als er meerdere functies in het gebouw zitten, specificatie van de functies per vertrek.

b) Stappen voor de adviseur:

- Volgens EPA-U standaarden de gebruikersfunctie(s) van het pand bepalen
- Met de gebruikersfunctie(s) en de installatietekeningen de energiesectoren bepalen

2.2 Bepalen welke installaties per energiesector zijn geïnstalleerd

a) Input door de eigenaar of gebruiker:

- Tekeningen van de technische installatie(s) van het gebouw.
- Specificaties van losse installatiecomponenten.
- Specificatie van de lampen in het gebouw, of eventueel het lichtplan.

b) Stappen voor de adviseur:

- Per energiesector bepalen welke installaties er zijn voor ventilatie, verwarming, bevochtiging, koeling, warm tapwater en zonne-energie.
- Bepalen wat het verbruik (in W/m^2) van de lichtinstallatie per energiesector is en hoe deze geregeld wordt.

2.3 Bepalen uit welke constructieve elementen het gebouw bestaat

a) Input door de eigenaar of gebruiker:

- Bouwtekeningen van het pand
- Indien voorhanden, specificaties van wanden, vloeren, daken, deuren en ramen.

b) Stappen voor de adviseur:

- Per constructief element aan de hand van verkregen input of aan de hand van (ver)bouwjaar bepalen wat de Rc waarde is voor dat specifieke element.

2.4 De resterende gebouwdata verzamelen tijden een locatiebezoek

a) Input door de eigenaar of gebruiker:

- Toegang tot het gebouw en tot de technische installaties
- Medewerking om de benodigde gegevens te achterhalen

b) Stappen voor de adviseur:

- Door de technische installaties of constructieve elementen op locatie te bekijken, de gebouwdata uit 2.2 en 2.3 compleet maken.
- Verifiëren of de data van de aangeleverde tekeningen overeenstemd met de werkelijke situatie.

2.5 Naar wens monitoren van de huidige installaties

a) Input door de eigenaar of gebruiker:

- Toegang tot het gebouw en tot de technische installaties
- Medewerking om de benodigde gegevens te achterhalen

b) Steps for the advisor

- Samen met een installateur nagaan of de installaties nog naar behoren werken.
- BOEI inspectie uitvoeren met de benodigde specialisten.

2.6 Bepalen wat de energie-index van het gebouw is en het daarmee corresponderende energielabel

a) Input door de eigenaar of gebruiker:

- Jaarrekeningen voor gas en elektra.

b) Stappen voor de adviseur:

- De input van 2.1 t/m 2.4 gebruiken om in Vabi EPA-U software de gebouwanalyse te maken.
- De energie-index voor het gebouw bepalen.
- Verbruik van het pand vergelijken met gas en elektra rekeningen.
- Het energielabel voor het gebouw opstellen, of op laten stellen door een gecertificeerde partner.

1.1. Doel van deze stap

Het doel van deze stap is het bepalen van het huidige energielabel van het kantoorpand

1.2. Procedures

- 2.1 t/m 2.3 kan voorafgaand aan het locatiebezoek worden gedaan
- 2.4 moet tijdens het locatie bezoek gedaan worden
- 2.5 kost meer tijd en dit zal met de installateur afgestemd moeten worden

1.3. Aandachtspunten

- Zorg dat het duidelijk is dat goede input zorgt voor snelle goede output. Hoe minder er uitgezocht hoeft te worden, hoe minder tijd en geld het kost.
- Benoem ook de kosten voor het onderzoek
- Goed met de installateur afstemmen welke onderdelen door wie worden opgepakt.
- Als de BOEI meegenomen wordt, de data vroeg afstemmen met alle betrokkenen

1.4. Output

- Niet gecertificeerd energielabel en energie index
- Eventuele analyse van de huidige installaties (uit stap 2.5)
- Data over technische installaties in het gebouw
- Data over de constructieve elementen waar het gebouw uit bestaat

1. Stap 3: Advies maken voor verbeteringen

Stap 3: Advies maken voor verbeteringen

3.1 Installatietechnische verbeteringen bepalen en doorrekenen

a) Per installatie component bepalen of en welke mogelijkheden er zijn tot verbetering. (ventilatie, verwarming, bevochtiging, koeling, warm tapwater, zonne-energie en licht)

b) De mogelijkheden afstemmen met calculators binnen Van Wijnen en indien nodig met onderaannemers. Afstemming op basis van kosten, verbetering van energie-index en de eisen en wensen van de eigenaar of gebruiker.

3.2 Constructieve verbeteringen bepalen en doorrekenen

a) Per constructie component bepalen of en welke mogelijkheden er zijn tot verbetering. (wanden, vloeren, daken, deuren en ramen).

b) De mogelijkheden afstemmen met calculators binnen Van Wijnen en indien nodig met onderaannemers. Afstemming op basis van kosten, verbetering van energie-index en de eisen en wensen van de eigenaar of gebruiker.

3.3 Kosten bepalen

a) Bepalen op welke subsidies aanspraak gemaakt kan worden bij zowel installatietechnische als constructieve verbetervoorstellen.

b) De kosten voor de verbetervoorstellen bepalen inclusief subsidie en door Van Wijnen toegevoegde percentages voor risico's en kosten.

3.4 Werkelijke kosten en terugverdientijd bepalen

a) Op basis van een MJOP bepalen wat de extra kosten zijn voor de toe te passen maatregelen gevonden in 3.1 en 3.2.

b) Op basis van de MJOP bepalen wat de terugverdientijd voor de verschillende maatregelen is.

c) Analyseren wanneer een maatregel economisch gezien het beste toegepast kan worden.

3.5 Compleet advies maken voor het gebouw

a) Adviesrapport opstellen met:

- Begeleidende brief.
- Het energielabel bepaald in 2.6
- Set met verbetervoorstellen die voldoen aan de wensen en eisen van de gebouw eigenaar of begruiker, inclusief kosten en terugverdientijd op basis van de MJOP
- Overige verbetervoorstellen zowel installatietechnisch als constructief.

3.6 Het advies aanbieden aan de gebouw eigenaar of gebruiker

a) Het adviesrapport aanbieden aan de gebouweigenaar of beheerder en toelichten. Hierbij met de eigenaar of beheerder afstemmen welkestappen er genomen worden richting de implementatie van de verbetervoorstellen.

- Als de eigenaar of beheerder over wilt gaan tot implementatie, afstemmen welke stappen er genomen gaan worden en wat de planning is.
- Als de eigenaar of beheerder **niet** verder wil met de verbetervoorstellen, afstemmen of Van Wijnen verder nog iets kan betekenen.

1.1. Doel van deze stap

Het doel van deze stap is het aanbieden van een maatwerkadvies aan de klant, waarin duidelijk wordt welke maatregelen hij het beste kan toepassen. Dit wordt onderbouwd door kostenberekeningen inclusief subsidies en terugverdientijden.

1.2. Procedures

- 3.1 Moet worden afgestemd met de installateur
- 3.2 Moet opgepakt worden binnen Van Wijnen
- 3.4 Hiervoor is ook de input van de installateur nodig om een goede berekening te kunnen doen.
- Voor de aanbieding, afstemming tussen Van Wijnen en de installateur om te weten wat er aangeboden wordt.

1.3. Aandachtspunten

- Goede afstemming met de installateur om samen tot een aanbieding te komen
- Benoem ook de kosten voor het onderzoek
- Let tijdens de afweging ook op de eisen en wensen zoals aangegeven in het intakegesprek.

1.4. Output

- Set met verbetermaatregelen inclusief kosten en terugverdientijden
- Kosten en terugverdientijden op basis de MJOP
- Compleet pakket met advies zoals opgesteld in 3.5
- Eventueel de planning voor implementatie

1. Stap 4: Implementatie van de verbetervoorstellen

Stap 4: Implementatie van de verbetervoorstellen

4.1 Voorbereiding en uitvoer van de werkzaamheden

a) Voorbereiden en uitvoeren van de werkzaamheden volgens standaarden binnen Van Wijnen. Dit zal worden opgepakt door de afdeling Onderhoud & Beheer.

4.2 Meerjaren- onderhoudsplan opstellen

a) Met in achtneming van de toegepaste maatregelen een meerjarenonderhoudsplan (MJOP) opstellen voor het kantoorgebouw.

b) Als gewenst ook het beheer van de het MJOP uitvoeren.

1.1. Doel van deze stap

Het doel van deze stap is het uitvoeren van de afgesproken verbetervoorstellen.

1.2. Procedures

- Uitgevoerd volgens procedures van O&B.
-
-

1.3. Aandachtspunten

- Nog aan te vullen in dit document want het was geen onderdeel van het afstudeeronderzoek
-
-

1.4. Output

- Een soepel uitvoeringsproces
-

1. Stap 5: Nieuwe energie-index en energielabel bepalen

Stap 5: Nieuwe energie-index en energielabel bepalen

5.1 Bepalen wat de energie-index van het gebouw is en het daarmee corresponderende energielabel

a) Met behulp van de VABI EPA-U software de uitgevoerde verbeteringen doorvoeren

b) De nieuwe energie-index bepalen, evenals het nieuwe energielabel en deze opstellen of laten opstellen door een gecertificeerde partner

c) Het nieuwe energielabel aanbieden aan de gebouweigenaar en/of beheerder

1.1. Doel van deze stap

Het doel van deze stap is het opstellen en verkrijgen van een rechtsgeldig energielabel.

1.2. Procedures

- Aanpassen van het VABI EPA-U model met de nieuwe verbeterde componenten
- Tijdens een persoonlijk gesprek het nieuwe energielabel overhandigen.

1.3. Aandachtspunten

- Zorg voor goed contact met de gecertificeerde partij die mag labelen
- Probeer zo goed mogelijk het model van Van Wijnen te laten aansluiten op het model dat de gecertificeerde partij gebruikt.

1.4. Output

- Een officieel energielabel
- Een tevreden klant