Preservation of the existing housing stock of housing associations

A case study for Woonbedrijf about organization models for implementation

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Date of final presentation:	May 27, 2013

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Preface

Hereby I present you my graduation thesis for the completion of the master course Construction Management & Urban Development at the Eindhoven University of Technology. Driven by the upcoming energy transition, sustainability and renewable energy where important subjects during the master course. Here, renewable energy got my special interest because of its potential to offer double benefits whereby financial and environmental benefits can be achieved at the same time. Furthermore, the energy transition will affect all of us and I hope that my research will contribute to the transition towards clean generated energy.

During the first months of this research, it was quite a challenge to understand the workfield of housing associations. Housing associations were completely unknown to me and it took me some time to understand their social tasks within a complex legal framework. After consulting a lot of internal and external experts, the workfield became clearer to me and the complex legal and financial framework challenged me to find the best solution.

I would like to thank all the people from Woonbedrijf, who have helped me during this study. A special thank you to Rob Bogaarts for the pleasant collaboration and the personal support during the project. I would also like to thank my supervisors Bauke de Vries, Brano Glumac and Bart van Weenen from the TU/e for their advice and feedback on my thesis.

Finally, I would like to thank my parents for giving me the opportunity to study and my friends for the welcome distractions during my graduation period.

This research has triggered my enthousiasm for sustainability and renewable energy tremendously. Hopefully, other people get inspired from this research and are motivated to use it in practice.

I hope you will enjoy reading this thesis,

Falco van den Aker
Roermond, May 2013.

Management summary

In the next fifteen years, some major changes will take place in the global energy field driven by increasing energy demand and declining stocks of fossil fuels. These developments will lead to further increasing energy prices causing a new situation called *energy poverty* where households are no longer able to pay their energy costs. Especially low-income households suffer from it. These types of households form the target group of housing associations in the Netherlands. Housing associations feel more and more responsible for the total housing expenses of their tenants. A possible strategy to fight these rising energy costs is to generate energy from renewable sources. This is not easy for housing associations because investments in renewable energy are often expensive and the constantly changing legal framework raises more questions than answers. Housing associations are therefore searching for organization structures that can be applied for investments in renewable energy within their specific discipline and legal framework. In this research, a case study called the Airey Neighbourhood provided by Woonbedrijf will be used to study organization models for preservation.

In order to generate a set of alternatives to assess against the case study, a literature study has been conducted whereby the legal framework, financing possibilities and organization structures have been studied. In general, three parties can play a rol in this type of projects, namely the housing association, the tenants and/or external companies. Depending on who is investing, there are several financing possibilities, payback options and organization structures available. Figure 13 on page 25 gives a summary and overview of all the possibilities. The 15 generated alternatives are shown in figure 14 on page 26.

In the second part of the research, the generated alternatives are assessed against the Airey neighbourhood case study for the scenario wherein 15 m2 of PV panels will be installed on all of the 226 dwellings. In order to make an objective selection, a two-step research structure has been applied wherein firstly the financial consequences for the tenants (client value) and the investor (company value) have been assessed and secondly the best alternative has been selected with the use of the Analytic Hierarchy Process (AHP).

The *client value* and *company value* were calculated with the use of a financial calculation model. The results showed that 13 alternatives have a positive *client value* which means that the tenants have financial benefits of up to € 90 per year as a result of the PV panels. This proves that investments in PV panels offer viable business cases and that renewable energy is able to compete with conventional energy. As a final step, AHP has been used in order to choose the best organization structure out of the 13 remaining alternatives. The data has been collected with the help of a questionnaire and short interviews with 13 managers from Woonbedrijf.

The organization structure where the tenants collectively participate in an energy cooperative turned out to be the most preferred alternative according to the AHP and sensitivity analysis. This structure is showed in figure 39 on page 54. In addition, an alternative organization structure has been developed wherein the essence of the energy cooperative and the possibility to kick-start the project by Woonbedrijf are combined (Figure 40, page 55).

1 Introduction

In the next fifteen years, some major changes will take place in the global energy field driven by two major developments. First, worldwide energy demand continues to rise especially because of the economical growth in the (former) developing countries. And second, the stocks of fossil fuels are declining rapidly whereby a large part of the remaining stock is located in politically unstable countries (Weevers, 2012).

These developments will lead to further increasing energy prices since an increase in demand from emerging economies and simultaneously decreasing stocks stimulate a market driven rise of prices. In the past years, the energy costs for households have risen considerably. Only electricity prices have already rose annually with an average of 5,2% over the past 10 years (Agentschap NL, 2012). The rising energy prices are mainly responsible for the increasing housing costs (rent/mortgage + energy expenses) of households where especially low-income households suffer from it. Low-income households often live in energetically poorer rental dwellings causing that the energy expenses of these households are often equal to their rental costs. This triggers a new situation called *energy poverty* where households are no longer able to pay their energy costs. According to NIBUD (2009) one particular group of the population is most at risk namely, households with a disposable income in the bottom 20% of incomes in the Netherlands and less educated people.

These types of households form the target group of housing associations in the Netherlands. Housing associations play a central role in the Dutch housing market since they own 2,4 million dwellings resulting in a market share of 31,5% on the total housing market and a market share of 85% on the rental market (AEDES, 2011). Their main task is to build, manage and rent social housing and social real estate. In the view of the rising energy costs, housing associations feel more and more responsible for the total housing expenses of their tenants. A possible strategy to fight these rising energy costs is to generate energy from renewable sources in order to create immunity for the constantly rising prices. This is not easy for housing associations because investments in renewable energy are often expensive and the constantly changing legal framework raises more questions than answers. Housing associations are therefore searching for organization structures that can be applied for investments in renewable energy within their specific discipline and legal framework.

One of these housing associations is Woonbedrijf from Eindhoven (NL). With an ownership of more than 30.000 rental units is Woonbedrijf by far the largest housing association in Eindhoven. Given their significant size and progressive sustainable policy, Woonbedrijf aims to play a leading role in the preservation of Eindhoven towards their goal to be energy neutral in 2045. Woonbedrijf makes their sustainable policy operational with the use of pilot projects in which they assess the usability, applicability and affordability of renewable techniques before they are applied to all their possessions. As a starting point, they have defined one neighbourhood as a pilot project, namely the Airey neighbourhood in Gestel (Eindhoven). Based on former research conducted by Victor de Vrede (Vrede de, 2012), Woonbedrijf already has a clear picture of sustainable techniques that can be applied for the preservation of the Airey Neighbourhood. However, the way of organizing and financing this kind of projects raises a lot of questions. Therefore, the following problem has been defined:

A lot of research has been conducted about techniques for the preservation of existing dwellings, but it is not clear to housing associations how the implementation of these techniques can be organized and financed!

1.1 Research questions and goal

The following research questions have been formulated in order to provide an answer to the defined problem.

Research question 1:
What aspects and developments regarding the preservation of existing housing stocks for housing associations are described in literature?

- *RQ 1.1: What are the legal concerns for housing associations when sustainable measures are implemented?*
- *RQ 1.2: What kind of possibilities are available for housing associations to finance the implementation of sustainable measures in their neighbourhoods?*
- *RQ 1.3: What kind of organization structures are available for housing associations to implement sustainable measures?*

Research question 2:
How can the preservation of the existing housing stock successfully be implemented in the Airey neighbourhood taking into account technical, organizational, legal and financial aspects?

- *RQ 2.1: What kind of organization has to be established in order to deal with the costs and benefits arising from the sustainable measures?*

Research goal
Formulating an advice on which Woonbedrijf can practically implement an energy preservation concept in the Airey neighbourhood in Genderdal.

1.2 Research boundaries

Given the limited timeframe of the research, the following research boundaries have been formulated:

- The research will focus on the existing housing stocks of housing associations;
- The Airey neighbourhood will be used as a case study;
- Only investments in renewable electricity in the form of PV panels will be taken into account according to Woonbedrijf's investment strategy;
- The research focuses on land-based dwellings.

1.3 Research design

In order to answer the research questions, the following research structure has been designed (Figure 1). First a literature study will be conducted to get an overview of the legal framework, the financing possibilities and the possible organization structures. The findings of the literature study will be used to generate a set of alternatives that can be assessed

against the Airey neighbourhood. The second part of the research consists of two steps in which the alternatives are objectively compared against each other based on real data of the Airey neighbourhood. In the first step, a financial calculation model will be used to calculate the financial consequences for the tenants (client value) and for the investor (company value). Only alternatives with positive client values will be further elaborated in step two which is the AHP analysis. The Analytic Hierarchy Process (AHP) will be used to choose the best organization structure for the Airey neighbourhood.

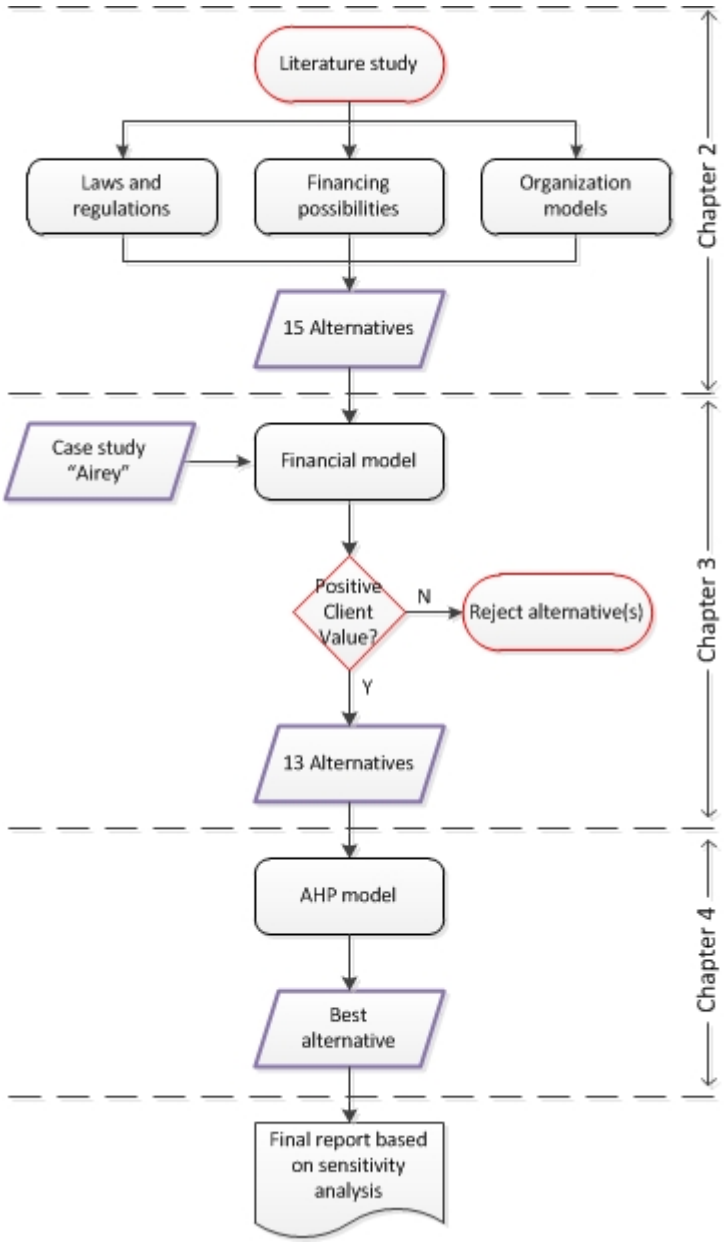

Figure 1: Research structure

1.4 Relevance of the research

This research will be relevant for the following parties:

TU/e: this research is relevant in the context of the master Construction Management & Engineering. This research combines one of the programs' key subjects *sustainability* with a business approach in order to generate viable business cases with renewable energy;

Woonbedrijf: Woonbedrijf can use this study as a tool to support the decision-making with regard to organization structures for sustainability. Furthermore they can use the financial model to calculate the financial consequences for other neighbourhoods.

Municipality of Eindhoven: the municipality could use the research as support tool for their collective agreements between all the housing associations in Eindhoven.

Other companies: companies can use the research as an input for the development of specific business cases for housing associations. Housing associations offer a giant market for sustainable initiatives given their huge amount of rental units, but ambiguities about the legal framework often withhold companies to enter this market. This research may remove some of these barriers.

1.5 Reading guide

This research consists of two parts. The first part (chapter 2) covers the possibilities to organize the preservation of existing housing stocks where the legal framework (2.1), the financing possibilities (2.2) and the organization structures (2.3) will be further elaborated. The second part consists of a case study where the best organization structure will be selected based on the results of a financial model (chapter 3) and an AHP analysis (chapter 4). The final conclusions can be found in chapter 5 followed by the references and the appendices.

2 Housing associations and sustainability: aspects and developments regarding the preservation of existing housing stocks

In order to get an overview of the possibilities to organize the preservation of existing housing stocks, a literature study has been conducted based on the following key subjects 1) the legal framework will be described to create a solution space, 2) the financing possibilities will be elaborated followed by 3) the organization structures. In the final part of this chapter the three subjects will be combined in order to generate a set of alternatives that can be assessed against the case study.

2.1 Legal framework

Acts are important subjects to study because these form the context in which solutions can be sought. This part considers relevant acts in order to answer research question 1.1: *What are the legal concerns for housing associations when sustainable measures are implemented?*

There are two key acts regarding sustainable electrical measures for housing associations, namely the Housing Act and the Electricity Act. The Housing Act is in the middle of a renewal process and is important in terms of organization structures. The new Housing Act, which is expected to be introduced in 2014, does not exclude alternatives, but provides specific regulations for some structures like connections with external entities.

The Electricity act regulates the prices and taxes that have to be paid for electricity usage. This is important for the development of renewable electricity based business cases because the exemption of energy taxes can make the difference between a viable and a non-viable business case.

Both acts do not exclude alternatives for this research. They only provide specific rules for some individual alternatives. A more detailed description of the acts and the consequences for housing associations can be found in appendix 1.

2.2 Financing sustainable measures

This part considers multiple financing possibilities in order to answer research question 1.2: *What kind of possibilities are available for housing associations to finance the implementation of sustainable measures in their neighbourhoods?*

Several financing sources will be elaborated followed by payback options, available grants and fiscal arrangements.

2.2.1 Financing possibilities

Since the market for sustainable energy is emerging, more and more parties are entering the market offering a broad spectrum of services ranging from single services like financing or customer support up to full package services including financing and exploitation. When financing options are considered it is important to know which party is going to invest in the project. According to Atrive (2012), the following parties could play a role in the implementation of sustainable measures in the social housing sector, namely the housing association (Woonbedrijf), the tenants and external companies. In the following paragraphs, the financing possibilities for these three parties will be described.

2.2.1.1 Equity capital

The first option is to finance the project with equity capital. Woonbedrijf generates income by executing their social and commercial activities and they can use their equity capital to invest in sustainable measures. Also external companies and tenants may have access to equity capital as a financing source. However, the use of equity capital is not always preferred because this kind of investments involve high initial costs that burden the investment budget. The use of equity capital to invest in sustainable measures causes less internal funds to execute other tasks.

2.2.1.2 Secured loan (only available for housing associations)

Most of the investment activities conducted by housing associations are financed using secured loans. Housing associations are united in the Waarborgfonds Sociale Woningbouw (WSW). They can establish cheaper loans against favourable conditions via the WSW for investments in social housing and social real estate. The guarantee structure of the WSW provides security towards financiers resulting in a lower interest rate for the investment (WSW, 2013). This advantage in interest rate can be used for extra investments in for instance housing quality and neighbourhood-oriented activities.

Secured loans can be only obtained for investments where the public interest is served. These so called Diensten van Algemeen Economisch Belang (DAEB) relate to tasks that are assigned to housing associations by the Dutch government. DAEB-financing is available for the development of dwellings with a maximum monthly rent of € 681,02 (price level 2013). This is the housing benefit limit (huursubsidie grens). At least 90% of these dwellings should be allocated to households with an income below € 34.229 (price level 2013). DAEB-financing is also available for the development of social real estate like community centres, social workplaces or care facilities (Rijksoverheid, 2013). DAEB-financing can only be applied for investments within the authorized institution (toegelaten instelling).

When it comes to energy saving measures, the WSW has defined some rules about the use of secured loans. Investments in heat and cold storage systems can only be financed when the installation is fully owned by the housing association and if the system is an indivisible part of the guaranteed dwelling. Furthermore it is important to make a distinction between the initial investment in a sustainable system and the exploitation of the system. According to the temporary regulation of the European Commission (EC), investments with secured loans in sustainable measures like renewable energy systems are allowed for DAEB-dwellings. However, the exploitation of sustainable measures and/or supplying renewable energy to tenants is not eligible for DAEB-financing (Atrive, 2012; VBTM Advocaten, 2012).

2.2.1.3 Commercial loan

When investments are related to not-DAEB properties like dwellings with a monthly rental price above the housing benefit limit or commercial real estate, housing associations cannot make use of secured loans. This also applies to investments outside the authorized institution such as separate entities/companies owned by the housing association. In these cases they have to use commercial financing for their investment like a commercial loan with a bank. External companies are automatically appointed to commercial loans given their intention to make profit.

Banks provide this kind of funding on project level. Due to the absence of the WSW guarantee structure, banks will assess the project as a business case based on a business plan and future cash flows. The financial position of the housing association or external company will also be verified and a higher interest rate has to be paid to cover the risks. In contrast to secured loans, this type of financing involves a more complex and longer process that is more labour-intensive. The association has to give guarantees in the form of mortgage securities or the pledge of rental incomes. Both existing (not-DAEB) dwellings, as newly built dwellings and even specific installations like thermal storage systems can be used as security towards banks (Agentschap NL, 2012).

The commercial approach of banks could cause difficulties for investments in renewable energy techniques because not every technique will be (directly) profitable. In these cases, financing requests will be rejected or only partially granted. The investment request should have a sufficient size (€ 0,5 – 1,0 million) because of the high transaction costs en lengthy process (Atrive, 2012).

Commercial loans are also available for individual tenants. Instead of project based financing banks will verify the financial position of the tenant in order to grant a loan.

2.2.1.4 Green loan

Green loans are special loans offered by some banks for investments in sustainable measures. The green loan structure has been created by the Dutch government to support projects that have a positive impact on the environment. Several banks established green funds in which investors and depositors could invest their money. Green funds offer lower interest rates for their investors, but the government offers them fiscal benefits in return. The lower interest rate is then used by the banks to support green projects with green loans.

A financing request for a project has to meet certain conditions in order to obtain a green declaration. Approved projects are eligible for a green loan which means that they will get a discount on the interest rate.

However, the green loan structure has been toned down the last few years as a result of the financial crisis and changes in the political landscape. The government decided to bring the fiscal benefits gradually back to 0% in 2014. Some banks with green funds no longer accept new investment requests for green projects anymore. A few other banks are still offering green loans with a maximum discount of 0,7% on the interest rate (Atrive, 2012).

2.2.1.5 Lease constructions

Lease constructions can be considered as an alternative to commercial loans. Within a lease construction there is a “lessor” and a “lessee”. The lessor, usually a bank, finances the investment and obtains the legal and/or economic ownership of the property. The lessee (Woonbedrijf, external company, tenant) obtains the right to use the property and pays a fixed fee to the lessor.

Investments eligible for leasing are sustainable investments outside de shell of the house or specific installations like thermal storage systems, PV panels or solar heaters. Both individual

as collective systems are eligible. Leasing enables lessee's to invest in sustainability without a direct cash out in the beginning of a project (Atrive, 2012). Lease constructions can be distinguished into financial lease and operational lease.

Financial lease
With financial leasing, the economic ownership remains at the lessee. This means that the lessee has to include the property on the balance sheet and that he has to take care off maintenance and insurance of the property. The risk for the lessor is more than normal economic depreciation, for example due to poor maintenance (Duijvestijn, 2012).

Operational lease
With operational leasing, the legal and economic ownership remains at the lessor. The lessor is responsible for the maintenance and insurance. The lessee will only get the advantages of the measure and does not have to include the property on the balance sheet.

2.2.1.6 Revolving fund

Revolving funds are tools used by provinces and municipalities to finance sustainable measures. In order to establish a revolving fund, a starting capital is needed to provide loans for investments in sustainability. This kind of funds maintain itself since interest and repayment of the loans flow back in the fund in order to become available for new investments. In this way the lender can use the same money over and over again.

Revolving funds can also be used as guarantee funds in which guarantees for a certain investment are given towards financiers.

At this time there are no examples of revolving funds available for housing associations or external companies. Revolving funds are currently only available for private individual investors and homeowners (Agentschap NL, 2012).

2.2.1.7 Linking financing possibilities to possible investors

The previous paragraphs described the financing possibilities for housing associations, external companies and individual tenants. Since not every source of financing is available for every involved party, the different financing options are combined with the availability for the different parties in the table below (table 1).

Financing type	Housing Association	External Company	Tenant(s)
Equity capital	✔	✔	✔
Secured loan	✔		
Commercial loan	✔	✔	✔
Green loan	✔	✔	✔
Lease construction	✔	✔	✔
Revolving fund			✔

Table 1: Financing possibilities for different parties

2.2.2 Payback options

Investments in sustainable measures are usually associated with significant amounts of money. In order to create a sound business case for sustainable investments, the following payback options are available to settle the investment with the tenants.

2.2.2.1 Increase in rent (only available for housing associations)

In case the housing association invests in the sustainable measures and also takes care of the exploitation within their own organization (authorized institution), they have two options to charge their tenants for the investment. First they the option to increase the rent for current tenants directly after the sustainable measures have been implemented and second they have the option to keep the rent equal at first and increase the rent for new tenants.

The main advantage of this approach is the fact that the relatively cheaper DAEB-financing is available for investments in social housing. However, the new rental price of the dwelling has to be taken into account in the context of housing benefit limit (huursubsidie grens). When there is enough space for the investment in the rental price, the tenants could have an additional advantage of increased rent subsidy (huurtoeslag) while their energy bill decreases.

Approval of the tenants

When the housing association wants to increase the rent for current tenants directly after implementation, they need approval of the individual tenants. If at least 70% of the tenants approve a rent increase on district level it is possible for the housing association to oblige all tenants within a neighbourhood to participate.

The housing association does not need approval of new tenants since they have the choice to accept or reject the new dwelling based on the new conditions.

2.2.2.2 Separate invoice

The second option should be applied when the housing association invests and operates using a separate entity like an Energy LLC (Energie BV). It is not allowed to include the energy services of an Energy LLC in the rental price for the tenants. The Energy LLC acts like standalone company and therefore has to send a separate invoice for their energy services towards the tenants. External companies that deliver energy services to tenants are also designated to sending a separate invoice for their services.

2.2.3 Grants and fiscal arrangements

In addition to the financing possibilities as described above, grants and fiscal arrangements can also be deployed in order to increase the fundability of investments in sustainability. There are several arrangements available initiated by the Dutch Government to stimulate investments in sustainability and renewable energy. The two main arrangements available for housing associations and companies are the Energy Invesment Allowance and the Renewable Energy Production Incentive. Because these arrangements only increase the fundability of sustainable projects but do not exclude alternatives for this research, the arrangements are further elaborated in appendix 2.

2.3 Organizational structures

Choosing the right organization structure is an important step in the preservation of the existing housing stock. Questions like: "*Who invests in the project? Who bears the risks? Who takes care of the exploitation? Outsourcing or do it yourself? What are the benefits for the housing association, external companies and the tenants?*" come together within the organization structure.

This part gives an overview of several possible organization structures in order to answer research question 1.3: *What kind of organization structures are available for housing associations to implement sustainable measures?*

The organization structures are a combination of financing possibilities (2.1) and payback options (2.1) within the legal framework (2.1) whereby a distinction has been made based on which party is going to invest in the project. The organization structures are divided into the following groups:

1. Housing association invests (2.3.1)
2. External company invests (2.3.2)
3. Tenant invests (2.3.3)
4. Hybrid organization structures (2.3.4)

2.3.1 Housing association invests

This section describes the possible organization structures in case the housing association invests in sustainable measures.

2.3.1.1 Housing association invests within the current organization

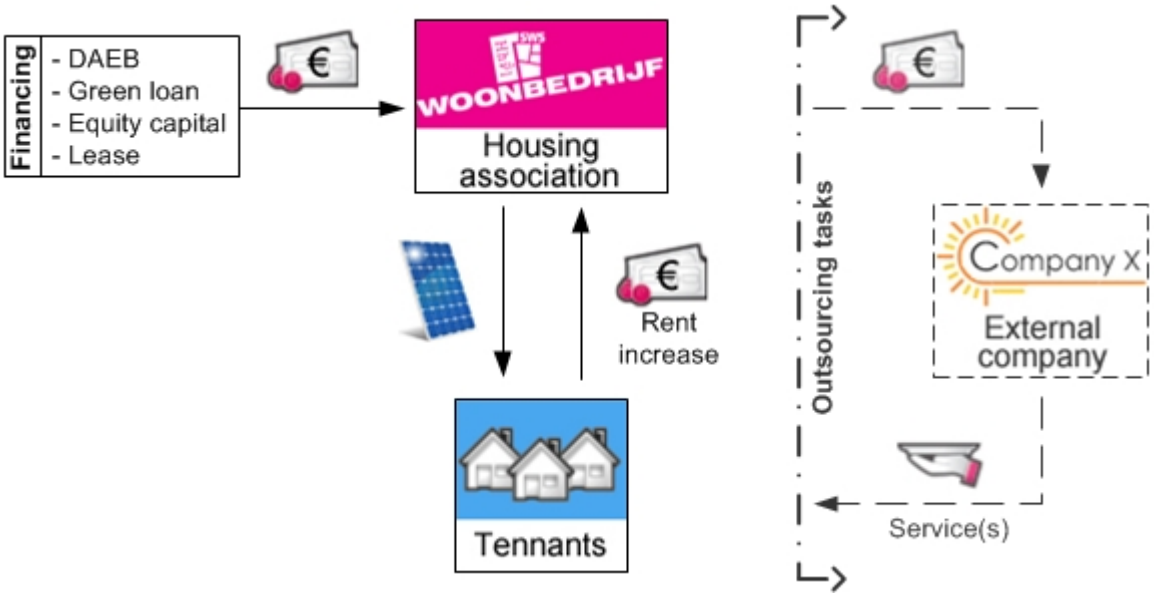

Figure 2: Housing association invests within the current organization

Figure 2 shows the organization structure where the housing association invests in sustainable measures and takes care of the exploitation. The investment is recouped through an increase in rent. DAEB-financing is available for dwellings with a rental price below the housing benefit limit. In this way the housing association keeps control of the

tenant's energy bill. Opportunities that may arise due to rising energy prices will go to the housing association. Tasks like invoicing and exploitation could possibly be outsourced to external parties.

Dwellings with a rental price against or across the housing benefit limit cannot be developed with this organization structure. This means that this structure can only be applied on a project basis for dwellings with enough space within the rental price. This structure can therefore not be uniformly applied across the entire housing stock of the housing association. The housing association bears the risks for the exploitation and it is not possible to sell, divest or transfer the energy services in the future because the whole organization structure is embedded in the main organization of the association.

Incorporating energy services within the rental price could lead to an unclear administration with no clear distinction between energy related costs and housing related costs. The housing association has to expand their knowledge about energy services and should possibly hire new people for this particular subject. The housing association also has to be aware of their double role as supplier of energy and housing services. Discussions with tenants about their energy bills are directly linked to the housing association. The development of energy services within the current organization of the association will be considered as ancillary service for VAT in relation to their primary service (rental housing) which is exempt from VAT. Therefore VAT cannot be deducted on the investment.

2.3.1.2 Housing association invests through a separate entity (Energy LLC)

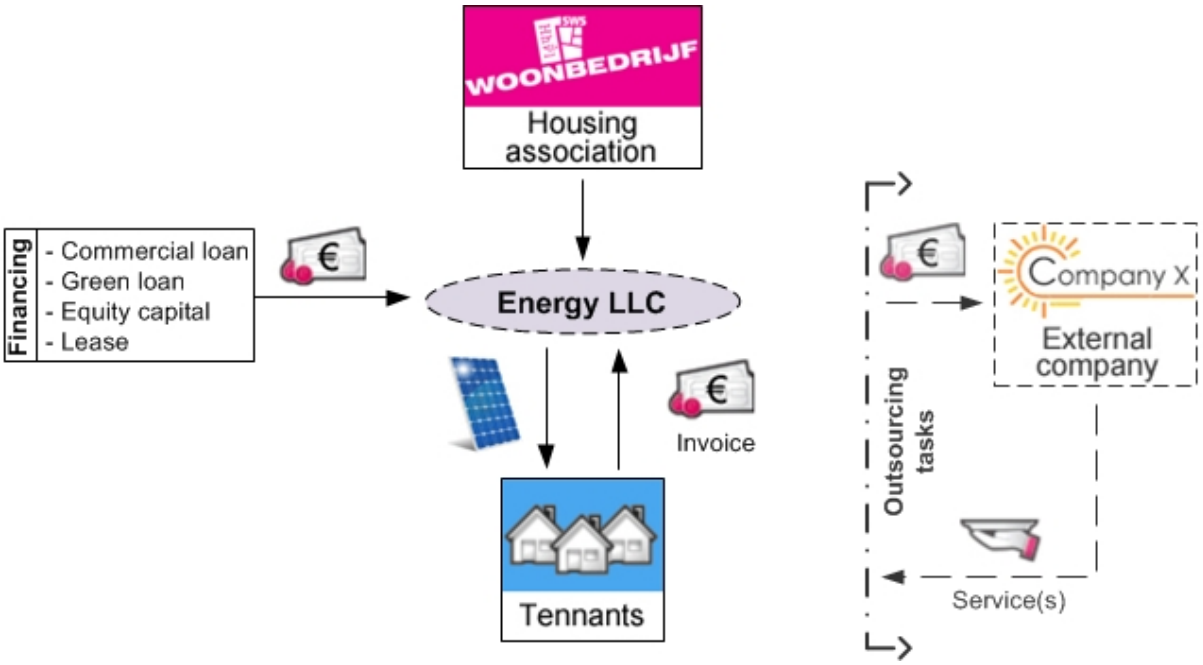

Figure 3: Housing association invests through a separate entity (Energy LLC)

Figure 3 shows the organization structure where the housing association takes care of the investment and the exploitation through a separate entity like an Energy LLC (Energie BV). The Energy LLC will be seen as a standalone company and it is therefore not allowed to recoup the investment through an increase in rent. The Energy LLC has to establish its own administration in order to send separate invoices for their energy services towards the

tenants. These separate invoices for energy services ensure a sound separate administration between housing and energy services for the association in the context of the new Housing Act.

The investment has to be financed commercially (higher financing costs) or with equity capital. The Energy LLC can make use of tax advantages and VAT can be deducted on the investment. The housing association keeps indirectly control of the tenant's energy bill and opportunities that may arise due to rising energy prices will go to the housing association. This structure allows the housing association to sell, divest or transfer the energy services in the future towards external parties like companies or energy cooperatives.

As an investor and operator, the housing association bears all the risks of the project. Therefore it is necessary to expand their knowledge about energy services. The housing association also has to be aware of their double role as supplier of energy and housing services. Discussions with tenants about their energy bills are indirectly linked to the housing association. Tasks like invoicing and exploitation could possibly be outsourced to external parties.

According to the new Housing Act, the Energy LLC requires an independent board and the establishment of the entity has to be approved by the new supervisory authority (FAW).

2.3.1.3 Housing association invests through a separate entity (Energy LLC) using a direct loan

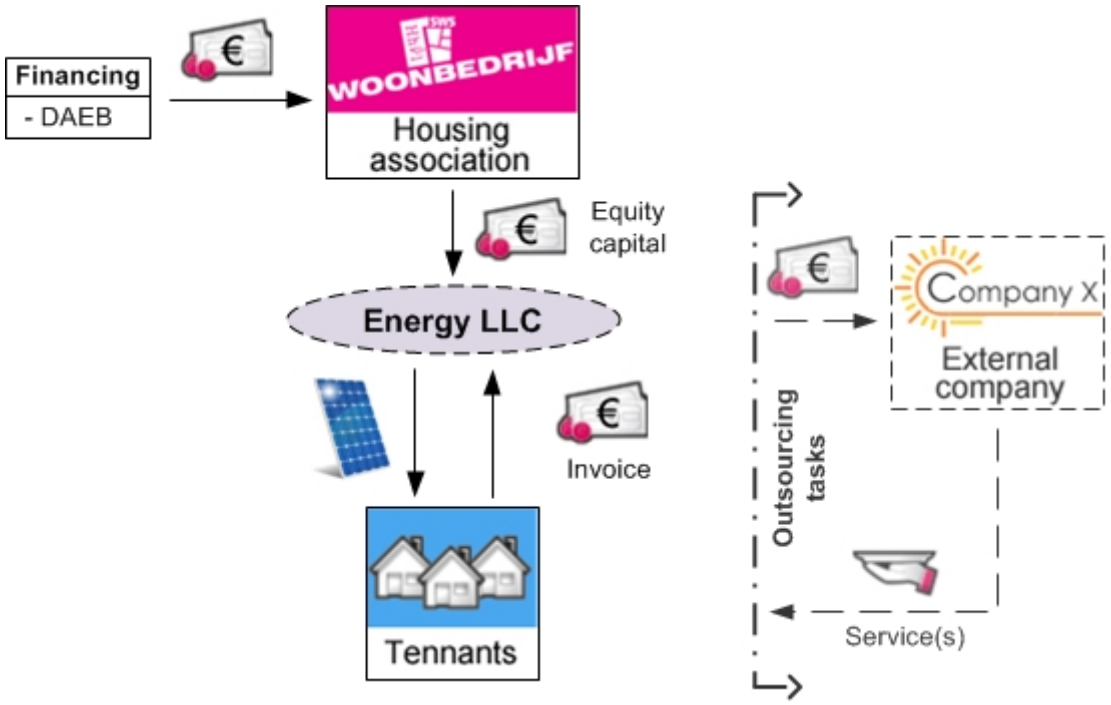

Figure 4: Housing association invests through a separate entity (Energy LLC) using a direct loan

This organization structure (Figure 4) can be considered as an alternative to the previous structure. All the characteristics are the same except the financing part. In this structure, the housing association provides a direct loan to the Energy LLC. Since the housing association is usually fully financed with DAEB-financing (lower financing costs), the Energy LLC could

benefit indirectly from this cheaper financing through a direct loan from the housing association.

According to the new Housing Act, the housing association has to comply with some asset criteria. The housing association is allowed to invest up to 15% of the balance sheet total into separate entities.

2.3.2 External company invests

This section describes the possible organization structures where an external company invests in sustainable measures. Here a distinction has been made between energy suppliers and other external companies like installation firms, contractors, specialized sustainability companies etc.

2.3.2.1 External company (energy supplier) invests

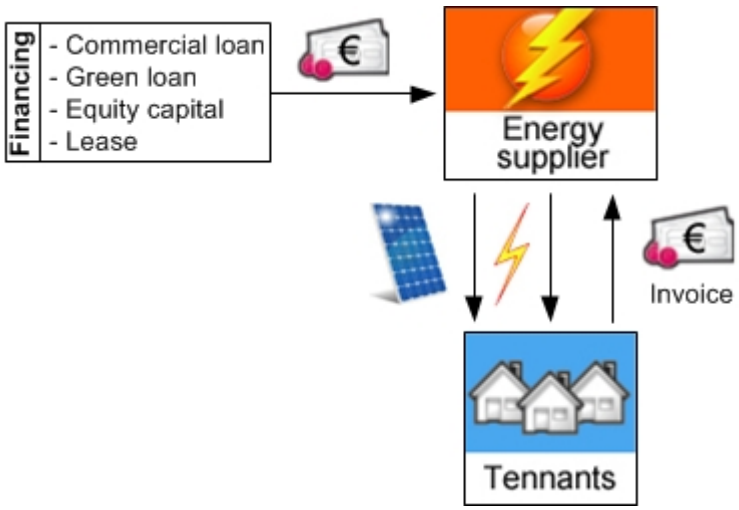

Figure 5: External company (energy supplier) invests

Figure 5 shows the organization structure where an energy supplier invests in sustainable measures and takes care of the exploitation. The housing association will not participate in the delivery of energy services and can therefore focus on their primary task (rental housing). Discussions about the energy bill have to be solved by the energy supplier.

The tenants receive a combined invoice from the energy supplier for both the sustainable measures as well as for the remaining purchased energy. Important characteristic of this organization structure is that the tenants are obliged to buy their remaining energy at this specific energy supplier. Here the principle of forced trading (gedwongen winkelnering) will be applied. The housing association will have to consider if they want to force their tenants to buy their energy from a particular energy supplier.

As an investor and operator, the energy supplier bears all the risks for the project. However, opportunities that may arise due to rising energy prices will go to the energy supplier as well. Given the goal to make a profit on the project, the costs will be higher which leads to lower benefits for the tenants. The housing association has therefore no direct control over their tenant's energy bill. Because the energy supplier does not own the property, the

housing association has to approve the installation of the measures by granting surface rights (recht van opstal).

2.3.2.2 External company invests

In this paragraph external companies other than energy suppliers are considered like installation firms, contractors, specialized sustainability companies etc.

Figure 6 shows the organization structure where an external company invests in sustainable measures and takes care of the exploitation. The housing association will not participate in the delivery of energy services and can therefore focus on their primary task (rental housing). Discussions about the energy bill have to be solved by the external party. The external company can make use of fiscal arrangements like EIA and VAT can be deducted on the investment. It is more complicated to sell, divest or transfer the energy services of a specific project in the future because the whole organization structure is embedded into the main organization of the company. Since the external company does not own the property, the housing association has to approve the installation of the measures by granting surface rights (recht van opstal).

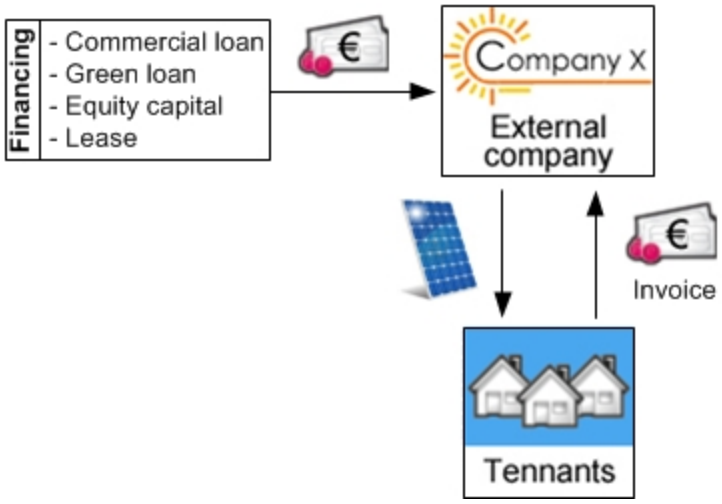

Figure 6: External company invests

The tenants receive an invoice for the delivered energy services. In contrast to the previous structure, the tenants are free to choose their energy supplier. As an investor and operator, the energy supplier bears all the risks for the project. However, opportunities that may arise due to rising energy prices will go to the energy supplier as well. Given the goal to make a profit on the project, the costs will be higher which leads to lower benefits for the tenants. In this way, the housing association has no direct control over their tenant's energy bill.

2.3.2.3 External company invests through a separate entity (Energy LLC)

Figure 7 shows the organization structure where an external company takes care of the investment and the exploitation through a separate entity like an Energy LLC (Energie BV). The characteristics of this structure are largely similar to the previous structure except the possibility to sell, divest or transfer the energy services.

The advantage of this structure is that since the energy services for a project have been placed into a separate entity, it is easier to sell, divest or transfer the energy services in the future towards other companies or energy cooperatives.

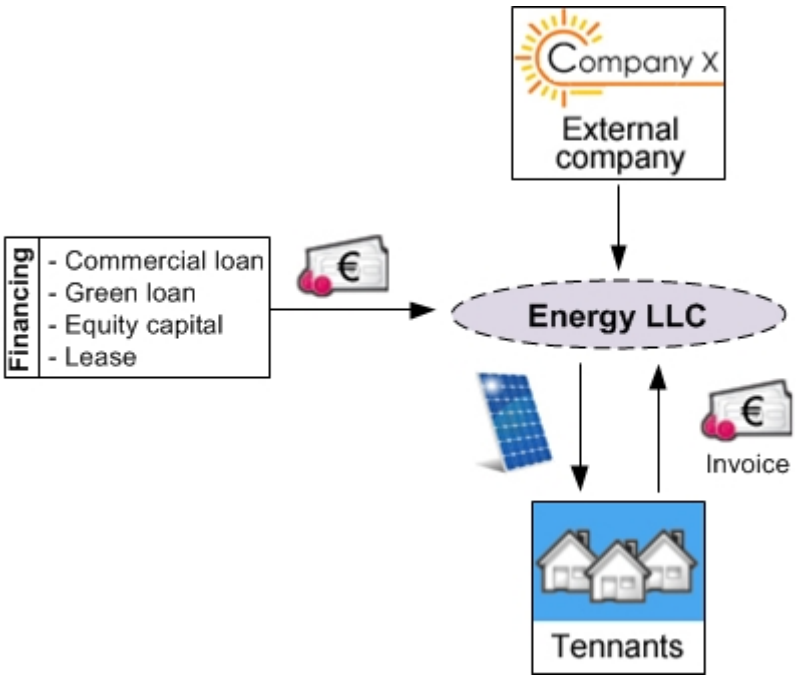

Figure 7: External company invests through a separate entity (Energy LLC)

2.3.2.4 *External company invests (customer service and invoicing via housing association)*

This organization structure (Figure 8) can be considered as an alternative to the structure described in section 2.3.2.2. All the characteristics are the same except the invoicing part. Housing associations can choose to be the first point of contact to their tenants for energy related services. In this way an external company takes care of the investment and exploitation where the housing association acts as an intermediary between the company and the tenants. It is easier for the tenants to have one single contact but it also has a downside for the housing association. Discussions with the tenants about their energy bills are in this way directly linked to the housing association.

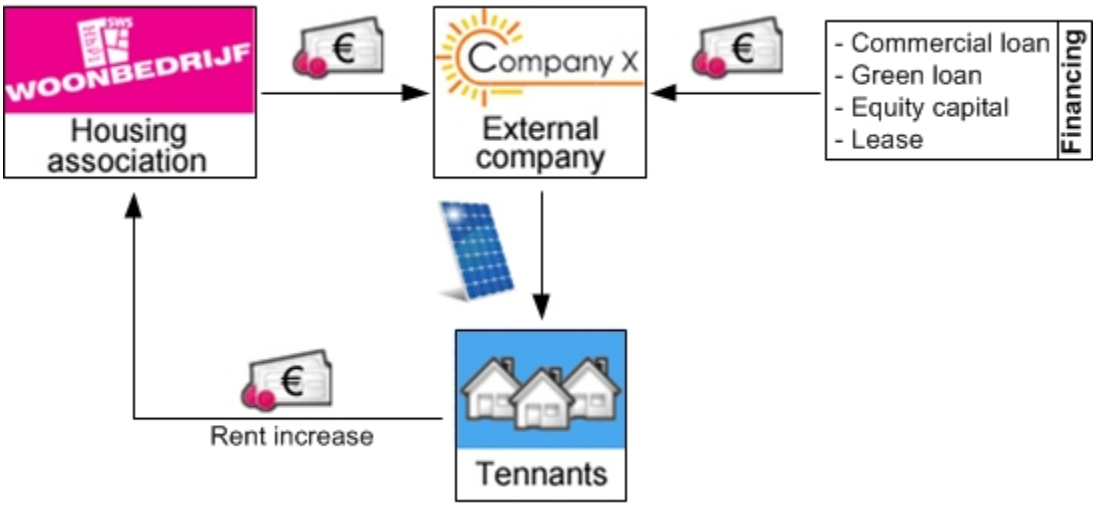

Figure 8: External company invests (customer service and invoicing via housing association)

2.3.3 Tenant invests

This section describes the possible organization structures where the tenant invests in sustainable measures. Here a distinction has been made between tenants who invest individually and tenants who invest collectively through an energy cooperative.

2.3.3.1 Tenant invests individually

Tenants may choose to invest in sustainable measures with their own equity capital or using commercial financing individually (Figure 9). This type of investment will be characterized as a self mounted device (zelf aangebracht voorziening). Since the tenant does not own the property, the housing association has to approve the installation of the measures by granting surface rights (recht van opstal).

Housing associations could support their tenants by negotiating competitive offers with suppliers. Since tenants take care of the investment, this organization structure does not burden the investment budget of the housing association. However, the sustainable system is owned by the tenants and could be removed when they move to another house. This may conflict the targets of the housing association regarding sustainability. The housing association could setup a takeover system to buy the system when tenants are moving.

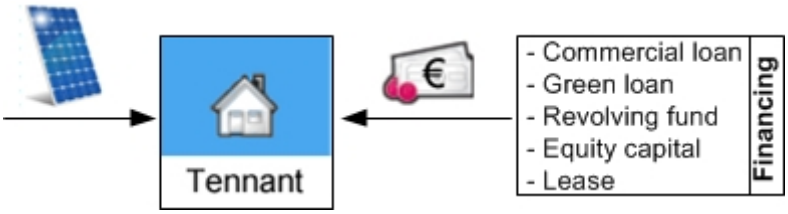

Figure 9: Tenant invests individually

2.3.3.2 Tenant invests collectively (energy cooperative)

Figure 10 shows the organization structure where the tenants unite voluntary in an energy cooperative. Over the past years, many local initiatives arose to generate renewable energy and achieve energy savings as successors of the cooperatives that are already known for windmills. The essence of an energy cooperative is the idea that residents (tenants and private property owners) establish a cooperative in order to buy and generate renewable energy collectively (Atrive, 2012). The local energy cooperative has no commercial targets so the members will directly benefit from the revenues. The energy cooperative takes care of the investment and exploitation and the members pay the cooperative through an invoice including a membership fee.

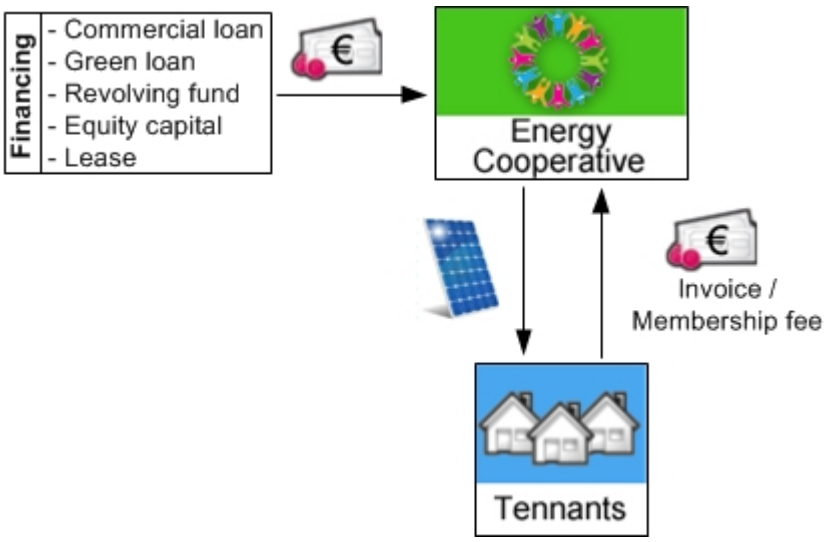

Figure 10: Tenant invests collectively (energy cooperative)

This organization structure is fully based on the initiative of the tenants. This is advantageous with enthusiastic tenants because they will be very involved in the project. However, this could also be harmful for the sustainable targets of the housing association when there is a lack of initiative from the tenants. Dispersed initiatives can obstruct possible future collective initiatives. The housing association can play a facilitating role in the project, but they are not actively or financially involved.

2.3.4 Hybrid organization structures

This section describes the last category of possible organization structures, namely the hybrid structures. It is imaginable that, especially in large-scale projects, multiple parties join their forces to take care of the investment and exploitation. The following two alternatives give an overview of possible hybrid organization structures in which several previously described structures are combined.

2.3.4.1 Housing association and external companies invest collectively using an Energy LLC

Figure 11 shows the organization structure where the housing association collectively invests with one or more external companies through an Energy LLC. The Energy LLC will be seen as a standalone company and it is therefore not allowed to recoup the investment through an increase in rent. The Energy LLC has to establish its own administration in order to send separate invoices for their energy services towards the tenants.

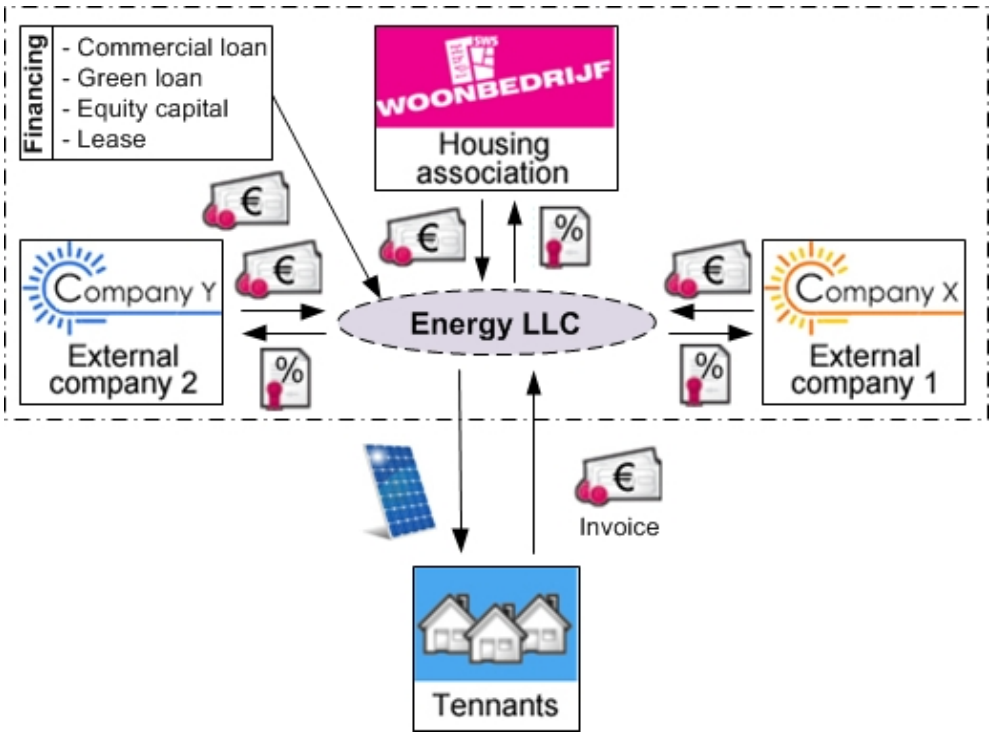

Figure 11: Housing association and external companies invest collectively using an Energy LLC

The investment has to be financed by the participants for which they receive shares in the Energy LLC in return. This structure allows the participants to sell, divest or transfer their shares in the future towards other companies or energy cooperatives. The participants bear the risks of the project collectively and tasks and responsibilities related to the exploitation can be divided between the parties. This structure can be beneficial for the participants because multiple parties bear the investment costs, risks are spread and specific knowledge of the individual parties can contribute to the entire organization. Given the goal of the commercial external companies to make a profit on the project, the costs will be higher which leads to lower benefits for the tenants.

2.3.4.2 Housing association, external companies and a energy cooperative invest collectively using an Energy LLC

This organization structure (Figure 12) can be considered as an alternative to the structure described previously. All the characteristics are the same except the involvement of an extra party, namely an energy cooperative. The participation of an energy cooperative is a way to unite the tenants into one local collective and to give them a voice in the Energy LLC. Via the energy cooperative, the individual tenants become small shareholders in the Energy LLC. This stimulates the involvement of the tenants in the project.

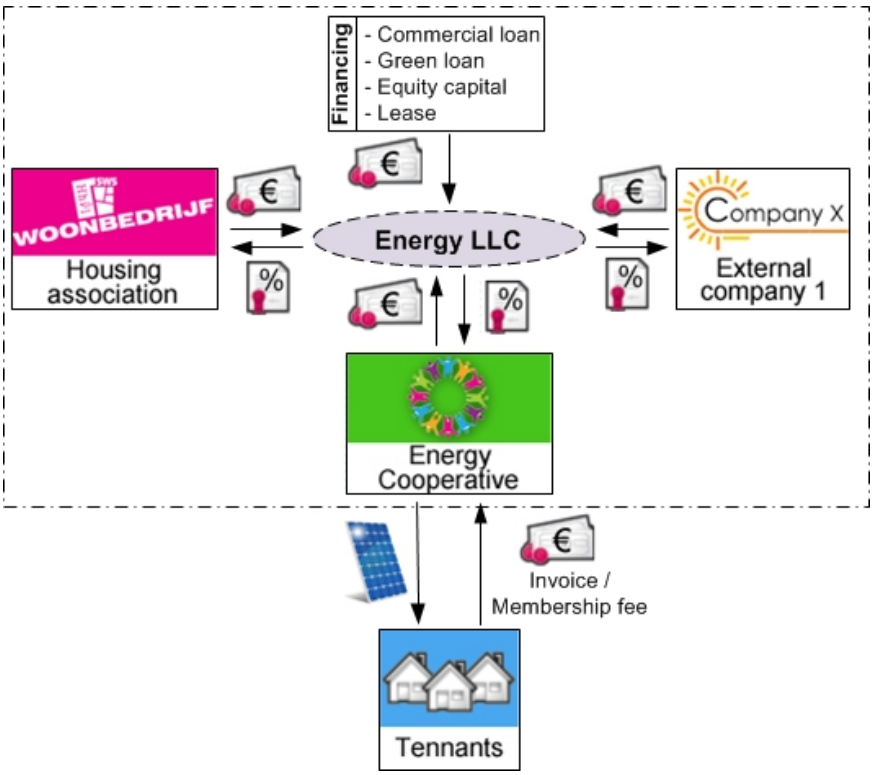

Figure 12: Housing association, external companies and a energy cooperative invest collectively using an Energy LLC

2.4 Generating a set of alternatives for further research

In this chapter, multiple aspects that are involved in the implementation of sustainable measures in existing housing stocks of housing associations are described in order to answer research question 1 and the associated subquestions. The legal framework for this type of projects is mainly formed by the new Housing Act and the Electricity Act. The Electricity act regulates the prices and taxes that have to be paid for electricity usage. This is important for the development of renewable electricity based business cases because the exemption of energy taxes can make the difference between a viable and a non-viable business case. The new Housing Act affects several possible organization structures. The act does not exclude alternatives, but provides specific regulations for some structures like Energy LLC's established by housing associations.

Several financing possibilities and organization structures have been identified. Hereby, there are three parties that can fulfil the role of investor, namely the housing association, the tenants or external companies. Depending on who is investing, there are several financing possibilities, payback options and organization structures available. Figure 13 on the next page gives a summary and overview of all the possibilities.

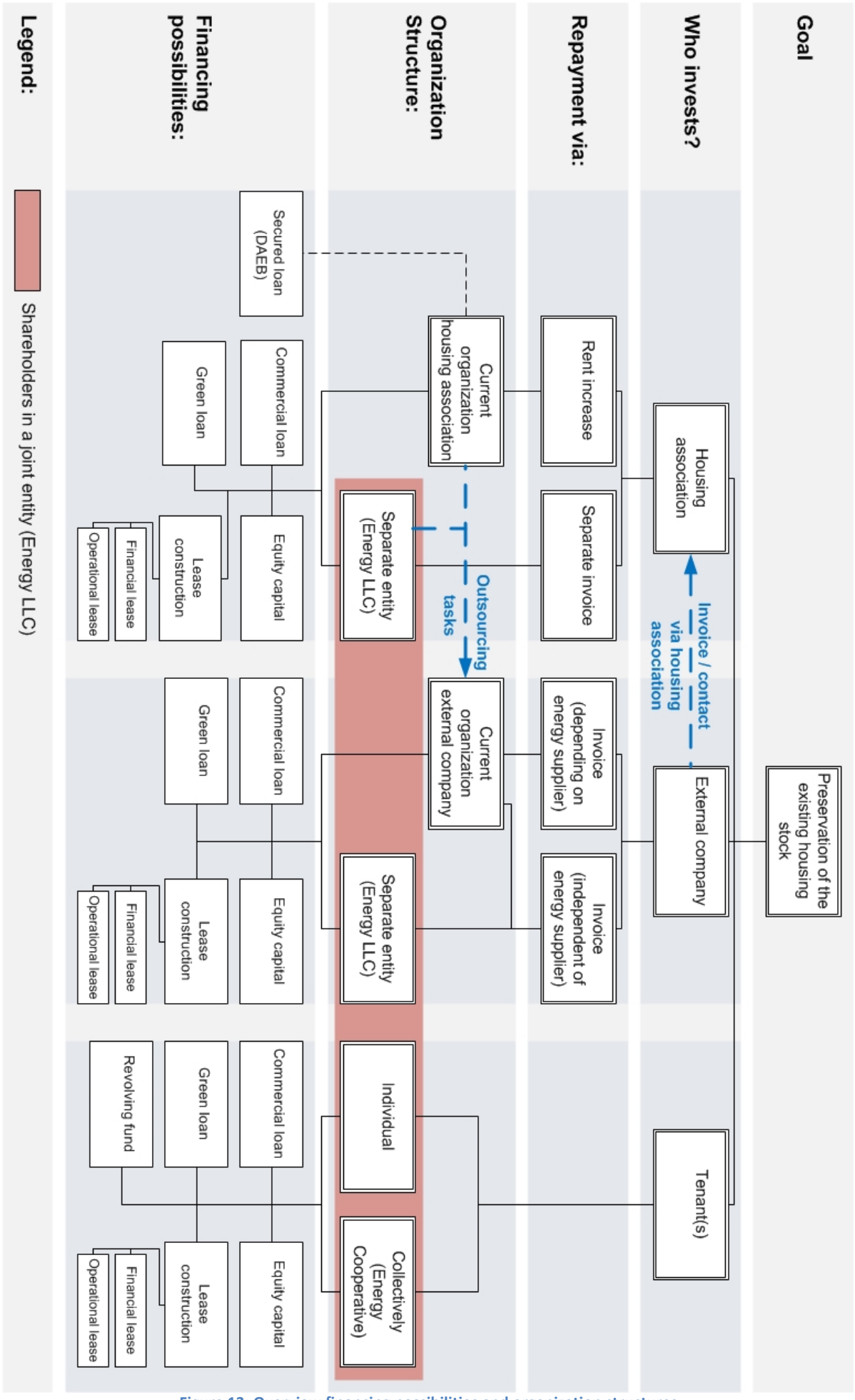

Figure 13: Overview financing possibilities and organization structures

2.4.1 Excluding possibilities

Since not all financing possibilities and organization structures are suitable for this research, the following possibilities will be excluded for further research:

- **Revolving funds**: at this time, these funds are only available for private individual investors and homeowners. This is not the target group for this research;
- **Green loans**: the government decided to bring the fiscal benefits gradually back to 0% in 2014. This makes green loans unusable for this research;
- **Operational lease:** the financing costs for operational lease are determined by the creditworthiness of the lessee. This is because PV panels are not seen as valuable collateral and the disposal costs are high. In addition, the essence of operational lease is the possibility to take back the system with a residual value. However, in the case of a PV system the installation of the PV panels would be seen as a transfer of the property which automatically results in a financial lease construction;
- **Individual tenants**: Woonbedrijf wants to implement the sustainable measures in the whole neighbourhood at once. Therefore individual initiatives are not applicable for this research;
- **Energy supplier (forced trading):** Woonbedrijf stated that their tenants must be free to choose an energy supplier at all times. The organization structure where the tenants are obliged to buy their energy from a specific energy supplier is therefore not applicable;
- **Housing association, Energy LLC, Commercial loan:** the organization structure where the housing association invests with a commercial loan via an Energy LLC will be excluded for further research because this alternative is more expensive compared to the alternative where a direct loan is used. The direct loan has lower financing costs making that it will have a more positive result compared to the commercial loan.

With the exclusion of the foregoing possibilities, a set of alternatives can be generated. Figure 14 gives an overview of the alternatives that will be further elaborated in this research. In total there are 15 alternatives divided over three main groups (housing association, external company, tenants) and five subgroups based on the type of organization structure.

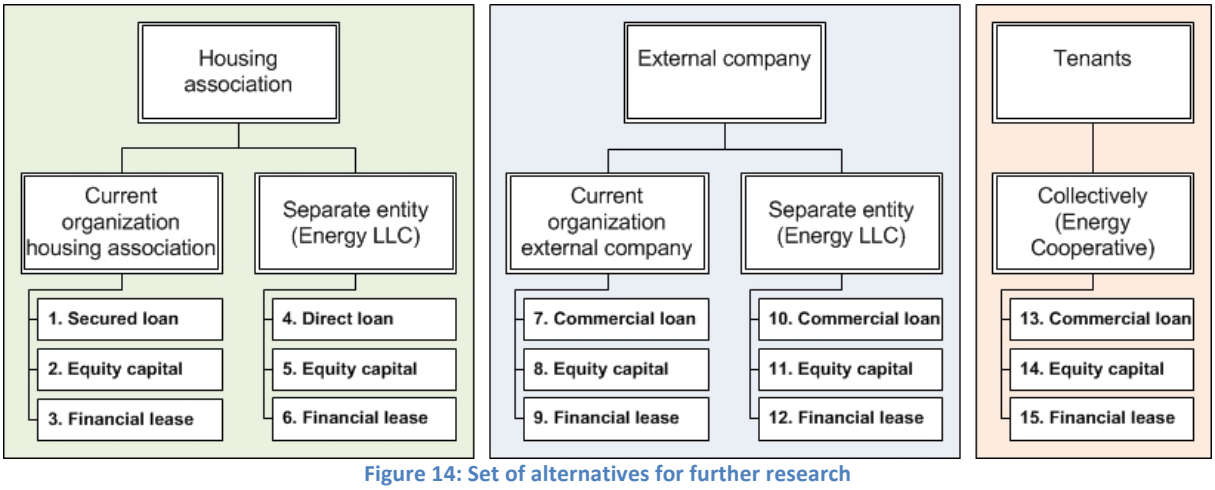

Figure 14: Set of alternatives for further research

3 Financial model

In order to make a founded choice for the best organization structure that can be applied by Woonbedrijf for the preservation of their existing housing stock, the 15 alternatives generated in chapter 2 will be financially tested. There are two types of stakeholders in this kind of projects, namely the customers (tenants) and the investor (Woonbedrijf, external company or energy cooperative). The financial consequences for these two stakeholders will be further elaborated in this chapter. An existing neighbourhood owned by Woonbedrijf with high sustainable ambitions will be used as an input for the financial model.

The financial consequences for the customer (client value) and for the investor (company value) will be calculated for the different alternatives with the help of a financial model. The Airey neighbourhood will be used as a case study for the financial model. At the end of this chapter, alternatives with negative consequences for the customers will be rejected for further analysis.

3.1 Case study: the Airey neighbourhood

Genderdal is a residential area in the district Gestel in the south of Eindhoven (NL). A neighbourhood of 226 dwellings so called Airey houses in Genderdal (built in 1958) is assigned as pilot project for sustainable measures and techniques in Eindhoven. Woonbedrijf wants to try out different sustainable measures and techniques in this neighbourhood (Vrede de, 2012).

3.1.1 Technical analysis

In the reconstruction period after the Second World War, a lot of so called Airey houses have been built in England and the Netherlands. The advantage of these houses was that they could be build very fast and that the steel that was needed for the frame could be taken from the frames of military vehicles. In the Netherlands the Airey houses are built with the Nemavo-Airey-system, also the Airey houses in Genderdal are build with this system. In figure 15 the Airey houses in Genderdal are shown. The Neighbourhood has a spacious urban layout, a wide street profile and large gardens.

Figure 15: Airey houses in Genderdal

3.1.2 Rental Prices

The validation of immovable property act of the Airey houses ranges between €123.000 and €177.000. With an average of € 135.000 the value of the houses is relative low compared with the other dwellings in the housing stock of Woonbedrijf (average of €182.500). Like the relatively low value of the houses they also have a relative low rental price with an average of € 375. Because of these low prices the houses are very attractive for people with a low income.

3.1.3 Social analysis

The Airey neighbourhood is a mono-functional area with only housing. Because of the low rents the houses are very popular among starters, single-parent families and immigrants.

There is no vacancy, when a dwelling becomes vacant there are more than enough people who would like to rent it.

3.1.3.1 Households

Residents of the neighbourhood are mostly retired Philips employees, starters, single-parent families and immigrants. 77% of the households are one-person households and 23% are two-person households. The average duration of residence is 15 years.

3.1.3.2 Housing costs

The mean income of the households is € 18.500. The total costs of housing are the rental price plus the costs of energy consumption. The average rental price is € 375 and the average costs of energy are € 145. This results in average total housing costs of € 520. Energy costs cover about 30% of the housing costs.

3.1.3.1 Energy consumption

The average energy consumption in the Netherlands is 1.617 m^3 gas and 3.480 kWh of electricity (Agentschap NL, 2011). The households in the Airey neighbourhood have an average energy consumption of 1.250 m^3 gas and 2.500 kWh electricity per year. This energy consumption results in an energy bill of approximately € 1.745 per year or € 145 per month.

3.1.3.1 Energy labels

Since 1998 the energy-index is the indicator of the energy performance of buildings and dwellings in the Netherlands. How better the construction, energetic and technical installation features how better the score of the energy-index and the matching energy label. A is the best score and G is the worst score. The Aireys have an average energy label of D/E and therefore there lays a potential to make a big improvement in the energy performance.

3.2 Preconditions

As a starting point for the financial model, some preconditions have been formulated in consultation with Woonbedrijf. This section gives an overview of the determined preconditions.

3.2.1 Decision criteria

An important part of the decision making process is to formulate the criteria that will be used to compare and judge the alternatives against each other. In Woonbedrijf's policy, three criteria have been formulated that are always used to assess upcoming investment plans, namely the *client value*, the *company value* and the *real estate value*. The client value is defined as all the added value for the client as a result of the investment. This can be measurable values like financial benefits, but also other subjective values like flexibility or comfort. The *company value* has been defined as all the added value for the company (Woonbedrijf) like income and profit, but also subjective values like image. The *real estate value* has been defined as the increase in value of the property as a result of the investment.

In the context of this research, it is important that the alternatives are objectively and measurable compared to each other in order to make a grounded decision. Therefore, the alternatives will be financially expressed based on Woonbedrijf's investment criteria. For this

research the *client value* is defined as the net monthly saving on the electricity bill per household. The *company value* is defined as the Net Present Value (NPV) for the investment based on the total project size and throughout the entire exploitation period. The *real estate value* is not considered because there is no objective data available with regard to the added real estate value of PV panels.

3.2.2 Decision rules

After defining the decision criteria, the second step is to formulate the decision rules. These decision rules are important because these will be used to exclude alternatives from the research. Woonbedrijf conducted a survey last year amongst their clients with sustainability as topic. In this survey, they asked what amount of rent increase would be accepted when sustainable measures are implemented. In other words, what *client value* is acceptable for the tenants. Figure 16 shows the results for this question. 33 + 18 + 28 = 79% of the tenants does not accept an increase in housing costs (rent + energy). After implementing the sustainable measures, the increase in rent must not exceed the cost savings caused by the sustainable measures. When cost savings exceed the increase in rent, the tenants will benefit from lower housing costs. A decrease in housing costs will be indicated as a *positive client value*. In the context of this research, only alternatives with *positive client values* will be considered for further research since at least 70% of the tenants has to approve the increase in rent before the project starts.

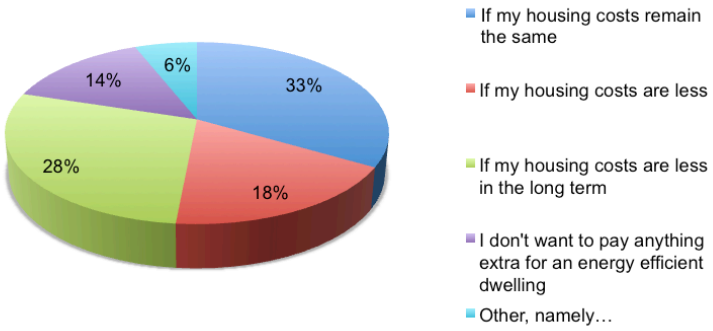

Figure 16: Results client survey

3.2.3 Other preconditions

In addition to the previously described preconditions, the following other preconditions have been defined in consultation with Woonbedrijf:

- 15 m2 of PV panels will be installed at once on all of the 226 houses in the Airey neighbourhood;
- The tenants can deliver the generated electricity directly to their own electricity system behind their meter box;
- Grants will be excluded from the calculations;
- Investments in renewable energy must be fully recouped, but there is no need to make profits on the investment.

3.3 Parameters

In order to make realistic calculations, the financial model requires multiple parameters varying from general financial parameters up to specific exploitation costs. This section covers the parameters that are used for the financial model. A more detailed explanation of the parameters can be found in appendix 3.

3.3.1 Investment

According to appendix 3, the total investment for the PV panels for the whole Airey neighbourhood will be € 815.125,50 including VAT and € 673.657,44 excluding VAT. This results in an investment of € 3.607 per dwelling including VAT and € 2.981 per dwelling

excluding VAT. The investment with and without VAT is important because taxes are deductible for some of the alternatives while other alternatives cannot deduct taxes.

3.3.2 Replacement inverters

The inverters need to be replaced after 10 years. Nowadays, the costs for inverters vary between € 500 and € 1.000. For this research, the costs to replace an inverter are assumed on € 600. This seems a reasonable value since prices of inverters decrease every year.

3.3.3 Financing and financial parameters

Table 2 shows the financing and financial parameters for the different alternatives. References for these parameters are given in appendix 3.

Organizational structure	Financing type	Investment	Financing parameters			Financial parameters	
			Interest rate	Period (years)	Annual repayment	Discount rate	Profit & risk rate
Housing Corporation (Current organization)	1: DAEB-financing	€ 3.607	4,0%	20	€ 265	4,00%	1,25%
	2: Equity capital	€ 3.607	-	-	-	4,00%	1,25%
	3: Financial lease	€ 2.981	5,8%	7	€ 530	5,80%	1,25%
Housing Corporation (Energy LLC)	4: Direct loan	€ 2.981	4,0%	20	€ 219	4,00%	1,25%
	5: Equity capital	€ 2.981	-	-	-	4,00%	1,25%
	6: Financial lease	€ 2.981	5,8%	7	€ 530	5,80%	1,25%
External company (Current organization)	7: Commercial loan	€ 2.981	5,0%	15	€ 287	5,00%	6,00%
	8: Equity capital	€ 2.981	-	-	-	5,00%	6,00%
	9: Financial lease	€ 2.981	5,8%	7	€ 530	5,80%	6,00%
External company (Energy LLC)	10: Commercial loan	€ 2.981	5,0%	15	€ 287	5,00%	6,00%
	11: Equity capital	€ 2.981	-	-	-	5,00%	6,00%
	12: Financial lease	€ 2.981	5,8%	7	€ 530	5,80%	6,00%
Tenants (Collectively)	13: Commercial loan	€ 2.981	5,0%	15	€ 287	5,00%	-
	14: Equity capital	€ 2.981	-	-	-	5,00%	-
	15: Financial lease	€ 2.981	5,8%	7	€ 530	5,80%	-

Table 2: Financing and financial parameters

Table 3 and table 4 show the parameters for the inflation and the annual increase in rent. These parameters correspond to the long-term budget planning of Woonbedrijf.

Inflation / Increase in costs	
Year	Rate
1	2,00%
2 t/m 5	2,25%
6 t/m 20	3,00%
Average	**2,80%**

Table 3: Inflation

Increase in rent	
Year	Rate
1	3,75%
2 t/m 5	3,90%
6 t/m 20	3,90%
Average	**3,89%**

Table 4: Increase in rent

3.3.4 Exploitation costs

The exploitation costs for the different alternatives are listed in table 5. These costs are further elaborated in appendix 3. The exploitation costs are divided into *initial costs* and *annual costs*. The *initial costs* are costs that have to be made during the start-up phase of the project. The *annuals costs* are fixed exploitation costs that will return every year.

Organizational structure	Financing type	Initial costs			Annual costs					
		Establish LLC	Surface rights	Monitoring system	Moni-toring	O&M	Customer services	Invoice	Insurance	Manager LLC
Housing Corporation (Current organization)	1: DAEB-financing	-	-	€ 4,87	€ 2,92	€ 30	€ 25	-	€ 9,82	-
	2: Equity capital	-	-	€ 4,87	€ 2,92	€ 30	€ 25	-	€ 9,82	-
	3: Financial lease	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	-	€ 9,82	-
Housing Corporation (Energy LLC)	4: Direct loan	€ 13,27	-	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	€ 59,73
	5: Equity capital	€ 13,27	-	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	€ 59,73
	6: Financial lease	€ 13,27	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	€ 59,73
External company (Current organization)	7: Commercial loan	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	8: Equity capital	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	9: Financial lease	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
External company (Energy LLC)	10: Commercial loan	€ 13,27	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	11: Equity capital	€ 13,27	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	12: Financial lease	€ 13,27	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
Tenants (Collectively)	13: Commercial loan	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	14: Equity capital	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-
	15: Financial lease	-	€ 6.000	€ 4,87	€ 2,92	€ 30	€ 25	€ 22	€ 9,82	-

Table 5: Exploitation costs

3.3.5 Other parameters

All of the 226 houses will be provided with 15m2 PV panels with an average power of 140Wp (Watt-peak). The average efficiency for the whole neighbourhood will be 94% (Vrede de, 2012) based on orientation and slope of the roofs. In addition, Eindhoven has a performance ratio of 0,83 (Vrede de, 2012).

According to Natuur & Milieu (2013), it is to be expected that energy prices will keep on rising in the future. They advise to calculate with an annual increase of 2,5% above inflation level in accordance to previous statements of Agentschap NL, ECN and Milieu Centraal. For this research the annual increase in energy price will be 5,3%.

Natuur & Milieu (2013) also provided data about the annual decrease in efficiency of the PV panels. For this research, an annual decrease of 0,6% will be used.

3.4 Financial model

In order to calculate the client and company values, a Microsoft Excel calculation model has been developed. The model has been designed in a way that it is applicable to every other neighbourhood. The following sections describe the different functions of the model.

3.4.1 Input screen

The first screen of the model is the input screen (figure 19). Here, all the parameters for a specific scenario can be entered. The input screen is divided into three vertical sections. The first section covers the more general parameters like information about the neighbourhood, specifications about the PV panels, possible obtained grants and general financial parameters that are often related to the long-term budget planning of the housing association. The second section covers the specific financial parameters. First the exploitation costs (initial and annual) can be entered followed by the financing parameters. Each financing possibility has its own input field. The third section can be used to enter reinvestments during the exploitation period like the replacement of the inverters. The input screen in figure 17 shows the parameters for alternative 1 (Woonbedrijf, current organization, secured loan).

Project data		
Number of dwellings	226	
Exploitation period	20	jr
Year of investment	2013	
Avg. rental price	375	€
Avg. electricity usage per household	2500	kWh

Parameters		
Inflation / Increase in costs	2,8	%
Increase in rent	3,89	%
Discount rate	4	%
Profit & risk rate	1,25	%
Avg. annual increase electricity price	5,3	%
Annual increase electricity usage	0	%

Parameters PV panels		
Surface per dwelling	15	m2
Avg. power per m2	140	Wp
Avg. efficiency (orientation and slope)	94	%
Performance ratio Eindhoven	0,83	
Annual efficiency decrease	0,6	%
Generation in year 1	1638,4	kWh

Grants		
Obtained grants	0	€

Initial costs		
Consultancy costs (total)	0	€
Separate entity (total)	0	€
Surface rights (total)	0	€
Monitoring system (total)	1100	€

Annual costs		
Operate & Maintenance	30	€
Monitoring system (total)	660	€
Invoicing	0	€
Insurance	9,82	€
Independent management (total)	0	€
Customer services	25	€

Financing (equity capital)		
Investment per dwelling	0	€

Financing (loan)		
Investment	3607	€
Interest rate	4	%
Duration	20	jr
Annuity	265,41	€

Financing (financial lease)		
Annual leasing price	0	€
Duration	0	jr

Reinvestments			
Year	Investment		Description
1	€	-	
2	€	-	
3	€	-	
4	€	-	
5	€	-	
6	€	-	
7	€	-	
8	€	-	
9	€	-	
10	€	600,00	Replace inverter
11	€	-	
12	€	-	
13	€	-	
14	€	-	
15	€	-	
16	€	-	
17	€	-	
18	€	-	
19	€	-	
20	€	-	

Figure 17: Input screen

3.4.2 Exploitation model

The second screen of the model covers the exploitation budget (Figure 18). In this screen, the parameters from the input screen are used to generate a budget planning for the whole exploitation period (20 years) wherein al the incoming and outgoing cash flows are listed. The exploitation model can be used in the following two ways:

First the required increase in rent can be calculated in order to cover the investment. The increase in rent is calculated with a built in macro. This macro (red button figure 20) calculates the increase in rent in year 1 (red arrow) that is required to equal the Net Present Value (NPV) of the whole exploitation period to 0 (green arrow). A NPV of 0 means that all of the outgoing cash flows are exactly covered by the incoming cash flows, so the exploitation does not generate additional profits. The macro function uses a target-seeking algorithm that iteratively adjusts the increase in rent in year 1 until a NPV of 0 is reached. The NPV is calculated with the following formula (Byers, Dorf and Nelson, 2011):

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$$ Where r=discount rate and C_n= cash flow.

The second way is to enter a fixed amount of rent increase in year 1 after which the model calculates the NPV of the whole exploitation.

So the model works in two ways whereby always one parameter (increase in rent or NPV) is a fixed value. This calculation method corresponds to the methods that are used by Woonbedrijf to assess this kind of investments.

Results		
Monthly rent increase	€ 22,97	push
Net Present Value investment	€ 0,00-	

	Total	0 2013	1 2014	2 2015	3 2016	4 2017	5 2018	6 2019	7 2020	8 2021	9 2022	10 2023	11 2024	12 2025	13 2026	14 2027	15 2028	16 2029	17 2030	18 2031	19 2032	20 2033
Investment																						
Initial investment	€ -	€ -																				
Reinvestment(s)	€ 600		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 600	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Incoming cash flows																						
Increase in rent	€ 8.115		276	€ 286	€ 297	€ 309	€ 321	€ 334	€ 347	€ 360	€ 374	€ 389	€ 404	€ 419	€ 436	€ 453	€ 470	€ 489	€ 508	€ 527	€ 548	€ 569
Grants	€ -	€ -																				
TOTAL INCOMING	**€ 8.115**	**€ -**	**€ 276**	**€ 286**	**€ 297**	**€ 309**	**€ 321**	**€ 334**	**€ 347**	**€ 360**	**€ 374**	**€ 389**	**€ 404**	**€ 419**	**€ 436**	**€ 453**	**€ 470**	**€ 489**	**€ 508**	**€ 527**	**€ 548**	**€ 569**
Outgoing cash flows																						
Operate & Maintenance	€ 790		€ 30	€ 31	€ 32	€ 33	€ 34	€ 34	€ 35	€ 36	€ 37	€ 38	€ 40	€ 41	€ 42	€ 43	€ 44	€ 45	€ 47	€ 48	€ 49	€ 51
Monitoring (per dwelling)	€ 77		€ 3	€ 3	€ 3	€ 3	€ 3	€ 3	€ 3	€ 4	€ 4	€ 4	€ 4	€ 4	€ 4	€ 4	€ 4	€ 4	€ 5	€ 5	€ 5	€ 5
Invoicing	€ -		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Insurance	€ 259		€ 10	€ 10	€ 10	€ 11	€ 11	€ 11	€ 12	€ 12	€ 12	€ 13	€ 13	€ 13	€ 14	€ 14	€ 14	€ 15	€ 15	€ 16	€ 16	€ 17
Management entity	€ -		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Customer services			€ 25	€ 26	€ 26	€ 27	€ 28	€ 29	€ 30	€ 30	€ 31	€ 32	€ 33	€ 34	€ 35	€ 36	€ 37	€ 38	€ 39	€ 40	€ 41	€ 42
Financing																						
Loan	€ 5.308		€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265	€ 265
Lease	€ -		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Other costs																						
Consultancy	€ -	€ -																				
Entity	€ -	€ -																				
Surface rights	€ -	€ -																				
Monitoring system	€ 5	€ 5																				
TOTAL OUTGOING	**€ 7.697**	**€ 5**	**€ 333**	**€ 335**	**€ 337**	**€ 339**	**€ 341**	**€ 343**	**€ 345**	**€ 348**	**€ 350**	**€ 952**	**€ 355**	**€ 357**	**€ 360**	**€ 362**	**€ 365**	**€ 368**	**€ 371**	**€ 374**	**€ 377**	**€ 380**
CASH FLOW RESULT	**€ 418**	**€ 5-**	**€ 58-**	**€ 49-**	**€ 40-**	**€ 30-**	**€ 20-**	**€ 10-**	**€ 1**	**€ 12**	**€ 24**	**€ 564-**	**€ 49**	**€ 62**	**€ 76**	**€ 90**	**€ 105**	**€ 121**	**€ 137**	**€ 154**	**€ 171**	**€ 189**
NET PRESENT VALUE	**€ 0-**	**€ 5-**	**€ 55-**	**€ 44-**	**€ 34-**	**€ 24-**	**€ 15-**	**€ 7-**	**€ 1**	**€ 8**	**€ 15**	**€ 338-**	**€ 28**	**€ 34**	**€ 39**	**€ 44**	**€ 49**	**€ 53**	**€ 57**	**€ 61**	**€ 65**	**€ 68**

Figure 18: Exploitation model

3.4.3 Electricity bill

In order to assess if the calculated increase in rent will be beneficial for the tenants, the cost savings generated by the PV panels have to be determined and compared to the rent increase. Therefore, a model of an electricity bill is included in the model. Because an electricity bill consists of fixed and variable costs it is important to decompose the costs precisely in order to make a fair comparison. The electricity model for this research has been checked and approved by Eindhoven's network operator Endinet. The references to the data can be found in appendix 3.

Figure 19 shows the model of the electricity bill. The model is divided into two vertical columns. The left column shows the current electricity bill of the tenants based on the average annual electricity usage of 2.500 kWh. The right column shows the electricity bill after installation of the PV panels. At the bottom of the model, the two scenarios are compared to each other in order to determine the cost savings on the electricity bill. The savings per month (€ 30,40) can then be compared to the calculated increase in rent from the exploitation model to assess if the sustainable measures will be beneficial for the tenants. Positive results will be valued as a positive *client value* and negative results will be valued as a negative *client value*.

Before			After		
Annual usage (kWh)	**2500**		**Annual usage (kWh)**	**862**	
Electricity bill:			**Electricity bill:**		
1. Delivery:			1. Delivery:		
Standing charge	23,52	€	Standing charge	€ 23,52	
Electricity tariff	175,00	€	Electricity tariff	€ 60,31	
Energy tax	285,00	€	Energy tax	€ 98,22	
Tax credit	318,62	€	Tax credit	€ 318,62	
2. Transport:			2. Transport:		
Capacity tariff	130,32	€	Capacity tariff	€ 130,32	
Standing charge	18,00	€	Standing charge	€ 18,00	
Connection charge	15,84	€	Connection charge	€ 15,84	
Sytem services	4,16	€	Sytem services	€ 4,16	
Meter rent	26,38	€	Meter rent	€ 26,38	
Total excl. VAT	359,60	€	Total excl. VAT	€ 58,13	
VAT (21%)	75,52	€	VAT (21%)	€ 12,21	
Total incl. VAT	**435,12**	**€/year**	**Total incl. VAT**	**70,34**	**€/year**
	36,26	€/month		5,86	€/month
		Saving per year	**€**	**364,78**	
		Saving per month	**€**	**30,40**	

Figure 19: Electricity bill

3.4.4 Housing costs

Since energy prices develop over the years, efficiency of PV panels decreases and costs increase due to inflation, it is important to model these parameters for the whole exploitation period in order to determine the total consequences for the tenants. Figure 20 shows the housing costs model wherein the total costs of housing (rent + energy) are modelled.

The model is divided into two sections. The upper section shows the current situation and the development of the costs in the future. The lower section shows the housing costs after installation of the PV panels. In this way the total benefit for the tenants over the whole exploitation period can be determined.

		Total	1 2013	2 2014	3 2015	4 2016	5 2017	6 2018	7 2019	8 2020	9 2021	10 2022	11 2023	12 2024	13 2025	14 2026	15 2027	16 2028	17 2029	18 2030	19 2031	20 2032
Before	Electricity usage		€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500	€ 2.500
	Costs																					
	Rent	€ 132.482	€ 4.500	€ 4.675	€ 4.857	€ 5.046	€ 5.242	€ 5.446	€ 5.658	€ 5.878	€ 6.107	€ 6.344	€ 6.591	€ 6.847	€ 7.114	€ 7.390	€ 7.678	€ 7.977	€ 8.287	€ 8.609	€ 8.944	€ 9.292
	Electricity	€ 14.852	€ 435	€ 458	€ 482	€ 508	€ 535	€ 563	€ 593	€ 625	€ 658	€ 693	€ 729	€ 768	€ 809	€ 851	€ 897	€ 944	€ 994	€ 1.047	€ 1.102	€ 1.161
	TOTAL	**€ 147.334**	**€ 4.935**	**€ 5.133**	**€ 5.339**	**€ 5.554**	**€ 5.777**	**€ 6.009**	**€ 6.251**	**€ 6.503**	**€ 6.764**	**€ 7.037**	**€ 7.320**	**€ 7.615**	**€ 7.922**	**€ 8.242**	**€ 8.575**	**€ 8.921**	**€ 9.281**	**€ 9.656**	**€ 10.047**	**€ 10.453**
After	Generated		€ 1.638	€ 1.629	€ 1.619	€ 1.609	€ 1.599	€ 1.590	€ 1.580	€ 1.571	€ 1.561	€ 1.552	€ 1.543	€ 1.533	€ 1.524	€ 1.515	€ 1.506	€ 1.497	€ 1.488	€ 1.479	€ 1.470	€ 1.461
	Electricity (to buy)		€ 862	€ 871	€ 881	€ 891	€ 901	€ 910	€ 920	€ 929	€ 939	€ 948	€ 957	€ 967	€ 976	€ 985	€ 994	€ 1.003	€ 1.012	€ 1.021	€ 1.030	€ 1.039
	Costs																					
	Rent	€ 140.597	€ 4.776	€ 4.961	€ 5.154	€ 5.355	€ 5.563	€ 5.780	€ 6.004	€ 6.238	€ 6.481	€ 6.733	€ 6.995	€ 7.267	€ 7.549	€ 7.843	€ 8.148	€ 8.465	€ 8.794	€ 9.137	€ 9.492	€ 9.861
	Electricity	€ 3.205	€ 70	€ 76	€ 83	€ 90	€ 97	€ 105	€ 114	€ 123	€ 132	€ 143	€ 154	€ 165	€ 178	€ 191	€ 206	€ 221	€ 237	€ 255	€ 273	€ 293
	TOTAL	**€ 143.802**	**€ 4.846**	**€ 5.038**	**€ 5.237**	**€ 5.445**	**€ 5.660**	**€ 5.885**	**€ 6.118**	**€ 6.361**	**€ 6.613**	**€ 6.875**	**€ 7.148**	**€ 7.432**	**€ 7.727**	**€ 8.034**	**€ 8.354**	**€ 8.686**	**€ 9.032**	**€ 9.391**	**€ 9.765**	**€ 10.154**
	Total saving	**€ 3.533**	**€ 89**	**€ 95**	**€ 102**	**€ 109**	**€ 117**	**€ 125**	**€ 133**	**€ 142**	**€ 151**	**€ 161**	**€ 172**	**€ 183**	**€ 195**	**€ 207**	**€ 221**	**€ 235**	**€ 249**	**€ 265**	**€ 281**	**€ 299**
	Net Present Value	**€ 2.213**	**€ 86**	**€ 88**	**€ 91**	**€ 93**	**€ 96**	**€ 99**	**€ 101**	**€ 104**	**€ 106**	**€ 109**	**€ 112**	**€ 114**	**€ 117**	**€ 120**	**€ 123**	**€ 125**	**€ 128**	**€ 131**	**€ 134**	**€ 136**

Figure 20: Housing costs

3.4.5 Results screen

The final screen of the model is the results screen. This screen shows some interesting graphs about the different models. Figure 21 shows the results of the exploitation model with the annual cash flows, the cash flow result and the NPV for alternative 1.

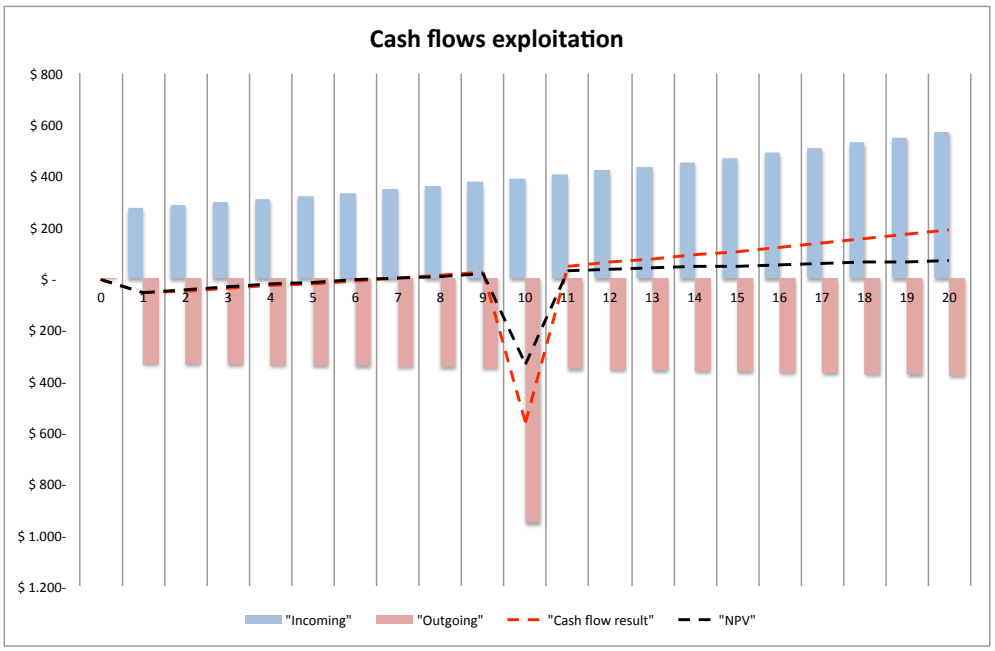

Figure 21: Cash flow results

Figure 22 gives insight in the development of the housing costs with and without implementation of the PV panels. The black lines show the housing costs before installation of the PV panels. In this scenario, the costs for rent are lower, but the total housing costs for the tenants are higher due to high energy costs. The blue areas show the housing costs after implementation of the PV panels. In this scenario, the rent is higher to cover the investment, but the total housing costs are lower due to savings on the electricity bill.

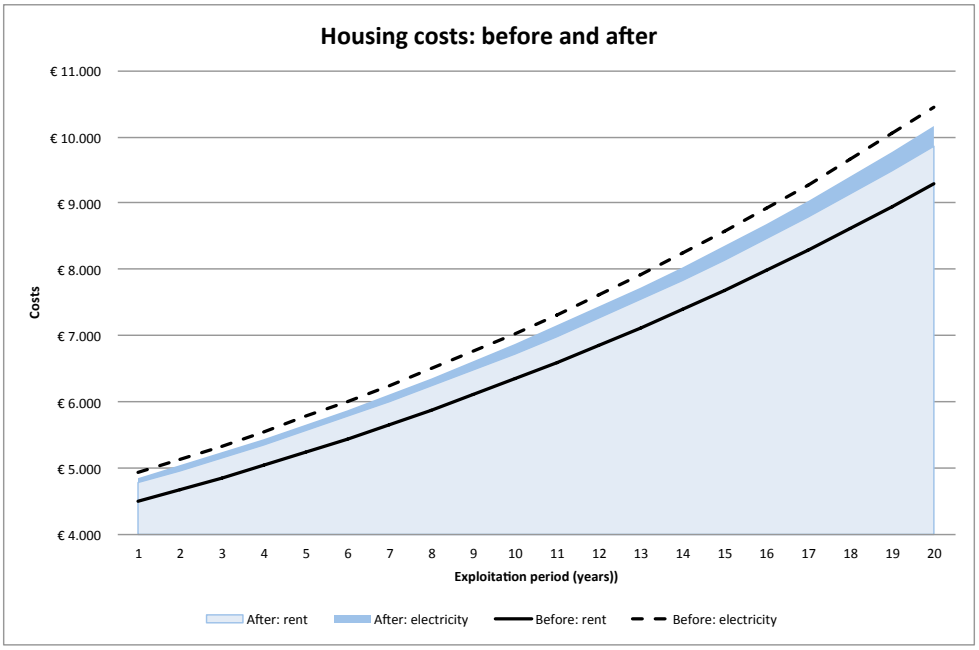

Figure 22: Housing costs before and after installation of the PV panels

3.5 Final results

The 15 alternatives generated in chapter 2 are all imported in the previously described calculation model. For each of the alternatives, the *client value* and the *company value* have been calculated. In the context of this research, the *client value* is expressed as the net monthly saving on the electricity bill per household (saving on electricity bill minus the required increase in rent to cover the investment). For calculating the client value, the electricity bill model has been used to determine the monthly savings (€ 30,40) after installation of the PV panels. In addition, the exploitation model has been used to determine the required increase in rent based on a fixed NPV of 0.

In the context of this research, the *company value* represents the NPV for the whole exploitation period (20 years) of the whole project (226 dwellings). Given the two-way functioning of the exploitation model, the model requires a value for the increase in rent in year 1 in order to calculate the NPV of the exploitation. For this research an increase in rent of € 25,40 in year 1 has been used to calculate the NPV. The value of € 25,40 is based on a *client value* of € 5. The model of the electricity bill showed that the tenants will save € 30,40 on their electricity costs after installing the PV panels. In order to give the tenants a certain amount of benefit from day one, the increase in rent in year one has been set on € 30,40 - € 5,00 = € 25,40.

Table 6 shows the results of the financial model for all the alternatives. According to the preconditions, alternatives with a negative client value will be rejected for further research. Table 6 shows that only alternative 8 and 11 generate negative client values. This is a positive result because this proves that investments in PV are viable business cases and that renewable energy is able to compete with conventional energy.

Organizational structure	Financing type	Increase rent (€/month)	Client Value	Company value	Increase rent (€/month)	Client Value	Company value
Housing Corporation (Current organization)	1: DAEB-financing	€ 22,97	€ 7,43	€ -	€ 25,40	€ 5,00	€ 110.966
	2: Equity capital	€ 24,79	€ 5,61	€ -	€ 25,40	€ 5,00	€ 27.798
	3: Financial lease	€ 23,78	€ 6,62	€ -	€ 25,40	€ 5,00	€ 62.602
Housing Corporation (Energy LLC)	4: Direct loan	€ 26,45	€ 3,95	€ -	€ 25,40	€ 5,00	€ 48.138-
	5: Equity capital	€ 27,96	€ 2,44	€ -	€ 25,40	€ 5,00	€ 117.068-
	6: Financial lease	€ 30,10	€ 0,30	€ -	€ 25,40	€ 5,00	€ 181.704-
External company (Current organization)	7: Commercial loan	€ 25,56	€ 4,84	€ -	€ 25,40	€ 5,00	€ 4.520-
	8: Equity capital	€ 32,96	€ 2,56-	€ -	€ 25,40	€ 5,00	€ 211.536-
	9: Financial lease	€ 29,75	€ 0,65	€ -	€ 25,40	€ 5,00	€ 114.808-
External company (Energy LLC)	10: Commercial loan	€ 25,67	€ 4,73	€ -	€ 25,40	€ 5,00	€ 7.684-
	11: Equity capital	€ 33,06	€ 2,66-	€ -	€ 25,40	€ 5,00	€ 214.474-
	12: Financial lease	€ 29,87	€ 0,53	€ -	€ 25,40	€ 5,00	€ 117.746-
Tenants (Collectively)	13: Commercial loan	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	14: Equity capital	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	15: Financial lease	€ 24,30	€ 6,10	€ -	€ 25,40	€ 5,00	€ 47.912
		Fixed company value (NPV=0)			**Fixed client value (CV=5)**		

Table 6: Final results

With maximum savings of around € 90 per year, the *client values* are relatively limited. This has several reasons. First the surface of the Airey roofs is very small making that it is not possible to install a larger PV system. A larger system generates more electricity and is relatively cheaper because costs for installation are almost equal to smaller systems. Second the average electricity usage of the Airey houses (2.500 kWh) is very small compared to

average households in the Netherlands (3.500 kWh) which reduces the energy saving potential. And finally, the annual exploitation costs burden the budget causing a reduction of the *client value*.

Despite the relatively limited client values, the PV panels offer viable and sustainable business cases for the Airey neighbourhood with real savings on the tenant's energy bill. Considering the whole exploitation of the project, significant saving can be achieved. Table 7 shows an overview of the cost savings for the whole neighbourhood during the exploitation period of 20 years. The tenants can save up to € 400.000 collectively on their electricity bills.

Organizational structure	Financing type	Client Value
Housing Corporation (Current organization)	1: DAEB-financing	€ 403.003,20
	2: Equity capital	€ 304.286,40
	3: Financial lease	€ 359.068,80
Housing Corporation (Energy LLC)	4: Direct loan	€ 214.248,00
	5: Equity capital	€ 132.345,60
	6: Financial lease	€ 16.272,00
External company (Current organization)	7: Commercial loan	€ 262.521,60
	8: Equity capital	€ 138.854,40-
	9: Financial lease	€ 35.256,00
External company (Energy LLC)	10: Commercial loan	€ 256.555,20
	11: Equity capital	€ 144.278,40-
	12: Financial lease	€ 28.747,20
Tenants (Collectively)	13: Commercial loan	€ 394.324,80
	14: Equity capital	€ 394.324,80
	15: Financial lease	€ 330.864,00

Table 7: Total client values

In this chapter, the *client value* and *company value* of the 15 alternatives generated in chapter 2 have been calculated. According to the preconditions, only alternatives with positive *client values* will be accepted. Alternative 8 and 11 produced negative *client values*. Therefore, these will be rejected for further research. Figure 23 shows an overview of the remaining 13 alternatives that will be taken into account in the further analysis.

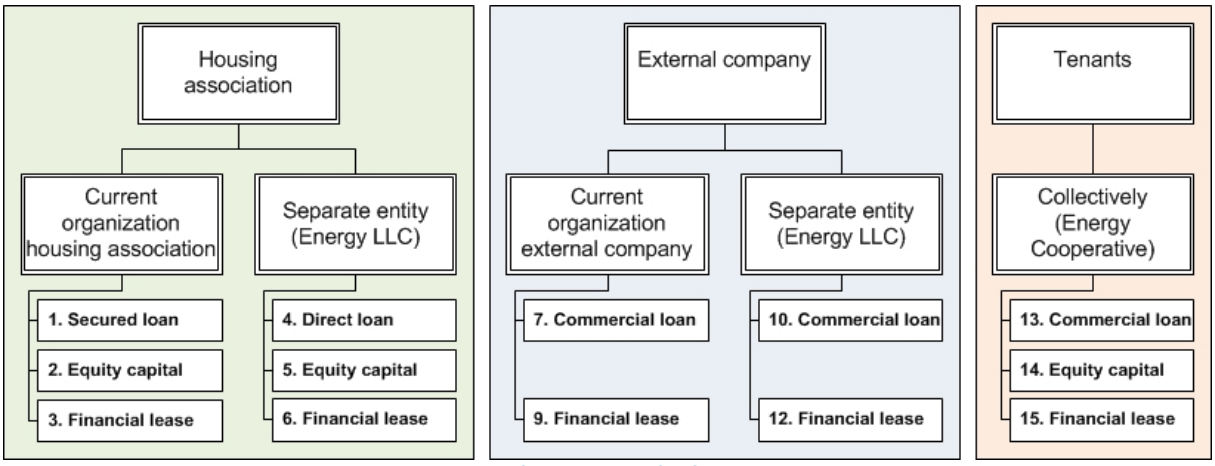

Figure 23: Set of alternatives for further research

4 Choosing the organizational structure with AHP

In the previous chapter, the financial model showed that only two alternatives could be excluded based on negative client values. In order to make a substantiated decision for the best organization structure, another method will be applied to support the decision-making.

In this chapter, the application of the analytic hierarchy process (AHP) will be described in order to select the best organization structure for the preservation of the Airey neighbourhood. First the methodology will be introduced in general followed by the AHP model and the results.

4.1 Method

The analytic hierarchy process (AHP) was developed by Thomas Saaty (Saaty, 2008) at the Wharton School of Business. The method is composed out of several concepts and techniques such as hierarchical structuring of complexity, pairwise comparisons, redundant judgments, an eigenvector method for deriving weights, and consistency considerations (Forman and Selly, 2002). It is broadly used around the world in decision situations and especially in group decision-making processes. The method proved to be useful as support tool for decision makers in urban development projects like studying the urban water supply scheme for Offa, Nigeria (Okeola and Sule, 2012) and sustainable urban development projects in Tehran (Javadiana, Shamskooshkia and Momenia, 2011).

AHP allows decision makers to model a complex problem into a hierarchical structure. It engages decision makers in breaking down a decision into smaller parts, proceeding from the goal to criteria to subcriteria and so on down to the alternatives of action (Arentze en Borgers, 2004).

AHP allows for the application of data, experience, insight, and intuition in a logical and thorough way. It enables decision-makers to derive ratio scale priorities or weights. In addition, AHP not only supports decision-makers by enabling them to structure complexity and exercise judgment, but also allows them to incorporate both objective and subjective considerations in the decision process (Forman and Selly, 2002).

AHP structures complexity as a hierarchy and derives ratio scale measures through pairwise relative comparisons. The pairwise comparison process can be performed using words, numbers, or graphical bars, and typically incorporates redundancy, which results in a reduction of measurement error as well as producing a measure of consistency of the comparison judgments (Forman and Selly, 2002).

Humans are much more capable of making relative rather than absolute judgments. In making the judgements, the elements of the problem are looked at in isolation: one element compared against another with respect to a parent element. The decision maker then makes only simple pairwise comparison judgements throughout the hierarchy to derive the priorities of the elements (Arentze and Borgers, 2004). These priorities are then used to prioritize the alternatives from best to worst.

4.1.1 Classification method

According to the AHP method, the relative importance of the different client and company values has to be determined by the experts. Different client and company values will be directly compared against each other using the pairwise comparison method. Comparing all the different values against each other will lead to an impractical number of questions for the experts. In order to reduce the number of questions, the values will be divided into several classes using a statistical classification method.

Because the number of classes is unknown, the data will be classified by using a two-stage analysis in SPSS. First hierarchical cluster analysis will be used to define the number of classes after which k-means clustering will be used to define the values of the classes.

According to Burns and Burns (2008), cluster analysis is a major technique for classifying information into manageable meaningful piles. It is a data reduction tool that creates subgroups that are more manageable than the individual data. In cluster analysis there is no prior knowledge about which elements belong to which classes. Hierarchical cluster analysis in SPSS is used to find relatively homogeneous classes based on the client and company values. It starts with each case as a separate class, so there are as many clusters as cases. Then the classes will be combined sequentially reducing the number of classes at each step until only one class is left. The classification method uses the distances between values when forming the classes. In SPSS, a hierarchical tree diagram (dendrogram) can be produced to show the linkage points of the classes. The distances are measured using the Squared Euclidean distance method in SPSS. This is the most straightforward and generally accepted method to compute distances between objects. The classes will be defined according to the Ward's clustering algorithm. This very efficient method uses an analysis of variance approach to evaluate the distances between classes. The criterion for fusion is that it should produce the smallest possible increase in the error sum of squares (Burns and Burns, 2008).

After determining the number of classes, the actual values of the classes are defined using the k-means clustering function in SPSS. The number of classes (k) are the input for the k-means clustering algorithm. This method will produce the exact k different classes demanded of greatest possible distinction (Burns and Burns, 2008).

4.1.1.1 Company value

According to the final results of the financial model, there are 13 alternative organization structures left, each with its own company value. The number of company values will be divided into classes. First the number of classes is determined using hierarchical clustering analysis in SPSS. Figure 24 shows the dendrogram coming from the output file of SPSS. The dendrogram shows that there are 13 classes at the beginning. After 1 iteration there are 4 classes left. After 2 iterations 2 classes are left and after 3 iterations all the values have been combined into one class. The 4 classes after the first iteration are the most accurate classification and these 4 classes will be used as an input for the k-means clustering analysis.

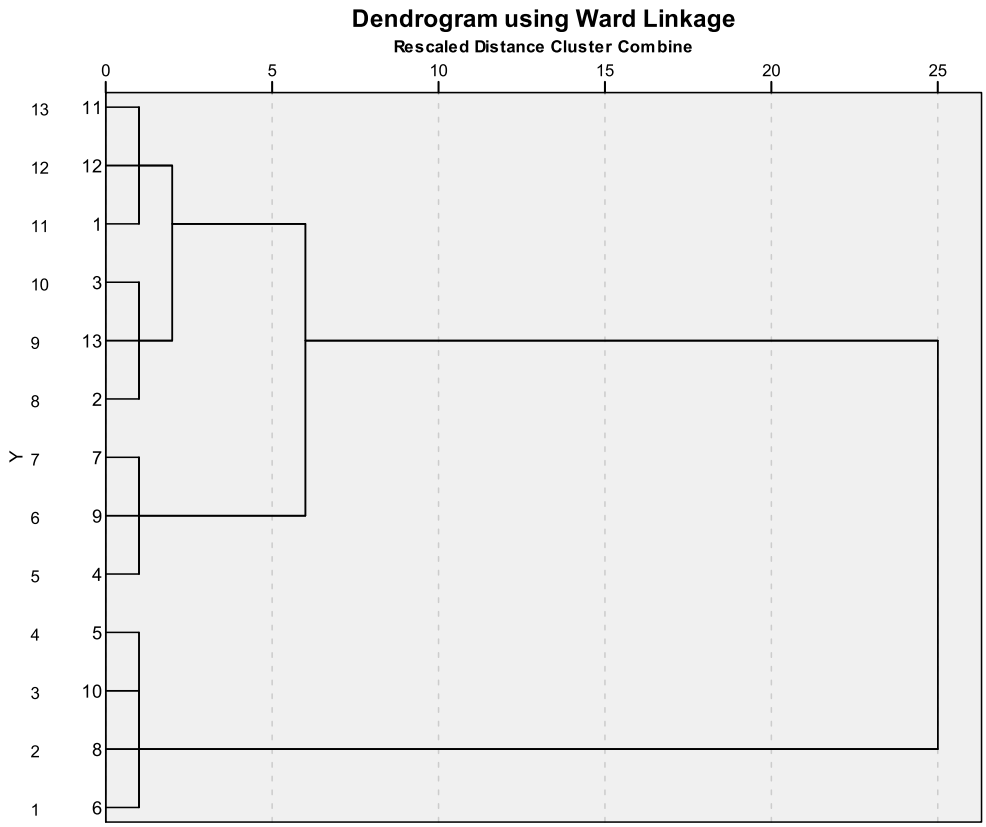

Figure 24: Defining the number of classes for the company value using SPSS

The k-means clustering algorithm in SPSS calculates the centre values for the 4 specified classes. Table 8 shows the results of the analysis. The rounded class centres will be used as subcriteria for the company value criterion in the AHP analysis.

	Cluster			
	1	2	3	4
Class centres (€)	96389,00	-116540,67	-181704,00	3073,60
Rounded class centres (€)	**96.000**	**-117.000**	**-182.000**	**3.000**

Table 8: Defining the class centres for company value using SPSS

4.1.1.2 Client value

The client values have also been classified in accordance with the previously described method. The dendrogram of the client values showed that there are 3 classes left after 2 iterations (Appendix 4). The k-means clustering algorithm in SPSS calculated the centre values for the 3 specified classes. Table 9 shows the results of the analysis. The rounded class centres will be used as subcriteria for the client value criterion in the AHP analysis.

	Cluster		
	1	2	3
Class centres (€)	6,94	0,98	4,78
Rounded class centres (€)	**6,90**	**1,00**	**4,80**

Table 9: Defining the class centres for client value using SPSS

4.1.2 Expert Choice 2000

The AHP analysis will be executed with the help of a software package called Expert Choice 2000. With the introduction of AHP software programs, the number and diversity of AHP applications has grown rapidly. As of 1995, Expert Choice was being used in 57 countries throughout the world and there were over 1000 journal and other citations about AHP (Forman and Selly, 2002). This section covers the underlying methodologies that are applied by the software.

4.1.2.1 Participants mode

Expert Choice 2000 can be used by a team to enhance the quality of group decisions by bringing structure to the decision making process and by synthesizing different points of view. The program features a "participants mode" in which personal profiles for individual experts can be created. The judgments of these individual experts can be linked to the personal profiles after which the individual judgments can be synthesized to arrive at a group conclusion.

Geometric Mean

There are two important issues in group decision-making, namely how to aggregate individual judgements in a group into a single representative judgement for the entire group and how to construct a group choice from individual choices. The reciprocal property plays an important role in combining the judgments of several individuals to obtain a single judgment for the group. Judgments must be combined so that the reciprocal of the synthesized judgments is equal to the syntheses of the reciprocals of these judgments. It has been proved that the geometric mean, not the frequently used arithmetic mean, is the only way to do that (Saaty, 2008).

Normally in a situation with only one expert (decision maker), the expert makes pairwise comparisons in a matrix. The software then calculates the priorities based on this matrix. In case of a group decision situation, the software creates a "combined model" based on the individual judgments by taking the geometric mean of each pairwise judgment and then putting this "averaged judgment" into a "combined matrix". The "combined matrix" is then used by the software to calculate the group priorities.

The software calculates the geometric mean using the following formula (Ishizaka and Labib, 2009):

$$p_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}}$$

Where a_{ij} is the comparison between object i and j;
p_i is the priority of object i; and
n is the number of comparisons

Consistency

AHP allows inconsistency, but provides a measure of the inconsistency in each set of judgments. This measure is an important by-product of the process of deriving priorities based on pairwise comparisons (Forman and Selly, 2002). As priorities make sense only if derived from consistent or near consistent matrices, a consistency check must be applied.

Saaty has proposed a consistency index (CI) with the following formulas (Ishizaka and Labib, 2009):

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Where λ_{max} is the maximal eigenvalue.

$$CR = \frac{CI}{RI}$$

Where RI is the random index (the average CI of 500 randomly filled matrices).

If CR is less than 10% (0,1), then the matrix can be considered as having an acceptable consistency.

Normalisation

One of the parts of the AHP model is to judge the likelihood of the alternatives related to the classified subcriteria. In case the value of the subcriterion is in between the client or company values of an alternative, the exact position for the cursor in Expert Choice 2000 is determined with the normalization method called linear interpolation. Figure 25 shows an example where the likelihood of the client values € 5,61 and € 2,44 has to be judged against the subcriterion € 4,80. In order to determine the global position of the cursor, the scale of Expert Choice (1-9) is divided into equal values between the two client values. The value of € 4,80 is somewhere in between 4 (4,62) and 5 (4,82).

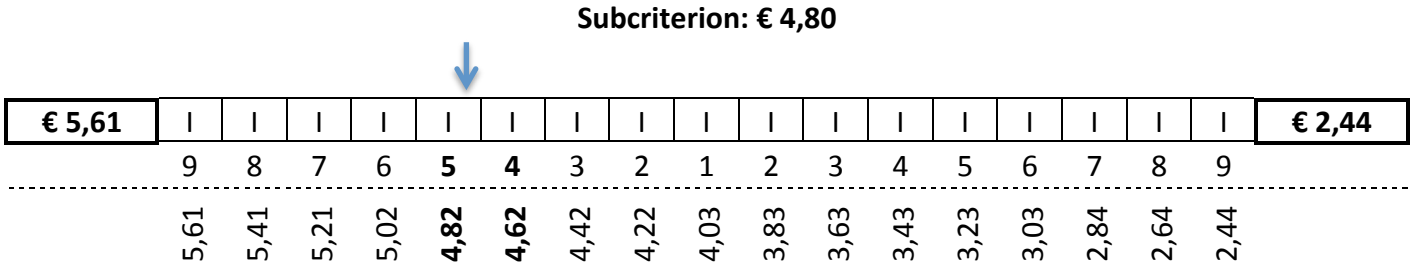

Figure 25: Example normalisation

The precise position can then be determined with the following formula:

$$y = y_0 + (y_1 - y_0)\frac{x - x_0}{x_1 - x_0}$$

Where y_0=5, x_0=4,82, y_1=4, x_1=4,62 and x=4,80, so the exact position of the cursor will be at 4,9.

All the alternatives are judged against the subcriterion using the previously described method except the cases where the client or company value exceeds the highest subcriteria of € 6,90 (client value) and € 96.000 (company value). In these cases the cursor has been adjusted manually.

4.2 The AHP model

The first step in de AHP process is the development of the hierarchical structure by breaking down the problem into its components. The four major levels of the hierarchy for this research are the goal, the criteria, subcriteria and the alternatives (Figure 26).

4.2.1 Goal

The goal is a statement of the overall objective. The goal for this research is to choose an organization structure for Woonbedrijf for the preservation of the Airey neighbourhood.

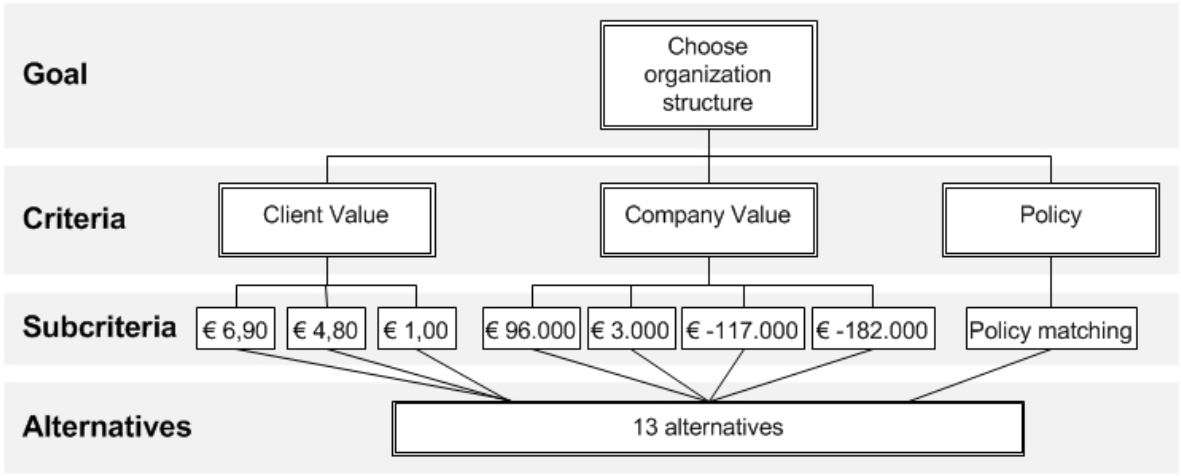

Figure 26: AHP model

4.2.2 Criteria and subcriteria

The factors that influence the problem are called criteria or objectives. They are located in the level immediately below the goal. The criteria have been formulated using a bottom-up approach. This means that the criteria emerged from the information of the already known alternatives. The subcriteria are directly related to the criteria because they represent various properties of the criteria. The following criteria and subcriteria have been identified for this research:

4.2.2.1 Client value

The client value is already introduced in the financial model. In the context of this research, the client value has been defined as the net monthly saving on the electricity bill per household as a result of the PV panels. So higher financial savings will lead to a higher client value. The subcriteria for the client value (€ 6,90, € 4,80 and € 1,00) are derived from the classification method applied in section 5.1.1.2.

4.2.2.2 Company value

As well as the client value, the company value is also introduced in the financial model. In the context of this research, the company value has been defined as the Net Present Value (NPV) of the whole exploitation (226 dwellings) in 20 years. So higher NPV's will lead to higher company values. The subcriteria for the company value (€ 96.000, € 3.000, € -117.000 and € -182.000) are derived from the classification method applied in section 5.1.1.1.

4.2.2.3 Policy

Besides the client and company value, a new criteria has been introduced named “policy”. During the research it became clear that it is not sufficient to judge alternatives only on financial parameters because the choice for an organization structure could include more fundamental principles like; should energy services be offered by Woonbedrijf, or is it not the core business of the housing association and should especially external companies perform these services? Answers on this type of questions are rooted in the policy of the housing association. In the context of this research, the criterion “policy” is therefore defined as the degree to which an organization structure matches the policy of the housing association.

4.2.3 Alternatives

The alternatives are located in the bottom level of the hierarchy. The alternatives for this model are coming from the financial model. The 13 alternatives with a positive client value serve as an input for the AHP model.

4.3 Data collection

After constructing the AHP hierarchy, judgements in the form of pairwise comparisons have to be made in order to derive the priorities for the different alternatives. According to the AHP model, the following judgements have to be made:

- Importance of the criteria related to the goal;
- Importance of the subcriteria related to the criteria;
- Likelihood of the different alternatives related to the subcriteria;

The data needed for these judgments is collected with the help of a questionnaire. This questionnaire has been sent to a selection of employees from Woonbedrijf. At the same time, short interviews of 30 minutes where planned with these employees. The goal of these interviews was to discuss the results of the questionnaire and to support the respondents with possible questions or ambiguities. They were very valuable since not every employee has the same amount of knowledge about sustainability. Another advantage of these interviews was that they encouraged an internal discussion between employees, managers and departments about sustainable projects.

4.3.1 Experts

The respondents who were consulted are selected based on their position and/or their involvement with the subject sustainability. For this research, 13 respondents were consulted with mainly positions in the senior management of Woonbedrijf. The respondents are spread across different departments varying from internal departments like finance and governance up to more client-oriented departments like housing and real estate.

4.3.2 Questionnaire

Given the fact that the senior managers have busy schedules, the questionnaire has been compiled as short and concise as possible. In order to reduce the number of questions as much as possible, the likelihood of the alternatives related to the client value and company value are not included in the questionnaire because these values can be programmed based on the results of the financial model. In this way the respondents are not overloaded with information and they can only focus on the most important subjects.

In order to improve the ease to fill in the questionnaire, the questionnaire was prepared as a digital PDF form that could be filled in and saved digitally without printing. The full questionnaire can be found in appendix 5. The questionnaire consists of the following parts:

1. General introduction about the method, the case study and the criteria with some examples;
2. Pairwise comparisons to judge the importance of the criteria related to the goal;
3. Pairwise comparisons to judge the importance of the classified company values (subcriteria) related to the company value (criterion);
4. Pairwise comparisons to judge the importance of the classified client values (subcriteria) related to the client value (criterion);
5. Pairwise comparisons to judge the preference for different possible organization structure related to the policy of Woonbedrijf.

4.4 Results

After constructing the AHP hierarchy and collecting the data, Expert Choice 2000 is used to generate the priorities and to analyse the results. Figure 27 shows the hierarchical structure in the model view of the software program. The left side of the screen shows the goal followed by the criteria and subcriteria. Since the software requires a minimum of two subcriteria to make the judgements, a *shadow* subcriterion has been introduced underneath the *policy* criterion. This *shadow* criterion has been judged manually with a minimum priority of 0,001 against a priority of 0,999 for the *policy matching* subcriterion. The right side of the screen shows the thirteen remaining alternatives that will be included in the analysis. Alternative 8 and 11 are excluded based on the negative client values in the financial model.

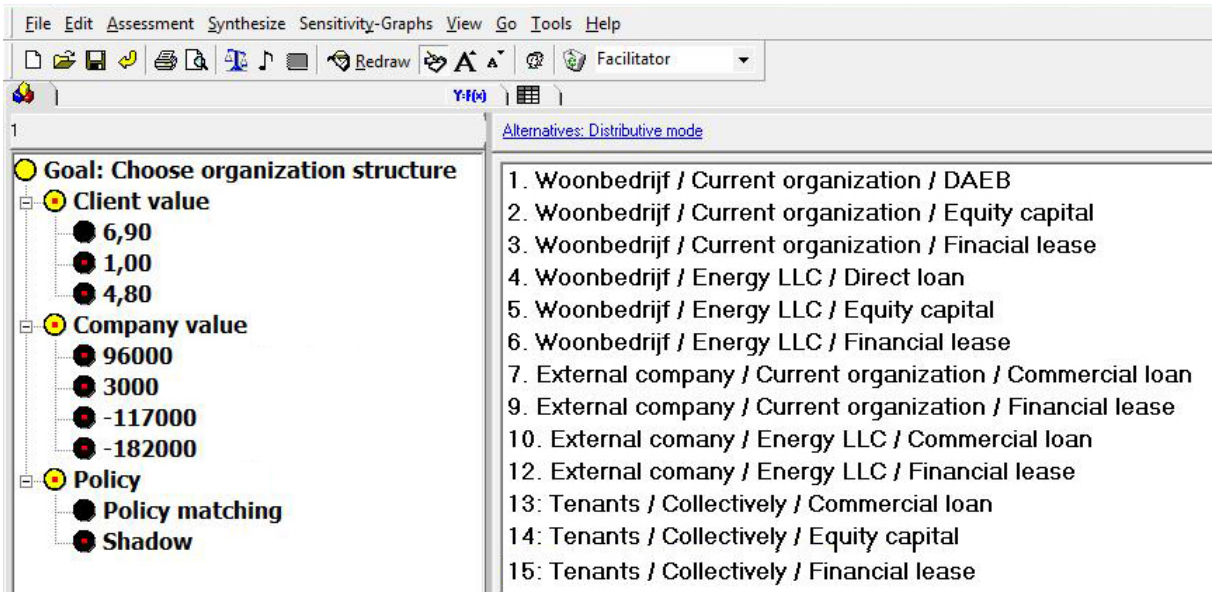

Figure 27: Model view in Expert Choice 2000

Figure 28 shows the *participants screen* of the software. For this research thirteen personal profiles have been created, one for each of the respondents. The screen shows two more profiles, namely *combined* and *facilitator*. The *facilitator* profile has the rights to make adjustments to the hierarchical structure of the AHP model. The *combined* profile combines the data and judgements of all the individual profiles into one *combined* profile in order to generate priorities for the whole group.

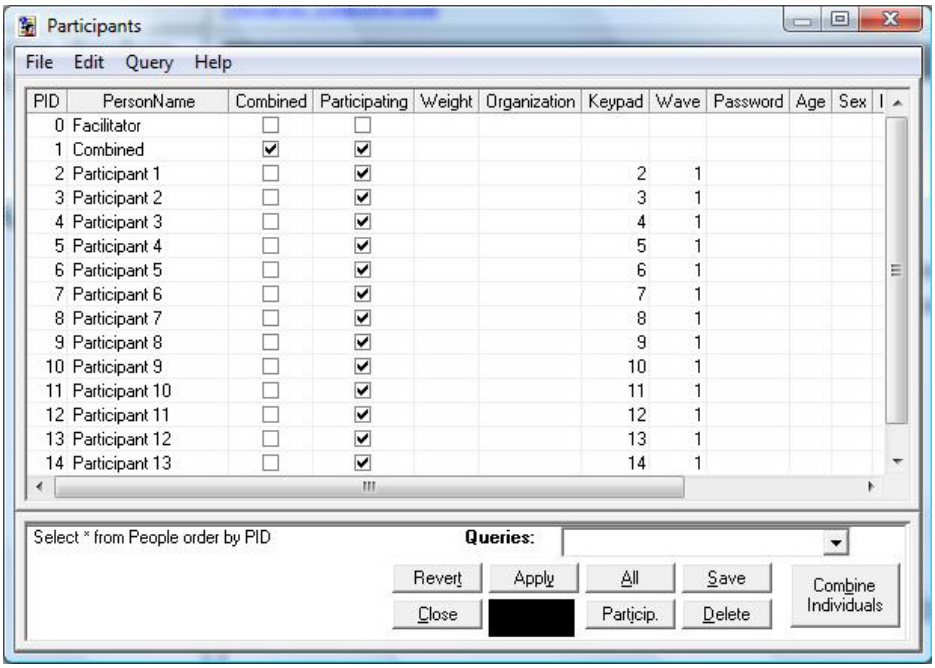

Figure 28: Participants screen in Expert Choice 2000

The following sections present the results for the whole group based on the *combined* profile.

4.4.1 Relative importance of the criteria related to the goal

First the weights for the criteria related to the goal will be analysed. Figure 29 shows the weights synthesized by the software. The *client value* turns out to be the most important criterion by far when an organization structure must be chosen. This outcome corresponds to the general policy of Woonbedrijf where investments are assessed against the criteria *client value*, *company value* and *real estate value* in descending order of importance. The company value also corresponds to the general policy of Woonbedrijf with a second place in the order of importance. The criterion policy turns out to be subordinate to the *client* and *company value*. Decisions for particular organization structures could be based on general policies in first instance, but offer room for discussion when higher *client* and *company values* could be achieved with alternative organization structures.

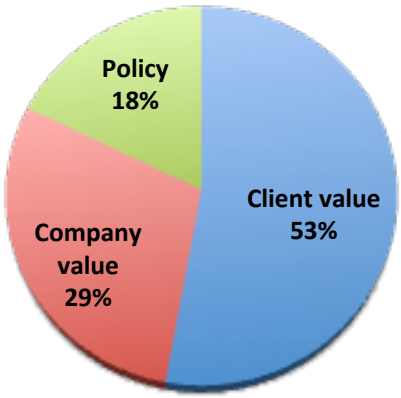

Figure 29: Weights of the criteria related to the goal

4.4.2 Preferences for the alternatives with respect to the criteria

Besides the weights for the main criteria related to the goal. The software also generates weights for the different subcriteria related to the main criteria. This section covers these weights combined with the priorities of the different alternatives related to the main criteria.

4.4.2.1 Client value

Figure 30 shows the weights for the subcriteria (classified client values) related to the main criterion *client value*. Since the *client value* turned out to be the most important criterion, the tenants are taken into account maximally regarding the height of the *client value*. The maximum *client value* of € 6,90 is judged as most important by far followed by the descending *client values* of € 4,80 and € 1,00.

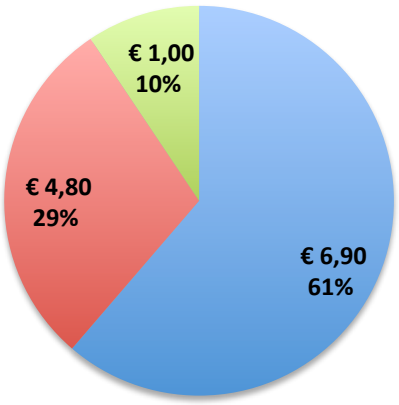

Figure 30: Weights of the subcriteria related to the client value

Figure 31 shows the priorities of the different alternatives related to the *client value*. The organization structure where Woonbedrijf invests in the project using a secured loan within their current organization turned out to be the alternative with the highest *client value*. This outcome corresponds to the results of the financial model. This alternative has minimum exploitation costs combined with lower financing costs due to the secured loan. This maximizes the benefits for the tenants. Secondly, the organization structure with an energy cooperative turned out to be also very beneficial in the context of the *client value*. This is caused by using volunteers and the absence of the commercial goal to make profit.

Figure 31: Synthesis with respect to the client value

4.4.2.2 Company value

Figure 32 shows the weights for the subcriteria (classified company values) related to the main criterion *company value*. The highest *company value* of € 96.000 has the highest degree of importance, but is closely followed by the *company value* of € 3.000. This means that a positive value is the most important factor in the context of judging the *company value* and that the height of this positive value is less important. The vast majority of the respondents accepts only a *company*

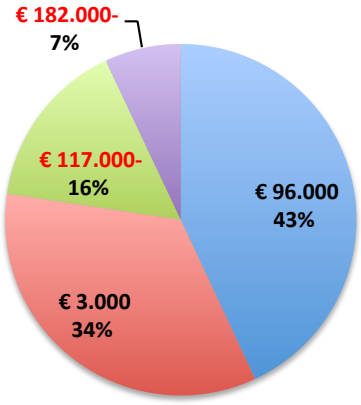

Figure 32: Weights of the subcriteria related to the company value

value that is higher or equal to 0. This corresponds to Woonbedrijf's policy that investments in renewable energy should be recouped without the goal to make profit on the investment.

Figure 33 shows the priorities of the different alternatives related to the *company value*. The two organization structures where an external company invests in the project using a commercial loan turned out to be the best alternatives regarding the *company value*. These alternatives do not generate the highest company values, but they have the closest *company values* to 0 which gives them high priorities based on the weights as discussed above (Figure 36).

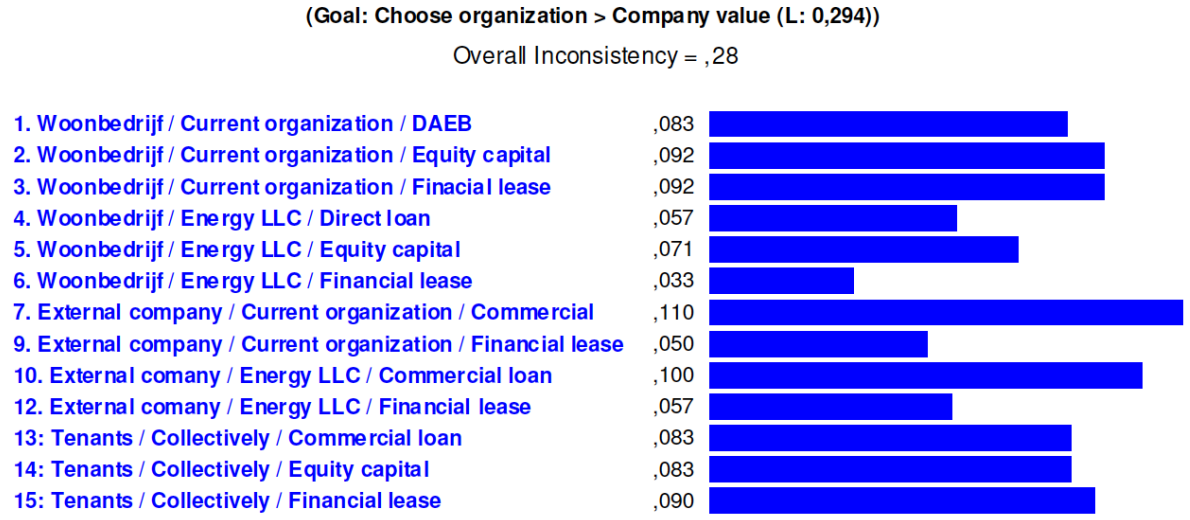

Figure 33: Synthesis with respect to the company value

4.4.2.3 Policy matching

In fact the *policy* criterion only has one subcriterion, namely *policy matching*. In order to complete the model in Expert Choice 2000, the software requires at least two subcriteria. Therefore a shadow criterion has been used with an insignificant priority. This shadow criterion will be left out of the further analysis.

Figure 34 shows the priorities of the different alternatives related to the subcriterion *policy matching*. The respondents prefer the organization structure with an energy cooperative with a large majority. The reason for this outcome is embedded in the essence of an energy cooperative structure. The idea of an energy cooperative is that residents establish a cooperative in order to buy and generate renewable energy collectively (Atrive, 2012). The local energy cooperative has no commercial targets so the members will directly benefit from the revenues. This organization structure is fully based on the initiative of the tenants which fits perfectly to the policy of Woonbedrijf to be a client driven housing association.

The results also show that it is preferred to invest in the project using a separate entity in the form of an Energy LLC. The reason for this is that a separate entity ensures a separate administration and that these structures allow to sell, divest or transfer the energy services in the future towards other parties like companies or energy cooperatives.

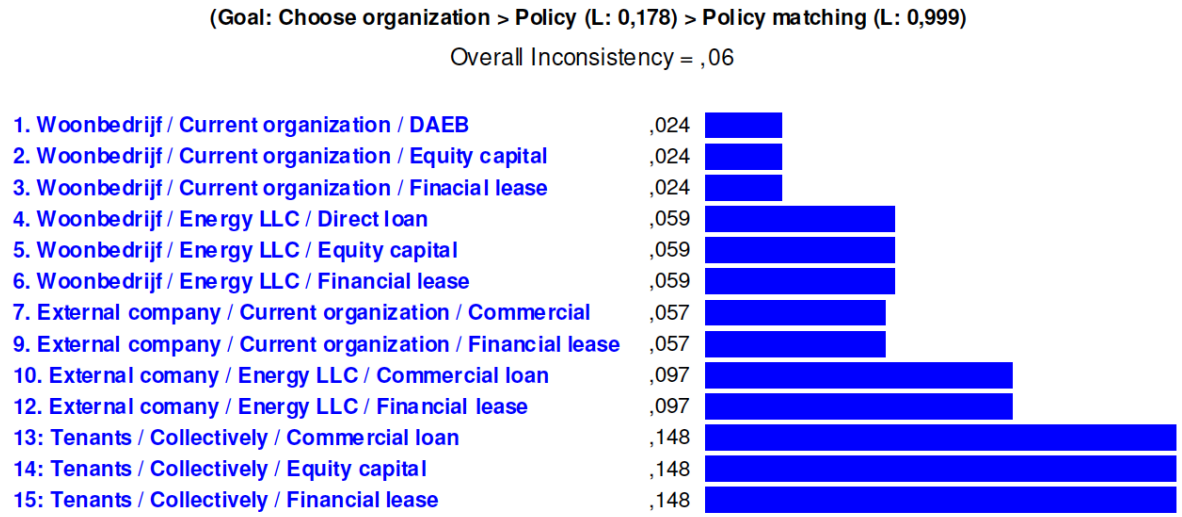

Figure 34: Synthesis with respect to policy matching

4.4.3 Synthesis with respect to the goal

After synthesizing the priorities of the alternatives related to the individual criteria, the final results can be generated where the priorities of the alternatives towards the goal are synthesized. Figure 35 shows these results.

The organization structure where the tenants collectively participate in an energy cooperative turned out to be the most preferred organization structure by the respondents. This organization structure perfectly fits the client driven policy of Woonbedrijf and also generates one of the highest client and company values due to the absence of commercial targets to generate profit. The high priorities of this alternative related to the individual criteria ultimately result in the highest overall priority related to the goal.

Figure 35: Synthesis with respect to the goal

Secondly the respondents prefer to outsource the energy activities to external companies. The rationale for this result is mainly driven by the *policy* and *company value* criteria. The alternatives where an external company finances the project using a commercial loan results in acceptable *client values* (€ 4,84 and € 4,73) and at the same time in company values

around € 0. This fits Woonbedrijf's policy to not make a profit on investments in renewable energy and also fits the policy criterion where outsourcing is preferred.

Despite the highest *client* and *company values*, the respondents do not prefer the alternative where Woonbedrijf invests and takes care of the exploitation within their current organization. The reason for this is that the *client* and *company values* are practically the same as the *client* and *company* values of the energy cooperative. Where the *policy* criterion is decisive with a preference for the energy cooperative structure.

4.4.3.1 Inconsistency

The software provides a measure of the inconsistency in each set of judgments called the Consistency Ratio (CR). Normally, if the CR is less than 10% (0,1), the matrix can be considered as having an acceptable consistency. However, the results exceed this rule with an overall consistency of 0,29, and consistencies for the individual criteria of 0,36, 0,28 and 0,06. This does not automatically mean that the outcomes are not sufficient because the real world is hardly ever perfectly consistent and we can learn new things only by allowing for some inconsistency with what we already know. The higher inconsistency rates can have various causes like (Forman and Selly, 2002):

Lack of information

Some respondents have less knowledge about the factors being compared than other respondents, then judgments will appear to be more randomly and a higher inconsistency ratio will result. Is has been tried to make the lack of information as small as possible by using the short interviews during the data collection to inform the respondents. However, some of the respondents remain extreme with their judgments putting al their preferences to the *extreme* checkbox in their pairwise comparisons. This results in a higher inconsistency rate.

Incapable scale

One might erroneously conclude that the AHP scale is incapable of capturing the differences since the scale ranges from 1 to 9. However, because the resulting priorities are based on second, third, and higher order dominances, AHP can produce priorities far beyond an order of magnitude. For example, if A is nine times B, and B is nine times C, then the second order dominance of A over C is 81 times. A higher than usual inconsistency ratio will result because of the extreme judgments necessary. If one recognizes this as the cause, one can accept the inconsistency ratio even though it is greater than 10% (Forman and Selly, 2002). This is the case in this research because many values are outside the range of the interpolation method (normalization) making the scales above 9 not clear.

According to Forman and Selly (2002), it is important that a low inconsistency does not become the goal of the decision-making process. A low inconsistency is necessary but not sufficient for a good decision. It is possible to be perfectly consistent but consistently wrong. It is more important to be accurate than consistent. The results of the AHP analysis correspond to the results of the financial model and the policy of Woonbedrijf. In addition, the causes for the higher inconsistency rates are also known. Therefore these inconsistency rates will be accepted.

4.4.4 Sensitivity analysis

If the priorities of the main criteria are changed, how will the outcome be affected? This type of questions can be answered with the help of a sensitivity or What-if analysis. The Expert Choice 2000 software offers several interesting tools that show how the priority of the alternatives would change if one of the criteria is made more important. This section shows the results of the sensitivity analysis.

Because the three criteria will always have a certain amount of importance, assigning a weight of 100% to one criterion does not make sense. Therefore a weight of 75% will be used to test the scenarios. Figure 36 shows the scenario with a high importance for the *client value*. In this scenario the energy cooperative appears to be the strongest organization structure followed by Woonbedrijf (current organization) and the external company structures.

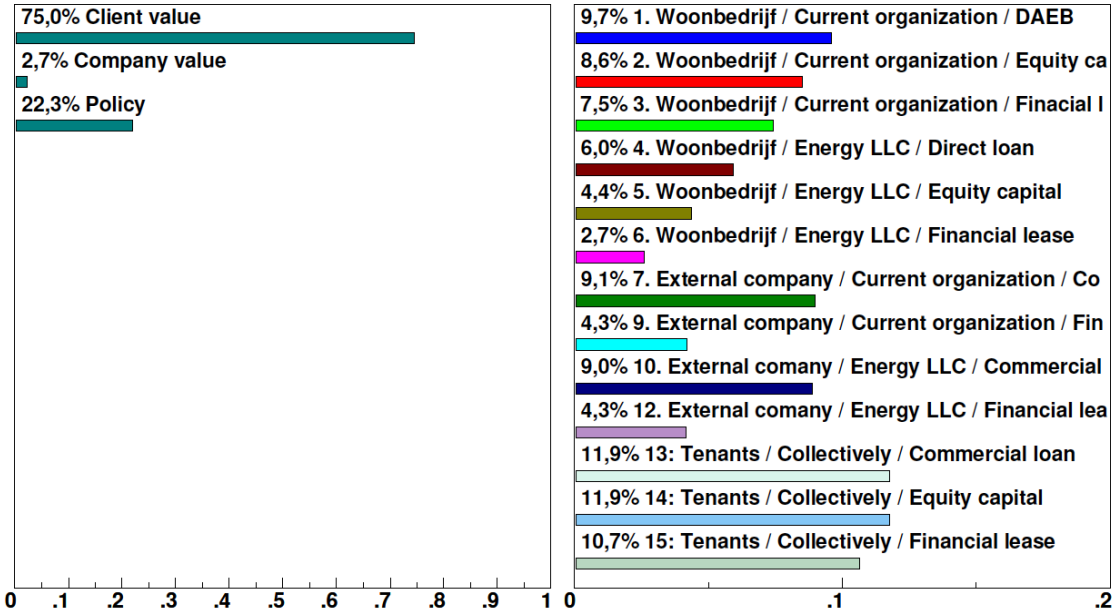

Figure 36: High priority for client value

In figure 37, the scenario with a high importance for the company value is showed. Here the external company (current organization) turns out to be the best alternative closely followed by the external company (Energy LLC) and the energy cooperative structures.

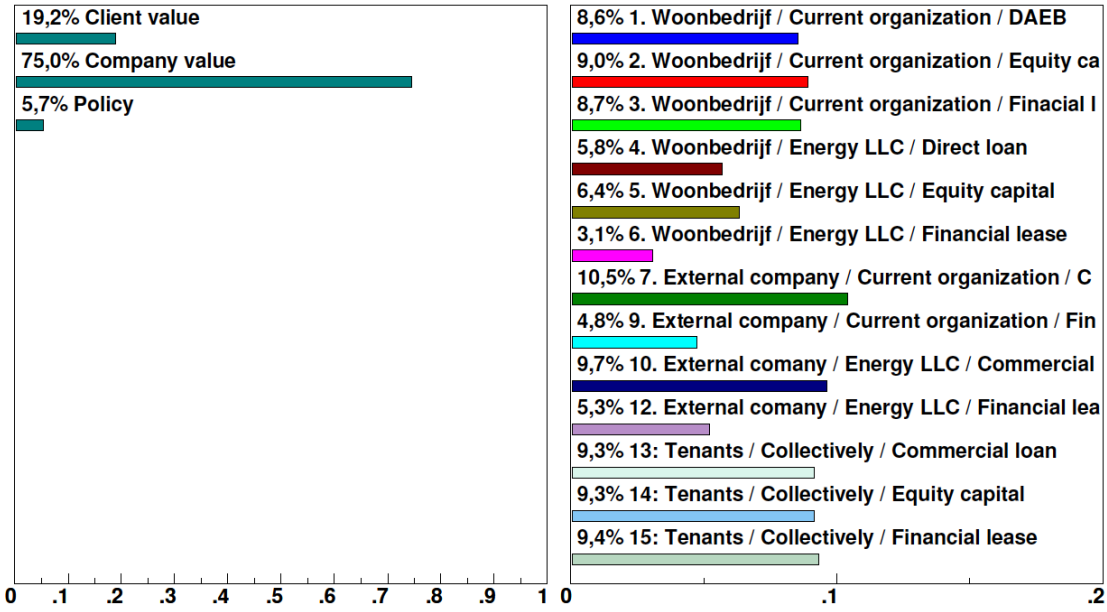

Figure 37: High priority for company value

Figure 38 shows the scenario with a high importance for policy. In this scenario the energy cooperative appears to be the strongest organization structure by far followed by the external company structures.

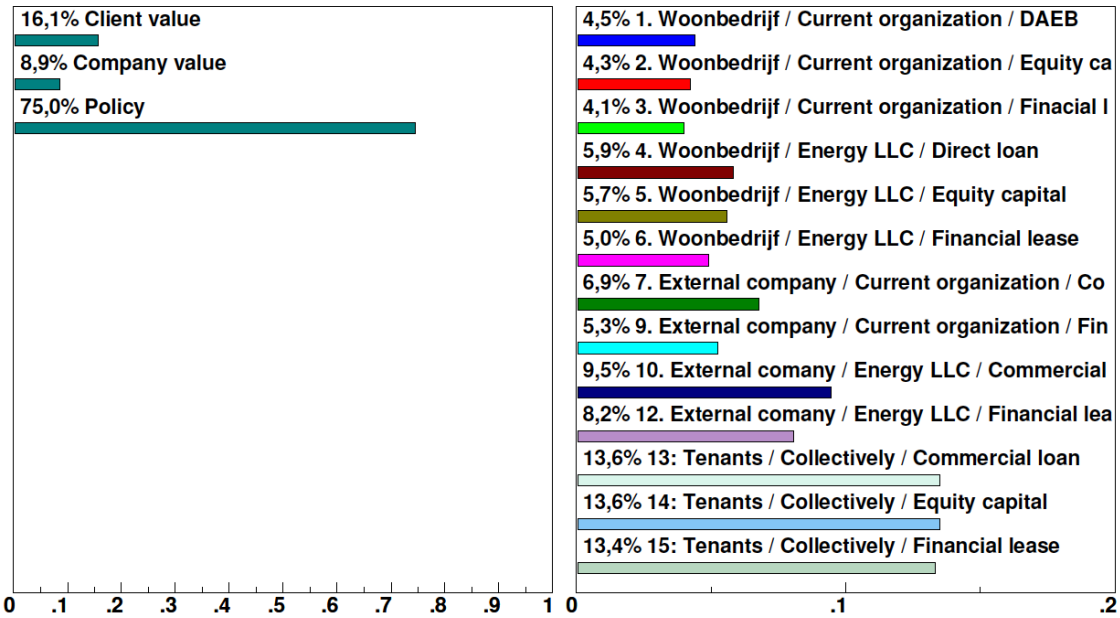

Figure 38: High priority policy

Based on these scenarios it can be concluded that the energy cooperative organization structure is the best organization structure. With the exception of the high company value scenario, the energy cooperative turned out to be the alternative with the highest overall priorities.

4.4.5 Choosing the organization model

Based on the results of the AHP analysis, a substantiated decision for the best organization structure for the preservation of the Airey neighbourhood can be made. The results show that the organization structure where the tenants collectively participate in an energy

cooperative is the most preferred alternative by the respondents. These are alternatives 13 and 14 where the energy cooperative finances the project with a commercial loan or equity capital. The reason for this outcome can be found in the decision criteria.

The first criterion, *client value*, appeared to be the most important criterion with a weight of 53% related to the goal. Within the *client value*, the subcriterion with the highest *client value* (€ 6,90) is the most preferred value with a weight of 61%. Alternative 13 and 14 share the second-highest priority (0,111) related to the client value with a monthly saving of € 7,27 per household just behind alternative 1 which has a monthly saving of € 7,43 and a priority of 0,119.

The *client value* is followed by the *company value* in descending order of importance. The *company value* has an overall weight of 29% related to the goal whereby the positive *company values* are strongly preferred by the respondents (total weight of 77%). Alternative 13 and 14 are here also in the upper segment of the priorities (0,083) with a *company value* of € 105.994.
The *policy* criterion has with a weight of 18% the smallest amount of importance related to the goal. However, this criterion definitely affects the final outcome. Alternatives 13 and 14 have by far the highest priority (0,148) because the energy cooperative structure fits perfectly to Woonbedrijf's policy.

The idea of the energy cooperative structure is that residents establish a cooperative in order to buy and generate renewable energy collectively. The local energy cooperative has no commercial targets so the members will directly benefit from the revenues. The organization structure is fully based on the initiative of the tenants which fits perfectly to the policy of Woonbedrijf to be a client driven housing association. This organization structure ensures the highest possible involvement of the tenants because the tenants own shares in the cooperative and at the same time this structure ensures a clear distinction between housing services offered by Woonbedrijf and energy services offered by the energy cooperative. Woonbedrijf will therefore only have a facilitating role in the project without active or financial involvement.

Figure 39 shows the organization structure of the energy cooperative. The energy cooperative takes care of the investment and exploitation of the PV panels and the members pay the cooperative through an invoice including a membership fee. The tenants will have a vote in the board of the cooperative through their shares.

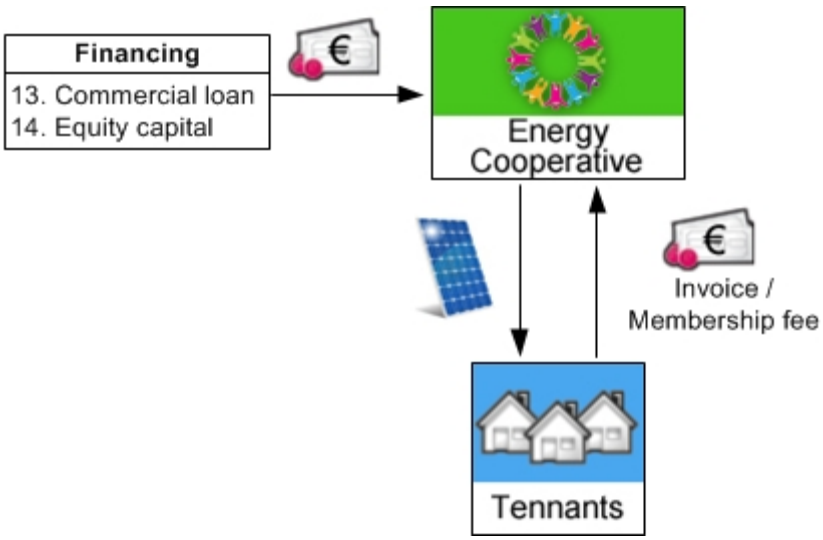

Figure 39: Energy cooperative structure

The fact that this organization structure is fully based on the initiative of the tenants is very

advantageous with enthusiastic tenants because they will be very involved in the project. However, this required involvement could also be harmful for the sustainable targets of the housing association when there is a lack of collective initiative from the tenants. Dispersed initiatives can obstruct possible future collective initiatives and the social housing target group may be difficult to motivate since energy expenses are not the first priority in these households.

4.4.5.1 Alternative structure

Since the energy cooperative structure is fully based on the tenant's initiative, some problems can occur during the start-up phase of the project when there is a lack of initiative among the tenants. This may harm the sustainable targets of Woonbedrijf to use the Airey neighbourhood as a pilot project for sustainable measures. Therefore, an alternative organization structure has been developed wherein the essence of the energy cooperative and the possibility to kick-start the project by Woonbedrijf are combined. Figure 40 shows this structure called the Airey fund structure.

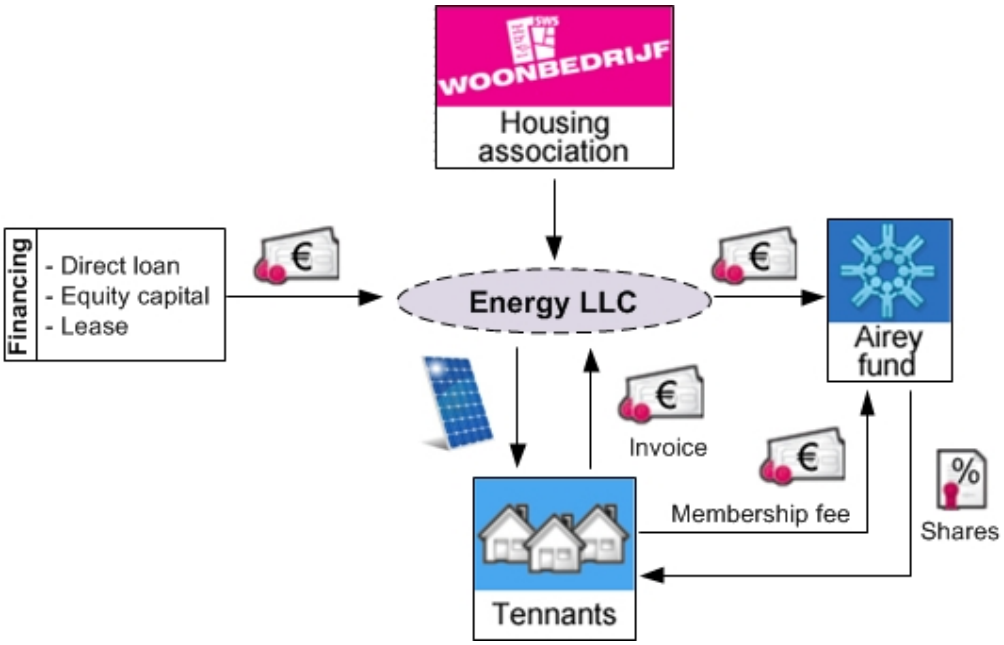

Figure 40: Airey fund structure

In order to conform to their policy to invest and exploit renewable energy in the Airey neighbourhood as a whole, Woonbedrijf could invest in the PV panels and establish an Energy LLC. In addition, a local fund (Airey fund) could be established that is fully owned by the tenants. The tenants all have an equal vote in the board of the Airey fund based on their shares for which they pay a membership fee in return. The Airey fund uses the income from the membership fees to organize collective events for the neighbourhood. The type of event is free to choose by the tenants. Additionally there is the possibility to formulate sustainable targets for the neighbourhood that can be monitored by the Energy LLC like a certain percentage of annual electricity reduction. If these targets are achieved the Energy LLC could transfer a part of the energy revenues into the Airey fund as a trigger for further preservation of the neighbourhood. With this construction, Woonbedrijf could directly start with the development of the project while the involvement of the tenants is simultaneously stimulated. This structure is also applicable in case an external company invest in the project instead of Woonbedrijf.

5 Conclusions

In the following paragraphs, the conclusions of this research will be presented by answering the sub research questions as defined in chapter 1.

The first part of the research aims to answer research question 1:
What aspects and developments regarding the preservation of existing housing stocks for housing associations are described in literature?

RQ 1.1: What are the legal concerns for housing associations when sustainable measures are implemented?

In the context of this research, there are two important acts that have to be taken into account, namely the *Housing Act* and the *Electricity Act*. The Housing Act is in the middle of a renewal process and is important in terms of organization structures. The new Housing Act, which is expected to be introduced in 2014, will have the following consequences for organizing sustainable projects:

- Core tasks and secondary activities will be replaced by Services of General Economic Interest (DAEB) and other permitted services (not-DAEB) in the context of the newly introduced administrative separation;
- Housing associations have to make an administrative separation between DAEB activities and Not-DAEB activities to ensure that the DAEB activities (core tasks) cannot suffer from disinvestments in commercial activities (Not-DAEB) and to prevent that DAEB financing can be used for commercial activities.
- The new Act prescribes specific rules for future connections between housing associations and separate entities:
    - The housing association is allowed to invest up to 15% of the balance sheet total into separate entities;
    - The board of the housing association may not be part of the board of the entity. The entity has to be governed individually;
    - Future establishments of connections with separate entities have to be approved by a newly formed supervisory authority.

Since this research is focussed on the implementation of PV panels, the following rules of the *Electricity Act* have to be taken into account:

- The living situation of the tenants has an essential influence on the feasibility of the project. If the generated electricity can be directly delivered to the own electricity system of the tenant behind the meter box (land-based dwellings), the tenant does not have to pay taxes on the generated electricity. If the generated electricity has to be transferred via the public electricity network towards the dwelling of the consumer, taxes have to be paid on the generated electricity making the business case infeasible.
- Regarding the fee for the generated electricity, the Electricity Act prescribes the following rules:
    - Up to 5000 kWh of the returned electricity has to be subtracted by the energy company from the supplied energy to the consumer (salderen);
    - In case the consumer exceeds the boundary of 5000 kWh, the energy company has to pay a reasonable compensation of € 0,05 per kWh;

- Consumers are partly compensated for the paid energy taxes. Every connection to the network receives € 318,63 as compensation.

RQ 1.2: What kind of possibilities are available for housing associations to finance the implementation of sustainable measures in their neighbourhoods?

When financing options in the social housing sector are considered, the following parties could play the role of investor in sustainable projects: 1) the housing association, 2) the tenants and 3) external companies. Since not every party has access to the same financing resources, the available resources per party are listed in table 1 on page 14.

There are two options available to recoup the investment with the tenants. First option is to increase the rent for the tenants. This option is only available in case the housing association invests within their current organization (authorized institution). Second option is to send a separate invoice to the tenants. This option has to be applied when a separate entity invests in the project (Woonbedrijf Energy LLC, External Company, Energy Cooperative).

RQ 1.3: What kind of organization structures are available for housing associations to implement sustainable measures?

The legal framework and the financing possibilities are closely connected to the organization structures since some financing resources are only applicable for specific organization structures. In general, organization structures can be divided into three groups based on who is investing. First the housing association could invest in the project with the possibility to use their current organization or to establish a separate entity. The current organization offers benefits in terms of cheaper financing possibilities (DAEB) and lower start-up costs while the separate entity ensures a sound administrative separation and fiscal benefits. Second an external company could take care of the investment and exploitation. This offers benefits in terms of relieving the housing association and a sound separation between housing services and energy services towards the tenants, but also burdens the benefits of the tenants because of the commercial targets. Third option is to leave the initiative to the tenants. The tenants have the possibility to invest individually in sustainable measures or to invest collectively using an Energy Cooperative organization structure. Figure 14 on page 26 gives an overview of the possibilities. The findings of the first part of this research are all summarized into one scheme. This scheme (Figure 13) can be found on page 25.

Research question 2:

How can the preservation of the existing housing stock successfully be implemented in the Airey neighbourhood taking into account technical, organizational, legal and financial aspects?

RQ 2.1: What kind of organization structure has to be established in order to deal with the costs and benefits arising from the sustainable measures?

The second part of the research was completely dedicated to the selection of the best organization structure for the scenario wherein 15 m2 of PV panels will be installed on 226 dwellings in the Airey neighbourhood. In order to make an objective selection, a two-step research structure has been applied wherein firstly the financial consequences for the

tenants (client value) and the investor (company value) have been determined and secondly the best alternative has been selected with the use of the Analytic Hierarchy Process (AHP).

The *client value* and *company value* were calculated for the 15 alternatives with the use of a financial calculation model. The results showed that 13 alternatives have a positive *client value* which means that the tenants have financial benefits of up to € 90 per year as a result of the PV panels. This is a positive result because this proves that investments in PV are viable business cases and that renewable energy is able to compete with conventional energy.

As a final step, AHP has been used in order to choose the best organization structure out of the 13 remaining alternatives. The alternatives have been assessed on three criteria, namely *client value*, *company value* and *policy*. The data has been collected with the help of a questionnaire and short interviews with 13 managers from Woonbedrijf. The results of the AHP analysis showed that the *client value* has the highest importance (53%) followed by the *company value* (29%) and *policy* (18%).

The organization structure where the tenants collectively participate in an energy cooperative is the most preferred alternative according to the AHP and sensitivity analysis. The energy cooperative structure has high priorities for the three criteria because this structure generates high *client values* (€ 7,27), high *company values* (€ 105.994) and fits perfectly to the policy of Woonbedrijf.

The idea of the energy cooperative structure is that residents establish a cooperative in order to buy and generate renewable energy collectively. The local energy cooperative has no commercial targets so the members will directly benefit from the revenues. The organization structure is fully based on the initiative of the tenants which fits perfectly to the policy of Woonbedrijf to be a client driven housing association. This organization structure ensures the highest possible involvement of the tenants because the tenants own shares in the cooperative and at the same time this structure ensures a clear distinction between housing services offered by Woonbedrijf and energy services offered by the energy cooperative. Figure 39 on page 54 shows the organization structure of the energy cooperative. The energy cooperative takes care of the investment and exploitation of the PV panels and the members pay the cooperative through an invoice including a membership fee. The tenants will have a vote in the board of the cooperative through their shares.

Despite the benefits, this organization structure also has some risks. The fact that this organization structure is fully based on the initiative of the tenants could be harmful for the sustainable targets of Woonbedrijf when there is a lack of collective initiative from the tenants. In addition, the social housing target group may be difficult to motivate since energy expenses are not the first priority in these households.

As a possible solution to these risks, an alternative organization structure has been developed wherein the essence of the energy cooperative and the possibility to kick-start the project by Woonbedrijf are combined (Figure 40, page 55). In this structure, Woonbedrijf or an external company invests in the PV panels via a separate Energy LLC. In addition, a local fund (Airey fund) will be established that is fully owned by the tenants. The tenants all

have an equal vote in the board of the Airey fund based on their shares for which they pay a membership fee in return. The Airey fund uses the income from the membership fees to organize collective events for the neighbourhood. The type of event is free to choose by the tenants. Additionally there is the possibility to formulate sustainable targets for the neighbourhood that can be monitored by the Energy LLC like a certain percentage of annual electricity reduction. If these targets are achieved the Energy LLC could transfer a part of the energy revenues into the Airey fund as a trigger for further preservation of the neighbourhood. With this construction, Woonbedrijf could directly start with the development of the project while the involvement of the tenants is simultaneously stimulated.

5.1 Discussion

Given the limited timeframe of the research and the size of the subject, it is valuable to review the research in order to locate improvements that could increase the value of the research field. When investments in renewable energy are considered, both electricity and heat play an important role. According to Woonbedrijf's investment strategy, this research focuses on electricity where mainly financial parameters are important. This reflects the financial approach for the *client value* and the *company value*. When heat is also taken into account more subjective parameters could play a role like *comfort*. Hereby, the *client value* could have a much broader meaning.

The applied research method AHP proved to be a very useful tool to support the decision-making process within Woonbedrijf. The subject is quite new and unknown for the organization, but becomes rapidly more important since the market for renewable energy emerges. The data collection with a questionnaire and additional interviews were very helpful to spread the information across the departments and to trigger the discussion about organization structures for preservation. The unfamiliarity with the subjects is reflected by the high rates of inconsistency and the low number of respondents. Therefore, the AHP analysis in this research must be seen as a tool to support the decision making from Woonbedrijf and to give insight in the importance of decision criteria when organization structures for preservation are considered.

5.2 Further research

During the research, some interesting subjects arose that could be interesting for further research:

- Given the electrical and financial focus, further research would be interesting where heat is included. The combination of electricity and heat covers the whole energy expenses for the tenants and additionally offers opportunities to include more subcriteria for the *client value* like *comfort*;
- The target group of housing associations is very specific. Since the tenants' behaviour is also an important factor for energy savings, further research about influencing behaviour and communication with tenants would be interesting;
- It became clear during the research that a lot of housing associations are struggling with the same questions about organizing preservation projects. It would be interesting to do research about the possibilities to join the forces of these housing associations like establishing a collective Energy LLC for all the energy services of the housing associations in Eindhoven.

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Appendix 1: Legal framework

As mentioned in part 2.1, there are two key acts regarding sustainable electrical measures for housing associations, namely the Housing Act and the Electricity Act. The following sections cover the most important issues for housing associations in more detail.

The Housing Act

The decision making process about the new Housing Act (Woningwet / Herzieningswets) has lasted for about ten years. In July 2012, the new Act has been approved by the House of Commons (tweede kamer). At this time, the draft law is waiting for approval of the Upper House (eerste kamer). However, this process has been delayed due to the new coalition agreement (regeerakkoord) of October last year. The minister (Blok) wants to implement several measures of the coalition agreement before it is treated in the Upper House. Therefore, it is expected that the act will be introduced not earlier than January 1st 2014 (Aedes, 2012).

The introduction of the new act will have consequences for the way in which the preservation of the existing housing stock can be organised. The following paragraphs will describe the most important issues.

Task field

The current tasks for housing associations are regulated by the Besluit Beheer Sociale Huursector (BBSH). The BBSH defines the following core tasks for housing associations (Duijvestijn, 2012):

- Appropriate housing for the target group;
- Maintaining the quality of the housing;
- Involvement of residents in policy and management;
- Guarantee of financial continuity;
- Promote the livability of the districts or areas;
- Contribute to the combination of housing and care.

Despite these core tasks, housing associations are allowed to execute secondary activities such as building homes for sale and executing activities for targets groups other than their own tenants.

In the new Housing Act, the distinction between core tasks and secondary activities will be replaced by Services of General Economic Interest (Diensten van Algemeen Economisch Belang, DAEB) and other permitted services (not-DAEB). The content of the tasks remains roughly the same in the new Housing Act. The new subdivision mainly affects the new introduced administrative separation.

Administrative separation

DAEB activities are related to the core tasks of the housing association like the development of social housing and social real estate. Housing associations can use secured loans (DEAB financing) to finance this kind of investments. DEAB financing is based on a guarantee system which allows housing associations to finance social projects against lower financing

costs (see section 2.2.1.2). Secondary activities cannot be financed with secured loans. This kind of projects have to be executed in competition with commercial parties.

The new Housing Act prescribes that housing associations have to make an administrative separation (administratieve scheiding) between DAEB activities and Not-DAEB activities. This ensures that the DAEB activities (core tasks) cannot suffer from disinvestments in commercial activities (Not-DAEB). This separation also prevents that DAEB financing can be used for commercial activities.

Connections with entities

The new Housing Act has some important consequences for future connections between housing associations and separate entities (deelnemingen en verbindingen). Housing associations may consider to invest in particular projects using a separate entity outside the Authorized Institution (Toegelaten Instelling). This could have several advantages like fiscal benefits and/or a clear separated administration. In the context of the new Housing act, the following issues have to be taken into account when housing associations use or participate into separate entities (Spies, 2012):

- Since there is only indirect supervision on separate entities, the Act determines some asset criteria. The housing association is allowed to invest up to 15% of the balance sheet total into separate entities;
- The board of the housing association may not be part of the board of the entity. The entity has to be governed individually. The Board of Supervision (Raad van Toezicht) of the housing association may also act as the Board of Supervision for the entity, so the housing association can influence the entity from their role as shareholder and via the Board of Supervision;
- Future establishments of connections with separate entities have to be approved by a newly formed supervisory authority. This new authority (Financiele Autoriteit Woningcorporaties, FAW) will monitor the financial activities of the housing associations.

Electricity Act

As described in the research boundaries, this research will focus on renewable generated electricity. Individuals and companies are allowed to generate electricity themselves by using for instance solar PV panels (photovoltaic). PV panels are very suitable to apply in the built environment and in most of the cases they can be economically competitive with conventional energy suppliers. However, there are some important issues that have to be taken into account when people decide to generate electricity themselves. This section describes the most important concerns related to the Dutch Electricity Act.

One of the main advantages of generating electricity with renewable sources is that it gives certainty with regard to the energy costs. Since the renewable energy will be generated against a fixed price for a long exploitation period of 20-25 years, there is immunity for rising electricity prices. This could have considerably financial benefits given the fact that electricity prices increased annually with an average of 5,2% over the past 10 years (Agentschap NL, 2012). The precise amount of the benefit depends on the living situation of the consumer, like:

1. Can the generated electricity be directly delivered to the own electricity system of the consumer behind the meter box; or
2. Is it necessary to transfer the generated electricity via the public electricity network towards the dwelling of the consumer.

In the first scenario, the Electricity Act considers the renewable energy system as a part of the internal electrical system of the house. In this case, the consumer does not have to pay taxes on the generated electricity. In the second scenario, taxes have to be paid on the generated electricity because the public network will be used to transfer the electricity.

If the consumer is able to use the generated electricity directly, the electricity costs (€ 0,07 per kWh) and taxes (€ 0,15 per kWh) will be saved resulting in a financial benefit of € 0,22 per kWh. In case the consumer generates more electricity than needed, the surplus can be returned to the public network. Regarding the fee for the generated electricity, the Electricity Act prescribes the following rules (Agentschap NL, 2012):

- Up to 5000 kWh of the returned electricity has to be subtracted by the energy company from the supplied energy to the consumer (salderen). The boundary of 5000 kWh will be eliminated from July 1st 2013 enabling the consumer to deduct an unlimited amount of electricity with the actual electricity usage (Energie Overheid, 2013);
- In case the consumer exceeds the boundary of 5000 kWh prior to July 1st 2013, the energy company has to pay a reasonable compensation for the generated electricity. This financial compensation has been determined by the Competition Commission (Nederlandse mededingingsautoriteit, NMa) on € 0,05 per kWh.

Energy taxes on electricity usage

In order to encourage consumers to consume less electricity, the government levies energy taxes. The energy taxes are divided into four categories based on annual usage. For this research only the first category of small users (≤ 10.000 kWh) is relevant. In this category, consumers pay per kWh € 0,07 for the electricity, € 0,11 for taxes and € 0,03 for VAT. According to the Electricity Act, consumers are partly compensated for the paid energy taxes. Every connection to the network receives € 318,63 as compensation. This is equivalent to energy taxes charged on an annual usage of 2.400 kWh. Consumers who use less than 2.400 kWh per year get more money in return than they actually have to pay for their usage.

Appendix 2: Grants and fiscal arrangements

This part gives an overview of the two main arrangements available for housing associations and companies, namely the Energy Investment Allowance and the Renewable Energy Production Incentive.

5.2.1.1 *Energy Investment Allowance (EIA)*

The Energy Investment Allowance (EIA) is a fiscal arrangement for companies to support investments in sustainable measures and renewable energy. With EIA, 41,5% of the investment costs in sustainable measures can be deducted from the taxable profit in addition to the usual depreciation of the company. This results in a lower corporate tax for the company. Sustainable measures that are eligible for EIA are specified on the Energy List provided by Agentschap NL.

Because housing associations are taxable since a few years it is possible for them to take advantage of this fiscal arrangement. Depending on whether the housing association makes a profit, the EIA rates are shown in table 10 (Atrive, 2012).

Profit (€)	Deduction of corporate tax (%)	Benefit (%)
0	-	
< 200.000	20	20% * 41,5% = **8,3%**
> 200.000	25	25% * 41,5% = **10,4%**

Table 10: EIA rates

The EIA request must be submitted within three months after commissioning. If the housing association or external company does not make a profit during the investment year, there is the possibility to take advantage of the fiscal deduction in a subsequent year using the so-called “carry back/forward“ arrangement.

No taxable entities and individuals are not eligible for EIA but in some cases they can benefit indirectly from the EIA arrangement by outsourcing the investment to a taxable company or entrepreneur and then rent back the system with a sale and lease back construction (Agentschap NL, 2012).

5.2.1.2 *Renewable Energy Production Incentive*

The Renewable Energy Production Incentive (SDE+: Stimulering Duurzame Energieproductie) stimulates the production of renewable energy for companies and (non-profit) institutions. SDE+ is an operating grant. This means that renewable energy producers receive a grant for the energy they generate instead of a grant for the purchase of the system as in the case of investment grants. The costs of renewable energy are often higher than conventional “grey” energy making the investments in renewable energy not always profitable. The SDE+ grant compensates the difference between the costs of grey energy and renewable energy for a fixed period of 5, 12 or 15 years depending on the applied technology. The height of the grant depends on the technology and the amount of generated renewable energy. The

available SDE+ money will be released in phases whereby the “cheaper” techniques can apply during the first phase (Agentschap NL, 2013).

Housing associations that deliver energy to their tenants can use the SDE+ grant to reduce the energy costs for the tenants and to make the sustainable measures more profitable (Agentschap NL, 2012). An important issue related to solar energy is the fact that only systems with a bulk consumer connection (grootverbruikersaansluiting) and a minimum volume of 15 kWp can apply for SDE+ grants (Atrive, 2012).

Appendix 3: Parameters for the financial model

Investment

Figure 41 shows the calculation of the total investment. According to the preconditions, 15m2 of PV panels will be installed on 226 dwellings in the Airey neighbourhood. The panels will have an average power of 140 Wp/m2 (Milieu Centraal). Acquisition of the panels including inverter, cabling installation and VAT will cost 2,29 €/Wp (Milieu Centraal). Several market parties mentioned during the research that significant purchasing advantages of 25%-50% could be reached when PV panels are installed on 226 dwellings at the same time. For this research, a purchasing advantage of 25% will be used.

This results in a total investment of € 3.607 per dwelling including VAT and € 2,981 per dwelling excluding VAT. The investment with and without VAT is important because taxes are deductible for some of the alternatives while other alternatives cannot deduct taxes.

Investment PV panels					
Number of dwellings		226			
Properties PV panels					
Surface per dwelling		15	m2		
Power		140	Wp/m2		
Costs		2,29	€/Wp	(Incl. inverter, cabling, installation and VAT)	
Investment per dwelling	€	4.809,00	incl. BTW		
Total investment	€	1.086.834,00	incl. BTW		
	€	898.209,92	ex. BTW		
Purchasing advantage		25	%		
Total investment	**€**	**815.125,50**	**incl. VAT**	**€ 3.607**	**per dwelling**
	€	**673.657,44**	**excl. VAT**	**€ 2.981**	**per dwelling**

Figure 41: Calculating the total investment

Financing and financial parameters

Table 11 shows the financing parameters and their sources.

Financing type	Interest rate (%)	Period (years)	Source
Secured loan (DAEB)	4,0	20	Financial department Woonbedrijf
Commercial loan	5,0	15	Financial department Woonbedrijf
Direct loan	4,0	20	Financial department Woonbedrijf
Financial lease	5,8	7	De Lage Landen (www.leaseloket.nl)

Table 11: Financing parameters

The discount rates are the same as the interest rates. This corresponds to Woonbedrijf's financial policy. In order to calculate the NPV, the discount rates can be stacked with an additional profit & risk rate. These profiy & risk rates are determined in consultation with Woonbedrijf's financial department.

Exploitation costs

The following paragraphs describe the parameters used for the exploitation costs in the financial model.

Separate entity

Some alternatives require the establishment of a separate entity (Energy LLC). This will cost around € 3.000 for registration and notary fees (Financial Department Woonbedrijf).

Surface rights

In case an external party or external financier (financial lease) invests in the project, surface rights have to be granted by Woonbedrijf because the ownership of the property remains to them. Surface rights can be granted for the whole Airey neighbourhood at once. This will costs around € 6.000 (Consultancy Firm working for Woonbedrijf).

Monitoring system

According to Atrive (2012), an individual monitoring system is currently still too expensive. Therefore an overall monitoring system has been proposed where some reference houses will be provided with a monitoring system. The tenants can then compare their amount of generated renewable energy against their assigned reference house. For the Airey neighbourhood, 11 reference houses will be assigned and provided with a monitoring system. The costs initial costs will be around € 1.100 (11 x € 100, Atrive (2012)) and annually around € 660 (11 x € 60, Atrive (2012)).

Operate & Maintenance

The Operate & Maintenance (O&M) costs are hard to estimate. Some examples calculate with annual costs per dwelling of € 50 (Advokaat, 2011) while others do not even include the costs in their calculations (Alliander). Therefore the O&M costs are assumed on € 30 per year per household.

Customer services

Questions of the tenants have to be answered and possible technical problems have to be solved. Therefore, some kind of customer service has to be established. The costs for customer services are estimated in consultation with Woonbedrijf's financial department around € 25 per household per year.

Invoicing

Several alternatives require a separate invoicing system. The costs for invoicing are divided into the repayment methods giro cards (€ 5,33 per transaction) and direct debits (€ 0,07 per transaction). Woonbedrijf applies a ratio of 1:3 between giro card transactions and direct debits. This results in the following costs for the Airey neighbourhood (226 dwellings):

151 x € 0,07 x 12 months = € 126,84 per year
75 x € 5,33 x 12 months = € 4797 per year
Total costs = € 4923,84 per year = **€ 22** per dwelling per year.

Insurance

PV systems with a value up to € 400.000 can be insured against a premium of 2,25‰ of the investment (including installation) with a minimum of € 45 per household per year (including

21% VAT and policy charges). Although the total investment is more than € 400.000, the insurance considers the PV systems as individual system. Therefor, these rules can be applied.
€ 815.125 x 0,00225 = € 1.834 per year (excl. VAT)
= **€ 2.219** per yeaar (incl. VAT)
= **€ 9,82** per dwelling per year

Manager LLC

The alternative where Woonbedrijf invests using a separate entity (energy LLC) requires an independent management board according to the new housing law. Managing the Energy LLC will not be a full time job. Therefore, the costs are estimated in consultation with Woonbedrijf's financial department based on 2 hours a week at an hourly fee of € 150. This brings the costs for the independent management on € 13.500 per year.

Electricity bill

Table 12 gives an overview of the references used to construct the electricity bill.

References parameters electricity bill	
Standing charge	Eneco 1,91 €/month, Essent 2,09 €/month, Nuon 1,89 €/month
Electricity tariff	0,07 €/kWh (Milieucentraal)
Energy Tax	0,1140 €/kWh (Rijksoverheid)
Tax credit	€ 318,63 €/year (Rijksoverheid)
Capacity tariff	aansluiting 3x25A (Endinet)
Standing charge	aansluiting 3x25A (Endinet)
Connection charge	aansluiting 3x25A (Endinet)
System services	€ 4,16 (www.energieleveranciers.nl)
Meter rent	(Endinet)

Table 12: References parameter electricity bill

Appendix 4: Classification method

According to the final results of the financial model, there are 13 alternative organization structures left, each with its own client value. The number of company values will be divided into classes. First the number of classes is determined using hierarchical clustering analysis in SPSS. Figure 42 shows the dendrogram coming from the output file of SPSS. The dendrogram shows that there are 13 classes at the beginning. After 1 iteration there are 4 classes left. After 2 iterations, 3 classes are left and after 3 iterations all the values have been combined into 2 classes. The 3 classes after the second iteration are the most accurate classification and these 3 classes will be used as an input for the k-means clustering analysis.

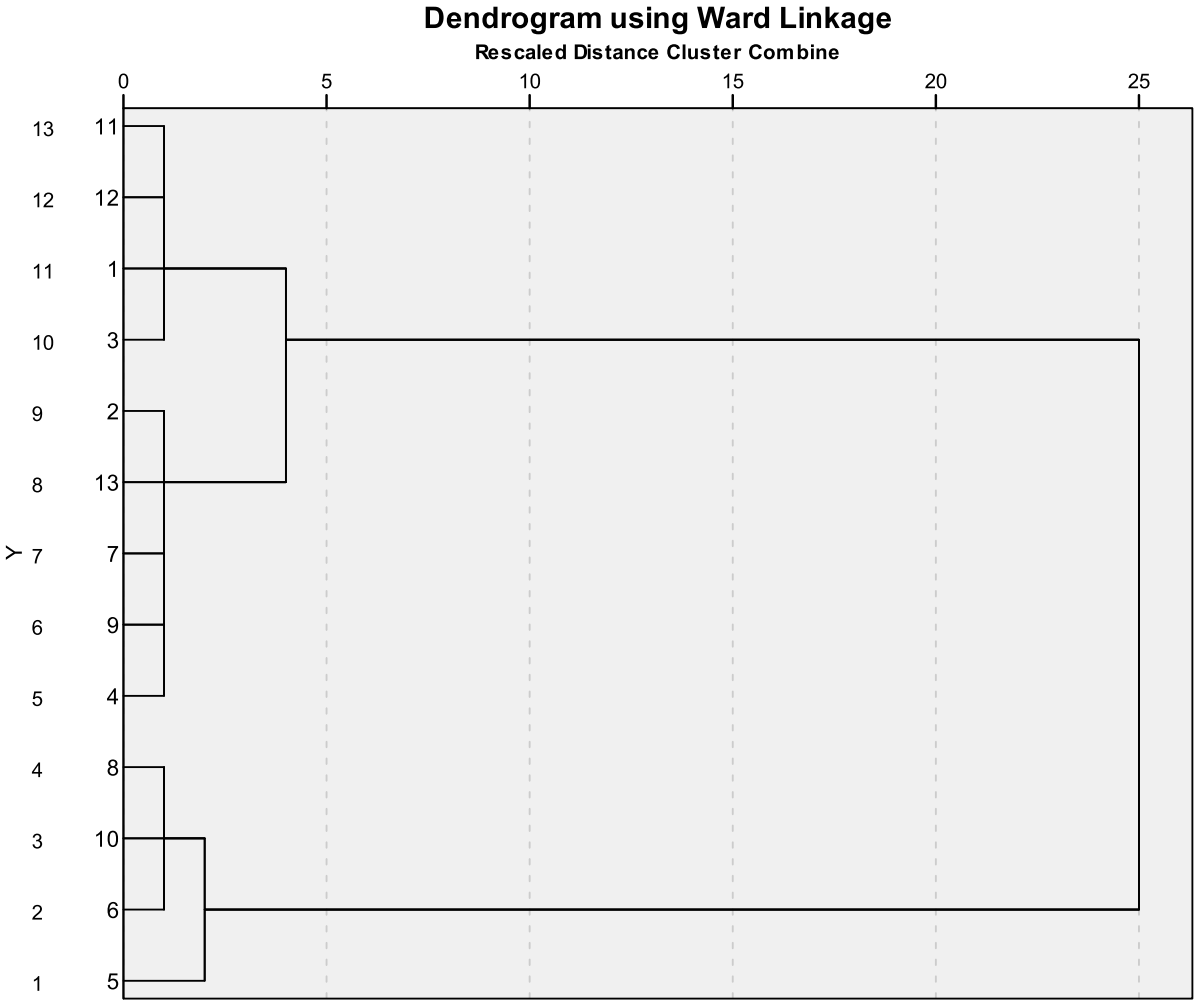


Figure 42: Defining the number of classes for the client value using SPSS

Appendix 5: Questionnaire

Wat is uw functie?

- ☐ Senior management
- ☐ Junior management
- ☐ Externe consultant
- ☐ Anders, namelijk _____

Verduurzaming van de bestaande woningvoorraad: hoe gaan we het organiseren?

In het kader van mijn afstudeeronderzoek aan de TU/e, doe ik onderzoek voor Woonbedrijf naar de mogelijke organisatievormen voor het verduurzamen van de bestaande woningvoorraad.

Het doel van deze vragenlijst is om Woonbedrijf te ondersteunen bij het selecteren van een organisatievorm voor verduurzaming.

De Airey wijk in Gestel wordt hiervoor als case study gebruikt aangezien deze wijk door Woonbedrijf is aangewezen als pilot project op het gebied van duurzaamheid.

Case study: Airey wijk Gestel
Projectfase: Ontwerp/voorbereiding
Actie: Installeren van zonnepanelen op alle 226 woningen

De verschillende organisatievormen zullen worden getoetst aan de volgende criteria:

- Klantwaarde (Waarde Woonbedrijf)
- Bedrijfswaarde (Waarde Woonbedrijf)
- Beleid

Klantwaarde wordt in het kader van betaalbaarheid in dit onderzoek uitgedrukt als de netto maandelijkse besparing per huishouden als gevolg van de zonnepanelen. Hoe groter de financiële besparing, des te groter de klantwaarde.

Bedrijfswaarde wordt in dit onderzoek uitgedrukt als de netto contante waarde voor Woonbedrijf voor de gehele exploitatie (226 woningen) over 20 jaar. Hoe hoger de netto contante waarde, des te hoger de bedrijfswaarde.

Beleid wordt in dit onderzoek uitgedrukt als de mate waarin de verschillende organisatievormen passen bij het beleid van Woonbedrijf. Bijvoorbeeld: de keuze om de verduurzaming zelf binnen Woonbedrijf te ontwikkelen, of juist bewust aan een externe partij uit te besteden heeft te maken met het algemeen beleid van Woonbedrijf. De beoordeling in hoeverre de organisatievormen passen bij het beleid van Woonbedrijf wordt in dit onderzoek uitgedrukt met het criterium “Beleid”.

* Vastgoedwaarde wordt in dit onderzoek buiten beschouwing gelaten aangezien er in de literatuur geen cijfers bekend zijn over de hoogte van een eventuele vastgoedwaarde van zonnepanelen.

Voorbeeld

Case study: Airey wijk Gestel
Projectfase: Ontwerp/voorbereiding
Actie: Installeren zonnepanelen op alle 226 woningen

Geef aan welk criterium naar uw mening belangrijker is en in welke mate.

Voorbeeld 1:

Klant waarde	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	**Bedrijfs waarde**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

Wanneer *Klantwaarde* en *Bedrijfswaarde* naar uw mening even belangrijk zijn bij het selecteren van een organisatievorm zet u een vinkje bij *Gelijk*.

Voorbeeld 2:

Klant waarde	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	**Bedrijfs waarde**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

Wanneer u van mening bent dat *Bedrijfswaarde* een sterke voorkeur heeft ten opzichte van *Klantwaarde* zet u een vinkje bij *Sterk*.

Voorbeeld 3:

Klant waarde	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**Bedrijfs waarde**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

Wanneer u van mening bent dat *Klantwaarde* een matige voorkeur heeft ten opzichte van *Bedrijfswaarde* zet u een vinkje bij *Matig*.

Deel 1: Criteria

Case study: Airey wijk Gestel
Projectfase: Ontwerp/voorbereiding
Actie: Installeren zonnepanelen op alle 226 woningen

Geef aan welk criterium naar uw mening belangrijker is en in welke mate bij het selecteren van een organisatievorm voor verduurzaming.

1:

Klant waarde	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**Bedrijfs waarde**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

2:

Klant waarde	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**Beleid**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

3:

Bedrijfs waarde	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**Beleid**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

Deel 2: Bedrijfswaarde

De onderstaande bedragen (bedrijfswaarden) vertegenwoordigen de Netto Contante Waarde voor Woonbedrijf voor de gehele exploitatie (226 woningen) over 20 jaar. De bedragen zijn berekend in een onderliggend exploitatiemodel waarin voor de verschillende organisatievormen telkens de bedrijfswaarde is bepaald. Om het aantal vragen voor deze vragenlijst te beperken, zijn de bedrijfswaarden samengevoegd in vier categorieën.

Geef aan welke *bedrijfswaarde* naar uw mening belangrijker is en in welke mate.
Let op + en – tekens!

4:

€ 96.000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ 3.000**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

5:

€ 96.000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ -117.000**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

6:

€ 96.000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ -182.000**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

7:

€ 3.000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ -117.000**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

8:

€ 3.000	☐ Extreem	☐ -	☐ Zeer Sterk	☐ -	☐ Sterk	☐ -	☐ Matig	☐ -	☐ Gelijk	☐ -	☐ Matig	☐ -	☐ Sterk	☐ -	☐ Zeer sterk	☐ -	☐ Extreem	€ -182.000

9:

€ -117.000	☐ Extreem	☐ -	☐ Zeer Sterk	☐ -	☐ Sterk	☐ -	☐ Matig	☐ -	☐ Gelijk	☐ -	☐ Matig	☐ -	☐ Sterk	☐ -	☐ Zeer sterk	☐ -	☐ Extreem	€ -182.000

Deel 3: Klantwaarde

De onderstaande bedragen (klantwaarden) vertegenwoordigen de maandelijkse netto besparing per huishouden. De bedragen zijn berekend in een onderliggend exploitatiemodel waarin voor de verschillende organisatievormen telkens de klantwaarde is bepaald. Om het aantal vragen voor deze vragenlijst te beperken, zijn de klantwaarden samengevoegd in drie categorieën.

Geef aan welke *klantwaarde* naar uw mening belangrijker is en in welke mate.

10:

€ 6,90	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ 1,00**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

11:

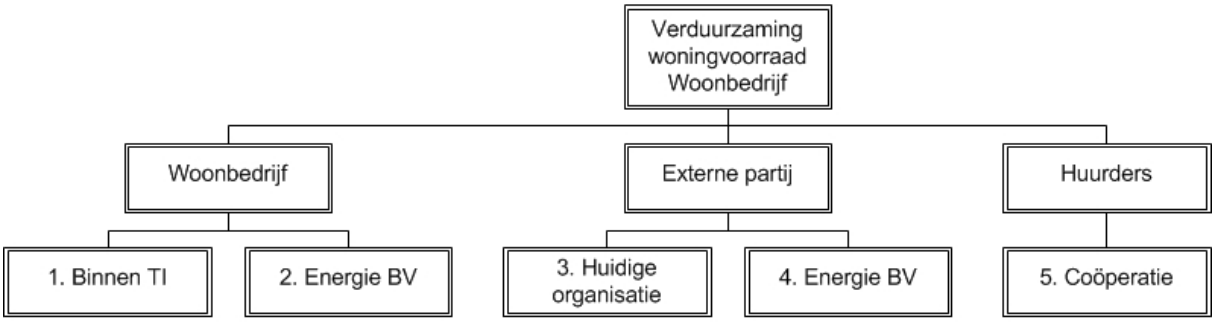
€ 6,90	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ 4,80**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

12:

€ 1,00	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	**€ 4,80**
	Extreem	-	Zeer Sterk	-	Sterk	-	Matig	-	Gelijk	-	Matig	-	Sterk	-	Zeer sterk	-	Extreem	

Deel 4: Beleid

De onderstaande vragen hebben betrekking op de beoordeling in hoeverre de verschillende organisatievormen passen bij het beleid van Woonbedrijf. Aan de hand van een literatuurstudie zijn een vijftal organisatievormen geselecteerd die kunnen worden toegepast bij het verduurzamen van de Airey wijk. Figuur 1 geeft een overzicht van de mogelijkheden.



Figuur 1: Mogelijke organisatievormen voor verduurzaming van de Airey wijk

Woonbedrijf kan de verduurzaming zelf organiseren binnen de TI of in een aparte Energie BV. Er kan ook worden gekozen om de verduurzaming uit te besteden aan een externe partij. Deze externe partij kan dit binnen de huidige organisatie uitvoeren of onderbrengen in een aparte Energie BV. Tot slot is het mogelijk om de huurders te verenigen in een energiecoöperatie.

De organisatievormen worden aan de hand van de onderstaande 8 onderwerpen één-op-één met elkaar vergeleken:

Onderwerp:	**Geeft antwoord op de vraag:**
Huurder	Wat betekent de organisatievorm voor het financiële voordeel van de huurder?
Risico's	Wie draagt de risico's?
Toekomst	Wat zijn de mogelijkheden om in de toekomst over te gaan tot fusie(s), verkoop of overdracht naar huurders?
Uniforme oplossing voor heel WB[1]	Biedt de organisatievorm een oplossing die in te zetten is voor het gehele bezit van Woonbedrijf?
Exploitatie	Wie verzorgt de exploitatie?
Corebusiness	Behoort het tot de corebusiness van de partij?
Administratieve scheiding WB	Biedt de organisatievorm mogelijkheden voor een duidelijke administratieve scheiding?
Fiscale voordelen	Kunnen er via de organisatievorm fiscale voordelen worden behaald?

[1] WB = Woonbedrijf

Geef aan welke organisatievorm uw voorkeur heeft en in welke mate.

13:	1. Woonbedrijf investeert (binnen TI)	2. Woonbedrijf investeert (in een aparte Energie BV)
Huurder	Meer voordeel door goedkopere DAEB financiering	Meer voordeel door goedkope lening vanuit corporatie
Exploitatie	Door Woonbedrijf	Door Woonbedrijf
Risico's	Geheel voor Woonbedrijf	Geheel voor Woonbedrijf
Corebusiness	Nee	Nee
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Fusies, verkoop en overdracht aan huurders mogelijk
Administratieve scheiding WB	Nee	Ja
Uniforme oplossing voor heel WB	Nee, alleen op projectbasis i.v.m. huursubsidiegrens	Ja
Fiscale voordelen	Nee	Ja

☐ Extreem ☐ - ☐ Zeer Sterk ☐ - ☐ Sterk ☐ - ☐ Matig ☐ - ☐ Gelijk ☐ - ☐ Matig ☐ - ☐ Sterk ☐ - ☐ Zeer sterk ☐ - ☐ Extreem

14:	1. Woonbedrijf investeert (binnen TI)	3. Extern bedrijf investeert
Huurder	Meer voordeel door goedkopere DAEB financiering	Minder voordeel door commerciële financiering en winstoogmerk
Exploitatie	Door Woonbedrijf	Door extern bedrijf
Risico's	Geheel voor Woonbedrijf	Geheel voor extern bedrijf
Corebusiness	Nee	Ja
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders
Administratieve scheiding WB	Nee	Ja
Uniforme oplossing voor heel WB	Nee, alleen op projectbasis i.v.m. huursubsidiegrens	Ja
Fiscale voordelen	Nee	Ja

☐ Extreem ☐ - ☐ Zeer Sterk ☐ - ☐ Sterk ☐ - ☐ Matig ☐ - ☐ Gelijk ☐ - ☐ Matig ☐ - ☐ Sterk ☐ - ☐ Zeer sterk ☐ - ☐ Extreem

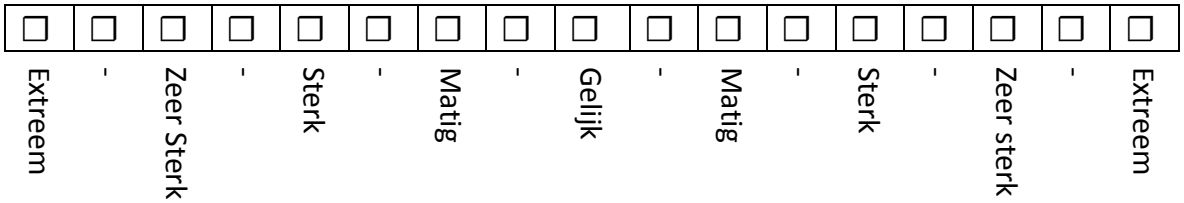
15:	1. Woonbedrijf investeert (binnen TI)	4. Extern bedrijf investeert (in een aparte Energie BV)
Huurder	Meer voordeel door goedkopere DAEB financiering	Minder voordeel door commerciële financiering en winstoogmerk
Exploitatie	Door Woonbedrijf	Door extern bedrijf
Risico's	Geheel voor Woonbedrijf	Geheel voor extern bedrijf
Corebusiness	Nee	Ja
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Fusies, verkoop en overdracht aan huurders mogelijk
Administratieve scheiding WB	Nee	Ja
Uniforme oplossing voor heel WB	Nee, alleen op projectbasis i.v.m. huursubsidiegrens	Ja
Fiscale voordelen	Nee	Ja

☐ Extreem ☐ - ☐ Zeer Sterk ☐ - ☐ Sterk ☐ - ☐ Matig ☐ - ☐ Gelijk ☐ - ☐ Matig ☐ - ☐ Sterk ☐ - ☐ Zeer sterk ☐ - ☐ Extreem

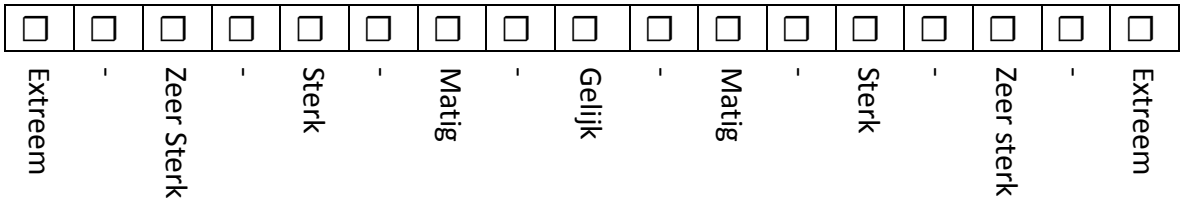
16:	1. Woonbedrijf investeert (binnen TI)	5. Huurders coöperatie investeert (energiecoöperatie)
Huurder	Meer voordeel door goedkopere DAEB financiering	Initiatief ligt bij de huurders. Geen winstoogmerk, dus meer voordeel
Exploitatie	Door Woonbedrijf	Door energie coöperatie
Risico's	Geheel voor Woonbedrijf	Geheel voor energie coöperatie
Corebusiness	Nee	Ja
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Geen gebrek aan draagvlak door actieve rol huurders
Administratieve scheiding WB	Nee	Ja
Uniforme oplossing voor heel WB	Nee, alleen op projectbasis i.v.m. huursubsidiegrens	Nee, afhankelijkheid van initiatief huurders kan doelstelling WB belemmeren
Fiscale voordelen	Nee	Ja

☐ Extreem ☐ - ☐ Zeer Sterk ☐ - ☐ Sterk ☐ - ☐ Matig ☐ - ☐ Gelijk ☐ - ☐ Matig ☐ - ☐ Sterk ☐ - ☐ Zeer sterk ☐ - ☐ Extreem

17:	2. Woonbedrijf investeert (in een aparte Energie BV)	3. Extern bedrijf investeert
Huurder	Meer voordeel door goedkope lening vanuit corporatie	Minder voordeel door commerciële financiering en winstoogmerk
Exploitatie	Door Woonbedrijf	Door extern bedrijf
Risico's	Geheel voor Woonbedrijf	Geheel voor extern bedrijf
Corebusiness	Nee	Ja
Toekomst	Fusies, verkoop en overdracht aan huurders mogelijk	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB*	Ja	Ja
Fiscale voordelen	Ja	Ja



18:	2. Woonbedrijf investeert (in een aparte Energie BV)	4. Extern bedrijf investeert (in een aparte Energie BV)
Huurder	Meer voordeel door goedkope lening vanuit corporatie	Minder voordeel door commerciële financiering en winstoogmerk
Exploitatie	Door Woonbedrijf	Door extern bedrijf
Risico's	Geheel voor Woonbedrijf	Geheel voor extern bedrijf
Corebusiness	Nee	Ja
Toekomst	Fusies, verkoop en overdracht aan huurders mogelijk	Fusies, verkoop en overdracht aan huurders mogelijk
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB	Ja	Ja
Fiscale voordelen	Ja	Ja



19:

	2. Woonbedrijf investeert (in een aparte Energie BV)	5. Huurders coöperatie investeert (energiecoöperatie)
Huurder	Meer voordeel door goedkope lening vanuit corporatie	Initiatief ligt bij de huurders. Geen winstoogmerk, dus meer voordeel
Exploitatie	Door Woonbedrijf	Door energie coöperatie
Risico's	Geheel voor Woonbedrijf	Geheel voor energie coöperatie
Corebusiness	Nee	Ja
Toekomst	Fusies, verkoop en overdracht aan huurders mogelijk	Geen gebrek aan draagvlak door actieve rol huurders
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB	Ja	Nee, afhankelijkheid van initiatief huurders kan doelstelling WB belemmeren
Fiscale voordelen	Ja	Ja

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

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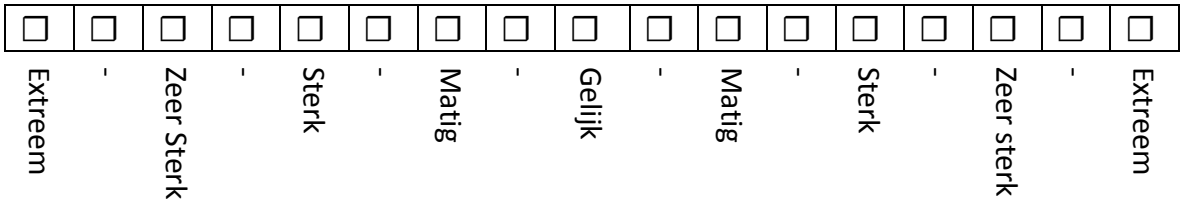
20:

	3. Extern bedrijf investeert	4. Extern bedrijf investeert (in een aparte Energie BV)
Huurder	Minder voordeel door commerciële financiering en winstoogmerk	Minder voordeel door commerciële financiering en winstoogmerk
Exploitatie	Door extern bedrijf	Door extern bedrijf
Risico's	Geheel voor extern bedrijf	Geheel voor extern bedrijf
Corebusiness	Ja	Ja
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Fusies, verkoop en overdracht aan huurders mogelijk
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB	Ja	Ja
Fiscale voordelen	Ja	Ja

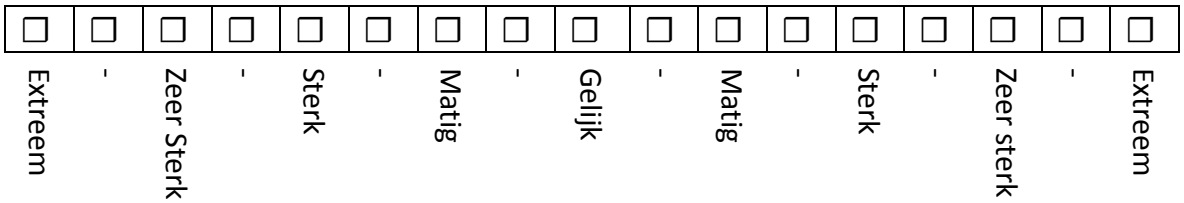
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extreem - Zeer Sterk - Sterk - Matig - Gelijk - Matig - Sterk - Zeer sterk - Extreem

21:	3. Extern bedrijf investeert	5. Huurders coöperatie investeert (energiecoöperatie)
Huurder	Minder voordeel door commerciële financiering en winstoogmerk	Initiatief ligt bij de huurders. Geen winstoogmerk, dus meer voordeel
Exploitatie	Door extern bedrijf	Door energie coöperatie
Risico's	Geheel voor extern bedrijf	Geheel voor energie coöperatie
Corebusiness	Ja	Ja
Toekomst	Geen mogelijkheid tot fusies, verkoop of overdracht aan huurders	Geen gebrek aan draagvlak door actieve rol huurders
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB	Ja	Nee, afhankelijkheid van initiatief huurders kan doelstelling WB belemmeren
Fiscale voordelen	Ja	Ja



22:	4. Extern bedrijf investeert (in een aparte Energie BV)	5. Huurders coöperatie investeert (energiecoöperatie)
Huurder	Minder voordeel door commerciële financiering en winstoogmerk	Initiatief ligt bij de huurders. Geen winstoogmerk, dus meer voordeel
Exploitatie	Door extern bedrijf	Door energie coöperatie
Risico's	Geheel voor extern bedrijf	Geheel voor energie coöperatie
Corebusiness	Ja	Ja
Toekomst	Fusies, verkoop en overdracht aan huurders mogelijk	Geen gebrek aan draagvlak door actieve rol huurders
Administratieve scheiding WB	Ja	Ja
Uniforme oplossing voor heel WB	Ja	Nee, afhankelijkheid van initiatief huurders kan doelstelling WB belemmeren
Fiscale voordelen	Ja	Ja



Appendix 6: English summary

PRESERVATION OF THE EXISTING HOUSING STOCK OF HOUSING ASSOCIATIONS

A case study for Woonbedrijf about organization models for implementation

Author: Ing. F. (Falco) van den Aker

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Date of graduation:
27-05-2013

ABSTRACT:
In the next fifteen years, some major changes will take place in the global energy field driven by increasing energy demand and declining stocks of fossil fuels. These developments will lead to further increasing energy prices causing a new situation called energy poverty where households are no longer able to pay their energy costs. Housing associations feel more and more responsible for the total housing expenses of their tenants, but are subject to a complex legal framework. The aim of this paper is to formulate an advice on which housing association Woonbedrijf from Eindhoven can practically implement an energy preservation concept in their pilot project the Airey neighbourhood. A literature study combined with a financial model and AHP analysis are used to select the best organization model. The results showed that the organization structure where the tenants collectively participate in an energy cooperative is the most preferred alternative.

Keywords: preservation, housing association, PV, organization models, AHP, financial model

INTRODUCTION

In the next fifteen years, some major changes will take place in the global energy field driven by two major developments. First, worldwide energy demand continues to rise especially because of the economical growth in the (former) developing countries. And second, the stocks of fossil fuels are declining rapidly whereby a large part of the remaining stock is located in politically unstable countries (Weevers, 2012).

These developments will lead to further increasing energy prices since an increase in demand from emerging economies and simultaneously decreasing stocks stimulate a market driven rise of prices. In the past years, the energy costs for households have risen

considerably. Only electricity prices already rose annually with an average of 5,2% over the past 10 years (Agentschap NL, 2012). The rising energy prices are mainly responsible for the increasing housing costs (rent/mortgage + energy expenses) of households where especially low-income households suffer from it. This triggers a new situation called *energy poverty* where households are no longer able to pay their energy costs. According to NIBUD (2009) one particular group of the population is most at risk namely, households with a disposable income in the bottom 20% of incomes in the Netherlands and less educated people.

These types of households form the target group of housing associations in the Netherlands. The main task of housing associations is to build, manage and rent social housing and social real estate. In the view of the rising energy costs, housing associations feel more and more responsible for the total housing expenses of their tenants. A possible strategy to fight these rising energy costs is to generate energy from renewable sources in order to create immunity for the constantly rising prices. This is not easy for housing associations because investments in renewable energy are often expensive and the constantly changing legal framework raises more questions than answers. Housing associations are therefore searching for organization structures that can be applied for investments in renewable energy within their specific discipline and legal framework.

One of these housing associations is Woonbedrijf from Eindhoven (NL). With an ownership of more than 30.000 rental units is Woonbedrijf by far the largest housing association in Eindhoven. Given their significant size and progressive sustainable policy, Woonbedrijf aims to play a leading role in the preservation of Eindhoven towards their goal to be energy neutral in 2045. Woonbedrijf makes their sustainable policy operational with the use of pilot projects in which they assess the usability, applicability and affordability of renewable techniques before they are applied to all their possessions. As a starting point, they have defined one neighbourhood as a pilot project, namely the Airey neighbourhood in Gestel (Eindhoven). Based on former research conducted by Victor de Vrede (Vrede de, 2012), Woonbedrijf already has a clear picture of sustainable techniques that can be applied for the preservation of the Airey Neighbourhood. However, the way of organizing and financing this kind of projects raises a lot of questions.

PROBLEM DEFINITION

Based on this context, the following problem has been defined for this research:
A lot of research has been conducted about techniques for the preservation of existing dwellings, but it is not clear to housing associations how the implementation of these techniques can be organized and financed!

Research objective

Formulating an advice on which Woonbedrijf can practically implement an energy preservation concept in the Airey neighbourhood in Genderdal.

Research boundaries

Given the limited timeframe of the research, the following research boundaries have been formulated:

- The research will focus on the existing housing stocks of housing associations;
- The Airey neighbourhood will be used as a case study;

- Only investments in renewable electricity in the form of PV panels will be taken into account according to Woonbedrijf's investment strategy;
- The research focuses on land-based dwellings.

METHOD

The research has been structured into two parts. First a literature study has been conducted in order to get an overview of the most important aspects and developments regarding sustainability and housing associations. Here, a set of alternatives is generated that will be tested against the Airey neighbourhood case study in part two of the research. The second part of the research consists of a two-step research structure wherein firstly the financial consequences for the tenants (client value) and the investor (company value) are determined and secondly the best alternative will be selected with the use of the Analytic Hierarchy Process (AHP).

GENERATING ALTERNATIVES BASED ON A LITERATURE STUDY

In order to get an overview of the possibilities to organize the preservation of existing housing stocks, a literature study has been conducted based on the following key subjects 1) the legal framework will be described to create a solution space, 2) the financing possibilities will be elaborated followed by 3) the organization structures. These three subjects will be combined in order to generate a set of alternatives that can be assessed against the case study.

Legal framework

Acts are important subjects to study because these form the context in which solutions can be sought. There are two key acts regarding sustainable electrical measures for housing associations, namely the Housing Act and the Electricity Act. The Housing Act is in the middle of a renewal process and is important in terms of organization structures. The new Housing Act, which is expected to be introduced in 2014, does not exclude alternatives, but provides specific regulations for some structures like connections with external entities.

The Electricity act regulates the prices and taxes that have to be paid for electricity usage. This is important for the development of renewable electricity based business cases because the exemption of energy taxes can make the difference between a viable and a non-viable business case.

Financing possibilities

Since the market for sustainable energy is emerging, more and more parties are entering the market offering a broad spectrum of services ranging from single services like financing or customer support up to full package services including financing and exploitation. When financing options are considered it is important to know which party is going to invest in the project. According to Atrive (2012), the following parties could play the role of investor in the implementation of sustainable measures in the social housing sector, namely the housing association (Woonbedrijf), the tenants and external companies. Table 1 shows the available financing possibilities for these three groups.

Financing type	Housing Association	External Company	Tenant(s)
Equity capital	✔	✔	✔
Secured loan	✔		
Commercial loan	✔	✔	✔
Green loan	✔	✔	✔
Lease construction	✔	✔	✔
Revolving fund			✔

Table 1: Available financing possibilities for different investors

Organization models

Choosing the right organization structure is an important step in the preservation of the existing housing stock. Questions like: "*Who invests in the project? Who bears the risks? Who takes care of the exploitation? Outsourcing or do it yourself? What are the benefits for the housing association, external companies and the tenants?*" come together within the organization structure. The organization structures are a combination of financing possibilities and payback options within the legal framework whereby a distinction has been made based on which party is going to invest in the project. Organization structures can be divided into the following groups:

- Housing association invests
- External company invests
- Tenant invests
- Hybrid organization structures

The financing possibilities combined with the organization models within the legal framework generate a lot of possible combinations. In order to keep things organized, an overview has been created (figure 1) in which all possibilities are summarized.

Set of alternatives

The legal framework, financing possibilities and organization models are combined in order to generate a set of alternatives. Figure 2 gives an overview of the alternatives that will be tested against the case study. In total there are 15 alternatives divided over three main groups (housing association, external company, tenants) and five subgroups based on the type of organization structure.

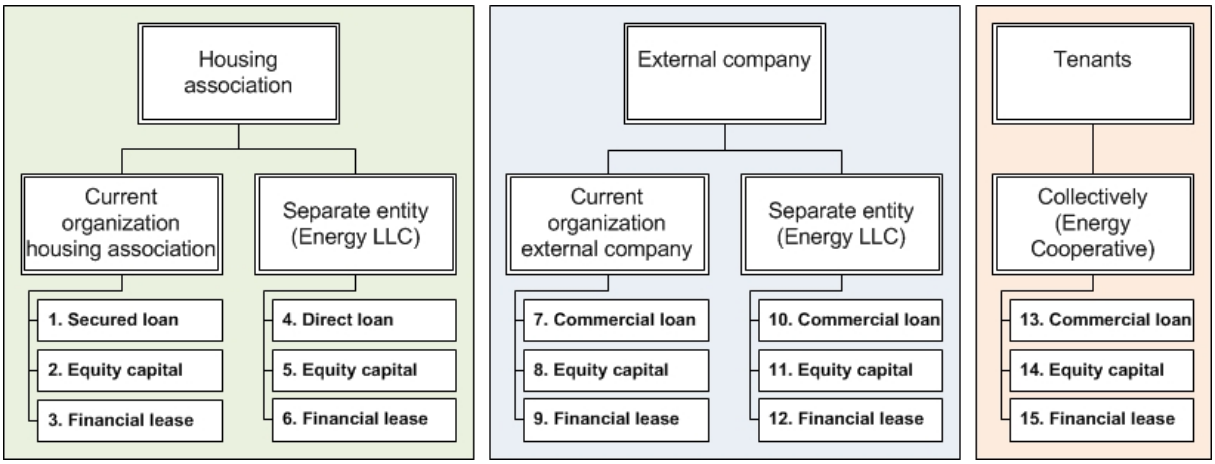

Figure 2: Set of alternatives for further research

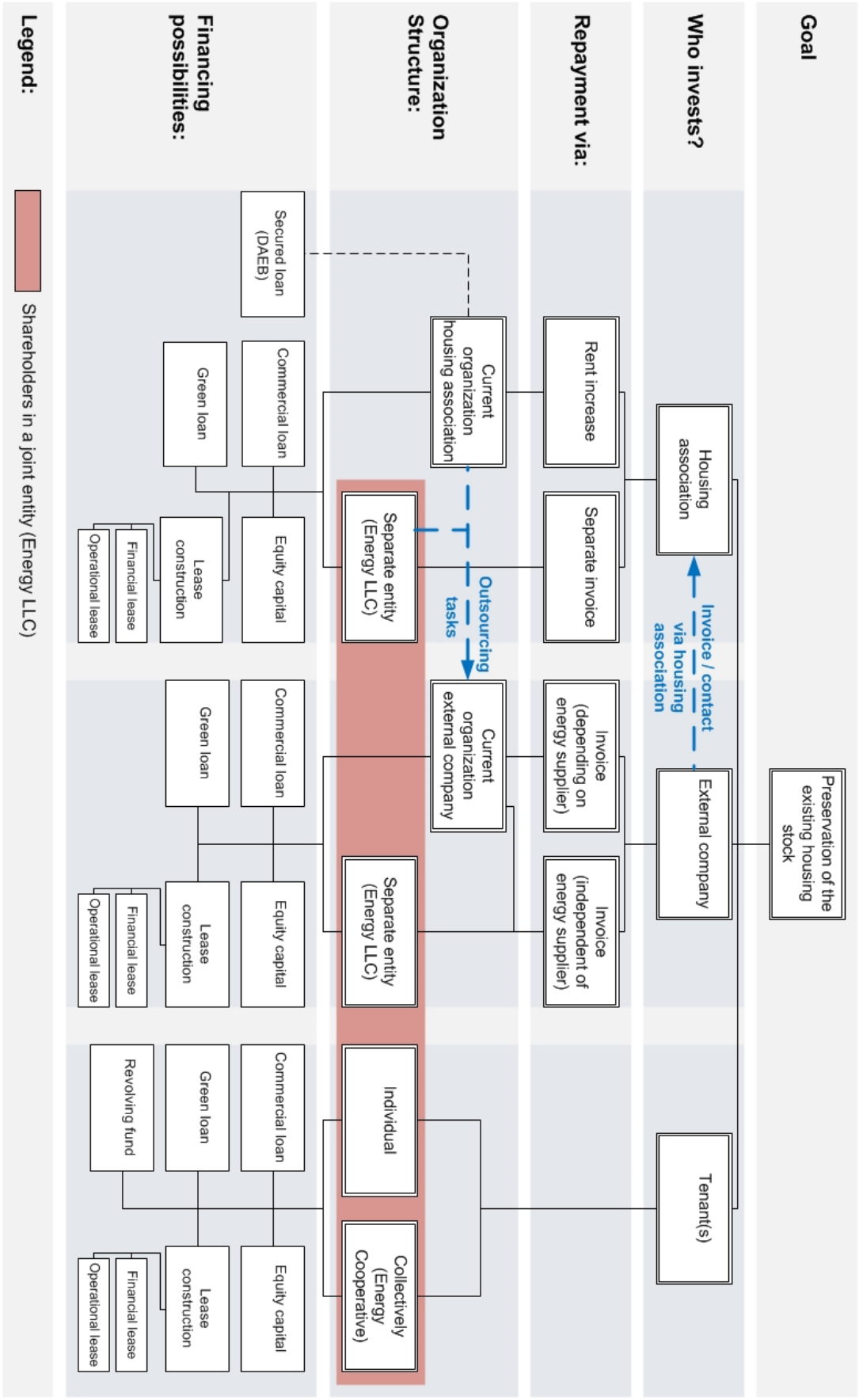

Figure 1: Overview of the financing possibilities and organization structures

CASE STUDY: THE AIREY NEIGHBOURHOOD

Genderdal is a residential area in the district Gestel in the south of Eindhoven (NL). A neighbourhood of 226 dwellings so called Airey houses in Genderdal (built in 1958) is assigned as pilot project for sustainable measures and techniques in Eindhoven. Woonbedrijf wants to try out different sustainable measures and techniques in this neighbourhood (Vrede de, 2012). The households in the Airey neighbourhood have an average energy consumption of 1.250 m³ gas and 2.500 kWh electricity per year. This energy consumption results in an energy bill of approximately € 1.745 per year or € 145 per month. The average rental price is € 375 per month. This results in average total housing costs of € 520 where energy costs cover about 30% of the housing costs.

FINANCIAL MODEL

The first part of the case study consists of a financial model in which the financial consequences for the tenants (client value) and the investor (company value) are determined.

Decision criteria

A customer survey conducted by Woonbedrijf showed that 79% of the tenants does not accept an increase in housing costs (rent + energy). When cost savings exceed the increase in rent, the tenants will benefit from lower housing costs. A decrease in housing costs will be indicated as a *positive client value*. In the context of this research, only alternatives with *positive client values* will be considered for further research since at least 70% of the tenants has to approve the increase in rent before the project starts.

Results

The 15 alternatives generated in chapter 2 are all imported in the previously described calculation model. For each of the alternatives, the *client value* and the *company value* have been calculated. Table 2 shows the results of the financial model for all the alternatives. According to the preconditions, alternatives with a negative client value will be rejected for further research. Table 2 shows that only alternative 8 and 11 generate negative client values. This is a positive result because this proves that investments in PV are viable business cases and that renewable energy is able to compete with conventional energy.

Organizational structure	Financing type	Increase rent (€/month)	Client Value	Company value	Increase rent (€/month)	Client Value	Company value
Housing Corporation (Current organization)	1: DAEB-financing	€ 22,97	€ 7,43	€ -	€ 25,40	€ 5,00	€ 110.966
	2: Equity capital	€ 24,79	€ 5,61	€ -	€ 25,40	€ 5,00	€ 27.798
	3: Financial lease	€ 23,78	€ 6,62	€ -	€ 25,40	€ 5,00	€ 62.602
Housing Corporation (Energy LLC)	4: Direct loan	€ 26,45	€ 3,95	€ -	€ 25,40	€ 5,00	€ 48.138-
	5: Equity capital	€ 27,96	€ 2,44	€ -	€ 25,40	€ 5,00	€ 117.068-
	6: Financial lease	€ 30,10	€ 0,30	€ -	€ 25,40	€ 5,00	€ 181.704-
External company (Current organization)	7: Commercial loan	€ 25,56	€ 4,84	€ -	€ 25,40	€ 5,00	€ 4.520-
	8: Equity capital	€ 32,96	€ 2,56-	€ -	€ 25,40	€ 5,00	€ 211.536-
	9: Financial lease	€ 29,75	€ 0,65	€ -	€ 25,40	€ 5,00	€ 114.808-
External company (Energy LLC)	10: Commercial loan	€ 25,67	€ 4,73	€ -	€ 25,40	€ 5,00	€ 7.684-
	11: Equity capital	€ 33,06	€ 2,66-	€ -	€ 25,40	€ 5,00	€ 214.474-
	12: Financial lease	€ 29,87	€ 0,53	€ -	€ 25,40	€ 5,00	€ 117.746-
Tenants (Collectively)	13: Commercial loan	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	14: Equity capital	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	15: Financial lease	€ 24,30	€ 6,10	€ -	€ 25,40	€ 5,00	€ 47.912
		Fixed company value (NPV=0)			**Fixed client value (CV=5)**		

Table 2: Results financial model

AHP ANALYSIS

In the second part of the case study, the analytic hierarchy process (AHP) has been applied in order to select the best organization structure for the preservation of the Airey neighbourhood.

Method

The analytic hierarchy process (AHP) was developed by Thomas Saaty (Saaty, 2008) at the Wharton School of Business. It is broadly used around the world in decision situations and especially in group decision-making processes. AHP allows decision makers to model a complex problem into a hierarchical structure. It engages decision makers in breaking down a decision into smaller parts, proceeding from the goal to criteria to subcriteria and so on down to the alternatives of action (Arentze en Borgers, 2004). The AHP analysis has been executed with the help of a software package called Expert Choice 2000.

The AHP model

Figure 3 shows the four level hierarchy for this research. The goal is a statement of the overall objective. The goal for this research is to choose an organization structure for Woonbedrijf for the preservation of the Airey neighbourhood. The factors that influence the problem are called criteria or objectives. They are located in the level immediately below the goal. The subcriteria are directly related to the criteria because they represent various properties of the criteria. The alternatives are located in the bottom level of the hierarchy. The alternatives for this model are coming from the financial model. The 13 alternatives with a positive client value serve as an input for the AHP model.

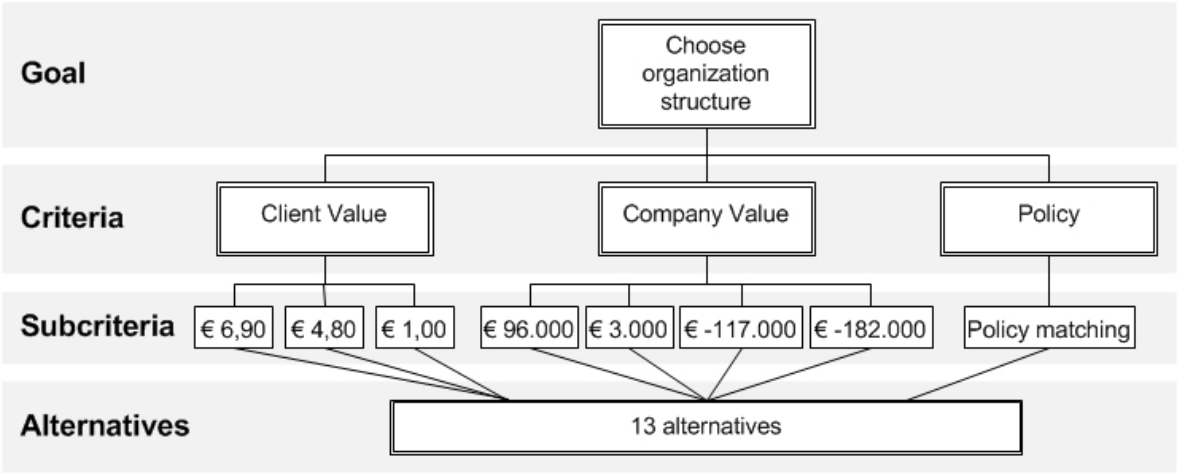

Figure 3: AHP model

Data collection

The data needed for the AHP analysis has been collected with the use of a questionnaire. This questionnaire has been sent to a selection of employees from Woonbedrijf. At the same time, short interviews of 30 minutes where planned with these employees.

RESULTS

Based on the results of the AHP and sensitivity analysis, a substantiated decision for the best organization structure for the preservation of the Airey neighbourhood can be made. The results in figure 4 show that the organization structure where the tenants collectively participate in an energy cooperative is the most preferred alternative by the respondents.

These are alternatives 13 and 14 where the energy cooperative finances the project with a commercial loan or equity capital.

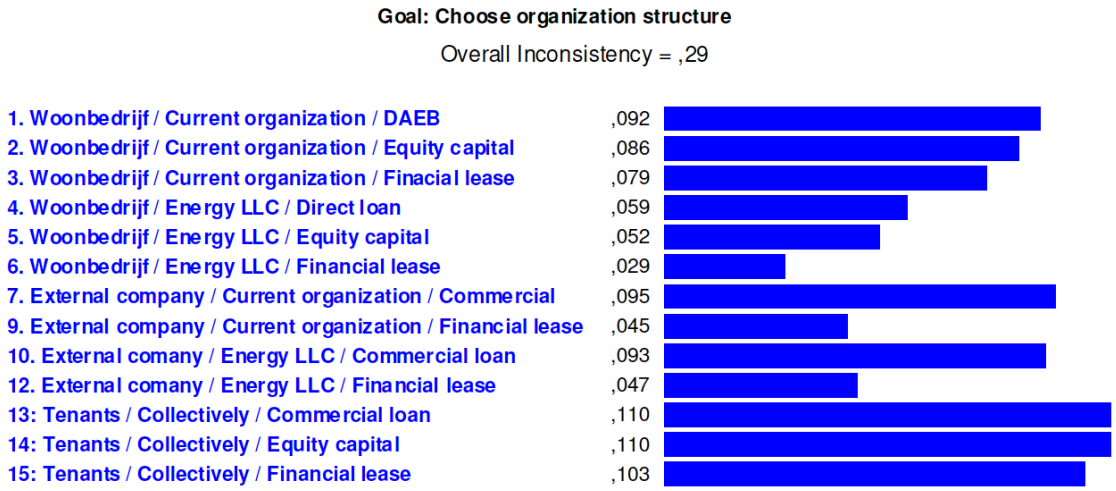

Figure 4: Priorities of the different alternatives with respect to the goal

The first criterion, *client value*, appeared to be the most important criterion with a weight of 53% related to the goal. Within the *client value*, the subcriterion with the highest *client value* (€ 6,90) is the most preferred value with a weight of 61%. Alternative 13 and 14 share the second-highest priority (0,111) related to the client value with a monthly saving of € 7,27 per household just behind alternative 1 which has a monthly saving of € 7,43 and a priority of 0,119.

The *client value* is followed by the *company value* in descending order of importance. The *company value* has an overall weight of 29% related to the goal whereby the positive *company values* are strongly preferred by the respondents (total weight of 77%). Alternative 13 and 14 are here also in the upper segment of the priorities (0,083) with a *company value* of € 105.994.

The *policy* criterion has with a weight of 18% the smallest amount of importance related to the goal. However, this criterion definitely affects the final outcome. Alternatives 13 and 14 have by far the highest priority (0,148) because the energy cooperative structure fits perfectly to Woonbedrijf's policy.

Figure 5 shows the organization structure of the energy cooperative. The energy cooperative takes care of the investment and exploitation of the PV panels and the members pay the cooperative through an invoice including a membership fee. The tenants will have a vote in the board of the cooperative through their shares.

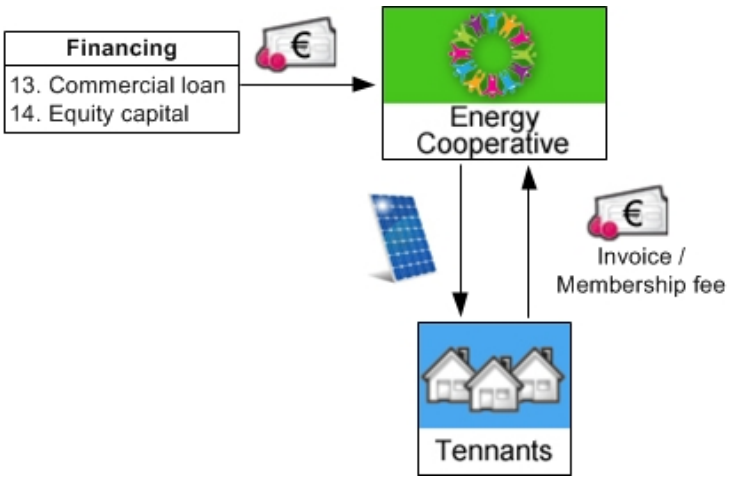

Figure 5: Energy cooperative structure

CONCLUSION

Based on the literature study in the first part of the research, the following conclusions can be made:

- There are two important acts that have to be taken into account, namely the *Housing Act* and the *Electricity Act*;
- When financing options in the social housing sector are considered, the following parties could play the role of investor in sustainable projects: 1) the housing association, 2) the tenants and 3) external companies;
- Organization structures can be divided into three groups based on who is investing. The findings of the first part of this research are all summarized into one scheme (figure 1).

The second part of the research was completely dedicated to the selection of the best organization structure for the Airey neighbourhood. In order to make an objective selection, a two-step research structure has been applied wherein firstly the financial consequences have been determined and secondly the best alternative has been selected with the use of the Analytic Hierarchy Process (AHP).

The organization structure where the tenants collectively participate in an energy cooperative (figure 5) is the most preferred alternative according to the AHP and sensitivity analysis. The energy cooperative structure has high priorities for the three criteria because this structure generates high *client values* (€ 7,27), high *company values* (€ 105.994) and fits perfectly to the policy of Woonbedrijf.

Discussion

When investments in renewable energy are considered, both electricity and heat play an important role. According to Woonbedrijf's investment strategy, this research focuses on electricity where mainly financial parameters are important. This reflects the financial approach for the *client value* and the *company value*. When heat is also taken into account more subjective parameters could play a role like *comfort*. Hereby, the *client value* could have a much broader meaning.

Further research

During the research, some interesting subjects arose that could be interesting for further research:

- Given the electrical and financial focus, further research would be interesting where heat is also included.
- The target group of housing associations is very specific. Further research about influencing behaviour and communication with tenants would be interesting;
- It would be interesting to do research about the possibilities to join the forces of these housing associations like establishing a collective Energy LLC.

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Renewable energy proved to be competitive with conventional energy. It only requires a change in people's mindset.

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Appendix 7: Dutch summary

VERDUURZAMING VAN DE BESTAANDE WONINGVOORRAAD VAN WONINGCORPORATIES

Een casestudy voor Woonbedrijf naar mogelijke organisatiemodellen

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Afstudeerprogramma:
Construction Management and Urban Development 2012-2013

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Datum van afstuderen:
27-05-2013

SAMENVATTING:
In de komende vijftien jaar zal de energiemarkt enorm veranderen gedreven door een toenemende vraag naar energie en tegelijkertijd sterk afnemende voorraden van fossiele brandstoffen. Deze ontwikkelingen zullen leiden tot verdere stijgingen van de energieprijzen. Voor huishoudens met lage inkomens worden hier door getroffen. Woningcorporaties voelen zich steeds meer verantwoordelijk voor de totale woonkosten (huur + energie) van hun huurders. Duurzame energie biedt mogelijke oplossingen voor dit probleem echter zijn woningcorporaties gebonden aan zeer specifieke regelgeving. Het doel van dit artikel is om een advies te geven richting Woonbedrijf voor de meeste geschikte organisatievorm voor de verduurzaming van de Airey wijk. Hierbij is gebruikt gemaakt van een literatuur studie gecombineerd met een financieel model en AHP analyse. Het organisatiemodel waarbij de huurders collectief deelnemen in een energie coöperatie resulteerde in de hoogste score.

Trefwoorden: verduurzaming, woningcorporatie, zonnepanelen, PV, organisatiemodellen, AHP, financieel model

INTRODUCTIE

In de komende vijftien jaar zal de energiemarkt enorm veranderen gedreven door een toenemende vraag naar energie en tegelijkertijd sterk afnemende voorraden van fossiele brandstoffen (Weevers, 2012). Deze ontwikkelingen zullen leiden tot verdere stijgingen van de energieprijzen. In de afgelopen jaren zijn alleen de elektriciteitskosten al jaarlijks met 5,2% gestegen (Agentschap NL, 2012). Dit veroorzaakt een nieuwe fenomeen genaamd energiearmoede waarbij huishoudens, voornamelijk met lage inkomens, de energielasten niet meer kunnen betalen.

Deze huishoudens vormen de doelgroep van woningbouwcorporaties in Nederland. Zij hebben de maatschappelijke taak om deze huishoudens van betaalbare woonruimte te voorzien. In het licht van de stijgende energiekosten voelen woningcorporaties zich steeds meer verantwoordelijk voor de totale woonkosten (huur + energie) van hun huurders. Duurzame energie biedt mogelijke oplossingen voor dit probleem. Echter gaan investeringen in duurzaamheid meestal gepaard met hogere initiële investeringskosten en roept de complexe wetgeving rondom corporaties meer vragen dan antwoorden op. Woningcorporaties zijn daarom op zoek naar geschikte organisatiemodellen voor het verduurzamen van de woningvoorraad.

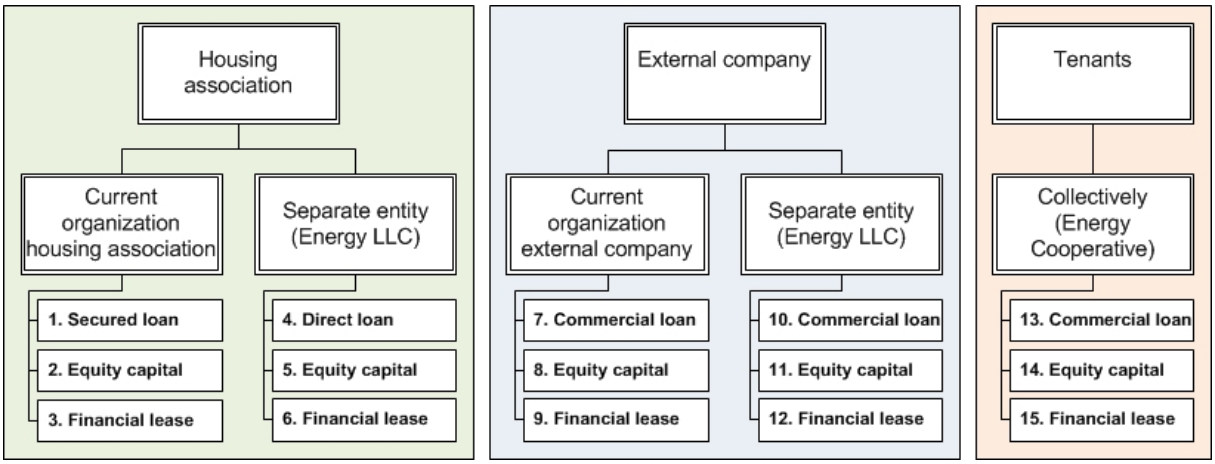
Een van deze corporaties is Woonbedrijf uit Eindhoven. Gedreven door een ambitieus duurzaamheidsbeleid heeft Woonbedrijf pilotprojecten aangewezen waarin alle mogelijke vormen van verduurzaming kunnen worden getest in de praktijk. Een van deze pilotproject is de Airey wijk in Eindhoven. Deze wijk zal als casestudy fungeren voor dit onderzoek.

METHODE

Dit onderzoek bestaat uit twee delen. Allereerst is er op basis van een literatuurstudie een set mogelijke organisatievormen gegenereerd. Deze modellen worden vervolgens getoetst aan de casestudy in deel twee waarbij gebruik wordt gemaakt van een financieel model en de AHP methode. Dit leidt uiteindelijk tot een keuze voor het meest geschikte model.

SET VAN ALTERNATIEVEN

Op basis van een literatuurstudie is een set van alternatieven gegenereerd waarbij wet- en regelgeving, financieringsmogelijkheden en organisatievormen zijn gecombineerd. Figuur 1 geeft een overzicht van de vijftien gegenereerde alternatieven.



Figuur 1: Set van alternatieven

FINANCIEEL MODEL

Het eerste deel van de casestudy bestaat uit het berekenen van de financiële gevolgen voor de huurders (klantwaarde) en de investeerder (bedrijfswaarde) middels een financieel model. Uitgangspunt hierbij is dat alleen alternatieven met een positieve klantwaarde worden meegenomen in het verdere onderzoek. De resultaten van het financiële model zijn weergegeven in tabel 1. Slechts twee alternatieven resulteren in negatieve klantwaarde. Dit bewijst dat duurzame energie kan concurreren met conventionele energie en winstgevende business cases kunnen worden ontwikkeld.

Organizational structure	Financing type	Increase rent (€/month)	Client Value	Company value	Increase rent (€/month)	Client Value	Company value
Housing Corporation (Current organization)	1: DAEB-financing	€ 22,97	€ 7,43	€ -	€ 25,40	€ 5,00	€ 110.966
	2: Equity capital	€ 24,79	€ 5,61	€ -	€ 25,40	€ 5,00	€ 27.798
	3: Financial lease	€ 23,78	€ 6,62	€ -	€ 25,40	€ 5,00	€ 62.602
Housing Corporation (Energy LLC)	4: Direct loan	€ 26,45	€ 3,95	€ -	€ 25,40	€ 5,00	€ 48.138-
	5: Equity capital	€ 27,96	€ 2,44	€ -	€ 25,40	€ 5,00	€ 117.068-
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	8: Equity capital	€ 32,96	€ 2,56-	€ -	€ 25,40	€ 5,00	€ 211.536-
	9: Financial lease	€ 29,75	€ 0,65	€ -	€ 25,40	€ 5,00	€ 114.808-
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	11: Equity capital	€ 33,06	€ 2,66-	€ -	€ 25,40	€ 5,00	€ 214.474-
	12: Financial lease	€ 29,87	€ 0,53	€ -	€ 25,40	€ 5,00	€ 117.746-
Tenants (Collectively)	13: Commercial loan	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	14: Equity capital	€ 23,13	€ 7,27	€ -	€ 25,40	€ 5,00	€ 105.994
	15: Financial lease	€ 24,30	€ 6,10	€ -	€ 25,40	€ 5,00	€ 47.912
		Fixed company value (NPV=0)			Fixed client value (CV=5)		

Tabel 1: Resultaten financieel model

AHP ANALYSE

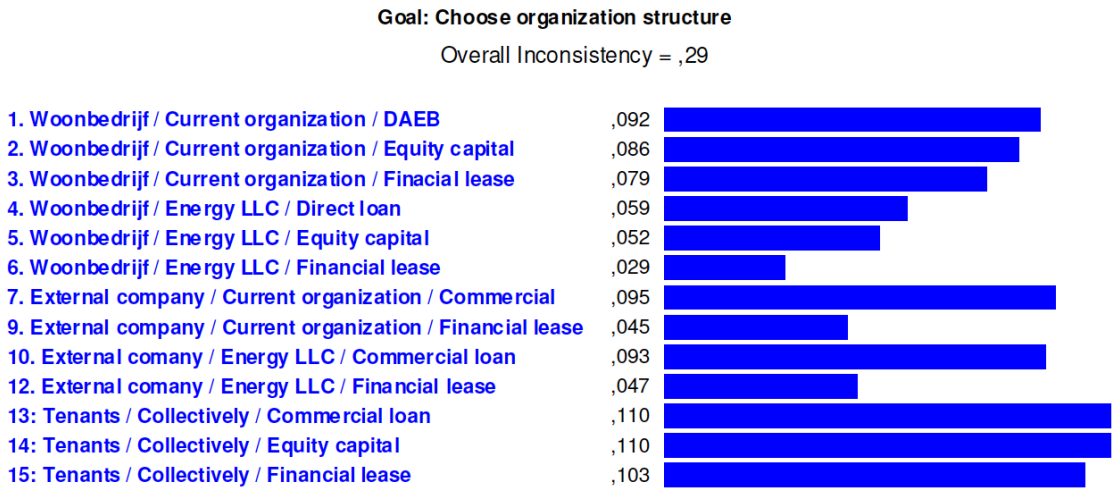
In het tweede deel van de casestudy is de Analytische Hiërarchische Procesmethode (AHP) gebruikt om het meest geschikte organisatiemodel voor verduurzaming van de Airey wijk te selecteren.

Methode

De AHP methode is ontwikkeld door Thomas Saaty (Saaty, 2008) en wordt veelvuldig gebruikt door groepen bij besluitvormingsprocessen. Bij de AHP methode wordt een probleem ontleed in een doel, criteria, sub criteria en vervolgens getoetst tegen de mogelijke alternatieven. De AHP analyse voor dit onderzoek is uitgevoerd met behulp van het softwarepakket Expert Choice 2000 en de benodigde data is verkregen middels een enquête en korte interviews met managers binnen Woonbedrijf.

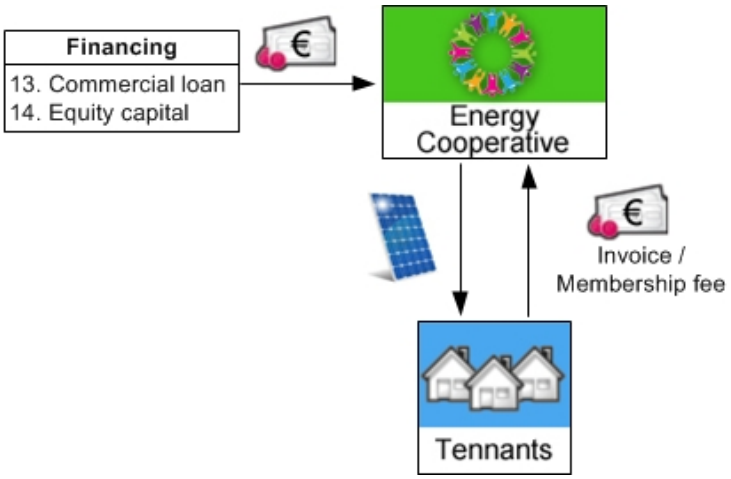
RESULTATEN

Op basis van de AHP analyse kan een gefundeerde keuze worden gemaakt voor een organisatiemodel. De resultaten in figuur 2 geven aan dat het organisatiemodel waarin de huurders collectief participeren via een energie coöperatie het meest geschikt is.



Figuur 2: Voorkeuren voor de verschillende alternatieven op basis van de AHP analyse

Het organisatiemodel met een energie coöperatie is weergegeven in figuur 3. De energie coöperatie verzorgt de investering en de exploitatie van de zonnepanelen waarvoor de leden (huurders) contributie betalen. De leden krijgen hiervoor zeggenschap in het bestuur van de energie coöperatie.



Figuur 3: Energie coöperatie

CONCLUSIE

Op basis van de literatuurstudie kunnen de volgende conclusies worden getrokken:

- Op het gebied van wet- en regelgeving spelen de Woningwet en de Elektriciteitsnet een belangrijke rol bij de verduurzaming;
- Wanneer investeringen in duurzaamheid worden beschouwd kan de woningcorporatie, de huurder(s) of een extern bedrijf de rol van investeerder op zich nemen;
- Organisatiemodellen kunnen op basis van deze drie groepen worden onderverdeeld met specifieke financieringsmogelijkheden voor de verschillende partijen.

Het tweede deel van het onderzoek stond in het teken van het selecteren van de meest geschikte organisatievorm voor verduurzaming van de Airey wijk. Hierbij is gebruik gemaakt van twee methoden. Allereerst zijn de financiële gevolgen voor de huurders en de investeerder bepaald met behulp van een financieel model waarna het meest geschikte model is geselecteerd met behulp van de AHP methode.

Het organisatiemodel waarbij de huurders collectief deelnemen in een energie coöperatie heeft de hoogste score op basis van de AHP analyse. Deze organisatievorm genereerd een hoge klantwaarde gecombineerd met een hoge bedrijfswaarde en past volledig bij het klantgestuurde beleid van Woonbedrijf.

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