Influence of tax benefits on energy neutral renovation of private homeowners

Using conjoint choice experiment to determine the willingness of homeowners to renovate

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Preface

This thesis is the last chapter of my master degree in Construction Management and Engineering at the Technical University of Eindhoven, under the chair of Construction management and Urban Development. The performed research is part of KENWIB initiative and it is conducted in collaboration with the municipality of Barendrecht.

The objective of this research is to investigate if tax benefit can influence the willingness of privet homeowner to renovate their homes towards energy neutral level.
Global warming and climate change are the threats that we and our future generation will face. A sustainable future is important, but it cannot be achieved without taking actions. Build environment is responsible for 36 percent of CO_2 in European Union member states. I hope that I can contribute something to the future of our planet with my research.

This project could not have been accomplished without guidance of my supervisor dr.ir. Qi Han and drs. P.H.A.M. Masselink. Also I would like to thank Prof. dr. ir. W.F.Schaefer for having faith in me and allowing me to do my research despite a delay of two months. I also want to thank Miss M. Overwater for her cooperation, guidance and useful tips for data collection in the municipality of Barendrecht.

I would like to thank my parents for being a source of encouragement and inspiration throughout my life. Last but not least, I would also like to thank my wife for her support and cooperation during the period of this thesis.

Edris Timori September, 2013

Contents

1. Introduction

The energy demand is growing so the demand for fossil fuels which cause more CO_2 emission. The Dutch government is committed to achieve the international (Kyoto and later Bonn) agreed objectives to reduce CO_2 emissions. According to the European Climate and Energy Package (ECEU, 2012) the aim is to have a 20-20-20 reduction in 2020 compared to 1990; 20% less greenhouse gas, 20% more sustainable energy and 20% energy saving. Different municipalities in the Netherlands have the intention to develop an energy neutral environment to achieve the goal. However this goal cannot be achieved without the Dutch built environment which is responsible for 30% of total energy consumption (BZK, 2011).

Energy conservation in the built environment can contribute to the European target of 20% CO_2 reduction in 2020. This specifies also that energy conservation by built environment will lead to the total reduction of energy nationwide. But the question is how the energy use of built environment, particularly the housing sector can be reduced and the goals of the government can be achieved. One option is the newly built energy neutral dwellings, but at the current rate of replacement which is around 1%, the total stock of dwellings will be sustainable in 350 years which is far away from 2020. Thus, an answer lies in energy neutral renovation of existing dwellings. By renovating the existing housing stock towards energy neutral, the energy consumption of built environment will be reduced and the governments' goals can be achieved. As the Energy Efficiency policy of EU stresses that the current rate and quality of building renovation needs to be substantially scaled up in order to allow the EU to significantly reduce the energy consumption of the existing building stock by 80%, relative to 2010 levels, by 2050 (EU, 2013). The focus of this research will be the energy neutral renovation of the existing dwellings which is outlined in the following part.

1.1 Problem definition

As mentioned before, the Netherlands has agreed at the European level to reduce the energy consumption by 20% in 2020 and to generate 20% sustainable energy. This means that the new dwellings from 2015 should have at least an EPC value of 0.4 and from the 2020 only energy neutral /zero energy houses should be built. With expected sharply increase of energy prices in the future, the share of energy cost as part of the total living cost will continue to increase. In a choice between energy efficient dwellings and energy inefficient dwellings, the marketability of energy-insufficient dwellings will come under great pressure.

The built environment in the Netherlands is responsible for around 30% of energy consumption. In the Netherlands there are around 7.3 million housing stocks (see figure 1).

Total housing stock	7.266.295
Private dwellings	4.083.808
Rental dwellings	3.130.363
Ownership unknown	52.124

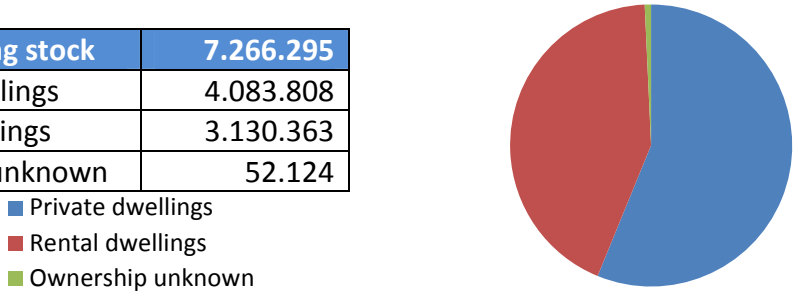


Figure 1: Characteristics of existing housing stocks (CBS, 2013)

Around 3.1 million of the housing stock is rental, the ownership of small number of houses is unknown, but the majority of the dwellings, around 4.1 million are private owned dwellings

In the recent past, the private homeowners have tried to take measures in order to reduce energy consumption through the provision of subsidies. This has often resulted in small changes and measures such as double glazing, solar panels and etc., without any comprehensive and structural approaches such as reducing energy loss through the shell of the building.

In order to compete with highly energy efficient (energy neutral) dwellings, it is important and desirable for the private homeowners to renovate their houses towards high energy efficiency / energy neutral level. But a renovation on such a level needs around €40.000 euro is needed (Weevers, B. 2013) and the willingness to invest. In return, the homeowners can receive benefits such as increase in lifespan of their houses, decrease in their energy-bill, better and healthier living environment and added value to their property.

In the Netherlands, inhabitants pay different kinds of taxes to the government: income tax, milieu tax, wealth tax, sewer tax, land value tax, inheritance tax, car taxes and etc. The government also supports its citizens though tax benefits. In order to reduce CO_2 emissions, purchasing an electric/ high energy efficient car is tax-free and the owners do not have to pay road tax. The tax benefit for a single car can be as high as 5000 euro during its life cycle. Other tax benefits are; the students can subtract their school costs from income tax; the patients can subtract their health cost from their income tax; part of donations to charities can also be subtracted from income tax and cancelling municipality and sewer taxes for people with low income. Thus, is it possible for private homeowners to receive tax benefit from the government in order to renovate their homes towards energy neutral? And will the house owners renovate their house if they get tax benefit from the government?

1.2 Research goal

The goal of this research is to investigate whether it is possible for the government to use tax benefits as an incentive to stimulate and increase the willingness of private house owners to renovate their homes into energy neutral dwellings.

1.3 Research questions

Combining the problem statement and the research goal, the following research question is formed:

Main question

Can tax benefits influence the willingness of private homeowners and motivate them to renovate theirs houses towards energy neutral level?

Sub questions

In support of the above mentioned main question of this research, the following sub questions are formulated:

1. What is energy neutral renovation and what are its benefits?

2. How successful are / were tax benefits in the Netherlands and other European countries regarding sustainability of dwellings?
3. In the available tax forms, which one is the most suitable and influential for tax benefits?
4. Which financial barriers do the homeowners face if they decide to do energy neutral renovation?
5. What kind of fiscal and financing structures are imaginable as solution for barriers and under which circumstances?

1.4 Research boundary

This research needs to be executed within a very strict time frame. Therefore, certain limitation and boundaries are defined.

- In this research, only the existing housing stock owned by private homeowners will be taken into account.
- The focus of the research will be especially on fiscal incentives that can influence the homeowner to renovate their dwelling towards energy neutral level.
- The data for the case study is collected from private homeowners in the city of Barendrecht. However, this does not mean that the result of this research cannot be valid for other cities in the Netherlands.

1.5 Research Relevance

The interest of Eindhoven University is to stimulate and realize energy neutral urban districts by joint interdisciplinary development and dissemination of knowledge. Therefore the master graduation students of TU/e will be directed to execute dedicated investigations and research on combined technical, organizational and socio-technical subjects related to sustainability. The general meaning of the presented studies is that they introduce and analyse ideas and concepts that are relevant for developing energy neutral districts and sustainability. In order to reach this goal, the university has started KENWIB (**K**ennis cluster **E**nergie-**N**eutraal **W**onen en **W**erken in **B**rabant) in 2009 in association with local governments of North-Brabant, different companies and housing corporations.

This research is chosen together with Eindhoven technical university and will be done in cooperation with the municipality of Barendrecht. The relevance of the research for the TU/e and municipality of Barendrecht is the knowledge about influence of tax benefits on willingness of private homeowner to renovate their home to energy neutral level. There is not a lot of scientific research about the influence of tax benefits. Also, knowledge can be gained about the benefits of energy neutral renovation to main stakeholders.

Furthermore, this report can provide an environmental instrument for the government in order to achieve the agreed goals on international and European level.

Finally, this research could be a base for the university to do further research in the future.

2. Research design

In the first part of this chapter, the research process is outlined. The research process describes how the research is conducted. A report outline of this research is given in the second part of this chapter for better understanding of the structure of this research.

2.1 Research process

In figure 2, an overview of the research process is visualized. This research consists of three main parts, namely desk research, field research and conclusion. These three parts were necessary in order to accomplish the research objective.

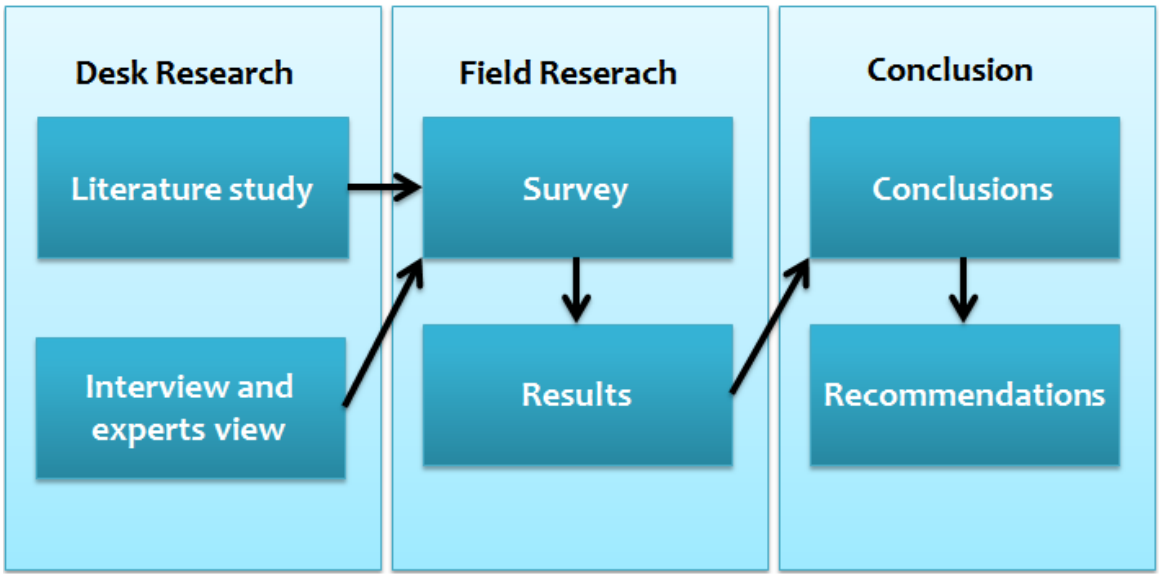


Figure 2: Overview of research process

Desk Research: First, a literature study in combination with interviews, consultation with experts in field of renovation, tax and financing has been used to answer the sub questions of the research. The findings of literature study have been checked by experts to check the reality and relevancy of them.

Field Research: After the completion of desk research, a field research is conducted. The answers of the sub questions delivered the attributes and attributes level for the survey. A questionnaire was designed with the attributes derived from the sub questions. Each question was carefully rated for its importance. After testing the questionnaire for its clarity, ambiguity and approval of the municipality Barendrecht, the questionnaires were sent to 1.500 households within the municipality of Barendrecht.

Conjoint choice experiment has been used to determine the preference of homeowners related to attribute and attribute level of the research. Conjoint choice has a better relation with the real world because costumers make a choice to choose a product when they are available.
After the data collection through survey, the results have been calculated by using statistical software such as NLOGIT and SPSS.

Conclusions: The conclusions are drawn based results from desk and field research. Recommendations are given at the end of report.

2.2 Report outline

After introduction and report design in the first two chapters, chapter three answers the first sub question. First, the definition of energy neutral dwelling is given, then the strategy which can be used for energy neutral renovation. Thereafter, the main stakeholders of this research are outlined by means of stakeholder's analysis. Finally the benefits of energy neutral renovation to stakeholders are given.

In chapter four of this research, the effect of tax benefits in Belgium, France and the Netherlands are given. First, the types of tax benefits are described and then the results of the measures are given. The most suitable tax form for this research is chosen in chapter five. After describing the available and relevant tax forms, the most suitable tax form is chosen by means of selection table.

Chapter six outlines the financial barriers which prevent the homeowners to do energy neutral renovation, while in chapter seven the solutions for these barriers are given. The solutions of chapter seven are used in a case study in chapter eight. Furthermore, research methodology, conjoint choice analysis and data analysis is described at the end of this chapter.

The results of this report can be found in chapter nine. Conclusion and recommendation based on the results are illustrated in final chapter of this research, namely in chapter ten.

3. Energy neutral renovation and its benefits

This chapter gives first the definition of energy neutral dwelling, and then it will outline how the energy neutral renovation can be achieved. Thereafter, the actors of this research will be defined and finally the benefits of energy neutral renovation to the actors will be clarified.

3.1 Energy neutral dwelling

A clear definition of energy neutral dwelling is important to prevent confusion about the used terms in this report.

Energy neutral

A project is energy neutral when there is no need for fossil or nuclear fuel on a yearly basis from outside of the project boundary to use or demolish a building. This means that the energy consumption within the project boundary is equal to the amount of renewable energy which will be generated within the project boundary (PEGO, 2009).

Thus, the definition for an energy neutral dwelling can be; Energy neutral or zero energy dwellings are the dwellings that generate as much energy as they need to be comfortable. An energy neutral dwelling has an EPC of 0.0 and that means energy label A++ on the ladder of energy labels.

The energy neutral dwellings are well insulated to keep the heat demand in the winter to its minimum and the needed artificial cooling in summer is almost unnecessary. Living comfort, good ventilation and a healthy indoor climate are all crucial aspects of energy neutral dwellings which can be achieved through renovation by using modern construction methods, the right materials, energy efficient systems, efficient installations (for walls, floors, windows and doors, façade, glazing) and making use of the sun, wind, water and soil in a correct way.

3.2 Energy neutral renovation

In this paragraph, the strategy and available technics will be described which can be used in order to renovate a house to energy neutral level.

3.2.1 Strategy

According to information sheet of AgentschapNL (AgentschapNL, 2012a) Trias Energetica is the most widely used strategy for energy efficient construction. Obviously, the Trias Energetica is also used extensively in the renovation of dwellings, in this case the possibilities are limited, for example because the shape of the building or the positioning fixed to the sun. However, there are lots of opportunities in the field of insulation of the shell, glazing or layout and etc. which can be used to renovate existing dwellings to energy neutral level.

In its simplest form, the three steps of Trias Energetica are:

- ✓ Step 1. Reduce the energy demand
- ✓ Step 2. Use of energy from renewable (sustainable) sources
- ✓ Step 3. Use finite (fossil) energy sources efficient

An additional step is added into Trias Energetica for energy neutral dwellings, which results as follow;

- ✓ Step 1. Reduce the energy demand

- ✓ Step 2a. Use energy from waste streams
- ✓ Step 2b. Use of energy from renewable sources
- ✓ Step 3. If use of finite (fossil) energy sources is inevitable, then use them very efficiently and compensate this by 100% renewable energy on a yearly basis

The above mentioned steps need to be applied in order to make the existing dwellings energy neutral.

Step 1: **Reduce the energy demand**
The energy demand of dwellings can be reduced in different ways, for example, the households use the energy in more efficient way or by using energy efficient devices. Energy demand can also be reduced by taking measures to insulate the building envelope. This is the most effective way. For reducing the energy demand, it is important to insulate the complete façade of the building, which includes wall insulation, roof insulation, floor insulation and window insulation. These insulations will be elaborated in this part of the report.

Step 2 a & b. **Use energy from waste streams**
When the amount of needed energy is reduce in step 1, it is important to make use of energy from residual flows and renewable sources in step 2a and 2b of Trias Energetica.

Step 3: Use finite (fossil) energy sources efficient
Step 3 is the lowest step of the Trias Energetica in terms of sustainability. If everything is done in previews steps, it is important that the installation such as boiler, heating system and lighting operate as efficiently as possible.

The measures and available technics for above mentioned steps are described and outlined in appendix A.

3.3 Stakeholders

The actors of this research are; the private homeowners, the owners association, government and local governments, financing companies and energy companies. But the important actors are the private homeowners, the owners association, the (local) government and the financing companies.

Private homeowners
Private homeowners need to be influenced to invest in energy neutral renovation of their properties. They also need to be convinced that an energy neutral renovation will increase the property value and living comfort. Due to the economic crisis, the expendable incomes of the house owners are decreased. However, they are aware of climate changes; they are not ready to invest in their houses due to an uncertain future. Therefore they need to be convinced that it is financially feasible and that the cost can be recovered over a period of time.

Owners Association
An owner of an apartment has to deal with different rules than an owner of a house. Next to the exclusive use of the apartment, the apartment owner is also co-owner and therefore

partly responsible for the entire building. Each apartment owner is obliged to work with the other apartment owners to maintain the building. To ensure that everyone has to fulfil this obligation, Owners Association is established and every apartment owner is automatically a member of it. Owners Association is an important stakeholder of this project, because they take the decision when it comes to renovation of entire apartment building.

Government

The (local) governments are the other important actors. The (local) governments can decide on tax benefits which can influence the willingness of private homeowner to invest in energy neutral renovation. Also the government has their own sustainable policies, agreements and objective which need to be achieved.

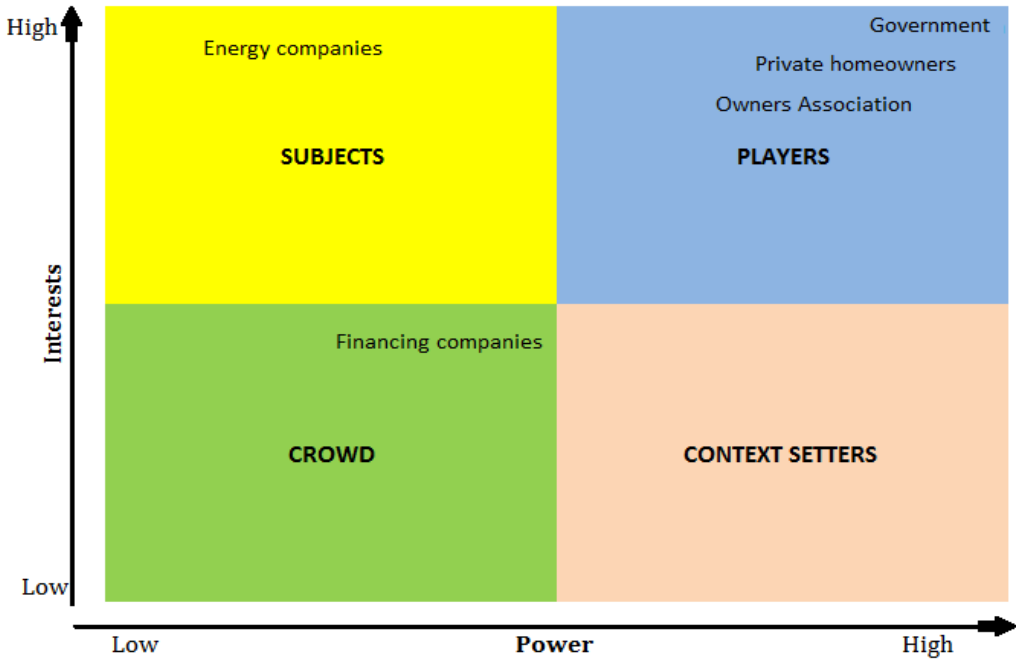
Financing companies

Few little homeowners have enough savings to pay the renovation cost at once. The majority of the home owners need to take a mortgage in order to pay the costs of renovation. The financing companies are needed who are available to provide loans (preferably with lowest interest rate) for private homeowner who can do energy neutral renovation.

3.3.1 Power versus Interest grid

Now that the stakeholders are identified, it is important to prioritize them. The stakeholders will be prioritized into interests and power. The stakeholders could be mapped out by their power and interest with the use of the Power versus Interest Grid. Power versus interest grids typically help determine which players' interests and power bases must be taken into account in order to address the problem or issue at hand (J.M Bryson, 2004).

The power vs. interest grid is a 2 by 2 matrix which gives information about the importance of stakeholders. The matrix consists of 4 parts and each of these parts has its own meaning. Below the power versus interest grid is given.



The 4 parts are:

- **PLAYERS (High power, interested people):** These are the stakeholders that need to be focused on, and kept satisfied
- **CONTEXT SETTERS (High power, less interested people):** These stakeholders need enough information to be kept satisfied, but not so much that they become bored.
- **SUBJECTS (Low power, interested people):** These stakeholders should be kept adequately informed, and they should be ensured that no major issues are arising.
- **CROWD (Low power, less interested people):** These stakeholders should be monitored, but they don't need to be bored with excessive communication.

When analysing the power versus interest grid it can be concluded that the government, the private homeowners and owners association are the main players of this research. The government has high power (policies and legislations) and is highly interested in environmental issues. The homeowners and owners associations have also power (The last word in, well or not renovate) and also have interests, but their interests are more personal rather than environmental.

3.4 Benefits of energy neutral renovation

In this paragraph the benefits of energy neutral renovation will be discussed for two important actors, namely the private homeowners and the government. It has been assumed that the third player (owners associations) has the same benefits as the homeowners as they are a bunch of private homeowners.

3.4.1 Benefits of homeowners

In this part of the report, the benefit of energy neutral renovation for homeowners will be outlined.

3.4.1.1 Low energy bills

The reduction in the energy bill can be seen as a generally accepted benefit for all households. Households pay on average between 5 and 6% of their income on their energy bill (ECN, 2012). Gas consumption is slightly increased in the last few years compared to 2008. This increase is mainly due to the cold and lengthier winters.
On the other hand, the energy prices have risen sharply in the last decade, especially in the period of 2002-2009 (see figure 3).

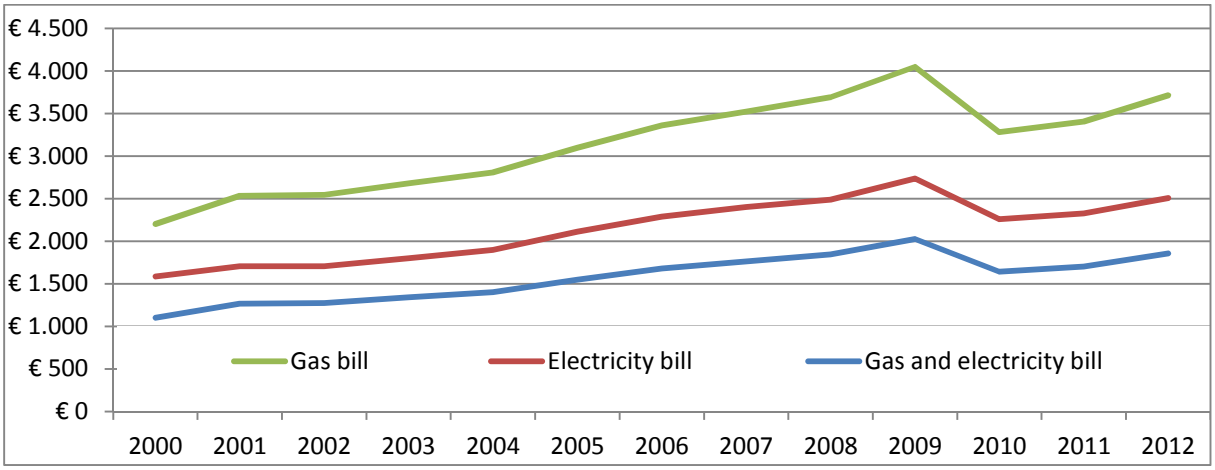


Figure 3: Average energy bill of households in the Netherlands (Source: Senternovem, 2013)

After the economic recession there has been a temporary reduction in the price. However the prices are rising again as the gas price has already risen by nearly 20% compared to 2011. In 2013, the energy bill is expected to rise further due to expected further increase in gas and electricity prices, long and colder winters and the VAT escalation from 19 to 21% (ECN, 2012).

Investing in energy neutral renovation will decrease the energy bill which is the direct return of investment. Reducing the energy usage and using energy from renewable sources for the remaining amount of energy will result in great energy bill reduction. A project in Sleephellingstraat of Rotterdam has led to energy bill saving of €1.200-, per year after renovation to energy label A++ (AgentschapNL, 2013a).

3.4.1.1 Better and healthy living environment

People spend on average 85% of their time indoors and 70% in their own homes. Kinds of substances released into the indoor environment, such as formaldehyde, combustion products and radon can accumulate when ventilation is inadequate. The concentrations of substances in the indoor environment are often higher than outside and can cause health effects.

Failure to provide good indoor air quality often manifests itself as complaints and reports of adverse health effects among the occupants. Many of the building-related health problems coincide with moisture damage and mold growth within the building (Huttunen et al., 2008).

In the Netherlands, 15 to 20% of the dwellings have moisture problems (GGD, 2013). Around 25% of children living in a humid house have more health problems than children in non-humid house (GGD, 2013). Furthermore, CBS scores show that 3% of households did not have enough money to heat their homes properly, while the percentage for households with low income was much higher, around 11% (ECN, 2012).This can also increase health problems for the households and especially for children.

The benefit of making a dwelling energy neutral is not only saving energy and reducing energy bill, but it is also about creating a healthy, comfortable, safe and affordable dwelling after renovation. In addition, the extension of the living space or the improvement of kitchen and sanitation are the other possible benefits of renovation which can make the live environment more comfortable and pleasant.

3.4.1.2 Added Property value

The investment in energy neutral renovation does not have the only benefit in from of substantial savings in energy bills, but it also improve the value of property which is the indirect return on investment.

Value is a word which can have many meanings and within the literature it was found that it was used in a variety of ways. For households it can mean the feeling of being home, the memories of the house, the comfort that the dwelling offers and etcetera. But in this report the value has the following definition:

'The estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's-length transaction after proper

*marketing wherein the parties had each acted knowledgeably, prudently and without compulsion (*IVS, 2010)'.

Well-insulated dwellings for sale structurally provide more money than poorly insulated dwellings. Research shows that the value of property rises as the energy label gets greener (BNN, 2012). Figure 4 shows that a dwelling with green label (A, B, C) has a higher average value of €6500 the higher value can rise up to €27000 the difference between energy label A and energy label G.

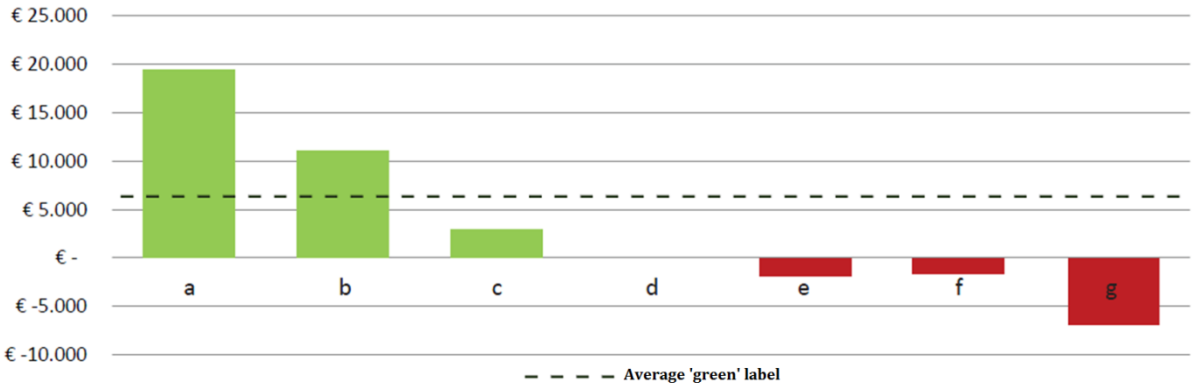


Figure 4: price revenue of dwelling per energy label compared to label D (Source: BNN, 2012)

Another study shows that people are willing to pay 5% higher for a dwelling with energy label A+ and up to 10% extra for a dwelling with energy label A++ (Eck, 2008). Groenestein has concluded in his study that the added value of energy sufficient dwelling can vary from €1000 to €25000 (Groenestein, 2011).
It is difficult to predict the added value of dwellings after energy neutral renovation, as every dwelling is unique qua its location, type, built year, size and etc., and due to uncertain price future of properties. But it can be assumed that an energy neutral dwelling has an added value of €10000 on average.

3.4.1.3 Additional benefits

It becomes essential to understand the different benefits options available to homeowners for building renovation. Beside the benefits which are mentioned above, there are also other various benefits which can be achieved be renovating a dwelling. Some of these addition benefits are described here below:

*Lifecycle***;** the renovation extends the lifespan of the building. Research (D. Langdon, 2007) shows that renovating buildings to green label is cost effective as building life is extended and depreciation may decrease.

*Lower operations and maintenance costs***;** other costs which occur for a dwelling are the maintenance and operation costs. Home-owners should carry out maintenance for their dwelling regularly to keep it up-to-date. These costs do not occur every year, but once in a few years and the cost are different for each dwelling. The maintenance cost is higher for older dwellings which also have poor energy performance. Also, operating cost for green buildings is on average 8 to 9% lower than regular buildings (US GAS, 2009).

Better global environment; the environmental benefits are the benefits that are of least importance for residents. The more environmental minded homeowners and idealists take these benefits into account. But by renovating to energy neutral and reducing the CO_2 emissions the homeowner and their next generations can profit from a better environmental future.

Reduction of noise nuisance, correspondence to the need of elderly people and housing adjustments for disabled people are also the benefits which can be achieved through energy neutral renovation.

3.4.2 Benefits of Government

This sub paragraph describes the benefit of energy neutral renovation for the government.

3.4.2.1 Job creation

Since the start of the economic crisis four years ago, unemployment in construction rose to 11 percent, according to the report of Economic Institute for the Building Industry (EIB, 2013). In the last four years 50,000 full-time jobs were lost in construction. The high unemployment in the construction industry will continue to grow and in the next two years 27,000 more full-time jobs will be lost according to the EIB report.

Also the CBS report shows that construction is hit hardest in 2012 by the economic crisis. The production decreased by 8 percent and the revenue dropped by 7 percent in 2012 (see figure 5)

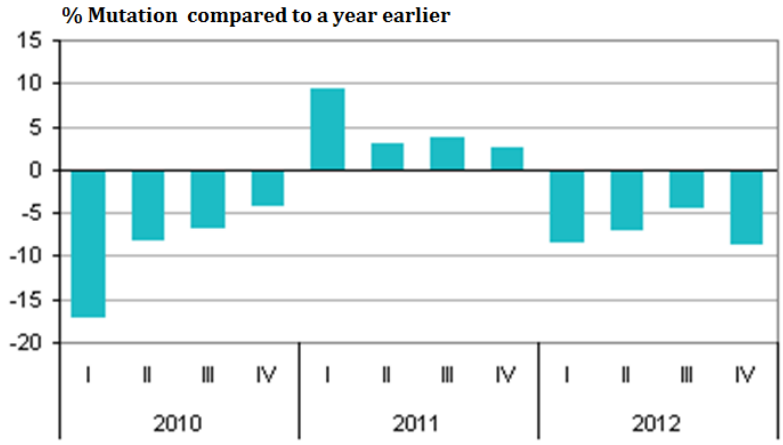


Figure 5: Revenue in construction sector (Source: CBS, 2013)

Energy neutral renovation thru tax benefits can create jobs, not only in the construction sector but also in the production and installation sector of PV panels, HR boilers, glazing companies and etc. Tax benefits in the form of VAT reduction had already a positive impact on the construction sector as the sector made a total of 2.2 billion euros additional revenue in a year and the jobs in the construction sector has been preserved (BouwendNL, 2011a).

In order to stimulate the construction sector, the government has reduced the VAT once again for a period of one year from 21% to 6%. It is a positive sign and it may help the construction sector as it did in 2011, but a bigger tax benefit which can influence the private homeowners (4.2 million) to renovate their homes to energy neutral level can create much more revenue and jobs than what VAT reduction did.

3.4.2.2 Achieving the agreed goals

The Dutch government is committed to achieve the international (Kyoto and later Bonn) agreed objectives to reduce CO2 emissions and reduce the dependency on fossil fuels. To achieve this goal, the Dutch government has set short and long term targets.
The government wants to shift towards a low CO2 emission society which is also energy objective of the European Union. The long-term goal of reducing greenhouse gas emissions by 80-95 % below 1990 levels by 2050 is set by the EU and agreed by the Dutch government. In addition to this long term goal, the government also set three energy goals for the short term (period 1990-2020), which are as follow;

1. 20% reduction in CO_2 emissions by 2020 (compared to 1990).
2. In 2020, 14% of energy from must be produced by renewable sources such as wind or biomass.
3. 20% energy saving by 2020 (compared to 1990). This goal is not compulsory.

(Source: Rijksoverheid, 2013)

The government can achieve these goals with energy neutral renovation of existing buildings as the Dutch built environment is responsible for 30% of total energy consumption (BZK, 2011).

3.4.2.3 Financial benefits

In February 2012 around 16600 people from the construction sector were receiving unemployment benefits (Dutch: werkloosheidswet uitkering) while in February 2013 it was escalated to 25500 people, a growth of 8900 people within a year (CBS, 2013). Job creation in the construction sector will reduce the number of receiving unemployment benefits.

The government will also receive 21% of every investment back via VAT for materials. The government will also receive income tax of labour and corporation tax when renovation companies make profit. The energy neutral renovation can also improve the public health which means less health care costs.

3.5 Conclusion

This chapter answers the first sub question of research, which is "*What is energy neutral renovation and what are its benefits?*"

Energy neutral or zero energy dwellings are the dwellings that generate as much energy as they need to be comfortable. For energy neutral renovation the Trias Energetica can be used which is already extensively used in the renovation of dwellings.

Furthermore, the main stakeholders of this research are the homeowners and the government. The benefit of homeowners from energy neutral renovation will be; low energy bills, better and healthy living environment and added property value. While the government can profit from benefits such as job creation in the construction sector, achieve the agreed goals on EU and international level and also have some financial benefits in the form of VAT, income Tax and will be less unemployment benefits.

4. Tax benefits in the Netherlands and other countries

In total, there are eight VAT reductions and four governmental instruments in the form of tax credit for energy efficiency of building in the European member states. United Kingdom, Italy, Belgium and France are the four countries which use tax credit as well as VAT reduction, while the Netherlands is among the countries which use VAT reduction only (BPIE, 2012).

In this chapter, the tax benefits and its impact on sustainability of France, Belgium and the Netherlands will be discussed. France and Belgium is chosen because they are only two countries in Europe besides the UK and Italy, which use income tax deduction.

4.1 Tax benefits in France

In France, several environmental policies are meant to encourage households to undertake energy saving renovations. There are four principal financial supports, and households can receive them if renovations are done by building professionals. The four principal financial supports and its description are shown in table 1.

Measure	Description	Rate
Income tax deduction	A part of the expenses in energy saving renovation can be deducted from the household income tax (or refunded if the household pays no income tax). This concern only a range of specific renovations and the expenses deducted is limited to a certain amount, depending on the household characteristics.	15% for double glazing 25% for roof and wall insulations 25% for modernization of heating system 40% for adoption of renewable energy
VAT reduction	A reduction of the indirect tax based on consumptions	5.5% (instead of 19.6%)
Zero rate bank loan	No interest on the amount of the bank loan. It concerns homeowners how to make several renovations or an important energy saving investment. The amount of the loan depends on the renovation.	
Subsidy	A subsidy, for homeowners, depending on household income (concerns mainly first income quintile households).	35% of renovation expense
Note: To receive these financial incentives, a household has to hire a company to make the renovation. If he decides to make the renovation itself, he cannot receive a subsidy, a VAT reduction, an income tax deduction or a zero bank loan.		

Table 1: Public policies in France (source: Charlier *et al.,* 2012)

In a research, Charlier and Risch (Charlier *et al*., 2012) construct a simulation mode to evaluate the impact of environmental public policy measures on potential source of energy savings in the residential sector.

The authors model energy consumption and GHG emissions, the decision to invest in energy saving renovations and the dynamics of the housing stock. Particular attention is paid to household investment decisions regarding home renovation. To generate the dynamics and

the structure of the housing stock through 2050, the authors introduce socioeconomic variables that alter the number of renovations and new constructions.

The study of Charlier and Risch has three major outputs. First, the authors estimate the energy consumption and GHG emissions of the residential sector in France through 2050. Second, the authors study the impact of environmental public policy measures. Lastly, they propose different means to reach the objectives which is an average energy consumption of 50kWhep/m2 by 2050 in the residential sector and reducing GHG emissions by 75% compared to the level of emissions in 1990.

However, for this research, the second output of their study is essential as it is important to know the impact of tax benefits. The authors used a simulation model built using a bottom-up approach. Bottom-up models calculate the energy consumption of groups of houses and then extrapolate these results to represent the nation. The major attributes of bottom-up approach of the research was the determination of typical end-use energy contribution and the inclusion of socioeconomic using billing data from a survey sample of households.

The authors test the impact of existing policies (income tax deduction, zero rate bank loans, subsidies and VAT) and one potential policy (bonuses). Furthermore, the authors considered a reference scenario in which public policies in 2050 are the same as in the period between 2006 and 2010 (e.g., an income tax deduction at a constant rate during the entire period, a zero rate bank loan, a subsidy, a VAT with a reduced rate of 5.5% instead of 19.6%, and households can receive several forms of financial support at the same time).Before to studying the impact of public policies, quantitative results of basic variables were presented using this reference scenario.

Results of policy

The research of Charlier and Risch showed that the policies were efficient. In 2010, an energy consumption of 240 kWhpe/m2/year and 63 millions of tons of CO_2 were reached in the model. In the absence of public policy, consumption would have been 28% higher and emissions would have multiplied by 1.5. These measures remain effective in future years.
The income tax deduction came out as the most efficient measure. Even it was possible to achieve the objectives of the government with tax deduction policy but with higher rates, namely 54% (See fig 6).

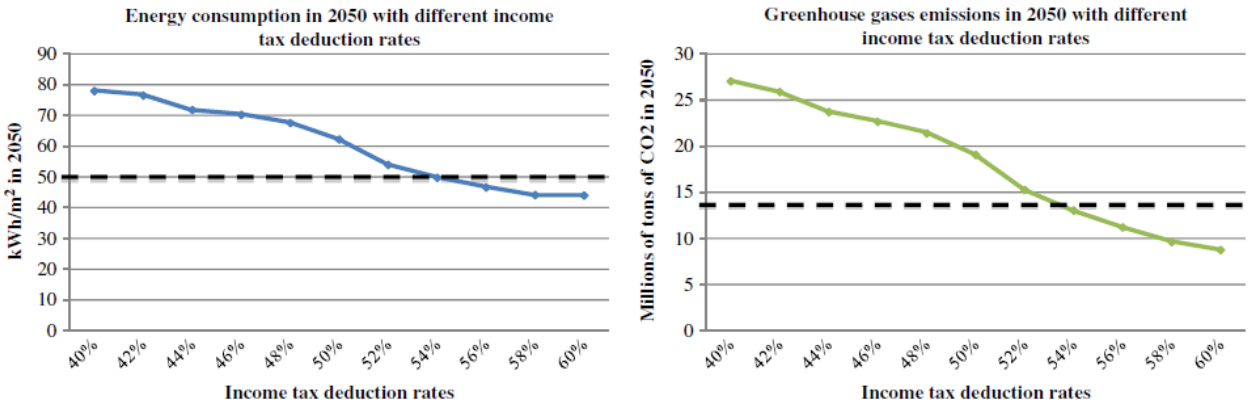


Figure 6: Tax deduction policy in achieving goals (source: Charlier *et al.,* 2012)

4.2 Tax benefits in Belgium

In Belgium, the dwellings which are older than 5 year can receive income tax benefits. The government is using two kinds of fiscal instruments in order to improve the energy performance of existing dwellings, namely tax deduction and VAT reduction. Homeowners and tenants can apply for the tax benefits when the investment's bill is on his/her name. Both forms are described in the following table (see table 2).

Measure	Description	Rate
Income tax deduction	In Belgium, the dwellings which are older than 5 year can receive income tax benefits. 30% of expenditure with a maximum of €3010 (for income of the fiscal year 2013) can be deducted from income tax.	30% for roof insulations
VAT reduction	For dwellings (from 5 year old) renovation, there is a VAT reduction of 15%. This measure is interesting for energy saving measures such as installation of solar panels, insulation, replacing heating boiler and etc.	6% (instead of 21%)
Note: These fiscal benefits are linked with a number of conditions which are listed here below.		

Table 2: Tax policies in Belgium (Source: VEA, 2013)

Condition for tax deduction

- The work must be carried out by a contractor according to the rules of good workmanship;
- The contractor confirms that the insulation material used has a thermal resistance R which is equal to or greater than 2.5 m^2 K / W;
- The contractor must use the obligatory wording on the invoice.

Conditions for VAT reduction

- The VAT rate reduction can be used for the transformation of a dwelling, for renovation, for improvements and maintenance. The VAT reduction is not applicable for demolishing and old house and rebuild or maintaining some walls alone.
- The VAT reduction must be used for private home. Office buildings and stores are not eligible.
- The work must be carried out by a registered contractor.
- The homeowner must deliver a certificate to contractor which declares that the house is older than 5 years and it is used for private purposes

Example

The roof insulation of a home cost €14000 without VAT reduction and tax benefits and it is done by a registered contractor.

The price with VAT reduction (6% instead of 21 %) will be €11900, a benefit of € 2100. Beside VAT reduction, 30% of the cost can be deducted from households' income tax. In this case,

€11900 (incl. VAT) *30% =€3570, the maximum amount of tax deduction for year 2013 is limited to € 3010, therefore only 3010 can be deducted from income tax.
The household will have a total benefit of €5110. €2100 thanks to the VAT rate reduction and €3010 due to income tax benefits.

Results of policy
According to the dossier of Bond Beter Leefmilieu (BBL ,2012), in recent years around 150000 households each year installed new high-efficiency boilers, double glazing or roof insulation in their homes due to tax benefit policies. There has been a sharp increase in roof insulation, from around 8000 in 2007 to 60000 in 2010 (see figure 7).

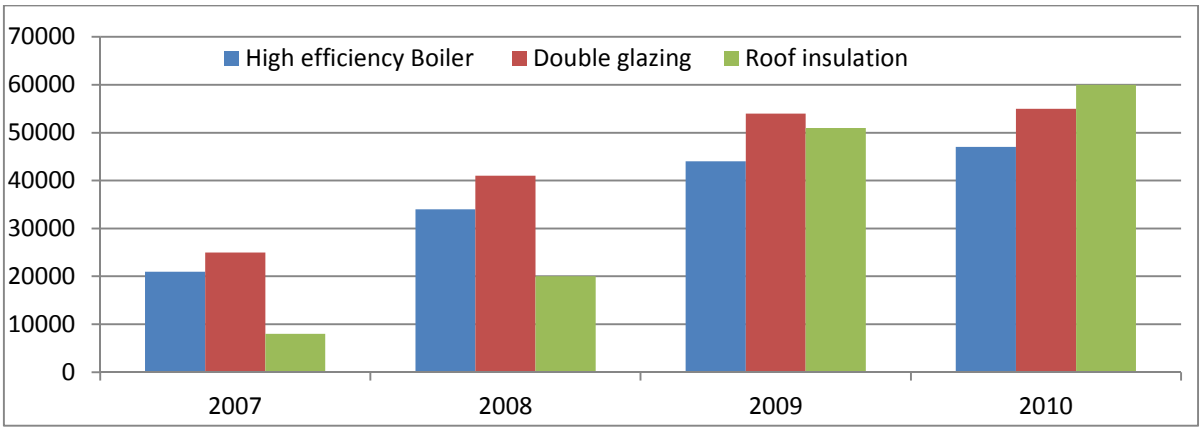


Figure 7: Increase of energy saving measures in Belgium

4.3 Tax benefits in the Netherlands

The Dutch government has used tax benefits in some level to promote and motivate its citizens to reduce CO_2 emission. For example, tax benefits for electric and energy sufficient cars. Recently, the Dutch government also used tax benefits to encourage homeowners to renovate their homes. And this year for the period of March, 2013 up to March, 2014 they are pursuing with the same policy.

The government had reduced Value Added Tax (VAT) from 19% to 6% for renovation and maintenance of existing dwellings for a limited period of time in the past (from 1 October 2010 to 1 July 2011). The VAT reduction was used as an incentive for homeowners to invest in their homes and also to stimulate the building sector.

The Dutch building sector was very positive about the impact of the stimulus measure. Research shows that the sector has had more than 800 million euro additional revenue in first few months, which is equal to 4000 jobs (BouwendNL, 2011b). The VAT reduction was extended for an extra three months which resulted in a total of 2.2 billion euros additional revenue (BouwendNL, 2011a).
After the success of 2010-2011, the Dutch government decided to reduce the VAT once again for one year (from March 2013 to March 2014).

Results of the policy
According to the report of WoonKennis, after the introduction of the VAT reduction on the 1st of March, 4% of the households in the Netherlands have done sustainable renovation. That is almost 300000 households (Duurzaam gebouwd, 2013).

WoonKennis studied more than 500 residential consumers whether they had home renovation plans before the measure and whether they are influenced by tax benefit measure. 11% were already planning to renovate next year and will stay with that plan. 4% had no plans, but they are now renovating because of tax benefit. Moreover, 74% of households never planned and they are not going to renovate next year and 11% did not replied (Duurzaam gebouwd, 2013).

4.4 Conclusion

This chapter tried to answer the second sub question of this research, which is "How successful are/ were tax benefit in the Netherlands and other European countries regarding sustainability of dwellings?"

France and Belgium use tax deductions and VAT reductions combined as a governmental instrument in order to improve the energy performance of existing dwellings, while the Netherlands uses only VAT reduction on the labour of energy saving measures as an instrument to improve the energy performance of buildings and to stimulate the construction sector.

In all three countries, tax benefit policies were efficient. In France the income tax deduction came out as the most efficient measure. It was even possible to achieve the objectives of the government with the tax deduction policy but with higher rates, namely 54%. In Belgium, the tax benefit also had a positive influence. There has been sharp increase in double glazing, use of high efficient boilers and specially roof insulation, from around 8.000 in 2007 to 60.000 in 2010.
After the success of the VAT reductions in 2010, where the Dutch construction sector benefited from €2.2 billion additional revenue, the second term of VAT reduction has also been successful. In the first few months of second term, around 300000 households took part in sustainable renovations.

Thus, it can be concluded that tax benefits as governmental instrument for sustainability has been successful for sustainability as well as for the construction sector.

5. Suitable tax for research

In the Netherlands there are different forms of taxes available, from income tax to dog's tax. However, only tax forms which are relevant for this research will be outlined in the first paragraph of this chapter. Thereafter, the most suitable tax form for tax benefits will be chosen via a selection criteria table.

5.1 Tax forms

In this paragraph, the relevant tax form for this research will be outlined. The information is obtained from governmental websites and is reviewed by tax consultant.

5.1.1 Income tax

Income tax in the most common tax levied on income of (natural and legal) individuals by a state. In the Netherlands the term income tax is used specifically for the government's taxes on the income of natural persons. Individuals living in or those who have an income from the Netherlands, have to pay taxes on their income to the Dutch government. In The Netherlands the government is the only administration that levies and may levy income tax under the current law. There are three taxable income categories for income tax:

- ✓ Box 1 work and property (werk en woning),
- ✓ Box 2 substantial interest (aanmerkelijk belang)
- ✓ Box 3 savings and investments (sparen en beleggen)

Box 1: work and property

In Box 1, the government levies taxes on the taxable income from employment (e.g. salary or profits from business activities) and property (e.g. rental income of owned dwelling). Income taxation of Box 1 is progressive because the Dutch government wants a more fair income distribution between the populations. The taxation rates are shown in table 2.

Box 1: Income tax		
Tax bracket 1:	€ 0 to € 19645	37%
Tax bracket 2:	€ 19645 to € 33363	42%
Tax bracket 3:	€ 33363 to € 55991	42%
Tax bracket 4:	Above € 55991	52%

Table 2: Income tax rates in the Netherlands

Box 2 substantial interest

The individuals have to pay income tax if they have any substantial interest, if the person (alone or together with partner) has at least 5% of the shares, options or profit shares of a company. The taxation rate for this Box is 25%.

Income from substantial interest includes:

- dividends
- capital gains (except in case of succession and divorce)

For 2007 only there was a reduced rate ranging from 22% to 25%.

Box 3 savings and investments

The taxation of Box 3 is on assets such as savings, stocks and second property. Some of assets are exempt from taxation. The tax-free asset in 2013 is €21139. The amount of money

invested in approved "green" investments (up to €56420) is also exempted. Moreover, a tax credit per year of 0.7% of the value is applied for these investments.

5.1.2 Corporation tax

The Dutch government also imposes corporation tax or company tax like many other countries impose. In the Netherlands, public limited companies or private companies have to pay corporate tax. Foundations and associations which conduct as a business also have to pay this form of tax. The amount of the corporation tax depends on the taxable sum. This is the taxable profit in a year, minus the deductible losses.

- Companies with a taxable sum to € 200000 pay a tax of 20% per year.
- For profits above € 200000, the levy in 2011 was set at 25%.

5.1.3 Environmental taxes

The Dutch government has several environmental taxes, such as taxes on packaging, on water and energy. It differs per tax type who pays those taxes and how, but for this research, only water tax and energy tax are important, as it is intended for houses.

Tap water tax

Tax on tap water is levied on the water that a household gets delivered via a supplier. This applies to a maximum rate of 300 cubic meters of water per year per connection. The suppliers have to pay this tax; they pay it to the tax authorities. The suppliers can pass these costs on to their customers. With this tax, the government wants to encourage people to use water in a more economical way.

Energy tax

Energy tax is levied on natural gas and electricity. Gases having the same function as natural gas are taxed in the same way. Energy suppliers pay this tax to the tax authorities. They can pass on the tax to their customers. The tax rate is shown on table 3.

Gas per m^3	Excl. VAT
0 to 5.000	€ 0,1862
5.001 to 170.000	€ 0,1862
170.001 to 1m	€ 0,0439

Electricity per kWh	Excl. VAT
0 to 10.000	€ 0,1165
10.001to 50.000	€ 0,0424
50.001 to 10 m	€ 0,0113

Table 3: Tax rates for gas and electricity (in 2013)

5.1.4 Real estate transfer tax

Real estate transfer tax is a tax that is imposed by the Dutch government on the privilege of transferring real estate property within the jurisdiction. The total transfer taxes range from 2% for dwellings to 6% for other properties such as companies and etc.

Transfer tax for dwellings

The government has reduced the transfer tax rate of dwellings from 6% to 2% on the 15th of June, 2011. The reduction was applied initially for one year, until the 1st of July, 2012. In a decision on the 25th of May 2012, the temporary reduction was converted to a permanent reduction for dwellings.

The reduction is set to pull the housing market out of recession. The transfer tax seems to be harmful to the flexibility of the housing market and the labour market. Therefore it is called

as the “Moving fine”. The tax causes extra travelling between home and work as the tax discourages people to move for a home closer to the place of their job. Also, employees will be less likely to move for a better job. The Central Planning administration advised to abolish the transfer tax in December 2010, because the transfer tax is an unjust and disruptive element in the Dutch tax system, as it is levied during each and every real property transfer.

5.1.5 Property tax

Property tax or land value tax is claimed annually by municipalities. A fraction of the value of real estate is defined as onroerendezaakbelasting. The money collected from the real-estate owners in its area can be used by the municipality to maintain the infrastructure (roads etc.). The real-estate values are estimated independently and updated annually. Taxation varies dramatically over different regions and municipalities. In addition to the property tax itself, there is a complicated additional taxation system for different infrastructural support systems: water-level management, water cleaning, waste management etc.

5.2 Tax selection

In this section, the most suitable tax form will be chosen from the available tax forms. The tax form will be chosen by means of a selection criteria table. The selection parameters are chosen in consultation with the experts from de Kredit Centrale. De Kredit Centrale is a specialized company in loans and mortgages for private individuals. The selection parameters are chosen in a way to choose a tax with maximal range (applicable for every homeowner), every income group can benefit from the same advantages and the tax benefits can cover the renovation cost in minimum number of years. The selection parameters are given in the following sub paragraph (§ 5.2.1)

5.2.1 Selection parameters

As mentioned here above, the selection parameters and weighing factors are chosen in consultation with the experts at de Kredit Centrale. Before choosing the most suitable tax for this research via a trade-off, it is important to explain the selection parameters. This will be done in the following section. Also a weighing factor is given per parameter. The most important parameter gets a weighing factor of **5** and the least important weighing factor of **1**.

Range - Applicable for all

Every homeowner should be able to apply and use the tax benefit in order to renovate his/her dwelling to energy neutral level.

This is the most important selection criteria and therefore it has the highest weighing factor. In order to make 4.2 million existing private dwellings energy neutral, it is important to choose a tax which has a maximum range and is applicable for every homeowner. In order that that every homeowner can benefit from it and not just a particular group. *Applicable for all has a weighing factor* **5.**

Similar benefit

It is essential that every homeowner with the same income gets the same tax benefits regardless the house size, dwelling type and dwelling location. *A similar benefit has also a weighing factor* **5.**

Shortest Payback time

The homeowners prefer a shorter payback time. They want to cover the investment cost as soon as possible; therefore it is important to choose a tax with high tax rate because only then it is possible to get the money back as soon as possible. Largest possible tax benefits will influence the willingness of the homeowners to invest. The larger the tax benefit is, the shorter the payback time will be. This selection parameter is also important but not as much as the previous two parameters; *therefore it has a weighing factor* ***4.***

Quick benefits

Due to the economic crisis and an uncertain future of labour market, the homeowners prefer direct benefits. The homeowners want to use the benefits as soon as they can because their work situation over a period of time can change. Even a new government can change the tax regulation. *Quick benefits has a weighing factor of* **2**

Transparent

The tax benefit should also be transparent for the government to control. It will reduce the regulatory and administration cost, additionally, it will prevent fraud. Transparent has a weighing factor of **4.**

5.2.2 Selection table

A detailed description of the relation between tax forms and selection parameters are given in appendix B. After the assessment of each tax form with selection parameter in appendix B, the following selection table (see table 4) is formed. Each tax form will receive a score between 1 and 5.The best tax form for the research will get a score of 5 and the worst a score of 1. An equal score can be given to two tax forms if they are evenly good or bad. The score of each tax form will be multiplied by using the weighing factor and added together to get a total score.

	Weighing factor	Income tax Score	Total score	Corporation tax Score	Total score	Real estate transfer tax Score	Total score	Environmental taxes Score	Total score	Property tax Score	Total score
Applicable for all	**5**	5	25	1	5	5	25	5	25	5	25
Similar benefit	**5**	5	25	5	25	2	10	3	15	4	20
Shortest Payback time	**4**	5	20	5	20	3	12	1	4	2	8
Quick benefits	**2**	4	8	4	8	1	2	5	10	4	8
Transparent	**4**	5	20	5	20	4	16	5	20	5	20
			98		78		65		74		81

Table 4: selection table for tax forms

Results of the selection Table

Income tax, with a score of 98 is comes out best of the selection table as tax form for this research. This tax form will be chosen for this study to research the influence of its benefit on energy neutral renovation of homeowners.

5.3 Conclusion

In this chapter, an answer was given on the sub question three, which was: *"In the available tax forms, which one is the most suitable and influential for tax benefit?"*

There are different forms of tax in the Netherlands. The most relevant forms of tax for this study are; income tax, corporation tax, real estate transfer tax, environmental taxes and property tax.

The most suitable tax for this research is chosen by means of the selection table. The parameters of the selection table and its weighing are selected in consultation with experts from the company of de Kredit Centrale. Income tax with a score of 98 came out as best tax form for this study from selection table. This tax form will be used in the following chapters in order to find out if it can influence the willingness of homeowner to renovate their homes towards an energy neutral level.

6. Financial barriers of renovation

Technical solutions exist for residential energy neutral renovation as mentioned in chapter 3. However, there are several barriers which prevent the implementation of such techniques. One of the important obstacles is the financial barrier. Tax benefit is a financial incentive measure, but before introducing such a measure it is important to know what the financial barriers are. Therefore, the aim of this chapter is to identify financial barriers which are preventing homeowners to do energy neutral renovation.

6.1 High investment cost

The biggest financial barrier to energy neutral renovation is the high investment costs (Tommerup *et al.,* 2012; IEA 2008). Researches (Nair et al., 2010; Tommerup *et al.,* 2012) also show that investment cost is one of the important factors of homeowners' choice of energy efficiency measures. Energy-efficient products often incur high investment cost and people who have low income or those who recently purchased a house using all their financial means typically do not have capacity to invest in energy saving renovation (Tommerup *et al.,* 2012).

Homeowners, especially those who were older and had lower income, reported that investment cost was one of the most important factors in their decision not to install a new heating system and implement building envelop measures such as improved insulation and energy efficient products (Nair et al., 2010 ; Tommerup *et al.,* 2012).

In practice, the cost of many energy saving measures and techniques are high which makes the payback period also longer and that makes the renovation projects less attractive to homeowners. In the case of energy neutral renovation, the total investment money varies as it is depending on the existing situation of dwellings, dwelling type and size and built year of the building. In order to renovate an average private dwelling with an energy label D/E to energy neutral an average investment of €40000 is needed (Weevers, B. 2013). Without subsidies and grants, the payback time will be around 30 years (with €1400 energy saving per year) which is way too long for homeowners. Especially when much of the citizens have a short term financial planning and climate change is not high on their priority list.

The high investment cost is also a major barrier for families with low income. On the other hand, the houses of low-income families often have low energy performance as shown in Table 5, making energy neutral renovation attractive and possible to this group will have notable effects.

Energy Label	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile	Total
Label A	7%	12%	19%	21%	41%	100%
Label B	8%	16%	16%	24%	36%	100%
Label C	12%	17%	19%	26%	26%	100%
Label D	16%	18%	23%	24%	20%	100%
Label E	17%	21%	21%	22%	19%	100%
Label F	21%	25%	18%	17%	19%	100%
Label G	26%	24%	21%	15%	14%	100%

Table 5: Relation between income and energy label of households (Rijksoverheid, 2011a)

6.2 Access to money

Lack of access to money or higher priority given to non-energy issues such as kitchen renovation, new bathroom, painting and etc. is limiting investments in energy efficiency measures. Energy efficiency renovations generally call for substantial additional up-front investments, as compared to repairing or overhauling options (Jakob, 2006). In the Netherlands, not every household has enough savings or can have access to capital in order to pay for an energy neutral renovation. Bank loans and mortgages are correlated with income. The higher the disposable income, the larger the amount of loans is. A household with an income of €2800 per month and housing cost of € 800 can borrow a maximum amount of € 4883 (Rabobank.nl), far below the amount of money which is needed to carry out an energy neutral renovation.

Thus, money remains the main barrier for many tenants and homeowners to invest in energy neutral renovation. The available subsidies are often for short-term and are project-oriented. Long term funding seems to be impossible; however this is necessary for large scale renovation projects. The beneficiaries face sometime complex and long procedures and application forms for relatively small amounts of subsidies.

6.3 Uncertainty

Uncertainty associated with costs and benefits

There are still a lot of challenges from homeowners to predict the exact cost and benefits of an energy saving renovation. It is difficult to evaluate additional benefits such as health benefits of projects (Jakob, 2006). For the investors, it is not possible to make tools which can calculate the exact costs and savings. Due to the small in size, difficult replicability of renovation projects (IEA 2008). Other criteria which make the projects uncertain are difficulty to control energy use behaviour of the occupants and the difficulty to predict future energy prices.

Job uncertainty

Due to the current recession, Netherlands has witnessed unprecedented increases in the level of unemployment. The unemployment rate was in April 2013 on a high record of 8.2 percent. The unemployment is increasing sharply, from 288.000 in October 2008 to 650.000 in April 2013 (CBS, 2013b). More and more citizens are uncertain about their job. People who have a job are afraid of losing their job. People without job are uncertain about finding a new job and whether it would be a permanent contract or temporary.
Independent professionals are uncertain about new orders and about getting their bills paid.

6.4 Conclusion

This chapter answers the fourth sub question this research which is; “Which financial barriers do the homeowners face if they decide to do energy neutral renovation?”

Literature study showed that high investment cost, access to money, uncertainties about labour market and about cost and benefits, the main financial barriers. In the next chapter, fiscal and financial constructions will be outlined in an attempt to find solution for these barriers.

7. Fiscal and financial constructions

The previous chapter showed that high investment cost is not the only financial barrier for renovation. Even if the homeowners get tax benefits, they will not be able to renovate their dwellings as they do not have enough financial sources to get the job done. Therefore with the aim to address the financial barriers in the previous chapter, the author of this research has constructed two fiscal scenarios to solve the first barrier, namely high investment cost, which is addressed in the first paragraph of this chapter (paragraph 7.1). The available financing measures and its conditions are outlined in paragraph 7.2 as a solution for second financial barrier, namely access to money. Finally, service options are given which can be a solution to the third barrier, uncertainties in paragraph 7.3.

7.1 Fiscal based -incentive measures

To discuss options to address the financial barrier (high investment costs), the following fiscal scenarios have been made to increase attractiveness of energy saving renovations and influence the private homeowner to renovate their homes, who maybe otherwise would not do anything. Tax deduction options likely to have less bureaucracy in comparison with other governmental policies.

7.1.1 Scenario 1: 40% tax benefit for energy neutral renovation

The homeowners will be allowed to deduct 40% of expenses, which has been made in order to renovate their homes with a maximum of €25000 from taxable income. This tax deduction will make the energy saving investments financially interesting for homeowners and will lower the payback time, as 40% of the high investment cost will be covered by this tax benefits. The percentage of the tax benefit is chosen in such a way that it can be favourable for the government as well. (see § 7.4).

The tax deduction will be eligible for payments which are paid for renovation cost including labour, professional services, materials, equipment and permits costs. These costs will be eligible only if the renovation is done by a professional contractor with an establishment in the Netherlands. Some homeowners on the border may employ cheaper contractors from neighbouring countries which will be harmful to the Dutch construction job sector and to the Dutch government.

To make this measure striking for homeowners with uncertainty, a **flexible** period of time is chosen, which means that the homeowners can declare the benefits in one year (if he has high income and pays high income tax) or spreads it in several years. A flexible time period is chosen as a solution for the barrier of *job uncertainty*. This makes the scenario interesting for homeowners who are uncertain about their job in the future and homeowners those are 65 years of age and over homeowners. As people without job pays fewer taxes and cannot have much benefit. While homeowners of 65 years of age and over do not want to wait long (for example 10 years) to proclaim the tax benefit from government, as they are uncertain about life expectancy.

The beneficiaries

This deduction will be available to all private homeowners who are paying income tax in the Netherlands and want to renovate their dwellings to energy neutral level, regardless of property type.

Obtaining the deduction

In order to prevent frauds and misuse of tax deduction the following points are taken into account.

- *The property is located in the Netherlands*: in the past a lot of governmental benefits (care allowance, children's allowance and housing rental benefit) have been misused. Thus it is important to give tax benefits only for dwellings in the Netherlands and not a vacation house in Spain or Turkey.
- *Only one owner of the house can apply for the tax benefit:* in case a house has two owners, it is not possible that both owners can have a 40% tax deduction. However the combined income will be taken into account for deduction.
- *EPC- report before and after renovation*: Before beginning the renovation work, it is necessary to send a copy of an EPC- report (Energy Presentation Coefficient) and after the renovation, an update of EPC-report is required, which is signed off by certified consultants, this is important in order to prevent misuse of tax benefits.
- *After renovation an EPC=0.0 is required;* Energy Presentation Coefficient of 0.0 or lower has to be achieved after renovation to be able to declare renovation cost.

Example: If a private homeowner has incurred a renovation cost of €28000, he can get €11200 of the renovation cost (which is 40%) from his taxable income. The tax deduction can be done in one year if the taxpayer has paid more than €11200, income tax (after home mortgage tax deduction and other benefits) or in ten years, with €1120 over ten years.

The financial benefits of this scenario for the government and private homeowners are outlined in **paragraph 7.4.**

7.1.2 Scenario 2: 20 % tax benefit for two energy label improvement

This scenario is chosen because it is not possible to achieve energy neutral level on every existing dwelling. Financially and technically it will not be possible for some dwellings to achieve energy neutral level. Therefore, the homeowner can choose to renovate his house and improve the energy label of his house at least with two labels. The investment cost of this measure is also lower than energy neutral renovation which can attract homeowners with low income.

The homeowners will be allowed to deduct 20% of expenses which have been made for renovation from taxable income. The tax deduction will also be eligible for payments which are related to eligible work and include cost of labour, professional services, materials, equipment and permits. These costs will be eligible only if the renovation is done by a professional contractor with an establishment in the Netherlands.

The beneficiaries

This deduction will be available to private homeowners with dwellings which have an energy label B or above. Two label improvements are chosen because some homeowners may improve their dwelling from a strong label C to a weak label B, which will be not really helpful for the government to achieve its environmental goals.

Obtaining the deduction

In order to prevent fraud and misuse of tax deduction the following points are taken into account.

- *The property is located in the Netherlands*: in the past a lot of governmental benefits (care allowance, children's allowance, Housing rental benefit) have been misused. Thus it is important to give tax benefits only for dwellings in the Netherlands and not a vacation house in Spain or Turkey.
- *The property has an energy label B or above (B->):* Only the energy label of these dwellings can be improved with two labels.
- *Only one owner of the house can apply for the tax benefit:* in case a house has two owners, it is not possible that both owners can have a 40% tax deduction. However the combined income will be taken into account for deduction.
- *EPC- report before and after renovation*: Before beginning the renovation work, it is necessary to send a copy of an EPC- report (Energy Presentation Coefficient) and after the renovation, an update of the EPC-report is required, that is signed off by certified consultants, this is important in order to prevent misuse of tax benefits.

Example: If private a homeowner has invested €8240 to improve his dwelling from energy label D to energy label B, he can get back €1648 (20% of renovation cost) from his taxable income. With this improvement, the CO_2 emission can be reduced by 899 kg/ year and the homeowner can save €233 on energy bill per year (see appendix C)

7.1.3 Scenario 3: 15% VAT reduction for renovation and restoration

The third scenario is the existing scenario in the Netherlands. The government has reduced the VAT from 21% to 6% in order to motivate homeowners and tenants for renovation and/or restoration of their dwellings. The VAT reduction rate of 15% can be applied to all renovation and repair work that has been made in a dwelling. Renovation and repair in this context can include; the renewal, addition, repair or replace of parts of the house. The reduced rate of VAT applies only to labour and not to the materials used in the renovation and restoration activities.

The beneficiaries

This deduction will be available to all private homeowners, tenants and housing associations.

Example

- A (labour cost) = € 10000
- B (material cost) = € 2500
- C (labour and material cost) = € 12500
- D (overhead cost) = € 1500
- E (contact sum excl. btw) = € 14000

Allocating the overhead cost

- F (overhead costs labour) = (A/C x D) = € 1200
- G (overhead costs material) = (B/C x D) = € 300

The VAT benefit will be:

Labour costs (A + F) x 6% = € 672 instead of € 2352. The benefit of homeowner will be € 1680.

7.2 Possible financial constructions

Tax benefits can make the energy neutral renovation project attractive and the payback time shorter, but energy neutral renovation needs huge amount of money and a source of financing. In this paragraph, the different possible financing constructions and funding which are available in the Netherlands for private homeowners will be outlined. This will be the solution for the second financial barrier mentioned in previous chapter (§ 6.2) access to money.

7.2.1 Green mortgage for private homeowners

Private homeowners can get green a mortgage with discount interest rate to finance the construction of their new home, to renovate their existing dwelling to a better energy efficiency level or to place a new energy efficient heating system. The money can also be borrowed for sustainable techniques such as solar panels or solar water heating system.
The green mortgage is available for the existing dwellings as well as for new construction. Private homeowners can complement the green mortgage into their existing mortgage or take it as a second mortgage.

Conditions for renovation projects:
The number of energy label steps that you can reach with the renovation, determines the maximum amount of mortgage, which is as follows (AgentschapNL, 2013b);

- From energy label E to at least energy label A : €50000
- From energy label E/G to at least energy label B: €50000
- From energy label G to at least energy label A: €100000

Energy neutral renovation meets the conditions mentioned above, as energy label A++ will be achieved after renovation. Thus, homeowners can use green mortgage for energy neutral renovation of their dwellings.
Green Mortgage has an attractive mortgage rate, due to its interest discount. This discount can be received for a period of ten years. After 10 years the interest discount cannot be applied. The bank than determines the interest rates.

7.2.2 Personal loan

Besides green mortgages, there are also personal loans available for private homeowners to use for renovation and sustainable measures. The interest rates are variable, the lower the amount of money, the higher the interest rate will be. The personal loans are mostly for a short duration of typically one to five years.

However there are a few financing companies: Alfam Consumer Credit, Advance Finance BV, which provide the homeowners green loans. The private homeowners can apply for green loans for investment in energy saving measures such as insulation measures and a new energy-efficient boiler. The green loan can also be used for to finance sustainable technologies such as a heat pump, PV panels and etc. The interest rate of the loan differs between 5.5% and 6.2 %, and the financing amount is between € 5000 and €50000. Green loans can be used for two energy label improvements.

7.2.3 Homeowners' own saving

Beside green loan and green mortgage, the other possibility is that the homeowners can use their own savings for renovations of any kind.

Own saving is especially appropriate for small scale renovation where homeowners may not need or like to take a loan if the renovation cost is not significant. The homeowners can also do big renovations step-by-step with their own saving. However, step-by-step renovation may does not have the same benefits as a complete renovation of dwellings towards energy neutral level. Furthermore, using own savings may also depend on homeowners' willingness and opportunity to invest in renovation of his dwelling or elsewhere, e.g. in stock exchange.

7.3 Service

The third financial barrier was uncertainty about the labour market and about the cost and benefits of renovation projects. The uncertainty about the labour market is addressed with flexible periods of tax deductions in sub paragraph 7.1.1. For the barrier, *uncertainty about cost and benefits* the one-stop-shop of Tommerup (Tommerup *et al.,* 2012) can be used (see figure 8).

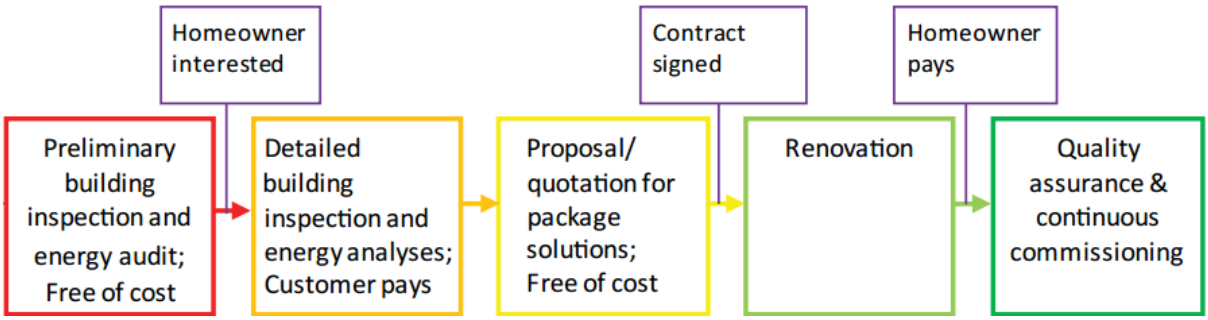


Figure 8: One-stop-shop service (Source: Tommerup *et al.,* 2012)

The purpose of such a shop is to help homeowners with the design and decision making process in connection with renovation costs and benefits of their house. Homeowners will get a quality renovated house with little risk and responsibility which usually is the case with traditional handicraft renovations (Tommerup *et al*. 2012).

7.4 Cost and benefit of energy neutral measure

The average private dwelling in the Netherland is built on 1964, has live surface of 120 m^2 and energy label D/E (Rijksoverheid, 2011b; Senternovem, 2013). To make such a dwelling energy neutral by means of renovation, an investment around €40000 is needed. The homeowner can get back €16000 of the renovation cost from his taxable income, and pays the remaining amount of €24000.

If the influence of 40% tax benefits can attract 3% of private homeowner to do energy neutral renovation on a yearly basis, then a total of 123000 dwellings will be renovated each year, with a total amount of €4.9 billion. Government pays €1.97 billion of the money through tax benefits. The government can receive €2.3 billion by means of VAT, income tax and corporation tax. Furthermore, the measure can create around 50000 new jobs, which means that the government has to pay fewer unemployment benefits.

The benefits of private homeowner will be: around €1400 saving on energy bills as direct return, around €10000 added value to his property (see section 3.4.1.2) comfort, healthy and better indoor climate as indirect return. The payback time of the investment will be 10 years if the added value of the property is taken into account, and 17 years without added value of property.

The costs and benefits are given in the following tables for a better overview. (For more detail, please see appendix D).

Cost of private homeowners		
Renovation cost	Tax benefits (40%)	Homeowner pays
€ 40000	€ 16000	€24000

Benefit of private homeowner			
Added property value	Energy bill savings /year	Payback Time (in years)	
		Taking added value in account	Without added value
€10000	€ 1400	10	17

Cost of goverment			
Private Homeowners	Renovation rate 3%/year	Renovation cost /year	Government pays (40%)
4.1 million	123000	€4.9 billion	€ 1.97 billion

Benefit of government					
VAT (21% of material)	Income tax (27% of manpower)	Company tax (20%)	Job creation	Less WW uitkering	Government receives
€258 million	€664 million	€147 million	49200	€1.23 billion	€2.3 billion

7.5 Conclusion

In this chapter the fiscal and financing possibilities are identified as an answer to the last sub question of this research, which was *"What kind of fiscal and financing structures are imaginable as solution for barriers and under which circumstances?"*

There are two kind of fiscal based incentive scenarios are constructed. These scenarios will cover part of high investment cost which was one of the financial barriers. The first scenario where the homeowners can receive 40% of renovation cost from their taxable income for energy neutral renovation and the second scenario where homeowners can get up to 20% of the renovation cost back from their taxable income. Furthermore, the results showed that the first scenario can shorten the payback time of renovation cost to 10 years. Additionally, this scenario can create around 50000 jobs and even if the government pays 40% of the renovation cost, this scenario can still be profitable for the government.

Moreover, this chapter presented the financial possibilities for renovation cost, which are green mortgages, green loans and the homeowners' own savings. Finally, one-stop-shop renovation service model is introduced which can help homeowners with design and decision making process in connection with renovation costs and benefits of their house.

8. Field research

In the previous chapter fiscal and financial measures were introduced as solutions to address the barriers of renovation. These solutions will be used tested in a field research in this chapter to find out if they are suitable to influence the willingness of homeowner to renovate their home into energy neutral.
The first paragraph of this chapter elaborates the problem and focus of field research. Then the experimental variables of field research will be outlined in the second paragraph. Thereafter, the case study area will be described in third paragraph and finally, the research methodology and data analyse of field research will be elaborated in final two paragraphs of this chapter.

8.1 Problem and focus of field research

Problem definition

It is technically possible to renovate the existing dwellings towards energy neutral levels, which will directly bring benefits to the homeowners as well as the local government. Conclusions from desk research showed that lack of financial resources and uncertainty about the costs versus benefits and especially high investment cost are the main motives behind the reluctance of renovation. The high investment cost causes longer payback time of renovation cost and in some cases not financially feasible.

Focus of field research

In the previous chapter the solutions for the main barriers were outlined. Alongside the existing tax scenario, two new scenarios are constructed in order to cover the part of the high investment cost. Furthermore, the possibilities for financing were outlined to address lack of financial resources. Finally, a new service method was introduced to help homeowners with the design and decision making process in connection with renovation costs and benefits of their dwellings.

The focus of this field research is to investigate whether the solutions formulated in chapter 7 are appropriate enough to influence the willingness of homeowner to renovate their home into energy neutral by answering the following research:

Which of the proposed solutions in chapter 7.1 to 7.3 can influence the willingness of homeowner to renovate their dwellings towards energy level?

Besides answering the above question, the output of the field research enables the assessment of different tax benefit scenarios made in chapter 7.

8.2 Experimental variables

In this paragraph the attributes which will be used in conjoint analysis are elaborated. The attributes and their levels are derived from desk research in previous chapters (paragraph 7.1 to 7.3). By taking the following attributes into survey in conjoint experiment (moreover in § 8.5), the preferences of the homeowners can be determined when doing renovation. It has been assumed that all attributes are independent.

Renovation option: The first attribute is the renovation option. The homeowners can choose from three renovation options. 1) Energy neutral renovation. 2) At least two energy label

improvement. 3) Taking some energy saving measures. These three levels are derived from paragraph 7.1.

Tax benefits: The second attribute is the tax benefits they can obtain. Besides three renovation options, the homeowners can choose from three forms of tax benefits. 1) 40% of the renovation cost is deductible from income tax. 2) 20% of the renovation cost is deductible from income tax. 3) 15% VAT reduction only on labour of the renovations costs. This attribute and its levels are also derived from three scenarios of paragraph 7.1.

Tax deduction period: The homeowner has also the option to choose from three periods of tax deductions. 1) Flexible, the homeowner can receive the cost in one time or divided into multiple number of years. 2) 5 years, the homeowner can receive the renovation cost in 5 years of time. 3) 10 years, the homeowner can get the renovation cost in 10 years of time. The last option is suitable for homeowners with low income who pays less income tax.

Financial possibilities: Energy efficiency renovations generally call for substantial additional up-front investments and not every homeowner has enough capital to do the renovation, therefore the homeowners are given three financial possibilities to choose from. 1) Green mortgage. 2) Green loans. 3) Own savings. These attribute levels are derived from section 7.2.

Service: The last attribute of the conjoint experiment is the service option. Literature research showed that uncertainty about renovation costs and benefits is one of the barriers that homeowners are facing. The service option *one-stop-shop* (§7.3) is taken as one of three options in renovation service. The options to choose from are; 1) One-stop-shop. 2) Different companies. 3) Do it self.

8.3 Case study

The case study area for this research is the municipality of Barendrecht. Barendrecht is a city in the Netherlands, located in the Rotterdam region in the province of South Holland. The municipality of Barendrecht has 47362 inhabitants on an area of 21.73 km^2.
Barendrecht consists of more than 96,000 dwellings. Only around 5300 of them are rental houses. More than 70% of the dwellings are privately owned. The percentage of private dwellings is much higher than the average percentage of 56% in the Netherlands (see Fig.8)

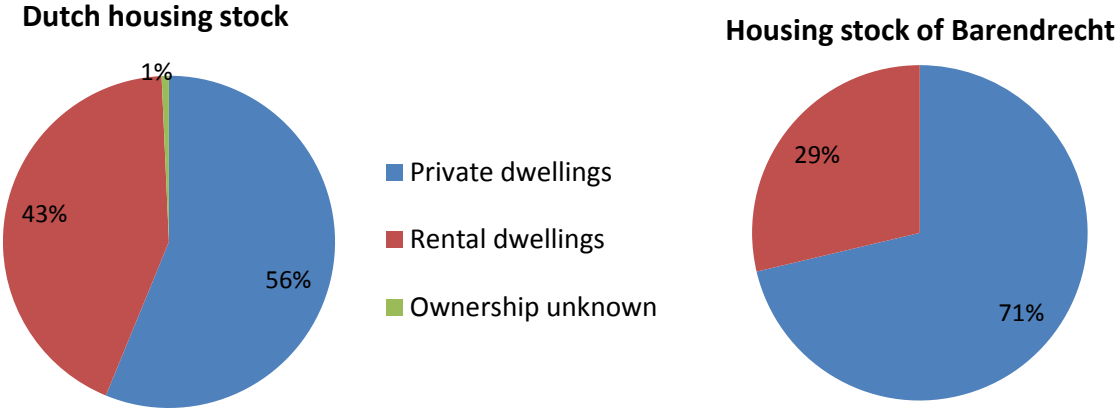


Figure 8: Housing stock of Barendrecht vs. Dutch housing stock (CBS, 2013)

The municipality has sustainability high on its list of priorities. Sustainability is not only one of the eight anchor points in the External Strategic Vision, but it is also part of the municipality's policies. This means that the municipality does not consider it as a separate subject, but as a basis for making decisions.

As a municipality, Barendrecht wants to contribute to a sustainable society. The aim of municipality is to reduce CO_2 emission compared to 1990 together with other neighbouring municipalities in the Rotterdam region. In order to achieve this goal, Barendrecht has decided to work together with other neighbouring municipalities in Rotterdam to prevent wasting energy and to make use of sustainable energy sources. The regional cooperation makes it possible for the municipalities to learn from each other.

8.4 Research methodology

In this paragraph, the used research methodology for this research is described. First, the data collection by means of questionnaire is sketched and then stated conjoint choice experiment is drafted.

8.4.1 Questionnaire

Researches in the past have shown that conducting a survey is a very valuable tool for assessing opinions. The questionnaire for this research contains three parts.

Several questions are asked concerning the respondents socio-demographic characteristics (such as age, level of education, employment status and income) in the first part of questionnaire to validate whether the sample group reflects the population or not. In the second part of the questionnaire, the respondents were asked about the characteristics of their dwellings (type of dwelling, year of construction, energy label and etc.) to verify the outcome of literature research and divide the respondents into groups. The last part of the questionnaire contains the conjoint choice experiment; this will be elaborated in the following section (section 8.4.2)

Each question is carefully rated by its value. After testing the questionnaire for its clarity, ambiguity, and approval of the municipality Barendrecht, the questionnaire were sent to 1488 households within the municipality of Barendrecht. The homeowners were chosen randomly from all over the municipality with different building type and different built year dwellings. The homeowners received an envelope with an invitation letter in it. The invitation letter addressed the receivers about the research and it included a short hyperlink of online questionnaire. The group could either fill in the questionnaire online or ask for paper version. The distributed questionnaire takes up to 15 minutes to fill in and it was made with www.enquetemaken.nu, a website that can be used as a tool to create simple and clear questionnaires. The sent questionnaire is added in to appendix E.

8.4.2 Stated conjoint choice experiment design

Conjoint choice analysis is a commonly used research method to determine how people value different features that make up an individual product or service. This research methodology is also used in various scientific fields. There are various conjoint analysis methods available which can be split into two approaches (see figure 9); the revealed methods are based on past behaviour, and the stated methods consider hypothetical situations.

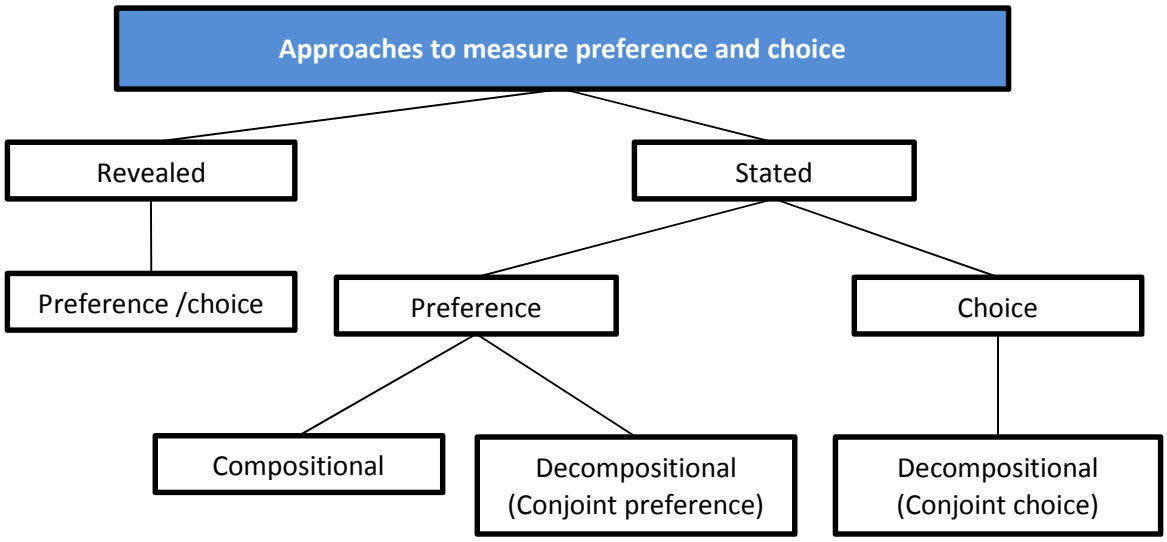


Figure 9: Scheme of the possible measurement (source: Kemperman, 2000)

For this research only the stated modelling is considered because the research is about a hypothetical situation of a governmental policy measure of tax benefit which is not brought into practice yet.

Conjoint choice has a better relation with the real world because costumers make a choice to choose a product when they are available. Therefore it is easier to predict what the market share will be of new products compared to existing products. In conjoint choice modelling respondents require to choose between two or more profiles. Usually there is also a "none of the above" option available if none of the presented profiles are attractive enough for the respondent.

In this case the profile consist of five attributes, renovation options, tax benefits, periods of tax deduction, financing possibilities and service as it is mentioned in paragraph 8.2. The attribute and its levels are given in table 6.

Attributes	Levels
Renovation options	1. Energy neutral 2. At least two energy labels improvement 3. Energy saving measures
Tax benefits	1. 40% of total renovation cost deductible 2. 20% of total renovation cost deductible 3. 15% VAT reduction on labour of renovation cost
Tax deduction period	1. Flexible 2. Divided on 5 years 3. Divided on 10 years
Financing possibilities	1. Green mortgages 2. Green loans 3. Own savings
Service	1. One-stop-shop 2. Different companies 3. Do it self

Table 6: The attributes and their levels

The 5 attributes and their 3 level will result in 3^5 = 243 choice profiles if the full fractional factorial design is used. Incorporating all the alternatives requires too many choice profiles to be taken into questionnaire which will take too much time of respondents. Therefore a fractional factorial design is created. A fractional factorial design is an experimental design presenting a small fraction of the full factorial design still enabling the researcher to discover the main effects for each factor level in the experiment.

The orthogonal generator function of SPSS 21 is used to design the fractional factorial design, holding 18 alternatives. These alternatives have randomly put in choice sets, each holding two profiles alternatives. In the experiment the respondents are first asked to give their preferred package from the set presented, totally nine choice sets are presented to them; an example is given in figure 10. Secondly, they are asked to reveal whether they find the packages acceptable to be implemented in practice. For the conjoint design it is assumed that the alternatives are independent from each other.

Choice set 1	Profile X	Pakket Y
Renovation	2 Energy label improvement	Energy neutral renovation
Tax benefits	20% of renovation cost deductible	40% of renovation cost deductible
Deduction period	Flexibel	5 jaar
Financing	GreenLoans lening	Green mortagage
Service	Different companies	One-stop-shop

Which choice profile do you prefer?

O Profile X

O Profile Y

Would you on the basis of above packages move on to renovate your home?

Profile X: O Yes O No

Profile Y: O Yes O No

Figure 10: Example of choice set

Effect coding

The variables of the profiles are coded by using effect coding (Kemperman, 2000) in order to enable the processing and analysing of the survey data. Effect coding is used to code the categorical variables; the variable levels take the values; -1, 0 and 1. The sum of the effects is equal to zero for all attributes, therefore it enables to determine the estimation for all three levels (see table 7)

Level	Effect 1	Effect 2
a	1	0
b	0	1
c	-1	-1

Table 7: Effect coding

8.5 Data analysis

The survey has resulted in data for descriptive statistics and conjoint choice experiment. With the gathered data the choice behaviour of the homeowners can be estimated. It can be estimated which attribute level has a high value for the homeowners. Also, by using the second answers of the choice set, it can be estimated whether a homeowner will implement

one of the packages to renovate his dwelling or not. The following models are used to analysis the data of survey.

8.5.1 Theory: Random Utility

This research is based on the random utility theory. The homeowners are given 9 choice sets each with two alternatives to choose from and the Random Utility theory is based on the following assumptions; if an individual must choose from a set of alternatives, then the alternative set with the highest random value will be chosen (Oppewal *et al.,* 1993).

In discrete choice models this value is determined by a structural and a random error component. The utility (U_r) for an alternative consists of a systematic utility (V_r) and a random error component(ε_r). The utility for a certain alternative can be calculated with multinomial Logit model in NLOGIT and can be displayed in the following formula:

$$U_r = V_r + \varepsilon_r$$

Then the systematic utility $V_r$of alternative r is described as a linear function. This is implicating that the utility V_r can be determined by the summation of all attribute utilities. This is expressed in the following formula:

$$V_r = \sum \beta_i + X_{ir}$$

All attributes have a utility value of X_{ir} . The parameter values β_i of the attributes indicate the relative influence of the various attributes on the utility of alternative r (Oppewal et al., 1993).
In addition, the relative importance of each attribute can be calculated compared to other four attributes in order to show which attribute is regarded as the most important one. This can be done by taking the absolute difference between the lowest and highest part worth value (Oppewal et al., 1993).

8.5.2 Goodness of fit

The goodness of fit also known as Rho-square needs to be calculated in order to define the predicting value of estimated model. Rho-square is an indication of how good the predictability is resulting from the analyses made and it is a value between 0 and 1. Value of 1 means that a model is predicting the data perfectly, while 0 indicates that the model has no advantage compared to a model without parameters.

Generally, a model with a Rho-square between 0.2 and 0.4 indicates a good fit and thus a well predictability. The Rho-square is calculated with the following formula:

$$\rho^2 = \frac{LL_\beta}{LL_0}$$

Where; LL_β *is log likelihood at convergence* and LL_0 is *log likelihood of the null choice model*

8.5.3 Regression analyses

In the survey, the respondents have given first their preference for a renovation package and then they gave answer to the question whether they would implement the renovation package to renovate their home or not. Ordinal regression enables analysing data in which causality might be involved (Vosters, 2008); in this case it is has been used to determine the influence of particular variable levels to the implementation of renovation package. NLOGIT software has been used for this analyse.

8.5.4 Latent class analysis

By use of Latent Class Analysis (LCA) a possible segmentation of the respondents can be derived from observed data. The latent class model can categorize the respondents into two or more classes which can result in more accurate results. The utility for latent class model is defined here below (Kemperman et al., 2006).

$$U_{jit} = \beta' X_{jit} + \varepsilon_{jit}$$

Every respondent has a choice probability for every class that is given. The class with the highest choice probability is most likely to be chosen. For performing and validation of this analysis, NLOGIT 4.0 is used.

9. Results

This chapter elaborates the results of field research. These results are obtained from gathered data of private homeowners in the municipality of Barendrecht. First, characteristics of the respondents are given. Thereafter, the descriptive statistics of the field research is presented. Finally, the results derived from conjoint choice experiment are outlined.

9.1 Characteristics of respondents

The respondents are approached via database of Barendrecht municipality. The respondents received an invitation letter with link to online questionnaire.

General statistics		
Approached	# 1488	100%
Finished questionnaire	# 324	22%
Finished Correct	# 307	21%

Table 8: General response statistics

The general statistics about the responses is shown in table 8. A total number of 1488 homeowners were approached for the survey. The number of responses were 324, and 17 out of them were filled wrongly. These questionnaires were removed from the database.

In the first part of the survey the respondents were asked to fill in several questions concerning their socio-demographic characteristics. The Socio- demographic data are given in table 9 a&b.

	Sample group		The Netherlands	
	Frequency	Percentage	Frequency	Percentage
Age				
Younger than 20	5	1.6%	3,870,423	23.1%
20 to 40 years	133	43.3%	4,119,832	24.6%
40 to 65 years	146	47.6%	5,963,523	35.5%
65 to 80 years	22	7.2%	2,121,391	12.6%
Over 80	1	0.3%	702,856	4.2%
Total	**307**	**100.0%**	**16,778,025**	**100.0%**
Work situation				
Full-time	223	72.6%	8,177,000	48.7%
Part-time	44	14.3%	907,000	5.4%
Searching for job	10	3.3%	636,000	3.8%
Retired	26	8.5%	3,166,540	18.9%
Other	4	1.3%	3,893,035	23.2%

Table 9 a: Socio- demographic data of the sample and Netherland

The data of sample group is compared with the population of the Netherlands. Some notable results came out of the comparison. Especially the education level of respondents, where 72% of the respondents have a PhD, WO or HBO diploma compared to 32% of Dutch population. This means that the majority of private homeowners who took part in the survey are highly educated people. This finding is in line with the literature indicating a positive relationship between educational attainment and environmental concern (Alibeli *et al.*, 2009). Literature shows that, well educated people are more likely to show higher levels of environmental concern than the less educated.

	Sample group		Netherlands	
	Frequency	Percentage	Frequency	Percentage
Household composition				
Single	20	6.5%	2.802.182	16.7%
Single parent	24	7.8%	521.578	3.1%
Family with children	120	39.1%	2.037.023	12.1%
Family without children	138	45.0%	2.174.829	13.0%
Others	5	1.6%	9.243.963	55.1%
Education level				
PhD ,WO ,HBO	221	72.0 %		32.0 %
VMBO ,MBO ,VWO,HAVO	86	28.0 %		67.0 %
Unknown	0	0.0%		1.0 %
Joint income of household				
Up to €19645	8	2.6%	Average joint income of household in The Netherlands = € 57400	
€19645 to €33363	60	19.5%		
€33363 to €55991	124	40.4%		
Above €55991	115	37.5%		

Table 9 b: Socio- demographic data of the sample and Netherland

9.2 Descriptive statistics

The literature study showed that the main barriers of renovation are the high investment cost, long payback time and limited financial resources. The respondents were asked what their main motive is/was to not invest in energy efficient improvements of their home. The results shows that “high investment cost”, “long payback time” and “limited financial resources” are indeed the main barrier which prevents the homeowners to invest (see figure 11).

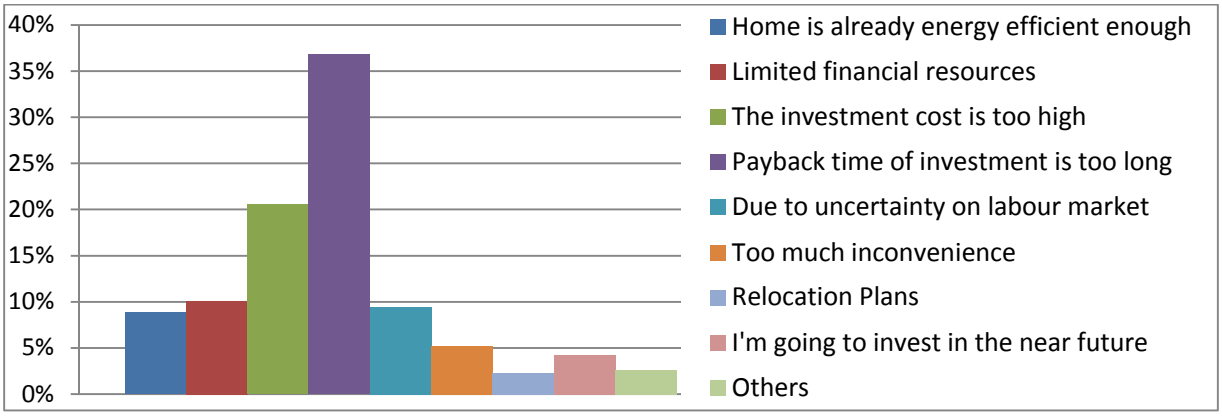


Figure 11: The main reason not to invest in energy efficient improvements of dwellings

With 37 percent, the choice "long payback time" resulted in the biggest reason of not investing. The second biggest reason was "the high investment cost" with 21 percent. "Limited financial resources" and "uncertainty on labour market" are the third and fourth biggest reason not to invest in energy saving measures with 10 and 9 percent, respectively.

The homeowners were asked about factors which are important in their decision making to renovate their home. Results shows (see figure 12) that around 55% of the respondents consider "saving on energy and electricity bill" as an important factor and around 30% of the respondents consider it as very important factor. Other main factors in decision making were "the healthcare" and "more comfort". "Enlarging the dwelling size" seemed to be an unimportant factor in their decision making, while the homeowners were neutral about "make the property better saleable" and "increase property value". This result is conflicting with literature (Eck, 2008 and Groenestein, 2011) where added value of property was important factor and people are ready to pay 10% extra for a dwelling with energy label A++.

The high income of respondents could have been the reason that homeowners were neutral about "make the property better saleable" and "increase property value". The residents of Barendrecht have an average income of €35900 while nationwide it is €29800 (cbsinuwbuurt.nl). Furthermore, 37.5% of the respondents have a joint household income of €55991 and above.

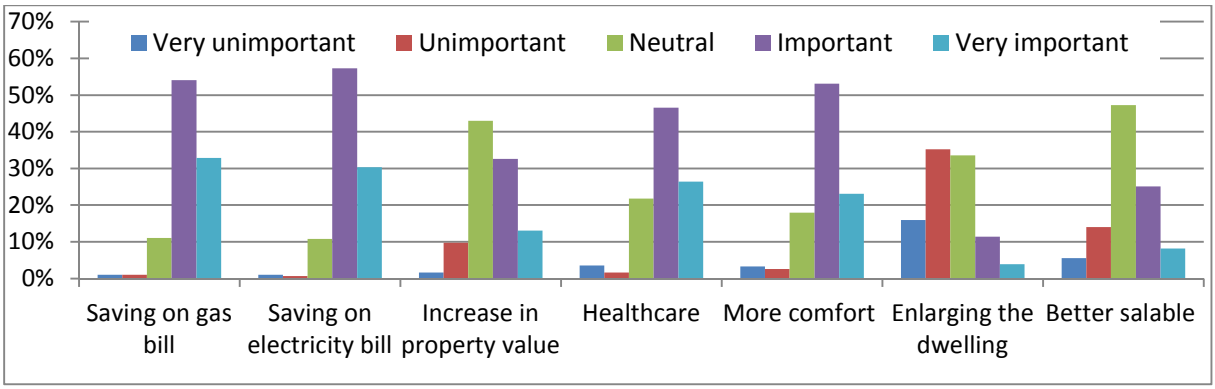


Figure 12: Importance of factors in decision making to renovate

In addition, the homeowner was asked about how long they are expecting to live in their existing dwelling. The majority of the homeowners are expecting to live longer than 10 years. Only 11% of the homeowners have planned to move in other dwelling within 5 years (see figure 13).

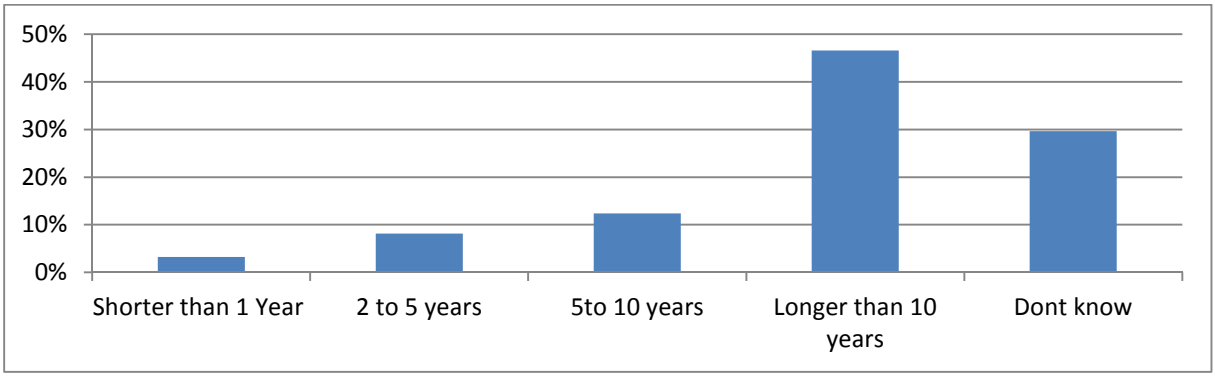


Figure 13: Expecting to live in the existing dwelling

This could have been the other reason that homeowners were neutral about “make the property better saleable” and “increase property value”. It is obvious when homeowner has no relocation plans, he will not be very interested to increase the value of property or the saleability of dwelling.

Furthermore, the respondents were asked if they have done any renovation in their dwellings in the last 10 years and if they have used any subsidy or loans for the renovation. The result of the survey showed that 41% of the homeowners have taken some energy saving measures in their homes. 76% of the homeowners, who have done energy saving improvements in their homes, have made use of subsidies or loans (see figure 14). It can be concluded that the majority of the homeowners take measures when they receive some financial helps.

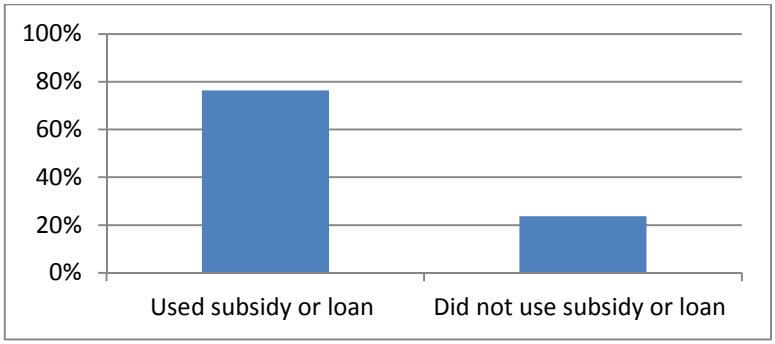


Figure 14: Use of subsidy and loan for renovation

9.3 Conjoint choice experiment

This paragraph elaborates the results of the conjoint choice experiment. First, the relative importance between the attributes is elaborated, then the part worth value of each level is given and finally the log likelihood of the research is described.

9.3.1 Relative importance of attributes

The relative importance of the attributes is calculated by taking the difference between the highest and lowest part worth value per attribute , then dividing by the total sum of difference times hundred (see figure 15).

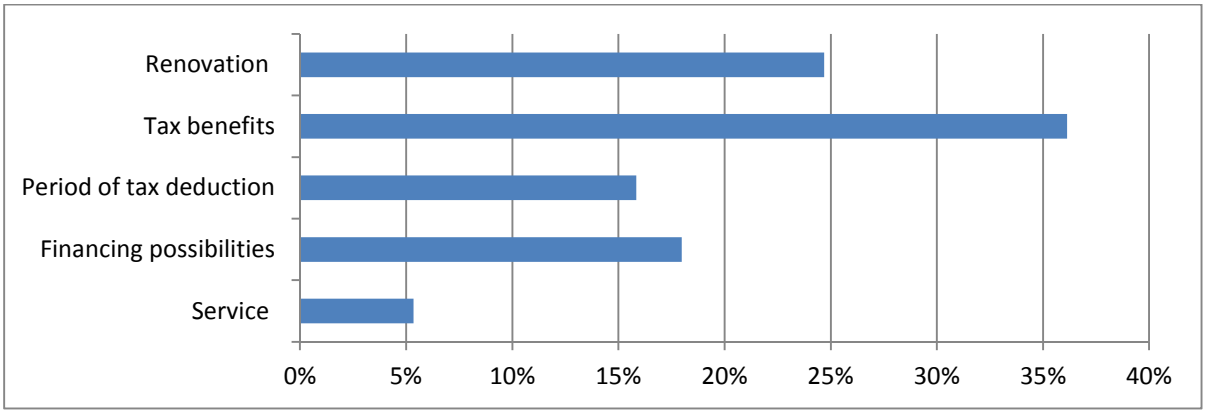


Figure 15: Relative importance of each attribute for choice sets

As shown in figure 15, tax benefits and renovation can be regarded as key attributes compared to other three attributes. With 36 percent the tax benefit is the most important, which means that the respondents seem to find it important policy for renovating their

home. Renovation options came out as second relative importance attribute with 25 percent, this shows that homeowners are eager to improve the energy performance of their dwellings. Financing possibilities is the third important attribute, implicating the needs of funding for high renovation costs. Period of tax deduction and service are the fourth and fifth important attributes, respectively.

9.3.2 Goodness to fit

The goodness to fit also known as Rho-square is calculated with NLogit (see table 10) in order to define the predicting value of estimated model.

McFadden Pseudo R-squared	
All attributes	.0491
Attributes with p-value <0.05	.0484

Table 10: Rho-square of attributes

As mentioned in section 8.6.2, the Rho-square between 02 and 0.4 indicates a good fit and thus a well predictability. In this research the Rho-square is 0.049 which is below required 0.2. This low value can be caused due to the small sample group. The model was estimated again by leaving the attribute *Service* out of the model as it has a p-value > 0.05, but the Rho-square did not improve.

9.3.3 Part worth value of levels

The following figures will elaborate the value of each level. If a bar is positive, than the respondents find the level attractive which results in an increased positive attitude towards a particular choice package. When a bar is negative, it shows that the respondents find the level not attractive. As mentioned before, NLOGIT has been used to calculate the values (see appendix F). The numbers allocated in the bars reflect the relative importance of each level. The insignificant value (levels with p-value >0.05) are shown in black colour.

Renovation: In the first part worth value of renovation (figure 16), the homeowners had a choice in energy neutral renovation, at least an improvement of two energy label and taking some energy saving measures. The results show that energy neutral renovation is the most important attribute level for homeowners. This is a logical result as energy neutral dwellings have the most of the benefits. Energy saving measures came as second and 2 energy label improvement came as last.

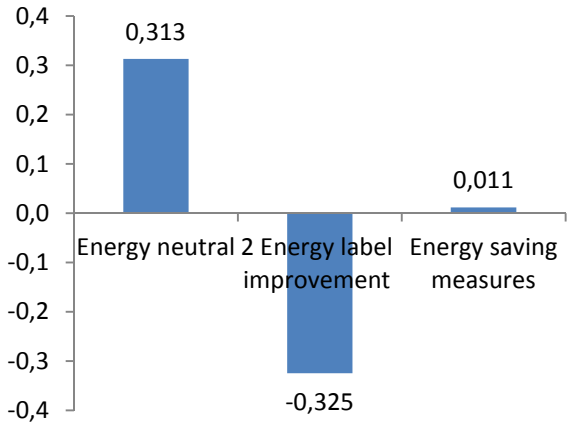


Figure 16: Part worth value of Renovation

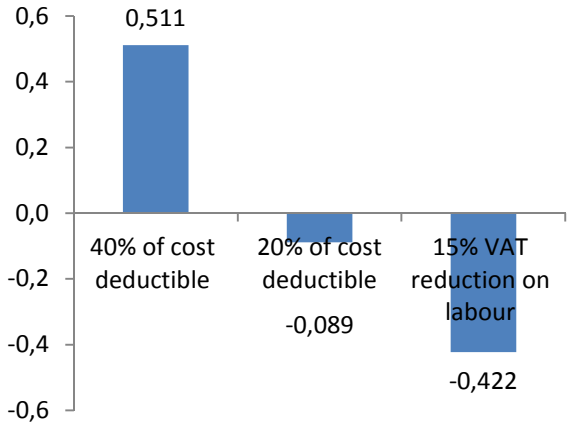


Figure 17: Part worth value of Tax benefits

Tax benefit: The part worth values concerning the tax benefits can be seen in figure 17. The figure shows that "40% of renovation cost deductible" has the highest value for the homeowners. "20% of cost deductible" has a negative value which means it has less value for the respondents, while 15% VAT reduction on labour which is current governmental policy to promote sustainability and create job in construction sector has least value for homeowners.

Tax deduction period: Figure 18 shows the part worth value of tax deduction period. The respondents had the option to choose from three periods. Noticeably, the option flexible has the least value for the homeowners. This could be due to reason that the majority of the respondents have no relocation plans and are expecting to live longer than 10 years in their existing dwellings. Period of 5 years has the highest value, while period of ten year is also in negative.

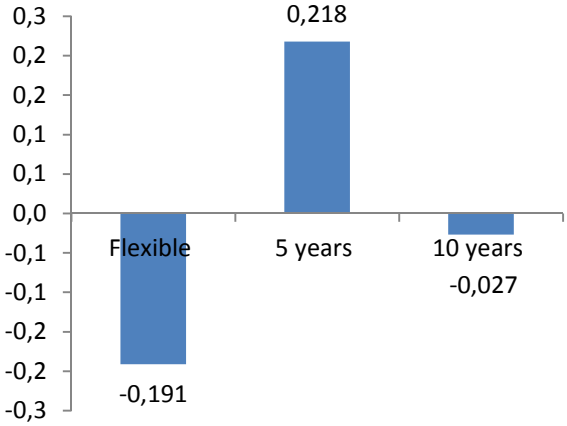


Figure 18: Part worth value of Tax deduction period

Financing possibilities and service: The following figures show the part worth value of financing possibilities and service. In figure 19, green mortgage and own saving has both positive values which mean that both of these two levels have important value for the homeowners. Green loans have the least value for the respondents as loans have a negative image in the Netherlands due to slogan of "Beware, borrowing money costs money".

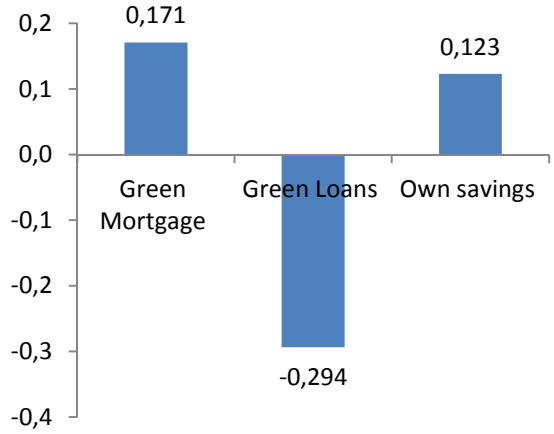


Figure 19: Part worth value of financing possibilities

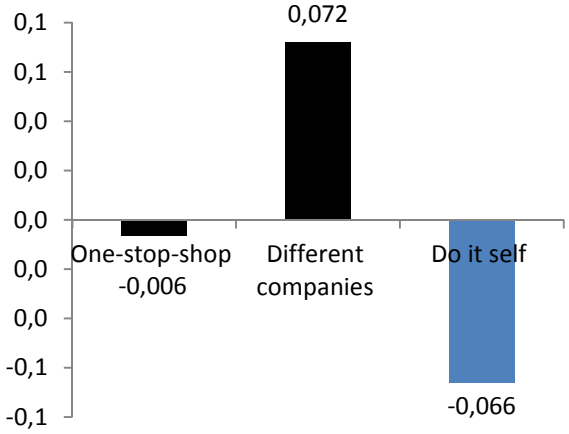


Figure 20: Part worth value of Service

The traditional way of renovation service which is getting the job done by different companies has the highest value for the respondents in service part worth value (figure 20).

The one-stop-shop, a new concept where all renovation service will be done by one contractor is negative, thus has less value for the respondents. However these values are insignificant as the p-values are larger than 0.05. Do-it-self option has the least value for the homeowners, which is a logical result, not every homeowner has the time or the knowledge to renovate his own home.

9.4 Comparison of socio demographic factors

The two important social demographic factors, namely education and income were also compared in this research to see if they have an impact on the results. The results show (figure 21) that renovation has more relative importance value for homeowners who are highly educated. This is a logical result because in general, higher educated people are more aware of renovation benefits and implication of energy use on costs and environment. Tax benefits and financing possibilities have slightly more relative importance to poorly educated respondents than to highly educated respondents.

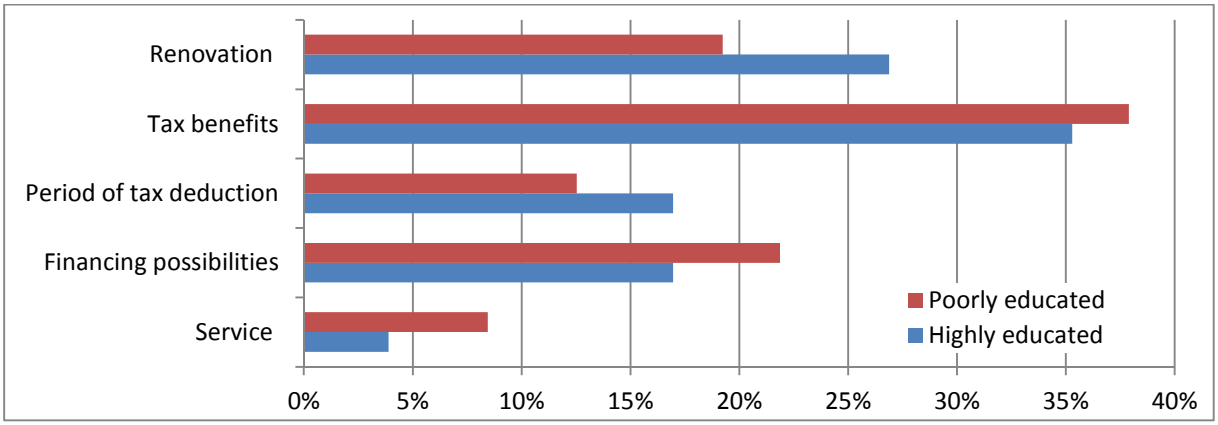


Figure 21: Relative importance of attributes for education

Figure 22 shows the relative importance of attributes for different income brackets. Bracket 1 was disregarded for this chart as the frequency was very low, namely 8. Factor income shows mixed results among the respondents. Tax benefits and period of tax deductions has the highest relative importance to respondents in income bracket 2, while financing possibilities and service has the highest relative importance for respondents in bracket 4, the highest bracket. Only renovation has the highest relative importance for respondents in bracket 3.

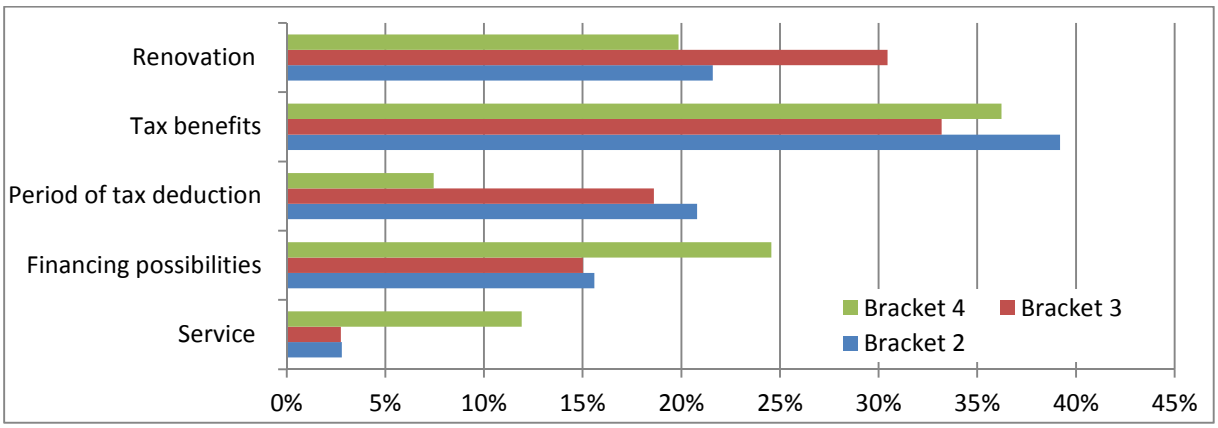


Figure 22: Relative importance of attributes for income brackets

9.5 Regression analyses

As mentioned before, in the survey the respondents have given first their preference for a renovation package and then then they gave the answer to the question whether they would implement the renovation package to renovate their home or not. Regression analysis is used to calculate the part worth value for the attribute levels which are chosen as a choice package and the homeowners would implement to renovate their dwelling. The analysis has been done in NLOGIT and the output is added in appendix F.

9.5.1 Relative importance of attributes for implementation

First the relative importance of the attributes are calculated and elaborated in figure 23. As shown in figure 23, tax benefits with 45% has the highest relative importance to homeowners who want to implement one of the renovation packages to renovate their home. It can be regarded as the key attribute compared to other attributes. Service has the lowest importance and while the other three attributes has almost equal importance to homeowners.

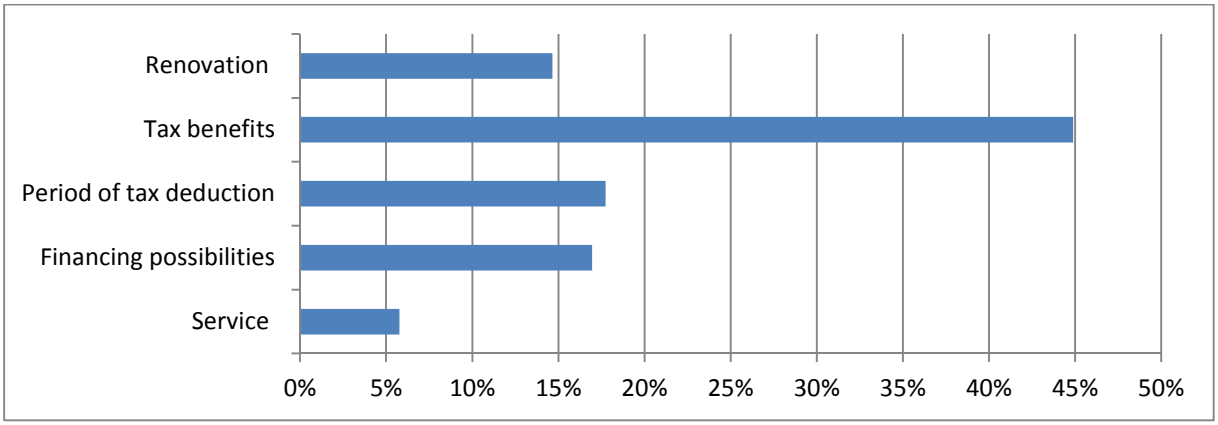


Figure 23: Relative importance of each attribute for implementation of choice sets

9.5.2 Part worth value of levels

The following figures will elaborate the value of each level. The insignificant value (levels with p-value >0.05) are shown in black colour. Part worth value of renovation and tax benefits are given in figure 24 and 25, respectively.

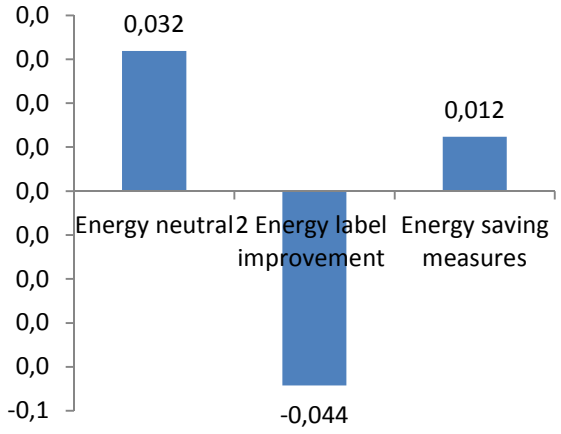


Figure 24: Part worth value of Renovation

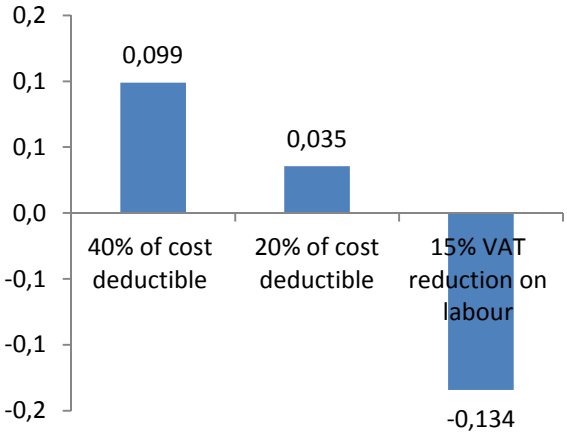


Figure 25: Part worth value of Tax benefits

The most notable differences between part worth value in choice of the renovation package and implementation of the renovation package is *20% of cost deductible* in tax benefit attribute is positive for implementation while it was negative in choice of packages.

The part worth value of tax deduction period and financing possibilities can be seen in figure 26 and 27, respectively. The only major different in this results are the attribute level *Own savings*. This attribute had a positive preference in choice packages while it has a negative value in implementation packages.

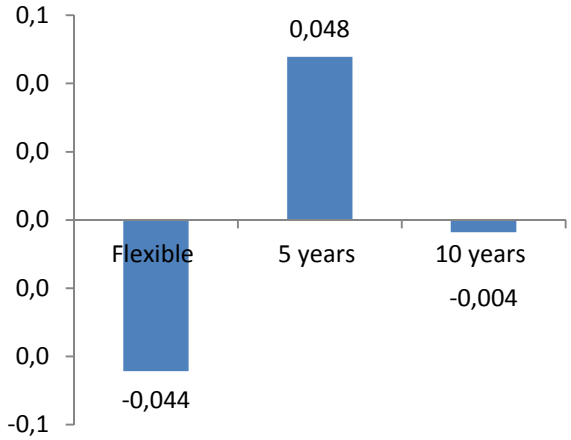


Figure 26: Part worth value Tax deduction period

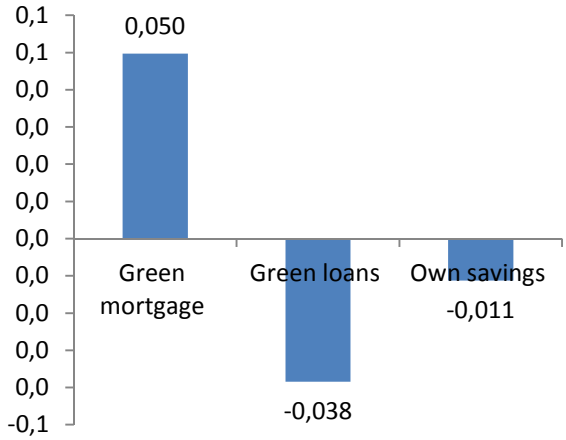


Figure 27: Part worth value financing possibilities

Figure 28, shows the part worth value of service levels. The part worth value for attribute level Do-it-self is positive while it was negative for part worth value of *service* in choice of renovation package. One-stop-shop was negative and remains negative.
The value for one-stop-shop and different companies are once again insignificant and therefore the bars are coloured in red. Both attribute levels had p-value higher than 0.05. One-stop-shop has a p-value of 0.2680 and the p-value of different companies is 0.7648.

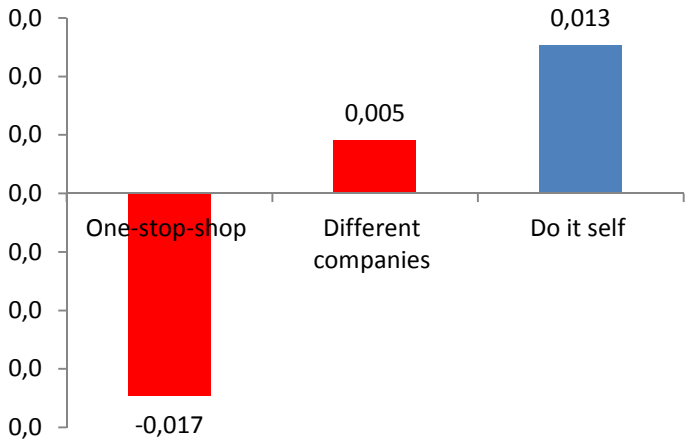


Figure 28: Part worth value of Service

9.6 Comparison of three scenarios

In paragraph 7.1, three scenarios were described. Two new scenarios, scenario 1 with 40% of renovation cost deductible and energy neutral renovation and scenario 2 with 20% of renovation cost deductible and at least two energy label improvement. The third scenario was the existing governmental policy which is VAT reduction of 15% on labour for taken energy saving measures. By adding up the part worth values of *renovation* and *tax benefits* together, it can be concluded that scenario 1 is the most acceptable scenario for the homeowner with a part worth value of 0.131. The homeowners have negative preference for Scenario 2, while the existing scenario of the government is least preferred scenario (see figure 29).

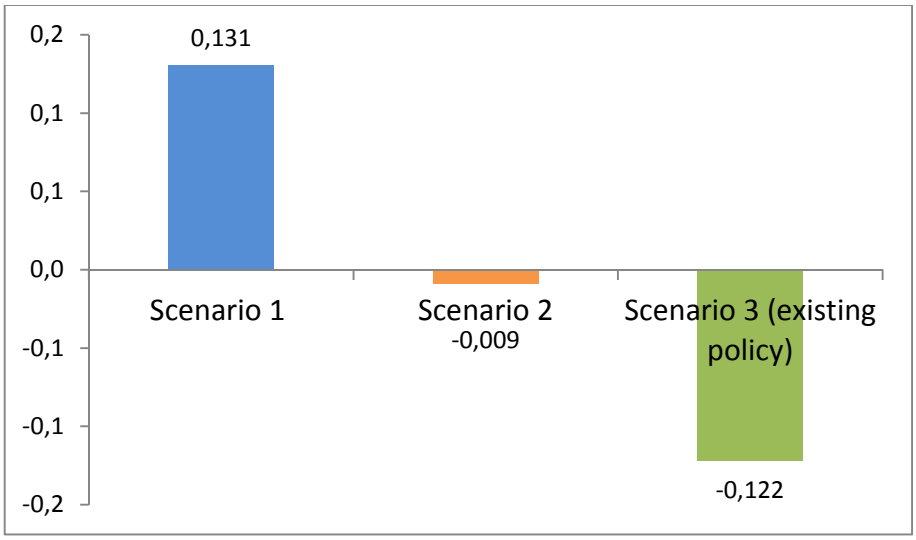


Figure 29: Comparison of different scenarios

By taking the antilog of each of the total part worth values, the percentages to predict the proportion of homeowners who choose each of the scenarios to renovate their home is calculated and elaborated in figure 28. As shown in figure 30, 38% of the homeowners have chosen for scenario 1, 33% have chosen scenario 2 and only 29% have chosen the existing scenario.

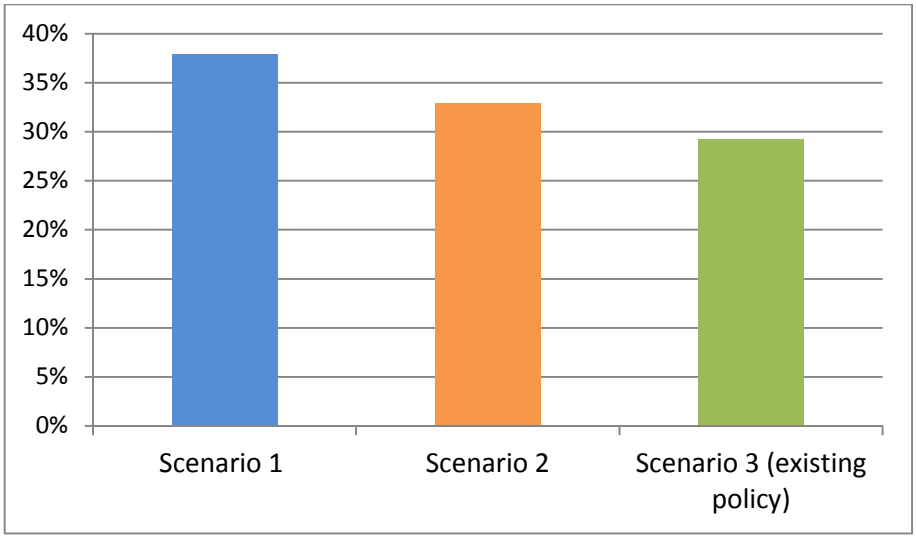


Figure 30: Choice of homeowner for scenario

9.6.1 Latent class analysis

As mentioned before, Latent Class Analyses (LCA) is a method which is able to find respondent segments in a sample group based on preference variables. For this research LCA is performed in NLOGIT. The output of the two segment latent class analyses is elaborated in appendix F.

There are two class found in NLOGIT, class 1 which represents 63% of the respondents and Class 2 which is representative of 37% respondents. The relative importance of both class are determined and expressed in figure 31.

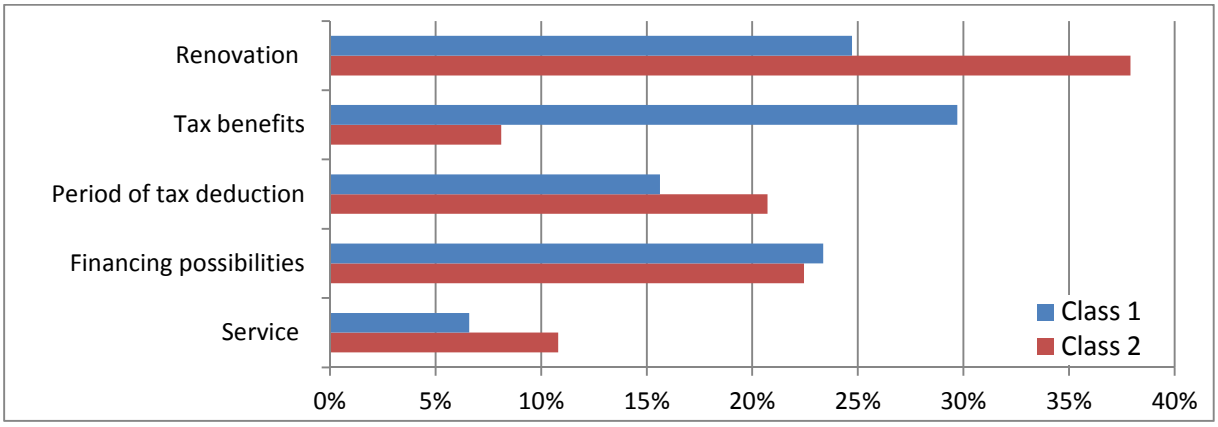


Figure 31: The relative importance of class 1 and class 2

As it is shown in figure 31, respondents belonging to class 1 found *Tax benefit*s more important attribute than class 2. The attribute *Renovation* has high important value for the respondents of class 2. Also a difference of 5% is showing in the attribute of *Period of tax deduction*, with class 2 showing more importance for this attribute than class 1. There is a minimum difference of 1% in attribute *financing possibilities*.

The part worth value of all attributes for both classes are given in the following figure (figure 32). The general differences can be elaborated in classes resulting in different part worth value.

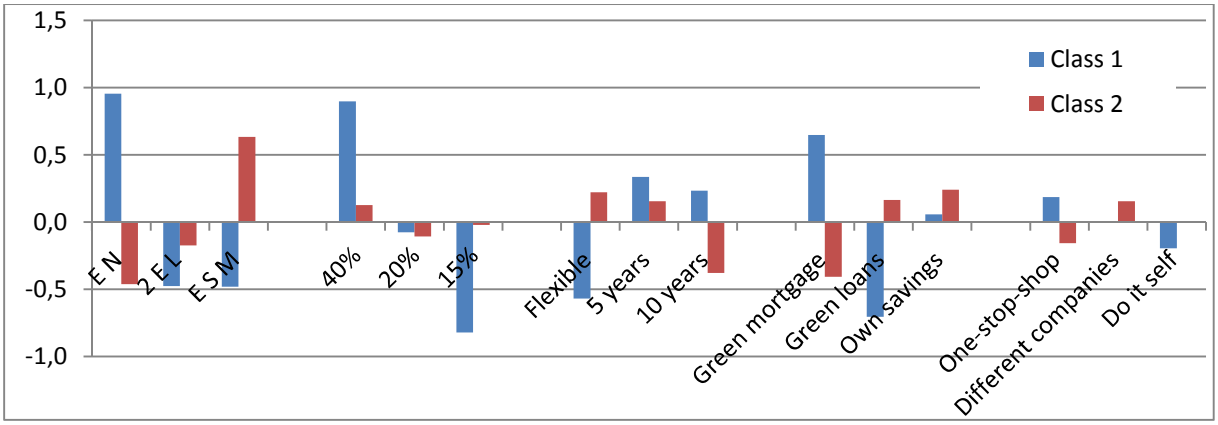


Figure 32: Path worth utilities attribute levels latent class

The classes are named after the analysing the differences in utilities in figure 32. As it shows, latent class 1 is interested in energy neutral renovation with tax benefit of 40% tax deduction of renovation costs. Furthermore, this latent class has chosen for green mortgage

and one-stop-shop as service option. All choices are logical and it seems that they are really interested in energy neutral renovation of their dwellings. In addition, the majority of the value in this class is significant and has p-value <0.05, except 20% of renovation costs deductible and Different companies (see table 11). This latent class is named as "Active homeowners". This class represents 63% of respondents.

Attributes and their levels	β Class 1	β Class 2
Constant	-0,0385	-0,0083
Renovation		
Energy neutral	0,9552	-0,4605
At least 2 Energy label improvement	-0,4749	-0,1740
Energy saving measures	-0,4803	0,6346
Tax benefits		
40% of renovation costs deductible	0,8976	0,1271
20% of renovation costs deductible	-0,0761	-0,1071
15% VAT reduction on labour	-0,8215	-0,0200
Tax deduction in nr of years		
Flexible	-0,5682	0,2216
5 years	0,3355	0,1556
10 years	0,2328	-0,3772
Financing possibilities		
Green mortgage	0,6471	-0,4070
Green loans	-0,7041	0,1656
Own savings	0,0571	0,2414
Service		
One-stop-shop	0,1871	-0,1564
Different companies	0,0069	0,1560
Do it self	-0,1940	0,0004

Table 11: Part worth values per LCA class (Note: value with p-value >0.05 is underlined)

As shown in figure 32 and table 11, the respondents in latent class 2 have minimal interest in *energy neutral renovation* and *2 energy label improvement*. Latent class 2 has high importance for *energy saving measures* and *40% tax benefits*. Therewith, it should be mentioned that 40% tax benefit has an insignificant value. It can be concluded that this latent class is not interested in energy neutral renovation, and therefore it will be named "*Passive Homeowners"*. This class represents 37% of respondents

With data from table 11 optimal packages are chosen for both classes. It has to be noted, if the preferred choice of the class has an insignificant value, then the second preference will be chosen for optimal packages.

This will result in two packages for classes, both with 95% confidence level. The packages are shown in the following table (see table 12).

	Class 1 - Active Homeowners	Class 2 - Passive Homeowners
Attributes	**Attribute level**	**Attribute level**
Renovation	Energy neutral	Energy saving measures
Tax benefits	40% of costs deductible	15% VAT reduction on labour
Deduction Period	In 5 year time	Flexible
Financing	Green mortgages	Own savings
Service	One-stop-shop	Do it self

Table 12: Characteristics of optimal packages

10. Conclusions

Before answering the main question of this research, which was "**Can tax benefit influence the willingness of the private homeowners and motivate them to renovate theirs houses towards energy neutral level?"** in paragraph 10.4, a short summary of conclusions drawn from questions will be described briefly in the section 10.2. Results of field research are given in section 10.3. Recommendations are listed in paragraph 10.5. But first, this chapter starts with a brief overview of problem and focus of this research in paragraph 10.1.

10.1 Problem and focus of research

The Dutch government is committed to achieve the international (Kyoto and later Bonn) agreed objectives to reduce CO2 emissions. The aim is to have a 20-20-20 reduction in 2020 compared to 1990; 20% less greenhouse gas, 20% more sustainable energy and 20% energy saving. However, this goal cannot be achieved without the Dutch built environment which is responsible for 30% of total energy consumption.

In the Netherlands there are around 7.3 million housing stocks. Around 3.1 million of the housing stock is rental, the ownership of small number of houses is unknown, but the majority of the dwellings, around 4.1 million are private owned dwellings. In the recent past, the private homeowners have tried to take measures in order to reduce energy consumption through the provision of subsidies. This have often resulted in small changes and measures such as double glassing, solar panels and etc. without any comprehensive and structural approaches such as reducing energy loss through the shell of the building. In order to compete with highly energy efficient (energy neutral) dwellings, it is important and desirable for the private homeowners to renovate their houses towards high energy efficiency / energy neutral level. But a renovation on such a level needs around €40000 and willingness to invest.

The goal of this research was to investigate whether it is possible for the government to use tax benefit as an incentive to stimulate and increase the willingness of private house owners to renovate their dwellings into energy neutral.

10.2 Conclusion of desk research

This paragraph illustrates a short summary of conclusions drawn from sub questions during desk research.

What is energy neutral renovation and what are its benefits?

Desk research showed that Trias Energetica strategy is extensively used in renovation of dwellings in the Netherlands and it can be used to renovate the exiting dwellings towards energy neutral level.

Furthermore, from desk research it can be concluded that energy neutral renovation has benefits for homeowners as well as for government. Homeowners save up to €1400 on energy bills each year, their property can be up to €27000 more valued after renovation. In addition, the homeowners can have more comfort, better and healthier indoor climate as indirect return after the renovation.

Alongside achieving agreed environmental objectives, the government can profit from job creation in construction sector as well as in production and installation sectors of sustainable

products. Furthermore, the government can collect more taxes such as more income tax due to job creation, more VAT due to sold renovation materials and products and more corporation tax as companies are going to make more profit.

How successful is/ was tax benefit in the Netherlands and other European countries regarding sustainability of dwellings?

From research in Belgium, France and Netherlands it can be concluded that tax benefit as an environmental instrument has been success in all these three countries. France can achieve its environmental goals by using tax deduction as an instrument, whereas households in Belgium and the Netherlands have taken energy saving measures in their home due to VAT reduction and tax deduction for roof insulation.

In the available tax forms, which one is the most suitable and influential for tax benefits?

Income tax has been selected for this research with a score of 98 by using selection table. Income tax has maximum range (is applicable for every homeowner), is transplant and can cover high percentage of the renovation cost at once. Corporation tax, real estate transfer tax, environmental tax and property tax were the other tax forms which were considered for this research.

Which financial barriers do the homeowners face if they decide to do energy neutral renovation?

Literature study showed that high investment cost, access to money, uncertainties about labour market, uncertainties about costs versus benefits of renovation are the main barriers which are preventing the homeowners to renovate their homes.

What kind of fiscal and financing structures are imaginable as solution for barriers and under which circumstances?

Finally, the desk research was concluded with a number of solutions for the financial barriers. Two fiscal incentive based measure scenarios were constructed to cover part of high investment cost. In the first scenario, the homeowners can deduct 40% of the renovation cost from their taxable income if their dwelling achieves an EPC=0.0. Calculation showed that even after paying 40% of the renovation cost, this scenario can be financially profitable for the government.

In the second scenario, the homeowners can deduct 20% of the renovation cost from their taxable income, if their dwelling is improved at least with two energy labels. Also a new renovation service is proposed to solve and help homeowners with assessments of costs and benefits of renovation. These scenarios were tested in field research (following section) to investigate if they were appropriate enough to solve the financial barriers and if the solutions can influence the willingness of private homeowners to do energy neutral renovation.

10.3 Field research

With gathered information from sub questions by desk research, a field research was conducted. The required data for the experiment was collected from 307 filled questionnaires by homeowners in the case study area of Barendrecht.

10.3.1 Descriptive statistics

The main barriers indicated in chapter 6 of this research were supported by descriptive statistics results of field research. Results showed that high investment costs, long payback time and limited financial resources are indeed the main barriers which prevent the homeowners to invest. Field research also showed that saving on energy bills, healthcare and better living comfort are the main factors in discussion making process of homeowners to renovate. Furthermore, the descriptive statistics results also showed that the majority of homeowners, around 75 %, renovated their homes only after using subsidy and loans.

10.3.2 Conjoint choice experiment

Choice of renovation packages

From choice of renovation package, it can be concluded that tax benefits has the highest relative importance for the homeowners followed by renovation with 36% and 25%, respectively. The Period of tax deduction and financing possibilities had almost equal importance for homeowners.

Also, from the part worth value of attributes it can be concluded that homeowners prefer energy neutral renovation with 40% of the renovation cost deductible from taxable income. They want to deduct the money in period of 5 year and want to make use of green mortgage. The comparison of attributes with socio demographic results showed that highly educated homeowners are more interested in renovation of their homes, while poorly educated homeowners are more interested in tax benefit that they get.

Implementation of renovation packages

From data where the respondents want to implement one of the renovation packages to renovate their dwellings, it can be can be concluded that tax benefit has the highest relative importance for homeowners with 45% .Almost 10% more than in choice of renovation packages. The other attributes such as renovation, period of tax benefits and financing possibilities have around 15% relative importance to homeowners.

Besides, it can be concluded that homeowner has chosen to renovate their dwellings into energy neutral with 40% of the renovation cost deductible from taxable income. They prefer deduction period of 5 year on flexible and 10 year. Likewise in choice of renovation packages, the homeowners want to use green mortgage for financing the renovation cost.

Comparison of three scenarios

The scenario comparison showed that scenario 1, energy neutral renovation with 40% tax benefits, is the most desired scenario for homeowners, followed by scenario 2 which is 2 energy label improvement with 20% tax benefits. The current scenario, 15% VAT reduction for labour of energy saving measures, is the least chosen scenario among homeowners. Furthermore, the results showed that 38% of the homeowners would implement scenario 1 if it is offered compared to 29% for current scenario.

Latent class analysis

Latent class analysis is performed to create different classes within respondents to make a better prediction. Based on the latent class analysis, two classes can be distinguished in the sample group. The first class covers 63 percent of the total sample group, while the remaining 37 percent is covered by second class.

From the relative importance of the attributes it can be concluded that class 1 values the renovation the most, while class 2 has high importance for tax benefits. Additionally, the classes are named after the analysing the differences in utilities. Class 1 was named as *Active Homeowners.* They are interested in energy neutral renovation with 40% tax benefits, green mortgage and one-stop-shop as service option. All choices were logical and the values were significant with 95% confidence level.
Class 2 which represents 37% of the respondents is named as *Passive Homeowners*. Class 2 has chosen for energy saving measure with 40% tax benefits doing the renovation with own savings and service of different companies. It has to be noted that the majority of preferred choices were insignificant with p-value>0.05.

10.4 Answering the research question

The conclusions in desk and field research leads back to answer the main question of this research:

Can tax benefit influence the willingness of the private homeowners and motivate them to renovate theirs houses towards energy neutral level?

It should be mentioned that special attention should be given to financing of energy neutral renovation. Tax benefits and added property value after renovation can cover big part of the renovation cost and they can make the payback time of renovation cost shorter and therewith the renovation more attractive for homeowners. However energy neutral renovation needs a substantial additional up-front investments and not every homeowner has that money. Thus, it is important to make access to financing resources possible and easy for homeowners besides tax benefits.

Then, with the results of field research based on gathered data from the municipality of Barendrecht, it can be concluded that the homeowners showed high interest in energy neutral renovation with 40% tax benefits. The interest was large in choice of renovation packages as well as in implementation of them. The results showed that tax benefits and energy neutral renovation has high value for private homeowners.

From scenario comparison it can be concluded that scenario 1 has the highest value for homeowners, followed by scenario 2. The existing scenario, scenario 3, has the least value and therewith it is the least chosen scenario among homeowners. Subsequently, the results of scenario comparison showed that 37 percent of homeowners, with 95% confidence level intend to renovate his dwelling towards energy neutral if 40% tax benefit is given.

By use of Latent Class Analysis two possible segmentations of the respondents are derived from observed data for more accurate results. From the result of LCA, it can be concluded that class 1 with 63 percent of the respondents and 95% confidence level, were interested in energy neutral renovation with 40% tax benefits and green mortgage. Whereas, class 2 with 37 percent of the respondents, appeared to be not interested in energy neutral renovation.

Finally, it can be concluded that tax benefits has a big influence on the willingness of homeowners to renovate their dwellings towards energy neutral level. The combination of 40% tax benefit and energy neutral renovation was preferred in all three sections; namely, in choice of packages, in implementation of packages and in the latent class analysis. The

homeowners could have chosen for 40% tax benefit and 2 energy label improvement or 40% tax benefit and energy saving measures, but they favoured energy neutral renovation on other two mentioned renovation options.

10.5 Recommendations

The personal ideas and knowledge gained from the experience of tax benefits and energy neutral renovation of privately owned dwellings and the benefits of energy neutral renovation to stakeholders are presented as recommendations. These recommendations are aimed at contributing towards energy neutral renovation of existing dwellings and achieving the environmental goals of Dutch government, showing the needs of supplementary research in field of sustainability. These recommendations can be used by students to do researches.

- The field research has been conducted in municipality of Barendrecht. The majority of the respondents were highly educated and had on average high income than average Dutch citizens. A similar research among a larger group of homeowners from different municipalities can be done for better prediction and a better Rho-square value.

- A detailed calculation of cost and benefits is needed before coming to a conclusion that 40% tax benefit is profitable for the government. For example, Homeowners pay energy taxes on every Kwh electricity and cubic meter gas that they use. When their dwelling is renovated, they will use less energy which means less energy tax. Thus, it is important to find out how much energy tax will government miss. On the other hand, the Dutch government achieves the agreed international goals, when the existing housing stock is renovated to energy neutral, it is important to calculate what the benefits of government will be by achieving environmental goals. Furthermore, the government and municipalities pay different subsides, when 40% tax profit is given to homeowners, than these subsidies will be not necessary for private homeowners. Thus, it is important to calculate how much the government and municipalities can profit from this measurement.

- System dynamic modelling can be used to predict the effect of different scenarios described in this research on environmental goals and construction sector for longer period of time.

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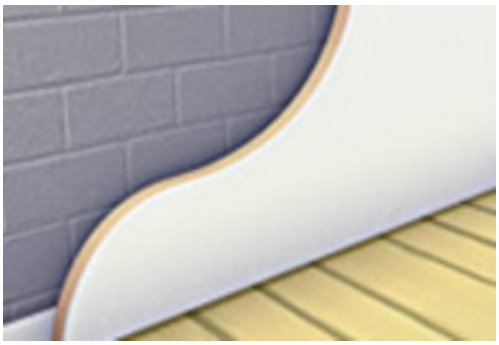
Appendix A: Energy saving techniques and measures

Step 1: Reduce the energy demand

Cavity wall insulation

Most dwellings built in the past 100 years were built with two layers of wall, leaving a small space or 'cavity' between the two layers. These unfilled cavities let heat escape and could be responsible for 35% of all heat lost from your home.



The purpose of the cavity wall insulation is to insert material such as mineral wool, beads or granules through openings in the cavity. The method has relative low costs and is easy to apply.

One of the disadvantages of the method is concerns wall-tie corrosion; cavity insulation makes the outer brick leaf colder, and therefore wetter, which can accelerate rusting of the wall ties. The payback time of the method is around 3 years with annual energy saving up to 180 euro.

Figure A1: Wall insulation

Solid wall insulation

Insulating solid walls could cut energy demand and heating costs considerably, because solid walls let through twice as much heat as cavity walls do. Solid walls can be insulated – either from the inside or the outside. This will cost more than insulating a standard cavity wall, but the savings on heating bills will be bigger too. The cost can be reduced by carrying out the work at the same time as other home improvements.

Internal wall insulation is done by fitting rigid insulation boards to the wall, or by building a stud wall filled in with mineral wool fibre. High insulation values and sound proofing between rooms can be achieved by this method. It is generally cheaper to install than external wall insulation but it will slightly reduce the floor area of any rooms in which it is applied. Internal wall insulation is disruptive, but can be done room by room.

External wall insulation involves fixing a layer of insulation material to the wall, then covering it with a special type of render (plasterwork) or cladding. The finish can be smooth, textured, painted, tiled, panelled, pebble-dashed, or finished with brick slips. The method can be applied without disruption to the households and it does not reduce the floor area of rooms. One of the disadvantages is that it may need planning permission.

Roof insulation

Heat rises and the roof of a house, if not well insulated, is the largest escaping station of heat in a house. If the roof is not insulated sufficiently, the energy consumption for heating in the winter could be twice as much. Thus good roof insulation is worth of effort and investing. Well and sufficiently thick roof insulation can save a lot of money.

Roof insulations can be insulated from the inside or the outside. Insulation from the inside of a pitched roof is applied underneath the roof deck. There are various insulation materials for inside roof insulation. All insulation materials have their pros and cons. The insulation value of the material is the most important during the choice of material. This is expressed by means of R and for rood insulation a value of 1.3 or better is recommended. For a flat

rood it is always advisable to opt for the outside insulation. By choosing to isolate a flat roof from the inside, the rooms will be confronted with moisture problems.

Floor insulation

Dwellings built before 1983 has no floor insulation as the crawl space insulation or floor insulation application was not yet standard. Much of heating is lost through floor of dwellings. A properly sealed, moisture-protected, and insulated crawlspace will increase comfort, save on energy costs, improve the durability of the home, and reduce entry of moisture, radon, and other potential irritants or pollutants into the home.

Floor insulation can be done by applying high insulation material underneath of the floor from the crawl space. If a dwelling does not have a crawl space, then there are two other options. First, an insulation layer can be applied on the ground floor. However the insulation layer will increase the high of floor, as a result the doors and kitchen cabinets needs to be shorten. The second option is to remove the old floor and lay a new floor with floor insulation at the bottom.

The temperature of the floor is considerably higher due to floor insulation (about 2 to 4 ° C) and it can save 10-20% on energy bill.

Windows insulation

From an energy standpoint, windows might seem like a detriment. A significant portion of heat loss is due to windows. The best way to reduce the energy demand through windows is to replace the single and normal double glazing with high performance glass, HR++ or HR+++. Double-glazed windows have two sheets of glass with a gap between them, usually about 16mm, to create an insulating barrier that keeps heat in. This is sometimes filled with gas. Triple-glazed windows have three sheets of glass. If Triple-glazed is chosen to replace the single or double glazed then the window frame needs to be changed as well, because the Triple-glazed does not fit in standard frames. There are well insulated window frames on the market that have high insulation values. By replacing the entire window frame, breeze can be decreased and heat losses can be minimized. As well as keeping the heat in, energy efficient-windows insulate the dwellings against outside noises.

Step 2 a. Use energy from waste streams

When the amount of needed energy is reduce in step 1, it is important to make use of energy from residual flows and renewable sources in step 2a and 2b of Trias Energetica. This will be outlined in here below.

Grey water system

Domestic wastewater can be divided into two wastewaters; black water and gray water. Black water is wastewater from toilets and gray water is the wastewater from kitchen sinks, washing machines, laundry tubs, hand basins, spas, the shower, bath and etc. Currently these two types of wastewater discharged through a combined sewer to a central water distillation plant where the water is purified. However grey water needs less treatment than black water, but in this way it undergoes the same treatment as black water. By separating gray water from black water much energy and water can be saved.

The first step in realizing a gray water system is to separate the gray water from black water as it is shown in figure A2. Then the gray water can be collected in a control box. After the gray water is recycled in the system it can be used for garden, car washing, toilet, washing machine and etc.

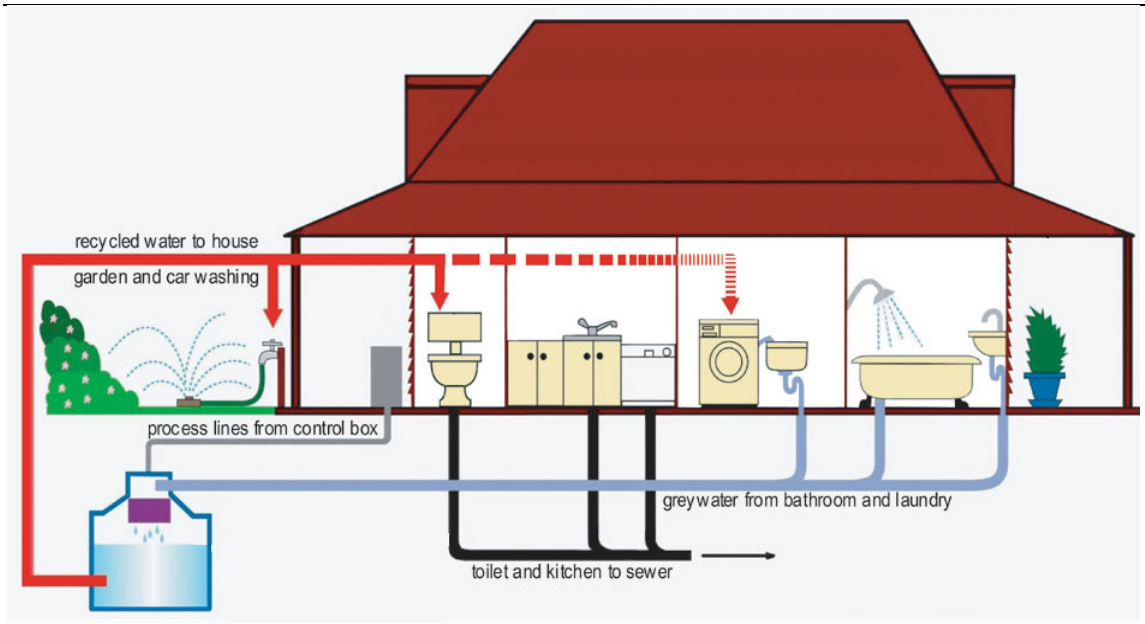


Fig. A2: Grey water system (source: environmentwriter.com)

Balanced Ventilation

Balanced ventilation will remove dirty and humid air from kitchen, bathroom and toilet removed while the same amount of clean, preheated air is filtered and fed into bedrooms and living room. The amount of exhaust air is equal to the amount that enters. Within balanced ventilation heat recovery (WTW) is used. The existing heat in the polluted air (which will be removed from the home) is used to clean the air (which is hauled) heating. This keeps 95% of the heat and keeps the home (cost) efficient ventilating. By using balanced ventilation, 85% to 95% of heat can be regained; it is a condition that the building is tightly sealed properly. The disadvantage of this system is that outlet and inlet pipes need to be installed in the ceiling and /or floor of the rooms.

Shower heat recycling

Shower water is one of the major energy consumers in a dwelling. The heat disappears quickly down in to the gutter. By the use of shower heat recycling, the heat can largely (65%) be withdrawn from the drain and fed to the boiler or to the cold shower water.
By using the shower heat recovery, the boiler will need less than the half of usual power to work properly. A dwelling with 3 to 5 households can save annually 160-200 m3 gas.

Step 2 b. Use of energy from renewable sources

Photovoltaic Cells (PV panels):

A photovoltaic cell (PV cell) is a device that converts the energy of sunlight directly in electricity. The PV cells are often assembled in a panel, namely PV panels. The PV panels can be installed in three ways; as loose panels, which can be placed on roofs, in waterproofing membranes or as façade elements. The benefit of loose panels is that they can be oriented ideally towards the sun, without setting conditions to the design of the building. The PV panels integrated in waterproofing membranes are the most easily to install. If placed on a flat roof the efficiently loss is quite acceptable. If PV cells are integrated in facades can be

visually attractive. However, orientation is very important when placed on a facade. Therefore it is recommended to install this only at facades facing southwest to Southeast. Sloped facades are very interesting to cover with PV panels.

Heat pumps:

A heat pump is a device, which can be used to heat (or cool) a building using endless sources such as geothermal energy or (ventilation) air. The heat pump uses the relative low temperature and increases it to suits the heating of a building or potable water.

The heat pump uses the energy of the surrounding and increases it to a higher temperature to heat the building. This is done by increasing the pressure in a compressor. Therefore, electric energy is needed.

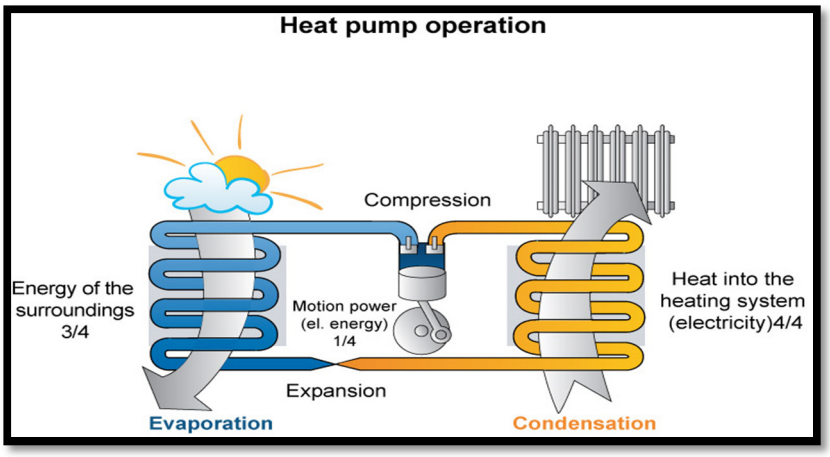


Figure A3: schematic working of the system (source: greenbuildingdesignblog.com)

Water / water system

With this system, heat is extracted from water. In winter, warm groundwater is pumped from which heat is withdrawn. The cooled water is then stored in the ground. In summers the ground water used for cooling, as described by heat-cold storage.

Air / water systems

For air / water heat pumps, heat is extracted from the air or the hot air from a mechanical ventilation system. The heat can be used to heat the building or warm water. Alternatively, heat can be captured and stored in a well of a heat storage system.

The disadvantage of this system is that it needs installation space within and outside of dwelling.

Solar collectors:

A solar collector can be used to capture solar energy to heat potable water. A solar collector, e.g. the flat plate collector is installed on the roof facing south. The sun heats up a fluid, which will heat up water in a heat exchanger. Two types of solar collectors exist: active and passive. An active solar collector uses a pump to circulate the fluid. The passive collector does not require a pump; the fluid that is heated in the collector will naturally flow above. This, however, requires the storage tank to be placed above the panel.

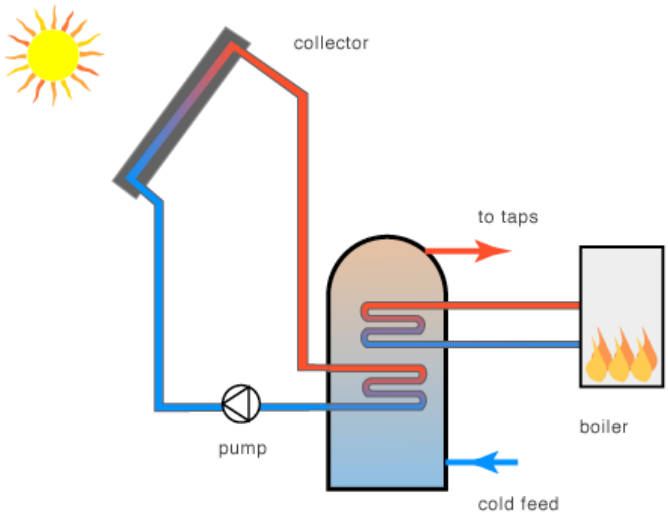


Figure A4: Solar collector and storage tank (Source:greenspec.co.uk)

The temperature of the water is not always sufficient. Therefore, an after heating system is required. This can be done in a central heating system, or in a boiler. Hot water is required during the whole year. Therefore, a solar collector saves energy every day.

Heat and Cold storage:

Thermal energy storage (TES), also commonly called heat and cold storage, allows the storage of heat or cold to be used later. To be able to retrieve the heat or cold after some time, the method of storage needs to be reversible. Thermal energy storage can be implemented by storage of Sensible Heat or Latent Heat (Energy Efficiency systems, 2012).

The most frequently used storage technology, which makes use of the underground, is Aquifer Thermal Energy Storage. This technology uses a natural underground layer (e.g. a sand, sandstone, or chalk layer) as a storage medium for the temporary storage of heat or cold (see schematic). The transfer of thermal energy is realized by extracting groundwater from the layer and by re-injecting it at the modified temperature level at a separate location nearby.

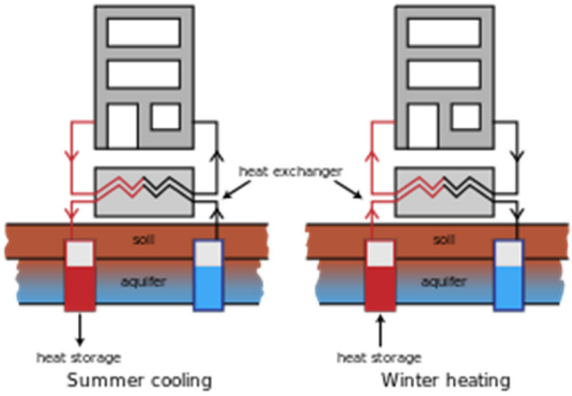


Figure A5: Heat and Cold storage (Source: geothermalgenius.org)

Other technologies for underground thermal energy storage are borehole storage, cavern storage and pit storage. Which of these technologies is selected, strongly depends on the local geologic conditions (Energy Technology Network, 2012).

Wind energy:

Since wind turbine technology has been more technically advanced in comparison with many other renewable energy technologies, and therefore most economically profitable, wind turbines, often deployed in arrays called wind farms, have been most often developed. (P.D. Wright, 2005). In relation to size, there are consistent results suggesting that smaller wind farms are more positively perceived in comparison with larger-scale developments (P.D. Wright, 2005).

The wind is one of the cleanest sources of energy, and because it is a naturally generated resource, it is also the most abundant energy source on the planet today. Wind energy is created through the use of Wind Turbines, or wind turbine towers. How much energy is produced from one wind turbine depends entirely on how large the turbine is. A large wind turbine will produce several hundred megawatts of electricity which is enough electricity to power several hundred homes. A smaller wind turbine is defined as one that provides 100 kW of electricity or less. These smaller turbines are used for homes or small businesses, or as a resource of backup for electricity. Some people use even smaller turbines to power sailboat batteries or for other uses. (ifpaenergyconference, 2012)

Step 3: Use finite (fossil) energy sources efficient

Step 3 is the lowest step of the Trias Energetica in terms of sustainability. If everything is done in previews steps, it is important that the installation such as boiler, heating system and lighting operate as efficiently as possible. The following options are available to make efficient use of finite resources:

High Efficiency Systems and Equipment

With HR installations (boilers, central heating, and hot water Combi) and systems LTV (low temperature heating) the efficiency of energy use can be significantly increased.

Energy efficient lighting

High frequency, adjustable and dimmable lighting with presence detection, timers and daylight control can be also useful to make efficient use of finite energy sources.

Saving hot tap water

It will not only save water, but also reduces energy consumption. It is important to keep supply lines short and isolate them well.

Ventilations

Making more use of natural ventilation and proper control of mechanical ventilation equipment (time, date and quantity) can also help to reduce the use of finite energy sources.

Energy monitoring

An energy monitoring system that allows the residents to receive an up-to-date status of general energy consumption and / or consumption per component can help the households to control their energy use. Furthermore, energy monitoring can display the energy production of the solar panels, so that the households can determine the energy balance of their houses (well or not energy neutral). Experience figures show that monitoring leads to an awareness of the occupant (s) and interprets into a significant energy reduction of about 9% (Bomenbuurt 2013).

Appendix B: Assessment of tax forms and selection parameters

Tax form	Range - applicable for all
Income tax	100%, every homeowner has an income weather it is from wages, saving on the bank, rental and etc. This is applicable for all homeowners and every homeowner can use the tax benefit of income tax. **Score: 5**
Corporation tax	The range of corporation tax is minimum. Only people with share in companies or own business can profit from tax benefits in this tax form. **Score : 1**
Real estate transfer tax	Real estate transfer tax is also has a range of 100% for homeowners. Every homeowner can profit from tax benefit of real estate transfer tax. **Score: 5**
Environmental taxes	Environmental taxes are the taxes that each homeowner pays by use of energy. This is also 100% applicable for all homeowners. **Score: 5**
Property tax	100% , every homeowner pays property tax to the local municipality. All homeowners can be reached by any tax benefit in property tax. **Score: 5**

Tax form	Similar benefits
Income tax	Income tax has similar benefits for people with same income bracket. Regardless where the homeowner lives. **Score: 5**
Corporation tax	Corporation tax has similar benefits for same income levels. Regardless where the homeowner is living. **Score: 5**
Real estate transfer tax	Not similar benefits. People with low education and low income are mostly living in low prized dwellings, which mean that the transfer tax will also be lower. For example, if it is chosen to give real estate tax benefit, people with expensive dwellings will have more benefit than people with cheap dwellings. Also the mobility in the housing market within higher

	education / higher income homeowners is on average higher than among people with lower income. **Score: 2**
Environmental taxes	Environmental taxes are dependent on the energy price of energy supplier; therefore it does not have similar benefits. **Score: 3**
Property tax	Property tax is more correlated with the type of dwelling and it is also dependent on the location of a dwelling. Thus, it does not have similar benefits. **Score: 4**

Tax form	Shortest payback time
Income tax	The average income in The Netherlands in 2012 was € 33.000 which means around € 10.000 of this money will go to income tax. After mortgage interest deduction and other benefits, the homeowners still can profit from a big amount of money on year basis. For example, if the homeowner has the right to have around € 15.000 euro tax benefits. It can be collected within 3 or 4 years. **Score: 5**
Corporation tax	20% to 25% of the income from shares in companies or own business goes to corporation tax. The renovation cost can be covered within 3 or 4 years. **Score: 5**
Real estate transfer tax	Real estate transfer tax is 2% of the property value. The average property value in the Netherlands is €237.000 (cbsinuwbuurt.nl), which means €4.740 on every transfer. It will not cover the renovation cost as soon as income and corporation tax. **Score: 3**
Environmental taxes	The environmental taxes paid via energy bills are a few hundred euros on year basis. It will be lesser when the house is energy neutral. Which means that homeowner has to wait very long to cover the renovation costs. **Score: 1**
Property tax	Every municipality has its own property tax rate. This tax is also around 400 euro on year basis. It will cover a few percent of the renovation. In this case the payback time will be very long. **Score: 2**

Tax form	Quickest benefit
Income tax Corporation tax Property tax	Income tax, corporation tax, property tax is calculated on year basis. Thus, the homeowner can deduct the renovation cost, or have the tax benefit at the end of each year. **Score: 4**
Real estate transfer tax	The homeowners have to wait long for benefits from real estate transfer tax. They can have enjoy from the benefit when they buy or sale their property. Thus, once or twice in a life time. **Score: 1**
Environmental taxes	Homeowners pay monthly energy bills, thus also energy taxes. Thus, it is possible to collect the benefit on monthly basis, if the tax is cancelled. **Score: 5**

Tax form	Transparent
Income tax	Benefit from income tax will be transparent and needs less bureaucracy. The government know what each homeowner earns and how much pays to income tax. **Score: 5**
Corporation tax	Corporation tax is also transparent like income tax. **Score: 5**
Real estate transfer tax	The real estate transfer tax is less transparent. In recent past there have been big frauds in real estate management. It is possible to show the value of property higher in order to get higher benefit. **Score: 4**
Environmental taxes	Environmental taxes are also transparent. The homeowner knows how much energy he /she use. And what the taxes can be. It is not possible to scam in this tax. However it needs more bureaucracy, as the energy supplier needs to pass al usage data to income tax office. **Score: 5**
Property tax	Property tax is also transparent and needs less bureaucracy if it is decided to give tax benefit on local government level. **Score: 5**

Appendix C: Example energy label improvement

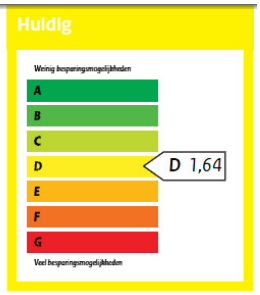
Kenmerken woning	
Gebruiksoppervlakte (m²)	106,0
Aantal bewoners	3,0

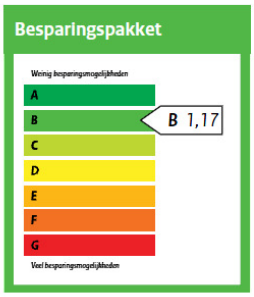
Bouwdelen	Huidig			Besparingspakket			Investeringskosten	
	Opp. (m²)	Rc-Waarde (m² K/W)	U-Waarde (W/m² K)	Opp. (m²)	Rc-Waarde (m² K/W)	U-Waarde (W/m² K)	Per m²	Totaal
Begane grondvloer [3]	51,0	0,52	1,28	51,0	2,53	0,36	€ 20	€ 1.020
Plat dak [3]	-	-	-	-	-	-	-	€ 0
Hellend dak [3]	68,6	1,30	0,64	68,6	2,53	0,36	€ 53	€ 3.640
Achter- en voorgevel								
– Gesloten [3]	40,6	1,30	0,64	40,6	2,53	0,36	€ 21	€ 850
– Enkelglas [3]	3,1		5,20	-		-	€ 139	€ 430
– Dubbelglas [3]	16,2		2,90	-		-	€ 142	€ 2.300
– HR++ glas	-		-	19,3		1,80		
Zijgevel								
– Gesloten	58,4	1,30	0,64	58,4	2,53	0,36	€ 21	€ 1.230
– Enkelglas	-		-	-		-	-	€ 0
– Dubbelglas	1,8		2,90	-		-	€ 142	€ 260
– HR++ glas	-		-	1,8		1,80		

Installatie	Huidig	Besparingspakket	Investeringskosten
Ruimteverwarming [3]	HR107 ketel	HR107 ketel	–
Warmtapwater	Combitap HR	Combitap HR	
Ventilatie	Natuurlijke ventilatie	Natuurlijke ventilatie	

Rijwoning, tussen: Investeringskosten [2] meest voorkomende subtype van energieniveau 'huidig' naar energieniveau 'besparingspakket'	€ 8.240

Energieprestaties subtype tussen	Huidig	Besparingspakket	Besparing
EI (-)	1,64	1,17	0,47
Energielabel	D	B	2 energielabel(s)
Totaal primair energiegebruik (MJ)	71.259	50.749	20.510
Gasgebruik (m³/jaar) [1]	1.542	1.037	505
Hulpenergie, verlichting, PV (kWh/jaar) [1]	924	924	0
CO_2 emissie (kg/jaar)	3.268	2.369	899
Energiekosten, exclusief BTW per jaar	€ 1.201	€ 978	€ 223





Source : Voorbeeldwoningen 2011, Bestaande bouw (Agentschap.nl)

Appendix D: Calculation of energy neutral measure

The average private dwelling in the Netherland is built on 1964, has live surface of 120 m^2 and energy label D/E (AgentschapNL 2011, Senternovem 2013). To make such a dwelling energy neutral by means of renovation, an investment around €40.000 is needed. The homeowner can deduct €16.000 of the renovation cost from his taxable income, and pays the remaining amount of €24.000. The homeowner can benefit from €1.400 energy bill saving and added value to his property, around 10.000. The payback time will be 10 years with added property value and 17 years without (see the following figure).

Renovationcost	Tax deduction (40%)	Homeowner pays	Added property value	Energy bill saving/year	Payback Time (in years)	
					Taking added value in account	Without added value
€ 40.000	€ 16.000	€ 24.000	€ 10.000	€ 1.400	10	17

The total amount of existing privet dwellings are around 4.1 million. If tax benefit of 40% can influence and attract 3% of the homeowners, 123000 dwellings will be renovated each year. With a total renovation cost of €4.92 billion and government pays 40% of it via tax benefits (€1.97 billion). See the following figure.

Private Homeowners	Renovation rate 3%/year	Renovationcost /year	Government pays
4.100.000	123.000	€ 4.920.000.000	€ 1.968.000.000

The construction companies receive the total amount of money and renovate 123.000 dwellings. 25% of the money goes to material costs, 50% to labour, 10% to overhead cost, the remaining amount will be profit of companies. See following figure.

Companies recieves	Material (25% cost)	manpower (50% of cost)	Overhead costs (10% of costs)	Profit companies (15% of costs)
€ 4.920.000.000	€ 1.230.000.000	€ 2.460.000.000	€ 492.000.000	€ 738.000.000

The government will receive back: 21% VAT on materials, 27% income tax of labour, and 20% corporation tax, there will be 49200 new jobs which means 49200 WW uitkering reduction See following figure.

VAT (21% of material)	Income tax (27% of manpower)	Company tax (20%)	Job creation	Less WW uitkering	Government recieves
€ 258.300.000	€ 664.200.000	€ 147.600.000	49200	€ 1.230.000.000	€ 2.300.100.000

How is job creation calculated?

The average salary in Construction Company is taken from loonwijzer.nl which was around 2600 euro on monthly basis with 38hour/week.

But the salary is not the only payment which companies pay to its workers, there are following costs:

Personeelskosten
Personeel kost u meer dan alleen salaris. U moet er rekening mee houden dat de personeelskosten ongeveer 30% hoger zijn dan het brutoloon. De personeelskosten bestaan uit:
1. Directe loonkosten
Dit zijn salaris, vakantiegeld, winstuitkeringen en provisies. Een werknemer heeft recht op minstens het minimum(jeugd)loon en vakantiegeld van minimaal 8% van het bruto jaarsalaris. In sommige bedrijfstakken moet u zich houden aan de voorwaarden die in een CAO zijn afgesproken.

2. Indirecte loonkosten
Dit zijn onder meer pensioen, reis- en onkostenvergoedingen.

3. Verplichte premies en bijdragen
Als u personeel in dienst hebt, dan moet u loonheffingen afdragen (loonbelasting/premie volksverzekeringen, inkomensafhankelijke bijdrage Zorgverzekeringswet en premies werknemersverzekeringen).

Then with above cost the annual salary of a worker are calculated which was 42646 and rounded to 50000, as there are project manager and etc. how does earn more than 2600 euro per month.

Resultaat

Totale loonkosten	€ 42.646 per jaar

Loonkosten	
Bruto jaarloon	31.200
+ vakantiegeld	2.496
+ bonus, 13e maand, etc.	2.496
+ werknemersverzekeringen (WW Awf/Wgf, WAO/WIA, WGA)	3.650
+ inkomensafhankelijke bijdrage Zvw	2.804
Totaal	**42.646**

Terug

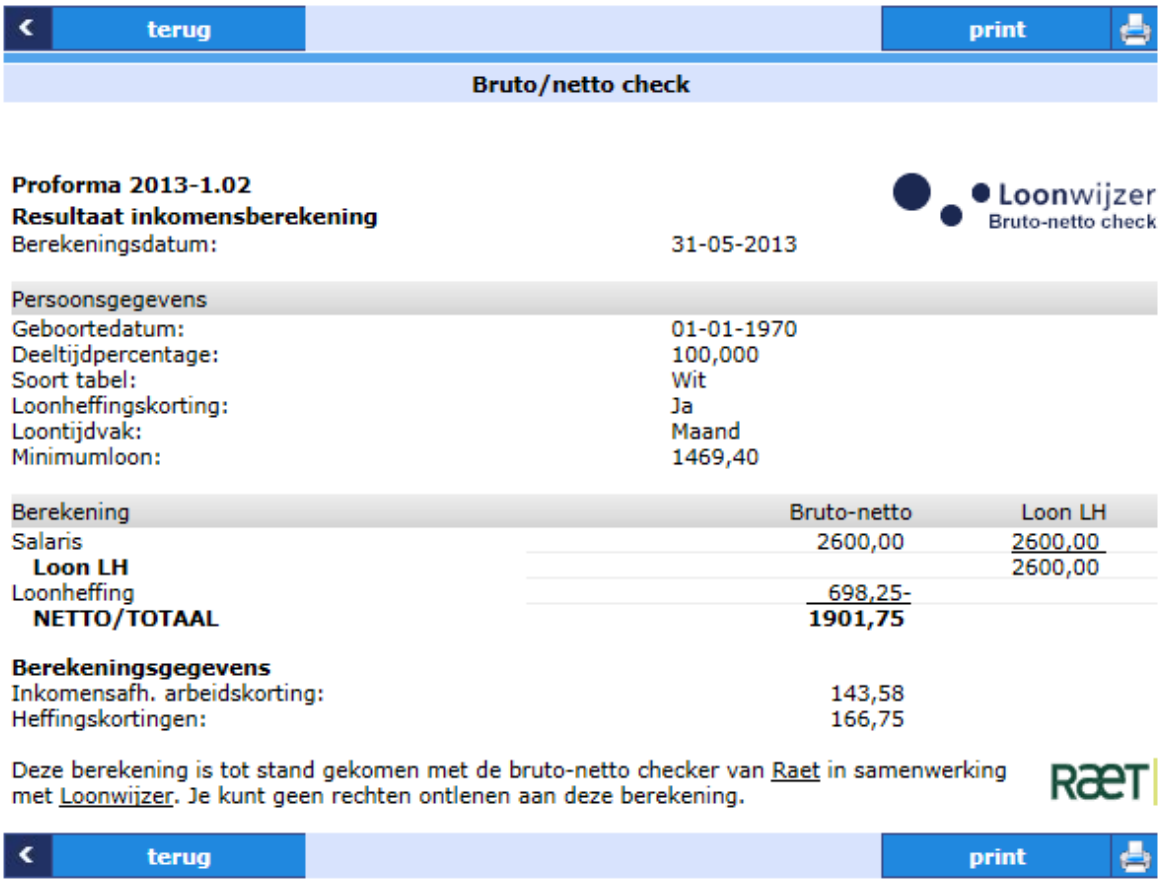
Gebaseerd op:

Sectoraansluiting	3.2 Bouwbedrijf Premiegroep lang
Brutoloon	€ 2.600 per maand
Bonus, 13 maand, etc.	€ 2.496
Vakantiegeld	8,0 %
Gedifferentieerde premie WGA	0,47 %

http://www.kvk.nl/ondernemen/personeel/personeelskosten/
Then manpower is divided to 50000 /2064000000 =41280 jobs.

27% income tax manpower?

This is calculated with loonwijzer.nl (see figure below). A worker with salary of 2600 euro has to pay 698 euro per month, which is 27% of salary.



terug print

Bruto/netto check

Proforma 2013-1.02
Resultaat inkomensberekening
Berekeningsdatum: 31-05-2013

Loonwijzer Bruto-netto check

Persoonsgegevens	
Geboortedatum:	01-01-1970
Deeltijdpercentage:	100,000
Soort tabel:	Wit
Loonheffingskorting:	Ja
Loontijdvak:	Maand
Minimumloon:	1469,40

Berekening	Bruto-netto	Loon LH
Salaris	2600,00	2600,00
Loon LH		2600,00
Loonheffing	698,25-	
NETTO/TOTAAL	**1901,75**	

Berekeningsgegevens

Inkomensafh. arbeidskorting:	143,58
Heffingskortingen:	166,75

Deze berekening is tot stand gekomen met de bruto-netto checker van Raet in samenwerking met Loonwijzer. Je kunt geen rechten ontlenen aan deze berekening.

RAET

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http://www.loonwijzer.nl/home/salaris/brutonetto

Less ww-uitkering?

If the measure can create 51600 new jobs, there will be 51600 less people who receive ww-uitkering. The average annual ww-uitkering is estimated around 25000 per year euros. 25000*51600 = 1.29 billion euros.

Appendix E: The presented questionnaire

Deel 1: Algemene vragen

1. Bent u de eigenaar of de huurder van de onderhavige woning?
    - Eigenaar (koopwoning)
    - Huurder (huurwoning). Indien u een huurder bent, dan hoeft u niet mee te werken aan dit onderzoek. Dit onderzoek is uitsluitend bedoeld voor mensen met een koopwoning. U mag het invullen van de enquête beëindigen. Hartelijk dank voor uw medewerking

2. Tot welk leeftijdscategorie behoort u?
    - Jonger dan 20 jaar
    - 20 tot 40 jaar
    - 40 tot 65 jaar
    - 65 tot 80 jaar
    - 80 jaar en ouder

3. Wat is uw gezinssituatie?
    - Alleenstaand
    - Alleenstaand ouder
    - Gezin zonder kinderen
    - Gezin met kinderen
    - Anders

4. Wat is uw hoogst genoten opleiding?
    - Postdoctoraal (Phd)
    - Wetenschappelijk onderwijs (WO)
    - Hoger beroepsopleiding (HBO)
    - Middelbaar beroepsopleiding (MBO)
    - Lager beroepsopleiding (LBO)
    - VWO
    - HAVO
    - MAVO
    - VMBO
    - Anders

5. Welk werksituatie is op u van toepassing?
    - Full-time
    - Part-time
    - Werkzoekend
    - Gepensioneerd
    - Anders

6. Hoe hoog is het gezamenlijk bruto inkomen van uw huishouden volgens de belastingschijf?
    - Minder dan € 19.645 per jaar (1e schijf)
    - Tussen € 19.645 - € 33.363, per jaar (2e schijf)
    - € 33.363 - € 55.991 per jaar (3e schijf)
    - 55.991 of hoger per jaar (4e schijf)

Deel 2: Woning en duurzaamheid

7. In wat voor type koopwoning woont u ?
    - Appartement
    - Tussenwoning
    - Vrijstaande woning
    - 2-onder 1 kap
    - Anders

8. Wat is het bouwjaar van uw woning?
    - Vooroorlogs
    - 1945-1959
    - 1960-1969
    - 1970-1979
    - 1980-1989
    - 1990-1999
    - Na 2000
    - Weet ik niet zeker

9. Wat is het huidige energielabel van uw woning?
    - A++
    - A+
    - A
    - B
    - C
    - D
    - E
    - F
    - Weet ik niet zeker

10. Hoelang woont u al in uw woning?
    - 0-5 jaar
    - 5-10 jaar
    - 10-20 jaar
    - Langer dan 20 jaar

11. Hoelang verwacht u nog in deze woning te wonen?
    - Minder dan 2 jaar
    - 2 tot 5 jaar
    - 5 tot 10 jaar
    - Langer dan 10 jaar
    - Weet ik niet zeker

12. Heeft u in de afgelopen tien jaar werkzaamheden aan uw woning verricht of laten verrichten, die betrekking hebben op de energiezuinigheid van uw woning?
    - Nee (sla vraag 13 t/m 15 over en ga door naar vraag 16)
    - Ja , de afgelopen 2 jaar
    - Ja , 2 tot 4 jaar geleden
    - Ja , langer dan 5 jaar geleden
13. Heeft u voor deze renovatie gebruik gemaakt van een subsidieregeling en/of een groene lening?
    - Ja
    - Nee

14. Binnen welk range lag het investeringsbedrag?
    - 0 tot € 500
    - € 500 tot € 1.000
    - € 1.000 tot € 2.000
    - € 2.000 tot € 5.000
    - € 5.000 tot € 10.000
    - Hoger dan € 10.000

15. Hoe hoog was de subsidieregeling en/of groene lening?
    - 0 tot € 500
    - € 500 tot € 1.000
    - € 1.000 tot € 2.000
    - € 2.000 tot € 5.000
    - € 5.000 tot € 10.000
    - Hoger dan € 10.000

16. Wat was uw voornaamste reden om niet te investeren in energiezuinige verbeteringen aan uw woning?
    - De woning is al energiezuinig genoeg
    - Beperkte financiële middelen
    - De benodigde investering was te hoog
    - De terugverdientijd van de investering is te lang
    - Verhuisplannen
    - Teveel ongemak
    - Ik ga in de nabije toekomst investeren in energiezuinige verbeteringen

17. Hoe belangrijk zijn de onderstaande overwegingen op uw beslissing om uw huis te verbeteren? (u kunt ze rangschikken volgens de volgende schaal: zeer onbelangrijk, onbelangrijk, neutraal, belangrijk, zeer belangrijk)

	zeer onbelangrijk	onbelangrijk	neutraal	belangrijk	zeer belangrijk
Kostenbesparing op gasrekening					
Kostenbesparing op elektriciteitsrekening					
Waarde van de woning verhogen					
Gezondheidsaspecten (vocht, ventilatie en tocht)					
Meer wooncomfort na renovatie (ventilatie en binnenklimaat)					
Vergroting van de woning					
De woning beter verkoopbaar maken					

Deel 3: Renovatiekeuze

In dit derde en laatste gedeelte van de enquête vraag ik u om negen keer een keuze te maken tussen twee verschillende renovatiepakketten die worden voorgesteld.

Deze renovatie pakketen worden gekarakteriseerd door 5 categorieën.

Categorie 1 : Onderhoud type

Bij onderhoud van woningen zijn er drie variaties:

1. Energieneutraal renoveren

Een woning kan tot een energieneutraal/zeer energiezuinig niveau worden gerenoveerd (energielabel A++). Een energieneutrale woning is gemiddeld € 10.000,- meer waard dan een woning met een energielabel D. Bovendien kunnen jaarlijks tot €1.400,- op energiekosten worden gespaard.

2. Verbetering van minimaal twee energielabels

Een woning zodanig renoveren dat het minimaal twee energielabels verbetert. Hierdoor kan de besparing op energiekosten oplopen tot €600,- .

3. Energiebesparende maatregelen

De huiseigenaren kunnen op hun energiekosten besparen door een of meer energiebesparende maatregelen uit te voeren. Bijvoorbeeld het vervangen van een VR combiketel door een combiketel met hoge rendement, die eenmalig €2.100 kost maar een jaarlijkse besparing van € 210,- oplevert.

Categorie 2 : Belastingvoordeel

Bij de renovatiepakketten zijn er drie opties voor belastingvoordeel:

1. 40% van de renovatiekosten aftrekbaar

De eigenaar van de woning kan 40% van de gemaakte renovatiekosten (incl. materiaal en arbeid) van de inkomstenbelasting aftrekken.

Voorbeeld : de renovatie van een energielabel D woning naar energielabel A++ kost € 30.000,- (incl. materiaal en arbeid). De eigenaar kan € 12.000,- van deze gemaakte kosten terug krijgen van de inkomstenbelasting.

2. 20% van de renovatiekosten aftrekbaar

De eigenaar van de woning kan 20% van de gemaakte onderhoudskosten (incl. materiaal en arbeid) van de inkomstenbelasting terug krijgen.

3. 15 % BTW korting op de arbeidskosten

15% korting op de BTW is van toepassing op alle renovatie- en herstelwerkzaamheden in en aan een woning. De BTW korting is uitsluitend van toepassing op de arbeidskosten en niet op de gebruikte materialen.

Categorie 3 : Periode belastingvoordeel

Flexibel : De huiseigenaar kan het voordeel in een keer aftrekken of verdeeld over een aantal jaren (wanneer het voordeel hoger is dan de ingehouden inkomstenbelasting)
5 jaar : Het belastingvoordeel wordt verdeeld over vijf jaar
10 jaar: Het belastingvoordeel wordt verdeeld over tien jaar

Categorie 4 : Financiering

De drie financieringsmogelijkheden voor renovatiepakketten zijn als volgt:

Groen hypotheek

De Groen Hypotheek is een hypothecaire lening die beschikbaar is voor bestaande woningen en nieuwbouwwoningen. De rentekorting bedraagt doorgaans 1 tot 2 procent. De Groen Hypotheek kan een aanvulling op uw bestaande hypotheek zijn of een tweede hypotheek.

GreenLoans lening

De huiseigenaar kan een GreenLoans lening aanvragen voor de renovatie van de woning. De rente van GreenLoans lening ligt tussen 5.5% en 6.2%.

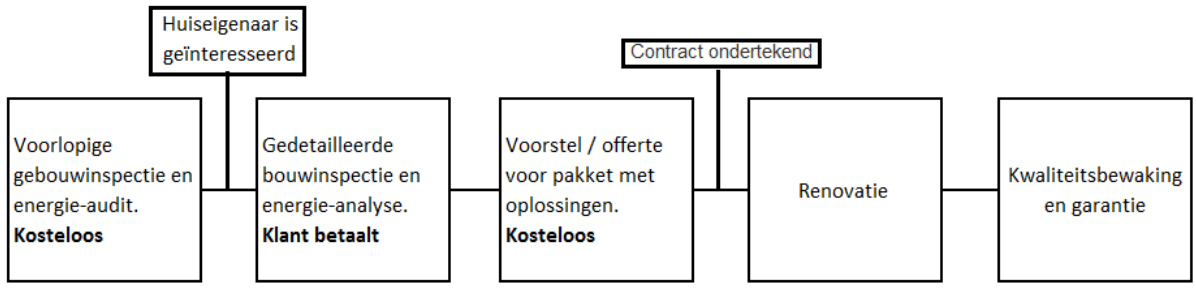
Eigen vermogen

De huiseigenaar gebruikt eigen vermogen zoals spaargeld om de renovatie uit te voeren.

Categorie 5 : Renovatie service

One-stop-shop

De renovatie van A tot Z wordt gedaan door een aannemer op grond van de volgende schema:



Verschillende bedrijven

De huiseigenaar regelt zelf de benodigde vergunningen en laat de renovatie doen door verschillende bedrijven (bv. installatie bedrijf, glas en kozijn specialist).

Doe-het-zelf

De huiseigenaar doet de renovatie zelf.

Renovatiekeuze 1	Pakket 1	Pakket 11
Onderhoud	Verbetering van minimaal twee energielabels	Energieneutraal renoveren
Belastingvoordeel	20% van renovatiekosten aftrekbaar	40% van renovatiekosten aftrekbaar
Voordeel verdeeld over	Flexibel	5 jaar
Financiering	GreenLoans lening	GreenLoans lening
Service	Verschillende bedrijven	One-stop-shop

Mijn voorkeur gaat uit naar:

Pakket 1
Pakket 11

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?

- Pakket 1 : O JA O NEE
- Pakket 11 : O JA O NEE

Renovatiekeuze 2	Pakket 2	Pakket 17
Onderhoud	Verbetering van minimaal twee energielabels	Energiebesparende maatregelen
Belastingvoordeel	15 % BTW korting op de arbeidskosten	20% van renovatiekosten aftrekbaar
Voordeel verdeeld over	10 jaar	5 jaar
Financiering	Groen hypotheek	Eigen vermogen
Service	One-stop-shop	One-stop-shop

Mijn voorkeur gaat uit naar:

- Pakket 2
- Pakket 17

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 2 : O JA O NEE
Pakket 17 : O JA O NEE

Renovatiekeuze 3	Pakket 3	Pakket 10
Onderhoud	Energieneutraal renoveren	Energiebesparende maatregelen
Belastingvoordeel	20% van renovatiekosten aftrekbaar	15 % BTW korting op de arbeidskosten
Voordeel verdeeld over	10 jaar	Flexibel
Financiering	Groen hypotheek	GreenLoans lening
Service	Doe het zelf	Doe het zelf

Mijn voorkeur gaat uit naar

- Pakket 3
- Pakket 10

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 3 : O JA O NEE
Pakket 10 : O JA O NEE

Renovatiekeuze 4	Pakket 4	Pakket 12
Onderhoud	Energiebesparende maatregelen	Verbetering van minimaal twee energielabels
Belastingvoordeel	40% van renovatiekosten aftrekbaar	40% van renovatiekosten aftrekbaar
Voordeel verdeeld over	Flexibel	5 jaar
Financiering	Groen hypotheek	GreenLoans lening
Service	Verschillende bedrijven	Doe het zelf

Mijn voorkeur gaat uit naar:

- Pakket 4
- Pakket 12

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 4 : O JA O NEE
Pakket 12 : O JA O NEE

Renovatiekeuze 5	Pakket 5	Pakket 16
Onderhoud	Energieneutraal renoveren	Verbetering van minimaal twee energielabels
Belastingvoordeel	15 % BTW korting op de arbeidskosten	20% van renovatiekosten aftrekbaar
Voordeel verdeeld over	5 jaar	5 jaar
Financiering	Eigen vermogen	Groen hypotheek
Service	Verschillende bedrijven	Verschillende bedrijven

Mijn voorkeur gaat uit naar:

- Pakket 5
- Pakket 16

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 5 : O JA O NEE
Pakket 16: O JA O NEE

Renovatiekeuze 6	Pakket 6	Pakket 14
Onderhoud	Verbetering van minimaal twee energielabels	Energiebesparende maatregelen
Belastingvoordeel	40% van renovatiekosten aftrekbaar	20% van renovatiekosten aftrekbaar
Voordeel verdeeld over	10 jaar	Flexibel
Financiering	Eigen vermogen	Eigen vermogen
Service	Doe het zelf	Doe het zelf

Mijn voorkeur gaat uit naar:

- Pakket 6
- Pakket 14

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 6 : O JA O NEE
Pakket 14 : O JA O NEE

Renovatiekeuze 7	Profile 7	Profile 18
Onderhoud	Energieneutraal renoveren	Energiebesparende maatregelen nemen
Belastingvoordeel	40% van renovatiekosten aftrekbaar	15 % BTW korting op de arbeidskosten
Voordeel verdeeld over	10 jaar	5 jaar
Financiering	Eigen vermogen	Groen hypotheek
Service	Verschillende bedrijven	Doe het zelf

Mijn voorkeur gaat uit naar:

- Pakket 7
- Pakket 18

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 7 : O JA O NEE
Pakket 18 : O JA O NEE

Renovatiekeuze 8	Profile 8	Profile 15
Onderhoud	Energiebesparende maatregelen nemen	Energieneutraal renoveren
Belastingvoordeel	20% van renovatiekosten aftrekbaar	40% van renovatiekosten aftrekbaar
Voordeel verdeeld over	10 jaar	Flexibel
Financiering	GreenLoans lening	Groen hypotheek
Service	One-stop-shop	One-stop-shop

Mijn voorkeur gaat uit naar:

- Pakket 8
- Pakket 15

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 8 : O JA O NEE
Pakket 15 : O JA O NEE

Renovatiekeuze 9	Profile 9	Profile 13
Onderhoud	Energieneutraal renoveren	Verbetering van minimaal twee energielabels
Belastingvoordeel	15 % BTW korting op de arbeidskosten	15 % BTW korting op de arbeidskosten
Voordeel verdeeld over	10 jaar	Flexibel
Financiering	GreenLoans lening	Eigen vermogen
Service	Verschillende bedrijven	One-stop-shop

Mijn voorkeur gaat uit naar:

- Pakket 9
- Pakket 13

Zou u aan de hand van bovenstaande pakketten overgaan tot renoveren van uw woning?
Pakket 9 : O JA O NEE
Pakket 13 : O JA O NEE

En tot slot

18. Wat zou voor u de belangrijkste reden zijn om uw huis te renoveren?
    - Belastingvoordeel: om gebruik te maken van belastingvoordeel
    - Financiering: om gebruik te maken van financieringsmogelijkheden
    - Onderhoud van mijn woning: de prestatie en het binnenklimaat van mijn woning te verbeteren
    - Lager energieverbruik na renovatie: zoveel mogelijk energieverbruik beperken met als doel om energiekosten te sparen

Appendix F: Output of NLogit 4.0

```
--> RESET
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> READ;FILE="C:\Users\KKB\Desktop\New data\307 dataset cset.xls"$
--> LOGIT;Lhs=Y;Rhs=R1,R2,T1,T2,P1,P2,F1,F2,S1,S2$
Normal exit from iterations. Exit status=0.

+--------------------------------------------+
| Binary Logit Model for Binary Choice       |
| Maximum Likelihood Estimates               |
| Model estimated: Aug 12, 2013 at 05:30:49PM.|
| Dependent variable                    Y    |
| Weighting variable                 None    |
| Number of observations             5526    |
| Iterations completed                  4    |
| Log likelihood function       -3642.183    |
| Number of parameters                 10    |
| Info. Criterion: AIC =          1.32182    |
|   Finite Sample: AIC =          1.32183    |
| Info. Criterion: BIC =          1.33379    |
| Info. Criterion:HQIC =          1.32599    |
| Restricted log likelihood     -3830.331    |
| McFadden Pseudo R-squared      .0491207    |
| Chi squared                    376.2971    |
| Degrees of freedom                    9    |
| Prob[ChiSqd > value] =         .0000000    |
| Hosmer-Lemeshow chi-squared =  64.98189    |
| P-value=  .00000 with deg.fr. =       8    |
+--------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
---------+Characteristics in numerator of Prob[Y = 1]
 R1      |     .31309846       .03936045     7.955   .0000      .000000
 R2      |    -.32450767       .03943946    -8.228   .0000      .000000
 T1      |     .51110730       .03957857    12.914   .0000      .000000
 T2      |    -.08884848       .03912049    -2.271   .0231      .000000
 P1      |    -.19129968       .04000026    -4.782   .0000      .000000
 P2      |     .21790941       .03901772     5.585   .0000      .000000
 F1      |     .17064842       .03929764     4.342   .0000      .000000
 F2      |    -.29363900       .03968357    -7.400   .0000      .000000
 S1      |    -.00631753       .03973024     -.159   .8737      .000000
 S2      |     .07229232       .03940969     1.834   .0666      .000000

+---------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                   |
|                          M=Model MC=Constants Only   M0=No Model    |
| Criterion F (log L)    -3642.18279       -3830.33132   -3830.33132   |
| LR Statistic vs. MC      376.29706            .00000        .00000   |
| Degrees of Freedom         9.00000            .00000        .00000   |
| Prob. Value for LR          .00000            .00000        .00000   |
| Entropy for probs.      3642.18279        3830.33132    3830.33132   |
| Normalized Entropy          .95088           1.00000       1.00000   |
| Entropy Ratio Stat.      376.29706            .00000        .00000   |
| Bayes Info Criterion       1.33223           1.40033       1.40033   |
| BIC(no model) - BIC         .06810            .00000        .00000   |
| Pseudo R-squared            .04912            .00000        .00000   |
| Pct. Correct Pred.        61.02063            .00000      50.00000   |
| Means:       y=0    y=1    y=2    y=3    y=4    y=5    y=6   y>=7   |
| Outcome     .5000  .5000  .0000  .0000  .0000  .0000  .0000  .0000   |
| Pred.Pr     .4991  .5009  .0000  .0000  .0000  .0000  .0000  .0000   |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).      |
|        Normalized entropy is computed against M0.                   |
|        Entropy ratio statistic is computed against M0.              |
|        BIC = 2*criterion - log(N)*degrees of freedom.               |
|        If the model has only constants or if it has no constants,   |
|        the statistics reported here are not useable.                |
+---------------------------------------------------------------------+
```

```
+---------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable Y          |
+---------------------------------------+
| Proportions P0= .500000   P1= .500000  |
| N =    5526 N0=    2763   N1=    2763  |
| LogL=    -3642.183 LogL0=   -3830.331  |
| Estrella = 1-(L/L0)^(-2L0/n) = .06744  |
+---------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .06701 |    .04912  |       .53340  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .06680 |    .10974  |       .06583  |
+---------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.32182       1.33379  |
+---------------------------------------+
+-----------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to      |
|100% because of rounding. Percentages are of full sample.|
+------+-----------------------------------+----------------+
|Actual|         Predicted Value           |                |
|Value |       0                1          | Total Actual   |
+------+----------------+-----------------+----------------+
|  0   |   1379 ( 25.0%)|   1384 ( 25.0%)|   2763 ( 50.0%)|
|  1   |    770 ( 13.9%)|   1993 ( 36.1%)|   2763 ( 50.0%)|
+------+----------------+-----------------+----------------+
|Total |   2149 ( 38.9%)|   3377 ( 61.1%)|   5526 (100.0%)|
+------+----------------+-----------------+----------------+

======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
----------------------------------------------------------------------
Prediction Success
----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                    72.132%
Specificity = actual 0s correctly predicted                    49.910%
Positive predictive value = predicted 1s that were actual 1s   59.017%
Negative predictive value = predicted 0s that were actual 0s   64.169%
Correct prediction = actual 1s and 0s correctly predicted      61.021%
----------------------------------------------------------------------
Prediction Failure
----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s           50.090%
False neg. for true pos. = actual 1s predicted as 0s           27.868%
False pos. for predicted pos. = predicted 1s actual 0s         40.983%
False neg. for predicted neg. = predicted 0s actual 1s         35.831%
False predictions = actual 1s and 0s incorrectly predicted     38.979%
======================================================================
```

```
--> RESET
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> READ;FILE="C:\Users\KKB\Desktop\New data\307 dataset choiceset and
imple...
--> reject;x=0$
--> REGRESS;Lhs=y;Rhs=one,R1,R2,T1,T2,P1,P2,F1,F2,S1,S2$

+----------------------------------------------------+
| Ordinary    least squares regression               |
| Model was estimated Sep 02, 2013 at 04:36:27PM     |
| LHS=Y        Mean                 =   .8001470     |
|              Standard deviation   =   .4000367     |
| WTS=none     Number of observs.   =       1361     |
| Model size   Parameters           =         11     |
|              Degrees of freedom   =       1350     |
| Residuals    Sum of squares       =   203.6025     |
|              Standard error of e  =   .3883512     |
| Fit          R-squared            =   .6449877E-01 |
|              Adjusted R-squared   =   .5756913E-01 |
| Model test   F[ 10,  1350] (prob) =   9.31 (.0000) |
| Diagnostic   Log likelihood       =  -638.3576     |
|              Restricted(b=0)      =  -683.7285     |
|              Chi-sq [ 10]  (prob) =  90.74 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -1.883641     |
|              Akaike Info. Criter. =  -1.883641     |
| Autocorrel   Durbin-Watson Stat.  =  2.2338172     |
|              Rho = cor[e,e(-1)]   =  -.1169086     |
+----------------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|     .76112198       .01150935    66.131   .0000
 R1      |     .03186130       .01556248     2.047   .0406    .04849375
 R2      |    -.04420718       .01599980    -2.763   .0057   -.01396032
 T1      |     .09885087       .01448760     6.823   .0000    .28949302
 T2      |     .03542823       .01601598     2.212   .0270    .09772226
 P1      |    -.04428244       .01600112    -2.767   .0056    .04481999
 P2      |     .04787227       .01519100     3.151   .0016    .07788391
 F1      |     .04967338       .01537176     3.231   .0012    .02792065
 F2      |    -.03841792       .01631372    -2.355   .0185   -.07494489
 S1      |    -.01727521       .01559528    -1.108   .2680    .08963997
 S2      |     .00457429       .01529023      .299   .7648    .07053637
```

```
--> RESET
Initializing NLOGIT Version 4.0.1 (January 1, 2007).
--> READ;FILE="C:\Users\KKB\Desktop\New data\307 dataset cset.xls"$
--> LOGIT;
    Lhs=y;
    Rhs=ONE,r1,r2,t1,t2,p1,p2,f1,f2,s1,s2;
    ;Pds=18
    ;LCModel
    ;Pts=2
    ;par
    ;maxit =200$

+---------------------------------------------+
| Logit    Regression Start Values for Y      |
| Maximum Likelihood Estimates                |
| Model estimated: Aug 16, 2013 at 00:03:06PM.|
| Dependent variable                    Y     |
| Weighting variable                 None     |
| Number of observations             5526     |
| Iterations completed                 10     |
| Log likelihood function       -3642.174     |
| Number of parameters                 11     |
| Info. Criterion: AIC =          1.32218     |
|   Finite Sample: AIC =          1.32219     |
| Info. Criterion: BIC =          1.33535     |
| Info. Criterion:HQIC =          1.32677     |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
 Constant|    -.00370249       .02789409     -.133   .8944
 R1      |     .31313624       .03935591     7.957   .0000      .000000
 R2      |    -.32451536       .03944557    -8.227   .0000      .000000
 T1      |     .51106679       .03957079    12.915   .0000      .000000
 T2      |    -.08873930       .03913083    -2.268   .0233      .000000
 P1      |    -.19152684       .04004065    -4.783   .0000      .000000
 P2      |     .21806444       .03903183     5.587   .0000      .000000
 F1      |     .17069109       .03929609     4.344   .0000      .000000
 F2      |    -.29373966       .03969677    -7.400   .0000      .000000
 S1      |    -.00642584       .03973872     -.162   .8715      .000000
 S2      |     .07229897       .03940839     1.835   .0666      .000000

Line search does not improve fn. Exit iterations. Status=3
Check derivatives (with ;OUTPUT=3). This may be a solution
if several iterations have been computed, not if only one.
  Error   806: (The log likelihood is flat at the current estimates.)

+---------------------------------------------+
| Latent Class / Panel Logit    Model         |
| Maximum Likelihood Estimates                |
| Model estimated: Aug 16, 2013 at 00:03:07PM.|
| Dependent variable                    Y     |
| Weighting variable                 None     |
| Number of observations             5526     |
| Iterations completed                 33     |
| Log likelihood function       -3483.279     |
| Number of parameters                 23     |
| Info. Criterion: AIC =          1.26901     |
|   Finite Sample: AIC =          1.26905     |
| Info. Criterion: BIC =          1.29655     |
| Info. Criterion:HQIC =          1.27862     |
| Restricted log likelihood     -3642.174     |
| McFadden Pseudo R-squared      .0436263     |
| Chi squared                   317.7893     |
| Degrees of freedom                 13     |
| Prob[ChiSqd > value] =         .0000000     |
| Sample is 18 pds and     307 individuals.   |
| LOGIT (Logistic) probability model          |
| Model fit with 2 latent classes.           |
+---------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Model parameters for latent class 1					
Constant	-.03850837	.04025020	-.957	.3387	
R1	.95516534	.11694043	8.168	.0000	.000000
R2	-.47489315	.08073088	-5.882	.0000	.000000
T1	.89759363	.09534520	9.414	.0000	.000000
T2	-.07607331	.07582525	-1.003	.3157	.000000
P1	-.56822868	.08564000	-6.635	.0000	.000000
P2	.33547717	.08648832	3.879	.0001	.000000
F1	.64705650	.07941196	8.148	.0000	.000000
F2	-.70414305	.07695648	-9.150	.0000	.000000
S1	.18710999	.08382253	2.232	.0256	.000000
S2	.00686325	.07933895	.087	.9311	.000000
Model parameters for latent class 2					
Constant	-.00826197	.04626647	-.179	.8583	
R1	-.46054955	.10015978	-4.598	.0000	.000000
R2	-.17404936	.08634291	-2.016	.0438	.000000
T1	.12710128	.08238502	1.543	.1229	.000000
T2	-.10710224	.08887112	-1.205	.2281	.000000
P1	.22160044	.08533568	2.597	.0094	.000000
P2	.15562074	.09927320	1.568	.1170	.000000
F1	-.40698906	.11871890	-3.428	.0006	.000000
F2	.16556990	.09249699	1.790	.0735	.000000
S1	-.15644808	.06957145	-2.249	.0245	.000000
S2	.15599914	.08368580	1.864	.0623	.000000
Estimated prior probabilities for class membership					
Class1Pr	.62247344	.05126631	12.142	.0000	
Class2Pr	.37752656	.05126631	7.364	.0000	

INFLUENCE OF TAX BENEFITS ON ENERGY NEUTRAL RENOVATION OF PRIVATE HOMEOWNERS

Using conjoint choice experiment to determine the willingness of homeowners to renovate

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ABSTRACT

In the recent past, the Dutch government has tried to motivate homeowners to take measures in order to reduce energy consumption through the provision of subsidies. This has often resulted in small changes and measures such as double glazing, solar panels and etc., without any comprehensive and structural approaches such as reducing energy loss through the shell of the building. However, to achieve the international (Kyoto and later Bonn) agreed objectives some comprehensive approaches are need to be taken to reduce CO_2 emissions of build environment.

Hence, the objective of this research is to investigate if tax benefit can influence the willingness of privet homeowner to renovate their homes towards energy neutral level. In this paper, a desk research has been conducted to find out what the benefits of energy neutral renovation are to its stakeholders. The desk research has been also helpful to find out what the impact of tax benefits regarding sustainability have been in the neighbouring countries. Thereafter, two fiscal scenarios have been constructed and taken into survey with the existing fiscal scenario. Subsequently, a stated conjoint choice experiment is used to determine the preferences of homeowners regarding renovation packages. Finally, the results are given and conclusions are drawn.

Keywords: Tax benefits, energy neutral renovation, private homeowners, conjoint choice experiments

INTRODUCTION

The Dutch government is committed to achieve the international (Kyoto and later Bonn) agreed objectives to reduce CO_2 emissions. According to the European Climate and Energy Package (ECEU, 2012) the aim is to have a 20-20-20 reduction in 2020 compared to 1990; 20% less greenhouse gas, 20% more sustainable energy and 20% energy saving. This means that the new dwellings from 2015 should have at least an EPC value of 0.4 and from the 2020 only energy neutral /zero energy houses should be built. With expected sharply

increase of energy prices in the future, the share of energy cost as part of the total living cost will continue to increase. In a choice between energy efficient dwellings and energy inefficient dwellings, the marketability of energy-insufficient dwellings will come under great pressure.

The built environment in the Netherlands is responsible for around 30% of energy consumption. In the Netherlands there are around 7.3 million housing stocks (see figure 1).

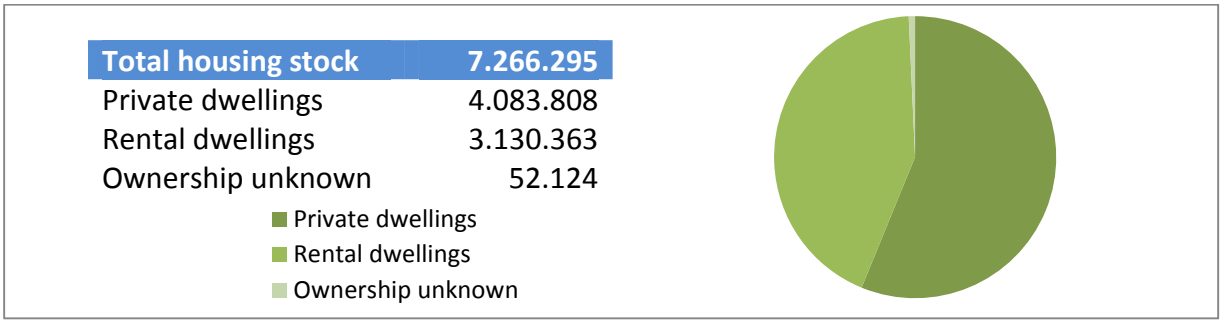

Figure 1: Characteristics of existing housing stocks (CBS, 2013)

Around 3.1 million of the housing stock is rental, the ownership of small number of houses is unknown, but the majority of the dwellings, around 4.1 million are private owned dwellings

In the recent past, the private homeowners have tried to take measures in order to reduce energy consumption through the provision of subsidies. This has often resulted in small changes and measures such as double glazing, solar panels and etc., without any comprehensive and structural approaches such as reducing energy loss through the shell of the building.

In order to compete with highly energy efficient (energy neutral) dwellings, it is important and desirable for the private homeowners to renovate their houses towards high energy efficiency / energy neutral level. But a renovation on such a level needs around €40.000 euro is needed (Weevers, B. 2013) and the willingness to invest. In return, the homeowners can receive benefits such as increase in lifespan of their houses, decrease in their energy-bill, better and healthier living environment and added value to their property.

In the Netherlands, inhabitants pay different kinds of taxes to the government: income tax, milieu tax, wealth tax, sewer tax, land value tax, inheritance tax, car taxes and etc. The government also supports its citizens though tax benefits. *The question is, can tax benefit influence the willingness of private homeowners to renovate their homes to energy neutral?*

In order to find answer to this question, first a desk research is conducted to find out what the benefits of energy neutral renovation are, what the impact of fiscal instruments have been concerning sustainability, what the most suitable tax form for this research is and what kind of financial barriers do the homeowners face when they decide to renovate their homes. Then, two fiscal scenarios are constructed and taken into survey with existing fiscal scenario to find out what the preferences of homeowners are. Finally, the results are given and the conclusion are drawn in the last part of this paper.

DESK RESEARCH

Energy neutral renovation and its benefits

A clear definition of energy neutral dwelling is important to prevent confusion about the used terms in this article.

Energy neutral

Energy neutral or zero energy dwellings are the dwellings that generate as much energy as they need to be comfortable. An energy neutral dwelling has an EPC of 0.0 and that means energy label A++ on the ladder of energy labels.

The energy neutral dwellings are well insulated to keep the heat demand in the winter to its minimum and the needed artificial cooling in summer is almost unnecessary. Living comfort, good ventilation and a healthy indoor climate are all crucial aspects of energy neutral dwellings which can be achieved through renovation by using modern construction methods, the right materials, energy efficient systems, efficient installations (for walls, floors, windows and doors, façade, glazing) and making use of the sun, wind, water and soil in a correct way.

Benefits of energy neutral renovation for homeowners

Investing in energy neutral renovation will decrease the energy bill which is the direct return of investment. Reducing the energy usage and using energy from renewable sources for the remaining amount of energy will result in great energy bill reduction. A project in Sleephellingstraat of Rotterdam has led to energy bill saving of €1.200-, per year after renovation to energy label A++ (AgentschapNL, 2013a).

The investment in energy neutral renovation does not have the only benefit in from of substantial savings in energy bills, but it also improve the value of property which is the indirect return on investment. Research shows that the value of property rises as the energy label gets greener (BNN, 2012). Groenestein has concluded in his study that the added value of energy sufficient dwelling can vary from €1000 to €25000 (Groenestein, 2011).

Creating a healthy, comfortable, safe and affordable dwelling are other benefits of energy neutral renovation. In addition, the extension of the living space or the improvement of kitchen and sanitation are the other possible benefits of renovation which can make the live environment more comfortable and pleasant.

Benefits of energy neutral renovation for government

Energy neutral renovation thru tax benefits can create jobs, not only in the construction sector but also in the production and installation sector of PV panels, HR boilers, glazing companies and etc. Tax benefits in the form of VAT reduction had already a positive impact on the construction sector as the sector made a total of 2.2 billion euros additional revenue in a year and the jobs in the construction sector has been preserved (BouwendNL, 2011a). Bigger tax benefit which can influence the private homeowners (4.2 million) to renovate their homes to energy neutral level can create much more revenue and jobs than what VAT reduction did.

Furthermore, the Dutch government can achieve its international (Kyoto and later Bonn) agreed objectives with energy neutral renovation of existing buildings as the Dutch built environment is responsible for 30% of total energy consumption (BZK, 2011).

Besides the job creation and achieving its goals, the government can have some financial benefits from the renovation of the existing dwellings. In February 2012 around 16600 people from the construction sector were receiving unemployment benefits (Dutch: werkloosheidswet uitkering) while in February 2013 it was escalated to 25500 people, a growth of 8900 people within a year (CBS, 2013). Job creation in the construction sector will reduce the number of receiving unemployment benefits. The government will also receive 21% of every investment back via VAT for materials. The government will also receive income tax of labour and corporation tax when renovation companies make profit. The energy neutral renovation can also improve the public health which means less health care costs.

Impact of tax benefits in the Netherlands and neighbouring countries

In total, there are eight VAT reduction and four governmental instruments in the form of tax credit for energy efficiency of buildings in the European member states (BPIE, 2012). France and Belgium use tax deductions and VAT reductions combined as a governmental instrument in order to improve the energy performance of existing dwellings, while the Netherlands uses only VAT reduction on the labour of energy saving measures as an instrument to improve the energy performance of buildings and to stimulate the construction sector.

Literature studies showed that in all three countries, tax benefit policies were efficient. In France the income tax deduction came out as the most efficient measure (Charlier *et al*., 2012). It was even possible to achieve the objectives of the government with the tax deduction policy but with higher rates, namely 54%.

In Belgium, the tax benefit also had a positive influence. There has been sharp increase in double glazing, use of high efficient boilers and specially roof insulation, from around 8.000 in 2007 to 60.000 in 2010 (BBL ,2012).

After the success of the VAT reductions in 2010, where the Dutch construction sector benefited from €2.2 billion additional revenue (BouwendNL, 2011a), the second term of VAT reduction has also been successful. In the first few months of second term, around 300000 households took part in sustainable renovations (Duurzaam gebouwd, 2013).

These results shows that tax benefits as governmental instrument for sustainability has been successful for sustainability as well as for the construction sector.

Suitable tax form for this research

In the Netherlands there are different forms of taxes available, from income tax to dog's tax. However the most relevant forms of tax for this study are; income tax, corporation tax, real estate transfer tax, environmental taxes and property tax.

The most suitable tax form for this research is chosen via a selection tables with 5 selection parameters, namely*; applicable for all homeowners, similar benefits, shortest payback time, quick benefits and transparency.* Income tax scored the highest as it has a maximum range (it is applicable for every homeowner), it is transparent and it has a shorter payback time (the homeowners can cover a big part of renovation cost at once).

Financial barriers of renovation

Technical solutions exist for residential energy neutral renovation. However, there are several barriers which prevent the implementation of such techniques. One of the most important barrier is the financial barrier.

Reports showed that high investment costs is the biggest financial barrier when it comes to sustainable renovation (Tommerup *et al.,* 2012; IEA 2008). Researches (Nair et al., 2010; Tommerup *et al.,* 2012) also show that investment cost is one of the important factors of homeowners' choice of energy efficiency measures. In practice, the cost of many energy saving measures and techniques are high which makes the payback period also longer and that makes the renovation projects less attractive to homeowners. Homeowners with low income and homeowners who recently purchased a house using all their financial means typically do not have capacity to invest in energy saving renovation (Tommerup *et al.,* 2012).

Lack of access to money or higher priority given to non-energy issues such as kitchen renovation, new bathroom, painting and etc. is limiting investments in energy efficiency measures. Energy efficiency renovations generally call for substantial additional up-front investments, as compared to repairing or overhauling options (Jakob, 2006). The homeowners do not have enough savings to do the renovation.

Additionally, uncertainties about labour market and about cost and benefits are the other important financially barriers when it comes to renovation of existing dwellings.

Fiscal and financial constructions

Two fiscal scenarios have been constructed by the author of this article as solution for mentioned financial barriers.

Scenario 1: 40% tax benefit for energy neutral renovation

The homeowners will be allowed to deduct 40% of expenses which has been made in order to renovate their homes to energy neutral from taxable income. The tax deduction will be eligible for payments which are paid for renovation cost including labour, professional services, materials, equipment and permits costs.

This tax deduction will make the energy saving investments financially interesting for homeowners and will lower the payback time, as 40% of the high investment cost will be covered by this tax benefit scenario. The percentage of the tax benefit is chosen in such a way that it can be favourable for the government as well.

Scenario 2: 20 % tax benefit for at least two energy label improvement

The homeowners will be allowed to deduct 20% of expenses which have been made for renovation from taxable income. The tax deduction will also be eligible for payments which are related to eligible work and include cost of labour, professional services, materials, equipment and permits. These costs will be eligible only if the renovation is done by a professional contractor with an establishment in the Netherlands.

This scenario is chosen because it is not possible to achieve energy neutral level on every existing dwelling. Financially and technically it will not be possible for some dwellings to achieve energy neutral level. Therefore, the homeowner can choose to renovate his house and improve the energy label of his house at least with two labels. The investment cost of this measure is also lower than energy neutral renovation which can attract homeowners with low income.

Scenario 3: 15% VAT reduction for renovation and restoration

The third scenario is the existing scenario in the Netherlands. The government has reduced the VAT from 21% to 6% in order to motivate homeowners and tenants for renovation and/or restoration of their dwellings. The VAT reduction rate of 15% can be applied to all renovation and repair work that has been made in a dwelling. Renovation and repair in this context can include; the renewal, addition, repair or replace of parts of the house. The reduced rate of VAT applies only to labour and not to the materials used in the renovation and restoration activities.

This scenario is taken into survey in the field research with two newly created scenarios for comparison.

Green mortgage, green loans, own saving of homeowners can be the solution for problem access to money. In the Netherlands, there are different banks which are willing to offer green loans and green mortgage if the homeowners improve the energy efficiency of their homes.

FIELD RESEARCH

A field research has been conducted to investigate whether the solutions formulated in previous section are appropriate enough to influence the willingness of homeowner to renovate their home into energy neutral.

The municipality of Barendrecht is used as case study area for field research. Barendrecht is a city in the Netherlands, located in the Rotterdam region in the province of South Holland. The municipality of Barendrecht has 47362 inhabitants on an area of 21.73 km^2. Barendrecht consists of more than 96,000 dwellings. Only around 5300 of them are rental houses. More than 70% of the dwellings are privately owned. The percentage of private dwellings is much higher than the average percentage of 56% in the Netherlands

Experimental variables of the field research were derived from desk research. Five attributes and their levels are taken into survey in conjoint experiment (moreover in methodology), to determine the preferences of the homeowners when doing renovation. It has been assumed that all attributes are independent. The attributes are as follow;

- *Renovation option:* The first attribute is the renovation option. The homeowners can choose from three renovation options. 1) Energy neutral renovation. 2) At least two energy label improvement. 3) Taking some energy saving measures.
- *Tax benefits:* The second attribute is the tax benefits they can obtain. Besides three renovation options, the homeowners can choose from three forms of tax benefits. 1) 40% of the renovation cost is deductible from income tax. 2) 20% of the renovation cost is deductible from income tax. 3) 15% VAT reduction only on labor of the renovations costs.
- *Tax deduction period:* The homeowner has also the option to choose from three periods of tax deductions. 1) Flexible, the homeowner can receive the cost in one time or divided into multiple number of years. 2) 5 years, the homeowner can receive the renovation cost in 5 years of time. 3) 10 years, the homeowner can get the renovation cost in 10 years of time.

- *Financial possibilities:* Energy efficiency renovations generally call for substantial additional up-front investments and not every homeowner has enough capital to do the renovation, therefore the homeowners are given three financial possibilities to choose from. 1) Green mortgage. 2) Green loans. 3) Own savings.
- *Service:* The last attribute of the conjoint experiment is the service option. The options to choose from are; 1) One-stop-shop. 2) Different companies. 3) Do it self.

Methodology

Stated conjoint choice experiment is used in this research. Conjoint choice experiment is a commonly used research method to determine how people value different features that make up an individual product or service. In conjoint choice modelling respondents require to choose between two or more profiles. Usually there is also a "none of the above" option available if none of the presented profiles are attractive enough for the respondent.

In this case the profile consist of five attributes, renovation options, tax benefits, periods of tax deduction, financing possibilities and service as it is mentioned in previous section. The 5 attributes and their 3 level will result in 3^5 = 243 choice profiles if the full fractional factorial design is used. Incorporating all the alternatives requires too many choice profiles to be taken into questionnaire which will take too much time of respondents. Therefore a fractional factorial design is created.

The orthogonal generator function of SPSS 21 is used to design the fractional factorial design, holding 18 alternatives. These alternatives have randomly put in choice sets, each holding two profiles alternatives. In the experiment the respondents were first asked to give their preferred package from the set presented, totally nine choice sets were presented to them. Secondly, they were asked to reveal whether they find the packages acceptable to be implemented in practice. The different attributes were coded by using effect coding (Kemperman, 2000).

Furthermore, three models have been used for calculation of the results. The three used models are theory of random utility, regression analyses and latent class analyses.

RESULTS

A total number of 1488 homeowners were approached for the survey. The number of responses were 324, and 17 out of them were filled wrongly. These questionnaires were removed from the database.

The Socio- demographic of sample group showed some notable results when comparing them to Dutch population. Especially the education level of respondents, where 72% of the respondents have a PhD, WO or HBO diploma compared to 32% of Dutch population. This means that the majority of private homeowners who took part in the survey are highly educated people. This finding is in line with the literature indicating a positive relationship between educational attainment and environmental concern (Alibeli *et al*., 2009). Literature shows that, well educated people are more likely to show higher levels of environmental concern than the less educated.

Additionally, the results showed that "high investment cost", "long payback time" and "limited financial resources" are indeed the main barrier which prevents the homeowners to

invest. With 37 percent, the choice "long payback time" resulted in the biggest reason of not investing. The second biggest reason was "the high investment cost" with 21 percent.

Relative importance of attributes for implementation

First the relative importance of the attributes are calculated and elaborated in figure 2. As shown in figure 2, tax benefits with 45% has the highest relative importance to homeowners who want to implement one of the renovation packages to renovate their home. It can be regarded as the key attribute compared to other attributes. Service has the lowest importance and while the other three attributes has almost equal importance to homeowners.

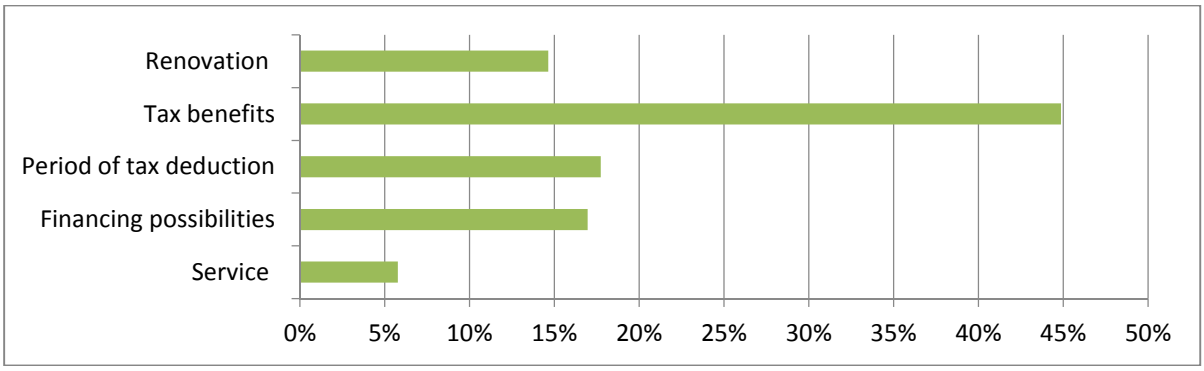

Figure 2: Relative importance of each attribute for implementation of choice sets

Part worth value of levels

The following figures will elaborate the value of each level for two important attributes. If a bar is positive, than the respondents find the level attractive which results in an increased positive attitude towards a particular choice package. When a bar is negative, it shows that the respondents find the level not attractive.

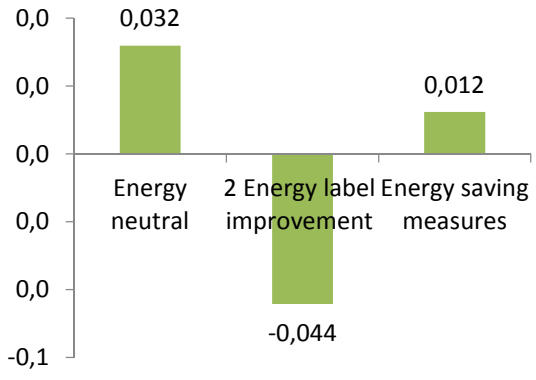

Figure 3: Part worth value of Renovation

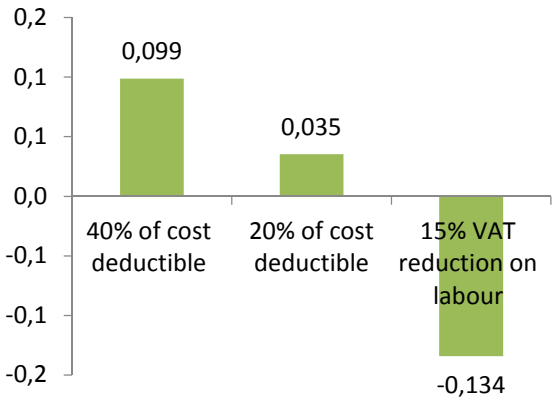

Figure 4: Part worth value of Tax benefits

Renovation: Figure 3 shows that energy neutral renovation is the most important attribute level for homeowners. This is a logical result as energy neutral dwellings have the most of the benefits. Energy saving measures came as second and 2 energy label improvement came as last.

Tax benefit: Figure 4 shows that "40% of renovation cost deductible" has the highest value for the homeowners. "20% of cost deductible" has a negative value which means it has less value for the respondents, while 15% VAT reduction on labour which is current governmental policy to promote sustainability and create job in construction sector has least value for homeowners.

Comparison of three scenarios

By adding up the part worth values of *renovation* and *tax benefits* together, it can be concluded that scenario 1 is the most acceptable scenario for the homeowner with a part worth value of 0.131. The homeowners have negative preference for Scenario 2, while the existing scenario of the government is least preferred scenario (see figure 5).

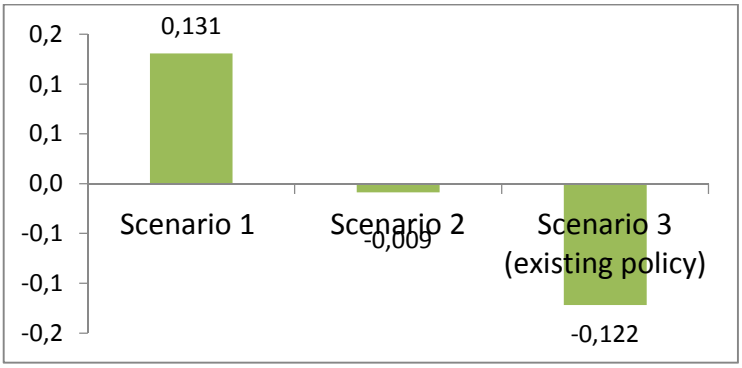

Figure 5: Comparison of different scenarios

By taking the antilog of each of the total part worth values, the percentages to predict the proportion of homeowners who choose each of the scenarios to renovate their home is calculated. The result showed in that 38% of the homeowners have chosen for scenario 1, 33% have chosen scenario 2 and only 29% have chosen the existing scenario.

Latent class analysis

As mentioned before, Latent Class Analyses (LCA) is a method which is able to find respondent segments in a sample group based on preference variables. For this research LCA is performed in NLOGIT. There are two class found in NLOGIT, class 1 which represents 63% of the respondents and Class 2 which is representative of 37% respondents. The classes are named after the analysing the differences in part worth values of levels.

Class 1 is named as "Active homeowners" as this class is interested in energy neutral renovation with tax benefit of 40% tax deduction of renovation costs. Furthermore, this latent class has chosen for green mortgage and one-stop-shop as service option. All choices are logical and it seems that they are really interested in energy neutral renovation of their dwellings. In addition, the majority of the value in this class is significant and has p-value <0.05.

The respondents in latent class 2 have minimal interest in *energy neutral renovation* and *2 energy label improvement*. Latent class 2 has high importance for *energy saving measures* and *40% tax benefits*. Therewith, it should be mentioned that 40% tax benefit has an insignificant value. It can be concluded that this latent class is not interested in energy neutral renovation, and therefore it will be named "*Passive Homeowners"*.

After analysing the output of part worth values and relative importance of attribute per class, two optimal packages with 95% confidence level are chosen for both classes. The packages are shown in the following table (see table 1).

Table 1: Characteristics of optimal packages

	Class 1 - Active Homeowners	Class 2 - Passive Homeowners
Attributes	**Attribute level**	**Attribute level**
Renovation	Energy neutral	Energy saving measures
Tax benefits	40% of costs deductible	15% VAT reduction on labour
Deduction Period	In 5 year time	Flexible
Financing	Green mortgages	Own savings
Service	One-stop-shop	Do it self

CONCLUSIONS

It should be mentioned that special attention should be given to financing of energy neutral renovation. Tax benefits and added property value after renovation can cover big part of the renovation cost and they can make the payback time of renovation cost shorter and therewith the renovation more attractive for homeowners. However energy neutral renovation needs a substantial additional up-front investments and not every homeowner has that money. Thus, it is important to make access to financing resources possible and easy for homeowners besides tax benefits.

Then, with the results of field research based on gathered data from the municipality of Barendrecht, it can be concluded that the homeowners showed high interest in energy neutral renovation with 40% tax benefits. The interest was large in choice of renovation packages as well as in implementation of them. The results showed that tax benefits and energy neutral renovation has high value for private homeowners.

From scenario comparison it can be concluded that scenario 1 has the highest value for homeowners, followed by scenario 2. The existing scenario, scenario 3, has the least value and therewith it is the least chosen scenario among homeowners. Subsequently, the results of scenario comparison showed that 37 percent of homeowners, with 95% confidence level intend to renovate his dwelling towards energy neutral if 40% tax benefit is given.

By use of Latent Class Analysis two possible segmentations of the respondents are derived from observed data for more accurate results. From the result of LCA, it can be concluded that class 1 with 63 percent of the respondents and 95% confidence level, were interested in energy neutral renovation with 40% tax benefits and green mortgage. Whereas, class 2 with 37 percent of the respondents, appeared to be not interested in energy neutral renovation.

Finally, it can be concluded that tax benefits has a big influence on the willingness of homeowners to renovate their dwellings towards energy neutral level. The combination of 40% tax benefit and energy neutral renovation was preferred. The homeowners could have chosen for 40% tax benefit and 2 energy label improvement or 40% tax benefit and energy saving measures, but they favoured energy neutral renovation on other two mentioned renovation options.

DISCUSSION AND RECCOMENDATIONS

The field research has been conducted in municipality of Barendrecht. The majority of the respondents were highly educated and had on average high income than average Dutch citizens. A similar research among a larger group of homeowners from different municipalities can be done for better prediction.

The percentage of tax benefit (40% for energy neutral renovation) is selected in a way that it is still profitable for the government. However a detailed calculation of cost and benefits is needed before coming to a conclusion that 40% tax benefit is profitable for the government. For example, homeowners pay energy taxes on every Kwh electricity and cubic meter gas that they use. When their dwelling is renovated, they will use less energy which means less energy tax. Thus, it is important to find out how much energy tax will government miss. On the other hand, the Dutch government achieves the agreed international goals, when the existing housing stock is renovated to energy neutral, it is important to calculate what the benefits of government will be by achieving environmental goals. Furthermore, the government and municipalities pay different subsides, when 40% tax profit is given to homeowners, than these subsidies will be not necessary for private homeowners. Thus, it is important to calculate how much the government and municipalities can profit from this measurement.

Finally, a system dynamic modelling can be used to predict the effect of different scenarios described in this research on environmental goals and construction sector for longer period of time.

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DE INVLOED VAN BELASTINGVOORDEEL OP BEREIDBAARHEID VAN HUISEIGENAREN TOT ENERGIENEUTRALE RENOVATIE

Construction Management and Urban Development 2012-2013

Auteur: Ing. E. (Edris) Timori

Afstudeerprogramma:
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ABSTRACT
In dit artikel wordt onderzocht of belastingvoordeel het investeringsgedrag van huiseigenaren zodanig kan beïnvloeden dat zij bereid zijn hun woning te renoveren naar energieneutraal niveau. Allereerst is er een literatuuronderzoek uitgevoerd om te achterhalen wat de voordelen van energieneutrale renovatie zijn voor de huiseigenaren. Het literatuuronderzoek is gericht op het effect van belastingvoordeel op duurzaamheid. Hierbij is ook gekeken naar de positieve effecten van duurzaamheid in andere landen. Middels een vergelijking is het effect van duurzaamheid aangekaart. Vervolgens zijn er twee fiscale scenario's opgesteld die samen met de huidige fiscale scenario in een enquête zijn verwerkt. Er is een conjoint meetexperiment gebruikt om de voorkeur van huiseigenaren met betrekking tot renovatiepakketten te kunnen bepalen. Ten slotte zijn de uitkomsten verwerkt en op basis daarvan zijn een aantal conclusies getrokken.

Trefwoorden: Belastingvoordeel, energieneutrale renovatie, conjoint meetexperiment, particuliere huiseigenaren

INLEIDING
Nederland staat voor de opgave het energieverbruik sterk terug te dringen. Dit zowel om de afhankelijkheid van fossiele brandstoffen en de aan het gebruik daarvan klevende nadelen te verkleinen met als doel om de stijgende energielasten in de woonlasten pakket terug te dringen. In Europees verband heeft Nederland zich verplicht om in 2020 het energieverbruik met 20% te reduceren en van het (resterende) energieverbruik 20% duurzaam op te wekken. Dit betekent ook dat nieuwbouw woningen vanaf 2015 een EPC moeten hebben van minimaal 0,4 en dat er vanaf 2020 slechts zero energy /energieneutrale woningen mogen worden gebouwd.

Door verder stijgende energieprijzen en energiegebruik zal naar verwachting het energieaandeel in de totale woonlasten verder toenemen. Ten gevolge hiervan zal de

verkoopbaarheid van een energieverspillende woning in vergelijking met een energiezuinige woning onder druk komen te staan.

In Nederland zijn er circa 7,3 miljoen woningen waarvan circa 4,1 miljoen particuliere woningen zijn. Om het energieverbruik van deze woningen te beperken, heeft de overheid in het recente verleden via het verstrekken van subsidies getracht woningeigenaren aan te zetten tot het nemen van bepaalde maatregelen.

Dit heeft vaak geresulteerd in kleine aanvullingen, aanpassingen en maatregelen gericht op het terugdringen van het energieverlies via de schil van het gebouw. Er was echter geen sprake van een integrale en structurele aanpak. Om de concurrentie met energieneutrale / zeer energiezuinige woningen aan te kunnen is het wenselijk de bestaande particuliere woningen ook tot een energieneutraal/zeer energiezuinig niveau te renoveren.
Echter, voor een grootschalige renovatie moet geld geïnvesteerd worden. Het is bekend dat veel woningeigenaren gevoelig zijn voor de kosten en de terugverdientijden van de maatregelen. Het is dus heel goed mogelijk (zoals ook het geval was bij allerlei subsidieregelingen) dat woningeigenaren zich laten verleiden tot structurele, energiebesparende en ingrijpende maatregelen, indien binnen een langere termijn belastingvoordeel wordt aangeboden.

Het doel van dit onderzoek is om te achterhalen of belastingvoordeel het investeringsgedrag van huiseigenaren zodanig kan beïnvloeden dat zij bereid zijn hun woningen te renoveren naar energieneutraal niveau.

LITRATUURSTUDIE

Energieneutrale woning en de voordelen hiervan

Een duidelijke definitie van energieneutrale woning is van belang om verwarring over de gebruikte termen in dit artikel te voorkomen.
Energieneutraal of nul-energie woningen zijn woningen die evenveel energie opwekken als ze nodig hebben voor een normaal leefpatroon en een hoog comfort niveau. Een energieneutrale woning heeft een EPC van 0,0 en dat betekent energielabel A ++ op de ladder van de energielabel.

Voordelen van energieneutrale renovatie voor de eigenaar

- Investering in de energieneutrale renovatie kan de energierekening verlagen. Dit kan men beschouwen als direct rendement van de investeringen. Een project in de Sleephellingstraat te Rotterdam heeft geleid tot een besparing op de energierekening van € 1,200-, per jaar na renovatie naar energielabel A ++ (AgentschapNL, 2013a).
- De energieneutrale renovatie kan de waarde van de woning verhogen. Dit kan als indirecte rendement van de investering worden beschouwd.
- andere bijkomende voordelen zijn; het comfort van een woning verbeteren, een beter betaalbare woning, betere geluidisolatie, een bijdrage leveren aan de bestrijding van de energiecrisis en de klimaatproblemen.

Voordelen van energieneutrale renovatie voor de overheid

- Renoveren naar energieneutraal niveau heeft uiteraard ook voordelen voor de overheid. De lage energiegebruik zorgt voor een lagere CO_2 uitstoot. Hierdoor kan de overheid haar CO_2 reductiedoelen realiseren.
- Energieneutrale renovaties die het gevolg zijn van een belastingvoordeel kunnen banen creëren; niet alleen in de bouwsector, maar ook in de productie en installatie sector van de PV-panelen, Hr-ketels, beglazing bedrijven en etc.
- De financiële voordelen voor de overheid kunnen zijn: minder WW-uitkering, meer belasting in de vorm van winstbelasting, inkomstenbelasting en BTW.

Belastingvoordeel in Nederland en omgevende landen

Uit het literatuuronderzoek bleek het volgende;

- In Frankrijk het inkomstenbelastingvoordeel bleek de meest efficiënte maatregel te zijn voor het verduurzamen van bestaande woningen(Charlier *et al*., 2012). Het was zelfs mogelijk om de doelstellingen van de overheid met deze maatregel te realiseren.
- In België heeft het belastingvoordeel ook een positieve invloed gehad op de bereidbaarheid van bewoners. Zo is er een sterke toename van dubbele beglazing, het gebruik van hoge efficiënte boilers en vooral dakisolatie laat een sterke stijging zien (van ongeveer 8.000 in 2007 naar 60.000 in 2010)(BBL, 2012).
- Door de btw-verlaging in 2010 in Nederland, behaalde de bouwsector 2,2 miljard euro extra omzet (BouwendNL, 2011a). De tweede termijn van de btw-verlaging is ook succesvol geweest. In de eerste paar maanden van de tweede termijn hebben rond de 300.000 huishoudens deelgenomen aan duurzame renovaties (Duurzaam gebouwd, 2013).

Deze resultaten tonen aan dat belastingvoordeel als een tool voor de overheid succesvol kan zijn, zowel op het gebied van duurzaamheid als voor de bouwsector.

Financiële belemmeringen van renovatie

Uit het literatuuronderzoek is gebleken dat de hoge investeringskosten, beperkte financiële middelen en langere terugverdientijd de voornaamste redenen zijn voor de huiseigenaren om niet in energiezuinige verbeteringen van hun woning te investeren.

Oplossing voor belemmeringen

Naast de huidige belastingvoordeelregeling zijn er twee nieuw belastingvoordeel scenario's opgesteld voor dit onderzoek.

- **Scenario 1**: de eigenaar van de woning kan 40% van de gemaakte renovatiekosten (incl. materiaal en arbeid) van de inkomstenbelasting terugkrijgen, indien de woning tot energieneutraal niveau wordt gerenoveerd. Dit scenario zal de energiebesparende investeringen financieel aantrekkelijker maken voor de huiseigenaren en zal de terugverdientijd van investering verlagen. Het percentage van het belastingvoordeel is zodanig gekozen dat het gunstig is zowel voor de overheid als voor de particulieren.
- **Scenario 2:** de eigenaar van de woning kan 20% van de gemaakte onderhoudskosten (incl. materiaal en arbeid) van de inkomstenbelasting terugkrijgen, indien de woning met minimaal twee energielabels is verbeterd.
- **Scenario 3:** dit betreft de huidige scenario. Op alle renovatie-en herstelwerkzaamheden in en aan een woning is 15% btw-korting van toepassing. De btw-korting is uitsluitend van toepassing op de arbeidskosten en niet op de gebruikte materialen.

FIELD RESEARCH

Een veldonderzoek is uitgevoerd om te analyseren of de oplossingen geformuleerd in de vorige sectie geschikt zijn om het investeringsgedrag van huiseigenaren te kunnen beïnvloeden.

Het veldonderzoek is uitgevoerd in de gemeente Barendrecht. Deze gemeente telt circa 96000 woningen waarvan 70% koopwoningen zijn. Het percentage van particuliere woningen is veel hoger dan het gemiddelde percentage van 56% in Nederland.

Onderzoeksmethode

Het kwantitatieve onderzoek is uitgezet door middel van een enquête. In deze enquête werden de huiseigenaren gevraagd om keuzes te maken uit 18 renovatiepakketten.

De renovatiepakketten werden samengesteld met behulp van attributen die bestonden uit 3 levels (zie tabel 1). Deze attributen werden gerandomiseerd en in renovatiepakketten geplaatst. Het fractionele factoren ontwerp is gebruikt bij maken van renovatiepakketten. Hiermee kunnen de hoofdeffecten van iedere variabele achterhaald worden. Vervolgens kon door middel van een conjunct meetexperiment de voorkeur van huiseigenaren met betrekking tot de attributen worden bepaald. Daarna zijn de drie belastingvoordeel scenario's met elkaar vergeleken om te achterhalen welk scenario de meeste voorkeur heeft bij de huiseigenaren. Tot slot is de Latente Klasse Analyse gebruikt om de huiseigenaren in bepaalde klassen in te delen voor een beter en betrouwbare voorspelling.

Attributen	Attributen level
Onderhoud	- Energieneutraal renoveren - Verbetering van minimaal twee energielabel - Energiebesparende maatregelen nemen
Belastingvoordeel	- 40% van renovatiekosten terugkrijgen - 20% van renovatiekosten terugkrijgen - 15 % BTW korting op de arbeidskosten
Voordeel verdeeld over	- Flexibel - 5 jaar - 10 jaar
Financiering	- Groen hypotheek - Groene lening - Eigen vermogen
Service	- One-stop-shop - Verschillende bedrijven - Doe het zelf

Tabel 1: Attributen en levels als input voor de renovatiepakketten

RESULTAAT EN CONCLUSIE

Van de in totaal 1488 benaderde huiseigenaren hebben uiteindelijk 324 gereageerd op de enquête. De resultaten zijn als volgt;

- De huiseigenaren hechten de meeste waarde aan het belastingvoordeel, gevolgd door renovatie, periode van belastingvoordeel en financiering. Renovatie services werden als minst belangrijk gezien.

- In de attributie van renovatie kozen de huiseigenaren vooral voor de level *energieneutrale renovatie*.
- In de attributie van belastingvoordeel kozen de huiseigenaren voor de level *40% belastingvoordeel*.
- Uit de vergelijking tussen de verschillende scenario's kwam naar voren dat huiseigenaren de meeste voorkeur hadden voor scenario 1 (40% belastingvoordeel voor energieneutrale renovatie). Met een betrouwbaarheidsinterval van 95%, was 38% van de huiseigenaren bereid om hun huizen te renoveren naar energieneutraal niveau met 40% belastingvoordeel. De minste voorkeur ging uit naar het huidige scenario (15% btw-korting voor energiebesparende maatregelen).
- De Latente Klasse Analyse resulteerde in twee groepen. Na het analyseren van de verschillende waarden is voor elke groep een renovatiepakket gekozen. Deze resultaten zijn weergegeven in tabel 2.

	Class 1 – actieve huiseigenaren 63%	Class 2 - Passieve huiseigenaren 37%
Attributie	Attributie level	Attributie level
Renovatie	Energieneutraal	Energiebesparende maatregelen
Belastingvoordeel	40%	15% btw-korting
Voordeel verdeeld over	5 jaar	Flexibel
Financering	Groene hypotheek	Eigen vermogen
Service	One-stop-shop	Doe het zelf

Tabel 2: Vergelijking van de kenmerken per Latente Klasse

Tot slot het kan worden geconcludeerd dat het belastingvoordeel grote invloed heeft op de bereidheid van huiseigenaren om hun woning naar energieneutraal niveau te laten renoveren. De combinatie van 40% belastingvoordeel en energieneutrale renovatie heeft de voorkeur van huiseigenaren. De huiseigenaren hadden de mogelijkheid om te kiezen uit de verschillende renovatiepakketten, onder andere 40% belastingvoordeel voor energiebesparende maatregelen. Uit het onderzoek is gebleken dat hun voorkeur toch uitgaat naar de energieneutrale renovatie.

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