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Assessment of policy instruments applied in the buildings sector in the Netherlands to improve energy savings and reduce GHG emissions

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Assessment of policy instruments applied in the buildings sector in the Netherlands to improve energy savings and reduce GHG emissions

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Summary

The concept of a green economy has gained a lot of attention in recent years as the world has been searching for solutions to numerous global challenges. The Green Economy aims at an "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2010). A green economy values environmental assets by placing regulations and policies that act as market incentives, adjusting the environmental losses and ensuring a sustainable development.

The buildings sector, compared to other sectors, has the biggest economic mitigation potential according to a study made by the IPCC in 2007. It means that the buildings sector is able to achieve CO2 emission reductions and energy savings far more than any other sector considering the same costs. Adopting simple measures such as improved insulation and efficient-energy use can be very effective in improving the building's energy performance and reducing its carbon footprint.

In the Netherlands, the building sector accounts for about one third of carbon emissions, particularly 33% (Joosen et al., 2004). The Dutch government is aiming to reduce the energy consumption from the existing building stock by 50% compared to 1990 levels, and only energy-neutral buildings will be constructed starting 2020 (VROM 2007). Accordingly, the buildings sector is able to play an important role in achieving long-term sustainability of the nation's energy economy, as well as it can reduce carbon emissions by around 90% by the year 2050, making it possible to reach the target of limiting global warming to 2°C as required by the Copenhagen Agreement set in December 2009. This can only be achieved through policy instruments that are used as enabling conditions and incentives to enhance the development of sustainable buildings.

The objective of this research is twofold. First this study will carry out exploratory and descriptive methodologies to find out the environmental policy instruments used to enhance the development of sustainable buildings in the Netherlands. It will also highlight the most effective and cost-effective policies in terms of energy savings and GHG emission reductions. Second, the success factors and the potential constraints for the development of sustainable buildings projects with above standards targets will be explored using two case studies for existing buildings renovation De Kroeven in Roosendaal, as well as new construction buildings Eva-Lanxmeer in Culemborg. Also the economic benefits that sustainable buildings generate will also be described in the context of the green economy where new jobs and products are created. The main tools and instruments used in this research, other than previous literature studies are in-depth interviews with local government officials, researchers, developers, and architects. The secondary data is gathered from government documents, policy reports, and statistical datasheets.

Despite the Dutch government's efforts and the policy instruments introduced to encourage the development of energy-efficient buildings, fossil energy consumption in residential buildings has continued to increase over the last decade. The current policy instruments are still not sufficient in securing the climate targets. Housing that was built in the post world war II period forms a substantial part of the Dutch existing buildings stock. Many existing buildings have great potential for energy savings and reducing the energy costs. However, the built environment is less targeted with the present policy instruments. There are no obligations and not many incentives for

building owners to improve the energy performance of their buildings. For that reason, further research should be done on environmental legislations that would require owners of the existing buildings stock to improve the energy performance of their buildings.

Keywords: *sustainable buildings, environmental policy instruments, effectiveness and cost-effectiveness of policy instruments, barriers, success factors, economic recovery, household energy consumption, energy-efficiency, green economy, sustainable development, and climate change.*

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Abbreviations

BREEAM	BRE Environmental Assessment Model
CPI	Consumer Price Index
DGBC	Dutch Green Building Council
EIA	Environmental Investment Allowance
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Coefficient
EPC	Energy Performance Certificate
EPN	Energy Performance Norm
EPR	Energy Premium Regulation
EU	European Union
GHG	Green House Gases
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LEED	Leadership in Energy and Environmental Design
MAP	Environmental Action Plan
MJA	Meerjarenafspraaken
NEPP	National Environmental Policy Plan
NL	Netherlands
PV	Photovoltaic
REB	Regulatory Energy Tax
UK	United Kingdom
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
VAT	Value Added Tax
VROM	Ministry of Housing, Spatial planning and the Environment, NL
WCED	World Commission on Environment and Development
WRI	World Resources Institute
WWF	World Wildlife Fund

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Chapter 1: Introduction

1.1 Background

The world population is estimated to grow to over 9 billion by mid century (UNFPA, 2007). This only increases the challenge of meeting the need of a growing population, which in turn depends on a sustainable economic development. The recent financial crisis in 2008, followed by social inequality and loss of jobs has made more pressures on governments to change the current development path. These issues brought up the concept of green economy as a way to sustainable development and poverty eradication. The Green Economy aims at an “improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP 2010). In 1987, the Commission on Environment and Development defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987). This was followed by the first study that made a connection between the economy and sustainable development. Pearce et al. in the book *Blueprint for a Green Economy (1989)* argued that current economies are based on depleting natural capital to secure profit, whereas a green economy values environmental assets by placing regulations and policies that act as market incentives, adjusting the environmental losses and ensuring a sustainable growth. There has always been concern that natural resources and the services that natural capitals provide are crucial for human welfare. For instance, in 1991, the World Wide Fund for Nature, the International Union for Conservation of Nature (IUCN), and UNEP defined sustainable development as “improving the quality of human life within the carrying capacity of supporting ecosystems” (WWF, IUCN and UNEP 1991). Ecological degradation and climate change has emerged as the most demanding challenge facing the earth today.

It is largely recognized that urban areas are rapidly expanding and are significantly contributing to global warming. Cities account for 60-80 % of energy consumption and roughly equal amount of green house gas emissions (IEA, 2008). It is estimated that the buildings sector has the largest ecological footprint contributing to one third of the global GHG emissions, while the remaining can be traced to industry and transport (UNEP, 2010). The way we design, build and operate buildings has a big impact on the environment. At the same time, it is critical to note that the buildings sector, compared to other sectors, has the biggest economic mitigation potential according to a study made by the IPCC in 2007. Adopting simple measures such as improved insulation and efficient energy use can save costs and results in a better quality of life. Sustainable buildings are efficient, resilient, and socially inclusive offering big opportunities to overcome these challenges.

Urban areas have the potential to change these negative patterns and act as “engines of economic growth”. A large scale investment in efficient, resilient, and socially inclusive infrastructure is the main feature of cities development. Accordingly, increasing investments in green buildings can be part of an integrated strategy to greening the building sector and facilitating the transition towards a green economy. Sustainable buildings contribute to a better health, energy savings, improved productivity, and an increase in jobs. Existing policies and market incentives caused a misallocation of capital, which made us locked in an unsustainable path dependency, ignoring the social and environmental externalities.

This calls for an urgent action by policy makers to create more incentives and more enabling conditions that makes the transition towards a green economy path possible.

In 2002, the European Union adopted the Energy Performance of Buildings Directive, setting efficiency standards for both residential and commercial buildings (DIRECTIVE 2002/91/EC). As part of the concerns for climate change taken by EU, the European Council and Parliament adopted the new Energy Performance of Buildings Directive in November 18th, 2009. The recast is intended to extend the 2002 Directive and double the efforts to limit climate change, and enhance a green economy by creating more jobs and improving energy security (DIRECTIVE 2010/31/EU). According to the Dutch embassy in Washington, the Netherlands is committed to make a transition to a green economy. The Dutch government and the civil society are committed to reduce energy consumption by 80% in all buildings by 2050. Only green buildings will be constructed in the Netherlands starting 2020. Existing building stocks will be retrofitted to become more energy-efficient.

1.2 Problem Statement

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change" (*Charles Darwin)*. Over the next few decades, the world will go through a significant change in climate which will have an impact on the whole society. With this in mind, there is a need to make a transition in the current development path. "A Green Economy can be thought of as an alternative vision for growth and development; one that can generate growth and improvements in people's lives in ways consistent with sustainable development" (WRI, 2011). The building industry is responsible for 40% of global annual GHG emissions (UNEP, 2009) and around 30% of the Netherland's energy consumption (Eurostat, 2011). Furthermore there is a high rate of urbanization with loss of jobs and poverty rising. Buildings have the opportunity to improve energy efficiency and act as "engines of economic growth" by creating jobs and reducing energy costs. Given these facts, there is a need for change to a sustainable development path which can be greatly influenced by the cooperation of different stakeholders such as policymakers, planners, designers and engineers. It should be clear for developers that adopting sustainability would create profits equal to or even more than the 'business as usual' practices. Increasing investments in the green industry has a vital role to play in making the transition towards a green economy, which promotes the triple bottom line of economy, environment, and society.

We've seen over the course of the last decade significant progress in sustainable buildings and energy-efficient technologies. However, in most countries, the concept of green buildings is still at a growing phase and is far from reaching the expected norm of future development. This can only be achieved through policy instruments that are used as enabling conditions and incentives to enhance the development of sustainable buildings. The concern is that non-efficient policies lead to misallocation of welfare and will weaken the abatement policy itself. Accordingly not all policy instruments are effective or cost-effective in terms of GHG emissions reduced and energy savings.

1.3 Research Objectives

The purpose of this research is to explore the different policy instruments used for the development of sustainable buildings in the Netherlands. Furthermore, the effectiveness and cost-effectiveness of certain policy instruments will be assessed. The research will also highlight the savings potential and the economic opportunities that are associated with sustainable buildings. Another objective is to describe the barriers and the success factors for the development of sustainable buildings projects with above standards targets. Therefore the specific objectives are:

- To carry out a critical review of the policy instruments used as incentives for the development of sustainable buildings in the Netherlands.
- Compare the most effective and cost-effective policy instruments in terms of energy savings and GHG emissions reduced.
- Explore the barriers and success factors for the development of sustainable buildings projects with above standards targets.
- To find out the potential benefits that sustainable buildings offer at the economic level in the Netherlands.

1.4 Provisional Research Question

What are the policy instruments that are used as incentives for the development of sustainable buildings in the Netherlands, and which supports the transition towards a green economy?

1.5 Provisional Sub-questions

- What are the environmental policy instruments (regulatory, economic, fiscal, support) used to enhance the development of sustainable in the Netherlands?

- Which instruments are the most effective and cost-effective in terms of energy savings and GHG emission reductions?

- What are the reasons for success or failure in the development of above standards sustainable buildings projects?

- How does the green buildings industry support job creation and economic recovery?

1.6 Significance of the Study

The city of New York is aiming to become a leader in the green economy by 2030 (Mayor M. Bloomberg, 2009). The plan is to drive demand for green products and services through environmental and infrastructure policies using 30 initiatives. The first initiative to implement among the thirty is Green Buildings. Throughout history, the Netherlands has been a leading country in setting a policy framework for sustainable buildings. During the 20th century, notably after the 1970's and the mid 1980's, the Netherlands started to develop a sustainable building policy framework to control the negative environmental impacts of this sector (National Dubo Centrum

2000). Given this fact, the time is crucial more than ever for the Dutch to expand and share their knowledge in sustainable buildings. This research is intended to discover if the Netherlands is still a leading country in sustainability, and how far is it meeting the targets set by the European Union directive for energy performance in buildings.

The subject of this research is at the heart of the challenges facing our world today. The externalities that emerge from a rapid rate of urbanization are significant, leading to more construction, more buildings, and more depletion of natural resources. This is inducing climate change, which is at the middle of the talks in all international treaties. Furthermore, the economic crisis and loss of jobs are placing more pressures on governments to innovate in policies and put more efforts on sustainability. That's where the concept of green economy comes in as a change in the current development path towards sustainable development and poverty eradication. Policy makers have the biggest role in making that transformation possible. That's why this research is considered of high significance. It highlights those policy instruments that are used to create enabling conditions for a change.

1.7 Scope and Limitations

This research will assess the effectiveness and cost-effectiveness of certain environmental policy instruments applied to the building sector, in terms of GHG emissions reduced, energy savings and ease of implementation. Both new construction and the renovation of existing buildings will be covered, with special consideration given to urban areas. According to the International Energy Agency, "green buildings and sustainable buildings are those with increased energy efficiency, but at the same time reductions are made on water consumption, use of materials and assessment of the general impact on health and environment." (Laustsen, 2008). While efficiency in resource use of water as well as raw materials and waste is considered, the emphasis is on energy, given its importance to the building industry and its significant impact to climate change. Covering a comprehensive plan for all life-cycle impacts of the building sector is beyond the scope of this research.

Chapter 2: Literature review

2.1 The Dutch sustainable buildings policy (history and process)

Despite its dynamic economy and dense population, the Netherlands has become a leading country in setting a policy framework for sustainable buildings. During the 20^{th} century, notably after the 1970's and the mid 1980's, the Netherlands started to develop a sustainable building policy framework to control the negative environmental impacts of this sector (National Dubo Centrum, 2000). Two distinguished periods represent the evolvement of sustainable building policies in the Netherlands. The first period started in the 1970's, during which solutions were based on self-sufficiency measures, without considering synergies with surrounding infrastructure. The second remarkable period evolved in the 1980's, where policies focused to improve environmental efficiency of buildings in relation to the existing infrastructure, taking into account 'the ecological modernization theory'(Liefferink 1997) .

In 1973, concerns regarding the energy security and environmental impacts of building sector were raised. This occurred when the Organization of Petroleum Exporting Countries (OPEC) reduced oil exports to some western nations and especially the United States and the Netherlands. This event resulted in an increase in the price of oil, which led to the revaluation of the energy consumption of Dutch building stocks, and gave more incentives to look for alternative energy sources. In 1974, the first Dutch Energy Policy document was adopted along with the completion of many subsidized green buildings (Melchert, 2007). Examples from this period for projects built based on environmentally sound principles are De Kleine Aarde in Boxtel and ING bank headquarters in Amsterdam. During that period, environmentally friendly measures were too costly and required subsidies for the implementation of several energy efficient housing projects. The target was mainly the insulation systems of buildings where for example cladding materials and windows were improved (National Dubo Centrum, 2000).

A more effective approach for reducing the environmental impacts of the building sector evolved one decade later, based on 'ecological modernization'. It is a theory of the environment emerging in the 1980s - 1990s in Western Europe. It advocates market based solutions to environmental problems, through technological development with environmentally beneficial outcomes. It explores innovative approaches to environmental policy, such as 'economizing ecology' by placing an economic value on nature. In the 1980's energy efficient buildings grew up to become crucial in the building sector. The publication of the Brundtland report 'Our Common Future' in 1987 caught the attention of policy makers and civil society (Brundtland, 1987). In 1988 another report 'Zorgen voor Morgen' was issued, focusing on status of the natural environment (Hajer, 1995; Gouldson & Murphy, 1998). These two reports were the basis for the formulation of the National Environmental Policy Plan (NEPP), *Kiezen of Verliezen,* which was issued in 1989 (VROM, 1989). The Environmental Policy Plan Plus (NEPP Plus) was issued later in 1990, comprising of a section entitled Sustainable Building (National Dubo Centrum, 2000). Thus, a new phase in the institutionalization of sustainable building practices initiated through environmental policy strategies aiming at a sustainable development. In the same period, the first international discussion about climate change emerged and the UN intergovernmental panel on climate change was established. The building industry was thereby indentified as a prime target sector to reduce climate change and environmental degradation. The most famous example for a sustainable building in that time was the Ecolonia residential district in Alphen aan den Rijn, which became a sustainable building icon and an incentive for the society to adopt similar measures and accept the idea.

In 1993, the Dutch government published the second National Environmental Policy Plan (NEPP) differentiating between economic growth and pollution (VROM, 1993). The third plan followed in 1998, focusing on overall prosperity (VROM, 1998). And the fourth plan was released in 2001 giving more attention to the quality of life and environmental objectives (VROM, 2001).

The implementation of sustainable building policies was under the responsibility of each municipality, where each local authority issue isolated manuals and recommendations. By 1993, more emphasis was given for a close cooperation of different actors involved in the building sector notably the government, the construction industry, designers, and other important actors. From this moment onwards, green solutions in construction projects started to take place. It was then realized that not only the involvement of different stakeholders was important to achieve sustainability goals, but also a more homogenized sustainable building policy at the national level is crucial to avoid any confusion about the subject. Accordingly, the national government worked on a policy framework that was introduced in 1996 as the National Sustainable Building Packages through the ministry of housing, spatial planning and environment (VROM) and the ministry of economic affairs (MINEZ). These packages were composed of specifications for green building from the urban scale to the single building (Melchert, 2007) and classified sustainable measures based on the environmental impacts.

This agreement and policy framework was based on the ALARA (as low as reasonably achievable) principle. Working in parallel, VROM started to shift the emphasis on new construction buildings to the renovation and improvement of the existing building stock. The Dutch energy and environmental agency (Novem) in coordination with the ministry of economic affairs (MINEZ), developed a climate program that was set in 1995. That program introduced an Energy Performance Standard (EPN) that determines the energy consumption standards for new residential and office buildings, with a decreasing performance over the years. For existing buildings, a long-term agreement (LTA) was launched obliging these building stocks to reduce their energy consumption by 25%, based on the 1995 levels within a period of 10 years. A great example for the ‘ecological modernization’ period for sustainable building in the Netherlands is the ABN AMRO headquarters in Amsterdam. A favourable integrated planning of the building with its surrounding was taken into account, resulting in a public square in front of the building and an accessible public transport. A cooperative environmental policymaking approach involving different actors was behind the success of the ABN AMRO green building in Amsterdam and other buildings aiming for sustainability goals (National Dubo Centrum, 2000).

By the end of 1990’s, local authorities in the Netherlands were given greater autonomy which was backed up by the flexibility of sustainable building policies. This wasn’t the case anymore when the rightward coalition took control of the government in 2002, supporting a top-down approach for urban planning and environmental policies (Bontje, 2003).

2.2 Sustainable energy policies - buildings sector in the Netherlands

Certain measures were introduced in order to stimulate the energy efficiency of residential and commercial buildings. These include:

- Energy Performance standards and Energy Certificates for buildings
- “More with Less” plan (Meer met Minder) for the housing sector
- Green Funds scheme
- Energy efficiency standards and labeling under the EU’s Eco-Design Directive
- Covenants with housing corporations

(OECD/IEA, 2009).

2.2.1 Buildings

In May 2010, the European Union adopted the energy performance of buildings directive (recast) 2010/31/EU, where member states must follow this legislative instrument to improve energy efficiency for new and existing buildings. Accordingly, the Netherlands is required to implement a policy framework that will improve the energy performance of buildings.

In December 1995, the Netherlands introduced the energy performance standard for new buildings, which is actually the building energy code. This energy performance standard differentiates between residential and commercial buildings, and evaluates them separately. The standard aims at an energy saving of 15-20% compared to the building energy performance of years before 1995. An overview is given in table 1.

Table 1: Energy use and CO2 emissions in buildings 1995-2002. Note that direct emissions are mainly space heating and hot water from natural gas. And indirect emissions are related to the use of electricity

Sector	Energy use (PJ_prim)		CO2 emission (Mton)		Direct CO2 emission (Mton)		Indirect CO2 emission (Mton)	
	1995	2002	1995	2002	1995	2002	1995	2002
Residential	573	546	34	32	22	19	12	13
Tertiary	369	459	23	28	12	12	12	16
Total	942	1005	57	60	33	31	24	29
% total NL	32%	32%	32%	34%				

Source: (ECN, 2003a), (ECN/RIVM, 2005)

Since 1995, the energy performance standards were reformed many times. The Netherlands government was aiming to reach the targets of the Kyoto protocol by setting a maximum amount of 29 million ton of CO2 for the buildings sector in 2008-2012. These emissions reached 31 million tons of CO2 by 2002 (ECN/RIVM, 2005). In order to comply with the EU energy performance of buildings directive (recast) 2010/31/EU, the Netherlands had to revise its standards to meet the new requirements.

For new buildings, an energy performance coefficient (EPC) was formed in order to comply with the energy performance standard, depending on the total energy consumption or maximum CO2 emissions per unit area. A low value coefficient has high energy performance significance. The energy performance coefficient (EPC) is considerably reduced with time from 0.8 to 0.6 in 2011 and to 0.4 in 2015 (OECD/IEA, 2009). An overview is given in table 2.

Table 2: Energy performance coefficient (EPC) required for new residential buildings

From	EPC
December 1995	1.4
January 1998	1.2
January 2000	1.0
January 2006	0.8
January 2011	0.6

Source: (ECN, 2003a), (ECN/RIVM, 2005)

In 2008, the “More with Less” plan started to be implemented. This voluntary plan aims at improving energy efficiency of existing buildings, which will lead to energy savings in almost 500 000 buildings of 20-30% through 2011, and adding 300 000 buildings annually from 2012 (OECD/IEA, 2009). This plan was initiated by the Energy Transition Platform for the Built Environment, along with energy providers and contractors. The Dutch government will contribute to this plan by providing financial incentives, advice services and an energy performance certificate scheme to improve energy efficiency. The average rate for compliance with building code In IEA countries and the Netherlands is around 70%. The government is aiming to achieve higher rates through enhanced enforcement measures.

The Dutch housing corporations are vital stakeholders in the efforts to improve energy performance because they own about 35% of the dwellings. The Dutch government is working on an agreement with the housing corporations to encourage energy savings. These efforts are crucial for the residential buildings, given that owners are only responsible for such improvements. In 2007, the housing corporations declared that they are willing to reduce energy consumption in buildings by 20% by 2018 (OECD/IEA, 2009).

2.2.2 Appliances

The European Union Eco-Design Directive (2005/32/EC) covers energy labelling for domestic appliances such as washing machines, refrigerators, dryers, dishwashers, lamps and ovens. These appliances are categorized from A to G, where G is the least energy efficient. In 2004, two new categories were introduced these are A+ 25% lower than class A and A++ 40% lower (OECD/IEA, 2009).

2.3 The Dutch Green Building Council (DGBC)

Founded in 2008, the Dutch Green Building Council started from an initiative from Redevco and ABN Amro, with cooperation with Dura Vermeer and SBR. Today, there are more than 50 partners, most importantly ING Real Estate and TNT (Dobbelsteen, 2008). DGBC is committed to ensuring that sustainability in the building sector is measured by creating a label and applying project certification programs. Buildings are being assessed in a uniform rating and complying with international standards. DGBC target is to progress the transition from conventional to sustainable buildings. The council uses BREEAM, the English methodology as a benchmark for sustainable buildings assessment. In 2008, DGBC developed a Dutch beta version BREEAM-NL that is more suitable for the local situation in the Netherlands. In September 2009, BREEAM-NL Version 1.0 was officially adopted by the council. This rating system is indented to add value to the building sector and increase property values for sustainable buildings. It will also encourage investments in green buildings and clean technology. The BREEAM-NL label that is given to a certified sustainable building is an added value by itself, which makes it more significant compared to other conventional buildings.

2.4 Environmental assessment methods

2.4.1 BREEAM

BRE Environmental Assessment Model (BREEAM) was launched in 1990 in Britain by the Building Research Establishment (BRE). It is the world's leading design and assessment method for buildings. BREEAM was initiated in order to improve the environmental performance of buildings from the early phase of design, to construction and management. It was originally introduced to stimulate sustainable building construction and as benchmark for environmental performance. It consists of 9 categories covering almost all industry sectors: Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land use and Ecology, Pollution. Accordingly a rating system is applied and used for the project certification process. Environmental performance of buildings is rated and awarded weighted point scores. Accordingly, a final score is given and the project is rated as Pass, Good, Very Good, Excellent or Outstanding (Dobbelsteen, 2008). There are different versions of rating systems depending on the types of buildings and projects: Retail, offices, education, prisons, courts, healthcare, industrial, and multi-Residential.

2.4.2 LEED

Leadership in Energy and Environmental Design (LEED) was initiated by United States Green Building Council (USGBC) in 2000. It is based on BREEAM assessment methods and is mostly used in the US. USGBC is a non-profit organization and a partnership between commercial, public and non-profit sectors, dedicated to sustainable building design and construction. LEED is a voluntary rating system that awards points for buildings according to certain criteria each according to its potential environmental damage, as follows:

- Sustainable sites (8 criteria, 12 points, 13% weighting factor)

- Water efficiency (4 criteria, 10 points, 8%)

- Energy and atmosphere (3 requirements, 6 criteria, 30 points, 32%)

- Materials and resources (2 requirements, 9 criteria, 14 points, 15%)

- Indoor environmental quality (3 requirements, 3 criteria, 19 points, 21%)

- Innovation and design (3 criteria, 7 points, 8%).

Accordingly the project is given a certification based on the final score. A LEED-certified project is given a certificate depending on its environmental performance at one of four levels: LEED Certified, LEED Silver, LEED Gold or LEED Platinum. There are different versions of rating systems depending on the types of buildings and projects such as homes, neighbourhood development, commercial interiors, core and shell, new construction and shops, healthcare and retailing (USGBC, 2012).

2.5 Barriers to sustainable buildings development

The number of barriers in the buildings sector is higher than in any other sector (IPCC 2007). Many studies have been carried out to explain why policy instruments do not meet expectations as initially planned (for example Deringer *et al.* 2004, Westling *et al*. 2003). Below are the acknowledged barriers for energy efficient buildings (UNEP, 2007):

2.5.1 Economic/financial barriers

The development of sustainable buildings requires high initial investment costs for the purchasing of more efficient equipment. Many people do not want to spend more and others can't afford to pay for these technologies (Carbon Trust, 2005). This is the most common limitation for energy efficient buildings mostly in developing countries but also in developed countries where consumers don't believe that such investments will pay back in the near future.

2.5.2 Market failures

Market failures obstruct the conversion of energy-efficient costs into energy saving profits (Carbon Trust, 2005). There's a conflict of interest between building tenants and building owners which is caused by misplaced incentives. Tenants pay their energy bill and are therefore concerned in reducing it. On the other hand, owners have no direct interest in efficiency improvements because it is an extra cost for them. For the public sector, the economic crisis which is leading to budget constraints is restricting energy efficiency developments (Urge-Vorsatz, Koeppel et al. 2007).

2.5.3 Behavioural and organizational constraints

Energy efficient technologies and practices are often ignored by individuals and businesses, which is caused by the difficulty of changing behavioral lifestyles (Chappells and Shove, 2005). This is related to the lack of awareness to the opportunities and potential savings that sustainable buildings offer. In developed countries, energy expenditures are limited in importance compared with the disposable income, which does not give any incentive to prioritize the improvement of energy efficiency. Whereas in developing countries, energy expenditure have a much larger share of the disposable income, but are subject to subsidies to lower the energy price which act as a barrier for energy efficiency (Alam, 1998).

2.5.4 Political and structural barriers

Political and organizational barriers are mostly common in developing countries where governments have no interest in energy efficiency improvements because of several reasons, among them: corruption, lack of expertise, insufficient policies, and inadequate enforcement (Deringer *et al* 2004).

2.5.5 Information barriers

This limitation is mostly common in developing countries where there is a lack of awareness of the possible benefits and the potential energy savings within sustainable buildings. Even in developed countries many architect graduates don't learn the skills to construct a sustainable building (Evander *et al*. 2004, Deringer *et al*. 2004).

2.6 Definition of policy instruments

Table 3: List of policy instruments used to enhance the development of sustainable buildings and their definitions

POLICY INSTUMENT	DEFINITION
Appliance standards	Define a minimum energy efficiency level for a particular product class such as refrigerators, to be fulfilled by the producer (Birner et al. 2002)
Building codes	Address the energy use of an entire building or building systems such as heating or air conditioning (Birner and Martinot 2002)
Procurement regulations	Provisions for energy efficiency in the public procurement process.
Energy efficiency obligations and quotas	Requirement for example for electricity and gas suppliers to achieve targets for the promotion of improvements in energy efficiency for instance in households (Lees 2006)
Mandatory labeling program	Mandatory provision of information to end users about the energy-using performance of products such as electrical appliances and equipment, and even buildings (Crossley et al. 2000)
Mandatory audit programs	Mandatory audit and energy management in commercial, industrial or private building, sometimes subsidized by government
Utility demand-side management (DSM)	Planning, implementing, and monitoring activities of energy efficiency programs among/by utilities

Energy performance contracting	A contractor, typically an Energy Service Company (ESCO), guarantees certain energy savings for a location over a specified period; implements the appropriate energy efficiency improvements, and is paid from the actual energy cost reductions achieved through the energy savings (EFA 2002)
Cooperative procurement	Private sector buyers who procure large quantities of energy-using appliances and equipment work together to define their requirements, invite proposals from manufacturers and suppliers, evaluate the results, and actually buy the products, all in order to achieve a certain efficiency improvement in products equal or even superior to world best practice (Crossley et al. 2000)
Energy efficiency certificate schemes	Tradable certificates for energy savings (often referred to as "white certificates")
Kyoto flexibility mechanisms	Joint Implementation (JI) and Clean Development Mechanisms (CDM)
Taxation (on CO2 or household fuels)	Imposed by government at some point in the energy supply chain. The effect is to increase the final price that end-users pay for each unit of energy purchased from their energy supplier, although the tax may be levied at any point in the supply chain (Crossley et al. 2000)
Tax exemptions/ reductions	Used to provide signals promoting investment in energy efficiency to end use customers (Crossley et al. 2000)
Public benefit charges	Raising funds from the operation of the electricity or energy market, which can be directed into DSM/ energy efficiency activities (Crossley et al. 2000)
Capital subsidies grants, subsidized loans	Financial support for the purchase of energy efficient appliances or buildings
Voluntary certification and labelling	Provision of information to end users about the energy-using performance of products such as electrical appliances and equipment, and even buildings. Voluntary for producer (Crossley et al. 2000)
Voluntary and negotiated agreements	Involve a formal quantified agreement between a responsible government body and a business or organisation which states that the business or organisation will carry out specified actions to increase the efficiency of its energy use (Crossley et al. 2000)
Public leadership programs	Energy efficiency programs in public administrations, demonstration projects to show private sector which savings and technologies are possible

Awareness raising, education, information campaigns	Policy instruments designed by government agencies with the intention to change individual behaviour, attitudes, values, or knowledge (Weiss & Tschirhart 1994)
Detailed billing and disclosure programs	Display detailed information related to the energy consumption to the user either on bill and/ or directly on appliance or meter

Source: UNEP, 2007

2.7 Classification of policy instruments

These policy instruments shown above are classified into the following four categories (UNFCCC 1999, IEA 2005b, UNEP SBCI 2007b):

A. Regulatory and Control Mechanisms;

- Regulatory-normative mechanisms: Appliance standards, Building codes, Procurement regulations, Energy efficiency obligations and quotas.
- Regulatory-informative mechanisms: Mandatory audits, Utility demand-side management programs, Mandatory labeling and certification programs.

B. Economic or Market-Based Instruments;
Cooperative procurement, Energy performance contracting, Efficiency certificate schemes and credit schemes, Kyoto flexibility mechanisms

C. Fiscal instruments and incentives;
Energy or carbon taxes, Tax exemptions and reductions, Public benefits charges, Subsidies, Grants

D. Capacity Support, Information and Voluntary Action;
Voluntary certification and labeling programs, Public-leadership initiatives, Awareness raising and education

2.8 Criteria for assessing environmental policy instruments

It is important to note that literature in the fields of economics and political science does not present clear guidance in determining the most appropriate criteria for the assessment of environmental policy instruments. The criteria listed below are used by many authors and was used by the IPCC's Working Group III in the Fourth Assessment Report (Gupta et. al 2007) and the UNEP report for sustainable buildings (2007).
Three main criteria for the assessment of environmental policy instruments:

- Environmental effectiveness
- Cost-effectiveness
- Institutional feasibility and success factors

2.8.1 Environmental effectiveness

It is the degree to which a policy achieves its determined environmental goal and meets positive environmental results. Policies that attain specific environmental quality objectives better than previous policies can be said to have a higher extent of environmental effectiveness. It should be clear that while climate protection is dependent on environmental objectives within any climate policy, there may be secondary environmental benefits such as air pollution and air quality benefits as stated by Burtraw et al. (2001a). In this research, effectiveness is not attributed to general environmental benefits, but specifically defined as the improvement of energy efficiency and reduction of GHG emissions (UNEP 2007).

2.8.2 Cost-effectiveness

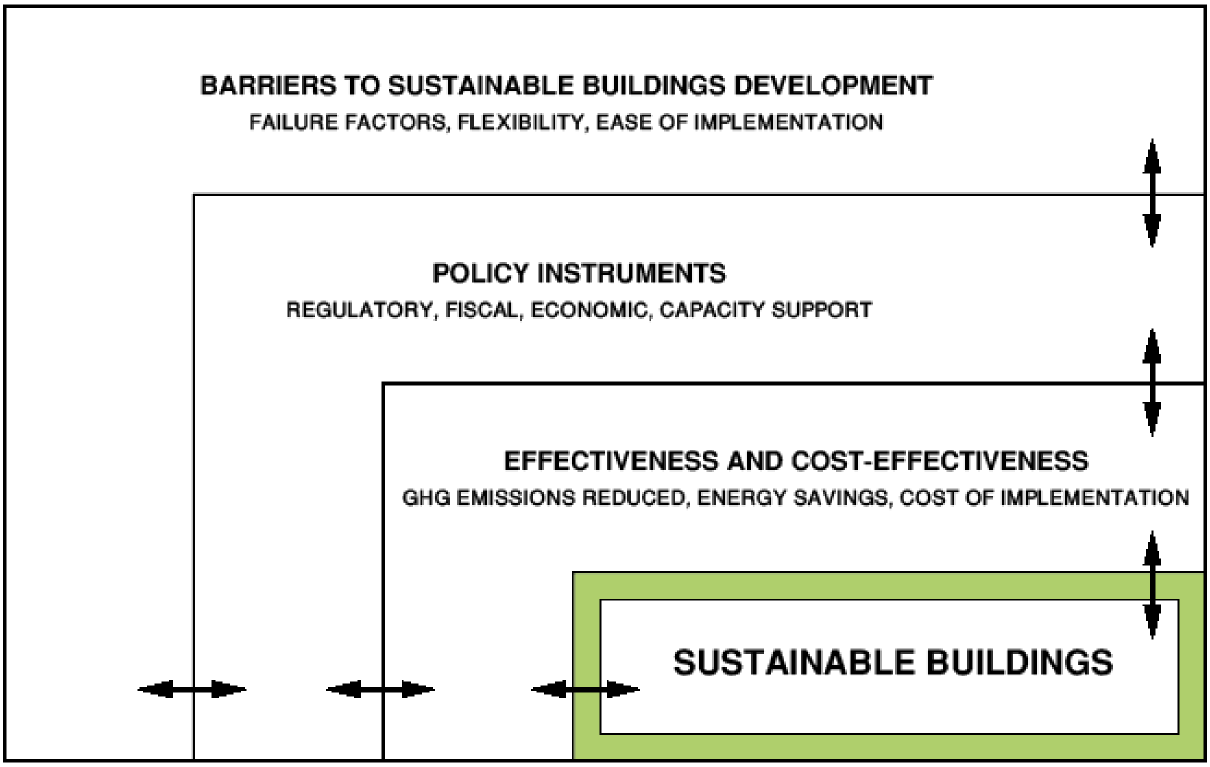
It is the degree to which a policy can meet its targets at a minimum cost to society. Cost-effectiveness can be evaluated from societal, individual or administrator's point of views (IEA, 2005b). It is the cost-effectiveness of CO2 reduction, in terms of USD/tCO2 (UNEP, 2007). It is different than economic efficiency in terms of objective. Cost-effectiveness takes into account specifically an environmental goal, whereas economic efficiency considers economic criteria while setting its objective (Sterner, 2003). There are several components of cost, and these consist of direct expenditures of implementing the policy, but also indirect costs which can be challenging to estimate (Davies and Mazurek, 1998).

2.8.3 Institutional feasibility and success factors

It is important to determine key factors that trigger the effectiveness of a certain policy instrument or the barriers for its success. For example building codes are less successful in developing countries than in developed countries due to lack of enforcement (Deringer et al. 2004). It is important that policy choices be supported by institutions and secured by legal systems. Institutional feasibility determines the likelihood of a policy instrument to be adopted and implemented, taking into account political and bureaucratic structures. Policy instruments must gain acceptance and be viewed as legitimate from a wide range of stakeholders (Gupta et. al 2007).

2.9 Conceptual framework

Figure 1: Conceptual framework



Source: D. Harake, 2012

Chapter 3: Methodology

3.1 Introduction

This chapter describes the methodological framework that will be adopted in order to answer the research questions. It will also present the research approach as well as the sources of information since they provide a backbone for the methodology employed. Moreover, the theoretical concepts will be translated into empirical measurable characteristics by selecting indicators and variables. An explanation of the sample size and selection of study area will be presented. Lastly, data collection methods, data analysis methods, validity and reliability will be described in a logical consistent manner, as it will comprehensively cover all aspects of the theories to be studied.

3.2 Research type

This research will carry out exploratory as well as descriptive methodologies to find out the environmental policy instruments used to enhance the development of sustainable buildings in the Netherlands. It will also highlight the most effective and cost-effective policies in terms of energy savings and GHG emission reductions.

Moreover, the success factors and the potential constraints for the development of sustainable buildings projects will be derived from two case studies: De Kroeven in Roosendaal, and Eva-Lanxmeer in Culemborg. Also the economic benefits that sustainable buildings generate will also be described in the context of the green economy where new jobs and products are created.

Both qualitative and quantitative data will be examined in order to answer the research questions. The primary data is derived from in-depth interviews with local government officials, researchers, developers, and architects. The secondary data is gathered from government documents, policy reports, literature studies, and statistical datasheets.

3.3 Variables and indicators

This section provides a backbone to the framework that need to be done. It presents the indicators that will be taken in the research in order to answer the questions. It also describes the sources of data that will be gathered during field work.

Table 4: Overview of research questions, variables, and indicators

Sub-questions	Variables	Indicators	Data type	Source of data
What are the policy instruments used to enhance the development of sustainable buildings in the Netherlands?	Hard and Soft measures	Regulatory instruments: Appliance standards Building codes Procurement regulations Energy efficiency obligations Mandatory certification and labelling Mandatory audit programs Economic and market-based instruments Cooperative procurement Energy performance contracting Efficiency certificate schemes and credit schemes Fiscal instruments: Energy or carbon taxes Tax exemptions and reductions Public benefits charges Subsidies Grants Capacity support, information and voluntary action Voluntary certification and labelling programs Public-leadership initiatives Awareness raising and education	Qualitative	Government documents Policy reports Interviews
Which instruments are the most effective and cost-effective in terms of energy savings and GHG emission reductions?	-Environmental effectiveness - Cost effectiveness	Energy consumption/savings Monetary savings GHG emissions reduced Cost of implementation	Qualitative and Quantitative	Government documents Literature studies Interviews
What are the reasons for success or failure in the development of above standards sustainable buildings projects?	Hard and Soft measures	Institutional feasibility Success factors Failure factors	Qualitative	Interviews Case study Eva-Lanxmeer Case study De Kroeven
How does the green buildings industry support jobs creation and economic recovery?	Hard measures	Products offered Types of jobs Number of jobs created by type	Quantitative and Qualitative	Interviews Case study Eva-Lanxmeer Case study De Kroeven

3.4 Sample size and selection of study area

The objective of this research is twofold. First the focus will be on environmental policy instruments used to enhance the development of sustainable buildings in the Netherlands. Policies set at the European Union level and national level will be reviewed. The study will also highlight the most effective and cost-effective policy instruments used in the Netherlands.

Second, the success factors, potential constraints, and economic benefits for the development of sustainable buildings projects will be explored using two case studies with above standards targets for existing buildings renovation De Kroeven in Roosendaal, as well as new construction buildings Eva-Lanxmeer in Culemborg. The main criteria that have been used to choose these areas are new construction urban districts and existing buildings. As discussed earlier, policy instruments used for both new construction and the renovation of existing buildings stock will be covered. Moreover, these two neighbourhoods are considered the most successful models of sustainable buildings construction and retrofitting in the Netherlands.

The first area selected is a relatively newly built urban district EVA-Lanxmeer project in Culemborg. It is considered one of the most remarkable models in the Dutch construction sector, and it is the first green district in the Netherlands to be designed and built completely in line with ecological principles based on Permaculture approach. The area consists of about 250 houses grouped in courtyards, several commercial properties and offices, and an organic city farm. Buildings have been built to save energy, and in harmony with surrounding landscape by using natural and sustainable construction materials. This type of urban district is ideal for conducting this research because it could act as a successful example for newly built sustainable buildings and neighbourhoods.

The second area chosen is De Kroeven, an urban residential district in Roosendaal. This neighbourhood was built in 1960, and consists of identical single family houses. During the past 40 years, minor improvements have been made along with a regular maintenance. The properties in this district are owned by social housing provider AlleeWonen, who decided to upgrade and retrofit the buildings to become more energy efficient. The renovation process will be based on efficient and cost-effective measures. The tenants of these houses expressed interest in such initiative and were supportive which makes the renovation process easier to implement. De Kroeven urban district consists of 370 single family houses, of which 246 will be retrofitted and 124 dwellings will be newly constructed. Early in 2011, 70 houses were retrofitted and completed as part of the project. This neighbourhood is ideal for conducting this research because it covers the upgrading of the existing building stocks.

3.5 Data collection methods

The qualitative part of this research will be mainly associated with primary data that will be derived from in-depth and semi-structured interviews (Annexe 1). Previous studies will be used as well in the qualitative part to support the primary data collected. On the other hand, the quantitative element will be based on secondary data sources such as statistical datasheets and previous studies.

Primary data will be based on three distinct sources, as follows:

Policy makers: local government officials, policy consultants, researchers.

Policy users: architects, developers.

Policy implementers: Private owners, housing corporations, local inhabitants.

3.6 Data analysis methods

Identified policy instruments will be analyzed using qualitative and quantitative methods. The aim is to backup qualitative findings derived from expert's judgments with quantitative data when evaluating the effectiveness or cost-effectiveness of a policy instrument. The effectiveness of a policy instrument is evaluated according to the amount of energy saved or the GHG emissions reduced as a result of the policy. The quantitative data of these criteria will be derived from evaluation studies wherever possible. Taking into account the limited availability and reliability of exact numerical values, expert's judgments will be dominant in forming the results given for the effectiveness of the policy instruments used for the building sector.

The cost-effectiveness of a policy instrument is assessed according to the degree to which a policy can meet its targets at a minimum cost to society. It is the cost-effectiveness of GHG emission reduction, in terms of USD/tCO2 (UNEP, 2007). There are several components of cost, but only direct expenditures of implementing the policy will be taken into account. Same as effectiveness, qualitative data will be based on numerical values where possible. But expert's judgment will be central in evaluating the cost-effectiveness of policy instruments.

The factors of success or failure of certain policy instruments will be analyzed using qualitative methods. The evaluation will be based on experts judgments derived from interviews and case studies.

The last category of analyzing the economic benefits and workforce implications of sustainable buildings will be based on the selected case studies and interviews performed with experts. The focus is to explore the jobs created and products offered as a result of the development of sustainable buildings.

3.7 Validity and reliability

Validity and reliability are commonly used in quantitative research and now they're applied in the qualitative research paradigm as well. In order to improve the validity and reliability of the research findings, and to cross validate the information collected, triangulation method is used. Creswell and Miller (2000) described triangulation as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (p.126). Accordingly, to improve the objectivity of the research, multiple methods will be used such as observations, interviews and discussions with different stakeholders at a different time and location. Patton (2002) believes that "triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including both quantitative and qualitative approaches" (p. 247). Data collected will be cross checked with secondary sources of information, leading to a reliable and objective description of realities.

Chapter 4: Research Findings and Analysis

4.1 Introduction

This chapter firstly describes the specific findings related to the research questions. These findings are based on data collected from in-depth interviews, previous studies, and official documents. It then presents a detailed analysis of data based on the research methodology.

As an introductory background, a brief explanation about the Dutch construction regulatory regime will be given, as well as the national organizations efforts for promoting sustainable buildings.

Results will be illustrated in five parts:

a) Netherlands buildings control system and regulatory regime;
b) Netherlands policy instruments for sustainable buildings;
c) Effectiveness and cost-effectiveness of the Dutch policy instruments;
d) Existing buildings – case study of De Kroeven in Roosendaal;
e) New construction buildings – case study of Eva-Lanxmeer in Culemborg.

4.2 Netherlands buildings control system and regulatory regime

In May 2010, the European Union adopted a modified energy performance of buildings directive (EPBD) 2010/31/EU, where member states are obliged to five specific activities for the energy performance of buildings:

a) requirements for calculating an integrated energy performance of buildings;
b) minimum energy performance requirements for new buildings;
c) minimum requirements for the energy performance of existing buildings undergoing significant renovation;
d) energy certification of buildings;
e) regular inspection of boilers and air conditioning systems in buildings and an assessment of boilers older than 15 years.

Accordingly, the Netherlands is required to implement a policy framework that will improve the energy performance of buildings and meet the requirements set by the EPBD. Construction regulations are set up at a national level in the Housing Act. Requirements are set in performance based manner, referring to the Building Decree for technical obligations. In order to comply with these requirements national standards, regulations and building codes have been drawn up. The Dutch Building Decree consists of five parts:

a) Safety (e.g. fire safety, user safety, emergency appliances…)
b) Health (e.g. ventilation, indoor air quality, sound insulation…)
c) Usefulness (e.g. accessibility for disabled people, communal space for domestic waste…)
d) Energy-saving (e.g. energy performance, thermal insulation…)
e) Environment

A building permit is required for any building construction project. Technical requirements are usually verified by a municipal building authority, and sometimes by an approved inspector. The building permit is issued at a local level by the municipality. Moreover, the municipal building authority is responsible for performing site inspections and has the power to stop a construction work. Local building authorities are supervised by national building examiners. After all, building requirements are set on a national level, inspected at a local level, and directed at the European Union level.

NL agency (Agentschap NL)

The Dutch Ministry of Economic Affairs, Agriculture and Innovation formed the NL agency with a mission to facilitate "t*he excellent implementation of international, innovation and sustainability policy". This organization ensures that government policies are effective through advice and support.* NL Agency is also responsible for monitoring and conducting impact assessment of policy implementation. As part of the efforts made towards sustainability in the housing sector, NL agency works closely with different parties including housing associations, developers, contractors, installers, architects, consultants and municipalities. NL agency offers support and gives relevant parties up to date information about the various agreements for energy efficiency, and policies on energy saving in housing.

4.3 Netherlands policy instruments for sustainable buildings

4.3.1 Regulatory instruments

Energy Performance Norm (EPN)

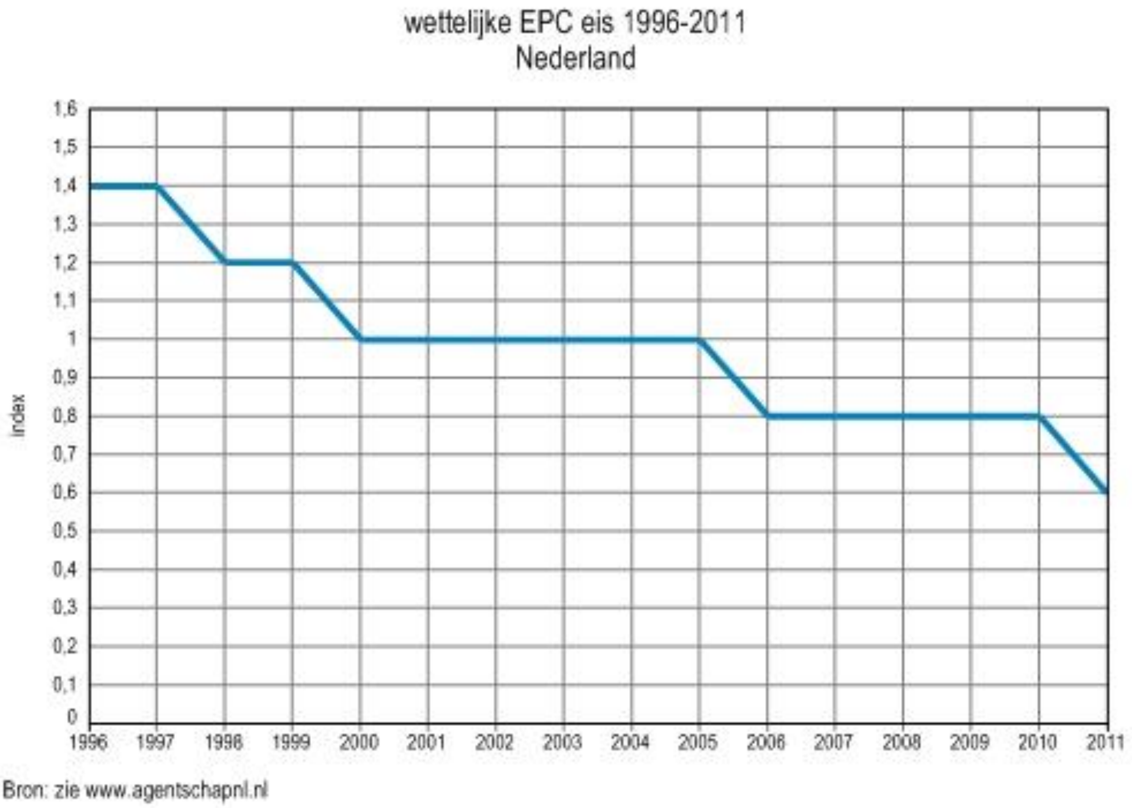
Duration: 1995 – present

In 1995, the Netherlands introduced the Energy Performance Standard (EPN). The focus of the EPN is to look at the overall energy efficiency of a building, instead of measures that stand alone. The measure of energy is expressed in an Energy Performance Coefficient (EPC). As a result, the construction industry itself provides the energy saving measures in order to attain the required EPC. The determination of the EPC is set out in Energy Performance Standards (EPN). The current EPC requirement for houses is 0.6, as shown in figure 2. The EPC for office buildings depends on its use and function. In recent years, the energy performance standards developed from practical experience, new developments, and available techniques. The European Directive on Energy Performance of Buildings (EPBD) gave a wide attention to improve the energy efficiency of buildings in the Netherlands.

From 1st of July 2012, the existing energy performance standards for new construction buildings are replaced by a new standard (BS 7120). The changes are largely related to the methods used for the determination of the EPC. Previously, separate determination methods were used. Whereas in the modified procedures, there is an integration of the assessment methods for new construction, existing construction, commercial and residential buildings. The new method adapts the European standards and the latest techniques. The aim is also to tighten the requirements towards energy-neutral buildings. In order to obtain a building permit, an EPC calculation is necessary. Accordingly the information about the requirements and new standards is intended for architects, consultants, installers, contractors and developers.

The European Union has set a target for new buildings after 2020 to be energy-neutral, with an EPC value of 0, where only renewable energy sources are used. This was mentioned in the revision of the EPBD in 2010. This means that the Dutch government is aiming for the same target to ensure that it meets the goals of the European Union. The Netherlands has ambitious goals in energy efficiency and the use of renewables for the building sector. The policy is to tighten the energy performance coefficient (EPC) to 0.4 in 2015, with the ultimate goal of 'zero energy' house in 2020.

Figure 2: Energy performance coefficient (EPC) required for new residential buildings, 1996-2011



Source: AgentschapNL (2012)

Energy Label

Duration: 2008 – present.

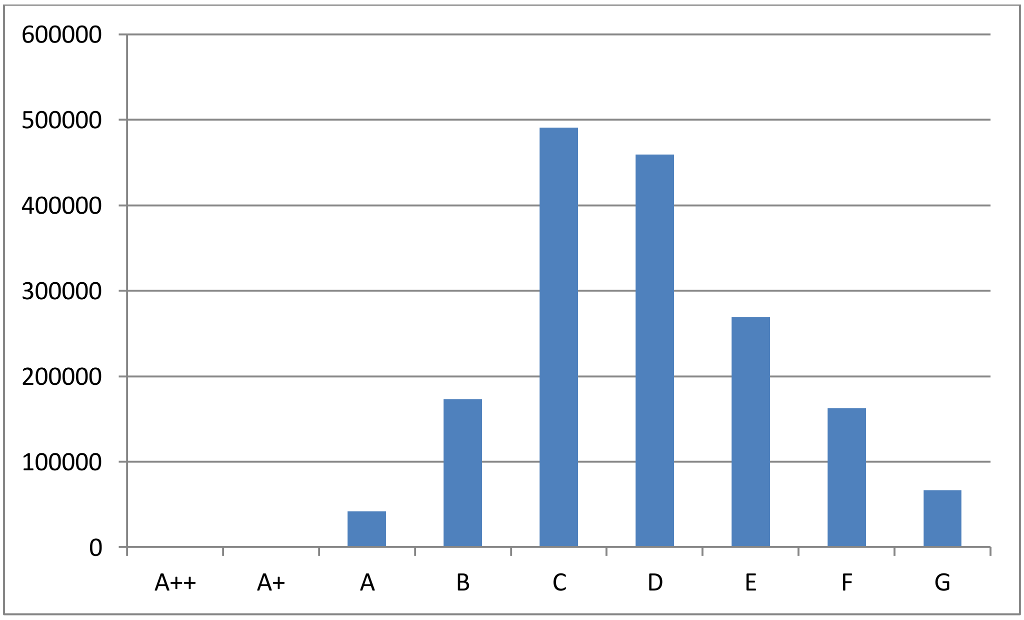
Since January 1st, 2008 an energy label is required for construction, sale or rental of housing. This label shows how energy efficient a home is and what could be the next target, as shown in figure 3. This gives more insight into the energy performance of buildings among home owners and corporations. The energy certificate is based on the European Energy Performance of Buildings Directive (EPBD).

Figure 3: EPBD Building Energy Rating (kWh/m²/yr): ***'A' rated buildings are the most energy efficient and will tend to have the lowest energy costs***

Source: AgentschapNL 2012

In the Netherlands, most of the houses are C and D rated with very few A rated buildings, as shown in figure 4 and table 5.

Figure 4: Energy labels for housing per type in Netherlands, 2010



Source: AgentschapNL 2012, Registratiesysteem voor energielabels van gebouwen

Table 5: Energy labels for housing per type in Netherlands, 2010

Housing energy labels	Number
A++	57
A+	306
A	41,627
B	173,236
C	490,444
D	459,342
E	269,079
F	162,272
G	66,771

Source: AgentschapNL 2012, Registratiesysteem voor energielabels van gebouwen

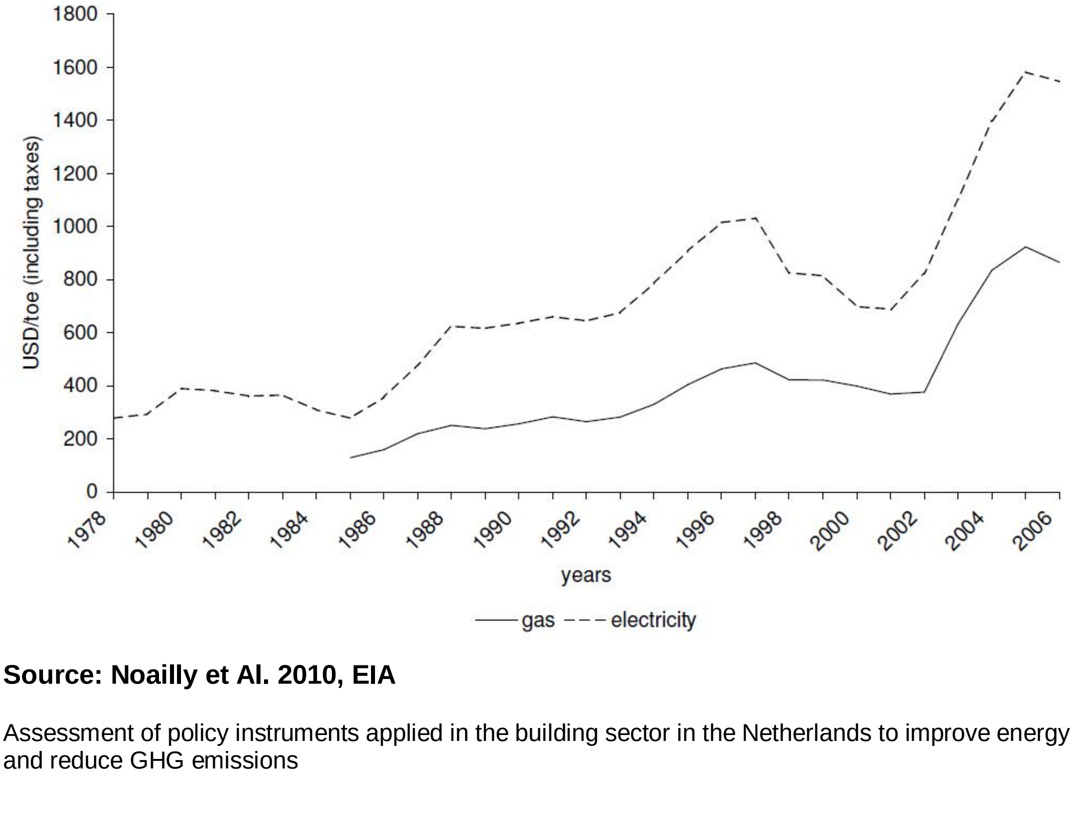
4.3.2 Fiscal instruments

Regulatory Energy Tax (REB – called EB after 2004)

Duration: 1996 – present;

The Regulatory Energy Tax (REB), so-called ecotax, was introduced in 1996 with an objective to increase energy efficiency. Initially, the target groups for REB were households and small enterprises until 2004 where it was also used for large commercial users. Regulatory Energy Tax is levied as a charge per kWh of electricity or gas m3. The amount of the charge depends on the energy consumption. The tax has been regularly increased over the years leading to an increase in household energy prices as shown in figures 5 and 6.

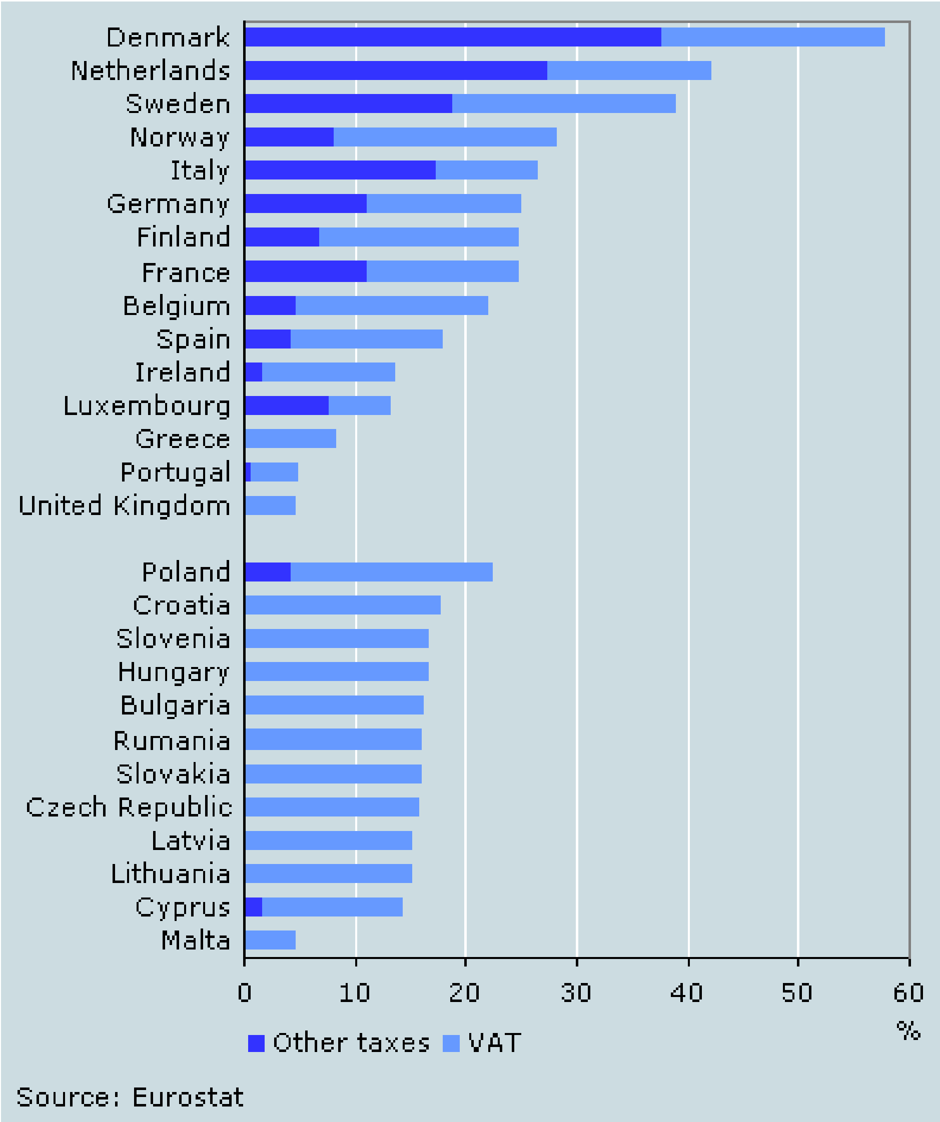
Figure 5: Evolution of gas and electricity prices in the Netherlands, 1978-2007



Source: Noailly et Al. 2010, EIA

The Netherlands is considered one of the most expensive countries for energy prices compared to other EU member states. Price differences are due to the fact that some of these countries did not impose energy taxes. The Netherlands is among the countries with highest energy taxes. As we can see in figure 6, the energy tax and VAT account for more than 40% of the total energy price.

Figure 6: Share of energy tax and VAT for electricity prices in Europe, 2006



VAMIL

Duration: 1991 – present;

VAMIL is a tax deduction scheme initiated by the Ministry of Infrastructure and Environment. The target groups for this program are entrepreneurs who invest in environmentally friendly technologies. These could be for example, environmentally friendly lighting systems, rainwater installations, low NOx burners, water saving toilets, or insulations systems. VAMIL provides improved liquidity for firms and interest rate advantage. This scheme also encourages innovative environmentally friendly products by facilitating their introduction to the market.

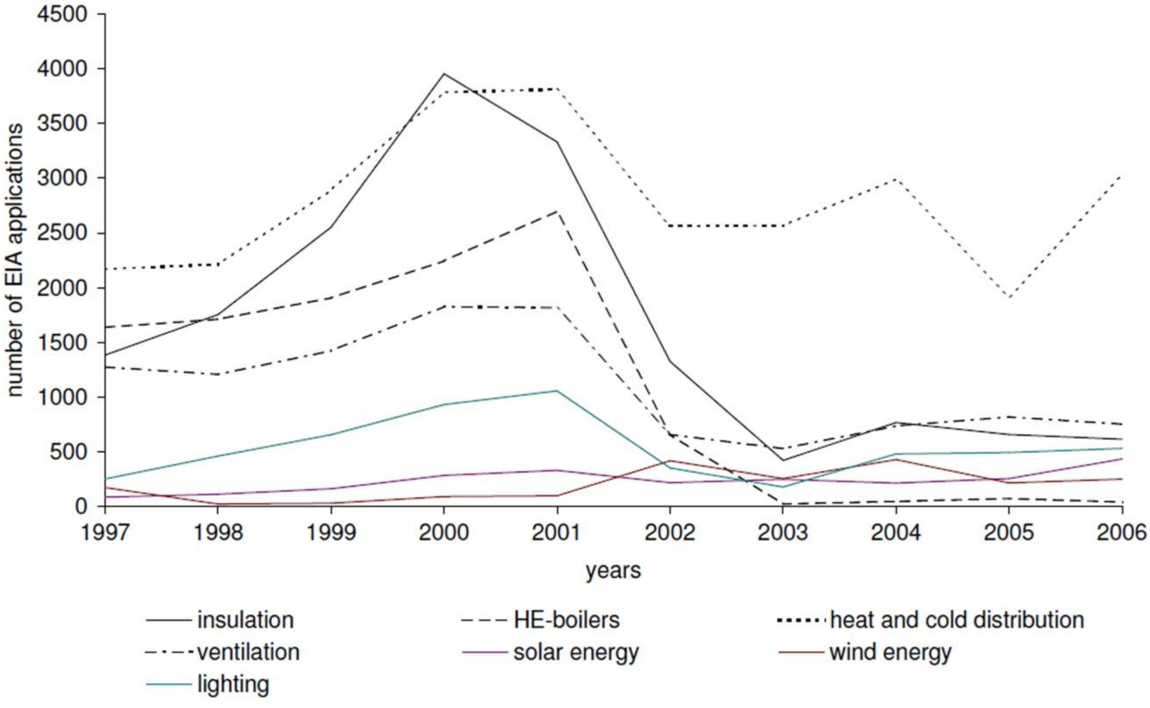
Environmental Investment Allowance (EIA)

Duration: 1996 – present;

EIA is a tax system provided by the Ministries of Finance and Economic Affairs for entrepreneurs who are investing in energy saving technologies or renewable energy. This kind of investment offers a double benefit: reduced energy costs and a deduction on taxable profit. EIA technologies are included in the Energy List, which is updated on a yearly basis. These investments can include heat pumps, geothermal heat storage in the soil (aquifers), ground heat exchangers, HR pumps, photovoltaic (PV) and solar systems (solar thermal). Figure 7 illustrates the progression of the number of EIA applications for a selected number of energy-saving technologies. Investments in improving energy efficiency of existing residential buildings are also eligible.

The deduction may not exceed 44% of investment costs. The direct financial benefit depends on the tax rate; it is approximately 10% of the approved investment. The EIA can be applied in addition to the 'ordinary' investment. The government wants the EIA to encourage Dutch companies on energy conservation and use of renewable energy. The budget for 2012 is € 151 million.

Figure 7: Number of EIA applications per type of technology



Source: Noailly et Al. 2010

Environmental Action Plan (MAP)

Duration: 1991 – 2002;

The Environmental Action Plan (MAP) provided subsidies for various energy-efficient appliances for households and commercial buildings. It aimed at CO2 emission reduction which is estimated that it reached 18,500 Mton by 2000 (Eiff et al, 2001). According to Joosen etl al. (2004) the largest share of the subsidies was spent on high-efficiency boilers, insulation and energy-saving lightings.

Energy Premium Regulation (EPR)

Duration: 2002 – 2003;

The energy premium regulation for existing dwellings (EPR) was introduced to improve energy efficiency of households and to encourage the purchase of energy-efficient equipment. Consumers could only get a subsidy for appliances with an A label. Joosen et al. (2004) estimate that most of the EPR subsidies were spent on insulation and about 30% on energy-saving appliances.

Solar Subsidy

Duration: 2012 – present;

From July 2nd 2012, a scheme was opened for individuals considering investing in renewable electricity with solar panels. The allowance for the purchase of solar panels is not available for entrepreneurs. From the start of the scheme on 2nd July until Wednesday 25th July, 14,000 applications were received. For a solar PV installation with a minimum capacity of 0.601 kWp (kilowatt peak) to 3.5 kWp, the subsidy is 15% of actual purchase costs. The grant for a solar plant with a capacity greater than 3.5 kWp (kilowatt peak) was calculated as follows: the outcome of 15% of actual cost is multiplied by 3.5 and divided by the kilowatt peak. In all cases the subsidy limit is up to 650 euro. Under the actual (purchase) costs are the costs of material, for example the purchase of the panels and supporting equipment such as inverters. No subsidy is given for labour and renovation costs.

Green scheme

Duration: 2010 – present;

On March 30th 2010, the Green Scheme was introduced to offer new opportunities for highly energy efficient buildings. Through this scheme, projects with a so-called green certificate are eligible for funding at lower interest rates. This scheme is applicable for the existing and new construction buildings in both commercial and residential properties. The green project that can be qualified for financing should fall under one of the following categories related to sustainable buildings (AgentschapNL, 2012):

a) New housing construction (category H1)

Newly built homes are eligible for a green certificate if they have ‘high sustainability ambitions’ and are very energy efficient. Properties that are only permanent residences are eligible. The green certificate may vary by property from € 100,000 to € 65,000 as green funding, and it must be obtained before starting construction.

b) Conversion of office buildings to residential (category H2)

The Netherlands has many office buildings that are empty and not being used for their initial purpose. Part of these buildings can be converted into residential homes. This reduces the construction of new homes elsewhere which is by itself sustainable. Such conversion requires retrofitting in order to reach an energy index equal to the one required by building new homes or better. Only properties that are intended for permanent residence are eligible. The green certificate is € 1,000 per square meter gross floor area as green funding with a maximum of € 100,000 per apartment.

c) Sustainable housing renovation by owners(category H3)

More than a quarter of privately owned homes have an energy label F or G. These homes are a burden on the environment and on the wallet of the owner. There is so much to earn in improving such properties to energy label A or B. The renovation project is only eligible for a green certificate if the home has an energy label F, G or E, and wants to improve it to A or B.

Based on the renovation plans and documents which show that the energy consumption of the home has improved sufficiently, the bank can offer a green loan or mortgage with an interest rate below the normal rate. The maximum amount for the loan or mortgage depends on the improvement of the energy of the house before and after renovation:

- From energy label E to A: € 50,000
- From energy label F to B: € 50,000
- From energy label F or G to A: € 100,000

d) Housing renovation through a company (category H4)

In this category, the renovation could be financed for example by the energy company, and the owner of the housing can pay back periodically through the energy bill.

The maximum amount of funding depends on the improvement of the energy consumption of the house before and after the renovation:

- From energy label B to A: € 25,000
- From energy label C to A or B: € 25,000
- From energy label D to A or B: € 25,000
- From energy label E to B or C: € 25,000
- From energy label E to A: € 50,000
- From energy label F to C or D: € 25,000
- From energy label F or G to B: € 50,000
- From energy label F or G to A: € 100,000
- From energy label G to C, D or E: € 25,000

e) New commercial building construction (Class H5)

Newly built offices and commercial buildings are eligible for a green certificate if they have high sustainability goals and if they are very energy efficient. These buildings should be at least 30% more efficient than conventional requirements. The green certificate is € 600 per square meter gross floor area as green funding.

f) Commercial building renovation (category H6)

Commercial building owners often tend to demolish their buildings and replace by a new one if they are old and not attractive anymore. For environmental sustainability reasons, it is better to make a passive renovation than new construction. Renovation will raise the life expectancy of the building and many materials can be reused. The energy index of the buildings that need renovation should improve by at least 0.6. The green certificate depends on the achieved reduction of the energy index per square meter of gross floor area:

- € 300 for an improvement of the energy index of at least 0.6
- € 450 for an improvement of the energy index of at least 1.2
- € 600 for an improvement of the energy index of at least 1.8

4.3.3 Voluntary agreements

MJA (Meerjarenafspraaken)

Duration: 1992 – present;

MJA is a voluntary long-term agreement between the Dutch government and large industries such as banks, universities and other big energy consumers. The purpose behind this agreement is to improve the energy efficiency of products, services and activities within businesses.

Covenant 'More with Less' for existing buildings (Meer met Minder)

Duration: 2008 – present;

Dutch existing houses have a relatively long average life expectancy of about 60 years. However, for a large part, the existing building stock is still poor in energy efficiency. Most of the energy consumed by households is used for heating the house. Many existing buildings have great potential for energy savings and reducing the energy costs. Similarly, the GHG emissions can be reduced by improving the energy efficiency of the existing buildings.

The national government introduced the covenant *More with Less* approach (Dutch: 'Meer Met Minder') to stimulate energy savings in existing buildings. The government developed a joint initiative with key players in the housing sector mainly energy and construction companies to reduce energy consumption by 100 PJ in existing buildings by 2020. It is assumed that if incentives were given for building owners, and if more awareness efforts were made to highlight the benefits of energy savings for the wallet and the climate, 200.000 buildings can be retrofitted annually. To make this possible the website *www.meermetminder.nl* was developed to give more information about incentives such as energy saving opportunities, grants, subsidies, tax reductions and providers. Adopting energy saving measures obviously costs money. But fortunately there has been many grant and funding schemes, which makes it possible for people that can't afford to pay such costs. There are national regulations, but also provinces and municipalities regularly use their own subsidies. However, since December 29, 2011, the grant budget for the More with Less program exhausted. Moreover, the ministry of Finance introduced a reduced VAT rate for home insulation to walls, roofs, and floors from 19% to 6%. Besides subsidies and tax reductions, the government is providing off the market rate loans for homeowners who want to invest in energy efficiency. This is encouraging owners to get a loan with low interest rate for solar panels, solar collectors and heat pumps.

The energy subsidy was developed by NL Agency after introducing the covenant 'More with Less' in the Ministry of the Interior and Kingdom Relation (BZK). It is intended for:

- Municipalities and provinces;
- Professionals in construction such as consultants, contractors, and installers;
- Housing associations;
- Private landlords and homeowners.

In order to facilitate this process, and for the different parties to check their eligibility, a website was developed by NL agency along with the program More With less which can be found at: *www.energiesubsidiewijzer.nl*

Covenant energy conservation in corporation sector ('Energiebesparing Corporatiesector)

Duration: 2008 – present;

A second covenant *energy conservation in corporation sector* (Dutch: 'Energiebesparing Corporatiesector') was set in October 10th 2008 between the national government (the former Ministry of VROM / WWI), Aedes (corporation sector) and Tenants. All parties acknowledged the importance of energy conservation because of the climate change, rising energy prices for tenants, and higher property value in the market. The goal in the next 10 years is to reach at least 20% savings on energy consumption. For new construction, the agreement seeks to reduce energy consumption by 25% on 1 January 2011 and by 50% on 1 January 2015 compared to the building regulations and the Energy Performance Standard in January 2007. This covenant aims particularly at improving energy consumption for space heating, hot water and ventilation.

4.4 Effectiveness and cost-effectiveness of policy instruments

The assessment of the Dutch policy instruments that are used for the development of sustainable buildings will be based on a number of previous studies and complemented by experts' opinion. (Cor Leguijt, Martijn Blom, Jowan Kelderman and Nico Tilli).

Environmental effectiveness is the degree to which a policy realizes its determined goal and achieves positive environmental results. In this research, effectiveness is not attributed to general environmental benefits, but specifically defined as the improvement of energy efficiency and reduction of GHG emissions (UNEP 2007).

Cost-effectiveness is the degree to which a policy can meet its targets at a minimum cost to society. It is the cost-effectiveness of CO2 reduction, in terms of USD/tCO2 (UNEP, 2007). Cost-effectiveness can be evaluated from societal, individual or administrator's point of views (IEA, 2005b).

Policy instruments were given a rating scale 'High', 'Medium' and 'Low' for their effectiveness and cost-effectiveness in reducing energy consumption and GHG emissions.

4.4.1 Regulatory instruments

Regulatory instruments are the most common tools used to control the environmental performance in the buildings sector. They can be defined as "enforcement of laws and regulations prescribing objectives, standards and technologies polluters must comply with" (Jean-Philippe Barde, 1994). They are institutional regulations aiming to control the maximum level of certain pollutants, to restrict activities to certain areas, to monitor energy efficiency by setting a standard. Regulatory instruments are usually effective if supported by enforcement. Moreover, they have to be revised regularly in harmony with technological innovations and market trends. This type of instruments is much more applicable for new construction buildings than existing buildings (Eurima, 2006).

Energy Performance Norm (EPN) – Building codes

In the Netherlands, the Energy Performance Coefficient is required as a norm to comply with the standard building code. Building codes are one of the most commonly used policy instruments for improving energy efficiency in buildings (OECD, 2003). Building codes could be standards aiming for the energy performance of an entire building, or separate performance levels such as HVAC systems or building insulation standards (Birner et Al. 2002). The Energy Performance Norm used in the Netherlands addresses the overall energy efficiency of a building, instead of measures that stand alone. According to Gann et al. (1998), the overall performance-based codes give more incentives for innovation but require skilled inspectors.

Nevertheless, the effectiveness of building codes differs from one country to another depending mostly on the presence of skilled government officials or due to difficulties in enforcement. For example in the United States it is estimated that building codes have reduced energy consumption by 15-16% compared to the baseline in 2000

(Nadel, 2004). In the EU, new construction buildings use at least 60% less energy compared to the existing buildings that were built in the 1960-70 (World Energy Council, 2004). On the other hand, in the Netherlands, it is estimated that only 20% of new buildings comply with building codes due to lack of enforcement (BPIE, 2011). The supervision of building codes in the Netherlands is assigned to municipalities. However the control of the municipalities has been minimal, but there are no indications that show that the limited enforcement by municipalities has led to a low compliance (Joosen et Al. 2004). In order to remain effective, building codes have to be enforced, regularly updated and have to comply with improvement in technologies.

As we can see in the table 6, building codes have a 'High' effectiveness in reducing energy consumption and GHG emissions. Moreover, the cost-effectiveness of this policy instrument showed that it can achieve high savings at low or even negative costs. In the Netherlands, the building codes net end-users costs were negative ranging from -189$/tCO2 to -5$/tCO2 meaning that the benefits are much greater than its cost. However, the net societal costs were 46-109$/tCO2.

Table 6: Effectiveness and cost-effectiveness for building codes

Policy Instrument	*Emission reduction examples*	*Effectiveness*	*Cost-effectiveness examples*	*Cost-effectiveness*
Building Codes	NL: 0.3 – 0.5 MtCO2 in 1995-2002 (EPN) UK: 7% less energy use in housing US: 15-16% of baseline in 2000 EU: up to 60% for new buildings	High	NL: from - 189$/tCO2 to - 5$/tCO2 for end-users, 46-109$/tCO2 for society	Medium

Source: UNEP 2007, Joosen et Al. 2004, Experts opinion

Energy Label

Mandatory certification and labelling programs are considered one of the most effective and cost-effective policy instruments. They can be used for both appliances and buildings. The Energy Performance of Buildings Directive (EPBD) set by the EU requires a compulsory energy certification of new and existing buildings. In the Netherlands, since January 1st, 2008 an energy label is required for construction, sale or rental of housing. This label shows how energy efficient a home is and what could be the next target. This gives more insight into the energy performance of buildings among home owners and corporations.

Building energy certification is normally much more costly than appliance labelling since every house have to be evaluated individually (UNEP, 2007). According to Cor Leguijt, mandatory labelling programs could be very cost-effective especially for existing buildings. However, the proportion of the Dutch buildings not yet certified remain above 75% (BPIE, 2011) which can be reduced through a system of enforcement and penalties for EPC non-compliance. Table 7 shows the progress of the total number of certified energy labels. Until the first half of 2011 there are 2,061,007 energy labels issued in the Netherlands.

Table 7: Progress of the total number of certified energy labels in the Netherlands, 2008-2012

	A++	A+	A	B	C	D	E	F	G	Total
2008	92	285	13.923	57.551	174.358	173.537	106.245	69.059	29.985	**625.035**
2009	140	513	31.256	135.032	407.507	384.701	223.928	137.946	58.744	**1.379.767**
2010	185	647	43.291	174.010	491.686	460.376	270.060	162.970	68.718	**1.671.943**
2011	296	1.371	59.052	234.768	611.873	557.898	324.461	192.129	79.159	**2.061.007**
2012	378	1.951	68.064	261.987	657.089	590.306	340.926	200.204	82.877	**2.203.782**

Source: AgentschapNL 2012

In order to strengthen the Energy Performance Certificates (EPC), amendments to the EPBD were included in 2010, adding several new provisions, in particular: the independent control systems for EPC's. This requires a random sampling annually by the responsible authorities to ensure the quality of the energy performance certificates. According to the impact assessment made for the proposal for a recast of the EPBD (2002/91/CE), the following savings and impacts are estimated to be realized in 2020 through the new requirements of the EPBD recast.

Table 8: Impact assessment - independent control systems for EPC's

EPBD recast reinforcement	*Final energy savings in 2020 (Mtoe/a)*	*CO2 emission reductions in 2020 (Mt/a)*	*Job creation in 2020*
Independent control systems for EPC's	21	57	60 000

Source: Proposal for a recast of the EPBD (2002/91/CE) – Impact assessment, (BPIE, 2011)

4.4.2 Fiscal instruments

Regulatory Energy Tax (REB – called EB after 2004)

The Regulatory Energy Tax (REB), so-called ecotax, was introduced in 1996 with an objective to increase energy efficiency. Regulatory Energy Tax is levied as a charge per kWh of electricity or gas per m3. The amount of the charge depends on the energy consumption. The tax has been regularly increased over the years leading to an increase in household energy prices.

Energy tax can strengthen the effect of other policy instruments such as standards and subsidies. It can also make energy efficiency improvements more cost-effective. According to Lowe (2000), energy taxes can directly impact the entire building lifecycle from design, to construction and operation, until demolition. Cor Leguit believes that in the Netherlands, energy taxes are very cost-effective for the national government, especially when the energy prices are raised and the taxes on labour are lowered. This type of instrument is more often used in developed countries and is less common in developing countries where energy is rather subsidized than taxed (UNEP, 2007).

Moreover, energy taxes can contribute to a reduction in GHG emissions in two ways. First taxes will increase the energy prices and therefore it will reduce the demand and consumption. Secondly, energy taxes are a source of income for authorities, allowing them to reinvest tax revenues into environmentally friendly measures (UNEP, 2007). According to Bernstein and Griffin (2005), the effectiveness of the energy tax is highly dependent on the price elasticity of the demand. In other words, if there is no substitution alternatives (for instance if residents can't replace their heating system) the price elasticity of the demand will limit the effectiveness of the energy tax. In the Netherlands, long-term price elasticity for household is low with -0.25 (Jeeninga and Boots, 2001) which means that a 1% energy price increase leads to a reduction in consumption of 2.5%. In Denmark, energy taxes were relatively effective by reducing the energy use in households by 15% from 1977 to 1991 (UNEP, 2007). The low price elasticity clarifies the limited effectiveness of energy taxes in reducing GHG emissions. Governments can reduce GHG emissions if they invest the energy tax revenues in subsidy schemes, green funds, or other energy efficiency incentives.

According to Martijn Blom, the energy tax (REB) is considered one of the success stories in the Netherlands energy savings policies. It is very effective and cost-effective, covering a large part of the total environmental impact, whereas other instruments focus only on smaller parts of the energy consumption of buildings. Since EPR is the only instrument that covers the entire energy performance of the building (including appliances) and the entire life cycle, the EPR has the greatest contribution to the reduction of energy use in housing. The total impact of the EPR is estimated approximately 1.6 million tons of CO2 emission reduction in 2002 (Joosen et Al. 2004).

Table 9: Impact and effectiveness of Energy Tax

Policy Instrument	***Emission reduction examples***	***Effectiveness***	***Cost-effectiveness***	***Barriers***	***Remedies***
Energy Tax	NL: 0.9 – 3 MtCO2 in 1995 - 2002 Germany: 0.9 % reduction in 2003, 1.5 MtCO2 in total Sweden: 5% from 1991-2001, 3MtCO2	High	High	Low elasticity of demand in many countries	Higher rates of taxes and longer period

Source: UNEP 2007, Joosen et Al. 2004, Experts opinion

VAMIL and Environmental Investment Allowance (EIA) – Tax reductions

VAMIL and EIA are tax deduction schemes provided for entrepreneurs who are investing in energy saving technologies or renewable energy. These schemes encourage innovative energy-efficient products by facilitating their introduction to the market. Investments in improving energy efficiency of existing residential buildings are also eligible.

Tax deductions can be more effective than energy taxes. They are crucial for introducing energy-efficient technologies and stimulating the development of sustainable buildings (Geller and Attali 2005). Tax reductions, if structured well, can support the market development of sustainable measures (such as energy-efficient buildings and efficient technologies), resulting in significant energy savings and GHG emissions reductions (Quinlan *et al.*, 2001). Moreover, the effectiveness of tax reductions is dependent on the following conditions: they should be implemented for superior technologies where the initial cost is a barrier, be high enough and not phase out too soon (Quinlan *et al.*, 2001). The qualifications for receiving the tax deduction should also be flexible for this instrument to be effective, but at the same time be cautious to free-riders (UNEP, 2007). Blom believes that EIA and VAMIL were more effective for commercial buildings than residential; however, they did help energy-efficient technologies to develop in the market.

Table 10: Effectiveness and cost-effectiveness of tax reductions

Policy Instrument	*Emission reduction examples*	*Effectiveness*	*Cost-effectiveness examples*	*Cost-effectiveness*
Tax reductions	NL: 0.1-0.7 MtCO2 in 1997-2002 US: 88 MtCO2 in 2006 France: 1Mt CO2 in 2002	Medium	US: B/C ratio commercial buildings: 5.4, New homes: 1.6	High

Source: UNEP 2007, Joosen et Al. 2004, Experts opinion

Capital subsidies, grants, funds

- Environmental Action Plan (MAP)
- Energy Premium Regulation (EPR)
- Solar Subsidy
- Green Scheme

This type of policy instruments are frequently used as an incentive for improving the energy performance in buildings. Subsidies are mostly beneficial for the residential sector by helping to overcome the barrier of high initial investment costs. Jowan Kelderman believes that financing green initiatives is one of the most effective policy tools.

In the Netherlands, the government introduced the Environmental Action Plan (MAP) providing subsidies for various energy-efficient appliances for households and commercial buildings. It aimed at CO_2 emission reduction which is estimated that it reached 18,500 Mton by 2000 (Eiff et al, 2001). In addition to financial support was awareness of consumers through mass media campaigns on energy conservation. In total in the 1995-2000 period about 108 million was granted to the housing sector (about 34% for appliances and boilers and 66% for insulation measures). MAP subsidies have led to an acceleration in the implementation of insulation measures and a market transformation of a number of installations and devices (Boilers, energy efficient refrigerators), so that a large number of energy-efficient products have become the standard in the market. The total reduction by the end of 2002, as a result of MAP subsidies is estimated at 0.4 million tonnes of CO_2 emissions (Joosen et al 2004).

Another subsidy scheme, the energy premium regulation for existing dwellings (EPR), was also introduced to improve the energy efficiency of households and to encourage the purchase of energy-efficient equipment. In total, over the period 2000-2002, around € 400 million were paid in the EPR scheme for the housing sector, of which roughly 70% for insulation and 30% for other measures, mainly for energy efficient appliances.

The effects of the EPR on CO_2 emissions reduction is small compared to other instruments because the scheme was only introduced for a limited period of time, and a large number in the list of products eligible for EPR were rapidly becoming the standard in the market. The overall reduction of CO_2 emissions in the end of 2002 as a result of the EPR is estimated to be approximately 0.2 million tonnes of CO_2 (Joosen et al 2004).

Recently in July 2012 a scheme was opened for individuals considering investing in renewable electricity with solar panels for their households. Subsidies are usually effective but, they are less cost-effective from a societal point of view (UNEP, 2007). According to Martijn Blom, this type of policy instruments facilitate the introduction of new technologies to the market and enable low income tenants to invest in energy efficiency measures. This is why subsidies and grants can be very effective in developing countries where high investment costs form a major barrier for energy efficiency improvements (UNEP, 2007). One of the major limitations to the effectiveness of subsidies is the risk of free-riders. For example in the Netherlands, subsidies for double glazing windows did not help much in the implementation of this measure, but rather gave “windfall gains” to the suppliers as half of the applicants were free-riders (Kemp , 1995).

Shaping subsidies for a specific target group and giving them for a limited period of time will maximize the effectiveness of this policy instrument. In the Netherlands, reimbursements for energy-efficient dryers did not lead to energy savings because of limited availability of such technology in the market. For other appliances such as fridges, the cost-effectiveness of the subsidy scheme was estimated at 300 €/tCO_2 and for dishwashers at 165 €/tCO_2 (UNEP, 2007). The explanation behind this is the increase in household energy consumption which limits the impact of subsidy programs. Joosen et al (2004) estimated a relatively high societal costs for subsidies at 41-105 $/t$CO_2$. Furthermore, Martijn Blom believes that the subsidies introduced for solar PV’s are not cost-effective given the commodity prices, and because it might do more harm for the sector than it could benefit.

Table 11: Effectiveness and cost-effectiveness of subsidies

Policy Instrument	*Emission reduction examples*	*Effectiveness*	*Cost-effectiveness examples*	*Cost-effectiveness*
Subsidies	NL: 0.7-0.9 MtCO2 in 1995-2000 (MAP) NL: 0.2 MtCO2 in 2000-2002 (EPR) UK: 6.48MtCO2/ yr, 100.8 MtCO2 in total	High/Medium	NL: 41-105 USD/t CO2 saved for society Denmark: – 20$/ tCO2 UK:29$/tCO2 for society	Low

Source: UNEP 2007, Joosen et Al. 2004, Experts opinion

4.4.3 Capacity support, information and voluntary action

Meerjarenafspraaken (MJA) – Voluntary agreement

MJA is a voluntary long-term agreement between the Dutch government and large industries such as banks, universities and other big energy consumers. The purpose behind this agreement is to improve the energy efficiency of products, services and activities within businesses.

According to Price (2005), the effectiveness of voluntary agreements in the buildings sector is very often controversial, where companies set these agreements to avoid regulatory policies. Voluntary agreements in the buildings sector are often used for appliances and can be effective when regulatory measures are difficult to impose (IPCC, 2007). Martijn Blom believes that in the Netherlands, voluntary agreements are often signed just on paper while the targets are not met, ending up with unfulfilled agreements.

The combination of voluntary programs with other policy instruments such as regulatory and public leadership programs increases the effectiveness (Geller et al. 2006). Voluntary agreements are more effective if the producers responsible for the equipment are included, if the energy savings targets are established from the beginning, and efficient monitoring programs are set up (IPCC, 2007). Moreover, a good relationship between the government and organizations enhances the effectiveness as well (Evander et al. 2004). The outcomes of the voluntary agreements in the UK related to climate change went beyond expectations, reaching an amount of 16.4 MtCO2 in 2002. Another success story is the Greenlight program of the EU where the aim is to implement energy-efficient lighting technologies in 300 buildings, resulting in 100 GWh per year (UNEP, 2007).

Table 12: Effectiveness and cost-effectiveness of MJA voluntary agreement

Policy Instrument	*Emission reduction examples*	*Effectiveness*	*Cost-effectiveness*
MJA	NL: 0.1 MtCO2 in 1995-2002	Low	Low

Source: UNEP 2007, Joosen et Al. 2004, Experts opinion

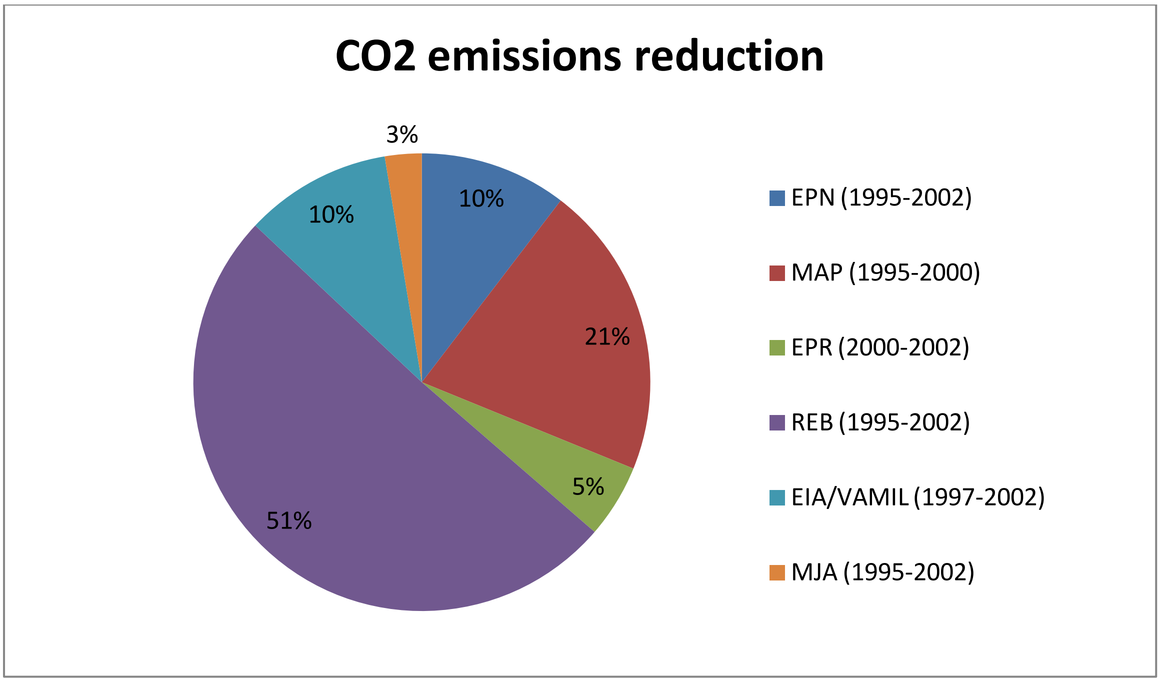
4.4.4 Comparison of policy instruments

This section compares the different policy instruments used in the Netherlands for the development of energy-efficient buildings. The aim of this comparison is to emphasize on the most significant policy instruments, and then reflect on successful combinations of policy tools that would enhance the effectiveness and cost-effectiveness of these instruments.

A study made by Joosen et. Al (2004) reveals that there are two categories of policy instruments used for the built environment: direct and indirect. Direct instruments are defined as instruments that are aimed at achieving a substantial amount of energy savings and CO2 emissions reduction such as building codes (EPN), energy tax (REB), and subsidies (MAP, EPR). Whereas indirect policies are defined as instruments used to support the implementation and execution of direct policies, for example: covenants and agreements, EU directives.

The average reduction of CO2 emissions stimulated by the policy instruments in the Netherlands is estimated to be 0.3 million tonnes per year over the period 1995-2002. This means that without these policies, the direct and indirect CO2 emissions from housing in 2002 would have been 7% higher (Joosen et. Al 2004). As we can see in figure 8, within the overall environmental policy instruments used, the regulatory energy tax (REB) is the most effective having the greatest impact of energy savings and CO2 emission reductions (Joosen et. Al 2004).

Figure 8: Comparison of CO2 emissions reduction impacts of policy instruments used to enhance sustainable buildings development in the Netherlands during the period 1995-2002



Source: Joosen et Al. 2004

The total effect of the energy tax (REB) instrument compared to other instruments is relatively high. While other instruments focus only on smaller parts of the energy consumption of buildings, the energy tax focuses on total electricity/gas consumption in existing and new buildings, covering a large part of the total environmental impact.

Although price elasticity in the Netherlands is low, the energy tax was still effective. This is because of the full policy package that was used, particularly fiscal measures such as EIA where certain investments were financed. According to Blom, the combination of the energy tax with other policy instruments in particular tax reductions and subsidies on energy-efficient technologies, and the energy performance norm was very effective. Furthermore, he believes that this combination of environmental policies shaped the market for energy saving techniques, and enhanced the effectiveness and cost-effectiveness of these policy instruments.

4.5 Passive renovation project – De Kroeven in Roosendaal

4.5.1 Background

De Kroeven is considered the first significant passive renovation project in The Netherlands. The area of De Kroeven is located in Roosendaal in the Southern Netherlands, and consists of identical single family houses that were built in the 1960. The owner of this residential development is a social housing provider AlleWonen.

Picture 1: De Kroeven in Roosendaal, Netherlands

Source: IEA ECBCS Annex 50, Trecodome report, 2011

Over the past years, the houses were only exposed to regular maintenance and minor improvements, until the owner came to a decision to upgrade the houses. AlleWonen generated knowledge in energy-efficient renovation after being part of the European Treco network for social housing providers. He noticed that there are good possibilities to go even far beyond what is currently the norm in the Netherlands. The residents were also supportive and expressed great interest in such passive renovation.

De Kroeven urban district consists of 370 single family houses, of which 246 will be upgraded and 124 dwellings will be newly constructed. The reason behind the new construction is to have more diverse typology; all the houses were identical single family houses with same technical qualities. Introducing low rise houses as well as apartments is intended to bring diversity to the population and break the monotony of the houses, making the neighbourhood more attractive.

Early in 2011, 70 houses were retrofitted and completed as part of the project. The occupants were not required to move from their houses during the renovation process which facilitated the implementation of the project. The key technologies that were used for this passive renovation are: Prefabricated timber facades and roofs, solar thermal collectors, condensing gas boilers, heat recovery ventilation, and triple glazed windows.

Picture 2: Buildings before passive renovation, De Kroeven in Roosendaal, Netherlands

Source: Chiel Boonstra, Trecodome

Picture 3: Buildings after passive renovation, De Kroeven in Roosendaal, Netherlands

Source: Chiel Boonstra, Trecodome

4.5.2 Renovation costs and benefits

According to Chiel Boonstra, energy consultant for this project, the passive renovation costs are more expansive than the conventional renovation by an estimated amount of € 25,000 per house. Prefabricated facades and roofs were adopted because they proved to be cheaper than the on-site insulation approach. Also the prefabricated elements were faster to install, which means less intrusive for occupants. From the tenants point of view, they benefited by a reduced energy bill which will become more significant in the future given the rise in energy prices.

Picture 4: Renovation process, De Kroeven, Roosendaal

Renovation in progress *New compact system*

Source: IEA ECBCS Annex 50, Trecodome report, 2011

The social housing provider and the tenants agreed on a formula to increase the rent by € 65 per month, which is the amount of reduced energy bill at the current energy prices. This way, the tenant will benefit from a better indoor air quality and an affordable cost of living even when energy prices increase in the future. And the owner will add value to his buildings with a longer life-expectancy and a higher property value.

Picture 5: Prefabricated elements on-site, De Kroeven, Roosendaal

Source: IEA ECBCS Annex 50, Trecodome report, 2011

4.5.3 Energy consumption

The energy consumption of the buildings is expected to reduce significantly. The heating energy demand decreased by 25-30 kWh/(m²·y), which is 80% less than the previous situation. Moreover, hot water demand decreased by around 55%, thus resulting in a total of 70% reduction in the house related energy demand. As a result the energy bill for these houses significantly reduced by approximately 70% at the current energy prices. This will make the houses much more attractive for tenants, especially in the future, given that they won't be affected by the increase in energy prices.

4.5.4 Success factors

The vision of the social housing provider AlleWonen was the main factor of success. They kept on this vision even when faced with problems to convince some of the tenants who weren't supportive for the idea. In order to move on with this project the owner was required to get 70% acceptance from the tenants, and they only had 65%. So they had to make extra efforts and personal talks with some of the residents to convince them about the project.

Another important aspect is the fact that that the majority of the occupants expressed interest in the passive renovation project, and were supportive to the idea. The renovation process was arranged in a way that the tenants stay in their houses. The process was fast at a rate of one building per day. But still, the tenants had to stay for one night without a roof or windows.

The policy that has been agreed upon between the owner and the tenants, which says that the rent increase will be the same as the reduction in energy cost, was also a major factor of success. The rent increase compensates partly for the investment costs and the improvements that are being made. And the reduced energy bill convinced the tenants to accept the rent increase given that they will still pay the same with a much better building. And if the energy prices are increasing, which they did by 6% above inflation in the last 15 years, they would still have a reliable energy cost in the future. So the total cost for the tenant is now predictable and stable while in the past it was unstable and keeps increasing with the energy prices.

4.5.5 Economic recovery

It is expected that after sustainable renovation to such good levels, the buildings will have a longer life-expectancy and a much higher property value. In the 10-20 years time, someone with a limited budget will prefer to live in a house with a very low heating cost compared to the same floor area with high heating cost. This will have an impact on the property value. This was revealed in a study made about the economic value of sustainable buildings in California Los Angeles, by Nils Kok, researcher at university of Maastricht, together with Matthew Kahn, professor at the University of California. The study examined single-family houses sold between 2007 and 2012. They concluded that a high performance single-family house adds an average of 9% price premium. The average home price in California is $400.000 for a conventional house, and $434.800 for an energy-efficient house with a green label.

Picture 6: Renovated building, De Kroeven, Roosendaal.

Source: IEA ECBCS Annex 50, Trecodome report, 2011

There are not many examples that were renovated to this quality level. According to the European guideline EPBD of 2008, all buildings in the Netherlands need to have an energy label from G rated the worst label to A++ the best. The houses in this project in Roosendaal are much better than what is currently the scope for the general policies applicable for existing buildings. In other words, the current energy labeling system is not able to cope with the technical qualities of the passive house components.

The buildings sector has so much potential for regional and local employment creation. For this project eight different parties were involved:

Table 13: All parties involved in the passive renovation project in De Kroeven, Roosendaal, NL

VDM WONINGEN	Manufacturer and producer of prefabricated timber elements, based in Drogeham and Almere, North of Netherlands
BRINK Climate Systems	HVAC manufacturing company, based in the middle of Netherlands
VAN IEPEREN GROEP	Contractor based in IJsselstein, Netherlands
aramis allee wonen	Buildings owner, social housing provider based in Breda and Roosendaal, Netherlands
Trecodome	Energy consultant, based in Roosendaal Netherlands
dat de architectenwerkgroep tilburg	Architects, based in Tilburg, Netherlands
KEMPAIR KLIMAATBEHEERSING	installers for “brink” products, based in Eindhoven, Netherlands
Passief Bouwen.nl	Foundation for passive buildings, based in Berkel and Rodernrijs, Netherlands

Source: D. Harake, 2012

The economic crisis has caused a lot of trouble to the construction sector, limiting the number and size of projects. This has caused many companies to go bankrupt and people got fired from their jobs. The industry should focus more than ever on passive renovation projects for the exiting building stocks, especially that the energy burden will rise in the near future. Chiel Boonstra believes that the government should put more emphasis on such projects than energy taxes for example. Although energy taxes generate income for the government, but it doesn’t create employment which will eventually get more income to the government and other social benefits. In addition, what is interesting is that this type of companies and contractors are distributed almost evenly in every region and village.

4.5.6 Barriers

The main issue with existing buildings is that it is difficult to put a compulsory law for renovation and energy-efficiency improvements (Chiel Boonstra). This is because at the time the building was built it was legal and it followed the required standards. So it is difficult for the government to impose any measure for existing buildings. While for new construction, compulsory measures can be set by the government without any limitation. However, there is a trend moving towards another direction, towards an agreement between the government and the social housing corporations. Since these corporations own around 40% of the existing housing stock and they manage large portfolios, it is possible to make a sort of frameworks with the government. It has been agreed between the two parties that in 2020 the majority of the existing buildings will be B rated.

Many of the decisions that are being made for existing buildings are short-sighted where corporations are still looking for the easy measures and not aiming for high levels of improvements and efficiency. In other words, many house owners think that it is enough to get a C or B rated building, whereas in reality the energy saving for a B rated building is 20-30% compared to a D rated building. What is needed is an 80% energy saving in order to get affordable heating cost in the near future. That's where a greater awareness in particular among professionals and owners that much better levels are needed and it is possible to get them. Awareness is also needed to change the scale of the rating for the building. The target to have a B rated buildings is sometime too easy. It is much better and less costly to do a renovation at once, aiming at the best scale than to do it on a gradual basis.

Another barrier is that there is a high initial investment cost if the aim is for high targets. This is because the products are much more expensive than what is normally being spent for less ambitious measures. The technology that has been used in Roosendaal passive renovation project can become cheaper once it is widely used and the industry for these products can develop. The construction industry is responding to the most common standards. So in a way the standards set by the government are by themselves acting as a barrier for industries to improve their products and make it affordable for the wide public. For example if we consider that the main insulation standard is to have a U-value of 0.3 and the ambitious target is 0.1 then it becomes much more expensive, even if it is about adding a little bit of thickness and a bit of insulation material. The fact that the exceptional product specifications are different than the normal ones makes the product more costly to get. The 'super-product' must become the standard product, which stimulates competition in the market and then the technology will become cheaper and affordable.

Table 14: Comparision between U values in best current energy labelling system and the values in De Kroeven, Roosendaal

Best U value in current energy labeling system	0.24 W/m2K
U values in De Kroeven after passive renovation	**0.10 – 0.15 W/m2K**
Best U window frames in current energy labeling system	1.5 W/m2K
U window frames in De Kroeven after passive renovation	**0.8 W/m2K**

Source: Trecodome

4.6 New construction project – Eva-Lanxmeer in Culemborg

4.6.1 Background

EVA-Lanxmeer is a sustainable urban district that was initiated in the mid-1990's in Culemborg, Netherlands. It is considered one of the most remarkable models in the Dutch construction sector, and it is the first green district in the Netherlands to be designed and built completely in line with ecological principles based on Permaculture approach. The area is about 24 Ha and consists of 250 houses grouped in courtyards, several commercial properties, and an organic city farm. Buildings have been built to save energy, and in harmony with surrounding landscape by using natural and sustainable construction materials.

The project was inspired by several events that took place in the late 1980's and early 1990's. The Brundtland report that was published in 1987 to promote sustainable development was the first inspiration. Later on the first Dutch National Environmental Policy Plan: 'To Choose or to Lose' was introduced in 1989 with the aim to achieve sustainable development in the Netherlands. Afterwards in 1992, the Ministry of Housing Spatial Planning and the Environment (VROM) introduced the VINEX (Vierde Nota Ruimtelijke Ordening Extra), a plan to build 800,000 new sustainable houses in 20 years throughout the Netherlands.

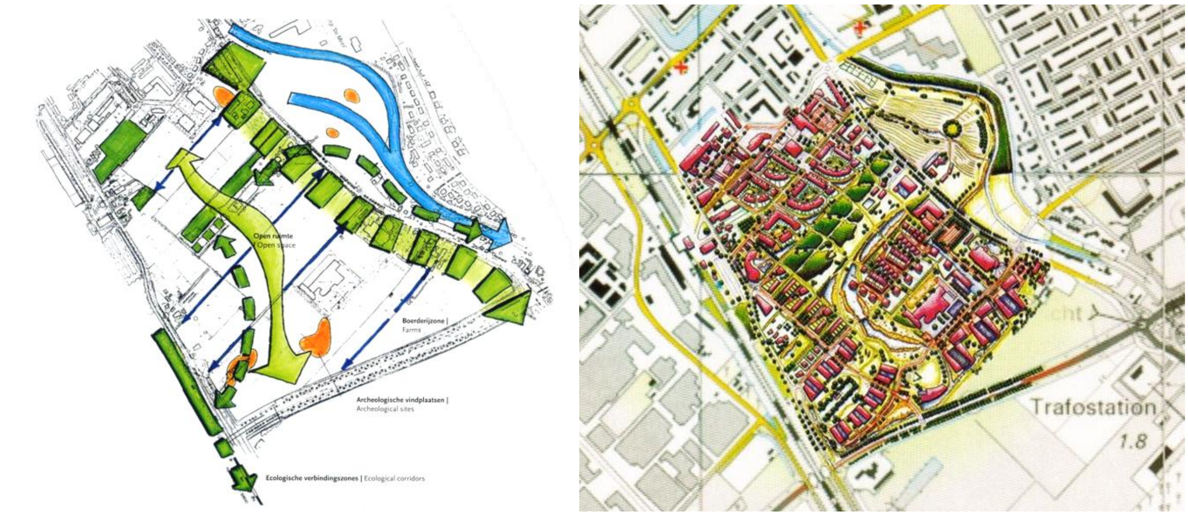
Picture 7: Aerial view of Eva-Lanxmeer, Culemborg, Netherlands

Source: Marleen Kaptein, project initiator

Marlein Kaptein, the initiator of Eva-Lanxmeer project, had a wish to contribute to a more ecological and environmentally friendly society by realizing a sustainable pilot-project. The vision was to involve future inhabitants from the start, even before the design and planning processes. The concept was developed by EVA foundation, a group of ten specialists from all the professions required. The EVA concept ‘People, Planet, Profit, Process’ was based on an integral approach that combined ecological architecture, organic landscapes, sustainable energy systems, water resource management, citizen participation, integration of functions, education, and permaculture design principles. Initially there was no specific location for that project; it was more of a conceptual idea that tried to capture the interest of the general public. The idea was developed further more and a professional proposal was prepared before the search for a site.

The city of Culemborg was very pleased with the concept because they already had some experience with sustainable development and they were enthusiastic about the concept. They also had a suitable location close to the rail station, which was excellent for visitors since the project had an educational purpose as well. There is also a water protection area for the production of drinking water and a water company next to the site. So it was suitable to run such an environmentally friendly project that will not damage the water protection area.

Figure 9: Plan and Design of Eva-Lanxmeer, Culemborg, Netherlands



Source: Marleen Kaptein, project initiator

In 1995 was the first contact with the municipality of Culemborg. One year later, a joint commission was formed between Eva foundation and the municipality of Culemborg. The site was owned by a farmer until then the municipality bought the land for this project. That was a blessing because if a project developer would have bought it, it would have been much more difficult to reach those ambitions. The city of Culemborg had run out from the permissible number of buildings which is normally issued by the province as a way to control the growth of a city. The province of Gelderland, responsable for assiging building permits to the city of Culemborg, accepted to commission 200 extra houses under the conditions that it would be a sustainable neighborhood. 80 families expressed interest in living in this neighborhoord and participated in the planning and design phase in several workshops. In 1999, the first construction phase started after the municipality decided to commision the first 100 houses. Every person who wanted to own or build a house had to follow the requirements set by the Eva-foudation. Currently, the neighborhood is 80% developed. The economic crisis slowed the construction process where choices have been made to focus on few places and develop the rest at a later stage in about 5 years.

The first two phases of building construction were commissioned by the Municipality, excluding project developers. According to Marleen Kaptein, they knew that they did not have any risk. Until the final design phase, the municipality selected a constructor who did not have the role of a developer. Later on, for phase 3 and 4, several projects were initiated in private and collective commissionership with different architects and builders. Projects must be in line with standards set by municipality and the EVA concept. The municipality sells individual building sites and provides building permits. An advisory body of project-group supports individual projects in the design phase in order to meet the requirements. There is a variety in types of dwellings, even for the first building phase, based on the preferences of future inhabitants. So there was an opportunity for several private initiatives. In 1998, the housing corporation KleurrijkWonen joined and it currently owns 30% of houses.

Figure 10: Master Plan, Eva-Lanxmeer, Culemborg, Netherlands

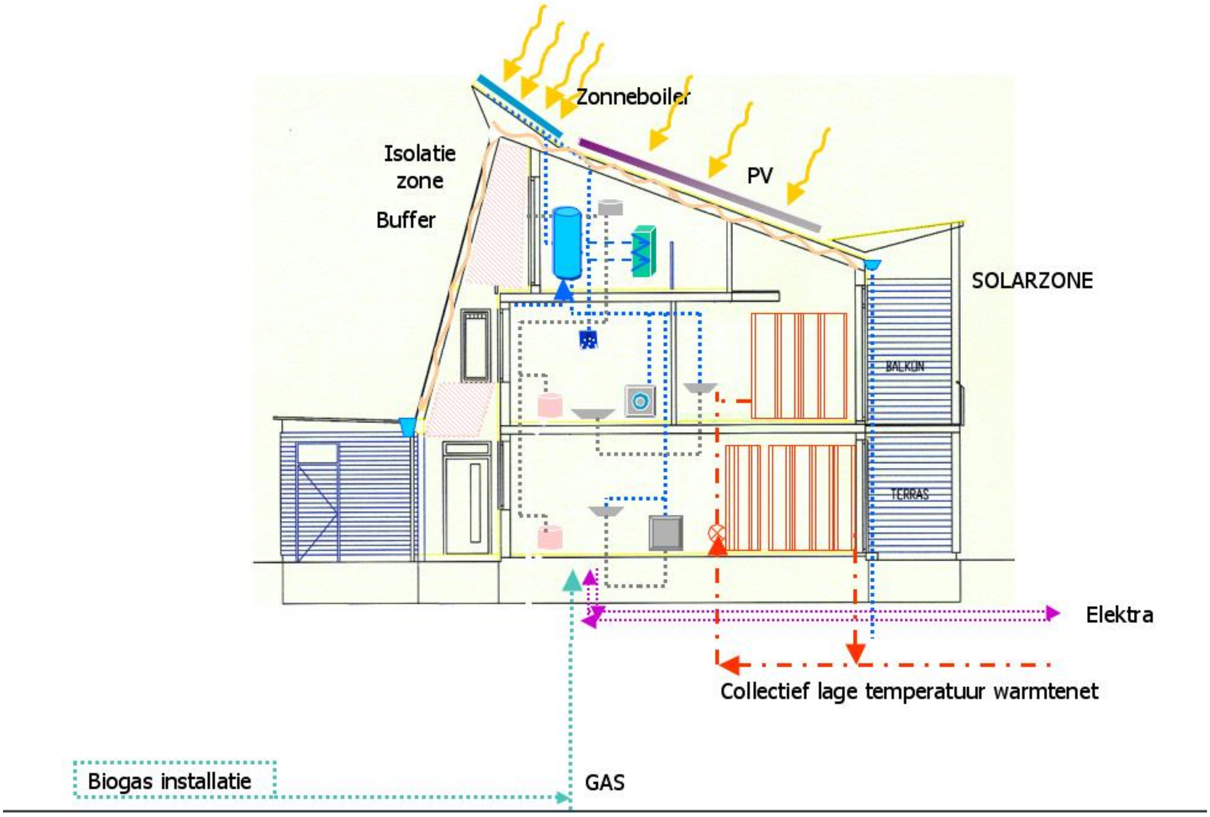
Source: Municipality of Culemborg

4.6.2 Energy concept

According to Jan Hanhart, local resident and energy expert involved in Eva-Lanxmeer, the sustainable energy concept 'Trias Energetica' was adopted for the district based on three measures:

- The use of passive solar energy;
- Good insulation of the houses, re-use of warmth;
- Use of renewable resources as much as possible before using fossil energy sources.

Figure 11: Building Energy system in Eva-Lanxmeer, Culemborg, Netherlands



Source: Marleen Kaptein, project initiator

In 1996, the normal EPC standard in the Netherlands was 1.2, whereas Eva-Lanxmeer project aimed for an EPC of 0.6. The annual energy use per house is about 40GJ which is approximately 1250m3 gas and 2500 kWh electricity. In order to reduce energy related demand, insulation for building envelopes were high at minimum of 21cm with an R value of 5. Moreover, solar panels were used for the generation of electricity and hot water. During the first phase of construction, individual HR-heaters were installed for every building. In the second building phase (2002), the energy experts and the water company that was already in the area established a way to have a collective heating system based on the warmth of the ground water. According to Marleen Kaptein, initiator of the project, all parties were involved in the collective low temperature heating system. These were the municipality of Culemborg, the water company Gelderland (now Vitens), and the inhabitants organisation 'BEL'. The water company was originally invited to be involved and participate in the energy system for the neighbourhood. In 2006, Vitens decided to stop exploitation of the local heating system of Eva-Lanxmeer. They consulted the municipality and the inhabitant's organization 'BEL'. Local inhabitants took the initiative and established a local energy company ThermoBello which is owned by the inhabitants themselves since 2009.

Figure 12: Sustainable buildings in Eva-Lanxmeer, Culemborg, Netherlands

Source: Marleen Kaptein, project initiator

4.6.3 Success factors

After 10 years, it has been acknowledged that the targets set for the project of Eva-Lanxmeer have been successfully realised due to several factors.

Firstly, the involvement of all stakeholders in the development of this project was crucial for its success. There was also a level of clarity about the responsibility of each stakeholder. In total seven different stakeholders could be indentified: the initiator of the project Marleen Kaptein, the Eva foundation which was formed by a group of specialists from all the professions required, the municipality of Culemborg, the local inhabitants association 'BEL', the private water company, social housing corporation, and constructors.

Secondly, from the very beginning, future inhabitants who were interested to live in such a neighbourhood took part in the design and planning phase by proposing ideas for their own sustainable district. They also took responsibility which enriched their quality of life and got them more attached to the project.

Picture 8: Future inhabitants' involvement in Eva-Lanxmeer, Culemborg, Netherlands

Source: Marleen Kaptein, project initiator

Thirdly, the concept was ambitious and realisable especially that the land was owned by the municipality. If the land was owned by a project developer, he wouldn't have gone so far with the ambitions.

Fourthly, the selection of experts and their willingness to co-operate was crucial to make this project happen. They voluntarily invested in time and sometime money to develop the concept of Eva-Lanxmeer, without receiving any financial compensation.

Fifthly, the support and commitment that the municipality of Culemborg gave to the project was significant. The municipality invested in the neighbourhood by financing the infrastructure and commissioning the houses.

Sixthly, it is important to note that the funding obtained from public organisations helped making the project possible. Subsidies and funds were granted mainly from the Dutch Ministry for Housing, Spatial Planning and the Environment, the German Ministry for Education, Science, Technology and Research, and the Stimulation Fund for Architecture.

Lastly, the initiative of the private water company Gelderland in investing in district heating infrastructure contributed for a large part in making Eva-Lanxmeer a sustainable neighbourhood.

4.6.4 Economic recovery

From the beginning, the project's goal was not to earn money; it was more of an educational initiative. However, the project did have an economical impact at a local level. According to Marleen Kaptein, originally the municipality of Culemborg bought the land which was used for agricultural purposes for a very low price, 10-12 guilders per m2 which is around 4-5 euro. Today, the square meter is sold for 500 euro. Although the municipality had to invest in infrastructure and development processes, the value of the land raised significantly. Also the property values in Eva-Lanxmeer are still high even with the construction market going down. Currently there is a waiting list for future inhabitants, which proves that there is a big demand.

Moreover, a few years ago, there were some complaints that there was not much tourism in the city of Culemborg. During the interview with Saskia Moolhuijzen, project manager on behalf of the municipality of Culemborg, it was revealed that Eva-Lanxmeer project became very famous and attracts a lot of visitors once or twice a week. However, according to Marleen Kaptein, there is no hotel in Culemborg where visitors could eat or stay. From the beginning there was a plan and even a fixed location to have the Eva-Centre which is a hotel, a restaurant, and conference rooms. The municipality withdrew the idea of the Eva-Centre because of lack of funding at that time. Kaptein believes that the city could have profited much more if they invested in the Eva-Centre. Saskia Moolhuijzen claim that the city of Culemborg is small so commercial activities shouldn't be dispersed. There will be a big commercial development project in the next 10 years next to Culemborg train station, which is in close proximity to Eva-Lanxmeer.

Picture 9: Design of Eva-Centre in Eva-Lanxmeer, Culemborg, Netherlands

Source: Marleen Kaptein, project initiator

4.6.5 Barriers

The development of the neighbourhood has been a long process from the conceptual phase in 1993 until today where more construction is taking place in some parts of the district. During that period, the political context changed where the mayor, the alderman, and members of the municipality got replaced for different reasons. This has caused a lack of continuity in the support for Eva-Lanxmeer, whereas at the beginning the project was given high priority from the municipality. Some modifications had to take place after the change of members, for the district as a whole and especially for the Eva-Centre where the municipality was not willing to invest in such a costly centre, although it was already planned and approved from the previous urban planning department.

Another barrier was that the neighbourhood is surrounded by a protected drinking water extraction area. Usually, it is not allowed to build near those areas, but the environmentally friendly approach of Eva-Lanxmeer made it possible. However, special measures had to be taken during the construction phase. In order to prevent any disturbance to the ground water, buildings were built on a wide foam concrete foundation instead of piles. Also impermeable floor surfaces were used to avoid rainwater infiltration to ground water.

Moreover, the fact that no cars were allowed in the neighbourhood created few problems for commercial activities. The plan of the district is to make a combination of work and living in the same location. However, this is negatively affecting the business of those people because visitors are not encouraged to come if they can’t park their car in front of the house. A rule was initiated by the municipality that only visitors can park inside the district, but it created some conflicts with inhabitants that came to live in Eva-Lanxmeer because of the fact that there are no cars allowed in the neighbourhood. The municipality had to amend the rule and today no cars are allowed even for visitors.

Chapter 5: Conclusions

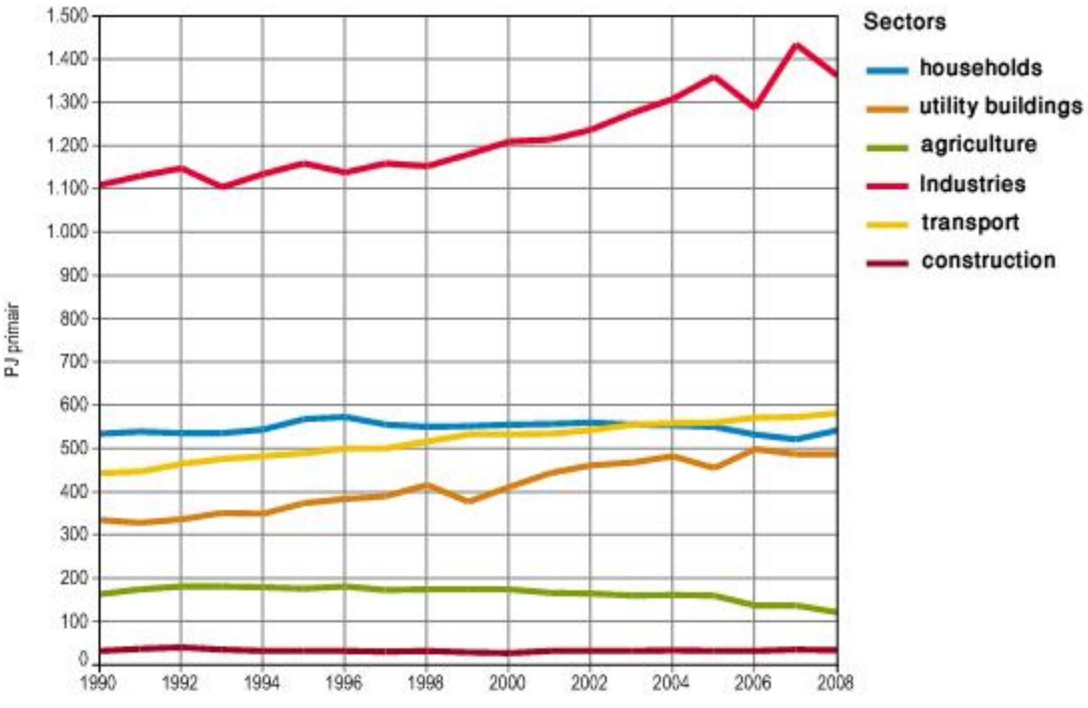
5.1 Introduction

This section begins with a concise restatement of the research purpose. It then draws conclusions entailing answers to the research questions and reflecting to the literature in chapter 2. Afterwards, recommendations for possible solutions to the problem will be presented. At last, a description of the way this study has added to the existing body of knowledge will be presented, as well as new challenges/questions to further develop the research area under study.

5.2 Research purpose

As part of the concerns for climate change taken by EU, the European Council and Parliament adopted the new Energy Performance of Buildings Directive in November 18th, 2009. The recast is intended to extend the 2002 Directive and double the efforts to limit climate change, and enhance a green economy by creating more jobs and improving energy security (DIRECTIVE 2010/31/EU). In the Netherlands, energy consumption for households is significant and comes in third place compared to other sectors in terms of energy use and CO2 emissions, as shown in figure 13.

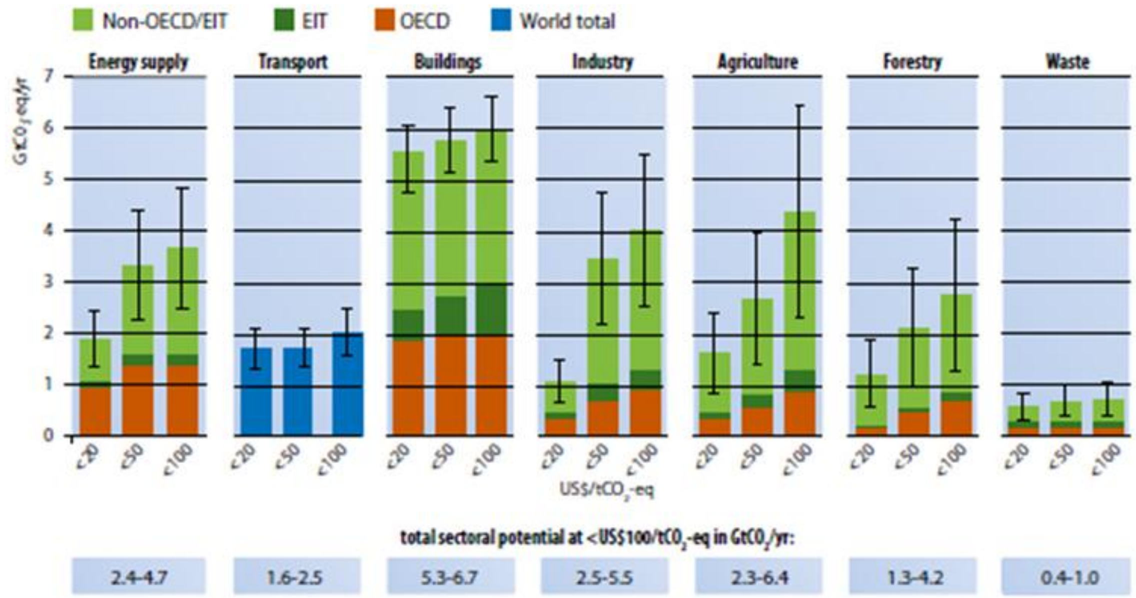
Figure 13: Energy consumption (PJ) per sector in the Netherlands during the period 1990-2008



Source: ECN, www.monitweb.energie.nl

At the same time, it is interesting to note that the buildings sector, compared to other sectors, has the biggest economic mitigation potential according to a study made by the IPCC in 2007 (as shown in figure 14). Meaning that the buildings sector could achieve CO2 emission reductions and energy savings far more than any other sector considering the same costs. Adopting simple measures such as improved insulation and efficient-energy use can be very effective in energy savings and reducing CO2 emissions.

Figure 14: IPCC projections of CO2 mitigation potential in 2030. The building sector has the biggest economic mitigation potential at 5.3-6.7 GtCO2/year at cost < 100 $ by 2030 at global level.



Source: IPCC 2007

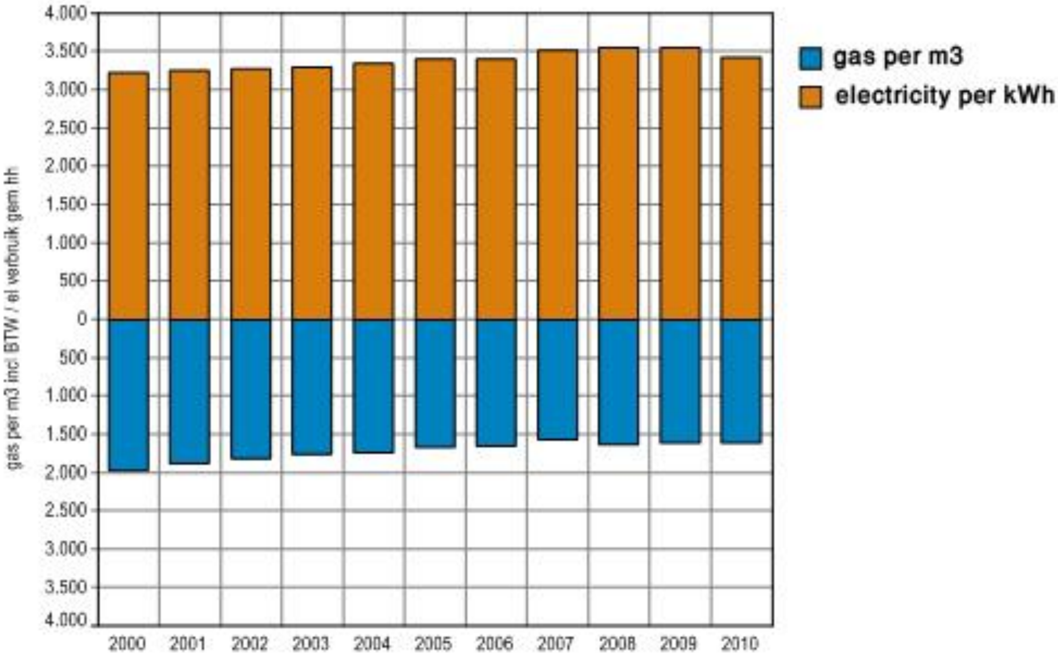
In the Netherlands, the building sector accounts for around one third of carbon emissions, particularly 33% (Joosen et al., 2004). The Dutch government is aiming to reduce the energy consumption from existing building stock by 50% compared to 1990 levels, and only energy-neutral buildings will be constructed starting 2020 (VROM 2007). Accordingly, the buildings sector is able to play an important role in achieving long-term sustainability of the nation's energy economy, as well as it can reduce carbon emissions by around 90% by the year 2050, making it possible to reach the target of limiting global warming to 2°C as required by the Copenhagen Agreement set in December 2009. This can only be achieved through policy instruments that are used as enabling conditions and incentives to enhance the development of sustainable buildings.

The objective of this research is twofold. First, the study aims to explore the different environmental policy instruments that are set by the national government in the Netherlands to stimulate the development of sustainable buildings. It then assesses the effectiveness and cost-effectiveness of these policy instruments in terms of energy savings and carbon emission reductions. The second purpose of this study is to reflect on two case studies with above standards targets for existing buildings renovation as well as new construction buildings. The success factors, barriers, and economic recovery are revealed from these two successful models of sustainable buildings projects.

5.3 Interpretations and recommendations

Despite the Dutch government's efforts and the policy instruments introduced to encourage the development of energy-efficient buildings, fossil energy consumption in residential buildings has continued to increase over the last decade. As we can see in figure 15 and table 15, gas consumption used for space heating decreased mainly due to insulation improvements and energy-efficient boilers. The average gas consumption has slightly diminished from 1,965 per m3 in 2000 to 1,608 per m3 in 2008, resulting in around 18% reduction. According to Cor Leguit, this reduction is not substantial because of the net growth in the housing stock. However, over the same period, electricity consumption rose by almost 6% over the last decade, from an average of 3230 kWh in 2000 to 3430 kWh in 2008. This means that the current policies are inadequate and not effective enough in reaching the ambitious targets set for 2020 and 2050.

Figure 15: Average gas/electricity consumption in Dutch residential buildings, 2000-2008.



Source: AgentschapNL 2012

Table 15: Average gas/electricity consumption in Dutch residential buildings, 2000-2008.

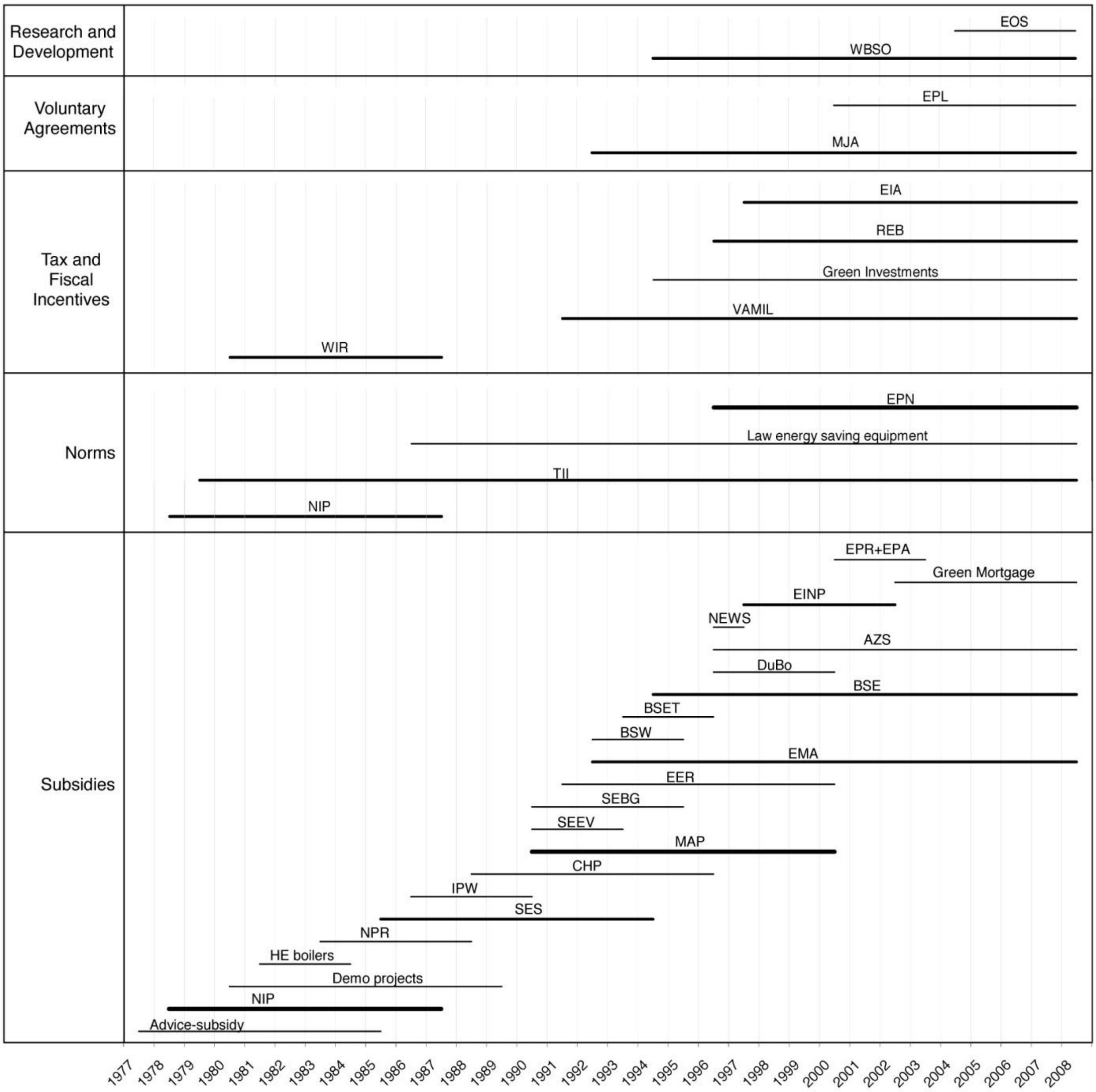
	gas per m3 incl BTW [m3]	electricity consumption per KWh
2000	1,965	3,230
2001	1,875	3,255
2002	1,812	3,275
2003	1,759	3,296
2004	1,736	3,346
2005	1,664	3,397
2006	1,643	3,402
2007	1,560	3,521
2008	1,625	3,558
2009	1,608	3,558
2010	1,608	3,430

Source: AgentschapNL 2012

The main policy instruments that have been used in the Netherlands to improve the energy performance for households are the energy performance norm (EPN), the regulatory energy tax (REB), the labeling program for buildings, tax reduction schemes for energy investments (EIA/VAMIL), subsidies (MAP, EPR, solar subsidy), funding with low interest rates (green scheme), and voluntary agreements (MJA). Although these policies have managed to slightly reduce the carbon emissions, they are still insufficient incentives for dwellers to reduce their energy consumption and move towards energy-efficient buildings at a national scale.

Looking at the overview of policy instruments that has been used in the last 30 years in the Netherlands, it is interesting to note that a large amount of the early environmental measures introduced from 1977 until 1990's were in the form of subsidies. Figure 16 presents an overview of the policy instruments used in the Netherlands in the period 1977- 2008 in order to enhance the development of sustainable buildings. A broader mix of policy instruments were introduced in the 1990's, mainly tax incentives and regulatory norms. Some of the most important policy instruments were implemented in the mid-1990, in particular the regulatory energy tax (REB), the energy performance norm (EPN), and other tax reduction measures (EIA, VAMIL).

Figure 16: Overview of policy instruments used to enhance the development of sustainable buildings in the Netherlands in the period 1977 - 2008



Source: Noailly et Al. 2010

Noailly et Al. (2010) revealed in their study about the impact of the Dutch environmental policy on energy-efficient innovations in buildings, that the environmental policy in the Netherlands has not been very stable. This is due to an unstable political determination, where some subsidies for example were cut back due to lack of financing and then went on again after some time. This was a major barrier for companies investing in innovative technologies with a fear to lose the financial support before the energy-efficient product is created. Incentives have to be uninterrupted and reliable. This would drastically reduce the effectiveness of such a policy where fewer companies will embark on innovative productions (Noailly et Al. 2010).

This can be explained by looking at the share of energy-efficient technologies from the total number of patents applied. In the Netherlands, this share accounts for only 5% compared to a 22% patents share in Germany (table 17). Noailly et Al. (2010) believe that this is relatively a high percentage for the Netherlands given that it is a small country. Moreover they revealed that it is mainly due to the large number of innovation activities in lighting technologies by Philips.

Table 16: Top ten patenting countries in energy-efficient innovations in buildings, 1977-2006

Country	Total number of patents 1977-2006	Share in total 1977-2006	Annual average
Germany	9348	22%	311.6
United States	8615	21%	287.2
Japan	5653	14%	188.4
France	2589	6%	86.3
Netherlands	2287	5%	76.2
United Kingdom	1891	5%	63.1
Italy	1577	4%	52.6
Switzerland	1302	3%	43.4
Sweden	1011	2%	33.7
Korea	932	2%	31.1

Source: Noailly et Al. 2010

The effectiveness of the energy tax (REB) instrument compared to other instruments is relatively high. While other instruments focus only on limited parts of the energy consumption of buildings, the energy tax focuses on total electricity/gas consumption in existing and new buildings, covering a large part of the total energy performance. However, it is the combination of policy instruments such as the energy tax supported by energy performance norm, tax deduction schemes and subsidies that have managed to be moderately effective in reducing CO2 emissions from buildings. The financial support that has been established for energy-efficient innovations increased the effectiveness of the energy tax as well as the energy performance norm by removing the financial barriers and facilitating the initial investments in sustainable buildings.

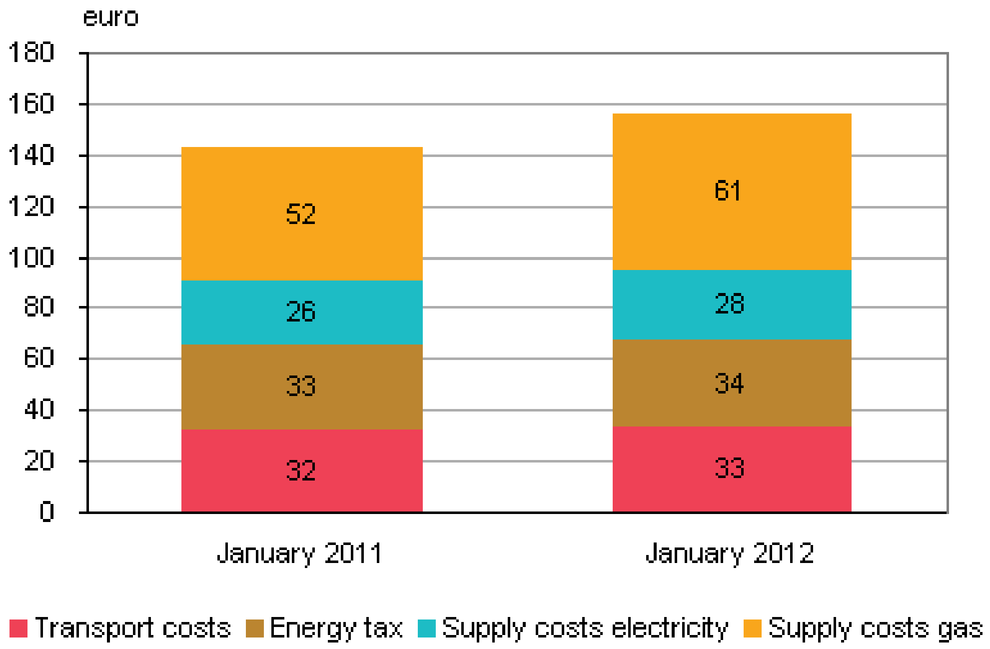
Nevertheless, these policy instruments are still not sufficient in securing the climate targets. A large part of the energy consumption and carbon emissions are accountable to the existing buildings stock. It is estimated that 70% of energy savings and GHG emission reductions can be achieved throughout measures taken in existing buildings compared to 30% in new buildings. However, not much is being implemented in the existing building stocks because of lack of enforcement. Eventually, there will be a need for a path of environmental regulatory obligations that overcome resistance. For the energy label, there is hardly any enforcement, leading to only 20% compliance among the Dutch buildings. People who sell their houses should acquire an energy label but in practice it doesn't take place and it is not enforced. In order to be effective there should be more stringency in environmental policies. Furthermore, the government should eliminate any confusion with certain policies that involve financial support and commit itself for a relatively longer period of time. Moreover, monitoring and evaluation of policies deserve more attention. The lack of quality of the data is reducing the effectiveness of certain policy instruments and not helping in understanding the impact of the policy which can be more efficiently controlled (Joosen et. Al 2004).

Case Studies

The two case studies reflected on some of the major barriers for the development of above standards sustainable buildings projects. They also illustrated the success factors behind the implementation of such projects and their economic recovery. It has been recognized that some of the standards and policies set by the government act by themselves as a limitation to the development of ambitious projects with high targets. This is because the products are much more expensive than what is normally being used. The technology that has been used in De Kroeven and Eva-Lanxmeer can become cheaper once it is widely used and the industry for these products can develop. The construction industry is responding to the most common standards. So in a way the standards set by the government are by themselves acting as a barrier for industries to improve their products and make it affordable for the wide public.

Furthermore, it has been revealed from both case studies that sustainable buildings are much more attractive for tenants than conventional buildings, and the economic recovery of energy-efficient buildings is even more promising on the long-run given the rise in energy prices. The average Dutch household expenditure on gas and electricity is estimated at 156 euro in 2012, which is 9% or 13 euro higher than in 2011 (CBS). Figure 17 compares the monthly energy bill in 2011 and 2012 and it also illustrates the constituents that contributed to the size of the energy bill. It is clear that gas and electricity costs are raising, along with the energy tax and the transport costs.

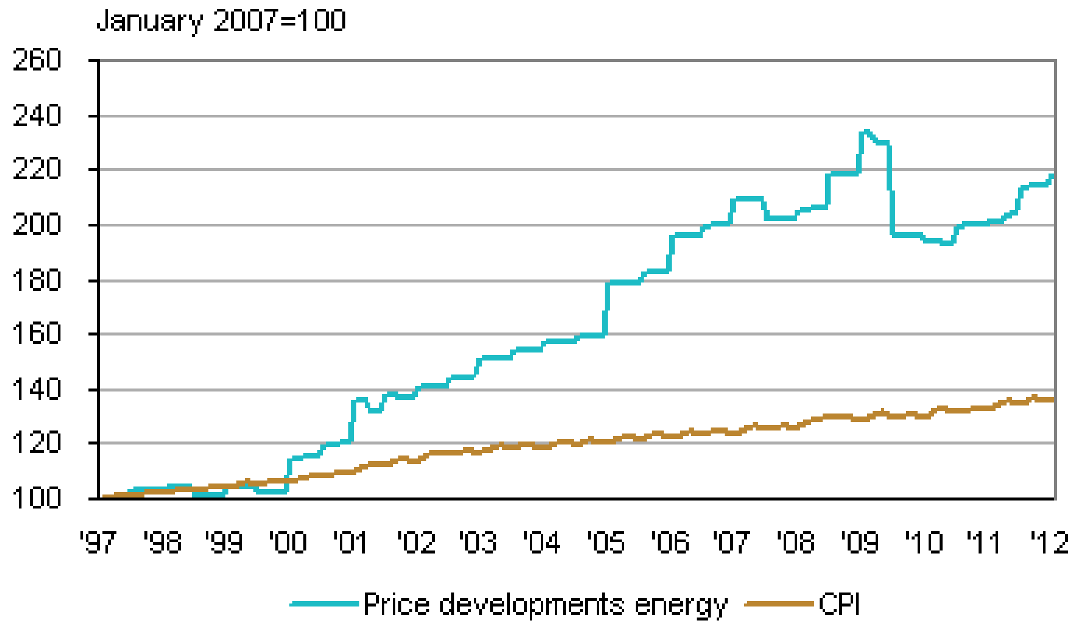
Figure 17: Comparison of the monthly energy bill in January 2012 and January 2011



Source: CBS

The consumer price index (CPI) shows the average change over time in the price of goods and services paid by households. The CPI includes all goods and services purchased for consumption by households; these consist of durable goods such as appliances, energy and house-related services, food and beverages, and other public services. Over the last decade, the energy price increased three times as fast as prices of other goods and services. Today, the cost of energy is almost 120% higher than 15 years ago. Moreover, the CPI increased by 35% from 1997 to 2012 (CBS).

Figure 18: Energy price development and CPI, 1997-2012



Source: CBS

De Kroeven in Roosendal – Existing buildings renovation

In the Netherlands there has been a huge focus in the last 10 years on the supply of better energy technologies to provide to buildings, and to a lesser extent to the insulation standards and building envelopes. The energy demand reduction strategies are crucial more than ever. It makes the building robust against changes in energy prices and makes it possible for renewable energy technologies to meet the small demand. Large scale passive renovation for the existing buildings stock in the Netherlands is highly desirable for several reasons.

First of all, housing that was built in the post world war II period forms a substantial part of the Dutch existing buildings stock. Also this type of housing is mostly inhabited by low income groups and owned by social housing corporations. With the rising energy prices, people with a limited budget will be the most vulnerable. More emphasis should be given on improving the energy efficiency of those buildings which will benefit the tenants by reducing the energy bill. Secondly, the renovation of existing old buildings is intended to extend the life-expectancy of those buildings and to raise the property value in the market on the long run. Thirdly it is nearly impossible to demolish all the existing housing stock and replace it with energy neutral buildings; even the waste that will be generated as a result of the demolition will be too large to process. Lastly, passive renovation using prefabricated facades and roof elements has demonstrated that it is effective and relevant. The renovation progress could be fast at a rate of one house per day, which makes it less disturbing for the tenants.

The passive renovation project in Roosendaal has an economical lifetime of 30-40 years but with a high initial cost. However, most housing corporations only make decisions with a lifetime of 10-15 years avoiding high initial investment costs. In order to become feasible, the initial investment cost should be spread on the entire life expectancy of the building and it should take into consideration the projected energy cost and the property value. So for buildings with a life expectancy of 30-40 years, it is not a problem to do such a renovation with high investment cost. Some of the new construction houses have the same quality as the renovated houses, but they have a much higher rent since they were much more expensive to build. Economic incentives are not the only solution for creating incentives to stimulate renovation projects for existing buildings. There should be a society requirement involving everybody to reduce CO2 emissions by 80% before 2050. More pressure should be done on building owners and corporations through environmental legislations.

Eva-Lanxmeer in Culemborg – new construction buildings

In Eva-Lanxmeer, from the beginning, the involvement of experts and professionals from different sectors in the conceptual phase gave more credibility to the project. This was important to create an integral proposal that covered all aspects of a neighbourhood and to get the support of the municipality.

The Eva-Foundation played a crucial role in setting a platform between the inhabitants and the municipality. This connection facilitated the development process and resulted in more coordination between bottom-up forces from the community, and top-down forces from the municipality. This situation guarded the ambitions set by the inhabitants and made sure that they are achievable. This has also given the inhabitants a sense of responsibility since they participated in the design and took part of some decisions that were made along with the municipality. In fact, this can be reflected when the inhabitants formed the energy company and became owners replacing the water company that was responsible for the collective heating system.

Nevertheless, the project in Eva-Lanxmeer has a number of limitations. First the project required a large time span from its conceptual phase to the construction phase. This wouldn't have been the case if a project developer was in charge. Second, the experts that were involved in developing the concept and the professional proposal didn't receive any financial compensation. Therefore, it was a voluntary participation that is very rare to see nowadays. Third, the support for the project by the municipality decreased with time because of political change, and part of it has been compromised notably the Eva-Centre. Communication with all stakeholders involved in the project, the local authorities in particular, is crucial not only in the beginning, but should also be consistent throughout the project in order to maintain support.

5.4 Further research

This research explored the different policy instruments used in the Netherlands for the development of energy-efficient buildings. It then assessed the effectiveness and cost-effectiveness of these policy instruments in terms of energy savings and GHG emission reductions. Another purpose of this study was to reflect on two case studies with above standards targets for existing buildings renovation as well as new construction buildings. The success factors, barriers, and economic recovery are revealed from these two successful models of sustainable buildings projects.

Further research should be focused on the following topics:

- Environmental legislations that would require owners of the existing buildings stock to improve the energy performance of their buildings.
- The full policy package which enhances the effectiveness and cost-effectiveness of individual policy instruments. In other words, further attention should be given for policy instruments combinations.
- Looking at the success factors in both case studies, local communities had a significant role in bringing these projects up to these ambitious standards. It would be interesting to give further attention to a framework that would link between bottom-up forces of the community, and top-down forces of authorities.
- Enabling developers to think for long-term processes and encourage them in running high performance buildings is another challenge that requires further research.

References

- Alam, M., Sathaye, J. and Barnes, D. 1998. Urban household energy use in India, efficiency and policy implications. Energy Policy

- Bernstein, M. A. and Griffin, J. 2005. Regional Differences in the Price-Elasticity of Demand For Energy. Report for the National Renewable Energy Laboratory, USA.

- BPIE, 2011, Europe's buildings under the microscope, A country-by-country review of the energy performance of buildings

- Birner, S. and Martinot, E. 2002. The GEF Energy-Efficient Product Portfolio: Emerging Experience and Lessons. Washington DC.

- Bontje, M. 2003. A "planner's paradise" lost? Past, present and future of Dutch national urbanization policy. European Urban and Regional Studies

- Burtraw, D., K. Palmer, R. Bharvirkar, and A. Paul, 2002: The effect on asset values of the allocation of carbon dioxide emission allowances. The Electricity Journal, June 2002, 15(5), pp. 51-62

- Chappells, H. and Shove, E. 2005. Debating the future of comfort: environmental sustainability, energy consumption and the indoor environment. Building Research and Information.

- CBS, statistics Netherlands, http://www.cbs.nl/en-GB/menu/themas/prijzen/publicaties/artikelen/archief/2012/2012-3582-wm.htm

- Creswell, J. W. & Miller, D. L. (2000). Determining validity in qualitative inquiry. Theory into Practice, 39(3), 124-131.

- Davies, J.C. and J. Mazurek, 1998: Pollution control in the United States: Evaluating the system.

- Deringer, J., Iyer, M. and Yu Joe Huang, Y. J. 2004. Transferred Just on Paper? Why Doesn't the Reality of Transferring/Adapting Energy Efficiency Codes and Standards Come Close to the Potential? Proc. 2000 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA, August 2004.

- DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings, [online] Available at:<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF> [Accessed 13 March 2012]

- DIRECTIVE 2005/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive

92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council, [online] Available at: <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:191:0029:0029:EN:PDF> [Accessed 13 March 2012]

- Dobbelsteen, AAJF (2008), DGBC, Model comparison for the Dutch Green Building Tool, final report version 2.4, [online] Available at:<http://www.dgbc.nl/images/TU_Delft_report_to_DGBC.pdf> [Accessed 29 May 2012]

- Eiff, V., E. Sons, A. Mol, M. ter Hedde and M. Pen, 2001, Evaluatieonderzoek milieu actie plan 1991- 2000, Tech. rep.

- Eurostat - June 2011 - COMEXT-Sirene energy data, 2011 revision of the period 1990-2009 and Targets data June 2010; EEA - June 2011 - CO2 emissions data; ECFIN - June 2011 - AMECO macro-economic data

- Eurima 2006. Better buildings through energy efficiency: A Roadmap for Europe. Meersen, Netherlands.

- Evander, A., Sieböck, G., and Neij, L. 2004. Diffusion and development of new energy technologies: lessons learned in view of renewable energy and energy efficiency end-use projects in developing countries. International Institute for Industrial Environmental Economics.

- Geller, H. Harrington, P., Rosenfeld, A. H., Tanishima, S., and Unander, F. 2006. Policies for increasing energy efficiencies. 30 years of experience in OECD countries.

- Geller, H and Attali, S. 2005. The experience with energy efficiency policies and programmes in IEA countries: learning from the critics. IEA Information Paper, Paris.

- Gouldson, A. & Murphy, J. 1998. Regulatory Realities: The Implementation and Impact of Industrial Environmental Regulation. London: Earthscan.

- Gupta, S., D. A. Tirpak, N. Burger, J. Gupta, N. Höhne, A. I. Boncheva, G. M. Kanoan, C. Kolstad, J. A. Kruger, A. Michaelowa, S. Murase, J. Pershing, T. Saijo, A. Sari, 2007: Policies, Instruments and Co-operative Arrangements. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

- Hajer, M. 1995. The Politics of Environmental Discourse: Ecological Modernization and the Policy Process. New York: Oxford University Press.

- IEA 2005b. Evaluating Energy Efficiency Policy Measures & DSM Programmes Volume I Evaluation Guidebook. IEA Paris.

- IEA. 2008. Energy technology perspectives 2008: Scenarios and strategies to 2050. International Energy Agency, Paris.
- IEA ECBCS Annex 50, Prefabricated Systems for Low Energy Renovation of Residential Buildings, Building Renovation Case Studies, March 2011
- IPCC (Intergovernmental Panel on Climate Change) 2007. Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007: Mitigation.
- Joosen, S., M. Harmelink and K. Blok, 2004, Evaluatie van het klimaatbeleid in de gebouwde omgeving 1995 - 2002, Ecofys Publication.
- Kemp, R.P. 1995. Environmental Policy and Technical change. A comparison of the technological impact of policy instruments. PhD thesis. Maastricht University.
- Laustsen, J. (2008). Energy efficiency requirements in building codes, energy efficiency policies for new buildings. International Energy Agency, Paris. Available at: http://www.iea.org/g8/2008/Building_Codes.pdf
- Lowe, R. 2000. Defining and meeting the carbon constraints of the 21st century. Building Research and Information 28 (3): 159-175.
- WRI, Manish Bapna and John Talberth (April 5, 2011), What is a "Green Economy?" http://www.wri.org/stories/2011/04/qa-what-green-economy
- Melchert, L. 2007. The Dutch sustainable building policy: a model for developing countries. Building and Environment
- Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM). 1989. To Choose or to Lose: National Environmental Policy Plan, 1990–1994. The Hague: SDU Publishers.
- Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM). 1993. Second National Environmental Policy Plan. The Hague: VROM.
- Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM). 1998. The National Environmental Policy Plan 3. The Hague: VROM.
- Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM). 2001. Where There’s a Will There’s a World: 4th National Environmental Policy Plan. The Hague: VROM.

- Melchert, L. 2007. The Dutch sustainable building policy: a model for developing countries. Building and Environment

- Nadel, S. 2004. Supplementary Information on Energy Efficiency for the National Commission on Energy Policy, American Council for an Energy-Efficient Economy, Washington, DC.

- Joelle Noailly, Svetlana Batrakova, and Ruslan Lukach, 2010, Home green home – A case study of inducing energy-efficient innovations in the Dutch buildings sector, No198, CPB Document, p. 55

- OECD 2003. Environmentally Sustainable Buildings - Challenges and Policies, Paris, OECD.

- OECD/IEA, 2009, Energy policies of IEA countries: The Netherlands 2008 review, p.40-42

- Jean-Philippe Barde, 1994, Technical Paper N 92, “Economic Instruments in Environmental Policy: Lessons from OECD Experience and their relevance to Developing Economies, produced as part of the research programme on Environmental Management in developing Countries.

- Patton, M. Q. (2002). Qualitative evaluation and research methods (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

- Pearce, D.W., Markandya A. and Barbier, E.B. (1989). Blueprint for a Green Economy. Earthscan, London.

- Price, L. 2005. Voluntary Agreements for Energy Efficiency or GHG Emissions Reduction in Industry: An Assessment of Programs Around the World.

- Sterner, T., 2003: Policy instruments for environmental and natural resource management. Washington, D.C., Resources for the Future Press.

- UNEP. 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy, ISBN:978-92-807-3143-9

- UNEP, 2007, Assessment of policy instruments for reducing greenhouse gas emissions from buildings, [online], Available at:< http://www.unep.org/themes/consumption/pdf/SBCI_CEU_Policy_Tool_Report.pdf> [Accessed 15 May 2012]

- UNEP - SBCI. 2009, Buildings and Climate Change: Summary for Decision-Makers

- United Nations publication, Are we building competitive and liveable cities, Guidelines for developing eco-efficient and socially inclusive infrastructure, 2011, www.unescap.org/esd/environment/infra/documents/Guidelines.pdf

- United Nations Framework Convention on Climate Change (UNFCCC) 1999. UNFCCC Guidelines and Reviewing. FCCC/CP/1999/7.

- Urge-Vorsatz, D., Koeppel, S. 2007. An assessment of Energy Service Companies worldwide. Report submitted to the World Energy Council.

- USGBC, 2012, [online], [Accessed 29 May 2012] Available at:<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>

- VROM, 2007: Nieuwe energie voor het klimaat – werkprogramma Schoon en Zuinig, VROM 7421/September 2007

- Westling, H. 2003. Performance Contracting. Summary Report from the IEA DSM Task X within the IEA DSM Implementing Agreement. International Energy Agency, Paris.

- World Energy Council, 2004. Energy Efficiency: A Worldwide review. Indicators, Policies, Evaluation. London.

- World Commission on Environment and Development (1987).Our Common Future. Oxford University Press, New York.

Annex 1: Interviewed personnel and their positions.

Interviewed Personnel	Position
Policy makers (local government officials, policy consultants, researchers...)	
Ms. Saskia Moolhuijzen	Project manager for Eva-Lanxmeer project, municipality of Culemborg
Dr. Cor Leguijt	Senior researcher / consultant at CE Delft, built environment expert
Mr. Jowan Kelderman	Senior policy advisor at DCMR
Drs. Martijn Blom	Senior energy and environmental economist at CE Delft
Mr. Nicco Tilli	*EU coordinator, department of spatial* planning and housing, dS+V City of Rotterdam
Policy users (architects, consultants, developers...)	
Mr. Chiel Boonstra	Owner Trecodome, energy consultant for De Kroeven project
Mr. Jan Hanhart	Expert in energy systems for Eva-Lanxmeer project, Thermo Bello
Mr. Niels Van Ham	Architect for De Kroeven project
Policy implementers (Private owners, housing corporations, local inhabitants...)	
Ms. Marleen Kaptein	Eva-Lanxmeer project initiator, local inhabitant
Ad Van Rekum	Project manager AlleeWonen housing corporation, De Kroeven project