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Dutch National Report

Written by

Lia De Simon, Arjan de Bruin (VMT)

FROM ZERO TO HERO

Wise Energy Use Volunteering Scheme for Youngster

Project Period: 01.09.2018 - 31.08.2020

Participants:

- **GU**-GAZI UNIVERSITY, Turkey
- **ANKU**-ANKARA UNIVERSITESI, Turkey
- **CIAPE** - CENTRO ITALIANO PER L'APPRENDIMENTO PERMANENTE, Italy
- **ERBIL**- ERBIL PROJECT CONSULTING ENGINEERING CO. INC, Turkey
- **AELV**- ASOCIACION AMIGOS DE EUROPA LEONARDO DA VINCI, Spain
- **TTMD**- TURKISH SOCIETY OF HVAC AND SANITARY ENGINEERS, Turkey
- **VMT**-VAN DER MEER & VAN TILBURG WEST BV, Netherlands
- **IZOCAM**- IZOCAM TICARET VE SANAYI ANONIM SIRKETI, Turkey

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List of Acronyms

ATES = Aquifer Thermal energy Storage

EPBD = Energy Performance Building Directive

EPC = Energy Performance Coefficient

EED = Energy Efficiency Directive

EU = European Union

GHG = Greenhouse gas

Ktoe = Tousend ton of oil equivalent

MS = Member State

Mtoe = Million ton oil equivalent

nZEB = nearly Zero Emission Building

PJ = Petajoule

PV = Photovoltaic

UTES = Underground Thermal Energy Storage

ZEB = Zero Emission Building

Executive summary

The scope of this report is to give an overview of the current situation in the Netherlands on sustainable construction and, in particular Zero Emissions Buildings (ZEBs).

Currently there has been a shift in focus in sustainability: not only from the energy prospective but also a social and economic problem.

1 Introduction

Climate change is a growing concern in the current international political agenda as it could represent the biggest challenge, so far, that humanity has had, and will have to face.

Rising of sea levels, expansion of the deserts and an increased number of extreme weather events such as heat waves, droughts, heavy rainfalls and floods that are being witnessed in the last two decades can all be connected to the effects of global warming.

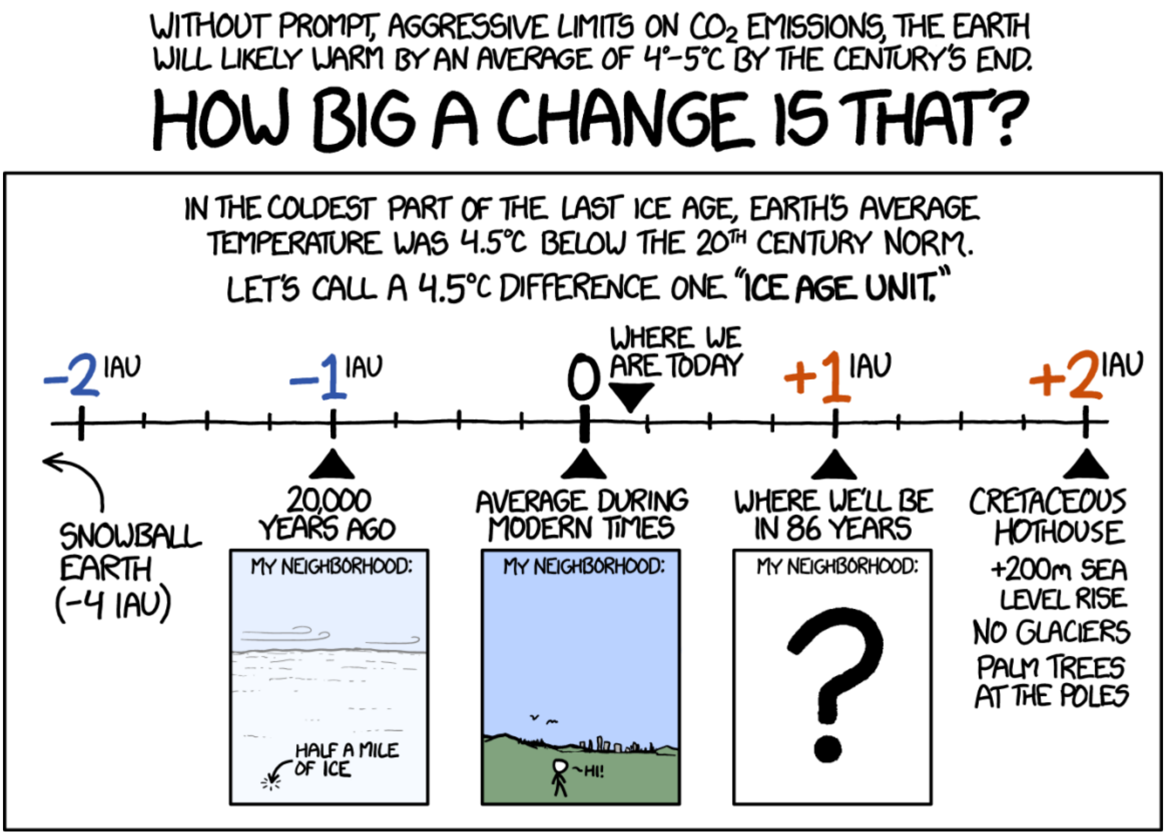

Figure 1: A light-hearted representation of the consequences of global warming. Source data: 4.5 Degrees, xkcd.com

Global warming has been related to the increasing emissions of greenhouse gases (GHG) generated by the combustion of fossil fuels and the activities characterising the development of the industrial era. Since this connection has been ascertained, there has been evidence of international efforts to reduce CO_2 and greenhouse gas emissions from all fronts of human activities, such as the Kyoto protocol, promoted by the United Nations Framework Convention on Climate Change. Under the protocol, the subscribing countries have to monitor their carbon emissions and reduce them, aiming to reach an agreed target: for most European countries, the second commitment period of the Kyoto protocol (2013-2020) requires a 20% reduction of the emissions of the 1990 baseline year (De Simon, 2017).

The European Union has set ambitious targets to cut the emissions of each member state and has put in place national legislation to achieve those targets.

The main contributors to carbon emissions are the transport sector, the built environment sector and the industry sector.

The focus of this report lies on the built environment, in line with the scope of the From Zero2Hero project. Indeed, the aim of From Zero2Hero is to give the possibility to youth leaders and young people to travel to EU countries and study the current top of the art practice in sustainable buildings and bring back the acquired knowledge to their communities.

This report will give an overview of the policy, economy and climate context where the efforts on improving the performance of the building stock in Europe and in the Netherlands are set. It will set the baseline to determine the content of the Dutch field trip, in order to maximise the exposure of the young visitors to all the aspects involved in improving the energy efficiency of buildings at national level.

1.1 Built Environment context

Buildings respond to basic human needs: shelter and protection from the external weather conditions. A building creates an enclosed space that is independent from the external environment and that can be controlled by humans to create comfortable living conditions. This includes the possibility of controlling indoor temperature, humidity, lighting, air quality, etc.

Historically buildings integrated passive strategies adapted to different climates to mitigate the harshness of the external weather, such as high ceilings in humid climates to favour ventilation and roofs with overhangs in hot countries to generate shade and prevent solar radiation from hitting the building envelope. In colder climates fireplaces for burning wood were often used for internal heating.

As technology evolved, more advanced systems came in place to control the indoor climate in a more precise and sophisticated fashion, such as gas or oil boilers, mechanical ventilation systems and air conditioning units. Most of these systems rely on a steady supply of fossil fuels or electricity to deliver their services and consequently are responsible for a considerable share of energy consumption carbon emissions at national and European level. In the context of fuel shortage and global warming that the world is currently facing, reducing the use of fossil resources in the built environment is paramount. For this reason, in recent years, research studies and governmental policy have been supporting the introduction of energy efficiency measures in the new and existing building stock, the inclusion of renewable energy generated on site for building operation and the setting of ever more tight performance standards for new and retrofitted buildings.

According to the latest European Building Energy Performance Directive, as of 2018, all new built public buildings will have to be *nearly Zero Energy Buildings* (nZEBs), (i.e. with zero or very low energy required that has to be covered by renewable sources for a significant extent) and by 2020 all new buildings will have to be nZEB (Schimschar, Hermelink, & John, 2014). The directive is vague and leaves the space to every Member State to determine a rigorous definition and a strategy to achieve the objective.

In the Netherlands, the energy performance of a building is defined by its “Energy Performance Coefficient” (EPC). The EPC is determined by dividing the calculated energy requirement of a building by a standardised energy performance, which is based on the heat-transfer surface and the total heated area of the dwelling. Since 2013, the EPC for new and renovated homes should be not more than 0.6. In 2015, it was further restricted to a maximum of 0.4. In order to meet the European standards, in 2018 the EPC was lowered further to 0.1.

This national report gives particular focus to the Dutch built environment context and policy, including a panoramic of natural resources, geographical features and landscape, energy production and use and the policy regulating the energy efficiency targets in the built environment.

The following paragraph gives an overview of the Dutch natural resources. Chapter 2 covers energy use and production at European and Dutch level. Chapter 3 focusses on the energy policy and building energy performance policies at EU and national level. Chapter 4 outlines the results of a survey on awareness of climate change and building energy efficiency issues amongst young people in the Netherlands. Chapter 5 draws the conclusions and sets the scene for the following actions during the From Zero2Hero project.

1.2 The Dutch context

According to the Central Bureau of Statistics, the European Netherlands has a total land area of 41,528 km2, including non-tidal water bodies. It lies between latitudes 50° and 54° N, and longitudes 3° and 8° E. The Netherlands is geographically very low relative to sea level and is considered a flat country, with about 26% of its area and 21% of its population located below sea level, only about 50% of its land exceed one metre above sea level. Most of the areas below sea level are man-made, caused by peat extraction or achieved through land reclamation. Since the late 16th century, large polder areas are preserved through elaborate drainage systems that include dikes, canals and pumping stations. Nearly 17% of the country's land area is reclaimed from the sea and from lakes. The county is rich is sweet water too, as it is crossed by the main European rivers, the Rheine, the Meuse and the Scheldt. The Netherlands is one of the countries that may suffer most from climate change. Not only the rising sea is a problem, but erratic weather patterns may cause the rivers to overflow and flood the neighbouring land.

The Netherlands enjoy a maritime temperate climate influenced by the Nord sea and the Atlantic Ocean, with cool summers, moderate winters and typically high humidity. The average temperature excursion between Summer and winter (as well and the night and day temperature difference) is not particularly large, especially on the coast line.

Precipitation throughout the year is distributed relatively equally each month. Summer and autumn months tend to gather a little more precipitation, mainly due to the intensity of the rainfall rather than the frequency of rain days.

The number of sunshine hours varies between barely eight hours in December and nearly 17 hours in June due to the latitude of the country.

With long coast lines and wide flat land, the country can harness large amounts of renewable energy from wind and tides. Historically, wind energy was used to power mills and pumps, giving rise to the iconic Dutch windmills scattered through the landscape. The leading renewable sources in the country are biomass, wind, solar and both geothermal and aerothermal power (mostly from ground source and air source heat pumps). Due to the low land conformation, there are not many possibilities for the installation of Hydroelectric power plants. Historically, peat, an accumulation of partially decayed vegetation of organic matter, was mined in the Netherlands to be used as fuel. This contributed to the creation of the modern below-sea level landscape.

The Netherlands was an important producer of natural gas, thanks to its large underground resources in the north of the country. In recent years though, due to environmental concerns, safety concerns for the local residents (gas extraction weakened the soil and gave rise to earthquakes) and depletion of the natural resource, the extraction activities have been considerably reduced and will be stopped by 2030.

2 National Situation of Energy and Built Environment

2.1 Energy Supply and Consumption

This chapter outlines the energy production and use across the EU and the Netherlands. The facts and figures presented are supported by the statistics provided by the Eurostat and the Dutch statistical office. Where possible, the latest data available have been used.

2.1.1 Energy Import and Production

With the exception of peat and coke, the European Union is a net importer of energy products. Indeed, according to the Eurostat, more than half (53.6%) of the EU-28's gross inland energy consumption in 2016 came from imported sources.

Crude oil largely dominates the EU imports in energy products with a share of 70 % in the first semester of 2018, followed by natural gas in gaseous state with a share of 20 %. Figure 2 gives an overview of the imported energy products (Eurostat, 2018c).

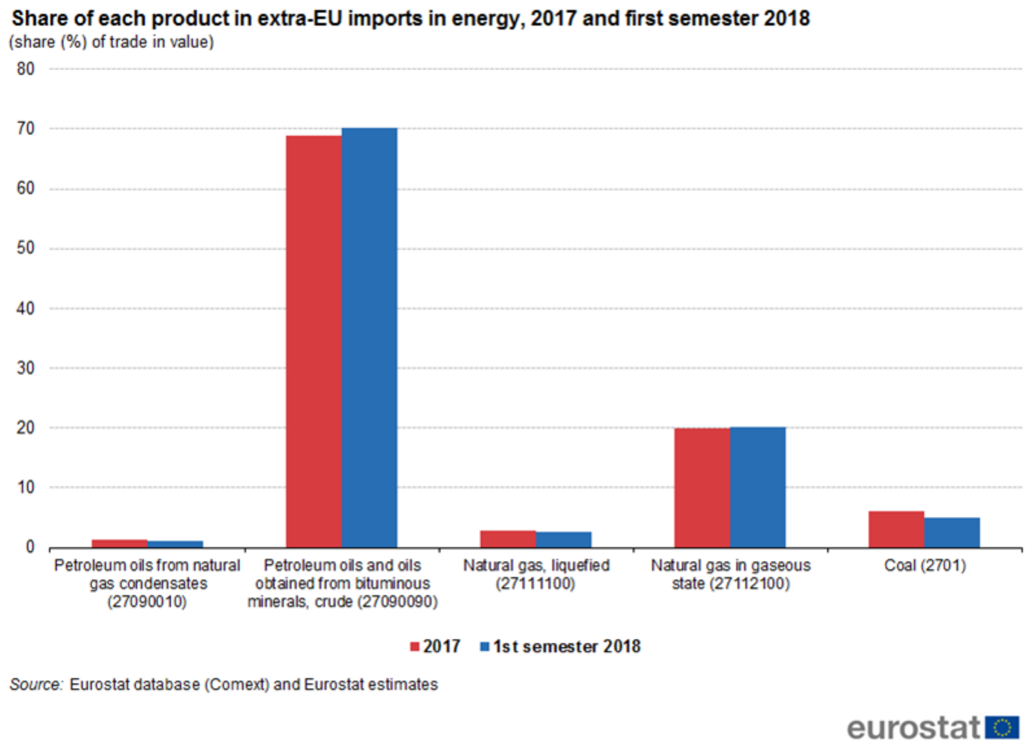

Figure 2: Share of each product in extra-EU imports in energy, 2017 and first semester 2018. Source: Eurostat.

Primary energy production in the EU-28 in 2016 was spread across a range of different energy sources, the most important of which in terms of the size of its contribution was nuclear energy (28.7 % of the total). More than one quarter (27.9 %) of the EU-28's total production of primary energy was accounted for by renewable energy sources, while the share for solid fuels (17.5 %, largely coal) was just below one fifth and the share for natural gas was somewhat lower (14.2 %) (see Figure 3) (Eurostat, 2018b). The most important renewable energy source was biomass and waste, covering more than 60% of the renewable energy production.

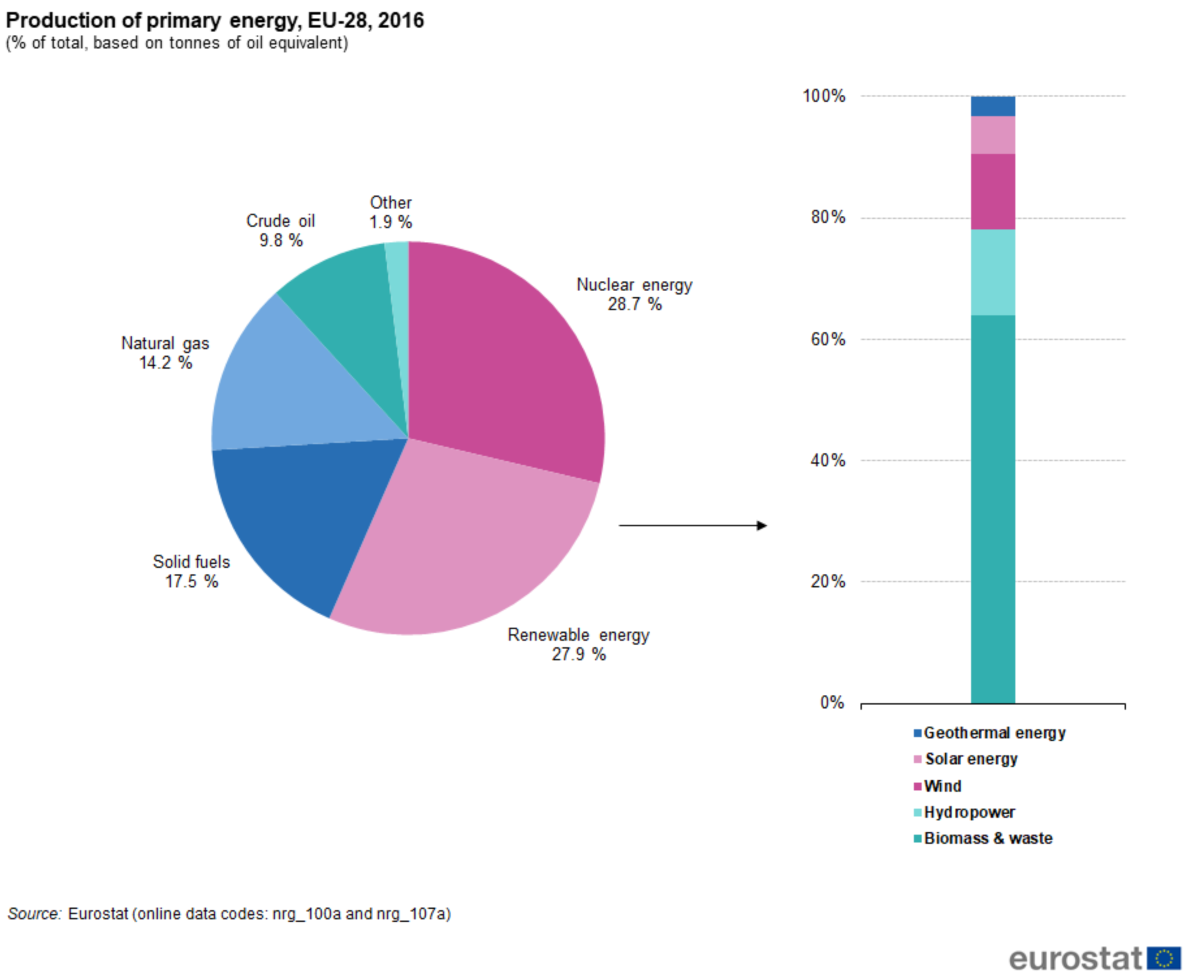

Figure 3: Production of primary energy, EU-28, 2016. Source: Eurostat.

The production of renewable energy has been on an upwards trend for the past 13 years. The growth of EU-28 primary production from renewable energy sources exceeded that of all the other energy types; this growth was relatively uniform during the period covering 2006-2016, with a small dip in production in 2011 (see Figure 4). Over this 11-year period the production from renewables increased by 66.5 %, replacing, to some degree, the production of other sources of energy. By contrast, the production levels for the other sources fell, the largest reductions being recorded for natural gas (-41.2 %), crude oil (-39.0 %) and solid fuels (-30.8 %), with a more modest fall of 15.2 % for nuclear energy.

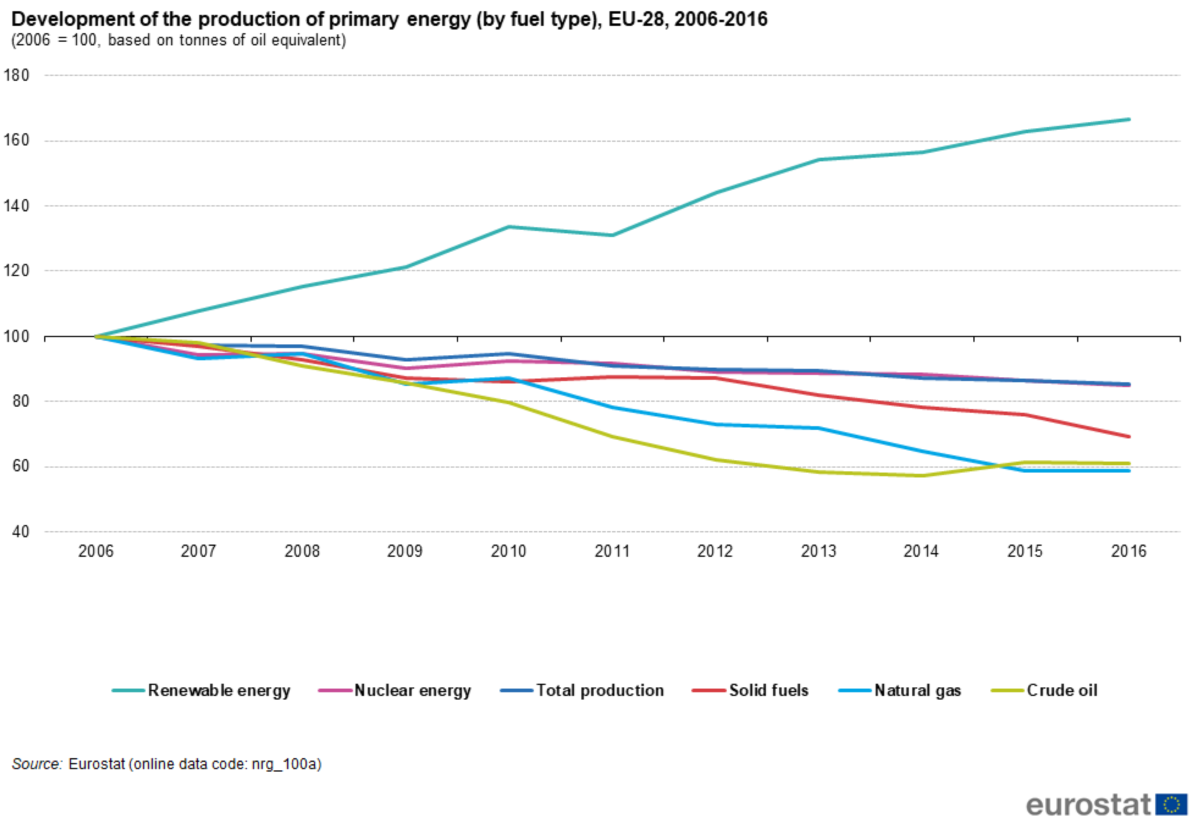

Figure 4: Development of the production of primary energy EU-28, 2006-2016. Source: Eurostat.

The primary production of renewable energy within the EU-28 in 2017 was 226.5 million tonnes of oil equivalent (toe). The quantity of renewable energy produced within the EU-28 increased overall by 64.0 % between 2007 and 2017, equivalent to an average increase of 5.1 % per year.

Among renewable energies, the most important source in the EU-28 was wood and other solid biofuels, accounting for 42.0 % of primary renewables production in 2017 (Eurostat, 2019) (see Figure 5).

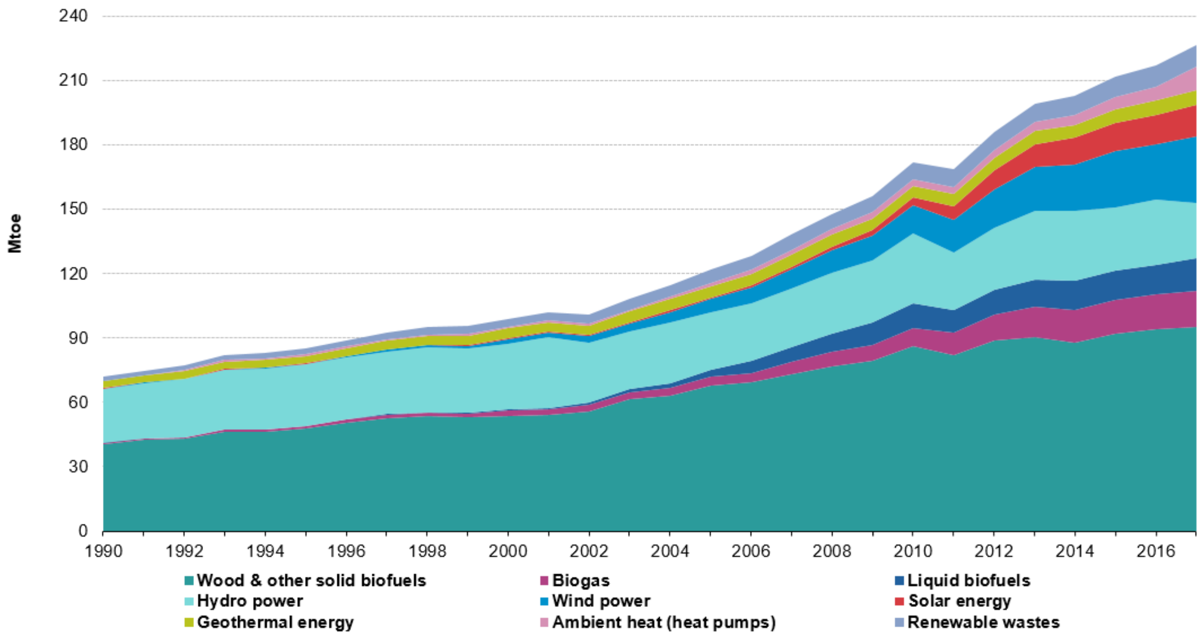

Figure 5: Renewable energy production in the EU by different sources, 1990-2017. Source: Eurostat

Wind power was, for the first time, the second most important contributor to the renewable energy mix (13.8 % of the total), followed by hydro power (11.4 %). Although their levels of production remained relatively low, there was a particularly rapid expansion in the output of biogas, liquid biofuels and solar energy, which accounted respectively for a 7.4%, 6.7% and 6% share of the EU-28's renewable energy produced in 2017. Ambient heat (captured by heat pumps) and geothermal energy accounted for 5.0 % and 3.0 % of the total, respectively, while renewable wastes increased to reach 4.4 %. There are currently very low levels of tide, wave and ocean energy production, with these technologies principally found in France and the United Kingdom.

2.1.1.1 Dutch situation

In particular, the Netherlands in 2016 produced 50.91 Mtoe of energy, of these only 4.71 (9,2 %) were harnessed from renewable resources. The majority of energy produced came by far from Natural gas: 38.18 Mtoe (75%), followed by petroleum products 6.33 Mtoe (12,4%) (EU publications, 2018). The production of natural gas has been declining since 2016 due to protests and demonstrations in the gas mining area. The extraction of natural gas lead to earthquakes and severe ground instability creating a danger for the residing population. In 2018 the government has promised to cease completely natural gas extraction by 2030. The reduction of natural gas production has been partly compensating by the generation of energy via renewable resources. Still, with only 14% of its energy production coming from renewables, the Netherlands lags behind many other EU countries, where the renewable energy production reaches nearly 30% of the national energy production.

The Netherlands is still a net energy importer, like the rest of the European countries. In 2016 it imported a total of 41.58 Mtoe, mainly consisting of petroleum and petroleum products (EU publications, 2018). The Dutch share in the total EU petroleum oils is more than 20% and between 5-10% for Natural gas. More detailed information is not provided in order to avoid revealing confidential figures (Eurostat, 2018c).

2.1.2 Energy consumption

According to the latest data available from the European Environmental Agency, the main three sectors responsible for the majority of the EU energy consumption are transport (33.15%), Households (25.71%) and industry (24.99%) (European environmental Agency, 2018).

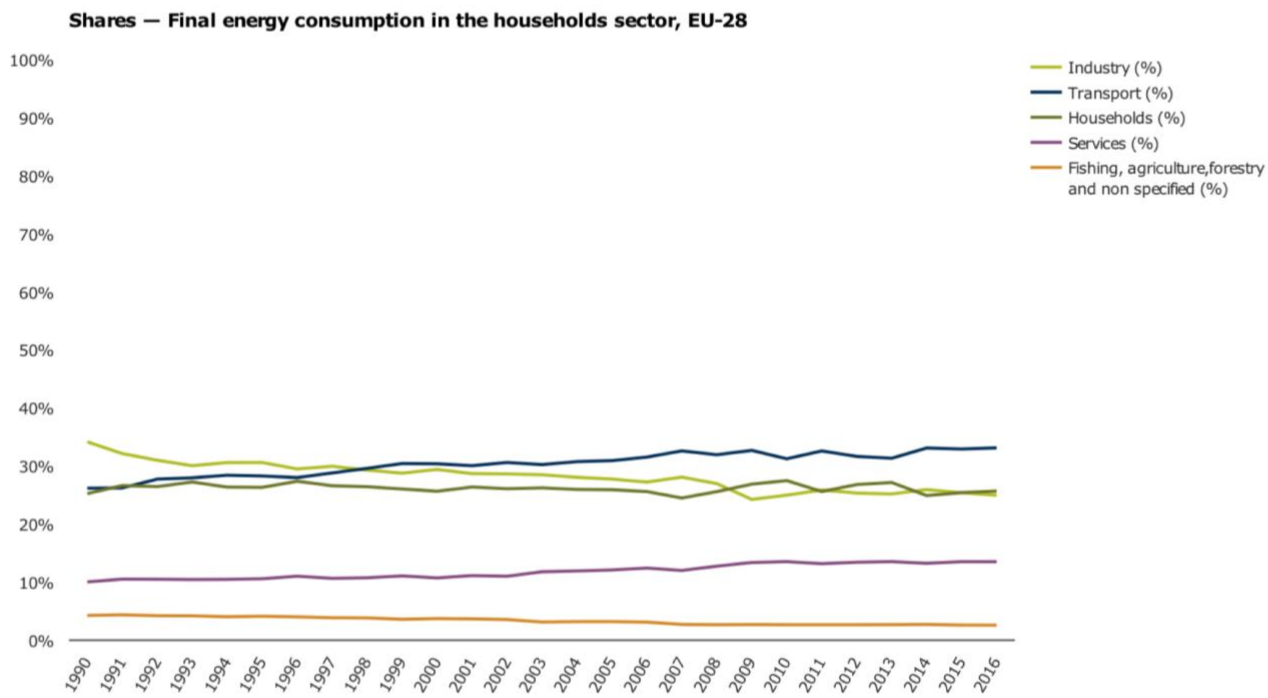

Figure 6: Final energy consumption share by sector in the EU. Source: European Environmental Agency, 2018

From the data presented above, it can be seen that the residential sector (households) is the second largest contributor to the energy consumption in the EU. The following paragraph will analyse how the energy is employed in the built environment to give a better understanding of the of the reasons behind the necessity of improving the environmental performance of existing and new buildings.

2.1.2.1 Energy consumption in the Built Environment

Most of the EU final energy consumption in the residential sector is covered by natural gas (37.1 %) and electricity (24.5 %). Renewables account for 16.0 %, followed by petroleum products (11.7 %) and derived heat (7.5%). A small proportion is still covered by coal products (solid fuels) (3.3 %). The main use of energy by households is for heating (64.7 % of final energy consumption in the residential sector). Electricity used for lighting and most electrical appliances represents 13.8 % of the total (this excludes the use of electricity for powering the main heating, cooling or cooking systems), while the proportion used for water heating is slightly higher, 14.5 %. Main cooking devices require 5.4 % of the energy used by households, while space cooling and other end-uses cover 0.3 % and 1.3 % respectively. Heating of space and water consequently represents 79.2 % of the final energy consumed by households (Eurostat, 2018a).

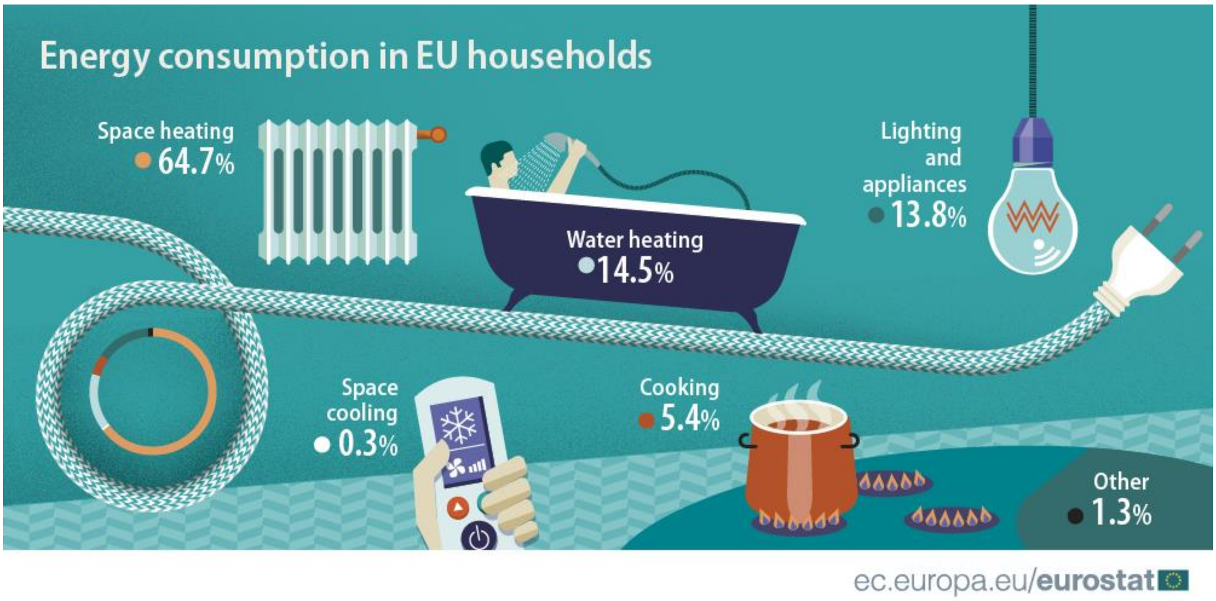

Figure 7:Energy Consumption in EU households. Source: Eurostat

Most of the energy products are almost exclusively used for space and water heating (from 94.1 % of oil products to 100 % of derived heat); only electricity has a wider use (56.6 % for lighting, 26.3 % for heating space and water, 11.0 % for cooking and 1.1 % for cooling) (see Figure 8).

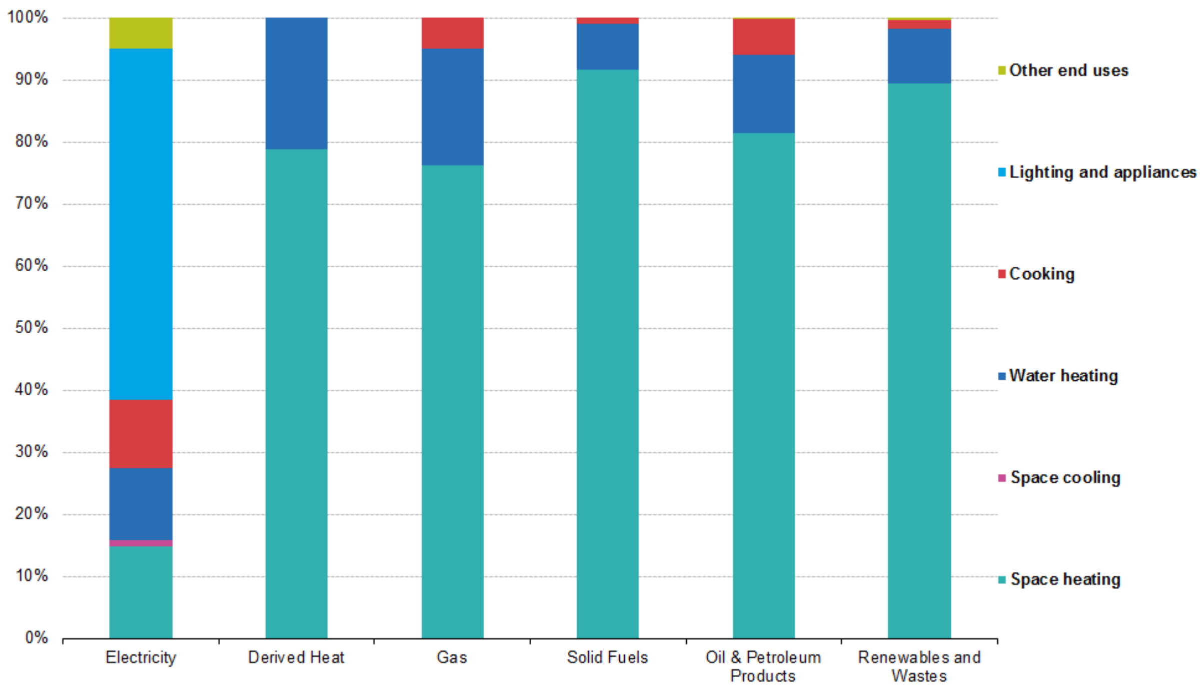

Figure 8: Final energy consumption in the residential sector by type of end uses for the different energy sources. Source: Eurostat.

When looking at the fuel type employed for the different end uses, the picture is more variegated. Electricity logically covers 100 % of the energy needs for lighting and space cooling in the EU but also 94 % of the other end-uses and 49.2 % for cooking. Gas plays an essential role in terms of space and water heating (respectively 43.4 % and 47.9 % of the energy consumed for these end-uses) and in cooking (33.1 %). Renewables cover 22.2 % of the energy needs for space heating, 9.6 % for water heating and 4.2 % for cooking. Derived heat plays an important role only in water heating (11.1 %) and in space heating (9.2 %), while oil products still cover 14.8 % of space heating energy use, 12.8 % of cooking and 10.4 % of water heating (see Figure 9).

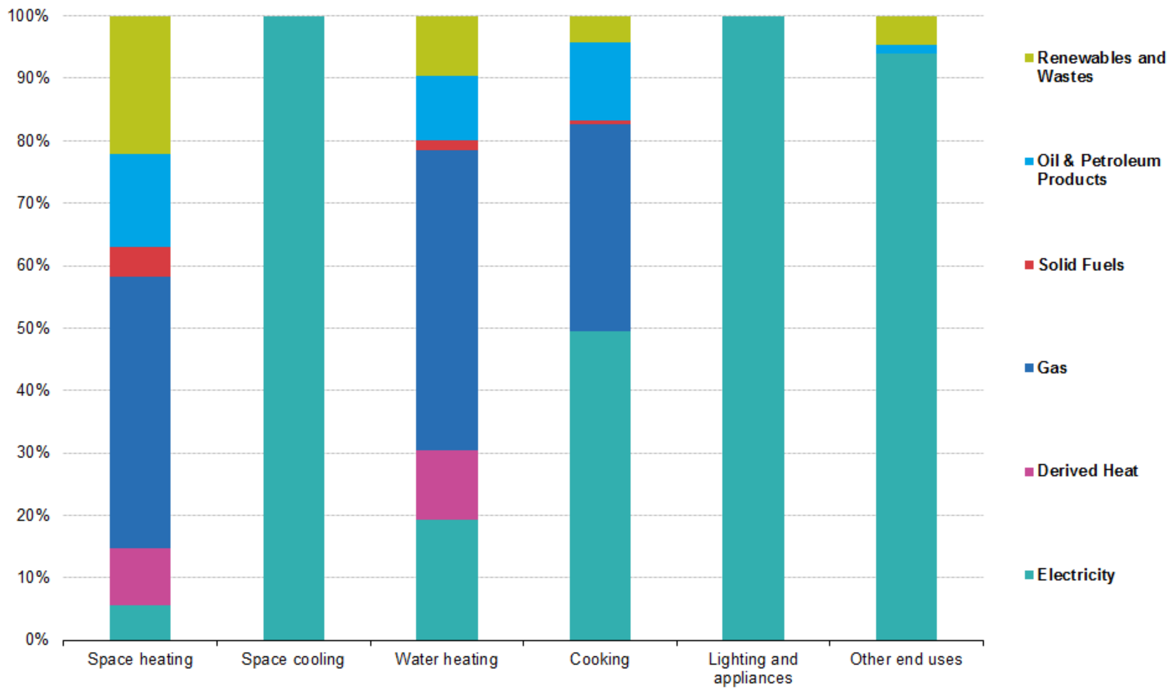

Figure 9: Main energy products in the final energy consumption in the residential sector for each type of end use. Source: Eurostat.

Most EU Member States rely mainly on natural gas (9 Member States use it as the main energy source in households) or electricity (9 Member States) for meeting their needs in the residential sector. However, in 7 Member States, renewable energies (mostly solid biofuels) are the main energy carrier in that sector (Eurostat, 2018a).

Another important aspect related to the building energy consumption are the energy losses intrinsic to the building construction. It is estimated that in a traditional dwelling construction up to 45% of the energy necessary to maintain a comfortable indoor environment is lost to the outdoor environment (NIA, 2019). In a traditional house, the most prominent heat loss mechanisms are infiltration, ventilation and conduction via the building envelope. The largest share of envelope heat losses occurs through the external walls, 35%, and roof, 25%. This means that, excluding doors and windows, the majority of heat losses occurs through the building fabric. Figure 10 shows a schematic diagram of the heat losses and heat gains in a typical dwelling.

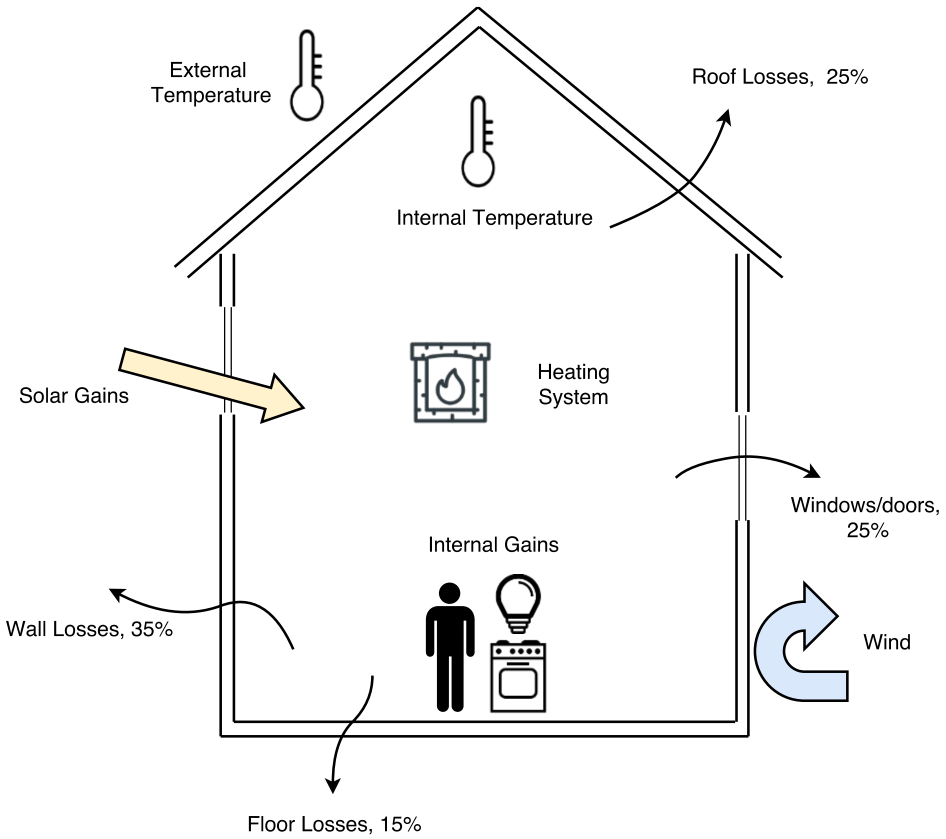

Figure 10: Heat losses from a typical dwelling

From the paragraphs presented above, it can be concluded that traditional buildings still rely mainly on fossil fuels for their energy needs and present high energy losses leading to higher energy consumption and thus higher carbon emissions. For this reason, it is essential to improve the energy performance of buildings in order to minimise the energy waste and be able to supply the building energy demand with clean, renewable resources.

2.1.2.2 Energy consumption in the Netherlands

The energy consumption in the Netherlands is in line with the situation of the EU. In 2017, total energy consumption in the Netherlands stood at 75.24 Mtoe, more or less equal to the 2016 consumption. Consumption of coal and other coal products declined by 1 Mtoe to 9.1 Mtoe; natural gas consumption, on the other hand, rose by 1.31 Mtoe to 31.02 Mtoe. For the first time, more natural gas was imported than was extracted from Dutch soil last year (cbs, 2018). Figure 11 shows the energy consumption in the Netherlands by fuel type between 1990-2016. Buildings are responsible for the consumption of 10 Mtoe

The main energy resource utilized in households is Natural gas followed by electricity.

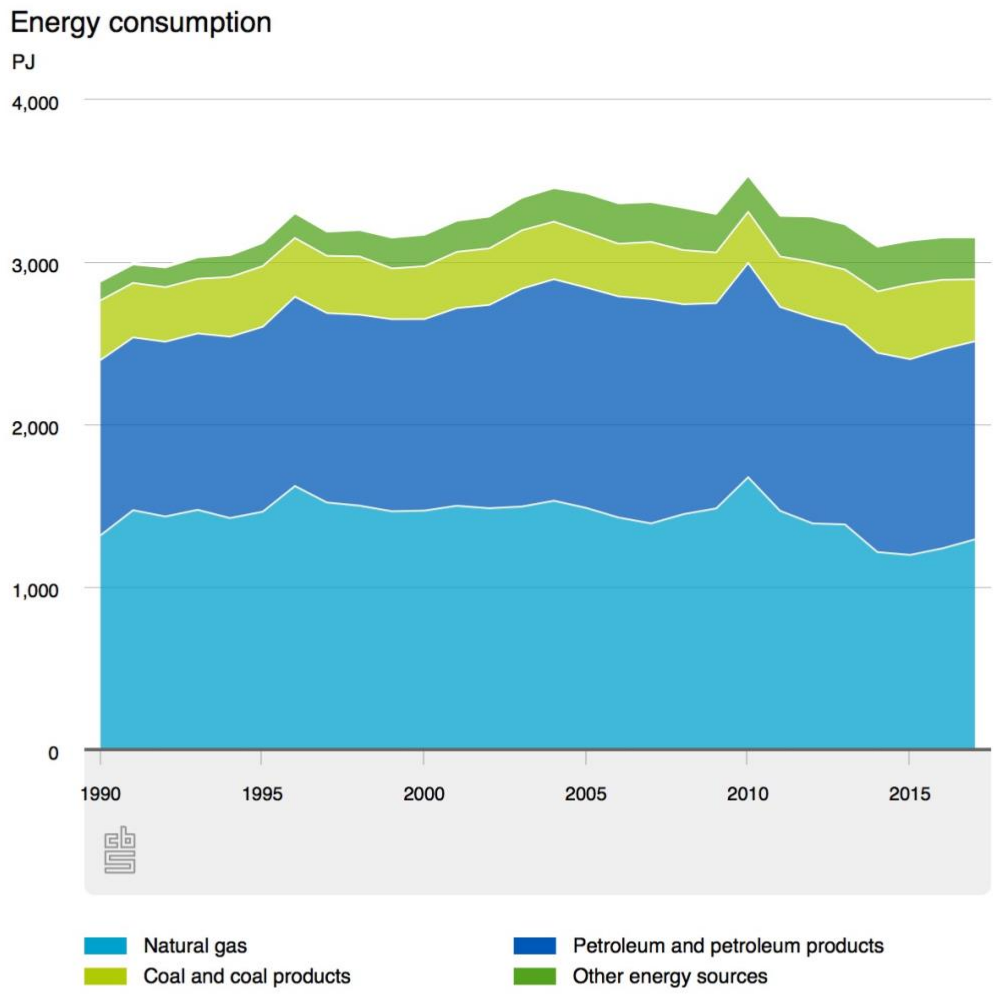

Figure 11: Energy Consumption in the Netherlands by fuel type, 2016. Source: Nederlands Statistics

2.2 Available solutions to achieve energy efficient buildings

The Built Environment Innovation Agenda (BEIA) is part of the Dutch Strategy to reach the goal of having one of the cleanest and most efficient energy supplies in Europe in 2020. This strategy, is called Schoon & Zuinig (S&Z). One of the main sectors on which S&Z focuses is the Built Environment (both residential and commercial buildings). The main objective is to ensure that, in 2020, the Built Environment reduces CO2 emissions by 6-11 Mton/year. The BEIA consists of three programmes: Thinking, (i.e. conceiving and developing new energy techniques, concepts and collaboratives forms), Doing, (i.e. small-scale basic techniques and concepts are implemented in practice and closely monitored), and Scaling Up (i.e. successful concepts and techniques are implemented on a large scale). The BEIA specifically focuses on removing obstacles and bottlenecks to innovation, such as research into market creation, attractive forms of financing, and persuading stakeholders to implement innovative projects. In particular, competent and careful monitoring of demonstration projects (Doing) form the basis for selecting market-ready concepts and optimising innovations. It is vital that the BEIA is implemented in close collaboration between the federal government, stakeholders (developers, builders), as well as the demand side of the market and knowledge institutes (Hameetman, Poolen, Versteeg, & Opstelten, 2009).

As mentioned by Hameetman et al. (Hameetman et al., 2009), there are several technologies available to improve the environmental performance of the built environment and the Dutch government is pushing for effort from different stakeholders to achieve its energy efficiency goals. From a practical point of view though, the most common approach to design an energy efficient building is to follow the "Trias energetica" principle. The Trias Energetica, is a model develop by TU Delft and acts as a guide to energy efficient construction and retrofit, (see Figure 12). The key principle of the Trias is to reduce the energy consumption of the building (by integrating energy efficiency measures, optimizing its orientation, using energy efficient devices etc.), meeting the reduced energy demands with renewable energy and using fossil fuels only for the demands that cannot be met with renewable energy (EURIMA, 2018).

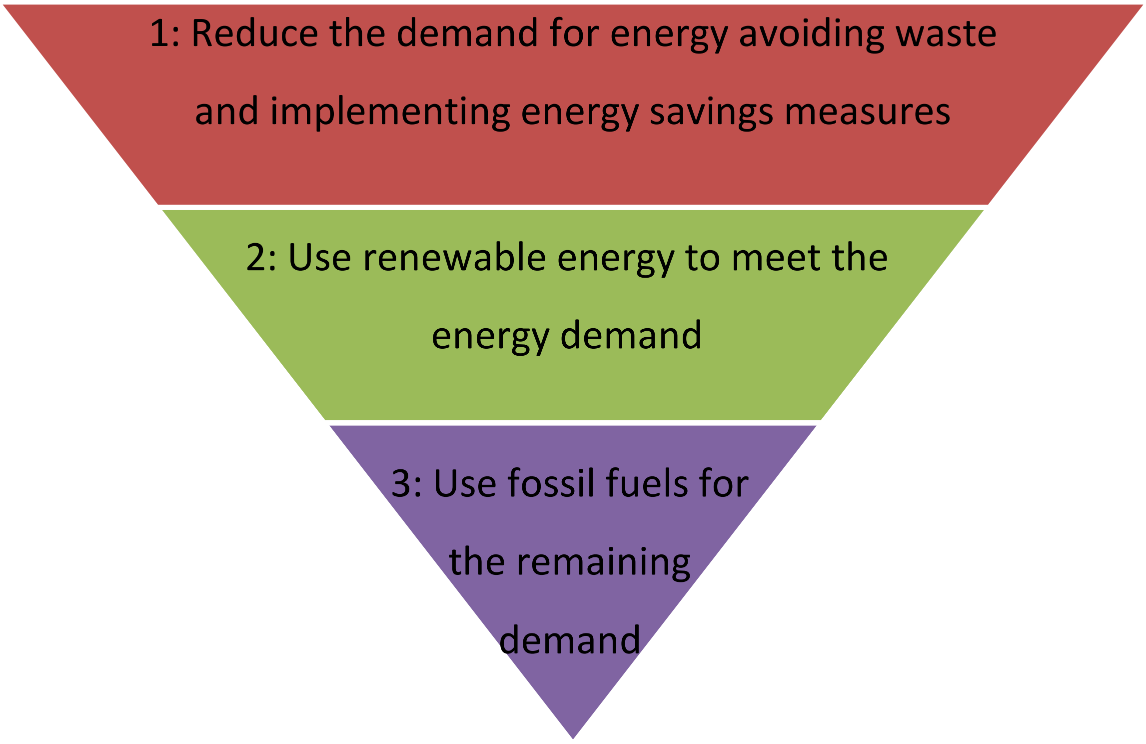

Figure 12: Diagram representing the Trias Energetica

2.2.1 Reducing energy consumption

There are several strategies to reduce the energy demand of a building. Improving the thermal insulation of the building envelope, (roof, external walls and floors), improving the airtightness of the building (i.e. avoid infiltration), improving the energy efficiency of the windows, use of passive cooling and heating strategies, use of energy efficient active heating, cooling and ventilation (HVAC) devices. Several studies have showed that building insulation, in particular roof insulation, is the most cost effective strategy to reduce CO_2 emissions.

Another important strategy to minimise the energy demand of a building, is designing according to the geographical location: this includes taking in consideration the building orientation, window surface and exposure, and natural shading provided by the surrounding environment. In this way, passive heating and cooling methods can be directly integrated in the building design. Passive heating and cooling can provide excellent CO_2 savings as they do not require energy inputs but rely on the local climate. For example, in the northern hemisphere with a cold/temperate climate, a building facing south will benefit from longer sunshine hours: increasing the south-facing window area will give rise to natural daylight and solar gains and minimising the northern window area will minimise heat losses. Movable shading devices or the presence of natural shading, such as the presence of trees or other buildings can exclude unwanted solar gains during the summer. Conversely, this is reversed in the southern hemisphere. In hot climates minimising the exposure to the south will also minimise solar heat gains and thus reduce the cooling load.

Passive solar heating strategies include, for example, the use of thermal mass or Trombe walls in the building design. *Thermal mass*, (for example concrete blocks or stone blocks in the facades), absorbs solar radiation during the day and releases the heat during the night, thus contributing to maintain a stable indoor climate.

A *Trombe wall* (or solar chimney) consists in a heavyweight surface (such as stone or concrete) with an external glazing layer, facing the sun. The air contained between the wall and the glazing will be heated by radiation and can be introduced into the buildings by appropriate ventilation gaps. See Figure 13 for a diagram illustrating the principle of a Trombe wall.

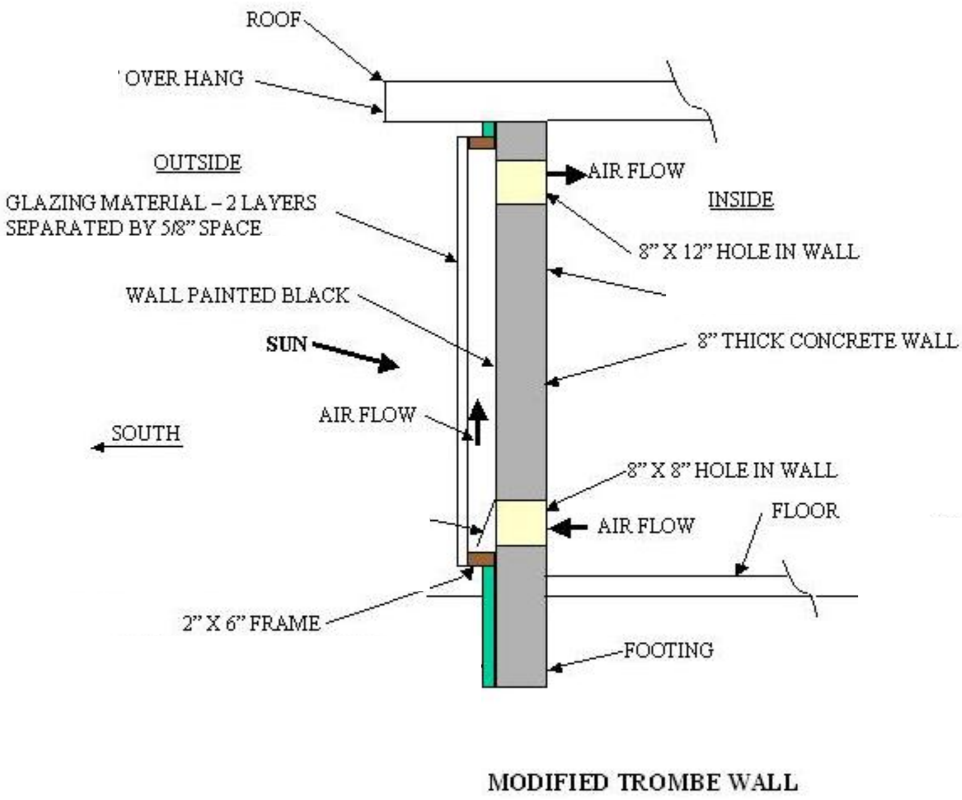

Figure 13: Diagram explaining the functioning of a trombe wall. Source: CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=769547

Besides the application of shading devices, passive cooling can be achieved by means of natural ventilation through the use of windows and doors.

A very effective system to reduce energy waste is heat recovery. This is not a passive system, as it requires a mechanical ventilation system but it can be used to reduce the energy required by the heating and cooling systems. Heat recovery consists in extracting the residual heat available in the exhaust air in the building and use that energy to pre heat (or pre cool) the fresh air inlet before it enters the building. See Figure 14 for a diagram explaining the principle of the heat recovery unit.

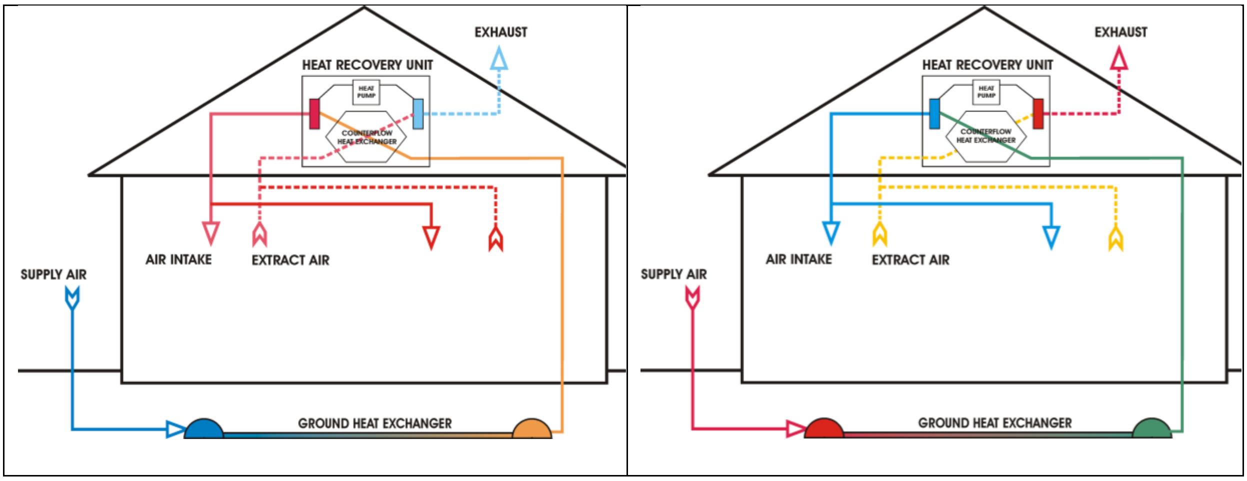

Figure 14: Diagram explaining the heat recovery mechanism. Left: heating mode, Right: cooling mode

2.2.2 Building integrated renewable energy sources

After reducing the building energy demand, meeting the energy need of the building with renewable energy produced on-site is the second step to achieve a nZEB. Currently there are several technologies that can be integrated in buildings to supply a building with renewable energy. The following paragraphs give an overview of the technologies available for each renewable energy source.

2.2.2.1 Solar energy

- Photovoltaic (PV) panels. PV panels are devices that can be mounted on roof tops and building facades that convert directly solar radiation in electricity. The electricity produced can be directly used by the building and the excess supplied to the national grid, contributing to the national renewable energy mix. The development of more efficient and affordable batteries to store the excess electricity can contribute to increase self-consumption.

Figure 15: PV installed on the roof of a domestic building.

- Solar thermal collectors. Solar thermal collectors are devices that can be mounted on roof tops or building facades and are used to heat water for domestic use. This can be used for domestic hot water applications or (more rarely) for domestic heating.

Figure 16: Solar thermal collector installed on a domestic building

2.2.2.2 Wind Energy

Wind turbines harness the wind energy and transform it directly in electricity. Wind turbines use large blades to catch the wind. When the wind blows, the blades are forced round, driving a turbine which generates electricity. The stronger the wind, the more electricity produced. Building mounted wind turbines are smaller can be installed on the roof of a home where there is a suitable wind resource. Often these are around 1kW to 2kW in size.

Figure 17: David Wilson Home, University of Nottingham, university Park, Nottingham. The David Wilson Home displays a domestic wind turbine and a solar chimney.

2.2.2.3 Geothermal energy

- Ground Source heat pumps (GSHP) are heating or cooling devices that transfer heat to and from the ground. GSHP are electrically operated and use the ground as heat source during the winter and heat sink during the summer. These systems are used to pre-heat (or pre-cool) the water and thus reduce the energy and cooling demands of the building heating and cooling system.

- Underground thermal energy storage is a form of energy storage that provides large-scale seasonal storage of “cold” and heat in natural underground sites. The underground is suitable for thermal energy storage, because it has high thermal inertia. If undisturbed, below a depth of 10-15 m, the ground temperature is only weakly affected by local climate variations above ground and maintains a stable temperature slightly above the local annual mean air temperature. UTES can efficiently store underground thermal energy from different sources, including the summer and winter ambient air, solar energy and by-product waste heat from industrial and other cooling processes, for a long period of time. During demand periods, it can supply space cooling/heating, ventilation air precooling/preheating and process cooling. There are currently three common types of UTES: aquifer thermal energy storage (ATES), borehole thermal energy storage (BTES) and rock cavern thermal energy storage (CTES) (Lim, 2013).

The principle of an Aquifer Thermal Energy System (ATES) is based on transferring groundwater between two separated storage wells. During summertime water is extracted from the coldest well and used to cool the building. During cooling, the water temperature increases from approximately 8°C to 16°C. The heated water is injected in the warmer well and stored until winter season. During winter the extraction/injection flow is reversed and the heated water (which still has a temperature of approx. 14 °C) is pumped back to the building. The water is cooled to approx. 6°C and is injected in the cold well. A heat exchanger between the groundwater and the building system water is used to avoid contamination of the water.

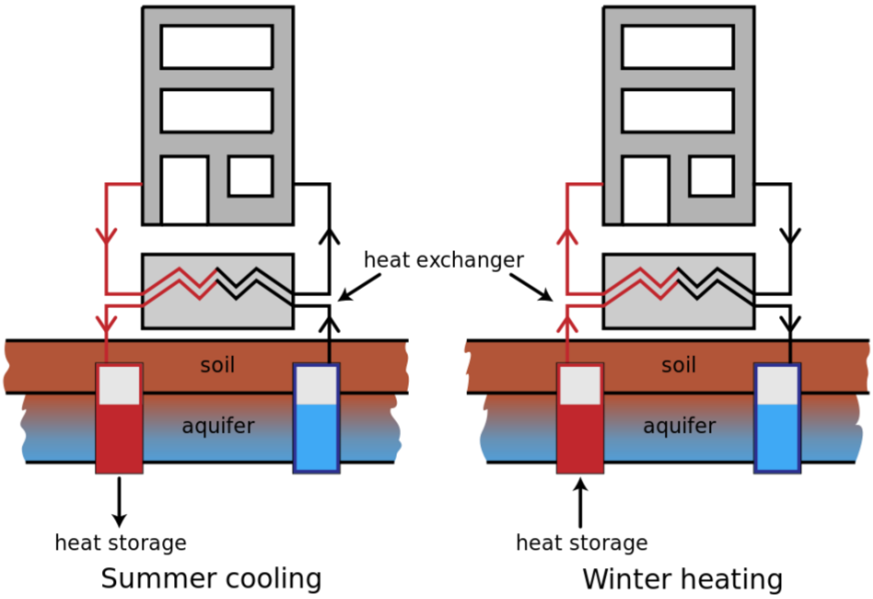

Figure 18: Diagram explaining the ATES concept. Source: https://commons.wikimedia.org/wiki/File:HeatAndColdStorageWithHeatPump.svg

The Dutch soil structure is particularly suitable for Aquifer Thermal Energy Systems (ATES) applications: the groundwater level is relatively close to the ground level (to avoid expensive deep drilling) and the natural flow in the groundwater should be low to avoid the stored heat/cold flowing away. Due to the flat Dutch landscape, the annual groundwater flow is only a few meters per year. Because of these favourable conditions, the use of ATES systems in the Netherlands has become increasingly popular since the first installations in 1990. In 2013 there were over 2000 installations in use and this number is expected to grow to 10.000 (worst-case) or 20.000 (best-case) in the year 2020 (de Bont, Gvozdenovic, Maassen, & Zeiler, 2016).

2.3 Conclusions

As shown in the paragraphs above, the Built Environment contributes to a large share of the National energy consumption and CO_2 emissions. For this reason, it is essential to improve the energy efficiency of the building stock and reduce its energy demands as much as possible. In paragraph 2.3 the governing principle to achieve a nZEB building has been illustrated along with the description of several technical solutions for the efficient renovation and construction of the building stock. The variety of solutions available shows that Building design is a very flexible discipline that can be adapted to every climate. This means that all the countries have the possibility of reducing the energy consumption of their building stock independently of their geographical location.

Still, as mentioned in (Hameetman et al., 2009), several stakeholders are involved in the building value chain, thus necessitating a coordination effort to align the vision of the different stakeholders to the same goal. Governments play a crucial role in guaranteeing solid guidelines for an effective building energy efficiency policy where all the stakeholders can and have to contribute. The following section will explore the policies and regulations at European and National level (in the Netherlands) governing the efforts in improving the energy efficiency of the existing building stock.

3 Energy Efficiency Policy and Strategy

Regulations represent an important drive for the improvement of the national building stock, as they provide a common reference point for every member of the construction value chain, setting clear targets and boundaries in energy efficiency and energy consumption.

The Netherlands, being part of the EU has both European and National regulations to achieve a more sustainable building stock.

While the EU regulation provide the general framework and goals to be achieved with respect to sustainability in the built environment, it is up to the National states to devise incentives and building regulations to achieve the goals set by the EU.

3.1 European regulations

In 2005 the EU has introduced a communal, mandatory and comprehensive European Energy policy that includes solidarity in energy supply amongst the states and unifies the energy policy across the Member States (MS). The main aim of the policy is to transform the European energy supply and reduce the amounts of imported energy resources from external countries. A fundamental part of this project, is its integration with a forward-looking climate policy including the reduction of carbon emissions and the increment of renewable resources usage. Within this framework, several directives have been promoted to achieve the "Energy Union" and set energy efficiency and environmental protection targets.

The 2012 Energy Efficiency Directive (2012/27/EU) establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. This means that overall EU energy consumption should be no more than 1483 million tonnes of oil equivalent (Mtoe) of primary energy. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain, including energy generation, transmission, distribution and end-use consumption.

In 2018, as part of the Clean energy for all Europeans package, the new amending Directive on Energy Efficiency (2018/2002) was agreed to update the policy framework in view of 2030 and beyond. The key element of the amended Directive is a headline energy efficiency target for 2030 of at least 32.5%. The target, to be achieved collectively across the EU, is set relative to the 2007 modelling projections for 2030. In absolute terms, this means that EU energy consumption should be no more than 1273 Mtoe of primary energy and/or no more than 956 Mtoe of final energy. The directive allows for a possible upward revision in the target in 2023, in case of substantial cost reductions due to economic or technological developments. It also includes an extension to the energy savings obligation in end use, introduced in the 2012 directive. Under the amending directive, EU countries will have to achieve new energy savings of 0.8% each year of final energy consumption for the 2021-2030 period.

These amendments entered into force in December 2018 and need to be transposed into national law by Member States by 25 June 2020, except for metering and billing provisions which has a different deadline (25 October 2020).

Other elements in the amended Energy Efficiency Directive include:

- extending the annual energy saving obligation after 2020 and beyond (requirement to achieve new savings of 0.8% each year of final energy consumption);
- stronger rules on metering and billing of thermal energy by giving consumers - especially those in multi-apartment building with collective heating systems – clearer rights to receive more frequent and more useful information on their energy consumption, also enabling them to better understand and control their heating bills;
- requiring Member States to have in place transparent, publicly available national rules on the allocation of the cost of heating, cooling and hot water consumption in multi-apartment and multi-purpose buildings with collective systems for such services;

- monitoring efficiency levels in new energy generation capacities;
- updated Primary Energy Factor (PEF) for electricity generation of 2.1 (down from the current 2.5).
- a general review of the Energy Efficiency Directive (required by 2024).

To reach the EU's 20% energy efficiency target by 2020, individual EU countries have set their own indicative national energy efficiency targets. Depending on country preferences, these targets can be based on primary or final energy consumption, primary or final energy savings, or energy intensity. The target for the Netherlands is 60.7 Mtoe of primary Energy Consumption and 52.2 Mtoe of Final Energy consumption (European Commission, 2018).

The Energy Efficiency directive sets the overarching energy policy for all sectors.

As the built environment is responsible for a large share of the EU energy consumption, the EU has developed specific directives targeting building energy efficiency.

The Energy performance of buildings directive (EPBD) is, together with the Energy efficiency directive, the main legislative instruments to promote the energy performance of buildings and to boost renovation within the EU.

The EPBD (2010/31/EU) has been in force since 2010 and helps consumers to make informed choices allowing them to save both energy and money. It has also resulted in a positive change of trends in the energy performance of buildings; following the EPBD introduction of energy efficiency requirements in national building codes, buildings of today consume only half as much as typical buildings from the 1980s (European Commission, 2019).

It was adopted on 9 July 2018 and constituted an important and concrete first delivery of the ‘Clean energy for all Europeans’ package and sent a strong political signal on the EU’s commitment to the clean energy transition, as the building sector has a vast potential to contribute to a carbon-neutral and competitive economy.

EU countries have until 10 March 2020 to write the new and revised provisions into national law.

The revised EPBD covers a broad range of policies and supportive measures that will help national governments in the EU boost energy performance of buildings and improve the existing building stock in both a short and long-term perspective. For Example:

- EU countries will have to establish stronger long-term renovation strategies, aiming at decarbonising the national building stocks by 2050, with indicative milestones for 2030, 2040 and 2050, measurable progress indicators and with a solid financial component. The strategy should clearly contribute to achieving the energy efficiency targets, as outlined in the National Energy & Climate Plan (NECP);
- Introduction of a common European scheme for rating the smart readiness of buildings, optional for EU countries;
- smart technologies will be further promoted, for instance through requirements on the installation of building automation and control systems and on devices that regulate temperature at room level;
- e-mobility will be supported by introducing minimum requirements for car parks over a certain size and other minimum infrastructure for smaller buildings;
- EU countries will have to express their national energy performance requirements in ways that allow cross-national comparisons. These will have to be reviewed every five years and, if necessary, updated;
- health and well-being of building users will be promoted, for instance through an increased consideration of air quality and ventilation;
- **all new buildings must be nearly zero-energy buildings (NZEB) from 31 December 2020. (Since 31 December 2018, all new public buildings already need to be NZEB)**;
- energy performance certificates must be issued when a building is sold or rented, and inspection schemes for heating and air conditioning systems must be established;

- EU countries must set cost-optimal minimum energy performance requirements for new buildings, for the major renovation of existing buildings, and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls and so on);
- EU countries must draw up lists of national financial measures to improve the energy efficiency of buildings.

In addition to these requirements, under the Energy efficiency directive (2012/27/EU), EU countries must make energy efficient renovations to at least 3% of the total floor area of buildings owned and occupied by central government, and national governments are recommended to only purchase buildings which are highly energy efficient.

To help EU countries properly implement the amendments to the EPBD and to achieve energy efficiency targets, the European Commission has established practical support initiatives called the energy performance of buildings standards (EPB standards), to be managed by the European Committee for Standardisation (CEN). The Commission has further published a recommendation on the building renovation aspects of the new rules (European Commission, 2019).

3.2 National (Dutch) regulations

In the Netherlands several policy measures have been in place since the last quarter of the 20th century, mainly through building decrees. New buildings and major renovations in the Netherlands are required to meet specific standards e.g. R_c values of floors, facades, roofs and U-values of windows, as of January 2015.

The majority of policy measures focus on the energy efficiency of buildings and the energy neutrality of new buildings. Still, energy neutrality of the building stock is hard to achieve relying only on newly built dwellings. Existing buildings will dominate the housing stock for the next 50 years based on their life cycle; in the Netherlands, the annual rate of newly built buildings is 0.6% of the existing residential building stock in 2014 (Statistics Netherlands

2015).Therefore, an important contribution to the decarbonization of the building stock should come via retrofitting (Filippidou, 2018).

The energy consumption of existing buildings has been regulated since 1975 consisting of limits on transmission losses based on insulation values (Boot, 2009). In 1995 these limits were expanded to include the national “EPC” (Energy Performance Coefficient) which is a non-dimensional figure that expresses the energy performance of a building depending on the energy consumed for space heating, hot water, lighting, ventilation, humidification and cooling.

The Dutch EPC is calculated by dividing the calculated energy demand of a building by a standard energy performance. The standardized energy performance is based on the heat transfer surface and the total heated area of the dwelling (NEN 2012). At the beginning (1995) the EPC value was set to 1.4, a number easily reached by the construction techniques of the time. Later on, EPC values were tightened to 1.2 in 1998, 1.0 in 2000, 0.8 in 2006, 0.6 in 2011, 0.4 in 2015 and 0.1 in 2018 in order to achieve nearly zero energy buildings (nZEB) by 2020 as shown in the 2012 National report on EPBD implementation (Figure 19).

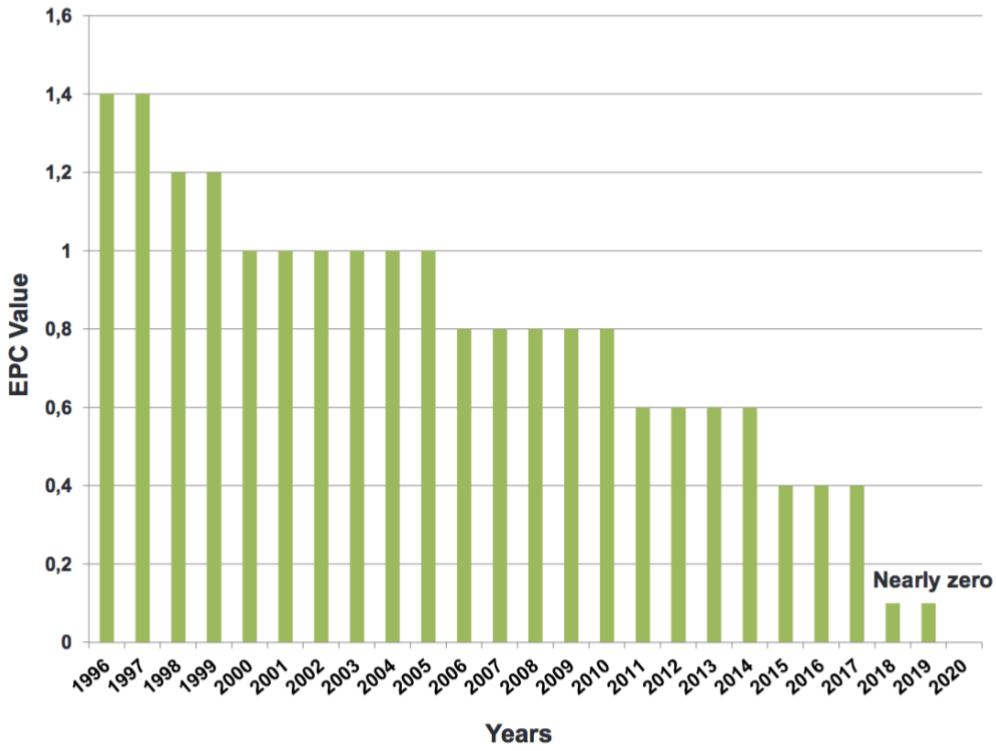

Figure 19: Evolution of the regulatory Energy Performance Certificate (EPC) for new and extensively renovated buildings in the Netherlands. Source: 2012 National report on EPBD implementation.

From 2008 onwards the energy label is a compulsory measure to be undertaken with the transfer of dwellings, as a result of the EPBD (Energy performance Buildings Directive) (European Commission, 2019). The energy label is based on an energy performance calculation or EPA provided by certified bodies according to the BRL9500-01/ 9501 building standards in the Netherlands. Advisors are authorised to deliver an energy label and give 'tailor made energy performance advice', EPA. As a result of the EPA, the EI (Energy Index) was created that is a performance coefficient for the existing building stock denoting the energy efficiency of a building.

Besides the EPC, the Netherlands have developed a wide range of subsidies to stimulate private owners to undertake energy efficiency retrofit of their buildings. Measures currently running at the end of 2016 are (van Eck, 2018):

1. “SDE+”: a subsidy scheme for investments in renewable energy systems such as geothermal systems and bio-based installations;

2. “EIA”: a tax reduction for investments in innovative sustainable energy systems based on an EPC indicator;

3. possibilities for an extra mortgage for private investment in extreme energy efficiency measures (zero energy bills) up to a maximum of 25,000 €;

4. “National Energy saving Fund” (NEF): cheap loans for energy saving measures for private owners (300 million €);

5. “STEP”: a subsidy scheme for social housing corporations for investment in energy efficiency (400 million €) based on EPC improvements;

6. “Funds for the Energy Saving Rental Sector” (FEH): cheap loans for extreme energy efficient renovations (75 million €);

7. “Energie Prestatie Vergoeding”: social housing corporations that rent houses or apartments with a “zero-energy-bill house” can oblige the occupants to pay a contribution to the energy investments; this overcomes the barrier of the split incentive;

8. “SEEH”: a subsidy scheme for investments in energy saving measures for private owners (65 million €).

As it can be seen form the previous measures, the Dutch government has put in place several support mechanisms to reach different population segments (tenants and house owners) and several building owner sectors (such as social housing and private owners).

In order to analyse how these efforts are received by the population, a survey was designed to assess the awareness of climate change and building energy efficiency issues of a group of young people. The results of this survey are reported in the appendix of this report.

4 Conclusions and Future Remarks

The data and information gathered so far give a clear outline of the efforts done in the EU, and in particular in the Netherlands, to improve the energy efficiency of the built environment.

This process follows clearly a strong top down approach, where the drive for change is determined by the top government bodies, and industry and citizens have to adapt to the new standards. The initial input is given by the European directives in energy efficiency (Energy Efficiency Directive and Energy Performance of Buildings Directive) that include goals and aims that must be translated into the Member States national rules and regulations. The European directives give a clear aim but to not specify a methodology for achieving the goal, leaving this task up to the National legislation.

The efforts for improving the building energy performance are inserted in the broader context of the national and European energy policy, that aims at achieving a cleaner and more independent energy supply. The EU and the Netherlands rely heavily on fossil fuels imports which play an important role in the energy usage of the built environment. Reducing the energy consumption of buildings and meeting the remaining energy demand with renewable energy sources (i.e. moving towards nearly Zero Energy Buildings) will reduce considerably the demand for fossil fuels at national level, and thus at European level. Besides reducing the reliance on energy imports, increasing the share of renewable energy in the national energy mix will considerably reduce the environmental impact associated with the extraction of fossil fuels, that, as in the case of the Groningen natural gas reservoir, lead to severe consequences on the landscape and the quality of life of the local residents.

A direct consequence of the reduction in fossil fuel usage is the decrease in CO_2 emissions derived by the combustion of gas and oil. Indeed, burning oil (or gas), a landmark feature of several industrial human activities, releases large amounts of carbon that took million years to be trapped in fossil fuel form below the ground. It has been demonstrated that these CO_2 emissions are directly connected to climate change and global warming. In turn, climate change affects the life of humans and the balance in the ecosystems in a dramatic way. Besides the rise of the sea levels, climate change can lead to erratic weather patterns, such as more acute draughts and more intense rain seasons, causing severe damages to human activities (e.g. agriculture) and animal life.

Reducing the impact of climate change is a global priority and for this reason reducing the reliance on the combustion of fossil fuels in all sectors is a priority.

This process starts with rising awareness in the public about the issues related to global warming and the possibilities of reducing the employment of fossil fuels in all sectors. For this reason, projects such as From Zero2Hero are essential to reach out to the population, starting from young people who have the ability to share their knowledge with their peers and local communities.

Indeed, the aim of From Zero2Hero is to give the possibility to youth leaders and young people to gain experience and knowledge on energy efficiency in the built environment and bring it back to their community, thus reaching a larger population group. This is the first step necessary to bring building energy performance issues to the public and building a consensus around the necessity of introducing new policies to require stricter standards on building energy efficiency.

The content of this report informed the structure of the field trip organised in the Netherlands. The field trip will include the points of view of several stakeholders involved in the improvement of the performance of the building stock: the local council who provides policies for the development of sustainable buildings and deep energy retrofits, visits to Zero Energy Buildings, presentations from Universities and research bodies who are developing the knowledge and technical skills necessary to achieve nZEBs and a special presentation from a Dutch project who has developed a business model to retrofit on a large scale social housing to nZEB levels. This program will provide a rich source of inputs and ideas for the visitors, who will be able to spread into their original communities.

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6 Appendix: Knowledge and Awareness in the Country

(approximately 15 pages)

6.1 *Educational Potentials, Activities and Curriculum on Energy and Energy Efficiency in Built Environments*

6.2 *Survey Results Showing the Awareness Level of Young People*

(results of 100 survey by questionnaire for each country (200 for Turkey) realized with youngsters)

6.3 *Available Technical/Conceptual Background*

(Results of 20 face to face meetings for each country (40 for Turkey) and 10 interviews for each country (20 for Turkey) with sectoral stakeholders, energy institutions, academicians, policy makers, experts *etc*.)

6.4 *Evaluation of Survey Results*