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Monitoring (N)ZEB dwellings in the Netherlands Lessons learned from current practices

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Abstract. Monitoring the energy performance of very low and zero energy buildings is fundamental to evaluate the efforts made to transition into an energy neutral built environment. Post occupancy monitoring has been embedded into current practice, supported by the availability of smart meters and affordable sensor technology. However, there is still a lack of standardised monitoring guidance, which complicates the comparison between projects. In this study, we reviewed reports and publicly available documents related to the monitoring of low energy and zero energy projects in the Netherlands. A total of 12 studies reporting on 65 projects containing 4,400 dwellings were analysed. These included both new and renovated housing built in the last decade. This study aims to provide an overview of actual energy performance in energy renovation projects across the Netherlands. It also analyses the difference with predicted energy performance and analyses the perceptions of residents involved in low and zero energy renovations. It answers questions such as: What energy and behavioural data is being gathered through energy monitoring in the residential sector (related to monitoring low and zero energy buildings/dwellings)? How is the data currently being utilized? What does the data tell us about actual energy use and resident perceptions? How can monitoring be improved to help develop better energy models, and help building owners optimize their investments in energy renovation projects? The results indicate that even though monitoring building performance in the Netherlands could be considered common practice, the results are seldomly reported or communicated. Furthermore, very few projects monitor indoor conditions and occupants' behaviour. As a consequence, the performance gaps found in these projects are not fully understood. These findings are summarised to provide an overview of the main goals for monitoring from a practical point of view. These findings are used to provide recommendations for monitoring setups according to the final goals.

Keywords. Energy monitoring, (n)zeb dwellings, occupant behaviour, performance gap
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1. Introduction

In the Netherlands, a significant amount of final energy consumption is used by households, the majority of which is used for space and water heating. In 2019, the Dutch government introduced a suite of policies and plans to support the transition to a carbon-free built environment via the Climate Plan, the National Energy and Climate Plan (NECP) and the National Climate Agreement [1]. Approximately 75% of the housing stock required in 2050 already exists today [2]. Therefore, a significant focus will be placed on energy efficiency renovations in the coming years to achieve the national targets. The Dutch government estimates that to achieve 2030 targets, over 50,000 existing homes should be renovated per year, beginning in 2021. By 2030, the rate of energy efficiency renovations should be 200,000 homes per year. Working toward these objectives, the number of low and zero energy renovations have accelerated in recent years. Although many projects report on innovative approaches and techniques for the renovation of residential buildings, for instance through the Topsector Energie Database [3], few projects report on the actual realized energy efficiency. However, building monitoring campaigns in energy renovations and new net-zero energy housing projects is becoming increasingly common in the building sector to evaluate actual energy performance in energy renovation projects. The gathered data can be utilized for a range of purposes, which can be categorised in four main goals: 1) data can be used to determine parameters for building models, with the goal of predicting more accurately the energy saving potential of buildings; 2) data can be used to determine the energy performance of buildings (e.g. in energy performance contracts) to evaluate the renovation concepts and to continuously monitor and manage actual and agreed performance; 3) monitoring is used to test and improve renovation concepts and products to help building owners, contractors, installers and technology companies make better decisions, save money and improve the experience of residents; and 4) data can be used as input in continuous fault detection to ensure proper operation of the systems. In this study, we mostly focus on monitoring campaigns for purpose 2: determining building performance to evaluate renovation concepts and improve their performance.

This study aims to provide an overview of actual energy performance in energy renovation projects across the Netherlands, by analysing the difference with predicted energy performance and the perceptions of residents of low and zero energy renovations. It answers the following questions: What energy and behavioural data is being gathered through energy monitoring in the residential sector? How is the data currently being utilized? What does the data tell us about actual energy use and resident perceptions?

2. Scope & Methodology

The report draws on energy monitoring campaigns, providing a data-driven approach to analysing energy efficiency measures and concepts. Reports and documents containing specific reference to at least one project and seriously targeting the occupants were considered. The focus of this study is on thermal energy renovation measures and concepts, including space and water heating and ventilation, concepts that targeted a low energy outcome (energy label B or better), measures based on technologies expected to become predominant in the future, studies carried out in the recent past (approximately 10 years), and renovation projects in both the social and private housing sector across the Netherlands. The information searched for with respect to the energy monitoring campaigns includes: What building characteristics were reported?, What aspects of energy performance were considered?, What aspects of occupancy were considered, and in which part of the renovation process?, What methods of data collection and analysis were used?, Which data was collected, with which time step and during which period?, How were other performance aspects (such as indoor environmental quality (IEQ)) considered?

Renovation projects and energy monitoring campaigns referenced in this study were identified through desktop research, where on a non-exhaustive search for reports and information about renovation projects where monitoring data (both quantitative and qualitative) was gathered. The report is therefore based on an analysis of existing data, results and publications which have been publicly reported. In total, 12 studies representing 65 Dutch renovation projects, and 4.404 houses were identified. From these houses, only 3.695 houses, from 10 different studies, reported on the results and could be accounted for in the analysis of energy performance or user experience. From these, only three projects reports combined all needed information on both energy performance and occupant perspective. The remaining 709 houses, belonging to a project without a written report, have been considered in a short analysis of how data is used (see section 3.3) through non-structured interviews/discussions with the ones processing the data.

Table 1 contains an overview the studied projects in which monitoring data or energy bills or occupants' related data were used to assess the energy performance and/or occupants' satisfaction of the dwellings. In total, the results from 10 studies were analysed.

3. The actual energy efficiency of renovated dwellings

Eight studies provided data on energy performance (see Table 1). The results are summarised in this section.

Quickscan huurderstevredenheid EPV [4]

The electricity generation exceeded the electricity consumption in 42 of the 46 dwellings, after correcting for the use of appliances and ventilation (a standard electricity use of 3,000 kWh was used), and in a reference climate year. In one dwelling, more energy was used for domestic hot water (DHW), and in three dwellings more energy was used for space heating. Ten out of 20 dwellings were monitored. After correcting for the use of appliances and ventilation, six of these dwellings were found to be net-zero energy or positive energy in a reference climate year. Building installations did not function correctly, causing the electricity use for heating to be higher than expected.

Thermal Compartmentation [5]

For three of the dwellings, annual electricity generation exceeded the electricity consumption with approximately 1,100, 1,500 and 800 kWh in a reference climate year, despite the fact that heat pumps had lower efficiencies than expected. One dwelling had an annual net energy use of approximately 600 kWh per year, which is at least partially the result of a dysfunctional heat pump.

Concepten nul op de meter en 80% besparing – Kerkrade [6]

For a number of the 153 renovated dwellings in Kerkrade, the gas and electricity use were analysed. User related energy use (for appliances, ventilation, domestic hot water and cooking) and electricity generation was lower than anticipated. The energy use for space heating was higher than expected. The difference is attributes to the calculation method for space heating in the EPC being too positive for heat pumps, or to the efficiency of the heat pump itself.

2nd SKIN (Demonstrator) [7]

Twelve Simplex buildings were renovated. During the first two years, a net energy surplus was measured due to the high yield of the PV-panels.

Tolhuis 1590 [8]

A net energy surplus of 1,300 kWh was measured in the heating season 2015/2016.

NOM-Zoetermeer

On average there was an annual surplus of energy of 2,300 kWh. Indoor parameters, temperature, humidity and CO_2 were mostly part of the time within good comfort range in the winter season. However, high temperatures were recorded during the summer season. The houses are well insulated, and they have not been equipped with external shading devices.

NOM renovation Heerhugowaard [9]

The total energy consumption, electricity generation, and energy use of the heat pumps of 55 buildings was monitored from 1 January 2015 to 22 December 2015. Due to issues with the monitoring systems in nine of the buildings, the energetic results of only 46 dwellings are reported. In 2015, all 46 dwellings were found to be positive energy. In a reference climate year (NEN 5060), 42/46 dwellings would be positive energy. 43/46 Dwellings used less energy for DHW than anticipated. 33/46 Dwellings used less energy for space heating than anticipated.

NOM renovation Tilburg [10]

Eighteen buildings were renovated, for ten of which monitoring data of sufficient quality was available. The total energy consumption, the electricity generation and the energy use of the heat pump was monitored from July 2015 to March 2016. For 2015, 8/10 dwellings were found to be at least net-zero energy. In a reference climate year (NEN 5060), 6/10 dwellings would be at least net-zero energy. The energy use for space hating is higher than anticipated.

4. Occupants' experiences in renovated dwellings

A considerable share of the variation in energy use is known to be due to variations in occupant behaviour. Previous research has shown that household composition, heating, cooling and ventilation practices, and lifestyle have a large effect on energy consumption and indoor air quality [11, 12]. These differences can contribute to the performance gap and to uncertainties regarding the financing of renovation projects.

Next, this study summarizes the existing knowledge regarding the role of the occupants in the success of zero energy and low energy renovation projects in the Netherlands, from a practical perspective, that is: focusing on the practices followed in current energetic renovations of dwellings.

In total, six public documents as well as non-public reports were analysed. In these reports, we found a focus on the overall results of the renovation, the information given to the occupants, and the performance of the building in terms of (energy) costs, thermal comfort, indoor air quality, noise, and the interaction of the people with the building's installations.

Four types of data collection and analysis methods were found in the projects reviewed in this study: surveys and interviews with residents, building monitoring, interviews with professionals, and desk studies based on previously documented cases. All of the cases in which building monitoring was carried out also included some method to obtain information from the residents (Concepten nul op de meter en 80% besparing [6,13], NOM Renovation – Heerhugowaard [9] and NOM – Tilburg [10]), while one project presented the results of a very elaborated residents survey (ZEN Nieuwbouwwoningen [14]). Other analyses focused on the review of previous studies (Quickscan Huurderstevredenheid EPV [4]) and interviews with experts on the topic but focusing on the residents' perspective. In this section, the results of the reviewed projects are summarised.

The aspects that are evaluated are the residents' satisfaction with communication (after care), quality of information (is it understandable), easiness of use and maintenance of the systems, energy costs, energy use, thermal comfort and indoor air quality, noise and odour complaints, and overall satisfaction with the final product (the renovated home). The fact that in most projects the communication, easiness of use, thermal comfort, indoor air quality and noise are investigated and reported, highlights how important these aspects are for both occupants, housing corporations and builders.

Communication (follow up)

The main reported sources of dissatisfaction regarding communication seem to be due to differences in expectation from part of the residents (showroom vs. prototype), the performance contract, and responsibilities for maintenance and malfunctions after the delivery of the house. The residents seem to experience the information about installation as complex or too technical. Since information is delivered in a short period of time, they are overwhelmed with it. Some expressed to require more personalized information.

Quality of information (understanding)

Residents in the different projects reported good understanding on how to use the systems from 54% to 79%, depending on the system. Residents in the different projects reported good understanding on how to maintain the systems from 20% to 76%, depending on the system.

Easiness of use and maintenance

Two reports state that most residents reported that they knew how to use the systems, but those that do not, are often dissatisfied with their comfort. Residents find more difficulties in the control of non-traditional systems such as low temperature heating systems (e.g.underfloor heating and convectors). They feel that it cannot be properly regulated, and the heat cannot be felt properly. In Heerhugowaard [9], residents had to deal with initial installation problems of the heat pump. In Kerkrade and Zorgeloos Wonen [6], up to 34% of households have the ventilation on the lowest level. There are complaints about noise, too cool air, and draughts. The Quickscan and the ZEN project [4, 14] reported complains about the usability of the ventilation system.

Thermal comfort and air quality

Most residents were satisfied with indoor climate (67-90%), especially in comparison with the previous situation (95%). Overheating seemed to be a problem in many cases, especially in bedrooms (10 to 44%). Measurements in Kerkrade, Montferland and RijswijkBuiten [6] confirmed the overheating problem. In projects with active cooling and an air heat pump to cool the ground floor, overheating complaints are reduced. However, there were complaints on too low temperatures in the winter and fluctuating temperatures in the summer. A small number of residents (5%) suffered from indoor air being too dry.

Noise

Residents experience less noise from outside, but more noise from neighbours and installations (ventilation system and heat pump). The measurements in Zorgeloos Wonen, Amsterdamse Buurt-Haarlem and Montferland [6] confirm the statements from residents.

Overall result (home)

Residents are mostly satisfied with their homes (78 to 95%). Residents appreciate when the exterior of the homes, as well as kitchens and bathrooms are also renovated. Projects in which this was investigated [9], report that most residents recognize the advantages (on energy and IEQ) of a NOM or energy efficiency home.

5. Takeaways

5.1 Reported energy performance

In most of the renovation projects reviewed in this report, the actual energy consumption was lower than was predicted or expected after correction for degree days. The monitoring periods were long enough to ensure a reliable estimation of the annual energy use. However, the targeted performance in these projects was not expressed in terms of energy savings but in terms of being 'net-zero' energy which may also explain the positive outcome.

Although the positive results are very promising, it may be useful to realize that more positive results may have been published than negative results. The higher-than-expected energy performance is surprising in comparison to the results from previous research on the Dutch housing stock [15-18] where it was found that deep renovation generally perform much worse than expected. However, monitoring campaigns were not conducted in these previous studies. It might also be that in projects where energy monitoring is being carried out, the data helps to acquire early insights in the functioning of building installations. Repairs may then be completed, and results may only be reported after adjustments have been made. Additionally knowing that monitoring will take place could influence positively the quality of the studied projects.

In the data reported on the energy monitoring campaigns associated with the renovation projects, it is often not clear why projects are outperforming or underperforming. More data, particularly from submeters, is essential for developing an understanding about why buildings are performing the way they do. For example: in the Thermal Compartmentation and Kerkrade projects, it was found that in reality, less energy was used for DHW, ventilation, lighting and appliances than anticipated. In the Thermal Compartmentation project, it was furthermore found that the efficiencies of the heat pumps were lower than expected (i.e. more energy was used for the heat pumps than anticipated). In the Quickscan huurderstevredenheid EPV project [4], monitoring revealed dysfunctional building systems.

Satisfaction of residents

All the projects covered concluded some success on achieving occupants' satisfaction, in comparison to their situation before the renovation or as low/zero energy projects. The satisfaction does not always have to do with energy performance, but has to do with a previous situation, a better indoor quality, upgraded services and exterior look of the dwellings.

In all projects there were some dissatisfied occupants. The causes for dissatisfaction were mostly related to residents not understanding the use or maintenance of the systems (ventilation, low temperature heating) that in some cases led to discomfort situations, and to complains about noise from the systems (heat pump and ventilation system). Where these aspects were investigated, it was concluded that there is a need for better introduction to the home's systems, better manuals and follow up information and support to the residents.

Where the satisfaction with the renovation process was also investigated, it was concluded that in most cases, the residents were not satisfied with the process. In two of the projects, it was also concluded that these issues after delivery could be affecting their satisfaction on a longer term (up to 1 year after completion). Issues affecting this dissatisfaction are extended or changed plans, lack of information, nuisance, lack of trust, and mismanagement of residents' expectations.

How is energy data used?

From non-structured interviews and discussions during IEBB partner meetings it seems that it is becoming more common to collect energy data. However, this data is used at a high aggregation level only. While energy meter data are collected, sometimes on a monthly basis, sometimes per hour or at 15 minute intervals, it seems that only aggregated data is used for yearly performance analysis and sometimes to roughly track malfunctioning in HVAC systems. In general, the largest part of the data is not used and there seems to be a need for methods and standards on the analysis of the data. As noted by an interviewee from an organization having collected data before and after renovation, the organization lacks time, capability and workforce to analyse the data. This was even more the case for data relating to occupant preferences and behaviour.

Some companies/organizations are working together with students and teachers at universities of applied sciences to make progress in their analyses. The remarks here were that in few projects a lot is measured, and even used to improve some parts of the system, like heat pumps. But in general, the students were the first ones to make detailed analysis and to find out that sometimes sensors were wrongly placed, or wrongly tagged, or that submetering data needed for the diagnostic of malfunctioning were not present.

Finally, in discussions with two companies selling and installing monitoring equipment for energy and indoor air quality, they both indicated that developments regarding the use and analysis of the data were urgently needed.

Satisfaction and opinions vs. measured data

Most reports focus on satisfaction of the residents on different stages of the process (before, during or after), as well as satisfaction on the final result (the product). Several aspects related to building performance were investigated, but with more attention to residents' satisfaction, experiences, and opinions regarding the easiness of use and maintenance of the new installed technologies, as well as perceptions regarding thermal comfort, noise, and air quality. The actual indoor environmental quality such as temperature, CO_2 concentration, noise levels, presence of draughts, etc., are often not investigated. Energy is monitored in some projects, which is used to assess whether a project performs within the expectations or the performance contract. However, in cases in which higher energy use is demonstrated and some users are dissatisfied, there is rarely the intention, or possibility, to investigate further the reasons for such deviations.

Qualitative vs. quantitative data collection and analysis

More than half of the reviewed reports focused on qualitative data from interviews and surveys with the residents. In addition, two reports were based on interviews with experts about the residents (second-hand information). The projects that also measured indoor temperatures or setpoint, and/or energy use were able to provide more insight in the performance of the buildings. However, it is difficult to assess what exactly causes poor performance (indoor environmental quality / energy use), since information on indoor environmental quality and energy submetering is rarely collected. In the reports, the experts were often able to estimate the cause of the performance gap, which was often attributed to technical malfunctions or poor quality of the construction. However, in many instances a non-technical reason could be also attributed to the perception, understanding or satisfaction of the residents regarding the technologies, for example, experiences in a previous home (new users), pre-renovation situation (very high energy bills or very bad indoor quality), previous problems with installations, etc. In all but one report, the role of occupants' behaviour was not explored. For example, the actual needs and preferences of the residents (e.g. regarding heating setpoint) were not investigated, and there was little reporting on thermostat use, heating setpoints and thermostat setbacks, which are known to have a large impact on comfort and energy use. On the other hand, a great deal of importance was given to the use of ventilations systems, which are also known to be problematic in terms of noise and user interaction.

6. Conclusions

Current energy models do not accurately predict energy savings in dwellings. The discrepancy between predicted and actual energy consumption is a main result of: 1) Models that do not consider occupant behaviour (number of occupants, ventilation behaviour, temperature settings, use of sun shading, maintenance, and settings of appliances); 2) Parameters and inputs of the models that cannot be well-determined (like infiltration flow rates or even R_C- and U-values); 3) Issues with the systems based on how they are installed and commissioned.

Based on data that is currently collected at a housing stock [15-18] and individual housing level, it is difficult to determine the exact causes of the discrepancies. Better models – digital twins – are therefore needed to predict the actual energy performance of renovation measures in dwellings. The goal of this study was to determine the performance of specific renovation concepts in practice and how the projects are monitored and evaluated. Building owners, contractors and technology providers are increasingly gathering data to assess the performance of net-zero energy renovation technologies and concepts. In this study, we found that the nature of the data gathered and reported varies significantly. For example, some organizations gather data on energy performance, some on indoor climate, some on resident preferences and opinions, but none are examining the complete picture, which makes it difficult to determine the actual performance of the renovation concepts. In cases where renovation concepts outperformed or underperformed compared to expectations, there was often insufficient data to determine the reasons. However, from the point of view of energy performance, many monitored project appeared to perform as expected or even better than expected. This may be a direct result of the monitoring and/or the result of expressing targeted performance in terms of absolute energy usage instead of energy savings.

In all studied cases, monitoring was generally not at the level that it could be used to diagnose and solve technical problems in a standardised way. The desk research also shows that the satisfaction of residents with the renovation process was often monitored, but not at a level allowing for a good understanding of their needs and interactions with the technical systems.

7. Recommendations

Recommendation 1: Renovation pojects that complete monitoring campaigns are better positioned to evaluate real energy savings and occupant satisfaction. Building owners and operators should therefore develop monitoring campaigns early in the renovation process. This could also help ensuring that results are realised and can support quicker diagnosis of (rough) malfunctioning.

Recommendation 2: More transparency is needed from parties involved in energy renovations about underperformance. With more information researchers, installers and producers can undertake targeted monitoring and even solve problems beforehand. This would also help in the development of more accurate energy prediction models.

Recommendation 3: More research/transparency is needed about what makes a successful renovation project. This could positively influence the market by making companies aware of what works well and creating positive dynamics.

Recommendation 4: More sub-metering data should be collected and disclosed by building owners, contractors and/or technology providers. With more sub-metering data, researchers and contractors will be better able to fix malfunctions as soon as possible malfunctioning. This would also help researchers explain the differences between the anticipated and actual energy efficiency of a building after renovation in such a way that better predictions can be made.

Recommendation 5: Develop GDPR-proof standards for sub-metering and data collection. In addition to smart meter data, sub-metering data should include: 1) Splitting gas use in space heating, domestic hot water (DHW) and cooking; 2) splitting electricity use in space heating, DHW, ventilation, cooking and appliances; 3) splitting electricity production of PV-cells in on-site energy used, and delivery to grid, 4) splitting net electricity use in electricity from grid, from PV-cells and electricity delivered to grid; 5) setpoint temperatures of the systems, especially when heat pumps are involved; 6) air temperature and CO_2 sensors; and 7) additional data like radiant temperature, humidity, air velocity, opening of windows and doors and residence presence are also useful in explaining higher or lower energy use and thermal (dis)comfort.

Recommendation 6: Develop guidance on how to analyse data from smart meters and other indoor environment meters should be developed by experts in the field, considering different objectives.

Recommendation 7: Those involved in energy renovation projects should ensure clear communication towards the residents about the renovation process. This is needed to keep the burden low during the renovation.

Recommendation 8: Those involved in energy renovation projects should provide residents with (long-term) follow up information about the use and maintenance of systems, . While clear manuals are important, they are not enough.

Recommendation 9: Building owners and managers should take resident's complaints seriously and investigate further possible malfunctioning of components and installations and mismatches with their use.

Recommendation 10: Those involved in energy renovations should ensure that a process is in place to investigate resident satisfaction and experience as well as actual indoor environment quality and energy. This is essential for deepening our understanding about why expected performance is achieved or not and what determines whether residents are satisfied or not.

Recommendation 11: The investigation of the non-technical reasons for underperformance of systems should be standardized. This includes resident's experiences and needs before the renovation, and their actual needs regarding heating and ventilation setpoints, as well as how they interact with these systems. This could strongly enrich existing simulation models.

Recommendation 12: Develop standardized methods for a) analysis of pre-renovation experiences and needs b) actual needs and interaction with systems.

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Tab. 1 – Overview of analysed projects

	Project	Energetic aim of the renovation	Sector	# monitored dwellings	Renovation concept used and goal of the monitoring campaign
1	Quickscan Huurderstevredenheid EPV [4]	NOM / Net-Zero Energy	Social	51 (3100 homes)	Monitoring of the energy use for one year after the renovation. Satisfaction with the EPV
2	Thermal Compartmentation [5]	NOM / Net-Zero Energy	Social	4	Insulation, airtightness and ventilation measures to kitchen and living room. Insulated floor between the living room and bedrooms
3a	Kerkrade [6,11]	80% reduction in energy use	Social	153	Prefab façades, ventilation ducts into timber frame. Prefab roof elements with PV-panels.
3b	Zorgeloos Wonen [6,11]	A or A+	Social	115	Insulated facades, insulation of the roof and ground floor, high- performance windows and doors.
3c	Amsterdamse Buurt – Haarlem [6,11]	B to A+	Social	108	Internal wall insulation, high-performance glazing and PV panels.
3d	Energiesprong Montferland [6,11]	N/a	Social	61	Air source heat pumps, low-temperature underfloor heating and convectors.
3e	RijswijkBuiten [6,11]	NOM New Build	Private	5	Ground-source heat pumps, solar panels, high-efficiency ventilation and a well-insulated shell.
4	2nd Skin Demonstrator [7]	NOM/Net-Zero Energy	Social	9	Testing user-centered methodologies for monitoring and data analysis Improved insulation, balanced mechanical ventilation, ground source heat pump, low-temperature convectors.
5	Tolhuis 1590 - Nijmegen [8]	NOM/Net-Zero Energy	Social	1	Monitoring to evaluate the efficacy of the ActiveWarmth electrical wall heating system
6	NOM – Zoetermeer	NOM/Net-Zero Energy	Social	120	Monitoring the energy and comfort performance, and to ensure the proper functioning of the energy system. Integrated Climate Energy Module (iCEM) of Factory Zero.
7	NOM Renovation – Heerhugowaard [9]	NOM/Net-Zero Energy	Social	55	Prefabricated facade and roof. Natural gas connection was disconnected, and PV panels were installed at the front and rear.
8	NOM Renovation – Tillburg [10]	NOM/Net-Zero Energy	Social	18	Modular building systems: prefabricated facade elements, new roof and floor insulation. Balanced ventilation system with heat recovery, heat pump, boiler, control box, monitoring system and a solar power inverter. No gas connection.
9	Zen Nieuwbouwwoningen [12]	NOM/Net-Zero Energy or Low-Energy	Social and private	31 projects and 302 residents engaged	measure the satisfaction of homebuyers, to investigate the experiences of residents of a ZEN home. Survey