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The Progress of Energy Renovations of Housing in the Netherlands

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ABSTRACT

The European Union formulated high ambitions of energy reductions to be realised in the built environment. The existing housing stock covers a major share of energy use and is seen as high potential to contribute to the savings. This should be realised in the first place by reducing the energy demand for heating by renovation of the existing stock and bring the dwellings to a higher energy performance standard. The targets, policies and programmes are already applied for several years now and the question arises of what progress can be seen in renovation activities and energy saving results. This paper is based on data on improvement rates of the Dutch non-profit housing sector and insight in the relation with actual energy reduction. It shows that the renovation progress is limited and that the actual energy reduction is less than is expected according to theoretical models. Furthermore, the paper presents some promising innovative approaches to realise nearly zero energy renovated residential buildings, the so called Net-Zero-Energy-Renovation programme (Stroomversnelling). Will it be possible to reach the energy saving goals with the current approach?

Keywords: *energy efficiency, housing stock, renovation, energy labels, actual energy use*

1. INTRODUCTION

Climate change mitigation is maybe the most important driver for the ambitions to reduce the use of fossil fuels. There are also other reasons for implementing energy efficiency policies in the EU and its Member States. These include the wish to decrease the dependency on fuel imports, the increasing costs and the fact that fuel resources are limited. The European building sector is responsible for about 40% of the total primary energy consumption. To reduce this share, the European Commission (EC) has introduced the Energy Performance of Buildings Directive, the EPBD (2010/31/EC) and the Energy Efficiency Directive (EED – 2012/27/EU). These frameworks require Member States to develop energy performance regulations for new buildings, a system of energy performance certificates for all existing buildings and policy programmes that support actions to reach the goals like building only 'Nearly Zero Energy Buildings (NZEB)' by 2020 and realizing an almost carbon neutral building stock by 2050. Formulating ambitions and sharpening regulations are relatively easy to do. These goals and programmes were already formulated back in 2008 for the Netherlands. Since then the renovation of the stock started and data was collected to monitor the progress as well as data about the (theoretical) energy performance of houses and actual energy use figures.

This paper presents some insights in the implementation of energy renovations in the Netherlands and the effects on actual reduction of CO_2. Section 2 presents the data on progress of energy renovations in the Dutch social housing stock. In section 3 the relation between modelled energy use according to the labels for existing housing and the actual energy use are described. Section 4 describes an innovative programme for Net Zero Renovations of housing in the Netherlands and the pros and cons of this approach. This all leads to some conclusions about the challenges and required innovations for the housing stock to meet the formulated energy reduction ambitions in section 5.

2. THE PROGRESS OF ENERGY RENOVATIONS IN THE SOCIAL HOUSING STOCK

The largest energy saving potential is in the existing building stock. New dwellings add about one per cent per year to the housing stock in Europe. The most important policy tool required by the EPBD in the European Member States is the issuing of Energy Performance Certificates (or EPCs). These EPCs give a hypothecated indication of the required energy to provide a certain average temperature in the building and depend on physical characteristics of the building. The certificate has no mandatory implications in the sense that owners could be forced to improve their buildings to certain levels. Nonetheless it is a crucial instrument for benchmarking and formulating policy goals. Building owners in all EU Member States have to obtain an EPC for a building at the moment it is sold or rented out. This is not yet current practice everywhere, mostly due to lack of enforcement. This especially applies to the private housing stock.

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The social housing sector in the Netherlands agreed with the government and the national tenants' union to a covenant about energy renovation goals. This was initiated in 2008 and updated in 2012. Most important goal is to initiate renovations that lead to average energy label B in 2020 for the whole sector, which comprises 2.3 million dwellings (35% of the total stock). Energy labels are the Dutch Energy Performance Certificates that express the energy performance of existing houses as required by the European EPBD.

The whole social housing stock is already labelled for many years. Since 2010 most of the stock has a label. Every year AEDES, the national umbrella organisation of the housing associations, wants to collect the energy label data of all housing associations. Every year more associates really do so. In 2015 the data of more than 60 % of the whole social housing stock was collected in this way. This database is called SHAERE. Research with the SHAERE data base enables to show the progress in renovation. Figure 1 demonstrates the label steps over the years 2010 to 2014. It can be noted that most of the renovations lead to small improvements. If the current figures are extrapolated to 2020, we can see that the goals of an average label B will not be reached (see Figure 2). The label indexes relate the calculation of the Energy Index, which is for label B 1,25.

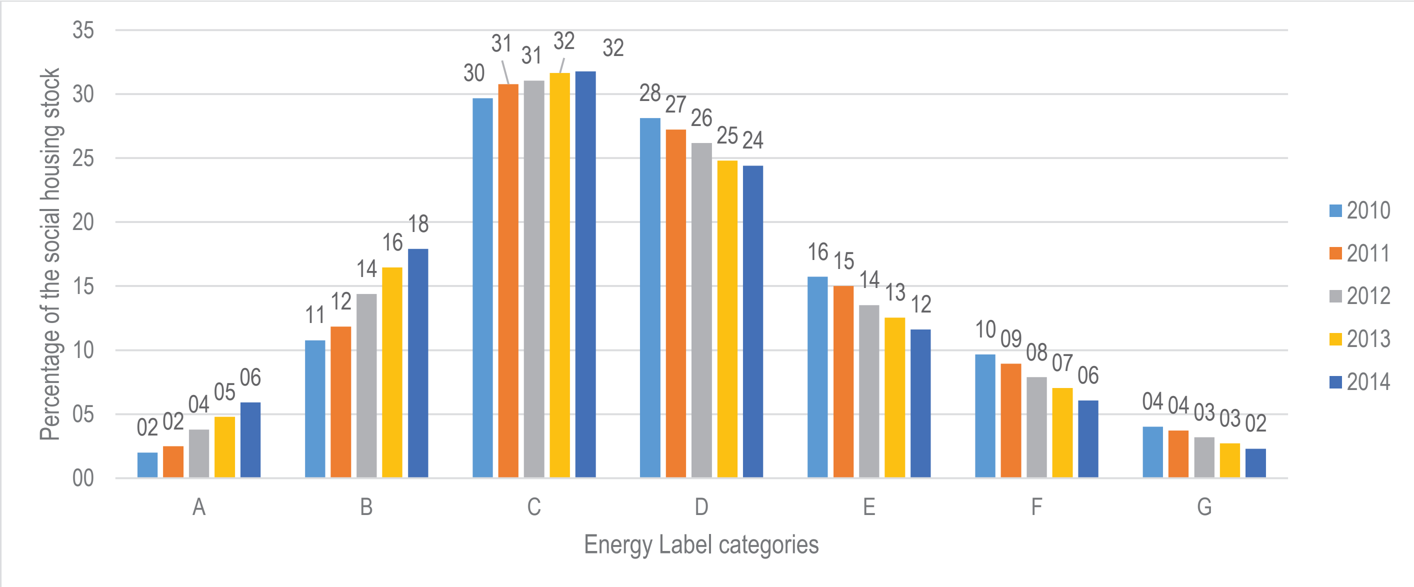

Figure 1: Distribution of the energy labels of the non-profit rented housing sector in SHAERE database (Filippidou, F, et al., 2014)

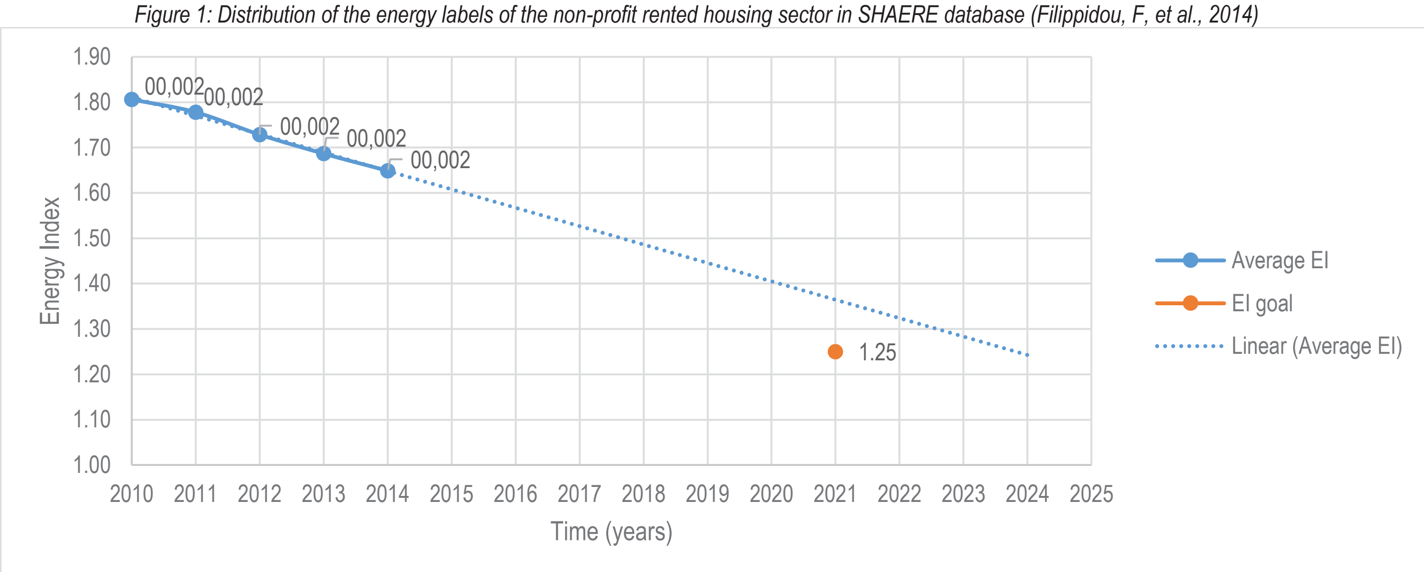

Figure 2: Development of the EI in the Dutch non-profit housing sector since 2010, (Filippidou, F, et al., 2015)

3. THE ENERGY PERFORMANCE CERTIFICATES FOR EXISTING DWELLINGS AND THE RELATION WITH ACTUAL ENERGY USE

The actual domestic energy use is besides the physical characteristics of a dwelling, largely influenced by the use and behaviour of the tenants. Some preliminary figures demonstrate the difficulty in 'forcing' reduced energy use by improvements of dwellings. The dwellings with the worst EPC (G) in practise use far less energy as expected, while the most advanced dwellings (A) use much more. This is probably due to a combination of the rebound effect and an increase in comfort level of the dwellings (Majcen et al 2013a, 2013b, 2015) and underperformance of the buildings and installations. The large difference between theory and practice is called the performance gap and is recognised in more and more international studies.

In a research project by Majcen (2013a, 2013b) the actual energy consumption was compared with the theoretical use according to the EPC's (see Figure 3).

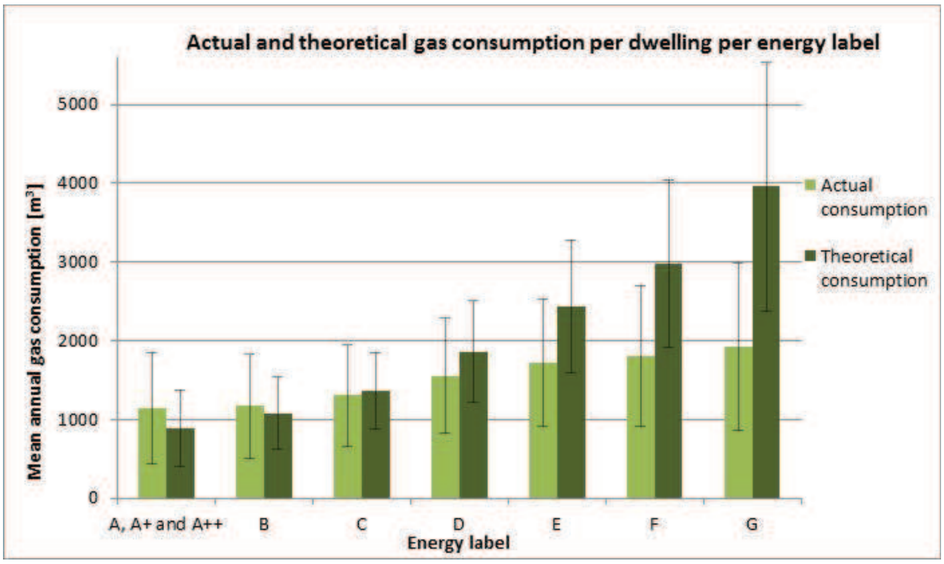

Figure 3: Actual and theoretical gas consumption in Dutch dwellings - per m2 dwelling area
Source: Majcen et al., 2013a

This research was based on the Dutch energy labels issued in 2010 - a total of over 340,000 cases with 43 variables (regarding building location and technical characteristics, the properties of the label itself etc.). This data set was derived from the publicly available database of the EPCs. This data was, on the basis of the addresses of the households, linked to actual energy use data. The energy data was provided by the CBS (Statistics Netherlands), which collected this data from the energy companies. The combined data file was then cleaned by deleting incomplete or obvious incorrect EPCs. This resulted in 193,856 usable cases. This still large sample proved to be representative for all housing types and energy label classes.

To understand how the energy label relates to the discrepancies, the gas and electricity consumption in various label categories were examined and analysed. The actual and theoretical gas use per dwelling was compared and then analysed per m2 of dwelling (Figure 5). Little difference exists between the actual and theoretical energy use calculated per dwellings and per m^2, except the difference in actual gas use between label A and label B. At the level of individual dwellings, the actual consumption was identical, but at the level of m2 the dwellings in category A use less gas than dwellings in category B. This may relate directly to the fact that dwellings in label category A were found to be considerably larger than all other dwellings. From these figures it is clear that although better labels lead to higher actual gas consumption, there is a clear difference between the mean theoretical and mean actual gas consumption for each label. For the most energy-efficient categories (A, A+ and A++) and for category B, Figure 5 shows that the theoretical calculation underestimated the actual annual gas consumption. This is in contrast to the rest of the categories for which the theoretical calculation largely overestimated the actual annual gas consumption. This research indicates that the energy label has some predictive power for the actual gas consumption. However, according to the labels, dwellings in a better label category should use on average significantly less gas than dwellings with poorer labels, which is not the case.

4. NET ZERO ENERGY RENOVATION PROGRAMME

Stimulated by government policies in 2013 an agreement was made by a group of 27 housing associations and buildings and the Dutch government to work on a programme for 111,000 houses to Net Zero Energy (E=0) levels (Munckhof et al, 2015). This was called Energiesprong (Energy leap). E=0 means, annually a house does not consume more energy for heating, hot water, lights and appliances than it produces. The concept is based on refurbishments financed by the energy cost savings; a refurbishment executed within 10 days and a 40-year energy performance warranty from the builder. The approach is further based on organizing a massive demand for a Net Zero Energy (E=0) refurbishments, making financers and governments tune their financing offerings and regulations towards this product and challenging the construction sector to start an ambitious innovation process. Since the take of of the programme several projects have started and some houses are yet already taken into use and even some monitoring results are yet available (Energiesprong 2016). Recently Energiesprong is working also in the UK and France to get an independent market development team set up to drive a similar approach as in the Netherlands.

The costs for Net Zero Energy refurbishment are substantially more than the net present value of today's energy bill. Therefore, an intensive innovation process in the construction sector is needed focused on reduction of costs and process time and energy performance guarantees. This will require moving from doing one-off projects towards developing mass-produced refurbishment packages with a performance standard. And then the idea is that these packages will be sold in shops, which are cosy and have helpful staff. To catalyse that innovation process, a large demand volume this new product is needed.

The financing of the refurbishment is done by giving the tenants an "energy plan" including a guarantee for a hot house (22o), warm water (certain amount of shower time per day) and an electricity bundle for electric appliances for which they together pay a fixed monthly fee. If they exceed that agreed amount of energy performance, they pay the additional electricity consumption to the utility. The bundle fee is paid to the housing association (HLM). This pays of the investment. In the private sector it works similarly, with an increase in mortgage installments to finance the investment covered by the reduction in energy costs. In the Dutch case, the cost of living stays therefore the same for tenants or private homeowners. Investing in factories are required to pre-fabricate these refurbishment solutions with a view to scale. It helped the government to change regulation (i.e. ability for associations to collect the energy plan money) and it made the financier revalue the properties that would be refurbished in order to free extra room to borrow money. The first 200 prototypes and test houses have been built. By the end of 2016, there should be 10000 Net Zero Energy refurbishments completed. Following that deal, Energiesprong is now working to bring these refurbishment packages to the private homeowner sector.

A common question is whether this only works for certain houses that all look the same. In fact, it is mass customization. Houses are all 3D scanned and refurbishment packages are individually produced because even a set of row houses are not all exactly the same, even if it looks like they are. The focus until now has been on the most prevalent typologies of houses in the Dutch market of which 2.3 million houses in the Netherlands exist, but flexibility will increase over time with the number of possible solutions. The first designs will establish whole new supply chains based on prefabricated industrially production methods providing new platforms for further, interactive innovation process (very much like the car industry).

5. CONCLUSION

Without any doubt there is a necessity to drastically reduce the use of fossil-fuel energy sources by reducing the demand for energy and switching from fossil to renewable sources. Buildings account for 40% of Europe's energy consumption and three-quarters of the floor area of the building stock is residential. The targets are clear and the technical solutions are available. Good insulation and product innovations can reduce the energy demand for heating and cooling for a large part. The remaining energy demand can be delivered by renewables like sunlight and heat, district heating, heat pumps, etc. The remaining electricity demand for appliances can in the first place be reduced by further product innovation and then be provided by photovoltaic panels. There are no reasons not to apply these solutions in new buildings at a large scale on the short term. Evaluations of the current practice show however that there is a lot to be gained here. To improve this situation, it has to be assured that constructions and installations are installed properly and in such way that they are not vulnerable for unpredictable or misuse by the occupants. This will set demands on both the construction industry as on the control and enforcement process (and the parties responsible).

The improvement of the existing building stock forms a big challenge. The potential energy savings are large, but the barriers to overcome are also high. As stated before, almost three quarters of the future housing stock (2050) has already been built. Studies show however that it is hard to increase the rate and depth of energy renovations of the existing stock. Actual energy (and financial) savings in renovated dwellings stay behind expectations because of rebound effects. There are important barriers. Many owners believe that the benefits of the measures do not outweigh the costs. Besides that, the cost of improving the energy performance of a dwelling does not (proportionally) increase the value of the dwelling.

We are faced with the difficult task to increase the energy renovation pace. The question is how this process can be accelerated. Maybe there is still room for further smart product development. Innovative products that that contribute significantly to the reduction of energy demand, that are cheap, easy to apply and to handle by occupants and users. The fast decrease of the price of PV cells is promising.

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