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Designing for residents: Building monitoring and co-creation in social housing renovation in the Netherlands

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ABSTRACT

Large differences between the expected and actual energy consumption have been found in energy efficient dwellings. Research has shown that these differences are partially caused by occupant behaviour. The financing and payback periods of low carbon technologies are often uncertain because of the impact of the occupants on building performance. This translates into a reluctance to invest in deep renovation projects. The goal of this design-inclusive research project is to develop a solution for zero energy renovation that reduces the uncertainty on building performance cause by occupants' behaviour by reducing the uncertainty in design decisions and energy calculations. This investigation focuses on the identification of building type specific occupants and their characteristics, requirements and living practices. This paper presents the user research approach developed for the renovation process. The approach consists of statistical analysis of Dutch households, a monitoring campaign in the area of study and co-creation research through mock-ups, enactments and interviews. Case studies results are presented to highlight the effect of different household types on energy consumption and occupants' requirements, and point at the importance of taking into account household typology and socio-economic characteristics in energy calculations or building simulations, as well as occupant requirements in the design process.
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1. Introduction

Renovation of the housing stock is an important item in the agenda of European countries. In the Netherlands, housing associations, which manage approximately 1/3 of the building stock, have set ambitious goals to improve the energy performance of their properties by 2020 [1]. They aim at achieving an average energy label B in the A to G energy performance rating scale, A being the highest. Furthermore, some housing associations are aiming for renovation projects with higher impacts. A number of zero-energy renovation projects have been conducted in recent years [2]. Renovation with a zero energy objective can be achieved through high envelope insulation, air tightness, triple glazing, efficient heating and ventilation systems and renewable energy installations, such as photovoltaic and geothermic. However, recent research has shown that low energy buildings do not always perform as expected [3]. Large differences between the expected and actual energy consumption have been found in dwellings with similar characteristics, some studies have reported a twofold difference [4]. These differences have been attributed to diverse factors such as rebound [5] and pre-bound effects [6], as well as on the interaction between occupants and building technologies [7]. These effects are partially caused by the different household typologies, comfort preferences and lifestyles of users. An in-depth literature review in these topics can be found in [8]. As a consequence of the impact of the occupant on building performance, the financing and payback periods of low carbon technologies are often uncertain; the periods are often longer than initially calculated. This translates into a reluctance to invest in far-reaching renovation projects by housing associations.

To address this issue, the research presented in this paper aims at developing a renovation concept for social rental multi-family housing. The concept consists of four main elements: 1) technical solution, 2) pre- and post- renovation monitoring campaigns, 3) acceptability process, and 4) business modelling. These four elements are integrated into the renovation strategy with the intention of developing a complete approach to building renovation. This paper presents and discusses the user research part of this strategy, which consists of 2) building monitoring and 3) acceptability process. The paper presents the approaches and summarises the results

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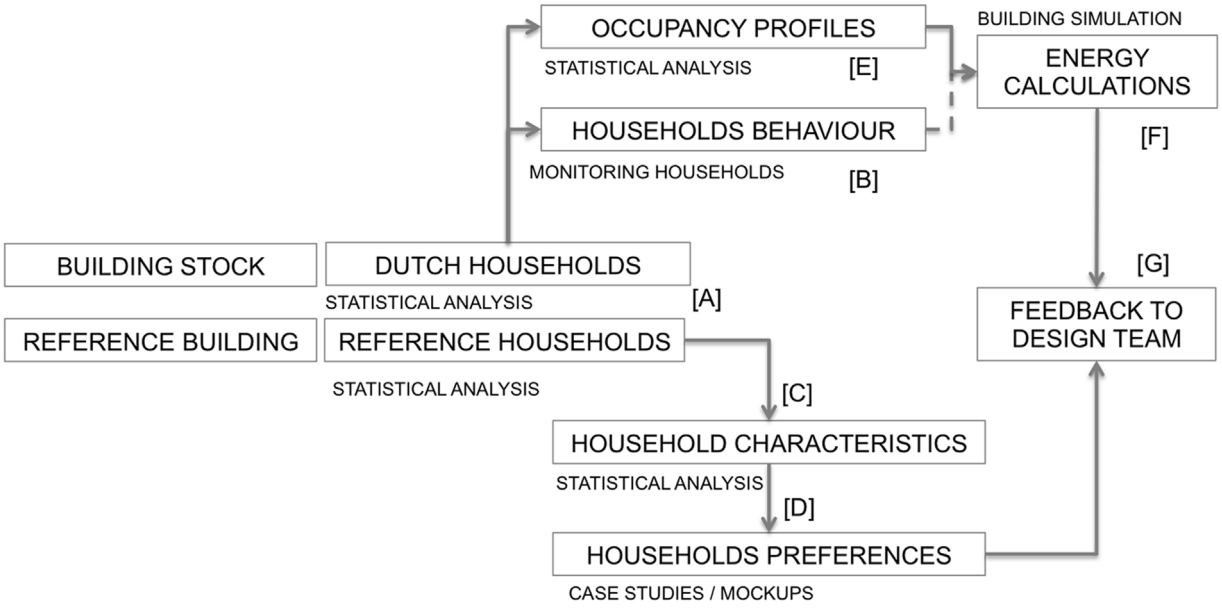

Fig. 1. Research approach.

obtained from case studies in which the approach was tested. The aim of this investigation is to contribute with a combined approach to replicate in actual renovation processes. The methods as well as results are reported in more depth elsewhere. The overall renovation strategy is further explained in [9], the technical solution in [10], the building performance in [11], and the business modelling in [12].

The technical solution consists in the façade system to be manufactured off-site and added to the buildings. Although, the description of the technical solution is out of the scope of this paper, it is important to mention that it presents challenges for tenant participation: standardization of design and home systems will create a technically and financially feasible design, but raises the question about the choices tenants would have for their specific building.

Pre- and post- renovation monitoring campaigns are intended to assess and improve the performance of the buildings. The renovation performance target has been defined as 'zero on the meter' (NOM). In the Netherlands, the concept of zero on the meter (nul-op-de-meter) is defined as a building (usually social housing renovation projects) in which the yearly building-and user-related energy consumption equals the generated renewable energy in the building and surrounding area, for example with Photo Voltaic panels on the roof [2]. The concept is based on residential buildings with 'standard' occupancy defined in Dutch norms [2]. However, actual occupancy patterns and their effect on energy consumption are currently not reflected in the 'standard' occupancy patterns defined in norms and simulation tools. Therefore, the achievement of energy targets defined by the concept (NOM) is uncertain. In addition, there is still uncertainty about the causes of rebound effects [7].

The acceptability process consists in the early involvement of the tenants in the renovation process so that they can give an input that can render the project acceptable to them. In other words, this is a participation process. Part of acceptability is that the process serves to enable tenants to understand and consider the new systems and solutions in their homes. In the Netherlands, 70% of the tenants in a building must agree on the renovation process, for it to be performed. This is not always achieved [8]. Additionally, if a renovation does go through, rebound effects often occur afterwards, meaning that the actual energy consumption is higher than predicted in calculations [13]. The reasons are still unclear, but are presumed to lie in residents' post-renovation behaviour and interaction with their home systems [14]. The current literature on good communication processes with tenants presents well-developed processes emphasizing open and timely communication, financial security, and a reliably scheduled and brief renovation process [15]. Breukers et al. [15] concur that a careful process of resident participation ahead of renovation would improve acceptability. However, the current literature on processes lacks a focus on daily living practices of tenants, both pre- and post-renovation, although these may affect energy use (pre-bound and re-bound). The acceptability research therefore adds this element by starting from the meanings that people attach to their home [15], to enable residents to find their own motivation for the renovation and to be open to the new experiences it brings.

A new business model is required for this renovation concept in order to implement and upscale the solution. Housing associations have only a limited budget to invest on their portfolio, and so, for a deep renovation, extra investments are needed. The business modelling seeks to find the best solution for the investment in the new technologies, taking into account market and occupancy uncertainties.

The third element of the approach is the acceptability process and consists of two parts: firstly, working towards the go-ahead from tenants, and secondly, reducing uncertainty about tenants' pre- and post-renovation lives with their home and its systems. The first part responds to a regulation in the Netherlands that states that a renovation process cannot start unless 70% of the tenants within the project scope give it the go-ahead, in other words, accept it. This go-ahead is by no means always achieved [8]. Consequently, there is Dutch literature on good communication processes with tenants, presenting well-developed processes emphasizing open and timely communication, financial security, and a reliably scheduled and brief building period [15]. However, the well-described processes [15] lack a focus on pre- and post-renovation daily lives of tenants although, as mentioned above, these may affect energy use (pre-bound and re-bound) and expected energy savings are not achieved [2,7,13]. The second part of this acceptability process therefore seeks to engage tenants in inquiry into their pre- and post-renovation interaction with their home and its systems, of which not much is known [14]. As Strengers [16] argues, such practices are not only economic-rational, but consist of fine-grained networks of routines co-shaped and managed with certain

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