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Transforming social housing neighbourhoods into sustainable carbon neutral districts

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Abstract

This paper gives an overview of the results of the European demonstration Project ECO-Life (2010-2016) in Belgium. The goal of the project was to transform a number of social housing neighbourhoods in Kortrijk, Belgium into a sustainable carbon neutral community. A neighbourhood of single family social houses built in the 1950's was partly replaced by new multi-family buildings and new housing blocks, and partly refurbished to current standards and comfort. Based on the ECO-Life targets and guided by energy performance calculations, different energy concepts have been defined for the demonstration buildings and systems within the community. In order to evaluate the actual operation of the buildings and building systems during the first years of occupation of the neighbourhood, energy monitoring and commissioning activities have been performed. They include monitoring of energy use and temperatures, surveys of the occupants and quality assurance tests. In this paper the approach and findings of monitoring activities are discussed. Monitoring results are used to assess primary energy balance and CO_2-balance. The monitoring has highlighted the importance of proper commissioning and operation of heating systems to achieve the design targets.

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Keywords: energy monitoring, carbon neutral community, rational use of energy, renewable energy supply

1. Introduction

In a carbon neutral community the building energy use is covered or compensated on a yearly basis by carbon neutral renewable energy generated within the community [1]. In the definition used in the project, the energy use

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includes all energy use for space heating, space cooling, hot tapwater and auxiliary energy. Carbon neutral energy supply sources are for example solar energy, geothermal energy and biomass from sustainable and reliable origin.

The ECO-Life project in Belgium consisted of 274 dwellings, located on 4 sites. Here only the largest site is discussed: the Venning district, where a neighbourhood of single family social houses built in the 1950's was partly replaced by new multi-family buildings and new housing blocks, and partly refurbished to current standards and comfort (Fig. 1) in three successive stages. Four multi-family buildings in Venning Phase 1 were newly built in the south of the Venning neighbourhood with a total of 82 apartments. The Venning Phase 2 new building blocks were located north of Venning Phase 1 and included 64 single-family terraced and semi-detached dwellings. They were disclosed by the surrounding streets with communal parking lots and new footpaths in between the buildings. In Venning Phase 3, 50 larger dwellings from the original neighbourhood were deeply renovated to today's building standards. The dwellings were located in between the Venning Phase 2 dwellings. The original terraced and semi-detached dwellings were stripped to the load-bearing walls and floors. The plan lay-out was adapted and building envelope systems were newly installed. A number of ground floor dwellings of Phase 1 and 2 were equipped for disabled tenants.

The building design in all 3 phases was guided by the passive house standards aiming at a net space heating energy demand of 15 kWh/m²/year, leading to building envelope U-values below 0.15 W/m²K and an airtightness n_{50} of 0.6 h^{-1}. Living rooms were oriented as much as possible to the south, while both fixed and movable shading elements were applied to reduce the overheating risk. The buildings in Phase 1 were equipped with collective balanced mechanical ventilation systems with heat recovery and air tight ventilation ducts (class C). Half of the houses in Phase 2 and 3 had individual balanced mechanical ventilation systems with rotary heat recovery, while the other half had individual demand-controlled ventilation system with natural supply and mechanical exhaust. The dwellings equipped with a demand-controlled ventilation systems typically had a higher predicted net space heating demand compared to the passive house standard, up to 25 kWh/m²/year, but a lower use of auxiliaries. The Venning district heating network supplied heat to the dwelling substations for space heating and domestic hot water production. The heating system consisted of radiators in the main rooms and, in case of houses with balanced mechanical ventilation, a heating coil to preheat the supply air if necessary. Grid-connected photovoltaic systems were provided on the rooftops of all buildings.

The heating plant of the Venning district heating system was located in the centre of the Venning neighbourhood. The main heating generation system was a 950 kWth biomass boiler that used wood chips as energy source. A mini-CHP that used rapeseed oil, produced auxiliary electricity and heat for the district heating system (e.g. for pumps, controls, storage losses…). This system had an installed capacity of 9 kWel and 14 kWth. In addition to these biomass-based systems, a 450 kW gas condensing boiler served as a back-up system. Every dwelling was connected to the heating plant through a local district heating network consisting of thermally insulated pipes which supplied hot water to the dwelling substations at supply temperatures of 60-70°C and a design return temperature of 35°C.

Fig. 1. Aerial view of the original (left) and transformed (right) Venning district.